



# **E104-BT53 User Manual**

**EFR32BG22 2.4G BLE5.2**

**Low power consumption Bluetooth module**



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# 1. Overview

## 1.1 Brief introduction

E104-BT53 is a small-sized SMD Bluetooth BT5.2 module based on Silicon Labs' original IC EFR32BG22; it uses 38.4MHz industrial-grade high-precision low-temperature drift crystal oscillator to ensure its industrial-grade function and stable performance.

EFR32BG22 chip integrates 32-bit ARM® Cortex®-M33 core and Bluetooth 5.2 RF transceiver and protocol stack, and has rich peripheral resources of UART, I2C, SPI, ADC, DMA, PWM. The module provides almost all IO ports (please check the pin definition for details) to allow users to carry out multi-directional development.

This module is a pure hardware SoC module without firmware program. The functions of Bluetooth-based broadcasting, scanning, connection, and transparent transmission can only be realized after the user's secondary development.



## 1.2 Features

- Support Bluetooth 5.2 protocol;
- Support Direction Finding;
- Maximum transmit power 6dBm, adjustable by software;
- Built-in 32.768kHz clock crystal oscillator;
- Support the global license-free ISM 2.4GHz band;
- Built-in high-performance low-power Cortex®-M33 core processor;
- Rich resources, 512KB FLASH, 32KB RAM;
- Support 1.9 ~ 3.6V power supply, 3.3-3.6V can guarantee the best performance;
- Industrial standard design, support long-term use at -40~+85°C;
- The experimental communication distance is 120 meters;
- The module uses a PCB antenna.

## 1.3 Application

- Smart home and industrial sensors;
- security system;
- Wireless remote control, UAV;
- Wireless game remote control;
- Healthcare products;
- Wireless voice, wireless headset;
- Asset tags, beacons, etc.

## 2. Parameters

### 2.1 Limit Parameters

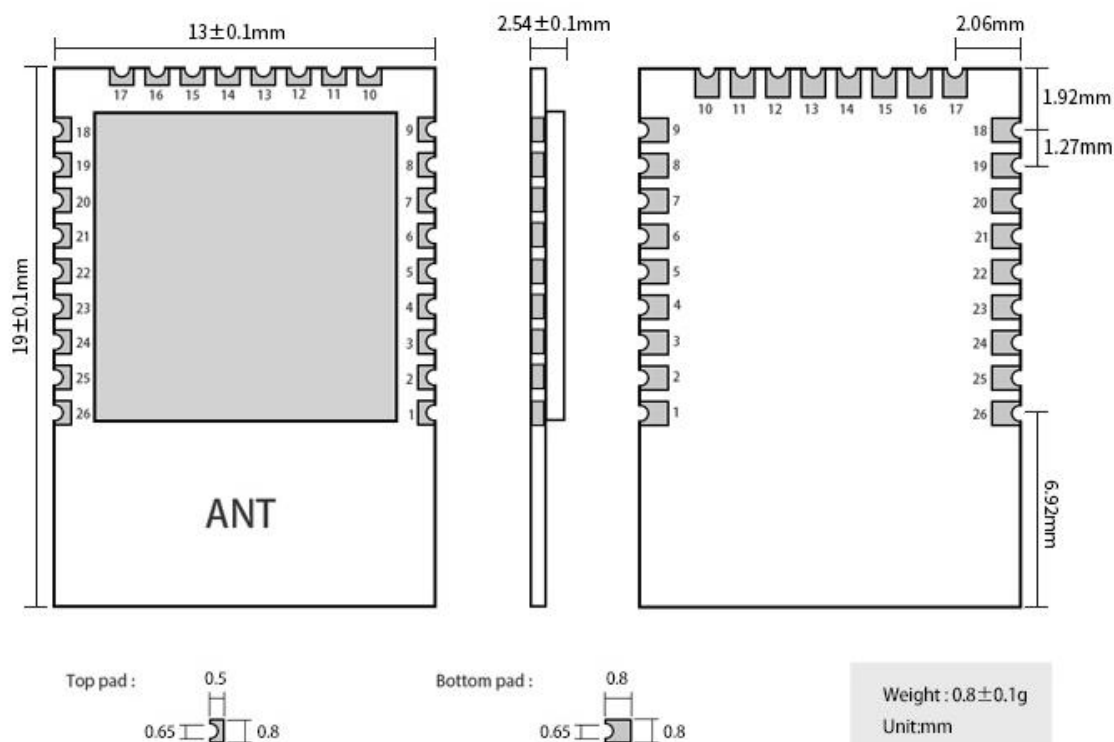
Parameters	Value		Specification
	Min	Max	
Power supply voltage (V)	0	3.6	Power over 3.6V will damage the Module
Blocking power (dBm)	-	10	Probability of burn down at close range
Working temperature (°C)	-40	+85	Industrial grade

### 2.2 Working Parameters

Parameters		Value			Specification
		Min	Typical	Max	
Working voltage (V)		1.9	3.3	3.6	≥3.3V can guarantee the output power
Communication level (V)		-	3.3	-	Using 5V level has the risk of burning
Working temperature (°C)		-40	-	+85	Industrial design
Working frequency band (MHz)		2402	2440	2480	Support ISM frequency band
TRX (mA)		-	7.5	-	@Transmit power 6dBm
RX (mA)		-	3.6	-	-
Sleeping Current (uA)		-	0.17	-	Software is off
Max TRX Power (dBm)		-	6	-	-
Receiving sensitivity (dBm)		-	-106.7	-	-106dbm sensitivity @125kbps GFSK; -98.9dbm sensitivity @1Mbit/s GFSK; -96.2dbm sensitivity @2Mbit/s GFSK;
Air Rate	GFSK (bps)	125k	-	2M	Programmable by User

Parameters	Specification	Note
Reference distance	120m	Clear and open, antenna gain 5dBi, antenna height 2.5m, air rate 1kbps
Crystal frequency	38.4MHz/32.768KHz	-
supporting agreement	BLE 5.2	-
Packaging method	SMD	-
Interface method	1.27mm	-
IC full name	EFR32BG22C224F512GM32	-
FLASH	512KB	-
RAM	32KB	-
Kernel	ARM®Cortex®-M33	-
Dimensions	13*19mm	-
RF interface	PCB	Equivalent impedance is about 50Ω

### 3. Size and Pin Definition



Pin No.	Name	Type	Definition
1	GND	Input	Ground wire, connect to power reference ground
2	PB02	input Output	MCU GPIO (see EFR32BG22 manual for details)
3	PB01	input Output	MCU GPIO (see EFR32BG22 manual for details)
4	PB00	input Output	MCU GPIO (see EFR32BG22 manual for details)
5	PA00	input Output	MCU GPIO (see EFR32BG22 manual for details)
6	PA01	Input	SWCLK, serial line debugging clock input debugging and programming (see EFR32BG22 manual for details)
7	PA02	Input	SWDIO, serial line debugging and programming debugging (see EFR32BG22 manual for details)
8	PA03	input Output	MCU GPIO (see EFR32BG22 manual for details)
9	GND	Input	Ground wire, connect to power reference ground
10	GND	Input	Ground wire, connect to power reference ground
11	PA04	input Output	MCU GPIO (see EFR32BG22 manual for details)
12	PA05	input Output	MCU GPIO (see EFR32BG22 manual for details)
13	PA06	input Output	MCU GPIO (see EFR32BG22 manual for details)
14	VCC	Input	Power supply, range 1.9 ~ 3.6V (recommended to add ceramic filter capacitors externally)
15	VCC	Input	Power supply, range 1.9 ~ 3.6V (recommended to add ceramic filter capacitors externally)
16	GND	Input	Ground wire, connect to power reference ground
17	GND	Input	Ground wire, connect to power reference ground
18	PD01	input Output	MCU GPIO (see EFR32BG22 manual for details)
19	PD00	input Output	MCU GPIO (see EFR32BG22 manual for details)
20	PC00	input Output	MCU GPIO (see EFR32BG22 manual for details)

21	PC01	input Output	MCU GPIO (see EFR32BG22 manual for details)
22	PC02	input Output	MCU GPIO (see EFR32BG22 manual for details)
23	PC03	input Output	MCU GPIO (see EFR32BG22 manual for details)
24	PC04	input Output	MCU GPIO (see EFR32BG22 manual for details)
25	PC05	input Output	MCU GPIO (see EFR32BG22 manual for details)
26	RST	Input	Chip reset trigger input pin, effective when low level

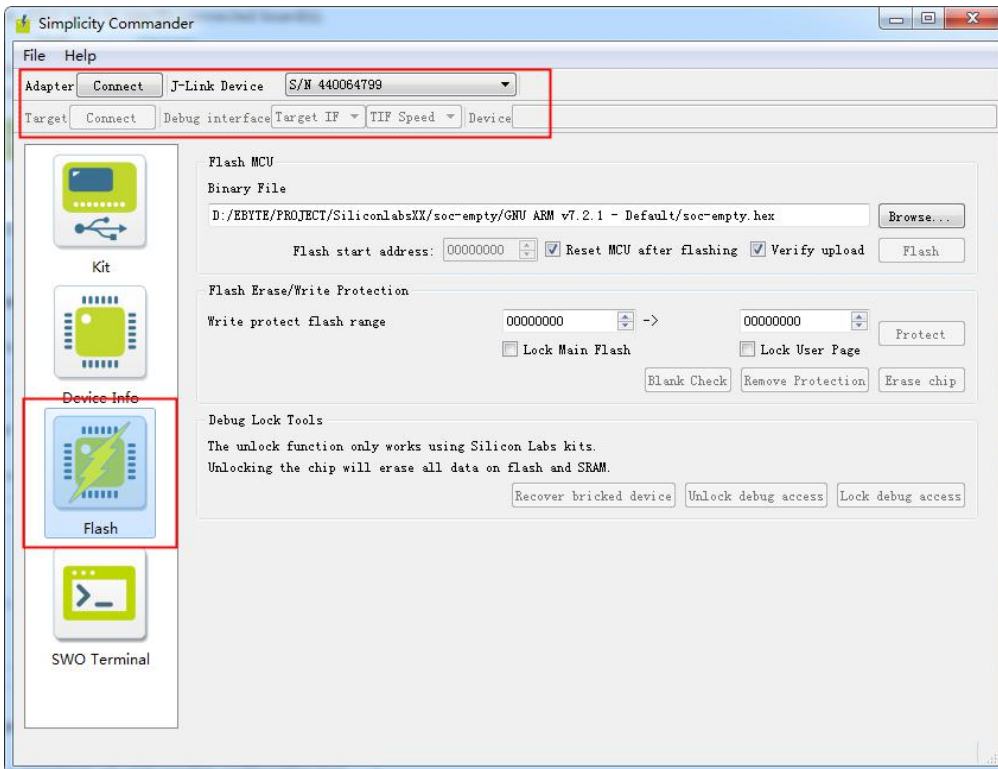
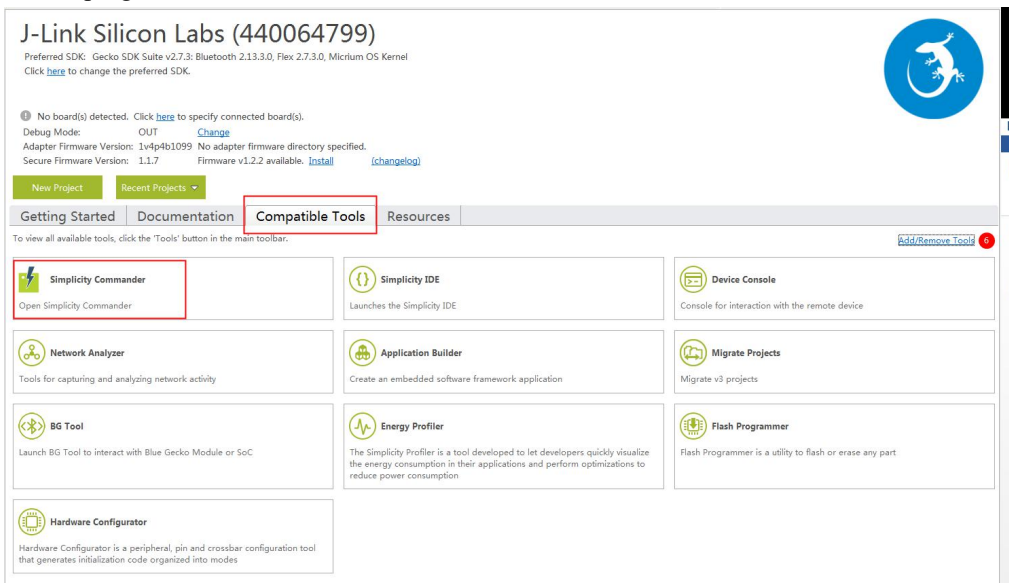
## 4. Hardware and Software

### 4.1 Hardware Notice

- If the communication line uses a 5V level, a 1k-5.1k resistor must be connected in series (not recommended, it may still damage the module);
- Try to stay away from the TTL protocol which is also 2.4GHz in some physical layers, for example: USB3.0;
- It is recommended to use a DC stabilized power supply to supply power to the module. The power supply ripple coefficient is as small as possible, and the module needs to be reliably grounded
- Please pay attention to the correct connection of the positive and negative poles of the power supply. Reverse connection may cause permanent damage to the module;
- Please check the power supply to ensure that it is between the recommended power supply voltage, if exceeding the maximum value will cause permanent damage to the module;
- Please check the power supply stability, the voltage cannot fluctuate significantly and frequently;
- When designing the power supply circuit for the module, it is often recommended to reserve more than 30% of the margin, so that the whole machine is conducive to long-term stable work;
- The module should be as far away as possible from the power supply, transformer, high-frequency wiring and other parts with large electromagnetic interference
- High-frequency digital traces, high-frequency analog traces, and power traces must be avoided under the module. If it is absolutely necessary to pass under the module, it is assumed that the module is soldered to the top layer, and the copper layer is laid on the top layer of the contact part of the module (all copper And well grounded), must be close to the digital part of the module and the wiring is on the Bottom Layer;
- Assuming that the module is soldered or placed on the Top Layer, it is also wrong to randomly route on the Bottom Layer or other layers, which will affect the module's spurs and receiving sensitivity to varying degrees;
- Assuming that there are devices with large electromagnetic interference around the module, it will greatly affect the performance of the module. It is recommended to stay away from the module according to the intensity of the interference. If the situation permits, appropriate isolation and shielding can be done;
- It is assumed that there are traces with high electromagnetic interference around the module (high-frequency digital, high-frequency analog, and power traces), which will greatly affect the performance of the module. It is recommended to stay away from the module according to the intensity of the interference. Isolation and shielding;
- The antenna installation structure has a great impact on the performance of the module. Make sure that the antenna is exposed, preferably vertically. When the module is installed inside the cabinet, you can use a high-quality antenna extension cord to extend the antenna to the outside of the cabinet;
- The antenna must not be installed inside the metal shell, which will greatly weaken the transmission distance.

## 4.2 Programming

- The core IC of this module is EFR32BG22C224F512GM32-C, and its programming method is the same as this IC. Users can follow the EFR32BG22C224F512GM32-C official programming guide;
- For general I/O port configuration, please refer to EFR32BG22C224F512GM32-C manual for details;
- Regarding software development, it is recommended that users use the **Simplicity Studio** officially provided by silicon-labs. This IDE document describes in detail and complete information. Using **Simplicity Studio**, users need to go to the silicon-labs official website to register an account to use.
- Users can use the development board provided by silicon-labs to download the program, or use the universal JLINK. JLINK program download software is as follows:



## 5. FAQ

### 5.1 Communication range is too short

- The communication distance will be affected when obstacle exists.
- Data lose rate will be affected by temperature, humidity and co-channel interference.
- The ground will absorb and reflect wireless radio wave, so the performance will be poor when testing near ground.
- Seawater has great ability in absorbing wireless radio wave, so performance will be poor when testing near the sea.
- The signal will be affected when the antenna is near metal object or put in a metal case.
- Power register was set incorrectly, air data rate is set as too high (the higher the air data rate, the shorter the distance).
- When the power supply at room temperature is lower than the recommended low voltage, the lower the voltage is, the lower the transmitting power is.
- The use of the antenna and the module is poorly matched or the quality of the antenna itself is defective.

### 5.2 Module is easy to damage

- Please check the power supply and ensure it is within the recommended range. Voltage higher than the peak will lead to a permanent damage to the module.
- Please check the stability of power supply and ensure the voltage not to fluctuate too much.
- Please make sure anti-static measures are taken when installing and using, high frequency devices have electrostatic susceptibility.
- Please ensure the humidity is within limited range for some parts are sensitive to humidity.
- Please avoid using modules under too high or too low temperature.

### 5.3 Bit error rate is too high

- When there are co-channel signal interference nearby, be away from interference sources or modify frequency and channel to avoid interference;
- Unfavorable power supply may cause code error. Make sure that the power supply is reliable.
- The quality of extension cables and feeders is poor or too long can also cause high bit error rate.

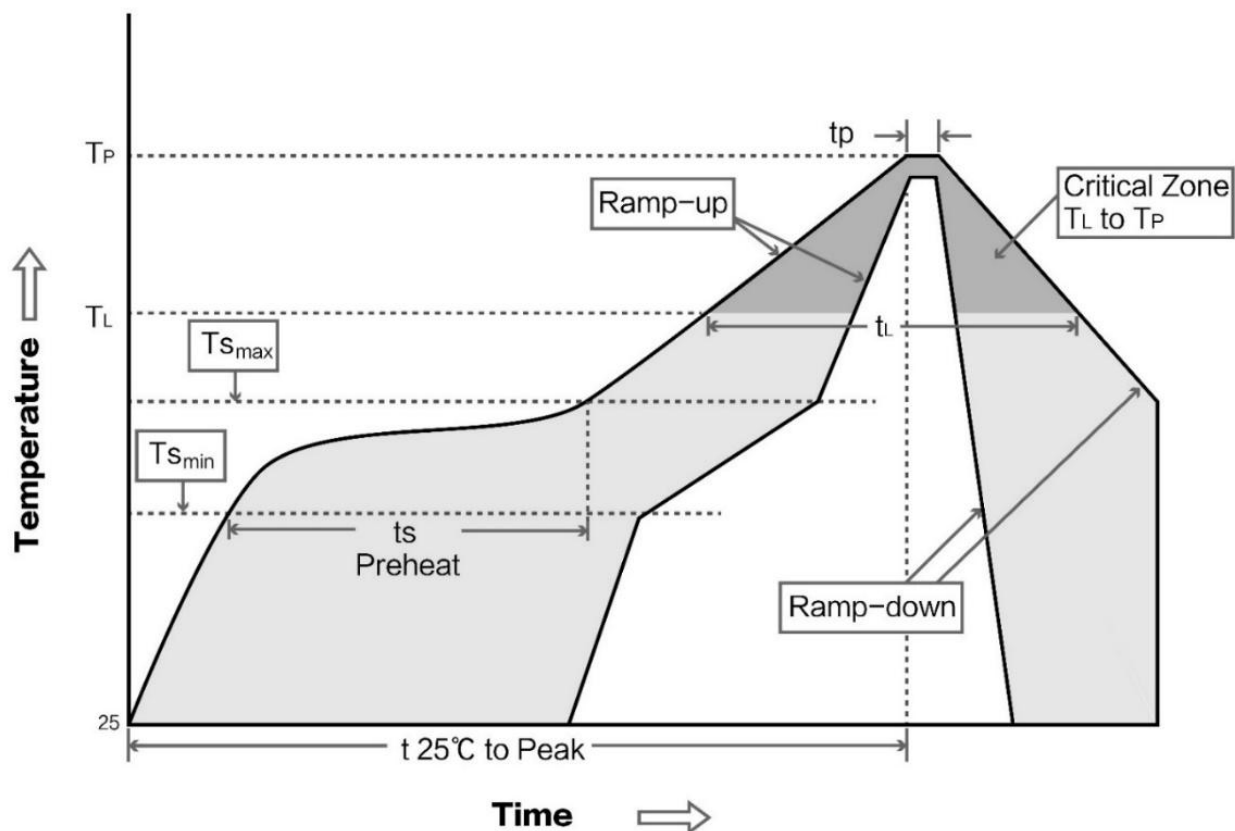


## 6. Welding operation guidance

### 6.1 Reflow Soldering Temperature

Profile Feature	Curve feature	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	Solder paste	Sn63/Pb37	Sn96.5/Ag3/Cu0.5
Preheat Temperature min (T <sub>smin</sub> )	Minimum preheating temperature	100°C	150°C
Preheat temperature max (T <sub>smax</sub> )	Maximum preheating temperature	150°C	200°C
Preheat Time (T <sub>smin</sub> to T <sub>smax</sub> )(t <sub>s</sub> )	Preheating time	60-120 sec	60-120 sec
Average ramp-up rate(T <sub>smax</sub> to T <sub>p</sub> )	Average rising rate	3°C/second max	3°C/second max
Liquidous Temperature (T <sub>L</sub> )	Liquid phase temperature	183°C	217°C
Time (t <sub>L</sub> ) Maintained Above (T <sub>L</sub> )	Time above liquidus	60-90 sec	30-90 sec
Peak temperature (T <sub>p</sub> )	Peak temperature	220-235°C	230-250°C
Average ramp-down rate (T <sub>p</sub> to T <sub>smax</sub> )	Average descent rate	6°C/second max	6°C/second max
Time 25°C to peak temperature	Time of 25 °C to peak temperature	6 minutes max	8 minutes max

### 6.2 Reflow Soldering Curve



## 7. Revision History

Version	Date	Description	Issued by
1.0	2020-05-08	Initial version	

## 8. Contact Us:

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