Build a Smarter World

# SC20 Hardware Design

**Smart LTE Module Series**

Rev: SC20_Hardware_Design_V1.4

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# About the Document

## History

| Revision | Date | Author | Description |
|---|---|---|---|
| 1.0 | 2016-04-12 | Tony GAO | Initial |
| 1.1 | 2016-05-04 | Mark ZHANG | 1. Updated RF Receiving Sensitivity<br>2. Updated Operation Temperature |
| 1.2 | 2016-07-22 | Sea BAI | Added Chapters 2.4, 3.6~3.22, 4, 5 and 9 |
| 1.3 | 2016-08-19 | Sea BAI | Updated Charging Parameters in Table 41 |
| 1.4 | 2017-10-17 | Sea BAI/<br>Beny ZHU/<br>Jenson WU | 1. Modified the name of SC20-CE to SC20-CE R1.1<br>2. Added the frequency bands of SC20-E, SC20-A, SC20-AU and SC20-J modules (Tables 2, 3, 4 and 5)<br>3. Added descriptions of Wi-Fi 5GHz frequency band (Tables 27, 28 and 35)<br>4. Updated SC20 module operating frequencies (Table 33)<br>5. Updated reference circuit design for GNSS passive antenna (Figure 37)<br>6. Updated antenna requirements (Table 38)<br>7. Added the current consumption of SC20-E, SC20-A, SC20-AU and SC20-J (Tables 44, 45, 46 and 47)<br>8. Updated RF output power (Table 48)<br>9. Added the RF receiving sensitivity of SC20-E, SC20-A, SC20-AU and SC20-J (Tables 50, 51, 52 and 53) |

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# 1 Introduction

This document defines the SC20 module and describes its air interface and hardware interface which are connected with customers' application.

This document can help customers quickly understand module interface specifications, electrical and mechanical details as well as other related information of SC20 module. Associated with application note and user guide, customers can use SC20 module to design and set up mobile applications easily.

## 1.1. Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating SC20 module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel, and incorporate these guidelines into all manuals supplied with the product. If not so, Quectel assumes no liability for customers' failure to comply with these precautions.

| | |
|---|---|
|  | Full attention must be given to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. You must comply with laws and regulations restricting the use of wireless devices while driving. |
|  | Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden, so as to prevent interference with communication systems. Consult the airline staff about the use of wireless devices on boarding the aircraft, if your device offers an Airplane Mode which must be enabled prior to boarding an aircraft. |
|  | Switch off your wireless device when in hospitals,clinics or other health care facilities. These requests are designed to prevent possible interference with sensitive medical equipment. |


Cellular terminals or mobiles operating over radio frequency signal and cellular network cannot be guaranteed to connect in all conditions, for example no mobile fee or with an invalid (U)SIM card. While you are in this condition and need emergent help, please remember using emergency call. In order to make or receive a call, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength.

Your cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency energy. RF interference can occur if it is used close to TV set, radio, computer or other electric equipment.

In locations with potentially explosive atmospheres, obey all posted signs to turn off wireless devices such as your phone or other cellular terminals. Areas with potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles such as grain, dust or metal powders, etc.

Please do not discard. Maybe wireless devices have an impact on the environment so please do not arbitrarily discarded.

- Operation frequency range and related output power levels for 2G/WCDMA/LTE, BT , BLE , WiFi 2.4GHz , WiFi 5GHz, WiFi 5.8GHz and GPS.

| | |
|---|---|
| Bluetooth | 2402MHz - 2480 MHz @ 8.96dBm |
| Bluetooth LE | 2402MHz - 2480MHz @ 6.92dBm |
| 802.11a/b/g/n (HT20/40/80) | 2412MHz - 2472 MHz @ 16.82dBm |
| | 5150MHz - 5250 MHz @ 17.26dBm |
| | 5250MHz - 5350 MHz @ 17.07dBm |
| | 5470MHz - 5725 MHz @ 16.36dBm |
| | 5725MHz - 5850 MHz @ 13.4dBm |

| | |
|---|---|
| GSM 900 | 880MHz - 915MHz @ 35dBm |
| DCS1800 | 1710MHz - 1785MHz @ 32dBm |
| WCDMA B1 | 1920MHz - 1980MHz @ 25dBm |
| WCDMA B8 | 880MHz - 915MHz @ 25 dBm |
| LTE B1 | 1920MHz - 1980MHz @ 25dBm |
| LTE B3 | 1710MHz - 1785MHz @ 25dBm |
| LTE B7 | 2500MHz - 2570MHz @ 25dBm |
| LTE B8 | 880MHz - 915MHz @ 25dBm |
| LTE B28 | 703MHz –748 MHz @ 25dBm |

| | |
|---|---|
| LTE B40 | 2300MHz - 2400MHz @25dBm |
| GPS Receiver | 1575.42MHz |

- The device is restricted to indoor use only when operating in the 5150 to 5350 MHz frequency range.

| | | | | | | |
|---|---|---|---|---|---|---|
| AT | BE | BG | HR | CY | CZ | DK |
| EE | FI | FR | DE | EL | HU | IE |
| IT | LV | LT | LU | MT | NL | PL |
| PT | RO | SK | SI | ES | SE | UK |

# 2 Product Concept

## 2.1. General Description

SC20 is a series of Smart LTE module based on Qualcomm platform and Android operating system, and provides industrial grade performance. It supports worldwide LTE-FDD, LTE-TDD, DC-HSDPA, HSPA+, HSDPA, HSUPA, WCDMA, TD-SCDMA, CDMA, EDGE and GPRS coverage, and also supports short-range wireless communication via Wi-Fi 802.11a/b/g/n and BT4.1 LE. Additionally, SC20 integrates GPS/GLONASS/BeiDou satellite positioning systems. Due to multiple speech and audio and video codecs as well as the built-in high performance Adreno™ 304 graphics processing unit, it enables smooth play of 720P videos. The module also offers multiple audio and video input/output interfaces as well as abundant GPIO interfaces.

SC20 module contains five variants: SC20-CE R1.1, SC20-E, SC20-A, SC20-AU and SC20-J. The following tables show the supported frequency bands and network standards of SC20.

**Table 1: SC20-CE R1.1 Frequency Bands**

| Type | Frequency |
|---|---|
| LTE-FDD | B1/B3/B5/B8 |
| LTE-TDD | B38/B39/B40/B41 |
| WCDMA | B1/B8 |
| TD-SCDMA | B34/B39 |
| CDMA | BC0 |
| GSM | 900/1800MHz |
| Wi-Fi 802.11a/b/g/n | 2400MHz~2482MHz<br>5180MHz~5825MHz |
| BT4.1 LE | 2402MHz~2480MHz |
| GNSS | GPS: 1575.42MHz±1.023MHz<br>GLONASS: 1597.5MHz~1605.8MHz |

| | |
|---|---|
| | BeiDou: 1561.098MHz±2.046MHz |

**Table 2: SC20-E Frequency Bands**

| Type | Frequency |
|---|---|
| LTE-FDD | B1/B3/B5/B7/B8/B20 |
| LTE-TDD | B38/B40/B41 |
| WCDMA | B1/B5/B8 |
| GSM | 850/900/1800/1900MHz |
| Wi-Fi 802.11a/b/g/n | 2400MHz~2482MHz<br>5180MHz~5825MHz |
| BT4.1 LE | 2402MHz~2480MHz |
| GNSS | GPS: 1575.42MHz±1.023MHz<br>GLONASS: 1597.5MHz~1605.8MHz<br>BeiDou: 1561.098MHz±2.046MHz |

**Table 3: SC20-A Frequency Bands**

| Type | Frequency |
|---|---|
| LTE-FDD | B2/B4/B5/B7/B12/B13/B25/B26 |
| WCDMA | B1/B2/B4/B5/B8 |
| GSM | 850/1900MHz |
| Wi-Fi 802.11a/b/g/n | 2400MHz~2482MHz<br>5180MHz~5825MHz |
| BT4.1 LE | 2402MHz~2480MHz |
| GNSS | GPS: 1575.42MHz±1.023MHz<br>GLONASS: 1597.5MHz~1605.8MHz<br>BeiDou: 1561.098MHz±2.046MHz |

**Table 4: SC20-AU Frequency Bands**

| Type | Frequency |
|---|---|
| LTE-FDD | B1/B3/B5/B7/B8/B28 |
| LTE-TDD | B40 |
| WCDMA | B1/B2/B5/B8 |
| GSM | 850/900/1800/1900MHz |
| Wi-Fi 802.11a/b/g/n | 2400MHz~2482MHz<br>5180MHz~5825MHz |
| BT4.1 LE | 2402MHz~2480MHz |
| GNSS | GPS: 1575.42MHz±1.023MHz<br>GLONASS: 1597.5MHz~1605.8MHz<br>BeiDou: 1561.098MHz±2.046MHz |

**Table 5: SC20-J Frequency Bands**

| Type | Frequency |
|---|---|
| LTE-FDD | B1/B3/B8/B18/B19/B26 |
| LTE-TDD | B41 |
| WCDMA | B1/B6/B8/B19 |
| Wi-Fi 802.11a/b/g/n | 2400MHz~2496MHz<br>5180MHz~5825MHz |
| BT4.1 LE | 2402MHz~2480MHz |
| GNSS | GPS: 1575.42MHz±1.023MHz<br>GLONASS: 1597.5MHz~1605.8MHz<br>BeiDou: 1561.098MHz±2.046MHz |

SC20 is an SMD type module, which can be embedded into applications through its 210-pin pads including 146 LCC signal pads and 64 other pads. With a compact profile of 40.5mm × 40.5mm × 2.8mm, SC20 can meet almost all requirements for M2M applications such as CPE, wireless POS, smart metering, router, data card, automotive, smart phone, digital signage, alarm panel, security and industry PDA, etc.

## 2.2. Key Features

The following table describes the detailed features of SC20 module.

**Table 6: SC20 Key Features**

| Feature | Details |
|---|---|
| Applications Processor | ARM Cortex-A7 microprocessor cores (quad-core) up to 1.1GHz<br>512KB L2 cache |
| Modem DSP | QDSP6 v5 core up to 691.2MHz<br>768KB L2 cache |
| Memory | 8GB EMMC+8Gb LPDDR3 |
| Operating System | Android 6.0 |
| Power Supply | Supply voltage: 3.5V~4.2V<br>Typical supply voltage: 3.8V |
| Transmitting Power | Class 4 (33dBm±2dB) for GSM850 and EGSM900<br>Class 1 (30dBm±2dB) for DCS1800 and PCS1900<br>Class E2 (27dBm±3dB) for GSM850 and EGSM900 8-PSK<br>Class E2 (26dBm±3dB) for DCS1800 and PCS1900 8-PSK<br>Class 3 (24dBm+1/-3dB) for WCDMA bands<br>Class 3 (24dBm+3/-1dB) for CDMA BC0<br>Class 2 (24dBm+1/-3dB) for TD-SCDMA bands<br>Class 3 (23dBm±2dB) for LTE-FDD bands<br>Class 3 (23dBm±2dB) for LTE-TDD bands |
| LTE Features | Support 3GPP R8 Cat.4 FDD and TDD<br>Support 1.4 to 20 MHz RF bandwidth<br>Support DL 2 x 2 MIMO<br>● FDD: Max 150Mbps (DL)/Max 50Mbps (UL)<br>● TDD: Max 130Mbps (DL)/Max 35Mbps (UL) |
| UMTS Features | Support 3GPP R8 DC-HSDPA/HSPA+/HSDPA/HSUPA/WCDMA<br>Support 16-QAM, 64-QAM and QPSK modulation<br>● DC-HSDPA: Max 42Mbps (DL)<br>● HSUPA: Max 5.76Mbps (UL)<br>● WCDMA: Max 384Kbps (DL)/Max 384Kbps (UL) |
| TD-SCDMA Features | Support CCSA Release 3<br>● Max 4.2Mbps (DL)/Max 2.2Mbps (UL) |
| CDMA2000 Features | Support 3GPP2 CDMA2000 1X Advanced, CDMA2000 1x EV-DO Rev.A<br>● EVDO: Max 3.1Mbps (DL)/Max 1.8Mbps (UL)<br>● 1X Advanced: Max 307.2Kbps (DL)/Max 307.2Kbps (UL) |

| | |
|---|---|
| GSM Features | **R99:**<br>CSD: 9.6kbps, 14.4kbps<br>**GPRS:**<br>Support GPRS multi-slot class 33 (33 by default)<br>Coding scheme: CS-1, CS-2, CS-3 and CS-4<br>Max 85.6Kbps (UL)/Max 107Kbps (DL)<br>**EDGE:**<br>Support EDGE multi-slot class 33 (33 by default)<br>Support GMSK and 8-PSK for different MCS (Modulation and Coding Scheme)<br>Downlink coding schemes: CS 1-4 and MCS 1-9<br>Uplink coding schemes: CS 1-4 and MCS 1-9<br>Max 236.8Kbps (UL)/Max 296Kbps (DL) |
| WLAN Features | Support 2.4GHz and 5GHz frequency bands<br>Support 802.11a/b/g/n, maximally up to 150Mbps<br>Support AP mode |
| Bluetooth Feature | BT4.1 LE |
| GNSS Features | GPS/GLONASS/BeiDou |
| SMS | Text and PDU mode<br>Point-to-point MO and MT<br>SMS cell broadcast<br>SMS storage: ME by default |
| LCM Interface | 4-lane MIPI_DSI, up to 1.5Gbps per lane<br>Support WVGA (2-lane MIPI_DSI), up to 720p (4-lane MIPI_DSI)<br>24bit color depth |
| Camera Interfaces | Use MIPI_CSI, up to 1.5Gbps per lane<br>Support two cameras:<br>2-lane MIPI_CSI for rear camera, max pixel up to 8MP<br>1-lane MIPI_CSI for front camera, max pixel up to 2MP |
| Video Codec | **Video encoding:**<br>H.264 BP/MP – 720p @30fps<br>MPEG-4 SP/H.263 P0 – WVGA @30fps<br>VP8 – WVGA @30fps<br>**Video decoding:**<br>H.264 BP/MP/HP – 1080P @30fps<br>MPEG-4 SP/ASP –1080P @30fps<br>DivX 4x/5x/6x –1080P @30fps<br>H.263 P0 – WVGA @30fps<br>VP8 –1080P @30 fps<br>(HEVC) H.265 MP 8 bit –1080P @30fps |
| Audio Interfaces | **Audio input:**<br>2 groups of analog microphone input, integrating internal bias voltage |

| | |
|---|---|
| | **Audio output:**<br>Class AB stereo headphone output<br>Class AB earpiece differential output<br>Class D speaker differential amplifier output |
| Audio Codec | HR, FR, EFR, AMR, AMR-WB |
| USB Interface | Compliant with USB 2.0 specification; the data transfer rate can reach up to 480Mbps<br>Used for AT command communication, data transmission, software debugging and firmware upgrade<br>Support USB OTG (Need additional 5V power supply chip)<br>USB Driver: Support Windows XP, Windows Vista, Windows 7/8/8.1 |
| (U)SIM Interfaces | 2 groups of (U)SIM interfaces<br>Support USIM/SIM card: 1.8V, 2.95V<br>Support Dual SIM Dual Standby (supported by default) |
| UART Interfaces | 2 UART interfaces: UART1 and UART2<br>● UART1: 4-wire UART interface with RTS/CTS hardware flow control; baud rate up to 4Mbps<br>● UART2: 2-wire UART interface used for debugging |
| Motor Drive Interface | Drive ERM motor |
| SD Card Interface | Support SD 3.0, 4-bit SDIO<br>Support hot-plug |
| I2C Interfaces | 3 groups of I2C<br>Used for peripherals such as camera, sensor, touch panel, etc. |
| ADC Interfaces | Support 3 ADC interfaces<br>Used for input voltage sense, battery temperature detection and general purpose ADC |
| Real Time Clock | Supported |
| Antenna Interfaces | Main antenna, DRX antenna, GNSS antenna and Wi-Fi/BT antenna |
| Physical Characteristics | Size: (40.5±0.15) × (40.5±0.15) × (2.8±0.2)mm<br>Package: LCC<br>Weight: approx. 9.8g |
| Temperature Range | Operating temperature range: -35°C~+65°C [1)]<br>Extended temperature range: -40°C~+75°C [2)] |
| Firmware Upgrade | Over USB interface |
| RoHS | All hardware components are fully compliant with EU RoHS directive |

**NOTES**

1. [1] Within operation temperature range, the module is 3GPP compliant.
2. [2] Within extended temperature range, the module remains the ability to establish and maintain a voice, SMS, data transmission, emergency call, etc. There is no unrecoverable malfunction. There are also no effects on radio spectrum and no harm to radio network. Only one or more parameters like $P_{out}$ might reduce in their value and exceed the specified tolerances. When the temperature returns to the normal operating temperature levels, the module will meet 3GPP specifications again.

## 2.3. Functional Diagram

The following figure shows a block diagram of SC20 and illustrates the major functional parts.

- Power management
- Radio frequency
- Baseband
- LPDDR3+EMMC flash
- Peripheral interfaces
  --USB interface
  --UART interfaces
  --(U)SIM interfaces
  --SD card interface
  --GPIO interfaces
  --I2C interfaces
  --ADC interfaces
  --LCM (MIPI) interface
  --TP interface
  --CAM (MIPI) interface
  --Audio interfaces

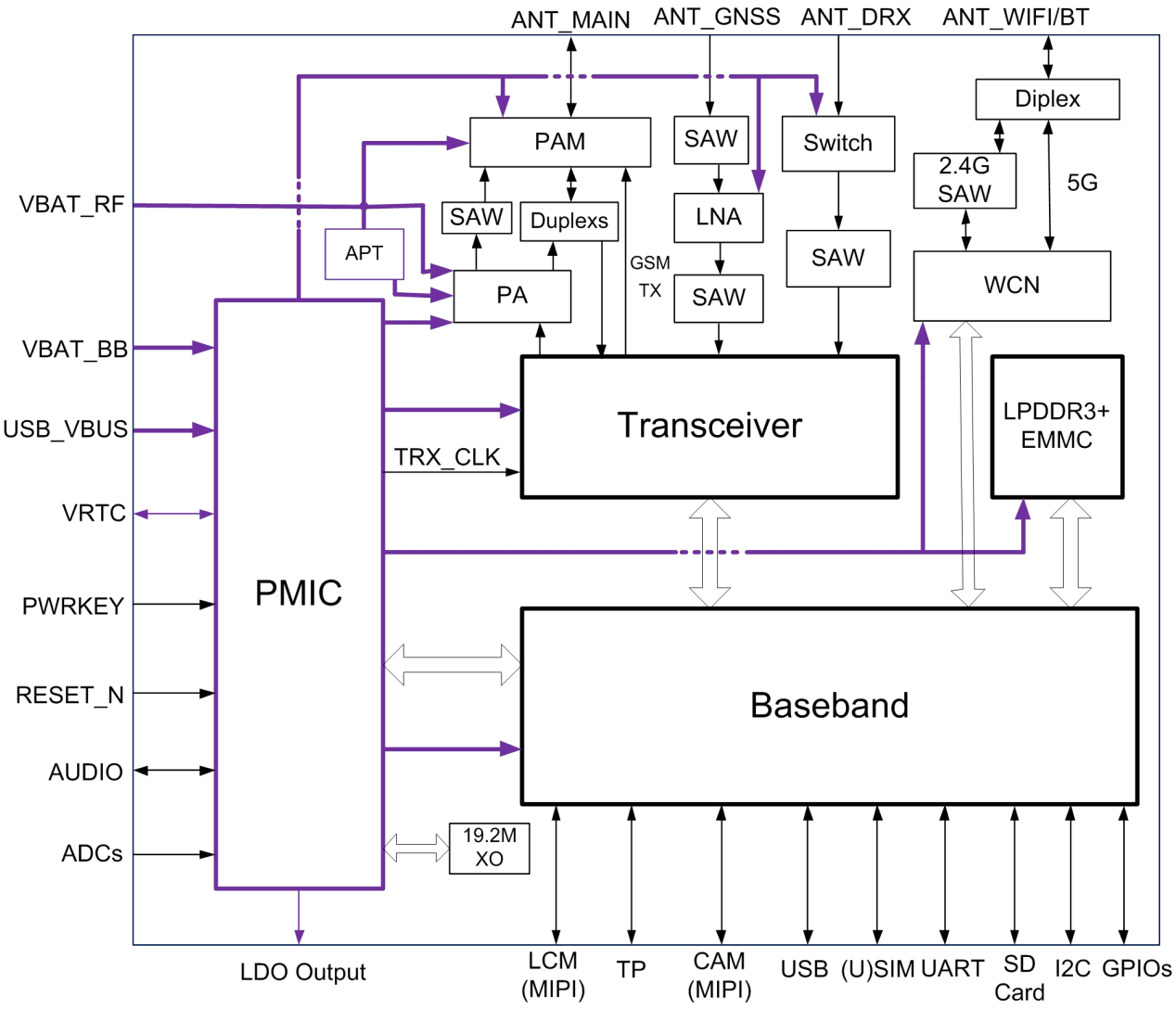



**Figure 1: Functional Diagram**

## 2.4. Evaluation Board

In order to help customers develop applications with SC20 conveniently, Quectel supplies the evaluation board (SMART EVB), USB to RS232 converter cable, USB data cable, power adapter, battery, earphone, antenna and other peripherals to control or test the module. For more details, please refer to ***document [1]***.

# 3 Application Interfaces

## 3.1. General Description

SC20 is equipped with 146-pin 1.0mm pitch SMT pads plus 64-pin ground/reserved pads that can be embedded into cellular application platform. The following chapters provide the detailed description of pins/interfaces listed below.

- Power supply
- VRTC interface
- USB interface
- UART interfaces
- SD card interface
- GPIO interfaces
- I2C interfaces
- ADC interfaces
- Motor drive interface
- LCM interface
- (U)SIM interfaces
- TP interface
- Camera interfaces
- Sensor interfaces
- Audio interfaces
- Emergency download interface

## 3.2. Pin Assignment

The following figure shows the pin assignment of SC20 module.

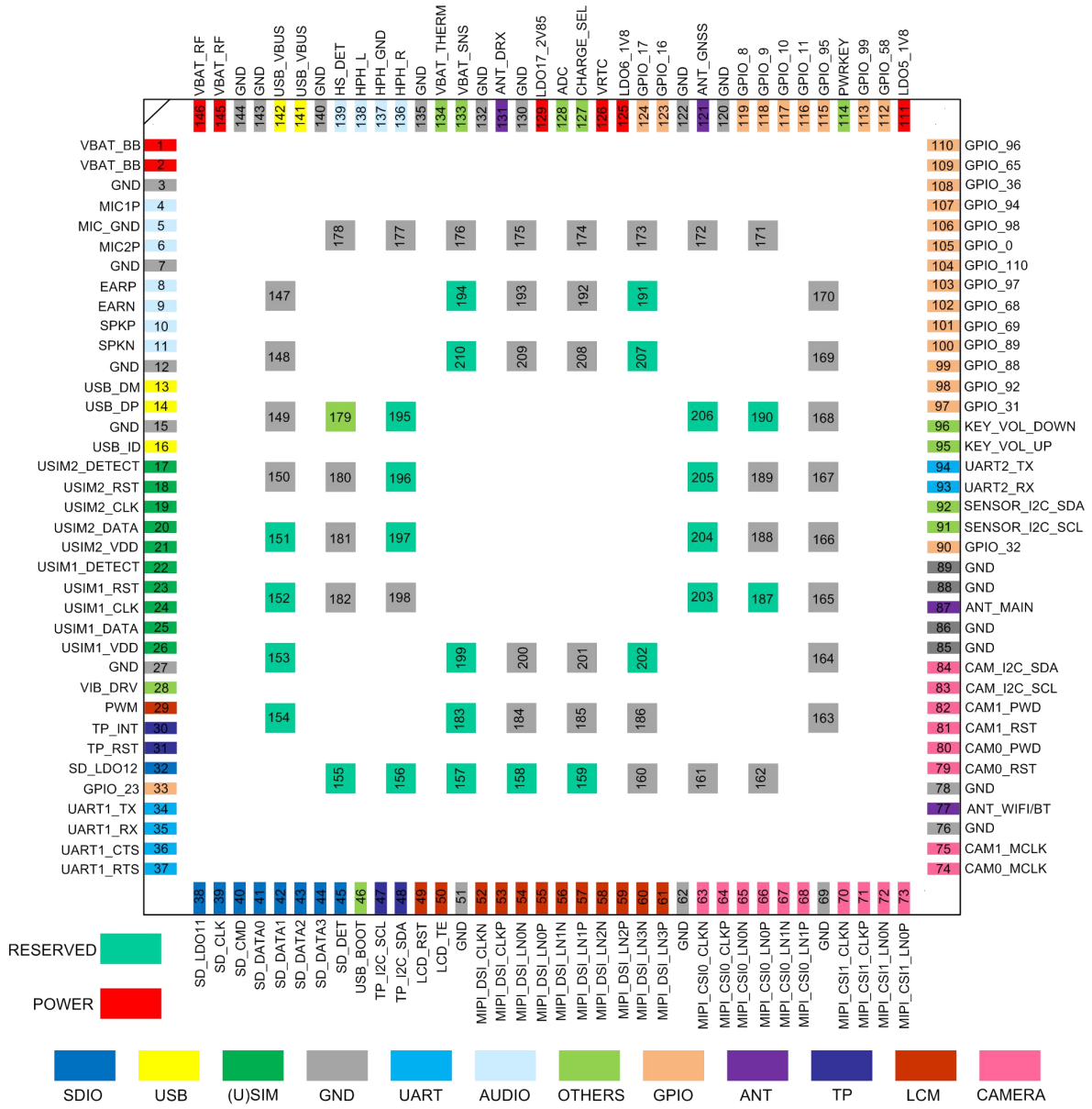



**Figure 2: Pin Assignment (Top View)**

## 3.3. Pin Description

The following tables show the SC20's pin definition.

**Table 7: I/O Parameters Definition**

| Type | Description |
|---|---|
| IO | Bidirectional |
| DI | Digital input |
| DO | Digital output |
| PI | Power input |
| PO | Power output |
| AI | Analog input |
| AO | Analog output |
| OD | Open drain |

**Table 8: Pin Description**

| **Power Supply** | | | | | |
|---|---|---|---|---|---|
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| VBAT_BB | 1, 2 | PI | Power supply for module's baseband part. | Vmax=4.2V<br>Vmin=3.5V<br>Vnorm=3.8V | It must be able to provide sufficient current up to 3.0A. |
| VBAT_RF | 145, 146 | PI | Power supply for module's RF part. | Vmax=4.2V<br>Vmin=3.5V<br>Vnorm=3.8V | It is suggested to use a zener diode for voltage stabilization. |
| VRTC | 126 | PI/PO | Power supply for internal RTC circuit. | $V_O$max=3.2V<br>$V_I$=2.0V~3.25V | If unused, keep this pin open. |
| LDO5_1V8 | 111 | PO | 1.8V output power supply | Vnorm=1.8V<br>$I_O$max=20mA | Power supply for external GPIO's pull up circuits and level conversion circuit. |

| | | | | | |
|---|---|---|---|---|---|
| LDO6_1V8 | 125 | PO | 1.8V output power supply | Vnorm=1.8V<br>$I_O$max=100mA | Power supply for peripherals.<br>2.2uF~4.7uF capacitor is recommended to be applied to the LDO6_1V8 pin.<br>If unused, keep this pin open. |
| LDO17_2V85 | 129 | PO | 2.85V output power supply | Vnorm=2.85V<br>$I_O$max=300mA | Power supply for peripherals.<br>2.2uF~4.7uF capacitor is recommended to be applied to the LDO17_2V85 pin.<br>If unused, keep this pin open. |
| SD_LDO11 | 38 | PO | Power supply for SD card. | Vnorm=2.95V<br>$I_O$max=600mA | |
| SD_LDO12 | 32 | PO | 1.8V/2.95V output power supply | Vnorm=2.95V<br>$I_O$max=50mA | Power supply for SD's pull up circuits. |
| GND | 3, 7, 12, 15, 27, 51, 62, 69, 76, 78, 85, 86, 88, 89, 120, 122, 130, 132, 135, 140, 143, 144, 147~150, 160~178, 180~182, 184~186, 188~189, 192~193, 198~200, 201~208, | | GND | | |

| | | | | | |
|---|---|---|---|---|---|
| | 209 | | | | |
| **Audio Interfaces** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| MIC1P | 4 | AI | Microphone positive input for channel 1 | | |
| MIC_GND | 5 | | MIC reference ground | | |
| MIC2P | 6 | AI | Microphone positive input for channel 2 | | |
| EARP | 8 | AO | Earpiece positive output | | |
| EARN | 9 | AO | Earpiece negative output | | |
| SPKP | 10 | AO | Speaker positive output | | |
| SPKN | 11 | AO | Speaker negative output | | |
| HPH_R | 136 | AO | Headphone right channel output | | |
| HPH_GND | 137 | AI | Headphone virtual ground | | |
| HPH_L | 138 | AO | Headphone left channel output | | |
| HS_DET | 139 | AI | Headset insertion detection | | High level by default. |
| **USB Interface** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| USB_VBUS | 141, 142 | PI | USB power supply | Vmax=6.3V<br>Vmin=4.35V<br>Vnorm=5.0V | Used for USB 5V power input and USB detection. |
| USB_DM | 13 | IO | USB differential data bus (minus) | Compliant with USB 2.0 standard specification. | Require differential impedance of 90Ω. |
| USB_DP | 14 | IO | USB differential data bus (plus) | | |
| USB_ID | 16 | AI | USB ID detection | | High level by default. |

| (U)SIM Interfaces | | | | | |
|---|---|---|---|---|---|
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| USIM2_ DETECT | 17 | DI | (U)SIM2 card hot-plug detection | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | Active Low. External pull-up resistor is required.<br>If unused, keep this pin open. |
| USIM2_RST | 18 | DO | (U)SIM2 card reset signal | $V_{OL}$max=0.4V<br>$V_{OH}$min= 0.8×USIM2_VDD | |
| USIM2_CLK | 19 | DO | (U)SIM2 card clock signal | $V_{OL}$max=0.4V<br>$V_{OH}$min= 0.8×USIM2_VDD | |
| USIM2_DATA | 20 | IO | (U)SIM2 card data signal | $V_{IL}$max= 0.2×USIM2_VDD<br>$V_{IH}$min= 0.7×USIM2_VDD<br>$V_{OL}$max=0.4V<br>$V_{OH}$min= 0.8×USIM2_VDD | |
| USIM2_VDD | 21 | PO | (U)SIM2 card power supply | **For 1.8V (U)SIM:**<br>Vmax=1.85V<br>Vmin=1.75V<br><br>**For 2.95V (U)SIM:**<br>Vmax=3.1V<br>Vmin=2.8V | Either 1.8V or 2.95V (U)SIM card is supported by the module automatically. |
| USIM1_ DETECT | 22 | DI | (U)SIM1 card hot-plug detection | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | Active low. External pull-up resistor is required.<br>If unused, keep this pin open. |
| USIM1_RST | 23 | DO | (U)SIM1 card reset signal | $V_{OL}$max=0.4V<br>$V_{OH}$min= 0.8×USIM1_VDD | |
| USIM1_CLK | 24 | DO | (U)SIM1 card clock signal | $V_{OL}$max=0.4V<br>$V_{OH}$min= 0.8×USIM1_VDD | |
| USIM1_DATA | 25 | IO | (U)SIM1 card data signal | $V_{IL}$max= 0.2×USIM1_VDD<br>$V_{IH}$min= 0.7×USIM1_VDD | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | $V_{OL}$max=0.4V<br>$V_{OH}$min=<br>0.8×USIM1_VDD | |
| USIM1_VDD | 26 | PO | (U)SIM1 card power supply | **For 1.8V (U)SIM:**<br>Vmax=1.85V<br>Vmin=1.75V<br><br>**For 2.95V (U)SIM:**<br>Vmax=3.1V<br>Vmin=2.8V | Either 1.8V or 2.95V (U)SIM card is supported by the module automatically |
| **UART Interfaces** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| UART1_TX | 34 | DO | UART1 transmit data | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | 1.8V power domain. If unused, keep this pin open. |
| UART1_RX | 35 | DI | UART1 receive data | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | 1.8V power domain. If unused, keep this pin open. |
| UART1_CTS | 36 | DI | UART1 clear to send | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | 1.8V power domain. If unused, keep this pin open. |
| UART1_RTS | 37 | DO | UART1 request to send | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | 1.8V power domain. If unused, keep this pin open. |
| UART2_RX | 93 | DI | UART2 receive data.<br>Debug port by default. | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | 1.8V power domain. If unused, keep this pin open. |
| UART2_TX | 94 | DO | UART2 transmit data.<br>Debug port by default. | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | 1.8V power domain. If unused, keep this pin open. |
| **SD Card Interface** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| SD_CLK | 39 | DO | High speed digital clock signal of SD card | **1.8V SD card:**<br>$V_{OL}$max=0.45V<br>$V_{OH}$min=1.4V<br><br>**2.95V SD card:**<br>$V_{OL}$max=0.37V | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | $V_{OH}$min=2.2V | |
| SD_CMD | 40 | IO | Command signal of SD card | **1.8V SD card:**<br>$V_{IL}$max=0.58V<br>$V_{IH}$min=1.27V<br>$V_{OL}$max=0.45V<br>$V_{OH}$min=1.4V<br><br>**2.95V SD card:**<br>$V_{IL}$max=0.73V<br>$V_{IH}$min=1.84V<br>$V_{OL}$max=0.37V<br>$V_{OH}$min=2.2V | |
| SD_DATA0 | 41 | IO | High speed bidirectional digital signal lines of SD card | **1.8V SD card:**<br>$V_{IL}$max=0.58V<br>$V_{IH}$min=1.27V<br>$V_{OL}$max=0.45V<br>$V_{OH}$min=1.4V<br><br>**2.95V SD card:**<br>$V_{IL}$max=0.73V<br>$V_{IH}$min=1.84V<br>$V_{OL}$max=0.37V<br>$V_{OH}$min=2.2V | |
| SD_DATA1 | 42 | IO | | | |
| SD_DATA2 | 43 | IO | | | |
| SD_DATA3 | 44 | IO | | | |
| SD_DET | 45 | DI | SD card insertion detection | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | Active low |
| **Touch Panel (TP) Interface** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| TP_INT | 30 | DI | Interrupt signal of TP | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | 1.8V power domain. |
| TP_RST | 31 | DO | Reset signal of TP | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | 1.8V power domain.<br>Active low. |
| TP_I2C_SCL | 47 | OD | I2C clock signal of TP | | 1.8V power domain. |
| TP_I2C_SDA | 48 | OD | I2C data signal of TP | | 1.8V power domain. |
| **LCM Interface** | | | | | |

| Pin Name | Pin No. | I/O | Description | DC Characteristics | Comment |
|---|---|---|---|---|---|
| PWM | 29 | DO | Adjust the backlight brightness.<br>PWM control signal. | $V_{OL}$max=0.45V<br>$V_{OH}$max=VBAT_BB | |
| LCD_RST | 49 | DO | LCD reset signal | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | 1.8V power domain.<br>Active low. |
| LCD_TE | 50 | DI | LCD tearing effect signal | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | 1.8V power domain. |
| MIPI_DSI_CLKN | 52 | AO | MIPI DSI clock signal (negative) | | |
| MIPI_DSI_CLKP | 53 | AO | MIPI DSI clock signal (positive) | | |
| MIPI_DSI_LN0N | 54 | AO | MIPI DSI data signal (negative) | | |
| MIPI_DSI_LN0P | 55 | AO | MIPI DSI data signal (positive) | | |
| MIPI_DSI_LN1N | 56 | AO | MIPI DSI data signal (negative) | | |
| MIPI_DSI_LN1P | 57 | AO | MIPI DSI data signal (positive) | | |
| MIPI_DSI_LN2N | 58 | AO | MIPI DSI data signal (negative) | | |
| MIPI_DSI_LN2P | 59 | AO | MIPI DSI data signal (positive) | | |
| MIPI_DSI_LN3N | 60 | AO | MIPI DSI data signal (negative) | | |
| MIPI_DSI_LN3P | 61 | AO | MIPI DSI data signal (positive) | | |
| **Camera Interfaces** | | | | | |
| **Pin Name** | **Pin No** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| MIPI_CSI0_CLKN | 63 | AI | MIPI CSI clock signal (negative) | | |
| MIPI_CSI0_CLKP | 64 | AI | MIPI CSI clock signal (positive) | | |

| | | | | | |
|---|---|---|---|---|---|
| MIPI_CSI0_LN0N | 65 | AI | MIPI CSI data signal (negative) | | |
| MIPI_CSI0_LN0P | 66 | AI | MIPI CSI data signal (positive) | | |
| MIPI_CSI0_LN1N | 67 | AI | MIPI CSI data signal (negative) | | |
| MIPI_CSI0_LN1P | 68 | AI | MIPI CSI data signal (positive) | | |
| MIPI_CSI1_CLKN | 70 | AI | MIPI CSI clock signal (negative) | | |
| MIPI_CSI1_CLKP | 71 | AI | MIPI CSI clock signal (positive) | | |
| MIPI_CSI1_LN0N | 72 | AI | MIPI CSI data signal (negative) | | |
| MIPI_CSI1_LN0P | 73 | AI | MIPI CSI data signal (positive) | | |
| CAM0_MCLK | 74 | DO | Clock signal of rear camera | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | |
| CAM1_MCLK | 75 | DO | Clock signal of front camera | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | |
| CAM0_RST | 79 | DO | Reset signal of rear camera | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | |
| CAM0_PWD | 80 | DO | Power down signal of rear camera | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | |
| CAM1_RST | 81 | DO | Reset signal of front camera | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | |
| CAM1_PWD | 82 | DO | Power down signal of front camera | $V_{OL}$max=0.45V<br>$V_{OH}$min=1.35V | |
| CAM_I2C_SCL | 83 | OD | I2C clock signal of camera | | 1.8V power domain. |
| CAM_I2C_SDA | 84 | OD | I2C data signal of camera | | 1.8V power domain. |
| **Keypad Interfaces** | | | | | |

| Pin Name | Pin No | I/O | Description | DC Characteristics | Comment |
|---|---|---|---|---|---|
| PWRKEY | 114 | DI | Turn on/off the module | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | Pull-up to 1.8V internally, active low. |
| KEY_VOL_UP | 95 | DI | Volume up | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | If unused, keep this pin open. |
| KEY_VOL_DOWN | 96 | DI | Volume down | $V_{IL}$max=0.63V<br>$V_{IH}$min=1.17V | If unused, keep this pin open. |
| **SENSOR_I2C Interface** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| SENSOR_I2C_SCL | 91 | OD | I2C clock signal for external sensor | | 1.8V power domain. |
| SENSOR_I2C_SDA | 92 | OD | I2C data signal for external sensor | | 1.8V power domain. |
| **ADC Interfaces** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| ADC | 128 | AI | General purpose ADC | | Maximum voltage not exceeding 1.7V |
| VBAT_SNS | 133 | AI | Input voltage sense | | Maximum input voltage is 4.5V. |
| VBAT_THERM | 134 | AI | Battery temperature detection | | |
| **RF Interface** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| ANT_MAIN | 87 | IO | Main antenna | 50Ω impedance | |
| ANT_DRX | 131 | AI | Diversity antenna | | |
| ANT_GNSS | 121 | AI | GNSS antenna | | |
| ANT_WIFI/BT | 77 | IO | Wi-Fi/BT antenna | | |
| **GPIO Interfaces** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |

| | | | |
|---|---|---|---|
| GPIO_23 | 33 | IO | GPIO |
| GPIO_32 | 90 | IO | GPIO |
| GPIO_31 | 97 | IO | GPIO |
| GPIO_92 | 98 | IO | GPIO |
| GPIO_88 | 99 | IO | GPIO |
| GPIO_89 | 100 | IO | GPIO |
| GPIO_69 | 101 | IO | GPIO |
| GPIO_68 | 102 | IO | GPIO |
| GPIO_97 | 103 | IO | GPIO |
| GPIO_110 | 104 | IO | GPIO |
| GPIO_0 | 105 | IO | GPIO |
| GPIO_98 | 106 | IO | GPIO |
| GPIO_94 | 107 | IO | GPIO |
| GPIO_36 | 108 | IO | GPIO |
| GPIO_65 | 109 | IO | GPIO |
| GPIO_96 | 110 | IO | GPIO |
| GPIO_58 | 112 | IO | GPIO |
| GPIO_99 | 113 | IO | GPIO |
| GPIO_95 | 115 | IO | GPIO |
| GPIO_11 | 116 | IO | GPIO |
| GPIO_10 | 117 | IO | GPIO |
| GPIO_9 | 118 | IO | GPIO |
| GPIO_8 | 119 | IO | GPIO |
| GPIO_16 | 123 | IO | GPIO |
| GPIO_17 | 124 | IO | GPIO |

| Other Interfaces | | | | | |
|---|---|---|---|---|---|
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| VIB_DRV | 28 | PO | Motor drive | | Connected to the negative terminal of the motor. |
| RESET_N | 179 | DI | Reset the module | | |
| USB_BOOT | 46 | DI | Force the module to boot from USB port | | Set USB_BOOT pin to high level will force the module to enter into emergency download mode. |
| CHARGE_SEL | 127 | DI | Used for charger selection | | If it is open, internal charger is used;<br>If it is connected to GND, external charger is used. |
| **Reserved Interface** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| RESERVED | 151, 152, 153, 154, 155, 156, 157, 158, 159, 183, 187, 190, 191, 194, 195, 196, 197, 199, 202, 203, 204, 205, 206, 207, 210 | | Reserved pins | | Not connected by default. |

## 3.4. Power Supply

### 3.4.1. Power Supply Pins

SC20 provides four VBAT pins dedicated to connection with the external power supply. Two VBAT_RF pins are used for module's RF part; two VBAT_BB pins are used for module's baseband part.

### 3.4.2. Decrease Voltage Drop

The power supply range of the module is 3.5V~4.2V, and the recommended value is 3.8V. The power supply performance, such as load capacity, voltage ripple, etc. directly influences the module's performance and stability. Under ultimate conditions, the module may have a transient peak current up to 3A. If the supply voltage is not enough, there will be voltage drops, and if the voltage drops below 3.1V, the module will be turned off automatically. Therefore, please make sure the input voltage will never drop below 3.1V.

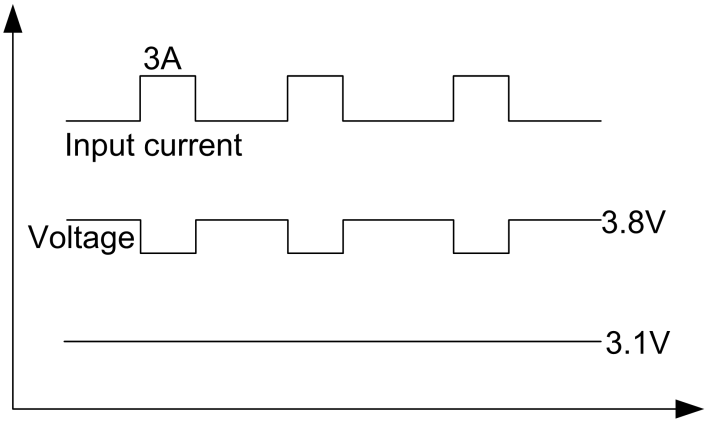



**Figure 3: Voltage Drop Sample**

To decrease voltage drop, a bypass capacitor of about 100μF with low ESR (ESR=0.7Ω) should be used, and a multi-layer ceramic chip capacitor (MLCC) should also be reserved due to its ultra-low ESR. It is recommended to use three ceramic capacitors (100nF, 33pF, 10pF) for composing the MLCC array, and place these capacitors close to VBAT_BB/RF pins. The main power supply from an external application has to be a single voltage source and can be expanded to two sub paths with star structure. The width of VBAT_BB trace should be no less than 1.5mm, and the width of VBAT_RF trace should be no less than 2mm. In principle, the longer the VBAT trace is, the wider it will be.

In addition, in order to get a stable power source, it is suggested to use a 0.5W zener diode and place it as close to the VBAT_BB/RF pins as possible. The following figure shows the star structure of the power supply.

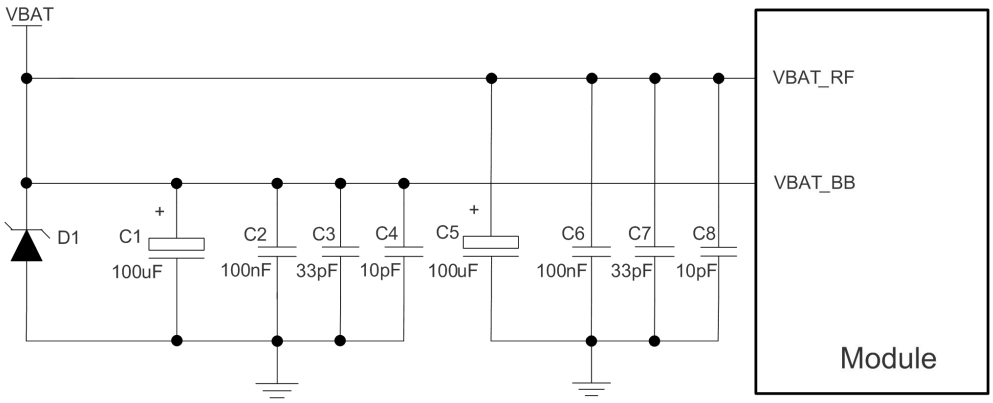



**Figure 4: Star Structure of the Power Supply**

### 3.4.3. Reference Design for Power Supply

The power design for the module is very important, as the performance of module largely depends on the power source. The power supply of SC20 should be able to provide sufficient current up to 3A at least. If the voltage drop between the input and output is not too high, it is suggested to use an LDO to supply power for the module. If there is a big voltage difference between the input source and the desired output (VBAT), a buck converter is preferred to be used as the power supply.

The following figure shows a reference design for +5V input power source which adopts an LDO (MIC29302WU) from MICREL. The typical output voltage is 3.8V and the maximum load current is 3.0A.

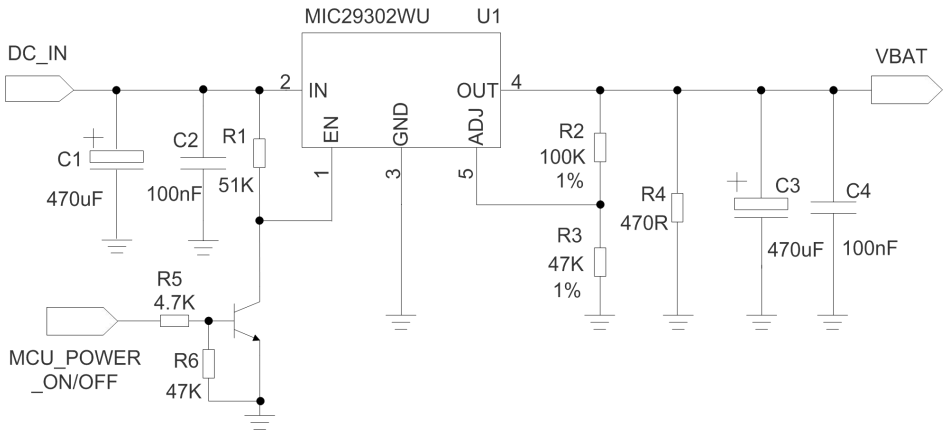



**Figure 5: Reference Circuit of Power Supply**

**NOTES**

1. It is suggested that customers should switch off the power supply for module in abnormal state, and then switch on the power to restart the module.
2. The module supports battery charging function by default. If the above power supply design is adopted, please make sure the charging function is disabled by software, or connect VBAT to Schottky diode in series to avoid the reverse current to the power supply chip.

## 3.5. Turn on and off Scenarios

### 3.5.1. Turn on Module Using the PWRKEY

The module can be turned on by driving PWRKEY pin to a low level for at least 1.6s. PWRKEY pin is pulled to 1.8V internally. It is recommended to use an open drain/collector driver to control the PWRKEY. A simple reference circuit is illustrated in the following figure.

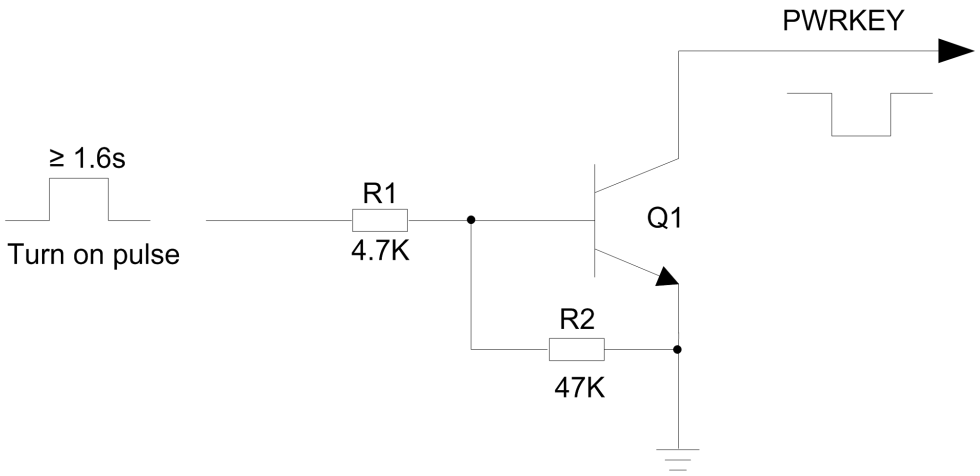



**Figure 6: Turn on the Module Using Driving Circuit**

The other way to control the PWRKEY is using a button directly. A TVS component is indispensable to be placed nearby the button for ESD protection. A reference circuit is shown in the following figure.

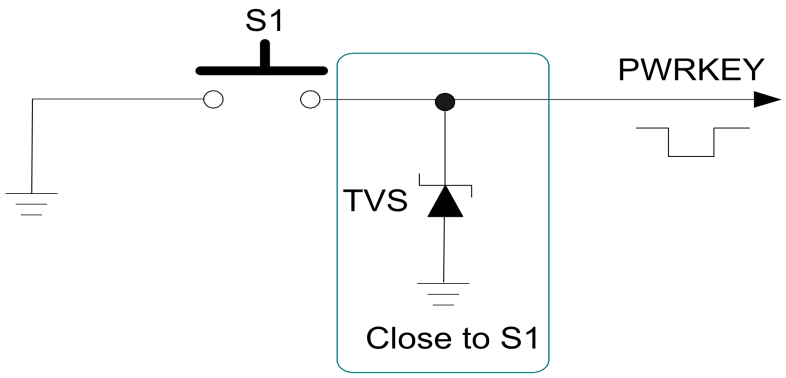



**Figure 7: Turn on the Module Using Keystroke**

The turning on scenario is illustrated in the following figure.

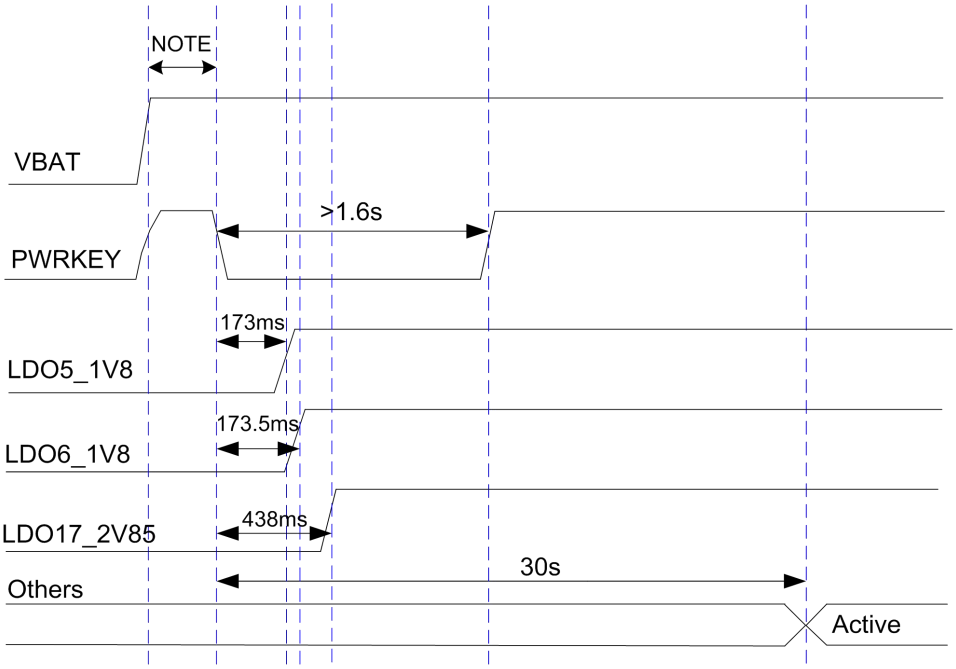



**Figure 8: Timing of Turning on Module**

**NOTE**

Make sure that VBAT is stable before pulling down PWRKEY pin. The recommended time between them is no less than 30ms. PWRKEY pin cannot be pulled down all the time.

### 3.5.2. Turn off Module

Set the PWRKEY pin low for at least 1s, and then choose to turn off the module when the prompt window comes up.

The other way to turn off the module is to drive PWRKEY to a low level for at least 8s. The module will execute forced shutdown. The forced power-down scenario is illustrated in the following figure.

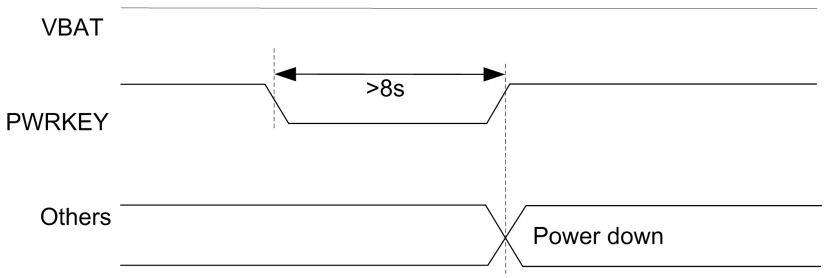



**Figure 9: Timing of Turning off Module**

## 3.6. VRTC Interface

The RTC (Real Time Clock) can be powered by an external power source through VRTC when the module is powered down and there is no power supply for the VBAT. The external power source can be capacitor or rechargeable battery (such as coil cells) according to application demands. The following are some reference circuit designs when an external battery or capacitor is utilized for powering RTC.

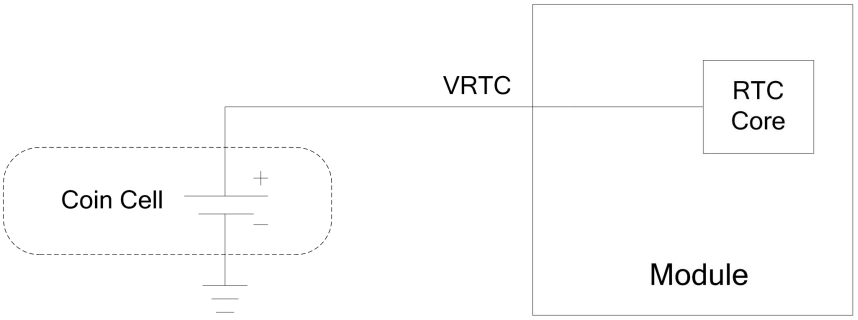



**Figure 10: RTC Powered by Coin Cell**

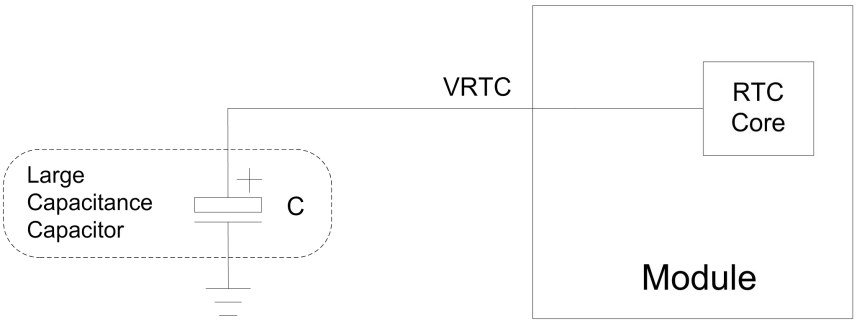



**Figure 11: RTC Powered by Capacitor**

If RTC is ineffective, it can be synchronized through network after the module is powered on.

- 2.0V~3.25V input voltage range and 3.0V typical value for VRTC. When VBAT is disconnected, the average consumption is about 5uA.
- When powered by VBAT, the RTC error is 50ppm. When powered by VRTC, the RTC error is 200ppm.
- If the rechargeable battery is used, the ESR of the battery should be less than 2K, and it is recommended to use the MS621FE FL11E of SEIKO.
- If large capacitance capacitor is selected, it is recommended to use a 100uF capacitor with low ESR. The capacitor will be able to power the real-time clock for 45 seconds.

## 3.7. Power Output

SC20 supports output of regulated voltages for peripheral circuits. During application, it is recommended to use parallel capacitors (33pF and 10pF) in the circuit to suppress high frequency noise.

**Table 9: Power Description**

| Pin Name | Voltage Range (V) | Default Voltage (V) | Driving Current (mA) | IDLE |
|---|---|---|---|---|
| LDO5_1V8 | - | 1.8 | 20 | KEEP |
| LDO6_1V8 | - | 1.8 | 100 | / |
| LDO17_2V85 | - | 2.85 | 300 | / |
| SD_LDO12 | 1.750~3.337 | 2.95 | 50 | / |
| SD_LDO11 | 1.750~3.337 | 2.95 | 600 | / |
| USIM1_VDD | 1.750~3.337 | 1.80/2.95 | 50 | |

| | | | |
|---|---|---|---|
| USIM2_VDD | 1.750~3.337 | 1.80/2.95 | 50 |

## 3.8. Battery Charge and Management

SC20 module can recharge batteries. The battery charger in SC20 module supports trickle charging, constant current charging and constant voltage charging modes, which optimize the charging procedure for Li-ion batteries.

- **Trickle charging:** There are two steps in this mode. When the battery voltage is below 2.8V, a 90mA trickle charging current is applied to the battery. When the battery voltage is charged up and is between 2.8V and 3.2V, the charging current can be set to 450mA maximally.
- **Constant current mode (CC mode):** When the battery is increased to between 3.2V and 4.2V, the system will switch to CC mode. The maximum charging current is 1.44A when adapter is used for battery charging; and the maximum charging current is 450mA while USB charging.
- **Constant voltage mode (CV mode):** When the battery voltage reaches the final value 4.2V, the system will switch to CV mode and the charging current will decrease gradually. When the battery level reaches 100%, the charging is completed.

SC20 module supports battery temperature detection in the condition that the battery integrates a thermistor (47K 1% NTC thermistor with B-constant of 4050K by default; SDNT1608X473F4050FTF of SUNLORD is recommended) and the thermistor is connected to VBAT_THERM pin. The default battery temperature range is -3.0°C~48.5°C. If VBAT_THERM pin is not connected, there will be malfunctions such as battery charging failure, battery level display error, etc.

A reference design for battery charging circuit is shown as below.

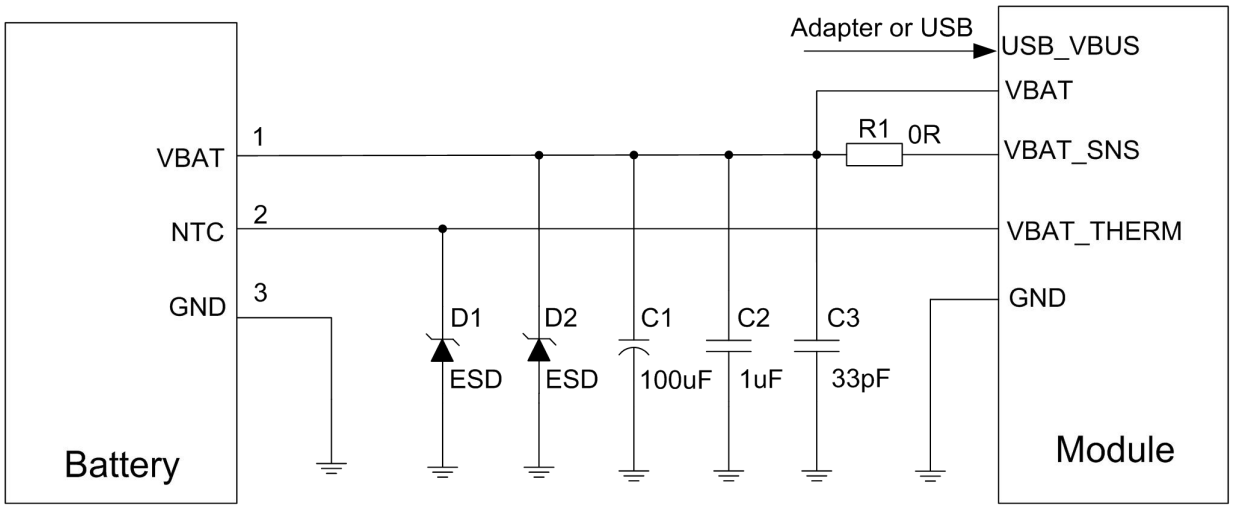



**Figure 12: Reference Design for Battery Charging Circuit**

Mobile devices such as mobile phones and handheld POS systems are powered by batteries. When different batteries are utilized, the charging and discharging curve has to be modified correspondingly so as to achieve the best effect.

If thermistor is not available in the battery, or adapter is utilized for powering module, then there is only need for VBAT and GND connection. In this case, the system may mistakenly judge that the battery temperature is abnormal, which will cause battery charging failure. In order to avoid this, VBAT_THERM should be connected to GND via a 47KΩ resistor. If VBAT_THERM is unconnected, the system will be unable to detect the battery, making battery cannot be charged.

VBAT_SNS pin must be connected. Otherwise, the module will have abnormalities in voltage detection, as well as associated power on/off and battery charging and discharging issues.

## 3.9. USB Interface

SC20 contains one integrated Universal Serial Bus (USB) interface which complies with the USB 2.0 specification and supports high speed (480Mbps) and full speed (12Mbps) modes. The USB interface is used for AT command communication, data transmission, software debugging and firmware upgrade.

The following table shows the pin definition of USB interface.

**Table 10: Pin Definition of USB Interface**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| USB_VBUS | 141, 142 | PI | USB power supply | 4.35V~6.3V.<br>Typical 5.0V. |
| USB_DM | 13 | IO | USB differential data bus (minus) | Require differential impedance of 90Ω |
| USB_DP | 14 | IO | USB differential data bus (plus) | |
| USB_ID | 16 | AI | USB ID detection | High level by default |

USB_VBUS can be powered by USB power or adapter. It can also be used for detecting USB connection, as well as for battery charging via the internal PMU. The input voltage of power supply ranges from 4.35 to 6.3V, and the typical value is 5V. SC20 module supports charging management for a single Li-ion battery, but varied charging parameters should be set for batteries with varied models or capacities. The module is available a built-in linear-charging circuit which supports maximally 1.44A charging current.

The following are two USB interface reference designs for customers to choose from.

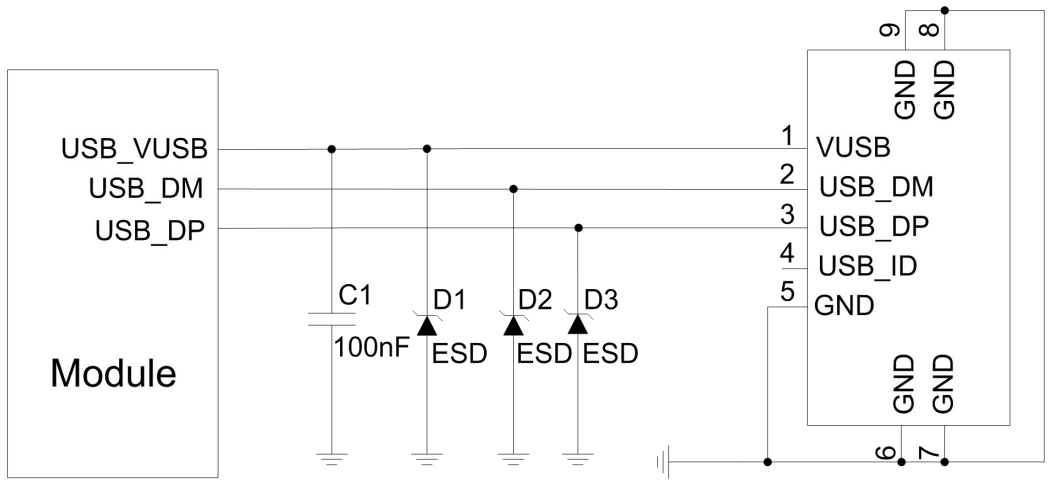



**Figure 13: USB Interface Reference Design (OTG is not Supported)**

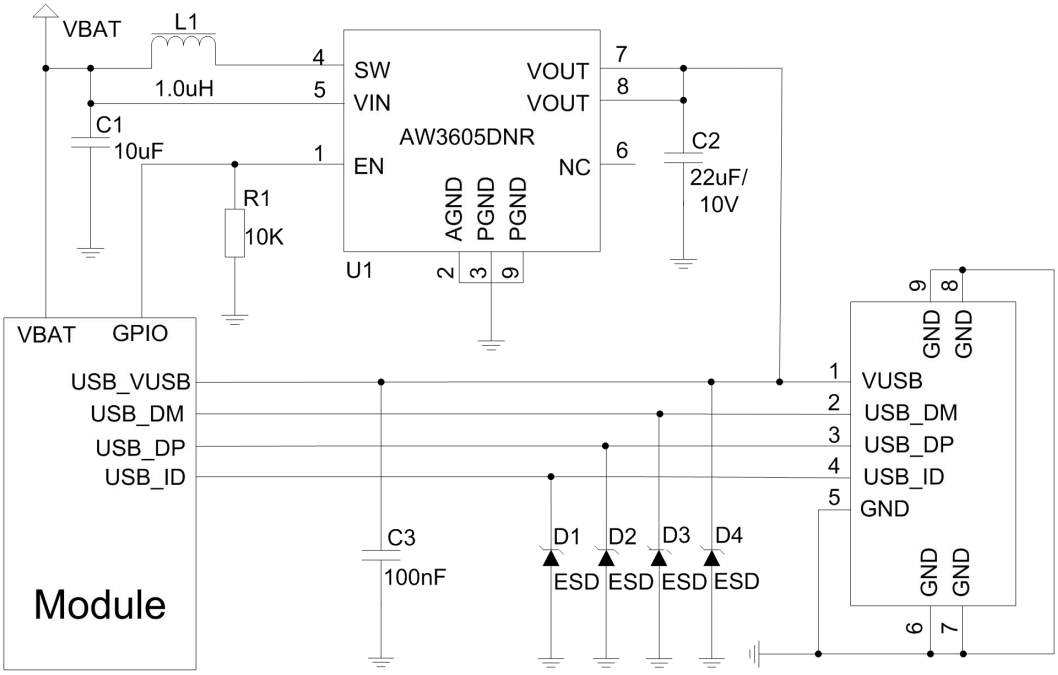



**Figure 14: USB Interface Reference Design (OTG is Supported)**

SC20 supports OTG protocol. If OTG function is needed, please refer to the above figure for the reference design. AW3605DNR is a high efficiency DC-DC chip manufactured by AWINIC, and customers can choose according to their own demands.

In order to ensure USB performance, please comply with the following principles while designing USB interface.

- It is important to route the USB signal traces as differential pairs with total grounding. The impedance of USB differential trace is 90Ω.
- Keep the ESD protection devices as close as possible to the USB connector. Pay attention to the influence of junction capacitance of ESD protection devices on USB data lines. Typically, the capacitance value should be less than 2pF.
- Do not route signal traces under crystals, oscillators, magnetic devices and RF signal traces. It is important to route the USB differential traces in inner-layer with ground shielding on not only upper and lower layer but also right and left sides.
- Make sure the trace length difference between USB_DM and USB_DP is not exceeding 6.6mm.

**Table 11: USB Trace Length Inside the Module**

| PIN | Signal | Length (mm) | Length Difference (DP-DM) |
|---|---|---|---|
| 13 | USB_DM | 29.43 | -0.07 |
| 14 | USB_DP | 29.36 | |

## 3.10. UART Interfaces

The module provides two UART interfaces:

- **UART1:** 4-wire UART interface which supports hardware flow control
- **UART2:** 2-wire UART interfaces and is used for debugging

**Table 12: Pin Definition of UART Interfaces**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| UART1_TX | 34 | DO | UART1 transmit data | 1.8V power domain.<br>If it is unused, keep it open. |
| UART1_RX | 35 | DI | UART1 receive data | 1.8V power domain.<br>If it is unused, keep it open. |
| UART1_CTS | 36 | DI | UART1 clear to send | 1.8V power domain.<br>If it is unused, keep it open. |
| UART1_RTS | 37 | DO | UART1 request to send | 1.8V power domain.<br>If it is unused, keep it open. |
| UART2_RX | 93 | DI | UART2 receive data.<br>Debug port by default. | 1.8V power domain.<br>If it is unused, keep it open. |
| UART2_TX | 94 | DO | UART2 transmit data.<br>Debug port by default. | 1.8V power domain.<br>If it is unused, keep it open. |

UART1 provides 1.8V logic level. A level translator should be used if customers' application is equipped with a 3.3V UART interface. A level translator TXS0104PWR provided by *Texas Instruments* is recommended. The following figure shows the reference design.

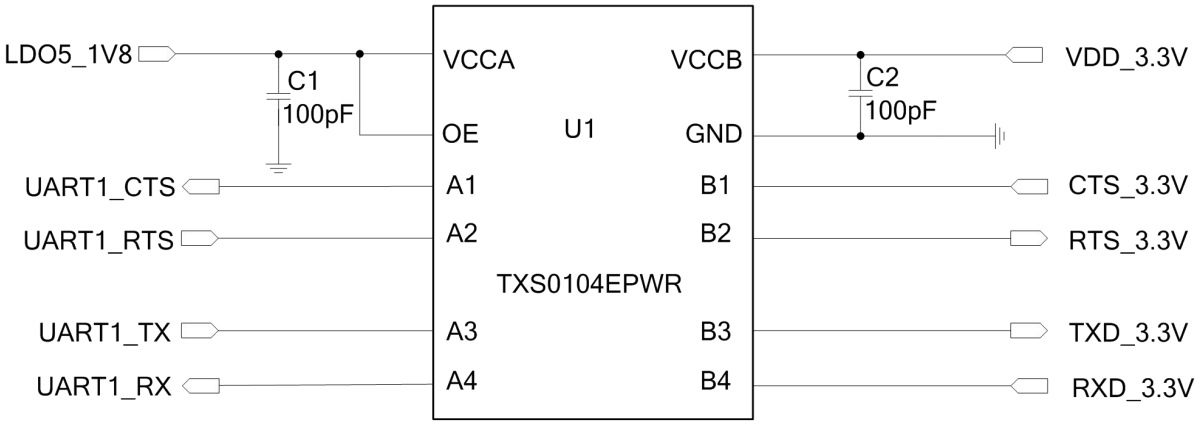



**Figure 15: Reference Circuit with Level Translator Chip (for UART1)**

The following figure is an example of connection between SC20 and PC. A voltage level translator and a RS-232 level translator chip are also recommended to be added between the module and PC, as these two UART interfaces do not support the RS-232 level, while support the 1.8V CMOS level only.

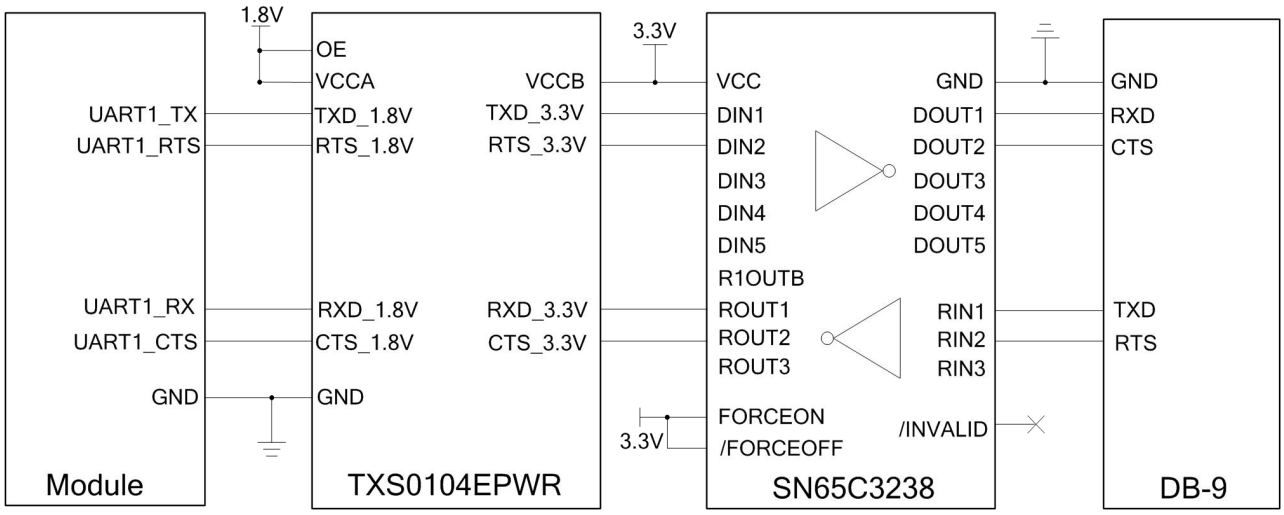



**Figure 16: RS232 Level Match Circuit (for UART1)**

**NOTE**

UART2 is similar to UART1. Please refer to UART1 reference circuit designs for UART2's.

## 3.11. (U)SIM Interfaces

SC20 provides 2 (U)SIM interfaces which circuitry meet ETSI and IMT-2000 requirements. Dual SIM Card Dual Standby is supported by default. Both 1.8V and 2.95V (U)SIM cards are supported, and the (U)SIM card interfaces are powered by the internal power supply of SC20 module.

**Table 13: Pin Definition of (U)SIM Interfaces**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| USIM2_DETECT | 17 | DI | (U)SIM2 card hot-plug detection | Active Low. External pull-up resistor is required.<br>If unused, keep this pin open. |
| USIM2_RST | 18 | DO | (U)SIM2 card reset signal | |
| USIM2_CLK | 19 | DO | (U)SIM2 card clock signal | |
| USIM2_DATA | 20 | IO | (U)SIM2 card data signal | Pull-up to USIM2_VDD with a 10K resistor. |
| USIM2_VDD | 21 | PO | (U)SIM2 card power supply | Either 1.8V or 2.95V (U)SIM card is supported by the module automatically. |
| USIM1_DETECT | 22 | DI | (U)SIM1 card hot-plug detection | Active low. External pull-up resistor is required.<br>If unused, keep this pin open. |
| USIM1_RST | 23 | DO | (U)SIM1 card reset signal | |
| USIM1_CLK | 24 | DO | (U)SIM1 card clock signal | |
| USIM1_DATA | 25 | IO | (U)SIM1 card data signal | Pull-up to USIM1_VDD with a 10K resistor. |
| USIM1_VDD | 26 | PO | (U)SIM1 card power supply | Either 1.8V or 2.95V (U)SIM card is supported by the module automatically. |

SC20 supports (U)SIM card hot-plug via the USIM_DETECT pin. A reference circuit for (U)SIM interface with an 8-pin (U)SIM card connector is shown below.

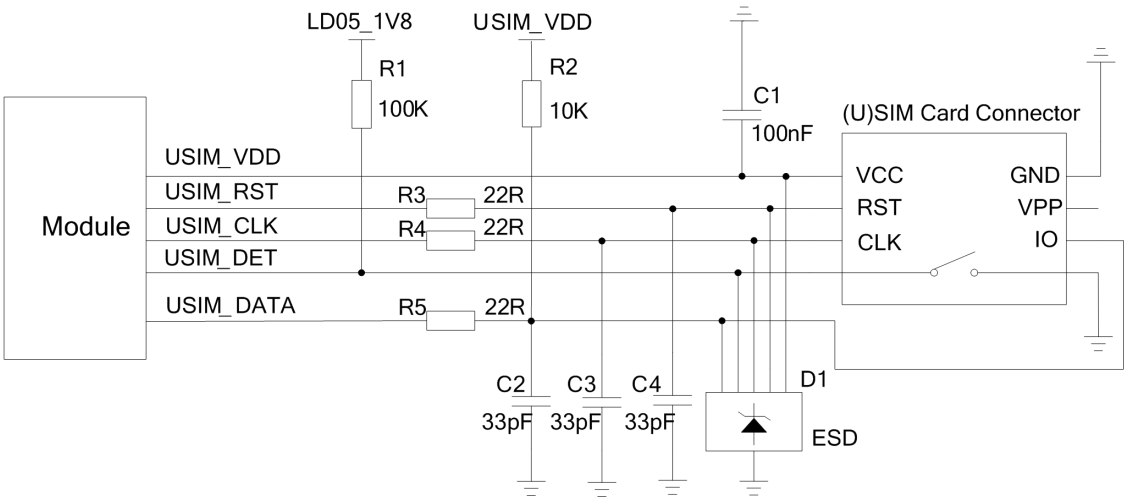



**Figure 17: Reference Circuit for (U)SIM Interface with an 8-pin (U)SIM Card Connector**

If there is no need to use USIM_DETECT, please keep it open. The following is a reference circuit for (U)SIM interface with a 6-pin (U)SIM card connector.

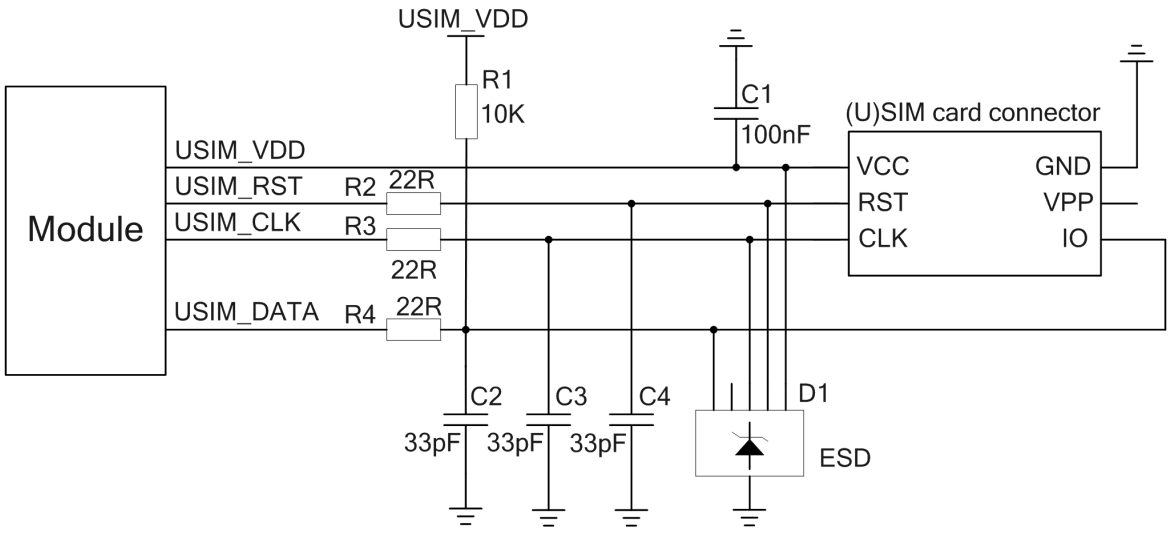



**Figure 18: Reference Circuit for (U)SIM Interface with a 6-pin (U)SIM Card Connector**

In order to ensure good performance and avoid damage of (U)SIM cards, please follow the criteria below in (U)SIM circuit design:

- Keep placement of (U)SIM card connector as close to the module as possible. Keep the trace length of (U)SIM card signals as less than 200mm as possible.
- Keep (U)SIM card signals away from RF and VBAT traces.
- A 100nF filter capacitor shall be reserved for USIM_VDD, and its maximum capacitance should not exceed 1uF. The capacitor should be placed near to (U)SIM card.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with ground. USIM_RST also needs ground protection.

- In order to offer good ESD protection, it is recommended to add a TVS diode array with parasitic capacitance not exceeding 50pF. The 22Ω resistors should be added in series between the module and (U)SIM card so as to suppress EMI spurious transmission and enhance ESD protection. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The 33pF capacitors should be added in parallel on USIM_DATA, USIM_CLK and USIM_RST signal lines so as to filter RF interference, and they should be placed as close to the (U)SIM card connector as possible.

## 3.12. SD Card Interface

SC20 module supports SD cards with 4-bit data interfaces or SDIO devices. The pin definition of the SD card interface is shown below.

**Table 14: Pin Definition of SD Card Interface**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| SD_LDO11 | 38 | PO | Power supply for SD card | Vnorm=2.95V<br>$I_O$max=600mA |
| SD_LDO12 | 32 | PO | 1.8V/2.95V output power supply | Support 1.8V or 2.95V power supply.<br>The maximum drive current is 50mA. |
| SD_CLK | 39 | DO | High speed digital clock signal of SD card | Control characteristic impedance as 50Ω. |
| SD_CMD | 40 | I/O | Command signal of SD card | |
| SD_DATA0 | 41 | I/O | High speed bidirectional digital signal lines of SD card | |
| SD_DATA1 | 42 | I/O | | |
| SD_DATA2 | 43 | I/O | | |
| SD_DATA3 | 44 | I/O | | |
| SD_DET | 45 | DI | SD card insertion detection | Active low |

A reference circuit for SD card interface is shown as below.

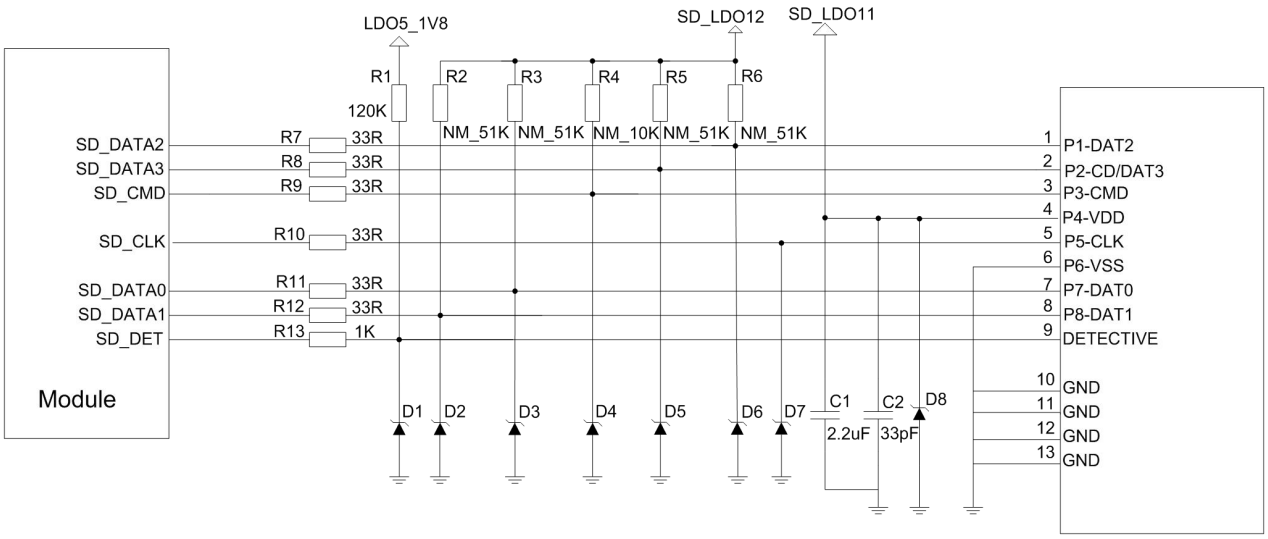



**Figure 19: Reference Circuit for SD Card Interface**

SD_LDO11 is a peripheral driver power supply for SD card. The maximum drive current is approx. 600mA. Because of the high drive current, it is recommended that the trace width is 0.6mm or more. In order to ensure the stability of drive power, a 2.2uF capacitor should be added in parallel near the SD card connector.

CMD, CLK, DATA0, DATA1, DATA2 and DATA3 are all high speed signal lines. In PCB design, please control the characteristic impedance of them as 50Ω, and do not cross with other traces. It is recommended to route the trace on the inner layer of PCB, and keep the same trace length for CLK, CMD, DATA0, DATA1, DATA2 and DATA3. CLK additionally needs ground shielding.

Layout guidelines:

- Control impedance as 50Ω±10%, and ground shielding is required.
- The total trace length difference between CLK and other signal line traces should not exceed 1mm.

**Table 15: SD Card Trace Length Inside the Module**

| Pin No. | Signal | Length (mm) | Comment |
|---|---|---|---|
| 39 | SD_CLK | 14.60 | |
| 40 | SD_CMD | 14.55 | |
| 41 | SD_DATA0 | 14.53 | |
| 42 | SD_DATA1 | 14.56 | |
| 43 | SD_DATA2 | 14.53 | |

| | | |
|---|---|---|
| 44 | SD_DATA3 | 14.57 |

## 3.13. GPIO Interfaces

SC20 has abundant GPIO interfaces with logic level of 1.8V. The pin definition is listed below.

**Table 16: Pin Definition of GPIO Interfaces**

| PIN | Pin Name | GPIO | Default state | Comment |
|---|---|---|---|---|
| 30 | TP_INT | GPIO_13 | B-PD: nppukp | Wakeup |
| 31 | TP_RST | GPIO_12 | B-PD: nppukp | Wakeup |
| 33 | GPIO_23 | GPIO_23 | B-PD: nppukp | |
| 34 | UART1_TX | GPIO_20 | BH-PD: nppukp | Wakeup |
| 35 | UART1_RX | GPIO_21 | B-PD: nppukp | UART1_RX Wakeup |
| 36 | UART1_CTS | GPIO_111 | B-PD: nppukp | Wakeup |
| 37 | UART1_RTS | GPIO_112 | B-PD: nppukp | Wakeup |
| 45 | SD_DET | GPIO_38 | B-PD: nppukp | Wakeup |
| 47 | TP_I2C_SCL | GPIO_19 | B-PD: nppukp | |
| 48 | TP_I2C_SDA | GPIO_18 | B-PD: nppukp | |
| 49 | LCD_RST | GPIO_25 | B-PD: nppukp | Wakeup |
| 50 | LCD_TE | GPIO_24 | B-PD: nppukp | |
| 74 | CAM0_CLK | GPIO_26 | B-PD: nppukp | |
| 75 | CAM1_CLK | GPIO_27 | B-PD: nppukp | |
| 79 | CAM0_RST | GPIO_35 | B-PD: nppukp | Wakeup |
| 80 | CAM0_PWD | GPIO_34 | B-PD: nppukp | Wakeup |
| 81 | CAM1_RST | GPIO_28 | B-PD: nppukp | Wakeup |
| 82 | CAM1_PWD | GPIO_33 | B-PD: nppukp | |

| | | | | |
|---|---|---|---|---|
| 83 | CAM_I2C_SCL | GPIO_30 | B-PD: nppukp | |
| 84 | CAM_I2C_SDA | GPIO_29 | B-PD: nppukp | |
| 90 | GPIO_32 | GPIO_32 | B-PD: nppukp | |
| 91 | SENSOR_I2C_SCL | GPIO_7 | B-PD: nppukp | |
| 92 | SENSOR_I2C_SDA | GPIO_6 | B-PD: nppukp | |
| 93 | UART2_RX | GPIO_5 | B-PD: nppukp | Wakeup |
| 94 | UART2_TX | GPIO_4 | B-PD: nppukp | |
| 95 | KEY_VOL_UP | GPIO_90 | B-PD: nppukp | Wakeup |
| 96 | KEY_VOL_DOWN | GPIO_91 | B-PD: nppukp | Wakeup |
| 97 | GPIO_31 | GPIO_31 | B-PD: nppukp | Wakeup |
| 98 | GPIO_92 | GPIO_92 | B-PD: nppukp | Wakeup |
| 99 | GPIO_88 | GPIO_88 | B-PD: nppukp | |
| 100 | GPIO_89 | GPIO_89 | B-PD: nppukp | |
| 101 | GPIO_69 | GPIO_69 | B-PD: nppukp | |
| 102 | GPIO_68 | GPIO_68 | B-PD: nppukp | |
| 103 | GPIO_97 | GPIO_97 | B-PD: nppukp | Wakeup |
| 104 | GPIO_110 | GPIO_110 | B-PD: nppukp | Wakeup |
| 105 | GPIO_0 | GPIO_0 | B-PD: nppukp | |
| 106 | GPIO_98 | GPIO_98 | B-PD: nppukp | Wakeup |
| 107 | GPIO_94 | GPIO_94 | B-PD: nppukp | Wakeup |
| 108 | GPIO_36 | GPIO_36 | B-PD: nppukp | Wakeup |
| 109 | GPIO_65 | GPIO_65 | B-PD: nppukp | Wakeup |
| 110 | GPIO_96 | GPIO_96 | B-PD: nppukp | Wakeup |
| 112 | GPIO_58 | GPIO_58 | B-PD: nppukp | Wakeup |
| 113 | GPIO_99 | GPIO_99 | B-PD: nppukp | |

| | | | | |
|---|---|---|---|---|
| 115 | GPIO_95 | GPIO_95 | B-PD: nppukp | Wakeup |
| 116 | GPIO_11 | GPIO_11 | B-PD: nppukp | Wakeup |
| 117 | GPIO_10 | GPIO_10 | B-PD: nppukp | |
| 118 | GPIO_9 | GPIO_9 | B-PD: nppukp | |
| 119 | GPIO_8 | GPIO_8 | B-PD: nppukp | |
| 123 | GPIO_16 | GPIO_16 | B-PD: nppukp | |
| 124 | GPIO_17 | GPIO_17 | B-PD: nppukp | |

**NOTE**

- Wakeup: interrupt pins that can wake up the system
- B: Bidirectional digital with CMOS input
- H: High-voltage tolerant
- PD: nppukp = default pull-down with programmable options following the colon (:)

## 3.14. I2C Interfaces

SC20 provides 3 groups of I2C interfaces which only support the master mode. As an open drain output, the I2C interfaces need a pull-up resistor on its external circuit, and the recommended logic level is 1.8V.

**Table 17: Pin Definition of I2C Interfaces**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| TP_I2C_SCL | 47 | OD | I2C clock signal of touch panel | Used for touch panel |
| TP_I2C_SDA | 48 | OD | I2C data signal of touch panel | |
| CAM_I2C_SCL | 83 | OD | I2C clock signal of camera | Used for camera |
| CAM_I2C_SDA | 84 | OD | I2C data signal of camera | |
| SENSOR_I2C_SCL | 91 | OD | I2C clock signal for external sensor | Used for external sensor |
| SENSOR_I2C_SDA | 92 | OD | I2C data signal for external sensor | |

## 3.15. ADC Interfaces

SC20 module provides three analog-to-digital converter (ADC) interfaces, and the pin definition is shown below.

**Table 18: Pin Definition of ADC Interfaces**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| ADC | 128 | AI | General purpose ADC | Max input voltage is 1.7V |
| VBAT_SNS | 133 | AI | Input voltage sense | Max input voltage is 4.5V |
| VBAT_THERM | 134 | AI | Battery temperature detection | Internal pull-up; externally connect to GND with a 47K NTC thermistor |

The resolution of the ADC is up to 16 bits.

**NOTE**

When the input voltage exceeds the maximum input voltage of VBAT_SNS pin, resistor divider cannot be used in the circuit design. Instead, general purpose ADC with resistor divider input can be used.

## 3.16. Motor Drive Interface

The pin of motor drive interface is listed below.

**Table 19: Pin Definition of Motor Drive Interface**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| VIB_DRV | 28 | PO | Motor drive | Connected to the negative terminal of the motor |

The motor is driven by an exclusive circuit, and a reference circuit design is shown below.

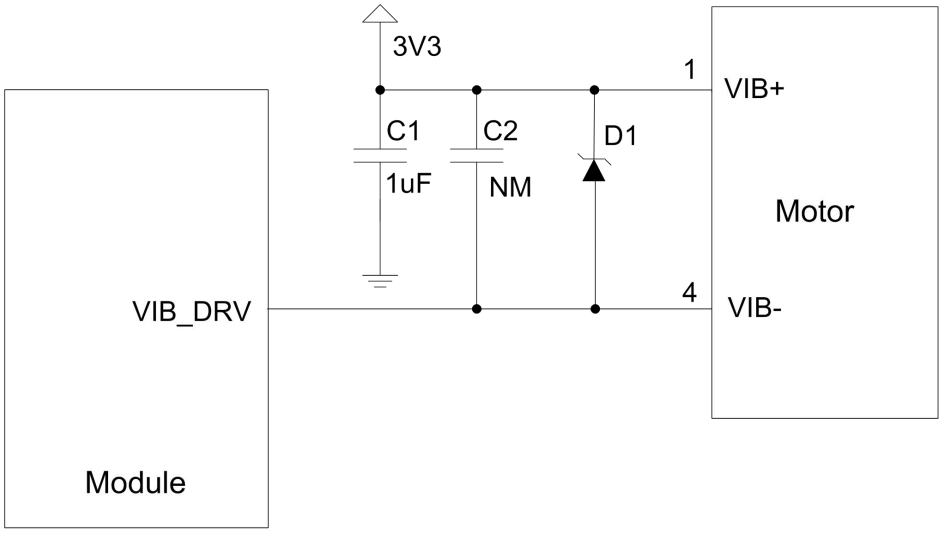



**Figure 20: Reference Circuit for Motor Connection**

When the motor stops, the redundant electricity can be discharged from the circuit loop formed by diodes, thus avoiding component damages.

## 3.17. LCM Interface

SC20 module provides an LCM interface meeting MIPI DSI specification. The interface supports high speed differential data transmission, with up to four lanes and a transmission rate up to 1.5Gbps per lane. It supports maximally 720P resolution displays.

**Table 20: Pin Definition of LCM Interface**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| LDO6_1V8 | 125 | PO | 1.8V output power supply for LCM logic circuit and DSI | 1.8V normal voltage.<br>Vnorm=1.8V<br>$I_O$max=100mA |
| LDO17_2V85 | 129 | PO | 2.85V output power supply for LCM analog circuits | 2.85V normal voltage.<br>Vnorm=2.85V<br>$I_O$max=300mA |
| PWM | 29 | DO | Adjust the backlight brightness. PWM control signal. | |
| LCD_RST | 49 | DO | LCD reset signal | Active low |
| LCD_TE | 50 | DI | LCD tearing effect signal | |

| | | | |
|---|---|---|---|
| MIPI_DSI_CLKN | 52 | AO | MIPI DSI clock signal (negative) |
| MIPI_DSI_CLKP | 53 | AO | MIPI DSI clock signal (positive) |
| MIPI_DSI_LN0N | 54 | AO | MIPI DSI data signal (negative) |
| MIPI_DSI_LN0P | 55 | AO | MIPI DSI data signal (positive) |
| MIPI_DSI_LN1N | 56 | AO | MIPI DSI data signal (negative) |
| MIPI_DSI_LN1P | 57 | AO | MIPI DSI data signal (positive) |
| MIPI_DSI_LN2N | 58 | AO | MIPI DSI data signal (negative) |
| MIPI_DSI_LN2P | 59 | AO | MIPI DSI data signal (positive) |
| MIPI_DSI_LN3N | 60 | AO | MIPI DSI data signal (negative) |
| MIPI_DSI_LN3P | 61 | AO | MIPI DSI data signal (positive) |

Four-lane MIPI DSI is needed for connection with 720P displays. The following is a reference circuit design, by taking the connection with LCM interface on LHR050H41-00 (IC: ILI9881C) from HUARUI Lighting as an example.

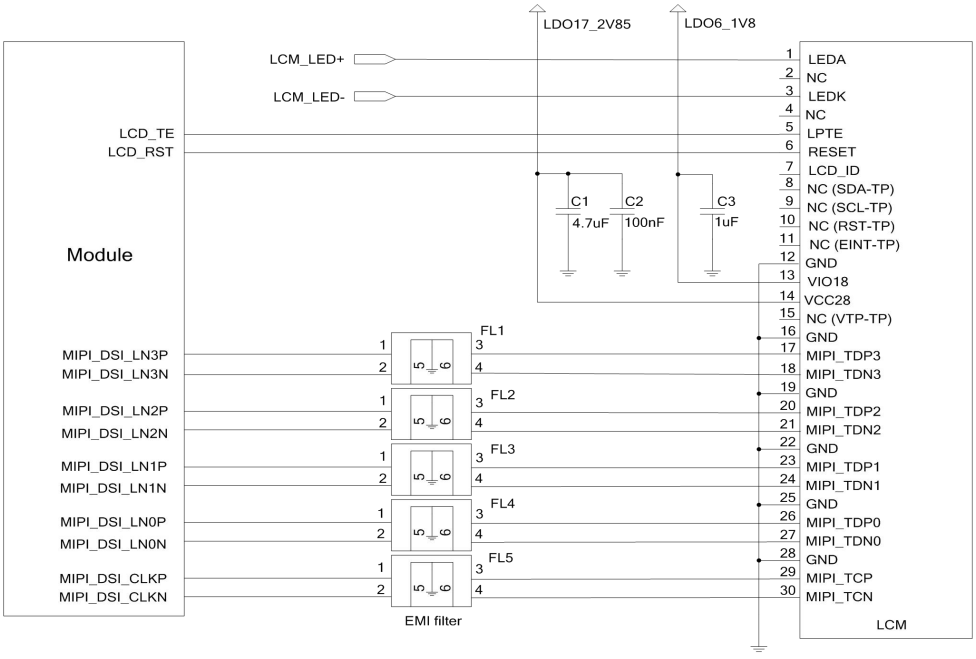



**Figure 21: Reference Circuit Design for LCM Interface**

MIPI are high speed signal lines. It is recommended that common-mode filters should be added in series near the LCM connector, so as to improve protection against electromagnetic radiation interference. ICMEF112P900MFR from ICT is recommended.

When compatible design with other displays is required, please connect the LCD_ID pin of LCM to the module's ADC pin, and please note that the output voltage of LCD_ID cannot exceed the voltage range of ADC pin.

Backlight driving circuit needs to be designed for LCM, and a reference circuit design is shown in the following figure. Backlight brightness adjustment can be realized by PWM pin of SC20 module through adjusting the duty ratio.

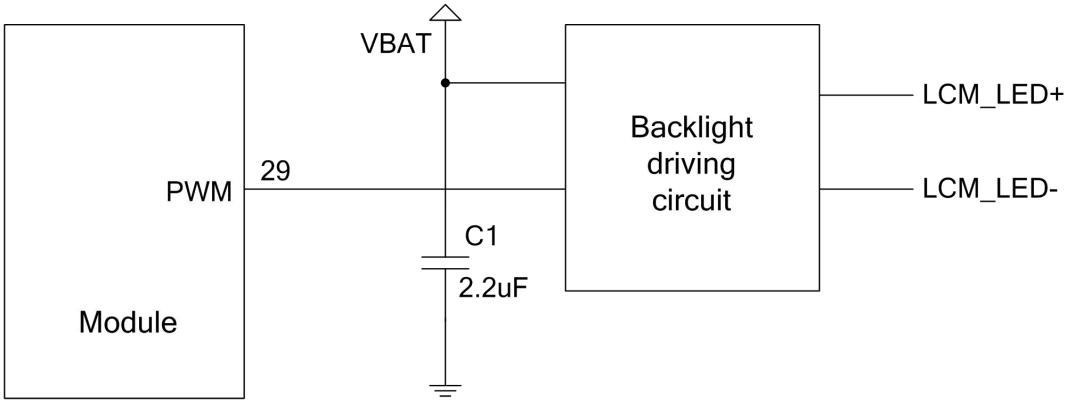



**Figure 22: Reference Design for Backlight Dirving Circuit**

## 3.18. Touch Panel Interface

SC20 provides a set of I2C interface for connection with Touch Panel (TP), and also provides the corresponding power supply and interrupt pins. The definition of TP interface pins is illustrated below.

**Table 21: Pin Definition of Touch Panel Interface**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| LDO6_1V8 | 125 | PO | 1.8V output power supply for TP I/O power | Pull-up power supply of I2C. 1.8V normal voltage |
| LDO17_2V85 | 129 | PO | 2.85V output power supply for TP VDD power | TP power supply. 2.85V normal voltage |
| TP_INT | 30 | DI | Interrupt signal of TP | |
| TP_RST | 31 | DO | Reset signal of TP | Active low |

| | | | |
|---|---|---|---|
| TP_I2C_SCL | 47 | OD | I2C clock signal of TP |
| TP_I2C_SDA | 48 | OD | I2C data signal of TP |

The following illustrates a TP interface reference circuit, by taking the connection with TP interface on LHR050H41-00 (IC: GT9147) from HUARUI Lighting as an example.

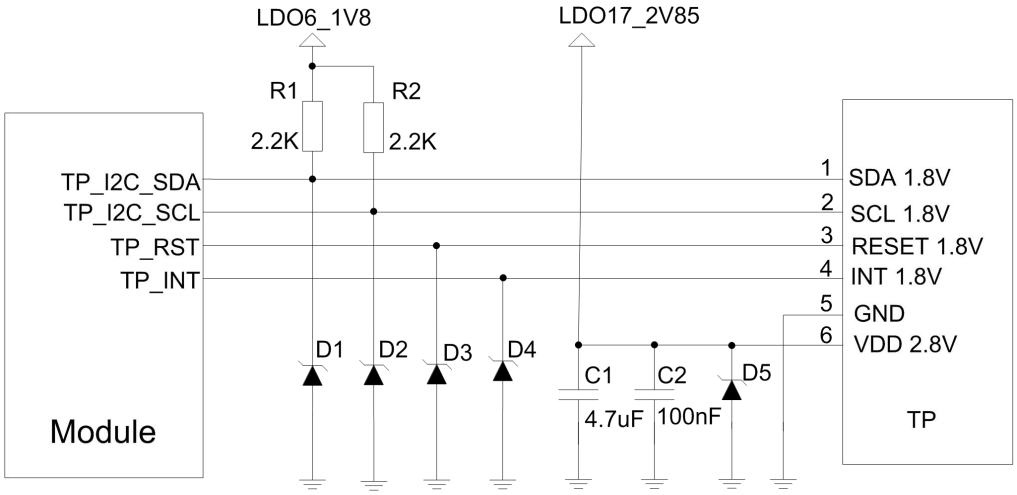



**Figure 23: Reference Circuit Design for TP Interface**

## 3.19. Camera Interfaces

Based on standard MIPI CSI video input interface, SC20 module supports two cameras, and the maximum pixel of the rear camera can be up to 8MP. The video and photo quality is determined by various factors such as the camera sensor, camera lens quality, etc. It is recommended to select a proper camera model, according to the specification of cameras verified and recommended by Quectel.

The following models of camera sensors have been verified by Quectel:

- For rear camera: Hi843 of SK Hynix, T4KA3 of TOSHIBA
- For front camera: Hi259 of SK Hynix, SP2508 of SuperPix

### 3.19.1. Rear Camera Interface

The rear camera realizes transmission and control via its FPC and a connector which is connected to the module. SC20 rear camera interface integrates a two-lane MIPI CSI for differential data transmission, and it maximally supports 8MP cameras.

The pin definition of rear camera interface is shown below.

**Table 22: Pin Definition of Rear Camera Interface**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| LDO6_1V8 | 125 | PO | 1.8V output power supply for DOVDD of camera | 1.8V normal voltage.<br>Vnorm=1.8V<br>$I_O$max=100mA |
| LDO17_2V85 | 129 | PO | 2.85V output power supply for AVDD of camera | 2.85V normal voltage.<br>Vnorm=2.85V<br>$I_O$max=300mA |
| MIPI_CSI0_CLKN | 63 | AI | MIPI CSI clock signal (negative) | |
| MIPI_CSI0_CLKP | 64 | AI | MIPI CSI clock signal (positive) | |
| MIPI_CSI0_LN0N | 65 | AI | MIPI CSI data signal (negative) | |
| MIPI_CSI0_LN0P | 66 | AI | MIPI CSI data signal (positive) | |
| MIPI_CSI0_LN1N | 67 | AI | MIPI CSI data signal (negative) | |
| MIPI_CSI0_LN1P | 68 | AI | MIPI CSI data signal (positive) | |
| CAM0_MCLK | 74 | DO | Clock signal of rear camera | |
| CAM0_RST | 79 | DO | Reset signal of rear camera | |
| CAM0_PWD | 80 | DO | Power down signal of rear camera | |
| CAM_I2C_SCL | 83 | OD | I2C clock signal of camera | |
| CAM_I2C_SDA | 84 | OD | I2C data signal of camera | |

The following is a reference circuit design for rear camera interface, by taking the connection with T4KA3 camera as an example.

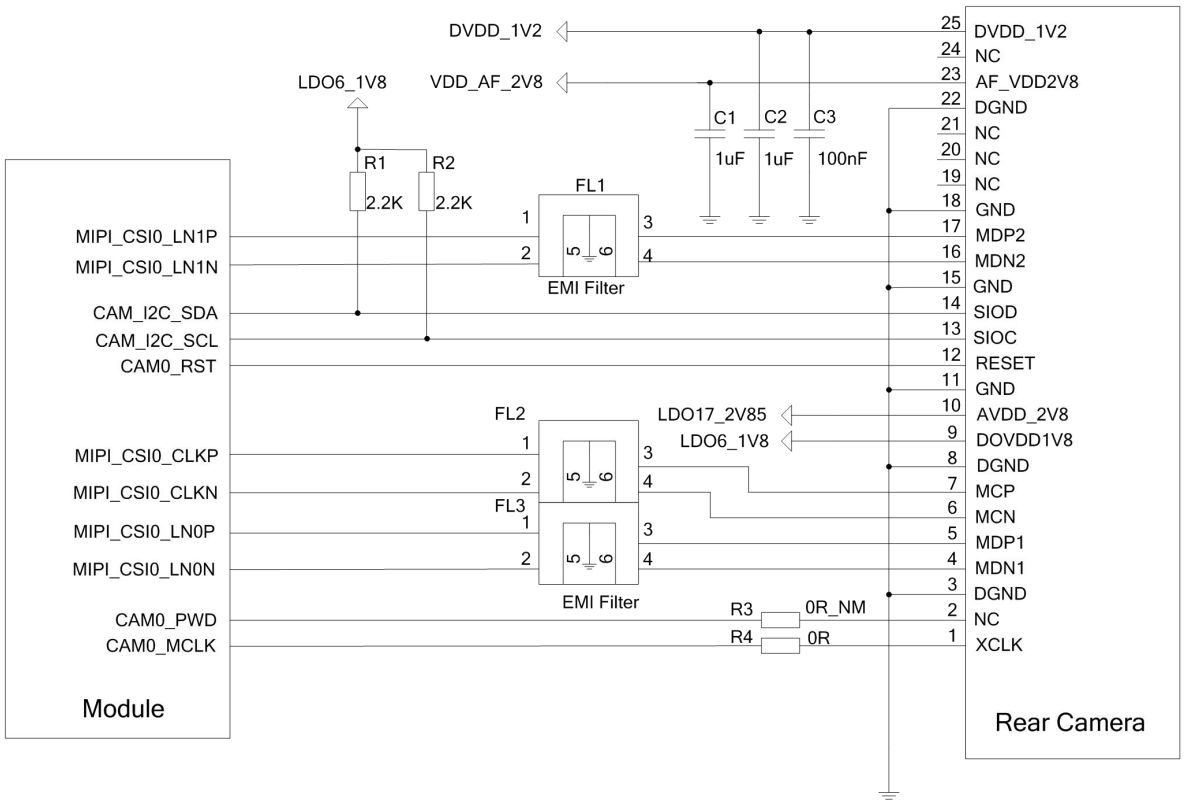



**Figure 24: Reference Circuit Design for Rear Camera Interface**

**NOTE**

DVDD_1V2 is used to power the rear camera core, and VDD_AF_2V8 is used to power the rear camera AF circuit. Both of them are powered by an external LDO.

### 3.19.2. Front Camera Interface

The front camera interface integrates a differential data interface meeting one-lane MIPI CSI standard, and is tested to support 2MP cameras.

The pin definition of front camera interface is shown below.

**Table 23: Pin Definition of Front Camera Interface**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| LDO6_1V8 | 125 | PO | 1.8V output power supply for DOVDD of camera | 1.8V normal voltage.<br>Vnorm=1.8V<br>$I_O$max=100mA |

| | | | | |
|---|---|---|---|---|
| LDO17_2V85 | 129 | PO | 2.85V output power supply for AVDD of camera | 2.85V normal voltage.<br>Vnorm=2.85V<br>$I_O$max=300mA |
| MIPI_CSI1_CLKN | 70 | AI | MIPI CSI clock signal (negative) | |
| MIPI_CSI1_CLKP | 71 | AI | MIPI CSI clock signal (positive) | |
| MIPI_CSI1_LN0N | 72 | AI | MIPI CSI data signal (negative) | |
| MIPI_CSI1_LN0P | 73 | AI | MIPI CSI data signal (positive) | |
| CAM1_MCLK | 75 | DO | Clock signal of front camera | |
| CAM1_RST | 81 | DO | Reset signal of front camera | |
| CAM1_PWD | 82 | DO | Power down signal of front camera | |
| CAM_I2C_SCL | 83 | OD | I2C clock signal of camera | |
| CAM_I2C_SDA | 84 | OD | I2C data signal of camera | |

The following is a reference circuit design for front camera interface, by taking the connection with SP2508 camera as an example.

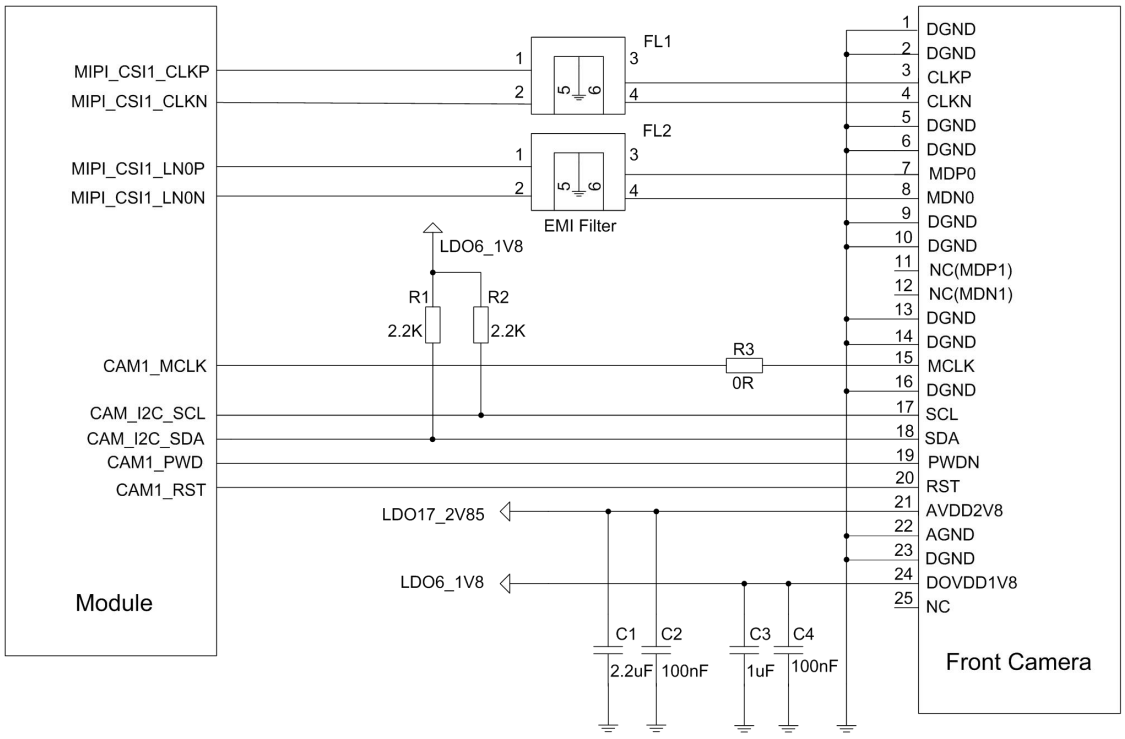



**Figure 25: Reference Circuit Design for Front Camera Interface**

### 3.19.3. Design Considerations

- Special attention should be paid to the definition of video device interface in schematic design. Different video devices will have varied definitions for their corresponding connectors. Assure the device and the connectors are correctly connected.
- MIPI are high speed signal lines, supporting maximum data rate up to 1.5Gbps. The differential impedance should be controlled as 100Ω. Additionally, it is recommended to route the trace on the inner layer of PCB, and do not cross it with other traces. For the same video device, all the MIPI traces should keep the same length. In order to avoid crosstalk, a distance of 1.5 times of the trace width is recommended to be maintained among MIPI signal lines. During impedance matching, do not connect GND on different planes so as to ensure impedance consistency.
- It is recommended to select a low capacitance TVS for ESD protection and the recommended parasitic capacitance is below 1pF.
- Route MIPI traces according to the following rules:
  a) The total trace length should not exceed 305mm;
  b) Control the differential impedance as 100Ω±10%;
  c) Control intra-lane length difference within 0.67mm;
  d) Control inter-lane length difference within 1.3mm.

**Table 24: MIPI Trace Length Inside the Module**

| PIN | Pin Name | Length (mm) | Length Difference (P-N) |
|---|---|---|---|
| 52 | MIPI_DSI_CLKN | 7.08 | -0.63 |
| 53 | MIPI_DSI_CLKP | 6.45 | |
| 54 | MIPI_DSI_LN0N | 6.15 | -0.30 |
| 55 | MIPI_DSI_LN0P | 5.85 | |
| 56 | MIPI_DSI_LN1N | 6.64 | -0.04 |
| 57 | MIPI_DSI_LN1P | 6.60 | |
| 58 | MIPI_DSI_LN2N | 8.20 | 0.74 |
| 59 | MIPI_DSI_LN2P | 8.94 | |
| 60 | MIPI_DSI_LN3N | 9.28 | 0.96 |
| 61 | MIPI_DSI_LN3P | 10.24 | |
| 63 | MIPI_CSI0_CLKN | 10.55 | 0.54 |
| 64 | MIPI_CSI0_CLKP | 11.09 | |

| | | | |
|---|---|---|---|
| 65 | MIPI_CSI0_LN0N | 12.13 | 0.40 |
| 66 | MIPI_CSI0_LN0P | 12.53 | |
| 67 | MIPI_CSI0_LN1N | 13.73 | 0.76 |
| 68 | MIPI_CSI0_LN1P | 14.49 | |
| 70 | MIPI_CSI1_CLKN | 17.32 | 0.13 |
| 71 | MIPI_CSI1_CLKP | 17.45 | |
| 72 | MIPI_CSI1_LN0N | 18.89 | 0.35 |
| 73 | MIPI_CSI1_LN0P | 19.24 | |

## 3.20. Sensor Interfaces

SC20 module supports communication with sensors via I2C interface, and it supports ALS/PS, Compass, G-sensor, and Gyroscopic sensors.

Verified sensor models by Quectel include: BST-BMA223, STK3311-WV, MPU-6881 and MMC35240PJ.

**Table 25: Pin Definition of Sensor Interfaces**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| SENSOR_I2C_SCL | 91 | OD | I2C clock signal for external sensor | |
| SENSOR_I2C_SDA | 92 | OD | I2C data signal for external sensor | |
| GPIO_88 | 99 | DI | Gyroscope sensor interrupt signal 2 | Default configuration; but not limited to these GPIO pins |
| GPIO_89 | 100 | DI | Gyroscope sensor interrupt signal 1 | |
| GPIO_94 | 107 | DI | Proximity sensor interrupt signal | |
| GPIO_36 | 108 | DI | Compass sensor interrupt signal | |
| GPIO_65 | 109 | DI | Gravity sensor interrupt signal 2 | |
| GPIO_96 | 110 | DI | Gravity sensor interrupt signal 1 | |

## 3.21. Audio Interfaces

SC20 module provides two analog input channels and three analog output channels. The following table shows the pin definition.

**Table 26: Pin Definition of Audio Interfaces**

| Pin Name | Pin No | I/O | Description | Comment |
|---|---|---|---|---|
| MIC1P | 4 | AI | Microphone positive input for channel 1 | |
| MIC_GND | 5 | | MIC reference ground | |
| MIC2P | 6 | AI | Microphone positive input for channel 2 | |
| EARP | 8 | AO | Earpiece positive output | |
| EARN | 9 | AO | Earpiece negative output | |
| SPKP | 10 | AO | Speaker positive output | |
| SPKN | 11 | AO | Speaker negative output | |
| HPH_R | 136 | AO | Headphone right channel output | |
| HPH_GND | 137 | AI | Headphone virtual ground | |
| HPH_L | 138 | AO | Headphone left channel output | |
| HS_DET | 139 | AI | Headset insertion detection | High level by default |

- The module offers two audio input channels which are both single-ended channels.
- The earpiece interface uses differential output.
- The loudspeaker interface uses differential output as well. The output channel is available with a Class-D amplifier whose output power is 879mW when VBAT is 4.2V and load is 8Ω.
- The headphone interface features stereo left and right channel output, and headphone insert detection function is supported.

### 3.21.1. Reference Circuit Design for Microphone

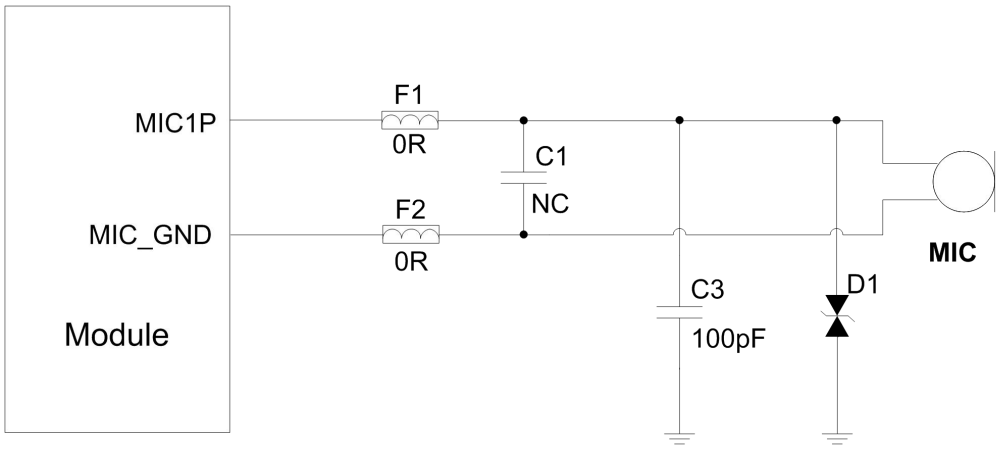



**Figure 26: Reference Circuit Design for Microphone Interface**

### 3.21.2. Reference Circuit Design for Receiver Interface

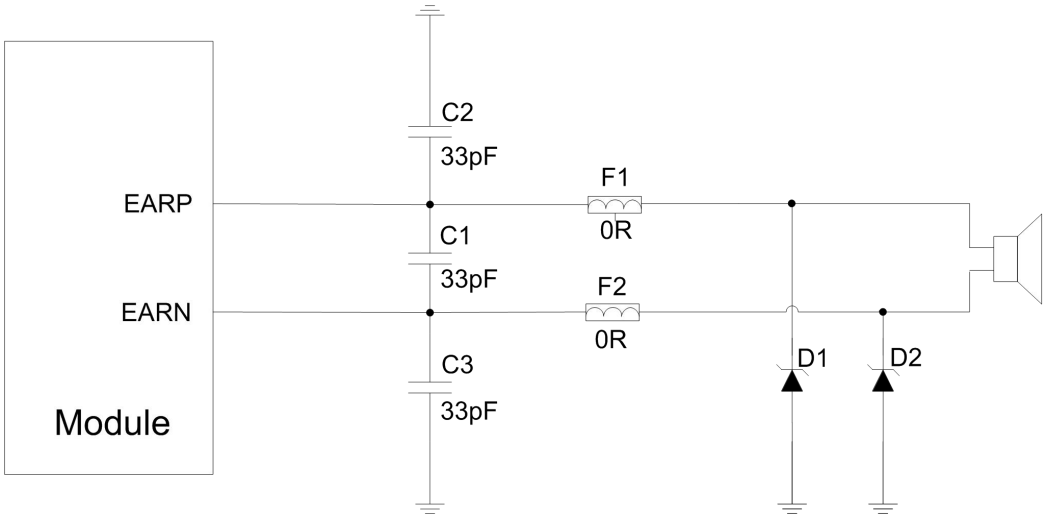



**Figure 27: Reference Circuit Design for Receiver Interface**

### 3.21.3. Reference Circuit Design for Headphone Interface

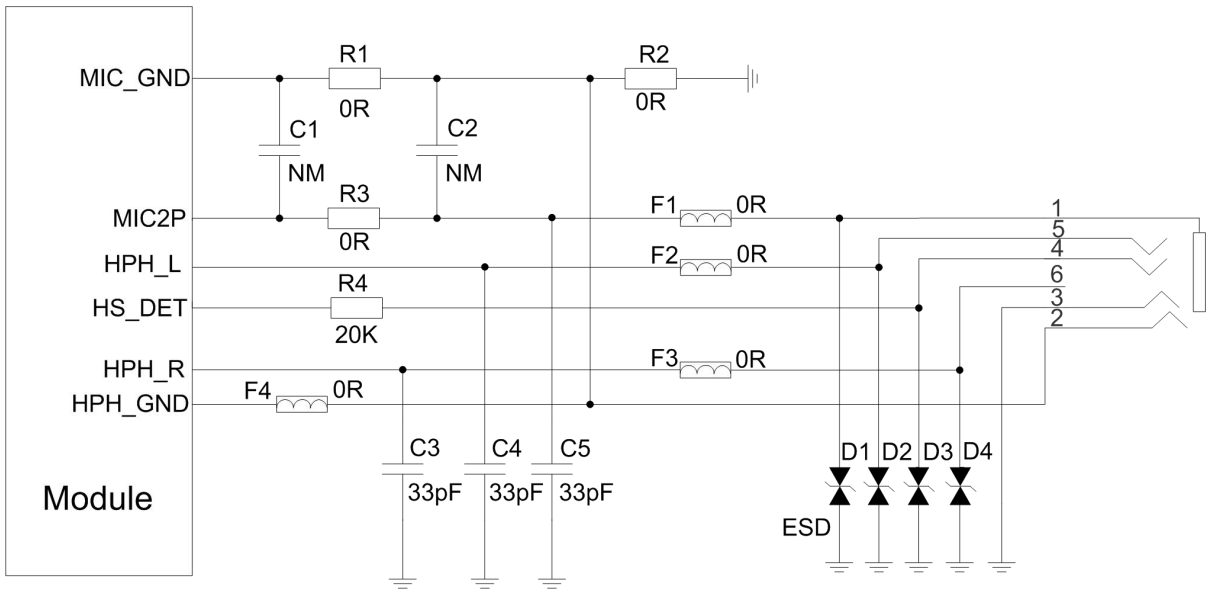



**Figure 28: Reference Circuit Design for Headphone Interface**

### 3.21.4. Reference Circuit Design for Loudspeaker Interface

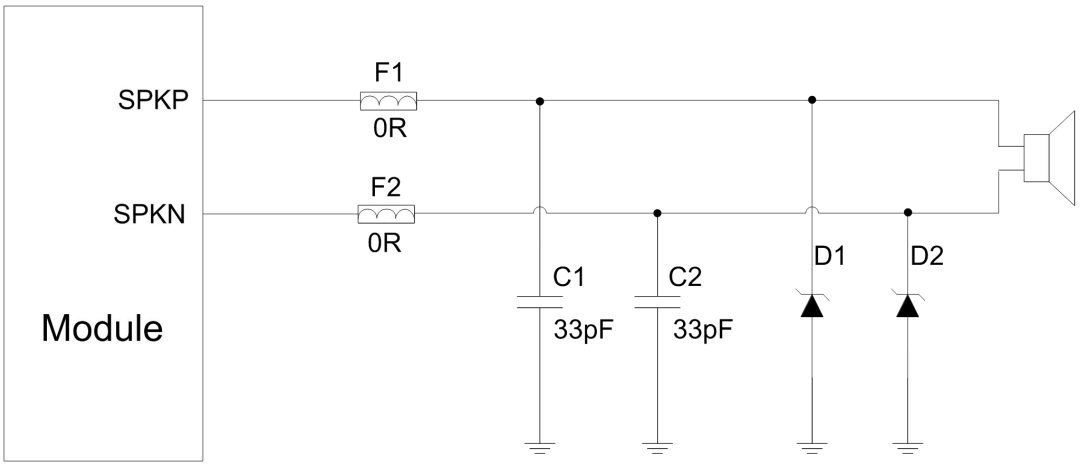



**Figure 29: Reference Circuit Design for Loudspeaker Interface**

### 3.21.5. Audio Interface Design Considerations

It is recommended to use the electret microphone with dual built-in capacitors (e.g. 10pF and 33pF) for filtering out RF interference, thus reducing TDD noise. The 33pF capacitor is applied for filtering out RF interference when the module is transmitting at EGSM900MHz. Without placing this capacitor, TDD noise could be heard. Moreover, the 10pF capacitor here is used for filtering out 1800MHz RF interference. Please note that the resonant frequency point of a capacitor largely depends on the material and production technique. Therefore, customers would have to discuss with their capacitor vendors to choose the most suitable capacitor for filtering out high-frequency noises.

The severity degree of the RF interference in the voice channel during GSM transmitting largely depends on the application design. In some cases, GSM900 TDD noise is more severe; while in other cases, DCS1800 TDD noise is more obvious. Therefore, a suitable capacitor can be selected based on the test results. Sometimes, even no RF filtering capacitor is required.

The capacitor which is used for filtering out RF noise should be close to the audio device or audio interface. The trace should be as short as possible, and it is recommended to route the trace for capacitors first and then for other points.

In order to decrease radio or other signal interference, RF antennas should be placed away from audio interfaces and audio traces. Power traces cannot be parallel with and also should be far away from the audio traces.

The differential audio traces must be routed according to the differential signal layout rule.

## 3.22. Emergency Download Interface

USB_BOOT is an emergency download interface. Pull up to LDO5_1V8 during power-up will force the module enter into emergency download mode. This is an emergency option when there are failures such as abnormal startup or running. For convenient firmware upgrade and debugging in the future, please reverse this pin. The reference circuit design is shown as below.

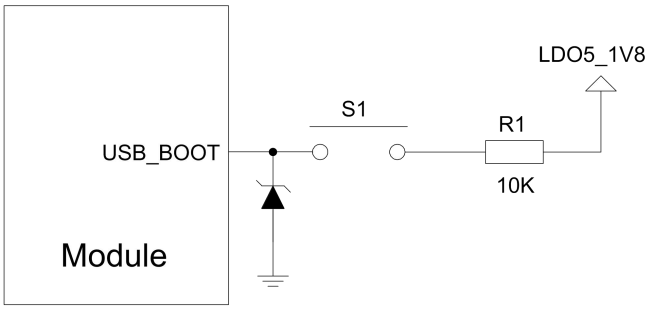



**Figure 30: Reference Circuit Design for Emergency Download Interface**

# 4 Wi-Fi and BT

SC20 module provides a shared antenna interface ANT_WIFI/BT for Wi-Fi and Bluetooth (BT) functions. The interface impedance is 50Ω. External antennas such as PCB antenna, sucker antenna and ceramic antenna can be connected to the module via the interface, so as to achieve Wi-Fi and BT functions.

## 4.1. Wi-Fi Overview

SC20 series module supports 2.4GHz/5GHz double-band WLAN wireless communication based on IEEE 802.11a/b/g/n standard protocols. The maximum data rate is up to 150Mbps.

The features are as below:

- Support Wake-on-WLAN (WoWLAN)
- Support ad hoc mode
- Support WAPI SMS4 hardware encryption
- Support AP mode
- Support Wi-Fi Direct
- Support MCS 0-7 for HT20 and HT40

### 4.1.1. Wi-Fi Performance

The following table lists the Wi-Fi transmitting and receiving performance of SC20 module.

**Table 27: Wi-Fi Transmitting Performance**

| | Standard | Rate | Output Power |
|---|---|---|---|
| 2.4GHz | 802.11b | 1Mbps | 16dBm±2.5dB |
| | 802.11b | 11Mbps | 16dBm±2.5dB |
| | 802.11g | 6Mbps | 16dBm±2.5dB |
| | 802.11g | 54Mbps | 14dBm±2.5dB |
| | 802.11n HT20 | MCS0 | 15dBm±2.5dB |

| | | | |
|---|---|---|---|
| | 802.11n HT20 | MCS7 | 13dBm±2.5dB |
| | 802.11n HT40 | MCS0 | 14dBm±2.5dB |
| | 802.11n HT40 | MCS7 | 13dBm±2.5dB |
| 5GHz | 802.11a | 6Mbps | 15dBm±2.5dB |
| | 802.11a | 54Mbps | 13dBm±2.5dB |
| | 802.11n HT20 | MCS0 | 14dBm±2.5dB |
| | 802.11n HT20 | MCS7 | 12dBm±2.5dB |
| | 802.11n HT40 | MCS0 | 14dBm±2.5dB |
| | 802.11n HT40 | MCS7 | 12dBm±2.5dB |

**Table 28: Wi-Fi Receiving Performance**

| | Standard | Rate | Sensitivity |
|---|---|---|---|
| 2.4GHz | 802.11b | 1Mbps | -96dBm |
| | 802.11b | 11Mbps | -87dBm |
| | 802.11g | 6Mbps | -91dBm |
| | 802.11g | 54Mbps | -74dBm |
| | 802.11n HT20 | MCS0 | -90dBm |
| | 802.11n HT20 | MCS7 | -72dBm |
| | 802.11n HT40 | MCS0 | -87dBm |
| | 802.11n HT40 | MCS7 | -68dBm |
| 5GHz | 802.11a | 6Mbps | -90dBm |
| | 802.11a | 54Mbps | -71dBm |
| | 802.11n HT20 | MCS0 | -88dBm |
| | 802.11n HT20 | MCS7 | -69dBm |
| | 802.11n HT40 | MCS0 | -86dBm |

| | | |
|---|---|---|
| 802.11n HT40 | MCS7 | -66dBm |

Referenced specifications are listed below:

- IEEE 802.11n WLAN MAC and PHY, October 2009 + IEEE 802.11-2007 WLAN MAC and PHY, June 2007
- IEEE Std 802.11b, IEEE Std 802.11d, IEEE Std 802.11e, IEEE Std 802.11g, IEEE Std 802.11i: IEEE 802.11-2007 WLAN MAC and PHY, June 2007

## 4.2. BT Overview

SC20 module supports BT4.1 (BR/EDR+BLE) specification, as well as GFSK, 8-DPSK, π/4-DQPSK modulation modes.

- Maximally support up to 7 wireless connections.
- Maximally support up to 3.5 piconets at the same time.
- Support one SCO (Synchronous Connection Oriented) or eSCO connection.

The BR/EDR channel bandwidth is 1MHz, and can accommodate 79 channels. The BLE channel bandwidth is 2MHz, and can accommodate 40 channels.

**Table 29: BT Data Rate and Version**

| Version | Data rate | Maximum Application Throughput | Comment |
|---|---|---|---|
| 1.2 | 1 Mbit/s | >80 Kbit/s | |
| 2.0 + EDR | 3 Mbit/s | >80 Kbit/s | |
| 3.0 + HS | 24 Mbit/s | Reference 3.0 + HS | |
| 4.0 | 24 Mbit/s | Reference 4.0 LE | |

Referenced specifications are listed below:

- Bluetooth Radio Frequency TSS and TP Specification 1.2/2.0/2.0 + EDR/2.1/2.1+ EDR/3.0/3.0 + HS, August 6, 2009
- Bluetooth Low Energy RF PHY Test Specification, RF-PHY.TS/4.0.0, December 15, 2009

### 4.2.1. BT Performance

The following table lists the BT transmitting and receiving performance of SC20 module.

**Table 30: BT Transmitting and Receiving Performance**

| **Transmitter Performance** | | | |
|---|---|---|---|
| Packet Types | DH5 | 2-DH5 | 3-DH5 |
| Transmitting Power | 10dBm±2.5dB | 8dBm±2.5dB | 8dBm±2.5dB |
| **Receiver Performance** | | | |
| Packet Types | DH5 | 2-DH5 | 3-DH5 |
| Receiving Sensitivity | -93dBm | -92dBm | -86dBm |

# 5 GNSS

SC20 module integrates a Qualcomm IZat™ GNSS engine (GEN 8C) which supports multiple positioning and navigation systems including GPS, GLONASS and BeiDou. With an embedded LNA, the module provides greatly improved positioning accuracy.

## 5.1. GNSS Performance

The following table lists the GNSS performance of SC20 module in conduction mode.

**Table 31: GNSS Performance**

| Parameter | Description | Typ. | Unit |
|---|---|---|---|
| Sensitivity (GNSS) | Cold start | -146 | dBm |
| | Reacquisition | -158 | dBm |
| | Tracking | -160 | dBm |
| TTFF (GNSS) | Cold start | 32 | s |
| | Warm start | 30 | s |
| | Hot start | 2 | s |
| Static Drift (GNSS) | CEP-50 | 6 | m |

## 5.2. GNSS RF Design Guidance

Bad design of antenna and layout may cause reduced GPS receiving sensitivity, longer GPS positioning time, or reduced positioning accuracy. In order to avoid this, please follow the reference design rules as below:

- Maximize the distance between the GNSS RF part and the GPRS RF part (including trace routing and antenna layout) to avoid mutual interference.
- In user systems, GNSS RF signal lines and RF components should be placed far away from high speed circuits, switched-mode power supplies, power inductors, the clock circuit of single-chip microcomputers, etc.
- For applications with harsh electromagnetic environment or with high requirement on ESD protection, it is recommended to add ESD protective diodes for the antenna interface. Only diodes with ultra-low junction capacitance such as 0.05pF can be selected. Otherwise, there will be effects on the impedance characteristic of RF circuit loop, or attenuation of bypass RF signal may be caused.
- Control the impedance of either feeder line or PCB trace as 50Ω, and keep the trace length as short as possible.
- Refer to ***Chapter 6.3*** for GNSS reference circuit design.

# 6 Antenna Interface

SC20 antenna interface includes a main antenna, an Rx-diversity/MIMO antenna, a GNSS antenna and a Wi-Fi/BT antenna. The antenna interface has an impedance of 50Ω.

## 6.1. Main/Rx-diversity Antenna Interfaces

The pin definition of main/Rx-diversity antenna interfaces is shown below.

**Table 32: Pin Definition of Main/Rx-diversity Antenna Interfaces**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| ANT_MAIN | 87 | IO | Main antenna | 50Ω impedance |
| ANT_DRX | 131 | AI | Diversity antenna | 50Ω impedance |

### 6.1.1. Operating Frequency

**Table 33: SC20 Module Operating Frequencies**

| 3GPP Band | Receive | Transmit | Unit |
|---|---|---|---|
| GSM850 | 869~894 | 824~849 | MHz |
| EGSM900 | 925~960 | 880~915 | MHz |
| DCS1800 | 1805~1880 | 1710~1785 | MHz |
| PCS1900 | 1930~1990 | 1850~1910 | MHz |
| WCDMA Band1 | 2110~2170 | 1920~1980 | MHz |
| WCDMA Band2 | 1930~1990 | 1850~1910 | MHz |
| WCDMA Band4 | 2110~2155 | 1710~1755 | MHz |

| | | | |
|---|---|---|---|
| WCDMA Band5 | 869~894 | 824~849 | MHz |
| WCDMA Band6 | 875~885 | 830~840 | MHz |
| WCDMA Band8 | 925~960 | 880~915 | MHz |
| WCDAM Band19 | 875~890 | 830~845 | MHz |
| CDMA BC0 | 869~894 | 824~849 | MHz |
| TD-SCDMA Band34 | 2010~2025 | 2010~2025 | MHz |
| TD-SCDMA Band39 | 1880~1920 | 1880~1920 | MHz |
| LTE-FDD Band1 | 2110~2170 | 1920~1980 | MHz |
| LTE-FDD Band2 | 1930~1990 | 1850~1910 | MHz |
| LTE-FDD Band3 | 1805~1880 | 1710~1785 | MHz |
| LTE-FDD Band4 | 2110~2155 | 1710~1755 | MHz |
| LTE-FDD Band5 | 869~894 | 824~849 | MHz |
| LTE-FDD Band7 | 2620~2690 | 2500~2570 | MHz |
| LTE-FDD Band8 | 925~960 | 880~915 | MHz |
| LTE-FDD Band12 | 729~746 | 699~716 | MHz |
| LTE-FDD Band13 | 746~756 | 777~787 | MHz |
| LTE-FDD Band18 | 860~875 | 815~830 | MHz |
| LTE-FDD Band19 | 875~890 | 830~845 | MHz |
| LTE-FDD Band20 | 791~821 | 832~862 | MHz |
| LTE-FDD Band25 | 1930~1995 | 1850~1915 | MHz |
| LTE-FDD Band26 | 859~894 | 814~849 | MHz |
| LTE-FDD Band28 | 758~803 | 703~748 | MHz |
| LTE-TDD Band38 | 2570~2620 | 2570~2620 | MHz |
| LTE-TDD Band39 | 1880~1920 | 1880~1920 | MHz |
| LTE-TDD Band40 | 2300~2400 | 2300~2400 | MHz |

| | | | |
|---|---|---|---|
| LTE-TDD Band41 | 2555~2655 | 2555~2655 | MHz |

**NOTE**

The bandwidth of LTE-TDD Band 41 for SC20-J is 2545MHz~2655MHz, and the corresponding channel range is 40140~41240.

### 6.1.2. Reference Design of Main and Rx-diversity Antenna Interfaces

A reference circuit design for main and Rx-diversity antenna interfaces is shown as below. A π-type matching circuit should be reserved for better RF performance. The π-type matching components (R1/C1/C2, R2/C3/C4) should be placed as close to the antennas as possible and are mounted according to the actual debugging. C1, C2, C3 and C4 are not mounted and a 0Ω resistor is mounted on R1 and R2 respectively by default.

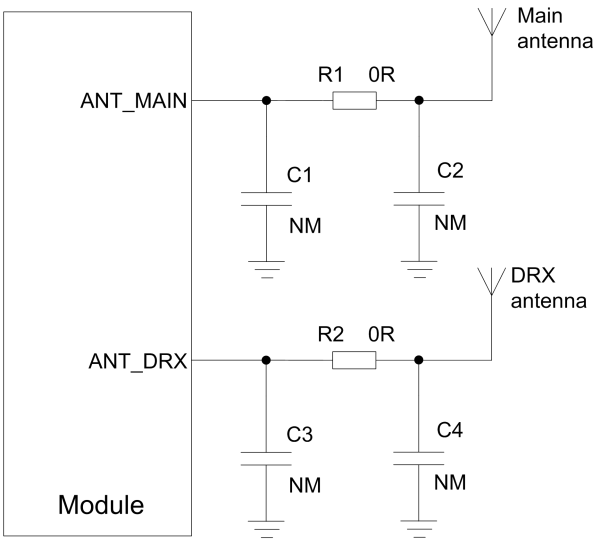



**Figure 31: Reference Circuit Design for Main and Rx-diversity Antenna Interfaces**

### 6.1.3. Reference Design of RF Layout

For user's PCB, the characteristic impedance of all RF traces should be controlled as 50Ω. The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the distance between signal layer and reference ground (H), and the clearance between RF trace and ground (S). Microstrip line or coplanar waveguide line is typically used in RF layout for characteristic impedance control. The following are reference designs of microstrip line or coplanar waveguide line with different PCB structures.

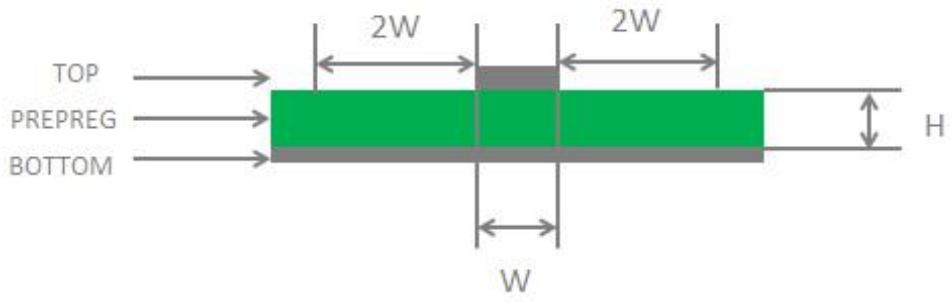



**Figure 32: Microstrip Line Design on a 2-layer PCB**

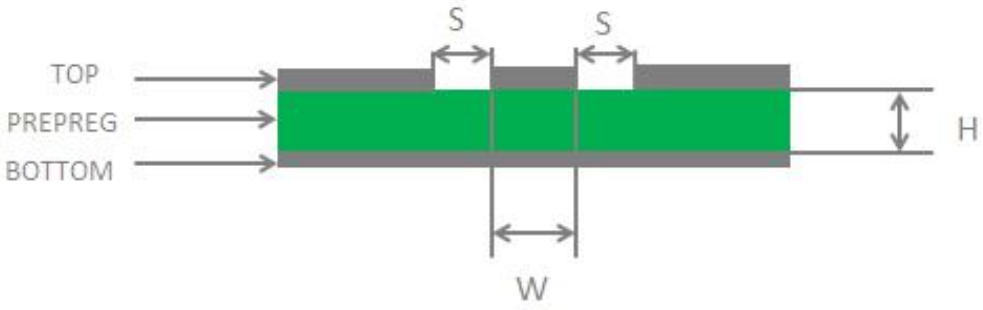



**Figure 33: Coplanar Waveguide Line Design on a 2-layer PCB**

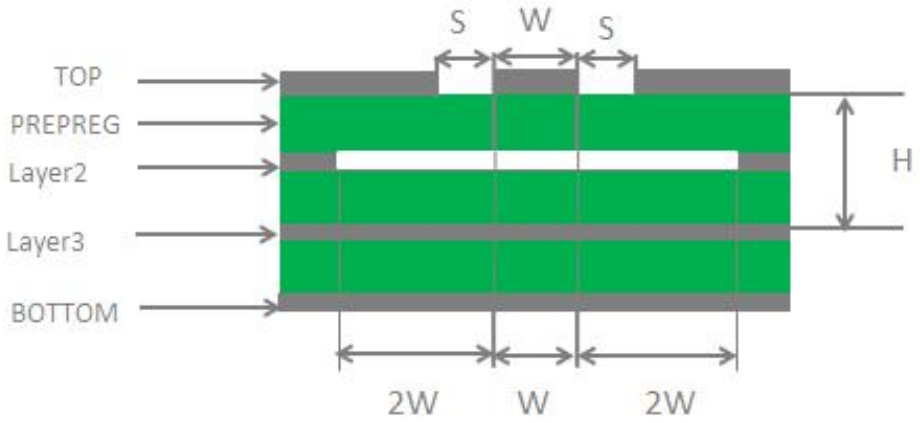



**Figure 34: Coplanar Waveguide Line Design on a 4-layer PCB (Layer 3 as Reference Ground)**

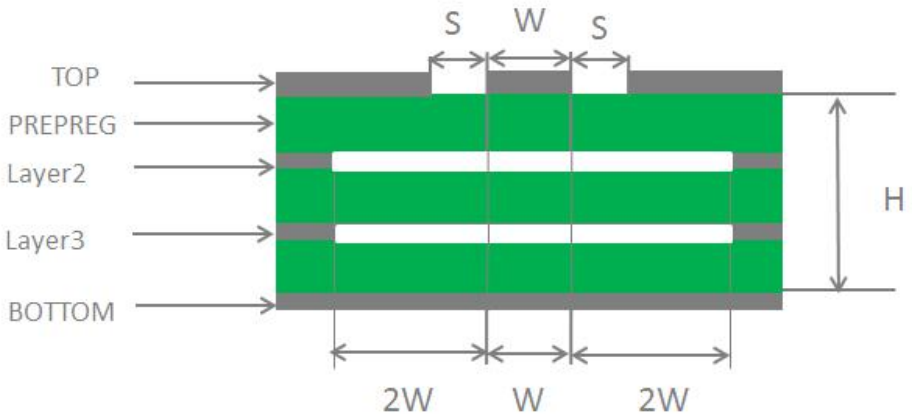



**Figure 35: Coplanar Waveguide Line Design on a 4-layer PCB (Layer 4 as Reference Ground)**

In order to ensure RF performance and reliability, the following principles should be complied with in RF layout design:

- Use impedance simulation tool to control the characteristic impedance of RF traces as 50Ω.
- The GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to ground.
- The distance between the RF pins and the RF connector should be as short as possible, and all the right angle traces should be changed to curved ones.
- There should be clearance area under the signal pin of the antenna connector or solder joint.
- The reference ground of RF traces should be complete. Meanwhile, adding some ground vias around RF traces and the reference ground could help to improve RF performance. The distance between the ground vias and RF traces should be no less than two times the width of RF signal traces (2*W).

For more details about RF layout, please refer to ***document [4]***.

## 6.2. Wi-Fi/BT Antenna Interface

The following tables show the pin definition and frequency specification of the Wi-Fi/BT antenna interface.

**Table 34: Pin Definition of Wi-Fi/BT Antenna Interface**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| ANT_WIFI/BT | 77 | IO | Wi-Fi/BT antenna interface | 50Ω impedance |

**Table 35: Wi-Fi/BT Frequency**

| Type | Frequency | Unit |
|---|---|---|
| 802.11a/b/g/n | 2400~2482<br>5180~5825 | MHz |
| BT4.1 LE | 2402~2480 | MHz |

**NOTE**

The supported Wi-Fi frequencies of SC20-J are 2400MHz~2496MHz and 5180MHz~5825MHz.

A reference circuit design for Wi-Fi/BT antenna interface is shown as below. A π-type matching circuit should be reserved for better RF performance. The π-type matching components (R1, C1, C2) should be placed as close to the antenna as possible and are mounted according to the actual debugging. C1 and C2 are not mounted and a 0Ω resistor is mounted on R1 by default.

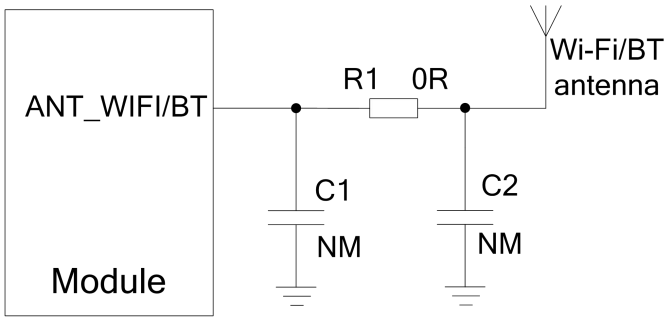



**Figure 36: Reference Circuit Design for Wi-Fi/BT Antenna**

## 6.3. GNSS Antenna Interface

The following tables show pin definition and frequency specification of GNSS antenna interface.

**Table 36: Pin Definition of GNSS Antenna Interface**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| ANT_GNSS | 121 | AI | GNSS antenna interface | 50Ω impedance |

**Table 37: GNSS Frequency**

| Type | Frequency | Unit |
|---|---|---|
| GPS | 1575.42±1.023 | MHz |
| GLONASS | 1597.5~1605.8 | MHz |
| BeiDou | 1561.098±2.046 | MHz |

### 6.3.1. Recommended Circuit for Passive Antenna

GNSS antenna interface supports passive ceramic antennas and other types of passive antennas. When the passive antenna is placed far away from the module (that is, the antenna trace is long), it is recommended to add an external LNA circuit for better GNSS receiving performance, and the LNA should be placed close to the antenna. A reference circuit design is given below.

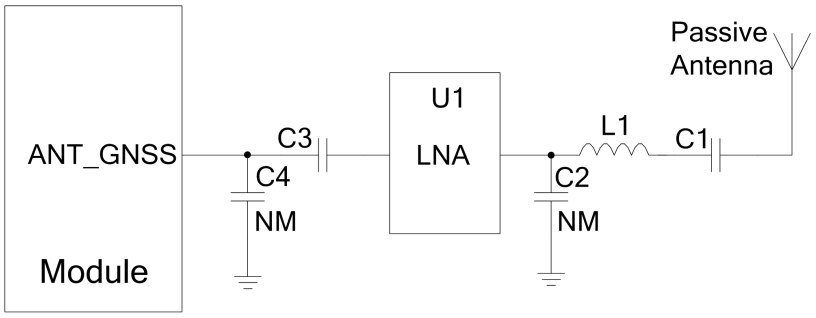



**Figure 37: Reference Circuit Design for GNSS Passive Antenna**

### 6.3.2. Recommended Circuit for Active Antenna

The active antenna is powered by VCC power supply through the R1 and L1 power paths shown in the following figure. The common power supply voltage ranges from 3.3V to 5.0V. Although featuring low power consumption, the active antenna still requires stable and clean power supplies. It is recommended to use high performance LDO as the power supply. A reference design of GNSS active antenna is shown below.

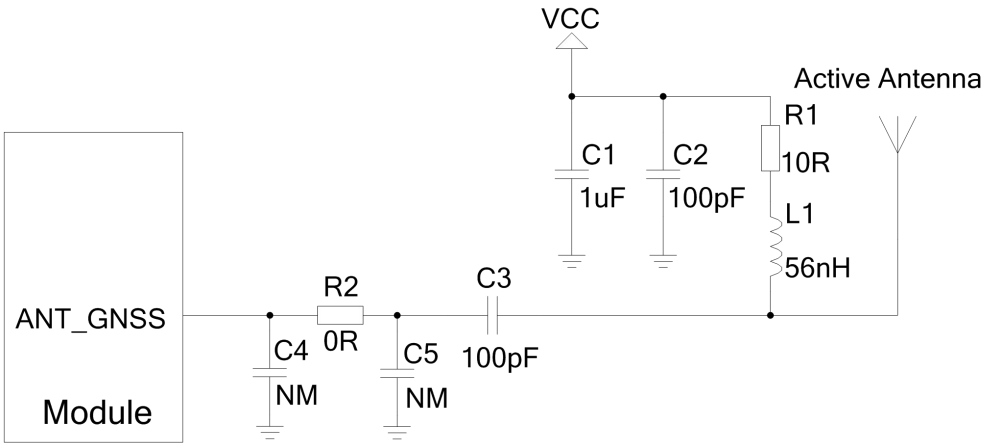



**Figure 38: Reference Circuit Design for GNSS Active Antenna**

## 6.4. Antenna Installation

### 6.4.1. Antenna Requirement

The following table shows the requirement on main antenna, RX-diversity antenna, Wi-Fi/BT antenna and GNSS antenna.

**Table 38: Antenna Requirements**

| Type | Requirements |
|---|---|
| GSM/WCDMA/TD-SCDMA/ LTE | VSWR: ≤ 2<br>Gain (dBi): 1<br>Max Input Power (W): 50<br>Input Impedance (Ω): 50<br>Polarization Type: Vertical<br>Cable Insertion Loss: < 1dB<br>(GSM850, EGSM900, WCDMA B5/B6/B8/B19, CDMA BC0, LTE-FDD B5/B8/B12/B13/B18/B19/B20/B26/B28)<br>Cable Insertion Loss: < 1.5dB<br>(DCS1800, PCS1900, WCDMA B1/B2/B4, TD-SCDMA B34/B39, LTE-FDD B1/B2/B3/B4/B25, LTE-TDD B39)<br>Cable Insertion Loss: < 2dB<br>(LTE-FDD B7, LTE-TDD B38/B40/B41) |
| Wi-Fi/BT | VSWR: ≤ 2<br>Gain (dBi): 1<br>Max Input Power (W): 50<br>Input Impedance (Ω): 50 |

| | |
|---|---|
| | Polarization Type: Vertical<br>Cable Insertion Loss: < 1dB |
| GNSS | Frequency range: 1565MHz~1607MHz<br>Polarization: RHCP or linear<br>VSWR: < 2 (Typ.)<br>Passive Antenna Gain: > 0dBi<br>Active Antenna Noise Figure: < 1.5dB<br>Active Antenna Total Gain: > 18dBi (Typ.) |

### 6.4.2. Recommended RF Connector for Antenna Installation

If RF connector is used for antenna connection, it is recommended to use the U.FL-R-SMT connector provided by HIROSE.

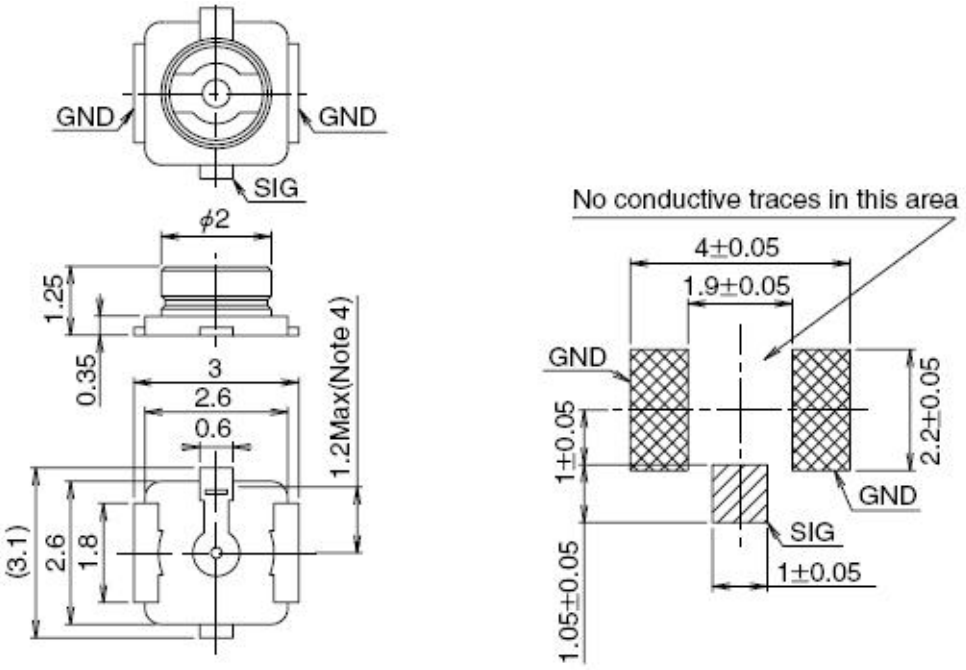



**Figure 39: Dimensions of the U.FL-R-SMT Connector (Unit: mm)**

U.FL-LP serial connectors listed in the following figure can be used to match the U.FL-R-SMT.

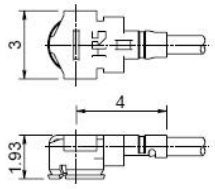
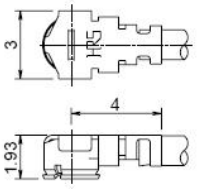
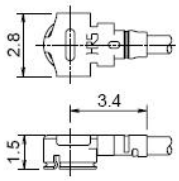
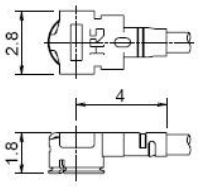
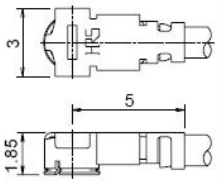
| Part No. | U.FL-LP-040 | U.FL-LP-066 | U.FL-LP(V)-040 | U.FL-LP-062 | U.FL-LP-088 |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| Mated Height | 2.5mm Max. (2.4mm Nom.) | 2.5mm Max. (2.4mm Nom.) | 2.0mm Max. (1.9mm Nom.) | 2.4mm Max. (2.3mm Nom.) | 2.4mm Max. (2.3mm Nom.) |
| Applicable cable | Dia. 0.81mm Coaxial cable | Dia. 1.13mm and Dia. 1.32mm Coaxial cable | Dia. 0.81mm Coaxial cable | Dia. 1mm Coaxial cable | Dia. 1.37mm Coaxial cable |
| Weight (mg) | 53.7 | 59.1 | 34.8 | 45.5 | 71.7 |
| RoHS | YES | | | | |

**Figure 40: Mechanicals of U.FL-LP Connectors**

The following figure describes the space factor of mated connector.

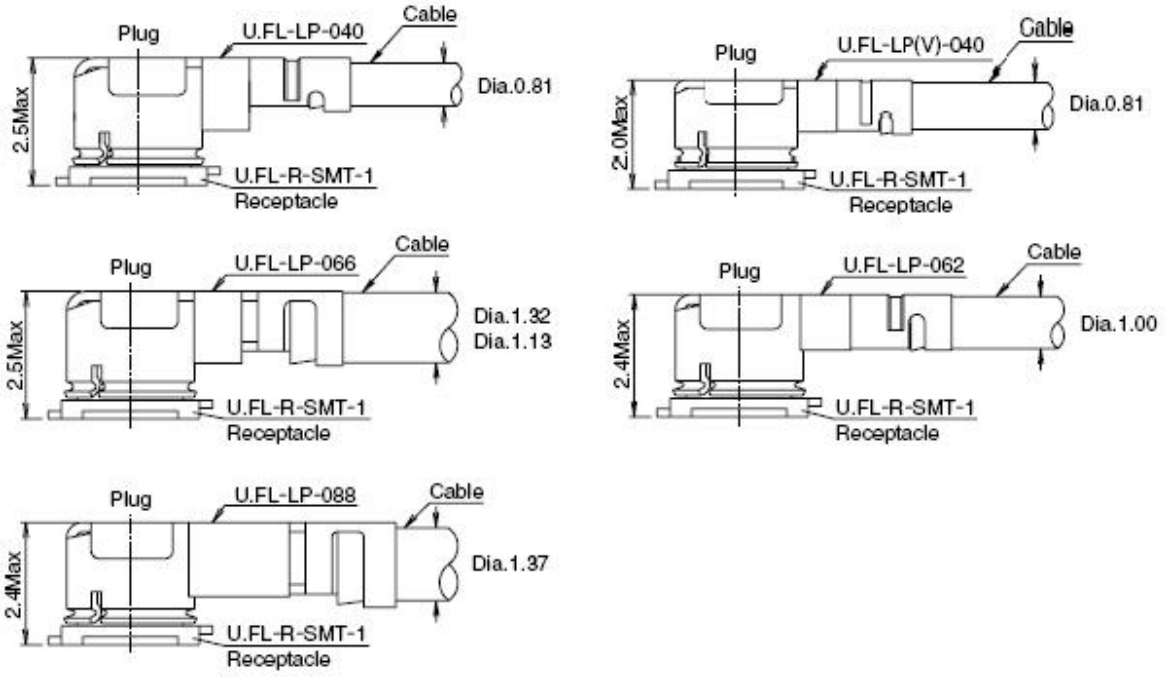



**Figure 41: Space Factor of Mated Connectors (Unit: mm)**

For more details, please visit http://www.hirose.com.

# 7 Electrical, Reliability and Radio Characteristics

## 7.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital and analog pins of the module are listed in the following table.

**Table 39: Absolute Maximum Ratings**

| Parameter | Min. | Max. | Unit |
|---|---|---|---|
| VBAT | -0.5 | 6 | V |
| USB_VBUS | -0.5 | 16 | V |
| Peak Current of VBAT | 0 | 3 | A |
| Voltage on Digital Pins | -0.3 | 2.3 | V |

## 7.2. Power Supply Ratings

**Table 40: SC20 Module Power Supply Ratings**

| Parameter | Description | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| VBAT | VBAT | The actual input voltages must stay between the minimum and maximum values. | 3.5 | 3.8 | 4.2 | V |
| | Voltage drop during transmitting burst | Maximum power control level at EGSM900. | | | 400 | mV |

| | | | | | | |
|---|---|---|---|---|---|---|
| $I_{VBAT}$ | Peak supply current (during transmission slot) | Maximum power control level at EGSM900. | | 1.8 | 3.0 | A |
| USB_VBUS | USB detection | | 4.35 | 5.0 | 6.3 | V |
| VRTC | Power supply voltage of backup battery. | | 2.0 | 3.0 | 3.25 | V |

## 7.3. Charging Performance Specifications

**Table 41: Charging Performance Specifications**

| Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Trickle charging-A current | 81 | 90 | 99 | mA |
| Trickle charging-A threshold voltage range (15.62mV steps) | 2.5 | 2.796 | 2.984 | V |
| Trickle charging-B threshold voltage range (18.75mV steps) | 3.0 | 3.2 | 3.581 | V |
| Charge voltage range (25mV steps) | 4 | 4.2 | 4.775 | V |
| Charge voltage accuracy | | | +/-2 | % |
| Charge current range (90mA steps) | 90 | | 1440 | mA |
| Charge current accuracy | | | +/-10 | % |
| Charge termination current:<br>when charge current is from 90mA to 450mA | | 7 | | % |
| Charge termination current:<br>when charge current is from 450mA to 1440mA | | 7.4 | | % |

## 7.4. Operating Temperature

The operating temperature is listed in the following table.

**Table 42: Operating Temperature**

| Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Operating temperature range [1)] | -35 | +25 | +65 | ºC |
| Extended temperature range [2)] | -40 | | +75 | ºC |

**NOTES**

1. [1)] Within operation temperature range, the module is 3GPP compliant.
2. [2)] Within extended temperature range, the module remains the ability to establish and maintain a voice, SMS, data transmission, emergency call, etc. There is no unrecoverable malfunction. There are also no effects on radio spectrum and no harm to radio network. Only one or more parameters like $P_{out}$ might reduce in their value and exceed the specified tolerances. When the temperature returns to the normal operating temperature levels, the module will meet 3GPP specifications again.

## 7.5. Current Consumption

The values of current consumption are shown below.

**Table 43: SC20-CE R1.1 Current Consumption**

| Parameter | Description | Conditions | Typ. | Unit |
|---|---|---|---|---|
| $I_{VBAT}$ | OFF state | Power down | 20 | uA |
| | GSM/GPRS supply current | Sleep (USB disconnected) @DRX=2 | 3.85 | mA |
| | | Sleep (USB disconnected) @DRX=5 | 3.01 | mA |
| | | Sleep (USB disconnected) @DRX=9 | 2.91 | mA |
| | WCDMA supply current | Sleep (USB disconnected) @DRX=6 | 3.30 | mA |

| | | | | |
|---|---|---|---|---|
| | | Sleep (USB disconnected) @DRX=7 | 2.79 | mA |
| | | Sleep (USB disconnected) @DRX=8 | 2.49 | mA |
| | | Sleep (USB disconnected) @DRX=9 | 2.33 | mA |
| | LTE-FDD supply current | Sleep (USB disconnected) @DRX=5 | 5.60 | mA |
| | | Sleep (USB disconnected) @DRX=6 | 3.83 | mA |
| | | Sleep (USB disconnected) @DRX=7 | 3.02 | mA |
| | | Sleep (USB disconnected) @DRX=8 | 2.65 | mA |
| | LTE-TDD supply current | Sleep (USB disconnected) @DRX=5 | 5.49 | mA |
| | | Sleep (USB disconnected) @DRX=6 | 3.87 | mA |
| | | Sleep (USB disconnected) @DRX=7 | 3.05 | mA |
| | | Sleep (USB disconnected) @DRX=8 | 2.67 | mA |
| | GSM voice call | GSM900 PCL=5 @31.84dBm | TBD | mA |
| | | GSM900 PCL=12 @18.49dBm | TBD | mA |
| | | GSM900 PCL=19 @4.95dBm | TBD | mA |
| | | DCS1800 PCL=0 @28.91dBm | TBD | mA |
| | | DCS1800 PCL=7 @15.35dBm | TBD | mA |
| | | DCS1800 PCL=15 @-0.21dBm | TBD | mA |
| | CDMA voice call | BC0 (max power) @23.91dBm | TBD | mA |
| | | BC0 (min power) @-60.28dBm | TBD | mA |
| | WCDMA voice call | Band1 (max power) @22.61dBm | TBD | mA |

| | | | | |
|---|---|---|---|---|
| | | Band8 (max power) @22.74dBm | TBD | mA |
| | EDGE data transfer | EDGE900 (1UL/4DL) @26.29dBm | TBD | mA |
| | | EDGE900 (2UL/3DL) @26.15dBm | TBD | mA |
| | | EDGE900 (3UL/2DL) @26.06dBm | TBD | mA |
| | | EDGE900 (4UL/1DL) @25.92dBm | TBD | mA |
| | | DCS1800 (1UL/4DL) @24.89dBm | TBD | mA |
| | | DCS1800 (2UL/3DL) @24.74dBm | TBD | mA |
| | | DCS1800 (3UL/2DL) @24.54dBm | TBD | mA |
| | | DCS1800 (4UL/1DL) @24.44dBm | TBD | mA |
| | CDMA data transfer | BC0 (max power) @23.68dBm | TBD | mA |
| | WCDMA data transfer | Band 1 (HSDPA) @21.64dBm | TBD | mA |
| | | Band 8 (HSDPA) @21.61dBm | TBD | mA |
| | | Band 1 (HSUPA) @21.36dBm | TBD | mA |
| | | Band 8 (HSUPA) @21.56dBm | TBD | mA |
| | LTE data transfer | LTE-FDD Band1 @22.96dBm | TBD | mA |
| | | LTE-FDD Band3 @22.95dBm | TBD | mA |
| | | LTE-FDD Band5 @22.90dBm | TBD | mA |
| | | LTE-FDD Band8 @23.17dBm | TBD | mA |
| | | LTE-TDD Band38 @22.02dBm | TBD | mA |
| | | LTE-TDD Band39 @22.13dBm | TBD | mA |
| | | LTE-TDD Band40 | TBD | mA |

| | | | | |
|---|---|---|---|---|
| | | @22.01dBm | | |
| | | LTE-TDD Band41 @22.31dBm | TBD | mA |

**Table 44: SC20-E Current Consumption**

| Parameter | Description | Conditions | Typ. | Unit |
|---|---|---|---|---|
| $I_{VBAT}$ | OFF state | Power down | 20 | uA |
| | GSM/GPRS supply current | Sleep (USB disconnected) @DRX=2 | 3.58 | mA |
| | | Sleep (USB disconnected) @DRX=5 | 2.46 | mA |
| | | Sleep (USB disconnected) @DRX=9 | 2.13 | mA |
| | WCDMA supply current | Sleep (USB disconnected) @DRX=6 | 2.99 | mA |
| | | Sleep (USB disconnected) @DRX=7 | 2.35 | mA |
| | | Sleep (USB disconnected) @DRX=8 | 2.01 | mA |
| | | Sleep (USB disconnected) @DRX=9 | 1.85 | mA |
| | LTE-FDD supply current | Sleep (USB disconnected) @DRX=5 | 5.51 | mA |
| | | Sleep (USB disconnected) @DRX=6 | 3.56 | mA |
| | | Sleep (USB disconnected) @DRX=7 | 2.62 | mA |
| | | Sleep (USB disconnected) @DRX=8 | 2.14 | mA |
| | LTE-TDD supply current | Sleep (USB disconnected) @DRX=5 | 5.93 | mA |
| | | Sleep (USB disconnected) @DRX=6 | 3.74 | mA |
| | | Sleep (USB disconnected) @DRX=7 | 2.70 | mA |
| | | Sleep (USB disconnected) @DRX=8 | 2.17 | mA |
| | GSM voice call | GSM850 PCL=5 @33.13dBm | 263.8 | mA |

| | | | | |
|---|---|---|---|---|
| | | GSM850<br>PCL=12 @19.15dBm | 134.7 | mA |
| | | GSM850<br>PCL=19 @5.31dBm | 109.2 | mA |
| | | EGSM900<br>PCL=5 @33.07dBm | 271.2 | mA |
| | | EGSM900<br>PCL=12 @19.53dBm | 137.3 | mA |
| | | EGSM900<br>PCL=19 @5.59dBm | 110.6 | mA |
| | | DCS1800<br>PCL=0 @30.00dBm | 203.0 | mA |
| | | DCS1800<br>PCL=7 @16.45dBm | 150.7 | mA |
| | | DCS1800<br>PCL=15 @0.67dBm | 130.8 | mA |
| | | PCS1900<br>PCL=0 @29.72dBm | 195.9 | mA |
| | | PCS1900<br>PCL=7 @16.72dBm | 151.3 | mA |
| | | PCS1900<br>PCL=15 @0.98dBm | 130.0 | mA |
| | WCDMA voice call | Band 1 (max power)<br>@23.18dBm | 544.1 | mA |
| | | Band 5 (max power)<br>@23.22dBm | 513.5 | mA |
| | | Band 8 (max power)<br>@23.29dBm | 522.7 | mA |
| | GPRS data transfer | GPRS850 (1UL/4DL)<br>@33.12dBm | 265.9 | mA |
| | | GPRS850 (2UL/3DL)<br>@33.02dBm | 435.1 | mA |
| | | GPRS850 (3UL/2DL)<br>@30.50dBm | 478.8 | mA |
| | | GPRS850 (4UL/1DL)<br>@29.49dBM | 564.0 | mA |
| | | GPRS900 (1UL/4DL)<br>@33.10dBm | 272.7 | mA |
| | | GPRS900 (2UL/3DL)<br>@33.00dBm | 445.0 | mA |
| | | GPRS900 (3UL/2DL)<br>@30.96dBm | 512.0 | mA |

| | | | | |
|---|---|---|---|---|
| | | GPRS900 (4UL/1DL) @29.93dBm | 599.2 | mA |
| | | DCS1800 (1UL/4DL) @29.96dBm | 205.8 | mA |
| | | DCS1800 (2UL/3DL) @29.86dBm | 314.3 | mA |
| | | DCS1800 (3UL/2DL) @29.73dBm | 420.8 | mA |
| | | DCS1800 (4UL/1DL) @29.63dBm | 531.7 | mA |
| | | PCS1900 (1UL/4DL) @29.77dBm | 199.3 | mA |
| | | PCS1900 (2UL/3DL) @29.64dBm | 307.2 | mA |
| | | PCS1900 (3UL/2DL) @29.54dBm | 411.5 | mA |
| | | PCS1900 (4UL/1DL) @29.34dBm | 518.7 | mA |
| | EDGE data transfer | EDGE850 (1UL/4DL) @26.75dBm | 172.2 | mA |
| | | EDGE850 (2UL/3DL) @27.13dBm | 266.6 | mA |
| | | EDGE850 (3UL/2DL) @26.63dBm | 353.1 | mA |
| | | EDGE850 (4UL/1DL) @26.54dBm | 446.9 | mA |
| | | EDGE900 (1UL/4DL) @27.05dBm | 182 | mA |
| | | EDGE900 (2UL/3DL) @27.13dBm | 177.4 | mA |
| | | EDGE900 (3UL/2DL) @27.28dBm | 278.3 | mA |
| | | EDGE900 (4UL/1DL) @27.19dBm | 371.0 | mA |
| | | DCS1800 (1UL/4DL) @26.04dBm | 170.6 | mA |
| | | DCS1800 (2UL/3DL) @25.98dBm | 260.5 | mA |
| | | DCS1800 (3UL/2DL) @25.71dBm | 349.8 | mA |
| | | DCS1800 (4UL/1DL) @25.46dBm | 440.2 | mA |

| | | | | |
|---|---|---|---|---|
| | | PCS1900 (1UL/4DL) @26.14dBm | 171.0 | mA |
| | | PCS1900 (2UL/3DL) @26.11dBm | 260.5 | mA |
| | | PCS1900 (3UL/2DL) @26.11dBm | 349.6 | mA |
| | | PCS1900 (4UL/1DL) @25.70dBm | 442.3 | mA |
| | WCDMA data transfer | Band 1 (HSDPA) @22.43dBm | 503.8 | mA |
| | | Band 5 (HSDPA) @22.23dBm | 471.6 | mA |
| | | Band 8 (HSDPA) @22.24dBm | 481.6 | mA |
| | | Band 1 (HSUPA) @22.30dBm | 504.6 | mA |
| | | Band 5 (HSUPA) @21.93dBm | 460.5 | mA |
| | | Band 8 (HSUPA) @21.90dBm | 464.8 | mA |
| | LTE data transfer | LTE-FDD Band1 @23.29dBm | 737 | mA |
| | | LTE-FDD Band3 @23.29dBm | 756 | mA |
| | | LTE-FDD Band5 @23.44dBm | 636 | mA |
| | | LTE-FDD Band7 @23.28dBm | 842 | mA |
| | | LTE-FDD Band8 @23.44dBm | 639 | mA |
| | | LTE-FDD Band20 @23.36dBm | 684 | mA |
| | | LTE-TDD Band38 @23.19dBm | 427 | mA |
| | | LTE-TDD Band40 @23.17dBm | 427 | mA |
| | | LTE-TDD Band41 @23.19dBm | 455 | mA |

**Table 45: SC20-A Current Consumption**

| Parameter | Description | Conditions | Typ. | Unit |
|---|---|---|---|---|
| $I_{VBAT}$ | OFF state | Power down | 20 | uA |
| | GSM/GPRS supply current | Sleep USB disconnected) @DRX=2 | 4.08 | mA |
| | | Sleep (USB disconnected) DRX=5 | 3.10 | mA |
| | | Sleep (USB disconnected) DRX=9 | 2.77 | mA |
| | WCDMA supply current | Sleep (USB disconnected) DRX=6 | 3.86 | mA |
| | | Sleep (USB disconnected) DRX=7 | 2.90 | mA |
| | | Sleep (USB disconnected) DRX=8 | 2.55 | mA |
| | | Sleep (USB disconnected) DRX=9 | 2.43 | mA |
| | FDD-LTE supply current | Sleep (USB disconnected) DRX=5 | 6.60 | mA |
| | | Sleep (USB disconnected) DRX=6 | 4.24 | mA |
| | | Sleep (USB disconnected) DRX=7 | 3.11 | mA |
| | | Sleep (USB disconnected) DRX=8 | 2.77 | mA |
| | GSM voice call | GSM850 PCL=5 @32.23dBm | 254.60 | mA |
| | | GSM850 PCL=12 @18.34dBm | 136.30 | mA |
| | | GSM850 PCL=19 @4.87dBm | 111.30 | mA |
| | | PCS1900 PC=L0 @29.14dBm | 196.60 | mA |
| | | PCS1900 PCL=7 @16.23dBm | 158.40 | mA |
| | | PCS1900 PCL=15 @0.62dBm | 135.50 | mA |
| | WCDMA voice call | Band 1 (max power) @23.24dBm | 548.13 | mA |
| | | Band 2 (max power) | 575.70 | mA |

| | | | | |
|---|---|---|---|---|
| | | @23.40dBm | | |
| | | Band 4 (max power) @23.20dBm | 561.35 | mA |
| | | Band 5 (max power) @23.47dBm | 558.00 | mA |
| | | Band 8 (max power) @23.5dBm | 557.10 | mA |
| | GPRS data transfer | GPRS850 (1UL/4DL) @32.18dBm | 254.50 | mA |
| | | GPRS850 (2UL/3DL) @32.00dBm | 410.70 | mA |
| | | GPRS850 (3UL/2DL) @30.43dBm | 496.10 | mA |
| | | GPRS850 (4UL/1DL) @29.37dBm | 573.90 | mA |
| | | PCS1900 (1UL/4DL) @29.13dBm | 198.70 | mA |
| | | PCS1900 (2UL/3DL) @29.19dBm | 306.50 | mA |
| | | PCS1900 (3UL/2DL) @29.05dBm | 408.90 | mA |
| | | PCS1900 (4UL/1DL) @28.84dBm | 514.60 | mA |
| | EDGE data transfer | EDGE850 (1UL/4DL) @26.39dBm | 186.00 | mA |
| | | EDGE850 (2UL/3DL) @26.30dBm | 280.00 | mA |
| | | EDGE850 (3UL/2DL) @26.30dBm | 368.00 | mA |
| | | EDGE850 (4UL/1DL) @26.07dBm | 456.00 | mA |
| | | PCS1900 (1UL/4DL) @25.70dBm | 184.40 | mA |
| | | PCS1900 (2UL/3DL) @25.55dBm | 276.60 | mA |
| | | PCS1900 (3UL/2DL) @25.39dBm | 365.20 | mA |
| | | PCS1900 (4UL/1DL) @25.17dBm | 456.50 | mA |
| | WCDMA data transfer | Band 1 (HSDPA) @22.24dBm | 506.35 | mA |

| | | | | |
|---|---|---|---|---|
| | | Band 2 (HSDPA) @22.44dBm | 535.10 | mA |
| | | Band 4 (HSDPA) @22.23dBm | 523.07 | mA |
| | | Band 5 (HSDPA) @22.38dBm | 513.13 | mA |
| | | Band 8 (HSDPA) @22.47dBm | 512.30 | mA |
| | | Band 1 (HSUPA) @22.2dBm | 516.00 | mA |
| | | Band2 (HSUPA) @22.4dBm | 545.60 | mA |
| | | Band 4 (HSUPA) @21.93dBm | 527.93 | mA |
| | | Band 5 (HSUPA) @22.26dBm | 528.94 | mA |
| | | Band 8 (HSUPA) @22 dBm | 507.70 | mA |
| | LTE data transfer | LTE-FDD Band2 @23.05dBm | 710.01 | mA |
| | | LTE-FDD Band4 @23.3dBm | 736.50 | mA |
| | | LTE-FDD Band5 @23.13dBm | 626.18 | mA |
| | | LTE-FDD Band7 @22.75dBm | 733.40 | mA |
| | | LTE-FDD Band12 @22.74dBm | 606.02 | mA |
| | | LTE-FDD Band13 @23.3dBm | 674.84 | mA |
| | | LTE-FDD Band25 @23.2dBm | 665.62 | mA |
| | | LTE-FDD Band26 @23.57dBm | 718.75 | mA |

**Table 46: SC20-AU Current Consumption**

| Parameter | Description | Conditions | Typ. | Unit |
|---|---|---|---|---|
| $I_{VBAT}$ | OFF state | Power down | 20 | uA |
| | GSM/GPRS supply | Sleep (USB disconnected) | TBD | mA |

| | | | | |
|---|---|---|---|---|
| | current | DRX=2 | | |
| | | Sleep (USB disconnected) DRX=5 | TBD | mA |
| | | Sleep (USB disconnected) DRX=9 | TBD | mA |
| | WCDMA supply current | Sleep (USB disconnected) DRX=6 | TBD | mA |
| | | Sleep (USB disconnected) DRX=7 | TBD | mA |
| | | Sleep (USB disconnected) DRX=8 | TBD | mA |
| | | Sleep (USB disconnected) DRX=9 | TBD | mA |
| | LTE-FDD supply current | Sleep (USB disconnected) DRX=5 | TBD | mA |
| | | Sleep (USB disconnected) DRX=6 | TBD | mA |
| | | Sleep (USB disconnected) DRX=7 | TBD | mA |
| | | Sleep (USB disconnected) DRX=8 | TBD | mA |
| | LTE-TDD supply current | Sleep (USB disconnected) DRX=5 | TBD | mA |
| | | Sleep (USB disconnected) DRX=6 | TBD | mA |
| | | Sleep (USB disconnected) DRX=7 | TBD | mA |
| | | Sleep (USB disconnected) DRX=8 | TBD | mA |
| | GSM voice call | GSM850 PCL=5 @32.96dBm | 268 | mA |
| | | GSM850 PCL=12 @18.83dBm | 133 | mA |
| | | GSM850 PCL=19 @5.31dBm | 109 | mA |
| | | GSM900 PCL=5 @32.96dBm | 267 | mA |
| | | GSM900 PCL=12 @19.21dBm | 137 | mA |
| | | GSM900 PCL=19 @5.60dBm | 108 | mA |

| | | | | |
|---|---|---|---|---|
| | | PCS1800<br>PC=L0 @29.93dBm | 202 | mA |
| | | PCS1800<br>PCL=7 @16.29dBm | 152 | mA |
| | | PCS1800<br>PCL=15 @0.62dBm | 131 | mA |
| | | PCS1900<br>PC=L0 @29.67dBm | 194 | mA |
| | | PCS1900<br>PCL=7 @16.74dBm | 149 | mA |
| | | PCS1900<br>PCL=15 @1.09dBm | 130 | mA |
| | WCDMA voice call | Band 1 (max power)<br>@23.33dBm | 561 | mA |
| | | Band 2 (max power)<br>@23.51dBm | 521 | mA |
| | | Band 5 (max power)<br>@23.37dBm | 551 | mA |
| | | Band 8 (max power)<br>@23.38dBm | 478 | mA |
| | GPRS<br>data transfer | GPRS850 (1UL/4DL)<br>@32.91dBm | 267 | mA |
| | | GPRS850 (2UL/3DL)<br>@32.73dBm | TBD | mA |
| | | GPRS850 (3UL/2DL)<br>@30.72dBm | 503 | mA |
| | | GPRS850 (4UL/1DL)<br>@29.38dBm | 574 | mA |
| | | GSM900 (1UL/4DL)<br>@32.92dBm | 266 | mA |
| | | GSM900 (2UL/3DL)<br>@32.74dBm | TBD | mA |
| | | GSM900 (3UL/2DL)<br>@30.85dBm | 509 | mA |
| | | GSM900 (4UL/1DL)<br>@29.58dBm | 583 | mA |
| | | DCS1800 (1UL/4DL)<br>@39.81dBm | 205 | mA |
| | | DCS1800 (2UL/3DL)<br>@39.70dBm | 316 | mA |
| | | DCS1800 (3UL/2DL)<br>@29.50dBm | TBD | mA |

| | | | | |
|---|---|---|---|---|
| | | DCS1800 (4UL/1DL) @29.34dBm | 530 | mA |
| | | PCS1900 (1UL/4DL) @29.58dBm | TBD | mA |
| | | PCS1900 (2UL/3DL) @29.48dBm | TBD | mA |
| | | PCS1900 (3UL/2DL) @29.31dBm | TBD | mA |
| | | PCS1900 (4UL/1DL) @29.40dBm | TBD | mA |
| | EDGE data transfer | EDGE850 (1UL/4DL) @26.70dBm | TBD | mA |
| | | EDGE850 (2UL/3DL) @27.02dBm | 300 | mA |
| | | EDGE850 (3UL/2DL) @26.60dBm | 389 | mA |
| | | EDGE850 (4UL/1DL) @26.33dBm | 457 | mA |
| | | GSM900 (1UL/4DL) @26.87dBm | 178 | mA |
| | | GSM900 (2UL/3DL) @27.27dBm | 276 | mA |
| | | GSM900 (3UL/2DL) @26.85dBm | 394 | mA |
| | | GSM900 (4UL/1DL) @26.53dBm | 490 | mA |
| | | DCS1800 (1UL/4DL) @25.39dBm | 197 | mA |
| | | DCS1800 (2UL/3DL) @25.40dBm | 287 | mA |
| | | DCS1800 (3UL/2DL) @25.35dBm | 373 | mA |
| | | DCS1800 (4UL/1DL) @25.05dBm | 461 | mA |
| | | PCS1900 (1UL/4DL) @26.03dBm | 168 | mA |
| | | PCS1900 (2UL/3DL) @26.07dBm | 257 | mA |
| | | PCS1900 (3UL/2DL) @25.81dBm | 345 | mA |
| | | PCS1900 (4UL/1DL) @25.70dBm | 436 | mA |

| | | | | |
|---|---|---|---|---|
| | WCDMA data transfer | Band 1 (HSDPA) @23.02dBm | 517 | mA |
| | | Band 2 (HSDPA) @23.11dBm | 550 | mA |
| | | Band 5 (HSDPA) @22.68dBm | 486 | mA |
| | | Band 8 (HSDPA) @22.72dBm | 466 | mA |
| | | Band 1 (HSUPA) @22.39dBm | 521 | mA |
| | | Band2 (HSUPA) @23.19dBm | 509 | mA |
| | | Band 5 (HSUPA) @22.44dBm | 503 | mA |
| | | Band 8 (HSUPA) @22.25dBm | 474 | mA |
| | LTE data transfer | LTE-FDD Band1 @23.37dBm | 698 | mA |
| | | LTE-FDD Band3 @23.06dBm | 709 | mA |
| | | LTE-FDD Band5 @23.25dBm | 643 | mA |
| | | LTE-FDD Band7 @22.82dBm | 802 | mA |
| | | LTE-FDD Band8 @23.47dBm | 620 | mA |
| | | LTE-FDD Band28 @23.13dBm | 756 | mA |
| | | LTE-TDD Band40 @23.24dBm | 388 | mA |

**Table 47: SC20-J Current Consumption**

| Parameter | Description | Conditions | Typ. | Unit |
|---|---|---|---|---|
| $I_{VBAT}$ | OFF state | Power down | 20 | uA |
| | WCDMA supply current | Sleep (USB disconnected) DRX=6 | TBD | mA |
| | | Sleep (USB disconnected) DRX=7 | TBD | mA |
| | | Sleep (USB disconnected) | TBD | mA |

| | | | | |
|---|---|---|---|---|
| | | DRX=8 | | |
| | | Sleep (USB disconnected) DRX=9 | TBD | mA |
| | LTE-FDD supply current | Sleep (USB disconnected) DRX=5 | TBD | mA |
| | | Sleep (USB disconnected) DRX=6 | TBD | mA |
| | | Sleep (USB disconnected) DRX=7 | TBD | mA |
| | | Sleep (USB disconnected) DRX=8 | TBD | mA |
| | LTE-TDD supply current | Sleep (USB disconnected) DRX=5 | TBD | mA |
| | | Sleep (USB disconnected) DRX=6 | TBD | mA |
| | | Sleep (USB disconnected) DRX=7 | TBD | mA |
| | | Sleep (USB disconnected) DRX=8 | TBD | mA |
| | WCDMA voice call | Band 1 (max power) @22.97dBm | TBD | mA |
| | | Band 6 (max power) @22.99dBm | TBD | mA |
| | | Band 8 (max power) @23.20dBm | TBD | mA |
| | | Band 19 (max power) @22.99dBm | TBD | mA |
| | WCDMA data transfer | Band 1 (HSDPA) @22.13dBm | 482 | mA |
| | | Band 6 (HSDPA) @22.28dBm | TBD | mA |
| | | Band 8 (HSDPA) @22.17dBm | 471 | mA |
| | | Band 19 (HSDPA) @22.31dBm | 500 | mA |
| | | Band 1 (HSUPA) @21.4dBm | 494 | mA |
| | | Band 6 (HSUPA) @22.11dBm | TBD | mA |
| | | Band 8 (HSUPA) @21.57dBm | 472 | mA |

| | | | | |
|---|---|---|---|---|
| | | Band 19 (HSUPA) @22.10dBm | TBD | mA |
| | LTE data transfer | LTE-FDD Band1 @23.64dBm | TBD | mA |
| | | LTE-FDD Band3 @23.52dBm | TBD | mA |
| | | LTE-FDD Band8 @23.40dBm | 637 | mA |
| | | LTE-FDD Band18 @23.45dBm | TBD | mA |
| | | LTE-FDD Band19 @23.42dBm | TBD | mA |
| | | LTE-FDD Band26 @23.36dBm | TBD | mA |
| | | LTE-TDD Band41 @23.23dBm | 451 | mA |

## 7.6. RF Output Power

The following table shows the RF output power of SC20 module.

**Table 48: RF Output Power**

| Frequency | Max. | Min. |
|---|---|---|
| GSM850 | 33dBm±2dB | 5dBm±5dB |
| EGSM900 | 33dBm±2dB | 5dBm±5dB |
| DCS1800 | 30dBm±2dB | 0dBm±5dB |
| PCS1900 | 30dBm±2dB | 0dBm±5dB |
| WCDMA Band1 | 24dBm+1/-3dB | <-49dBm |
| WCDMA Band2 | 24dBm+1/-3dB | <-49dBm |
| WCDMA Band4 | 24dBm+1/-3dB | <-49dBm |
| WCDMA Band5 | 24dBm+1/-3dB | <-49dBm |
| WCDMA Band6 | 24dBm+1/-3dB | <-49dBm |

| | | |
|---|---|---|
| WCDMA Band8 | 24dBm+1/-3dB | <-49dBm |
| WCDMA Band19 | 24dBm+1/-3dB | <-49dBm |
| CDMA BC0 | 24dBm+3/-1dB | <-49dBm |
| TD-SCDMA Band34 | 24dBm+1/-3dB | <-49dBm |
| TD-SCDMA Band39 | 24dBm+1/-3dB | <-49dBm |
| LTE-FDD B1 | 23dBm±2dB | <-39dBm |
| LTE-FDD B2 | 23dBm±2dB | <-39dBm |
| LTE-FDD B3 | 23dBm±2dB | <-39dBm |
| LTE-FDD B4 | 23dBm±2dB | <-39dBm |
| LTE-FDD B5 | 23dBm±2dB | <-39dBm |
| LTE-FDD B7 | 23dBm±2dB | <-39dBm |
| LTE-FDD B8 | 23dBm±2dB | <-39dBm |
| LTE-FDD B12 | 23dBm±2dB | <-39dBm |
| LTE-FDD B13 | 23dBm±2dB | <-39dBm |
| LTE-FDD B18 | 23dBm±2dB | <-39dBm |
| LTE-FDD B19 | 23dBm±2dB | <-39dBm |
| LTE-FDD B20 | 23dBm±2dB | <-39dBm |
| LTE-FDD B25 | 23dBm±2dB | <-39dBm |
| LTE-FDD B26 | 23dBm±2dB | <-39dBm |
| LTE-FDD B28 | 23dBm±2dB | <-39dBm |
| LTE-TDD B38 | 23dBm±2dB | <-39dBm |
| LTE-TDD B39 | 23dBm±2dB | <-39dBm |
| LTE-TDD B40 | 23dBm±2dB | <-39dBm |
| LTE-TDD B41 | 23dBm±2dB | <-39dBm |

**NOTE**

In GPRS 4 slots TX mode, the maximum output power is reduced by 3dB. This design conforms to the GSM specification as described in ***Chapter 13.16*** of *3GPP TS 51.010-1*.

## 7.7. RF Receiving Sensitivity

The following table shows the RF receiving sensitivity of SC20 module.

**Table 49: SC20-CE R1.1 RF Receiving Sensitivity**

| Frequency | Receive Sensitivity (Typ.) | | | |
|---|---|---|---|---|
| | Primary | Diversity | SIMO | 3GPP(SIMO) |
| EGSM900 | TBD | NA | NA | -102dBm |
| DCS1800 | TBD | NA | NA | -102dBm |
| WCDMA Band1 | TBD | NA | NA | -106.7dBm |
| WCDMA Band8 | TBD | NA | NA | -103.7dBm |
| CDMA BC0 | TBD | NA | NA | -104dBm |
| TD-SCDMA Band 34 | TBD | NA | NA | -108dBm |
| TD-SCDMA Band 39 | TBD | NA | NA | -108dBm |
| LTE-FDD B1 (10M) | TBD | TBD | TBD | -96.3dBm |
| LTE-FDD B3 (10M) | TBD | TBD | TBD | -93.3dBm |
| LTE-FDD B5 (10M) | TBD | TBD | TBD | -94.3dBm |
| LTE-FDD B8 (10M) | TBD | TBD | TBD | -93.3dBm |
| LTE-FDD B38 (10M) | TBD | TBD | TBD | -96.3dBm |
| LTE-FDD B39 (10M) | TBD | TBD | TBD | -96.3dBm |
| LTE-FDD B40 (10M) | TBD | TBD | TBD | -96.3dBm |
| LTE-FDD B41 (10M) | TBD | TBD | TBD | -94.3dBm |

**Table 50: SC20-E RF Receiving Sensitivity**

| Frequency | Receive Sensitivity (Typ.) | | | |
|---|---|---|---|---|
| | Primary | Diversity | SIMO | 3GPP (SIMO) |
| GSM850 | -109dBm | NA | NA | -102dBm |
| EGSM900 | -109dBm | NA | NA | -102dBm |
| DCS1800 | -109dBm | NA | NA | -102dBm |
| PCS1900 | -109dBm | NA | NA | -102dBm |
| WCDMA Band1 | -110dBm | NA | NA | -106.7dBm |
| WCDMA Band5 | -110dBm | NA | NA | -104.7dBm |
| WCDMA Band8 | -110dBm | NA | NA | -103.7dBm |
| LTE-FDD B1 (10M) | -98dBm | -99dBm | -102dBm | -96.3dBm |
| LTE-FDD B3 (10M) | -97dBm | -98dBm | -101dBm | -93.3dBm |
| LTE-FDD B5 (10M) | -99dBm | -98dBm | -102dBm | -94.3dBm |
| LTE-FDD B7 (10M) | -97dBm | -97dBm | -102dBm | -94.3dBm |
| LTE-FDD B8 (10M) | -98dBm | -98dBm | -101dBm | -93.3dBm |
| LTE-FDD B20 (10M) | -98dBm | -98dBm | -101dBm | -93.3dBm |
| LTE-TDD B38 (10M) | -97dBm | -98dBm | -100dBm | -96.3dBm |
| LTE-TDD B40 (10M) | -97dBm | -98dBm | -100dBm | -96.3dBm |
| LTE-TDD B41 (10M) | -96dBm | -98dBm | -100dBm | -94.3dBm |

**Table 51: SC20-A RF Receiving Sensitivity**

| Frequency | Receive Sensitivity (Typ.) | | | |
|---|---|---|---|---|
| | Primary | Diversity | SIMO | 3GPP (SIMO) |
| GSM850 | -109dBm | NA | NA | -102dBm |
| PCS1900 | -108dBm | NA | NA | -102dBm |
| WCDMA Band1 | -110dBm | NA | NA | -106.7dBm |
| WCDMA Band2 | -110dBm | NA | NA | -104.7dBm |

| | | | | |
|---|---|---|---|---|
| WCDMA Band4 | -110dBm | NA | NA | -106.7dBm |
| WCDMA Band5 | -110dBm | NA | NA | -104.7dBm |
| WCDMA Band8 | -110dBm | NA | NA | -103.7dBm |
| LTE-FDD B2 (10M) | -98dBm | -99dBm | -102dBm | -94.3dBm |
| LTE-FDD B4 (10M) | -97dBm | -98dBm | -101dBm | -96.3dBm |
| LTE-FDD B5 (10M) | -99.5dBm | -99.5dBm | -102.5dBm | -94.3dBm |
| LTE-FDD B7 (10M) | -97dBm | -99dBm | -100dBm | -94.3dBm |
| LTE-FDD B12 (10M) | -97.5dBm | -98.5dBm | -101dBm | -93.3dBm |
| LTE-FDD B13 (10M) | -99dBm | -99dBm | -101dBm | -93.3dBm |
| LTE-FDD B25 (10M) | -99dBm | -99dBm | -102dBm | -92.8dBm |
| LTE-FDD B26 (10M) | -99dBm | -100dBm | -102.5dBm | -93.8dBm |

**Table 52: SC20-AU RF Receiving Sensitivity**

| Frequency | Receive Sensitivity (Typ.) | | | |
|---|---|---|---|---|
| | Primary | Diversity | SIMO | 3GPP (SIMO) |
| GSM850 | -109dBm | NA | NA | -102dBm |
| EGSM900 | -109dBm | NA | NA | -102dBm |
| DCS1800 | -108dBm | NA | NA | -102dBm |
| PCS1900 | -109dBm | NA | NA | -102dBm |
| WCDMA Band1 | -110dBm | NA | NA | -106.7dBm |
| WCDMA Band2 | -110dBm | NA | NA | -104.7dBm |
| WCDMA Band5 | -110dBm | NA | NA | -104.7dBm |
| WCDMA Band8 | -110dBm | NA | NA | -103.7dBm |
| LTE-FDD B1 (10M) | -98dBm | -99dBm | -101dBm | -96.3dBm |
| LTE-FDD B3 (10M) | -97dBm | -98dBm | -101.8dBm | -93.3dBm |
| LTE-FDD B5 (10M) | -99dBm | -100dBm | -103dBm | -94.3dBm |

| | | | | |
|---|---|---|---|---|
| LTE-FDD B7 (10M) | -97dBm | -99dBm | -100.6dBm | -94.3dBm |
| LTE-FDD B8 (10M) | -98dBm | -100dBm | -102dBm | -93.3dBm |
| LTE-FDD B28 (10M) | -97.5dBm | -100dBm | -101.8dBm | -94.8dBm |
| LTE-TDD B40 (10M) | -97dBm | -98dBm | -100.7dBm | -96.3dBm |

**Table 53: SC20-J RF Receiving Sensitivity**

| Frequency | Receive Sensitivity (Typ.) | | | |
|---|---|---|---|---|
| | Primary | Diversity | SIMO | 3GPP (SIMO) |
| WCDMA Band1 | -110dBm | NA | NA | -106.7dBm |
| WCDMA Band6 | -110dBm | NA | NA | -106.7dBm |
| WCDMA Band8 | -110dBm | NA | NA | -103.7dBm |
| WCDMA Band19 | -110dBm | NA | NA | -106.7dBm |
| LTE-FDD B1 (10M) | -97dBm | -97.5dBm | -100dBm | -96.3dBm |
| LTE-FDD B3 (10M) | -97dBm | -98dBm | -101.5dBm | -93.3dBm |
| LTE-FDD B8 (10M) | -97dBm | -98dBm | -100dBm | -93.3dBm |
| LTE-FDD B18 (10M) | -98dBm | -99dBm | -101.5dBm | -96.3dBm |
| LTE-FDD B19 (10M) | -98dBm | -99dBm | -101.5dBm | -96.3dBm |
| LTE-FDD B26 (10M) | -98dBm | -99dBm | -101.5dBm | -93.8dBm |
| LTE-FDD B41 (10M) | -96dBm | -96.5dBm | -100dBm | -94.3dBm |

## 7.8. Electrostatic Discharge

The module is not protected against electrostatic discharge (ESD) in general. Consequently, it should be subject to ESD handling precautions that are typically applied to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module.

The following table shows the module electrostatic discharge characteristics.

**Table 54: Electrostatic Discharge Characteristics ( Temperature: 25ºC, Humidity: 45%)**

| Tested Points | Contact Discharge | Air Discharge | Unit |
|---|---|---|---|
| VBAT, GND | +/-5 | +/-10 | KV |
| All Antenna Interfaces | +/-5 | +/-10 | KV |
| USB Interfaces | +/-0.5 | +/-1 | KV |
| Other Interfaces | +/-0.5 | +/-1 | KV |

# 8 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm). The tolerances for dimensions without tolerance values are ±0.05mm.

## 8.1. Mechanical Dimensions of the Module

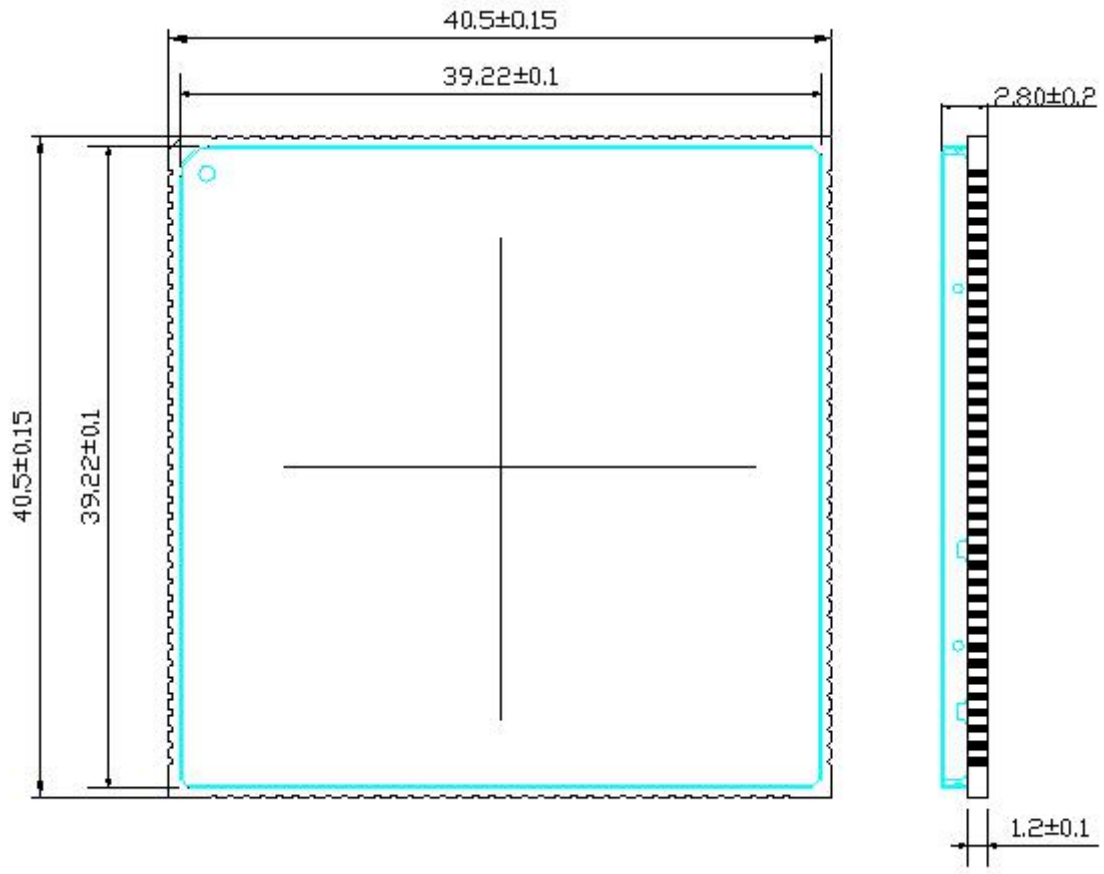



**Figure 42: Module Top and Side Dimensions**

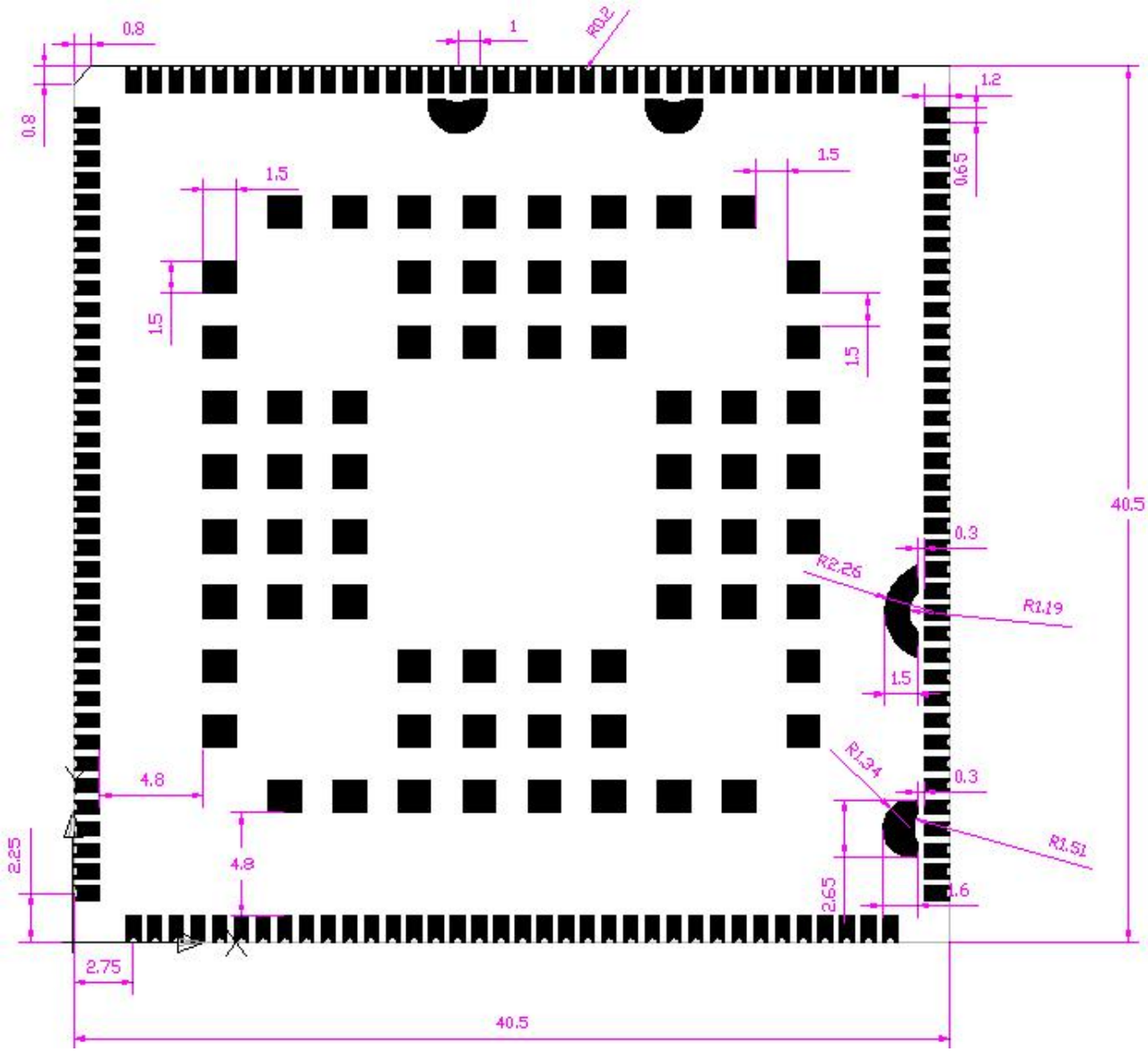



**Figure 43: Module Bottom Dimensions (Top View)**

## 8.2. Recommended Footprint

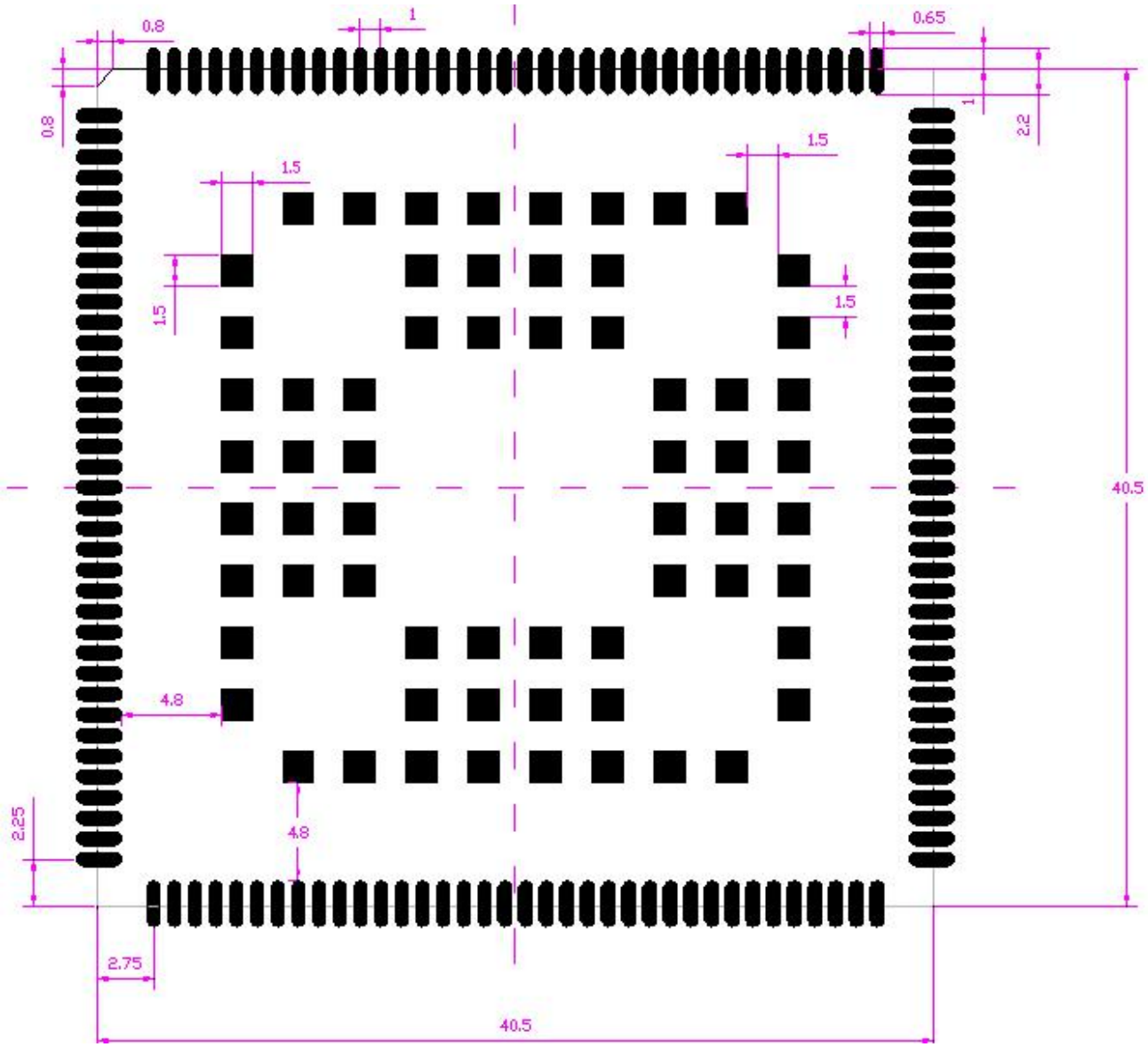



**Figure 44: Recommended Footprint (Top View)**

**NOTES**

1. For easy maintenance of the module, keep about 3mm between the module and other components on host PCB.
2. All RESERVED pins should be kept open and MUST NOT be connected to ground.

## 8.3. Top and Bottom Views of the Module


**Figure 45: Top View of the Module**

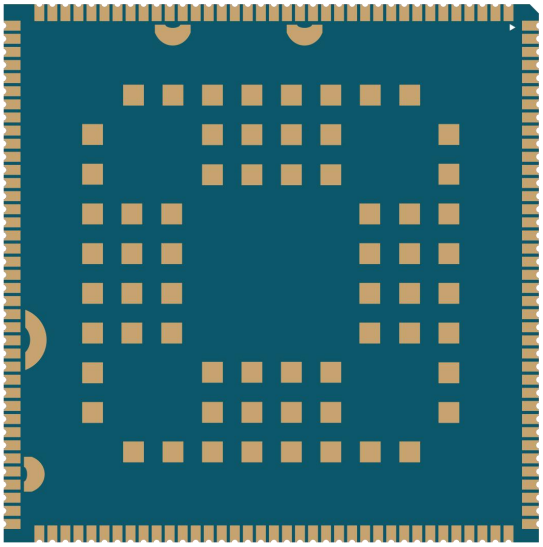


**Figure 46: Bottom View of the Module**

**NOTE**

These are design effect drawings of SC20 module. For more accurate pictures, please refer to the module that you get from Quectel.

# 9 Storage, Manufacturing and Packaging

## 9.1. Storage

SC20 is stored in a vacuum-sealed bag. The storage restrictions are shown as below.

1. Shelf life in the vacuum-sealed bag: 12 months at < 40ºC/90%RH.

2. After the vacuum-sealed bag is opened, devices that will be subjected to reflow soldering or other high temperature processes must be:
   - Mounted within 168 hours at the factory environment of ≤30ºC/60%RH.
   - Stored at <10%RH.

3. Devices require baking before mounting, if any circumstance below occurs.
   - When the ambient temperature is 23ºC±5ºC and the humidity indication card shows the humidity is >10% before opening the vacuum-sealed bag.
   - Device mounting cannot be finished within 168 hours at factory conditions of ≤30ºC/60%.

4. If baking is required, devices may be baked for 48 hours at 125ºC±5ºC.

**NOTE**

As the plastic package cannot be subjected to high temperature, it should be removed from devices before high temperature (125ºC) baking. If shorter baking time is desired, please refer to *IPC/JEDECJ-STD-033* for baking procedure.

## 9.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.18mm. For more details, please refer to ***document [3]***.

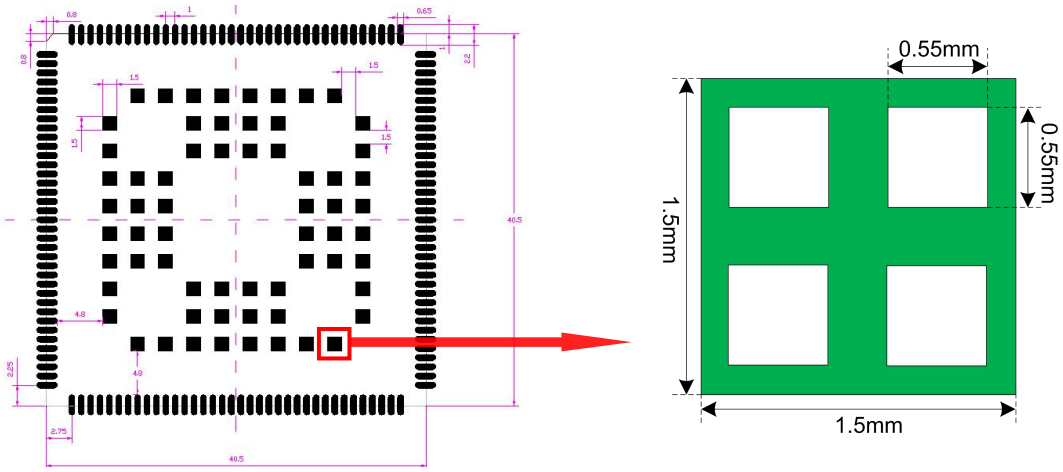



**Figure 47: Recommended Stencil Design for LGA Pads**

It is suggested that the peak reflow temperature is from 235ºC to 245ºC (for SnAg3.0Cu0.5 alloy). The absolute maximum reflow temperature is 260ºC. To avoid damage to the module caused by repeated heating, it is suggested that the module should be mounted after reflow soldering for the other side of PCB has been completed. Recommended reflow soldering thermal profile is shown below:

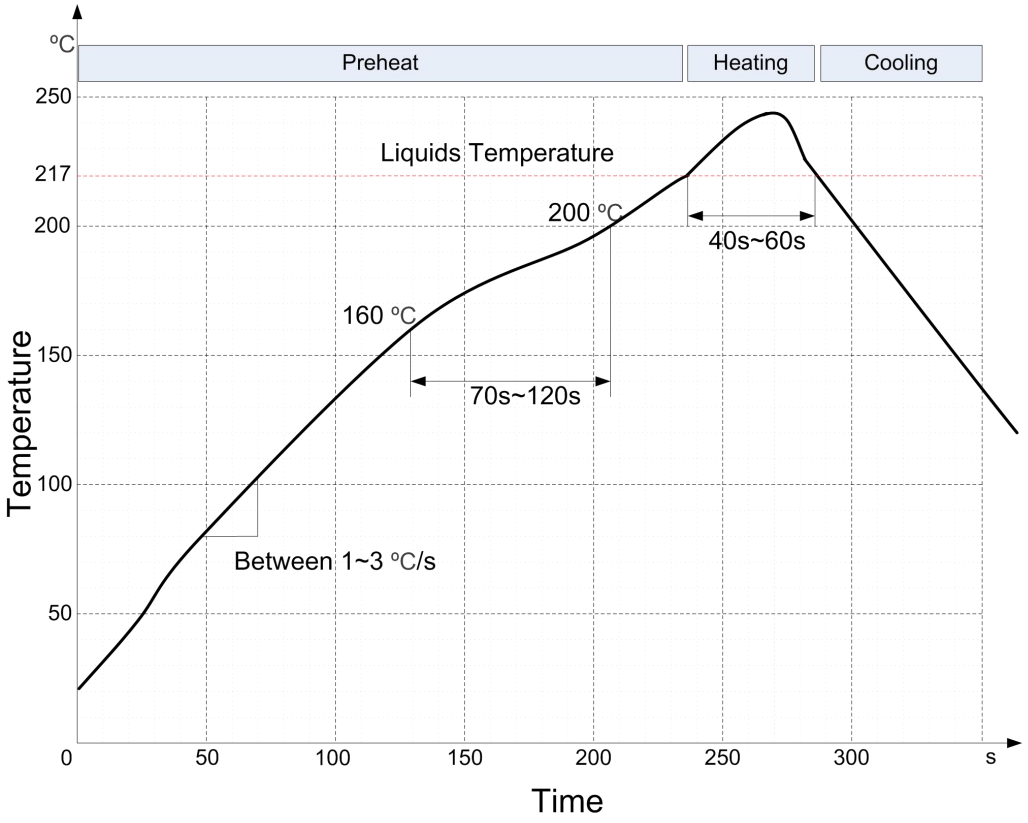



**Figure 48: Reflow Soldering Thermal Profile**

## 9.3. Packaging

SC20 is packaged in tape and reel carriers. Each reel is 12.32m long and contains 200 modules. The following figures show the package details, measured in mm.

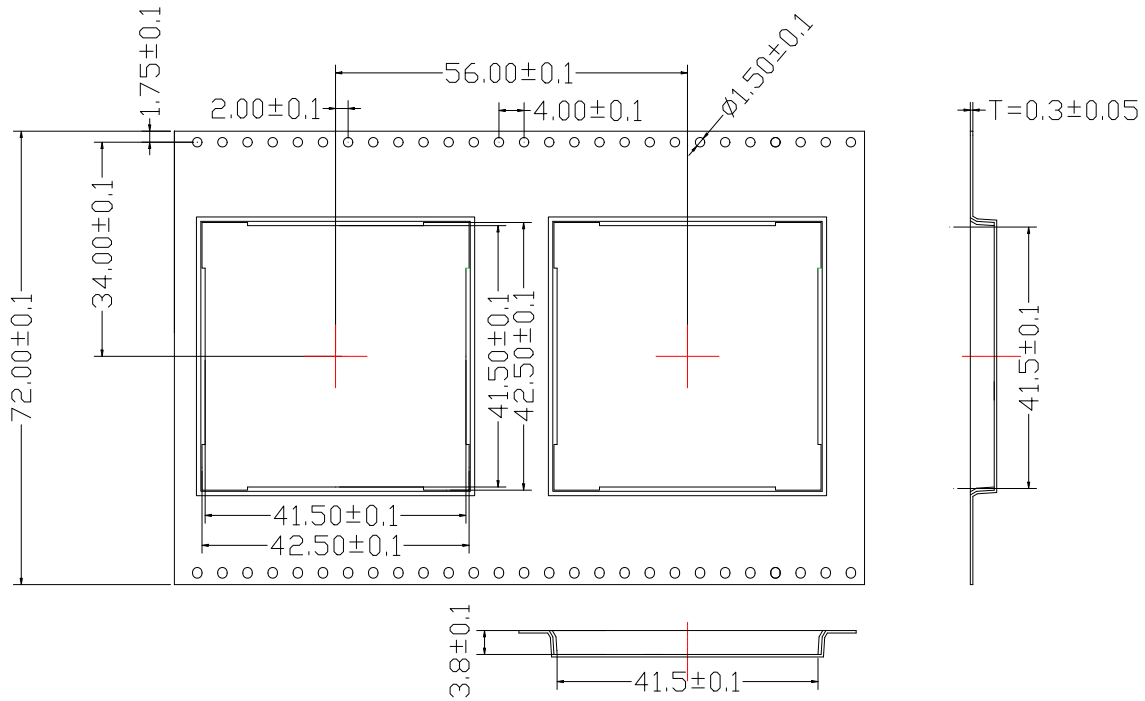



**Figure 49: Tape Dimensions**

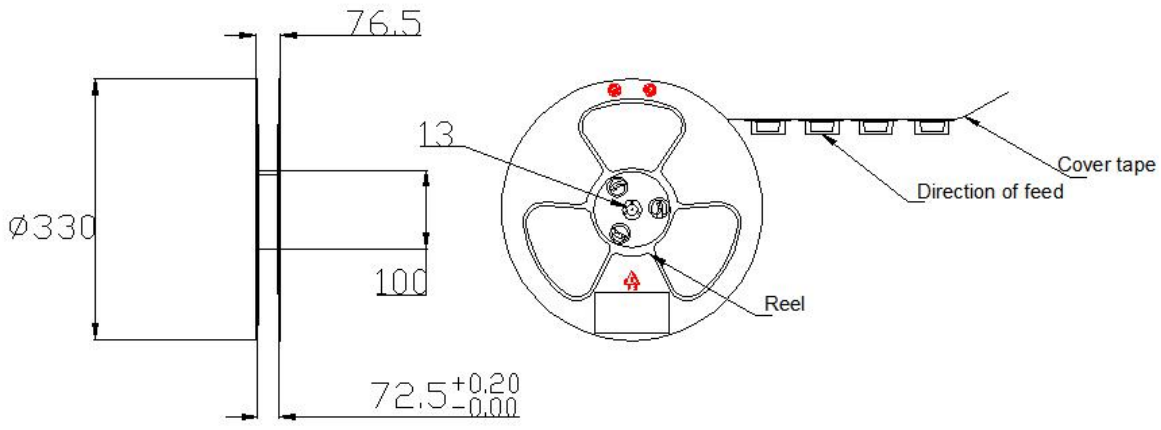



**Figure 50: Reel Dimensions**

**Table 55: Reel Packaging**

| Model Name | MOQ for MP | Minimum Package: 200pcs | Minimum Package × 4=800pcs |
|---|---|---|---|
| SC20 | 200 | Size: 370mm × 350mm × 85mm<br>N.W: 1.92kg<br>G.W: 3.17kg | Size: 380mm × 365mm × 365mm<br>N.W: 7.68kg<br>G.W: 13.63kg |

# 10 Appendix A References

**Table 56: Related Documents**

| SN | Document Name | Remark |
|---|---|---|
| [1] | Quectel_Smart_EVB_User_Guide | Smart EVB user guide |
| [2] | Quectel_SC20_Reference_Design | SC20 reference design |
| [3] | Quectel_Module_Secondary_SMT_User_Guide | Module secondary SMT user guide |
| [4] | Quectel_RF_Layout_Application_Note | RF layout application note |

**Table 57: Terms and Abbreviations**

| Abbreviation | Description |
|---|---|
| ADC | Analog-to-Digital Converter |
| AMR | Adaptive Multi-rate |
| ARP | Antenna Reference Point |
| bps | Bits Per Second |
| CHAP | Challenge Handshake Authentication Protocol |
| CS | Coding Scheme |
| CSD | Circuit Switched Data |
| CTS | Clear to Send |
| DRX | Discontinuous Reception |
| DCE | Data Communications Equipment (typically module) |
| DTE | Data Terminal Equipment (typically computer, external controller) |
| DTR | Data Terminal Ready |

| | |
|---|---|
| DTX | Discontinuous Transmission |
| EFR | Enhanced Full Rate |
| EGSM | Extended GSM900 band (includes standard GSM900 band) |
| eSCD | Enhanced Synchronous Connection Oriented |
| ESD | Electrostatic Discharge |
| FR | Full Rate |
| FPC | Flexible Printed Circuit |
| GMSK | Gaussian Minimum Shift Keying |
| GPS | Global Positioning System |
| GSM | Global System for Mobile Communications |
| HR | Half Rate |
| HSPA | High Speed Packet Access |
| I/O | Input/Output |
| IMEI | International Mobile Equipment Identity |
| Imax | Maximum Load Current |
| Inorm | Normal Current |
| LED | Light Emitting Diode |
| LNA | Low Noise Amplifier |
| MO | Mobile Originated |
| MS | Mobile Station (GSM engine) |
| MT | Mobile Terminated |
| PAP | Password Authentication Protocol |
| PBCCH | Packet Broadcast Control Channel |
| PCB | Printed Circuit Board |
| PDU | Protocol Data Unit |

| | |
|---|---|
| PPP | Point-to-Point Protocol |
| PSK | Phase Shift Keying |
| QAM | Quadrature Amplitude Modulation |
| QPSK | Quadrature Phase Shift Keying |
| RF | Radio Frequency |
| RHCP | Right Hand Circularly Polarized |
| RMS | Root Mean Square (value) |
| RTC | Real Time Clock |
| Rx | Receive |
| SDIO | Secure Digital Input and Output |
| SIM | Subscriber Identification Module |
| SMS | Short Message Service |
| TDMA | Time Division Multiple Access |
| TE | Terminal Equipment |
| TP | Touch Panel |
| TX | Transmitting Direction |
| UART | Universal Asynchronous Receiver & Transmitter |
| UMTS | Universal Mobile Telecommunications System |
| URC | Unsolicited Result Code |
| (U)SIM | Universal Subscriber Identity Module |
| USSD | Unstructured Supplementary Service Data |
| Vmax | Maximum Voltage Value |
| Vnorm | Normal Voltage Value |
| Vmin | Minimum Voltage Value |
| $V_{IH}$max | Maximum Input High Level Voltage Value |

| | |
|---|---|
| $V_{IH}$min | Minimum Input High Level Voltage Value |
| $V_{IL}$max | Maximum Input Low Level Voltage Value |
| $V_{IL}$min | Minimum Input Low Level Voltage Value |
| $V_{I}$max | Absolute Maximum Input Voltage Value |
| $V_{I}$min | Absolute Minimum Input Voltage Value |
| $V_{OH}$max | Maximum Output High Level Voltage Value |
| $V_{OH}$min | Minimum Output High Level Voltage Value |
| $V_{OL}$max | Maximum Output Low Level Voltage Value |
| $V_{OL}$min | Minimum Output Low Level Voltage Value |
| VSWR | Voltage Standing Wave Ratio |
| WCDMA | Wideband Code Division Multiple Access |

# 11 Appendix B GPRS Coding Schemes

**Table 58: Description of Different Coding Schemes**

| Scheme | CS-1 | CS-2 | CS-3 | C4-4 |
|---|---|---|---|---|
| Code Rate | 1/2 | 2/3 | 3/4 | 1 |
| USF | 3 | 3 | 3 | 3 |
| Pre-coded USF | 3 | 6 | 6 | 12 |
| Radio Block excl.USF and BCS | 181 | 268 | 312 | 428 |
| BCS | 40 | 16 | 16 | 16 |
| Tail | 4 | 4 | 4 | - |
| Coded Bits | 456 | 588 | 676 | 456 |
| Punctured Bits | 0 | 132 | 220 | - |
| Data Rate Kb/s | 9.05 | 13.4 | 15.6 | 21.4 |

# 12 Appendix C GPRS Multi-slot Classes

Twenty-nine classes of GPRS multi-slot modes are defined for MS in GPRS specification. Multi-slot classes are product dependent, and determine the maximum achievable data rates in both the uplink and downlink directions. Written as 3+1 or 2+2, the first number indicates the amount of downlink timeslots, while the second number indicates the amount of uplink timeslots. The active slots determine the total number of slots the GPRS device can use simultaneously for both uplink and downlink communications.

The description of different multi-slot classes is shown in the following table.

**Table 59: GPRS Multi-slot Classes**

| Multislot Class | Downlink Slots | Uplink Slots | Active Slots |
|---|---|---|---|
| 1 | 1 | 1 | 2 |
| 2 | 2 | 1 | 3 |
| 3 | 2 | 2 | 3 |
| 4 | 3 | 1 | 4 |
| 5 | 2 | 2 | 4 |
| 6 | 3 | 2 | 4 |
| 7 | 3 | 3 | 4 |
| 8 | 4 | 1 | 5 |
| 9 | 3 | 2 | 5 |
| 10 | 4 | 2 | 5 |
| 11 | 4 | 3 | 5 |
| 12 | 4 | 4 | 5 |
| 13 | 3 | 3 | NA |
| 14 | 4 | 4 | NA |

| | | | |
|---|---|---|---|
| 15 | 5 | 5 | NA |
| 16 | 6 | 6 | NA |
| 17 | 7 | 7 | NA |
| 18 | 8 | 8 | NA |
| 19 | 6 | 2 | NA |
| 20 | 6 | 3 | NA |
| 21 | 6 | 4 | NA |
| 22 | 6 | 4 | NA |
| 23 | 6 | 6 | NA |
| 24 | 8 | 2 | NA |
| 25 | 8 | 3 | NA |
| 26 | 8 | 4 | NA |
| 27 | 8 | 4 | NA |
| 28 | 8 | 6 | NA |
| 29 | 8 | 8 | NA |
| 30 | 5 | 1 | 6 |
| 31 | 5 | 2 | 6 |
| 32 | 5 | 3 | 6 |
| 33 | 5 | 4 | 6 |

# 13 Appendix D EDGE Modulation and Coding Schemes

**Table 60: EDGE Modulation and Coding Schemes**

| Coding Scheme | Modulation | Coding Family | 1 Timeslot | 2 Timeslot | 4 Timeslot |
|---|---|---|---|---|---|
| CS-1 | GMSK | / | 9.05kbps | 18.1kbps | 36.2kbps |
| CS-2 | GMSK | / | 13.4kbps | 26.8kbps | 53.6kbps |
| CS-3 | GMSK | / | 15.6kbps | 31.2kbps | 62.4kbps |
| CS-4 | GMSK | / | 21.4kbps | 42.8kbps | 85.6kbps |
| MCS-1 | GMSK | C | 8.80kbps | 17.60kbps | 35.20kbps |
| MCS-2 | GMSK | B | 11.2kbps | 22.4kbps | 44.8kbps |
| MCS-3 | GMSK | A | 14.8kbps | 29.6kbps | 59.2kbps |
| MCS-4 | GMSK | C | 17.6kbps | 35.2kbps | 70.4kbps |
| MCS-5 | 8-PSK | B | 22.4kbps | 44.8kbps | 89.6kbps |
| MCS-6 | 8-PSK | A | 29.6kbps | 59.2kbps | 118.4kbps |
| MCS-7 | 8-PSK | B | 44.8kbps | 89.6kbps | 179.2kbps |
| MCS-8 | 8-PSK | A | 54.4kbps | 108.8kbps | 217.6kbps |
| MCS-9 | 8-PSK | A | 59.2kbps | 118.4kbps | 236.8kbps |