

# **GR5515 Starter Kit User Guide**

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# Preface

#### Purpose

This document introduces the GR5515 Starter Kit (GR5515 SK), the hardware layout, the circuit schematics, hardware functional modules, and RF and current tests of the GR5515 Starter Kit Board (GR5515 SK Board), to help you get started with the GR5515 Starter Kit Board quickly in developing Bluetooth Low Energy (Bluetooth LE) products and applications with GR551x System-on-Chips (SoCs).

#### Audience

This document is intended for:

- GR551x user
- GR551x developer
- GR551x tester
- Technical writer

#### **Release Notes**

This document is the seventh release of *GR5515 Starter Kit User Guide*, corresponding to GR551x SoC series.

#### **Revision History**

| Version        | Date       | Description  |  |
|----------------|------------|--|--|
| 1.0            | 2019-12-08 | Initial release  |  |
| 1.3            | 2020-03-16 | Updated the release time in the footers.   |  |
| 1.5            | 2020-05-30 | Optimized the descriptions in "Buttons and LEDs" and "On-board QSPI Flash".              |  |
| 1.6            | 2020-06-30 | Added limitations for PCB antenna RF tests in "RF Test".                                 |  |
| 1.7            | 2020-09-30 | Added "Why Do Connection to J-Link and Connection/Download to GR5515 SK Board Fail?".    |  |
| 1.8            | 2022-02-20 | Added "SK Board Dimensions".   |  |
| 1.0            | 2022 04 20 | Updated the relevant images of the GR5515 Starter Kit Board to those in GR5515-SK-BASIC- |  |
| 1.9 2023-04-20 |            | RevE.  |  |

# G@DiX

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# **1** Introduction

The GR5515 Starter Kit (GR5515 SK) is a development platform based on GR551x System-on-Chips (SoCs) (supporting Bluetooth 5.1). It contains a GR5515 Starter Kit Board (GR5515 SK Board), a schematic diagram, and a user guide. The GR5515 SK allows you to get familiar with GR551x-related development tools, quickly develop product prototype, and verify related functions.

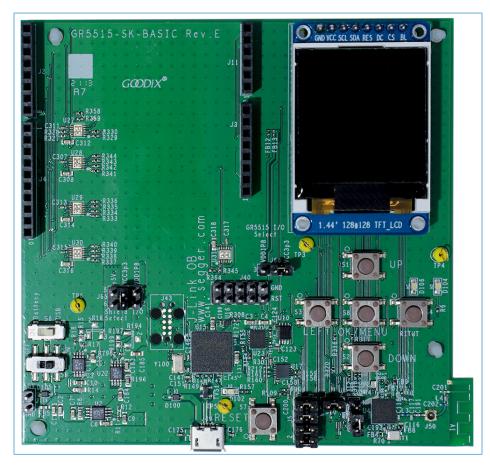


Figure 1-1 GR5515 SK Board

By default, no software is pre-downloaded on a GR5515 SK Board. It is recommended to download the Bluetooth or peripheral application example projects provided in a GR551x Software Development Kit (SDK) to a GR5515 SK Board for development and debugging.

To make best use of the GR5515 SK, it is recommended to refer to the following documents.

| Table 1-1 Reference | documents |
|---------------------|-----------|
|---------------------|-----------|

| Name   | Description   |
|--|---|
| GR551x Developer Guide Introduces GR551x SDK and how to develop and debug applications based on the SDK. |   |
| J-Link/J-Trace User Guide  | Provides J-Link operational instructions. Available at <u>https://www.segger.com/downloads/jlink/</u><br>UM08001_JLink.pdf. |
| GR5515-SK-BASIC-RevE Offers GR5515 SK Board schematic diagrams.  |   |

# 1.1 Features

- A single-mode Bluetooth Low Energy (Bluetooth LE) SoC that supports Bluetooth 5.1
- Multi-functional buttons and LEDs
- Interfaces that support inserting the Arduino module, with I/O voltage configurable by level shift
- SEGGER J-Link OB that supports debugging
- UART-to-USB connector
- Micro USB connector, which connects a GR5515 SK Board to a PC
- 1.44-inch color thin film transistor (TFT) display
- On-board QSPI flash

# 2 Quick Start Guide

## **2.1 Preparation**

Perform the following tasks before getting started with a GR5515 SK Board.

### 🛄 Note:

SDK\_Folder is the root directory of GR551x SDK.

#### • Hardware preparation

Table 2-1 Hardware preparation

| Name              | Description   |
|-------------------|---|
| Cable             | Micro USB 2.0 cable                                     |
| Development board | GR5515 SK Board   |
| Android phone     | A mobile phone running on Android 5.0 (KitKat) or later |

#### • Software preparation

#### Table 2-2 Software preparation

| Name                | Description  |  |
|---------------------|--|--|
| Windows             | Windows 7 or later versions, or Ubuntu 16.04 LTS or later versions (both 32-bit and 64-bit are acceptable)           |  |
| Keil MDK5           | An integrated development environment (IDE). Available at <u>https://www.keil.com/</u><br><u>download/product/</u> . |  |
| GRToolbox (Android) | A Bluetooth LE debugging tool for GR551x. Available in SDK_Folder\tools\GRTool box.                                  |  |

# 2.2 Power Supply and Connection Settings

Figure 2-1 shows the assembly diagram of a GR5515 SK Board.



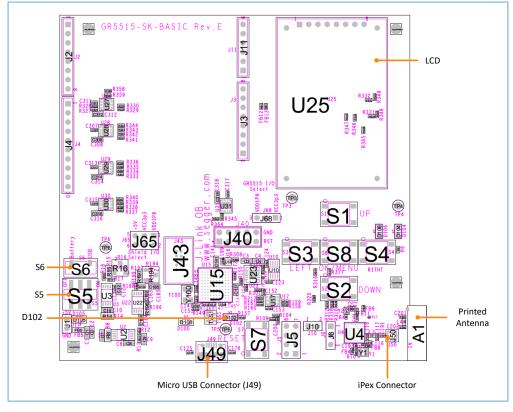


Figure 2-1 GR5515 SK Board assembly

Before using a GR5515 SK Board, follow the steps below to configure power supply and establish connection:

- 1. Connect the GR5515 SK Board to a PC with a Micro USB 2.0 cable. The Micro USB connector is used for power supply and programming through J-Link.
- 2. Switch **S6** (power switch) to the right side (as shown in the figure above) to power the board with current passing through the on-board LDO; switch **S6** to the left side to power the board by lithium batteries.
- 3. Switch **S5** (power switch) to the right side (marked with **ON**) to turn on the power.
- 4. D102 starting flashing indicates that the PC begins to detect the J-Link port. If the detection succeeds, D102 stops flashing and remains on.
- 5. When D102 remains on, open the File Explorer of the PC, and check whether J-Link is in the list of Device Manager > Ports (COM & LPT). J-Link in the list indicates that power and connection settings are completed, and downloading and programming for GR551x are permitted; otherwise, check whether the J-Link driver is installed properly, and reinstall the J-Link driver in the latest version if necessary.

## 2.3 Example Running

The GR551x SDK provides various example projects, which are in SDK\_Folder\projects. After completing power supply and connection settings, you can run any example project. For more information about compiling and downloading example projects with Keil, see *GR551x Developer Guide*.

# 2.4 Mobile Connection Test

Install GRToolbox App on a mobile phone (Android), and enable Bluetooth on the phone. Run the GRToolbox to start scanning and establish connection with the GR5515 SK Board.

# **3 Hardware Overview**

## 3.1 Hardware Layout

The top view and the bottom view of a GR5515 SK Board are shown in Figure 3-1 and Figure 3-2 respectively. The board mainly integrates an interface microcontroller unit (MCU), a power module, Arduino Uno Shield Connectors, buttons and LEDs, a LCD connector, a Bluetooth LE RF module, and an on-board QSPI flash.

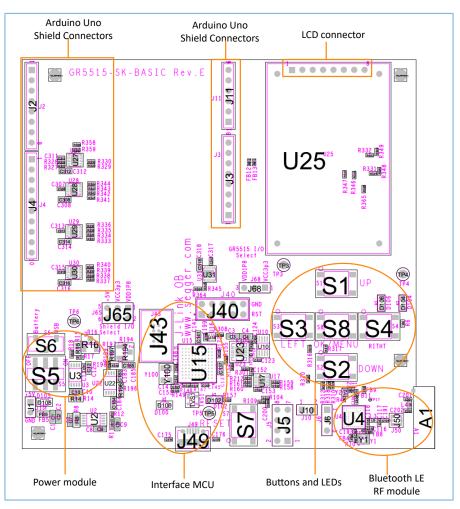


Figure 3-1 Hardware layout of GR5515 SK Board (top view)



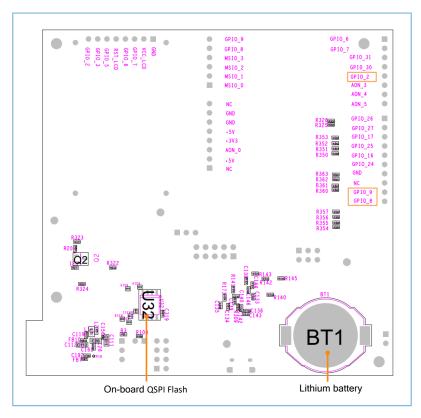


Figure 3-2 Hardware layout of GR5515 SK Board (bottom view)

## **Note**:

```
"GPIO_2", "GPIO_9", and "GPIO_8" in Figure 3-2 should be "AON_2", "GPIO_8", and "GPIO_9", respectively.
```

## 3.2 Block Diagram

The following block diagram of a GR5515 SK Board shows connections between modules.



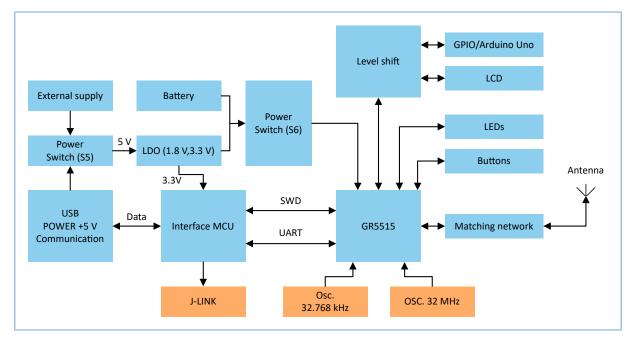


Figure 3-3 Block diagram of GR5515 SK Board

# 4 Interface MCU

The board integrates an Atmel interface MCU, which can be converted to a J-Link port and a CDC virtual serial port.

## 4.1 J-Link Port

The GR5515 SK Board integrates a J-Link OB chip, which allows you to perform online debugging and emulation with the J-Link driver of the PC.

# 4.2 CDC Virtual Serial Port

J-Link OB chip internally integrates CDC serial protocols, which allow you to open the J-Link CDC virtual serial port on the PC, to debug with UART.

Table 4-1 Relationship between UART connectors and interface MCU

| GR5515 SK Board |      | Interface MCU |
|-----------------|------|---------------|
| Default GPIO    | UART | UART          |
| GPIO_10         | RX   | ТХ            |
| GPIO_11         | ТХ   | RX            |

## 4.3 Software Download Port of Interface MCU

The J-Link port, J43, on the GR5515 SK Board is used for SEGGER J-Link OB firmware download for interface MCU.

### **Note**:

GR5515 SK Boards have been factory-programmed with J-Link OB firmware. No programming is required for users.



# **5** Power Supply

The GR5515 SK Board provides three power supply modes: power supply via USB connection, power supply from external sources, and from lithium battery.

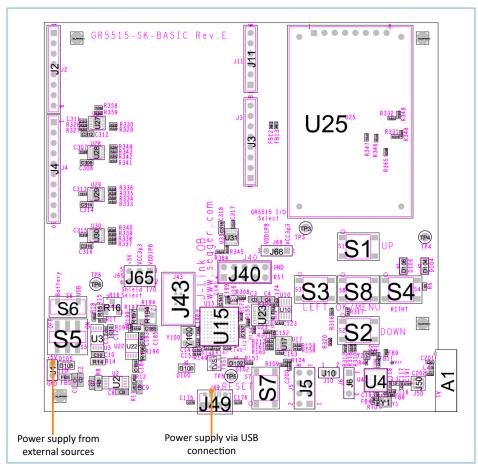


Figure 5-1 Power supply (top view)



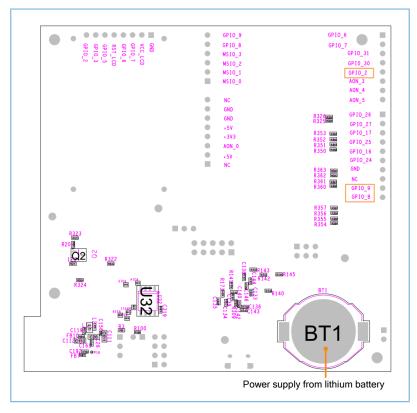


Figure 5-2 Power supply (bottom view)

## **Note**:

"GPIO\_2", "GPIO\_9", and "GPIO\_8" in Figure 5-2 should be "AON\_2", "GPIO\_8", and "GPIO\_9", respectively.

- Power supply via USB connection: Power the board by connecting the board to the PC with a USB cable with current passing through the on-board LDO. The LDO output voltage ranges from 1.8 V to 3.3 V; default: 3.3 V.
- Power supply from external sources: Power the board by external sources (5 V) with current passing through the on-board LDO. The default LDO output voltage is 3.3 V.
- Power supply from lithium battery: Power the board by lithium batteries.

You can switch **S6**, to select the power supply mode (from lithium battery or the 3.3 V power output by the on-board LDO). Reverse voltage protection is provided for power supply via USB connection and from external sources through a pair of diodes (D100 and D105).

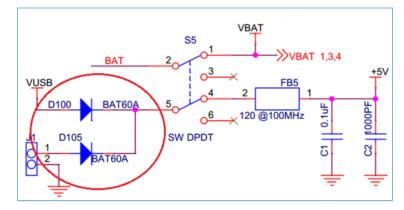


Figure 5-3 Voltage protection diodes for power supply via USB connection/from external sources

# **6 Arduino Uno Shield Connectors**

The GR5515 SK Board provides standard Arduino Uno Shield Connectors, and the connector locations on the SK printed circuit board (PCB) comply with Arduino standards. You can connect peripherals, such as G-sensor and heart rate sensor, through Arduino Uno Shield Connectors.

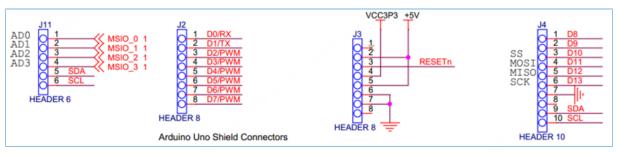


Figure 6-1 Arduino Uno Shield Connectors on GR5515 SK Board

The I/O voltage of Arduino Uno Shield Connectors can be set to 1.8 V, 3.3 V, or 5 V by using a jumper cap on J65.

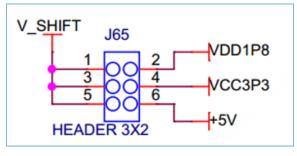


Figure 6-2 Voltage options of Arduino Uno Shield Connectors

## **Note**:

GPIO\_6 and GPIO\_7 are shared by D0/RX, D1/TX, and LCD display interface in Time-Division Multiplexing (TDM). For more information about GR5515 SK Board circuit, see the schematic diagram *GR5515-SK-BASIC-RevE*.

# 7 Buttons and LEDs

The GR5515 SK Board integrates 6 buttons and 3 LEDs, which map to corresponding pins on a GR551x SoC:

| Button/LED | GPIO Pin   | Description                    | Note   |
|------------|------------|--------------------------------|--|
| Button1    | GPIO_14    | S3 (LEFT)                      | -  |
| Button2    | GPIO_15    | S4 (RIGHT)                     | -  |
| Button3    | GPIO_12    | S1 (UP)                        | -  |
| Button4    | GPIO_13    | S2 (DOWN)                      | -  |
| Button5    | AON_GPIO_1 | S8 (OK)                        | AON_GPIO_1. It can be configured to wake the system up from sleep mode in application, just like the PCS project in SDK.                                 |
| Button6    | CHIP_EN    | S7 (RESET)                     | It is used for chip reset.   |
| LED1       | MSIO_4     | D104 (PWM controllable)        | LED1 can be driven by different PWM modes.   |
| LED2       | GPIO_4     | D106 (user-defined)            | -  |
| LED3       | -          | D102 (J-Link status indicator) | It is connected to interface MCU to indicate J-Link status.<br>When it is powered on, it flashes; if J-Link driver on the PC is<br>ready, it remains on. |

| Table 7-1 Corresponding | pins to | buttons/LEDs |
|-------------------------|---------|--------------|
|-------------------------|---------|--------------|



# 8 LCD Connector

The GR5515 SK Board integrates a color TFT LCD display (1.44 inch, 128 x 128 dpi) and a 3-wire serial peripheral interface (SPI), to help you develop and demonstrate products with display function. In addition, the LCD display is pluggable. You can replace it with different-size displays supporting the same type of connection interfaces, to adapt to different application scenarios.

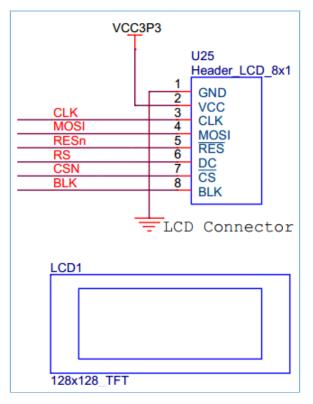


Figure 8-1 Interface network of the LCD connector

#### Table 8-1 Pin definition of LCD connector

| Pin | NET      | Description             |
|-----|----------|-------------------------|
| 1   | GND      | Ground                  |
| 2   | VCC      | +3.3 V                  |
| 3   | SCL/CLK  | SPI clock input         |
| 4   | SDA/MOSI | SPI data input          |
| 5   | RES      | Display reset           |
| 6   | DC       | Data/Command selection  |
| 7   | CS       | Chip selection for SPI  |
| 8   | BLK      | Backlight control input |

# 9 On-board QSPI Flash

The GR5515 SK Board integrates a 32 MB QSPI flash, to expand flash memory and store application data.

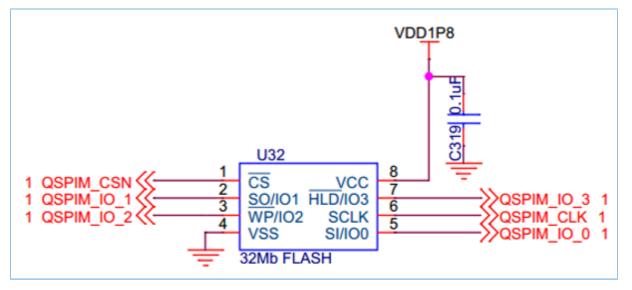


Figure 9-1 Expanded QSPI flash schematic diagram

#### Note:

- QSPI flash pins, buttons (UP, LEFT, RIGHT, DOWN), and Arduino Uno Shield Connectors pins (GPIO\_8 and GPIO\_9) multiplex. By default, the zero-ohm resistor is disconnected, and QSPI flash pins do not work.
- To use QSPI flash pins, disconnect these pins from buttons, GPIO\_8, and GPIO\_9, and solder a zero-ohm resistor at the corresponding DNI resistance part.

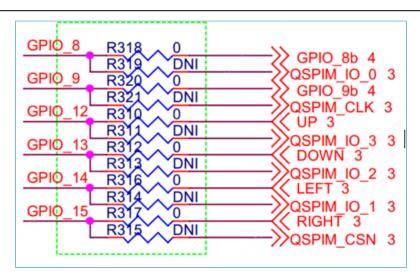


Figure 9-2 Connections shared by buttons and QSPI flash pins

# **10** Performance Test

## 10.1 RF Test

The GR5515 SK Board reserves a small RF connector (J50), which can be connected to a spectrum analyzer or a Bluetooth LE tester (for example, TLF3000) to test the RF performance of the GR5515 SK Board.

The RF connector, J50, integrates an internal switch:

- By default, if no test line probe is connected to J50, the RF circuit signal is connected to on-board antenna.
- If any test line probe is connected to J50, the RF circuit signal is directly connected with the test line, not the board-level antenna any more. The other end of the test line is connected to a test instrument through a standard SMA connector.

### Note:

It is recommended to use a high-frequency test line, such as MURATA MXHS83QE3000, to test RF performance for the GR5515 SK Board; the test probe is not included in the GR5515 SK package.

Since the board-level PCB antenna is a non-omnidirectional antenna, there will be differences in gain at different angles, so it is only used for functional connection tests and not suitable for performance tests. For performance tests, such as high-throughput and long-distance tests, an omnidirectional antenna shall be connected to J50.

Figure 10-1 shows test connection between a GR5515 SK Board and TLF3000 by taking TLF3000 as an example.

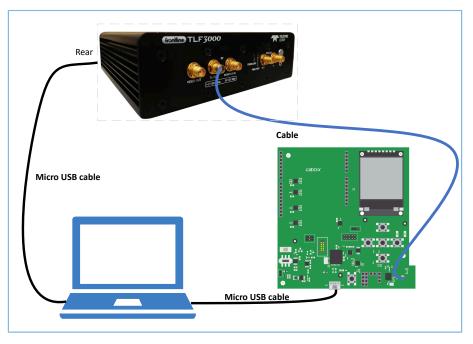


Figure 10-1 Connection between GR5515 SK Board and TLF3000

After establishing connection, you can select different test items from the software on the PC, to test RF-related parameters.



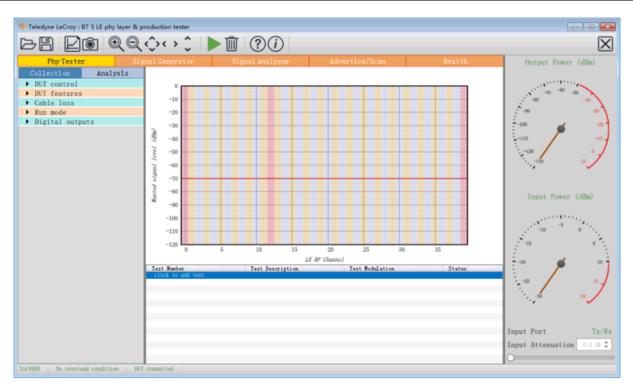


Figure 10-2 RF parameter test demo

#### **Note**:

For more information about RF tests, see *GR5xx DTM Test Application Note*.

## **10.2 Current Consumption Test**

You can test the current consumption of the GR551x SoC on the GR5515 SK Board with a test instrument. On the board, VBAT powers VBATH, VBATL, and VBAT-RF of the GR551x SoC through the jumper pin J10. Therefore, you can connect a test instrument to J10 to test the current.



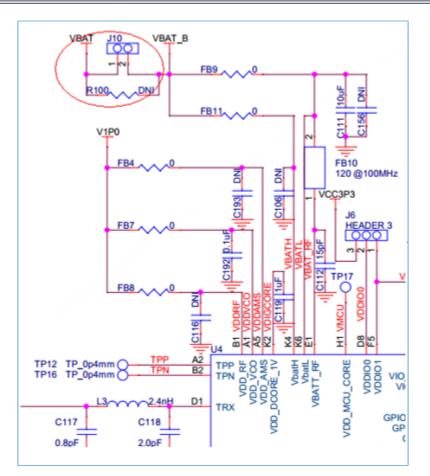


Figure 10-3 Current consumption test interface J10

Current test instruments include a multimeter, an oscilloscope, and a power analyzer.

• Multimeter

A multimeter is used to test static current or average current.

Set the multimeter to mA/ $\mu$ A level, and connect the red and black probes to Pin 1 and Pin 2 of J10 respectively, to read the static or the average current values.

When a Bluetooth chip is working, the current level may change from  $\mu$ A level to mA level. Therefore, the dynamic test range of the multimeter used shall be 1  $\mu$ A to 15 mA. It is recommended to use a multimeter with True RMS current test function. Otherwise, major errors may occur in the test results.

Oscilloscope

An oscilloscope is used to test the average current within a period of time or capture the current curve of a single Bluetooth LE event.

As shown in Figure 10-3, solder a 10-ohm resistor to R100, and connect two oscilloscope probes to Pin 1 and Pin 2 of J10 respectively for measurement in the differential measurement mode of the oscilloscope.

When instantaneous current runs through the 10-ohm resistor, certain voltage drop occurs at the two probes. The voltage drop is in direct proportion to current. Therefore, the oscilloscope display shows a current change curve. You can also take average or integral values of the measured data, to analyze the current consumption within a period of time.

Due to the wide current change range of a Bluetooth event, it is difficult to guarantee the precision of  $\mu$ Alevel current and to reduce the impact from voltage difference of mA-level series resistor on circuit by using an oscilloscope in current testing. Therefore, the accuracy of test results cannot be guaranteed.

Power analyzer

The two ways mentioned above (by multimeter and by oscilloscope) compromise accuracy and precision, and therefore cannot satisfy the requirements on current consumption test of a Bluetooth LE event. A power analyzer is a better choice, such as Keysight N6705C.

To power the GR551x SoC with a power analyzer, connect the power output port of the power analyzer to Pin 2 of J10, as shown in Figure 10-3. During a Bluetooth LE event, the power analyzer automatically stores and displays current curve changes for the moment. You can zoom in the curves to see current consumption details. For more information, see operational instructions of the power analyzer.

# **11 SK Board Dimensions**

The GR5515 SK Board has dimensions of 101.1 mm x 95.25 mm, with details shown in the figure below.

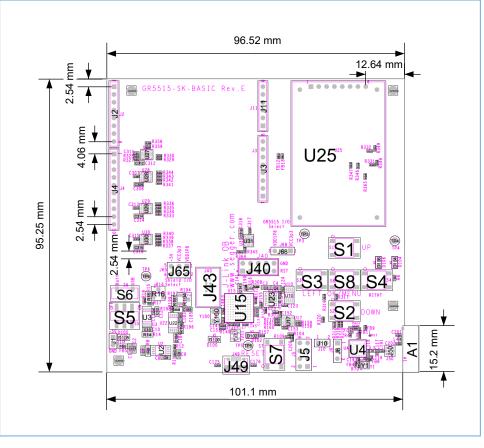


Figure 11-1 GR5515 SK Board dimensions (top view)

# 12 FAQ

# **12.1** Why Do Connection to J-Link and Connection or Download to GR5515 SK Board Fail?

• Description

When users download firmware to the GR5515 SK Board by using Keil/GProgrammer, J-Link cannot be connected, and connection/download to the GR5515 SK Board fail.

Analysis

When users download firmware, the GR551x SoC may be in sleep state (the firmware with sleep mode enabled is running), and therefore J-Link fails to normally interact with the PC, and connection/download to the GR5515 SK Board fail.

• Solution

Press **RESET** on the GR5515 SK Board and wait for about 1 second; then re-download the firmware.