BG96&BC95-G&EG9x&UG9x&M95 Compatible Design

LPWA/LTE Standard/UMTS/HSPA/GSM/GPRS Module Series

Rev. BG96&BC95-G&EG9x&UG9x&M95_Compatible_Design_V1.0

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About the Document

History

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1.0	2019-06-06	Lyndon LIU/ Ewent LU/ Ward WANG/ Lorry XU/ Yeoman CHEN/ Andy ZHAO	Initial

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1 Introduction

Quectel BG96 module is compatible with Quectel LPWA BC95-G module, LTE standard EG9x (EG91&EG95) modules, UMTS/HSPA UG9x (UG95&UG96) modules, and GSM/GPRS M95 module. This document briefly describes the compatible design among BG96, BC95-G, EG9x, UG9x, and M95 modules.

2 General Descriptions

2.1. Product Description

BG96 is an embedded LPWA (LTE Cat M1/LTE Cat NB1/EGPRS) wireless communication module. It provides data connectivity on LTE-TDD/LTE-FDD/GPRS/EGPRS networks, and supports half-duplex operation in LTE networks.

BC95-G is a high-performance LPWA module with low power consumption.

EG9x is a series of embedded 4G wireless communication module with receive diversity. It supports LTE-FDD/WCDMA/GSM wireless communication, and provides data connectivity on LTE-FDD, DC-HSDPA, HSPA+, HSDPA, HSUPA, WCDMA, EDGE and GPRS networks.

UG9x series is an embedded 3G wireless communication module. It supports GSM/GPRS/EDGE and UMTS/HSDPA/HSUPA networks.

M95 is a quad-band GSM/GPRS module that works at frequencies of GSM850, EGSM900, DCS1800 and PCS1900.

BG96, BC95-G, EG9x, UG9x and M95 modules are designed as compatible products. Customers can choose a suitable module according to specific application requirements. The compatible design guideline ensures a smooth migration among these modules for customers' products.

Table 1: Module General Information

Module	Appearance	Packaging	Dimensions (mm)	Description
BG96		102-pin LGA	22.5 x 26.5 x 2.3	LTE Cat M1/Cat NB1/ EGPRS module

UG95		102-pin LGA	19.9 x 23.6 x 2.2	UMTS/HSPA module
UG96		102-pin LGA	22.5 x 26.5 x 2.2	UMTS/HSPA module
BC95-G		54-pin LCC+ 40-pin LGA	19.9 x 23.6 x 2.2	LPWA module
EG9x		106-pin LGA	25.0 x 29.0 x 2.3	LTE standard module. Contains eight variants: EG91 (EG91-E, EG91-NA, EG91-NS, EG91-VX, EG91-EX) EG95 (EG95-E, EG95-NA, EG95-EX)
M95		42-pin LCC	19.9 x 23.6 x 2.65	GSM/GPRS module

2.2. Features Overview

The following table compares general properties and features of BG96, BC95-G, EG9x, UG9x and M95 modules.

Table 2: Features Overview

Feature	BG96	BC95-G	EG9x-NA	EG9x-E	EG91-NS	EG91-VX	EG9x-EX	UG95	UG96	M95
Power Supply	3.3V~4.3V Typ. 3.8V	3.1V~4.2V Typ. 3.6V	3.3V~4.3V Typ. 3.8V	3.3V~4.3V Typ. 3.8V	3.3V~4.3V Typ. 3.8V	3.3V~4.3V Typ. 3.8V	3.3V~4.3V Typ. 3.8V	3.3V~4.3V Typ. 3.8V	3.3V~4.3V Typ. 3.8V	3.3V~4.6V Typ. 4.0V
Peak Current	**VBAT_BB:** Max 0.8A **VBAT_RF:** Max 1.8A	**VBAT:** Max 0.5A	**VBAT_BB:** Max 0.8A **VBAT_RF:** Max 1.8A	**VBAT_BB:** Max 0.8A **VBAT_RF:** Max 1.8A	**VBAT_BB:** Max 0.8A **VBAT_RF:** Max 1.8A	**VBAT_BB:** Max 0.8A **VBAT_RF:** Max 1.8A	**VBAT_BB:** Max 0.8A **VBAT_RF:** Max 1.8A	**VBAT_BB:** Max 0.8A **VBAT_RF**: Max 2.0A	**VB AT_BB:** Max 0.8A **VBAT_RF:** Max 2.0A	**VBAT:** Max 2.0A
PSM Current	Typ. 10uA	Typ. 3uA	No supported	No supported	No supported	No supported	No supported	No supported	No supported	
Sleep Current	0.9mA @Rock Bottom [3] **LTE Cat M1:** 1.5mA @DRX=1.28s 1.2mA @e-I-DRX=40.96s **LTE Cat NB1:** 1.96mA @DRX=1.28s 1.1mA @e-I-DRX=40.96s **2G:** 2.0mA	0.5mA @DRX=2.56s, ECL=0	1.0mA @Rock Bottom [3] **3G:** 2.2mA @PF=64 **4G:** 2.6mA @PF=64	1.3mA @Rock Bottom [3] **2G:** 2.0mA @DRX=5 **3G:** 1.8mA @PF=64 **4G:** 2.3mA @PF=64	1.2mA @Rock Bottom [3] **3G:** 2.0mA @PF=64 **4G:** 2.5mA @PF=64	TBD	TBD	**2G:** 1.12mA @DRX=5 **3G:** 1.98mA @DRX=6	**2G:** 1.1mA @DRX=5 **3G:** 2.52mA @DRX=6	
Frequency Bands	**LTE Cat M1 & NB1** **LTE-FDD:** B1/B2/B3/B4/B5/B8/B12/ B13/B18/B19/B20/B25 [4]/ B26*/B28 **LTE-TDD:** B39 (for Cat M1 only) **EGPRS:** GSM850/EGSM900/ DCS1800/PCS1900 **GNSS:** GPS, GLONASS, BeiDou/Compass, Galileo, QZSS	**LTE Cat.NB1** **LTE-FDD:** B1/B3/B5/B8/ B20/B28	**EG91-NA&** **EG95-NA** **LTE-FDD:** B2/B4/B5/B12/ B13 **WCDMA:** B2/B4/B5 **GNSS:** GPS, GLONASS, BeiDou/Compass, Galileo, QZSS	**EG91-E&EG95-E** **LTE-FDD:** B1/B3/B7/B8/B20/ B28A **WCDMA:** B1/B8 **GSM:** EGSM900/ DCS1800	**LTE-FDD:** B2/B4/B5/B12/B13 /B25/B26 **WCDMA:** B2/B4/B5 **GNSS:** GPS, GLONASS, BeiDou/Compass, Galileo, QZSS	**LTE-FDD:** B4/B13 **GNSS:** GPS, GLONASS, BeiDou/Compass, Galileo, QZSS	**EG91-EX&** **EG95-EX:** **LTE-FDD:** B1/B3/B7/B8/B20/ B28A/B28B **WCDMA:** B1/B8 **GSM:** EGSM900/ DCS1800 **GNSS:** GPS, GLONASS, BeiDou/Compass, Galileo, QZSS	**UG95-A:** **UMTS:** 850/1900MHz **UG95-E:** **GSM:** EGSM900/ PCS1900 **UMTS:** 900/2100MHz	**UMTS:** 800/850/900/ 1900/2100MHz **GSM:** GSM850/EGSM900 /DCS1800/PCS1900	**GSM:** GSM850/EGSM900 /DCS1800/ PCS1900
UMTS	Not supported	Not supported	Supported	Supported	Supported	Not supported	Supported	Supported	Supported	Not supported
LTE-FDD	Supported	Supported	Supported	Supported	Supported	Supported	Supported	Not supported	Not supported	Not supported

EDGE	Multi-slot class 33	Not supported	Not supported	Multi-slot class 33	Not supported	Not supported	Multi-slot class 33	Multi-slot class 12	Multi-slot class 33	Not supported
GPRS	Multi-slot class 33	Not supported	Not supported	Multi-slot class 33	Not supported	Not supported	Multi-slot class 33	Multi-slot class 12	Multi-slot class 33	Multi-slot class 12
Temperature Range	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C	Operation temperature range: -35 ~ +75°C 1) Extended temperature range: -40 ~ +85°C 2) Storage temperature range: -40 ~ +90°C
Main Serial Interface	**Baud rates:** 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, 230400bps, 460800bps, 921600bps, 115200bps by default **Flow control:** RTS/CTS **Signal level:** 1.8V	**Baud rates:** 4800bps, 9600bps, 57600bps, 115200bps, 230400bps, 460800bps **Flow control:** RTS/CTS **Signal level:** 3.0V	**Baud rates:** 9600bps~ 921600bps, Up to 3000000bps 115200bps by default **Flow control:** RTS/CTS **Signal level:** 1.8V	**Baud rates:** 9600bps~ 921600bps, Up to 3000000bps 115200bps by default **Flow control:** RTS/CTS **Signal level:** 1.8V	**Baud rates:** 9600bps~ 921600bps, Up to 3000000bps 115200bps by default **Flow control:** RTS/CTS **Signal level:** 1.8V	**Baud rates:** 9600bps~ 921600bps, Up to 3000000bps 115200bps by default **Flow control:** RTS/CTS **Signal level:** 1.8V	**Baud rates:** 9600bps~ 921600bps, Up to 3000000bps 115200bps by default **Flow control:** RTS/CTS **Signal level:** 1.8V	**Baud rates:** 300bps~ 921600bps **Autobauding:** 4800bps~ 115200bps **Flow control:** RTS/CTS **Signal level:** 1.8V	**Baud rates:** 300bps~ 921600bps **Autobauding:** 4800bps~ 115200bps **Flow control:** RTS/CTS **Signal level:** 1.8V	**Baud rates:** 300bps~ 115200bps **Autobauding:** 4800bps~ 115200bps **Flow control:** RTS/CTS **Signal level:** 2.8V
USB Interface	USB 2.0 (Slave only) High speed	Not supported	USB 2.0 (Slave only) High speed	USB 2.0 (Slave only) High speed	USB 2.0 (Slave only) High speed	USB 2.0 (Slave only) High speed	USB 2.0 (Slave only) High speed	USB 1.1/2.0 (Slave only) High speed	USB 1.1/2.0 (Slave only) High speed	Not supported
Analog Audio	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Two analog input channels and two analog output channels
Digital Audio	PCM	Not supported	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM
ADC	Supported	Supported	Supported	Supported	Supported	Supported*	Supported	Not supported	Not supported	Supported
RTC Backup	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Vnorm=1.8V VI=1.0V~1.9V	Vnorm=1.8V VI=1.0V~1.9V	$V_O$max=3.0V V_I=1.5V~3.3V
I2C Interface	Supported	Not Supported	Supported	Supported	Supported	Supported	Supported	Supported	Supported	Not supported

(U)SIM Card Detection	Supported	Not Supported	Supported	Supported	Supported	Supported	Supported	Supported	Supported	Supported
Firmware Upgrade	USB, DFOTA	DFOTA, UART	USB, DFOTA	USB, DFOTA	USB, DFOTA	USB, DFOTA*	USB, DFOTA	USB, DFOTA	USB, UART	Via UART

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 normal operation temperature levels, the module will meet 3GPP specifications again.
3. [3] means the operation is performed with **AT+CFUN=0** and **AT+QSCLK=1** (DTR pin at high level).
4. [4] LTE B25 will be supported on BG96 with R1.2 hardware version.
5. "*" means under development.

2.3. Pin Assignment

The following figure shows the pin assignment of BG96, BC95-G, EG9x, UG9x and M95.

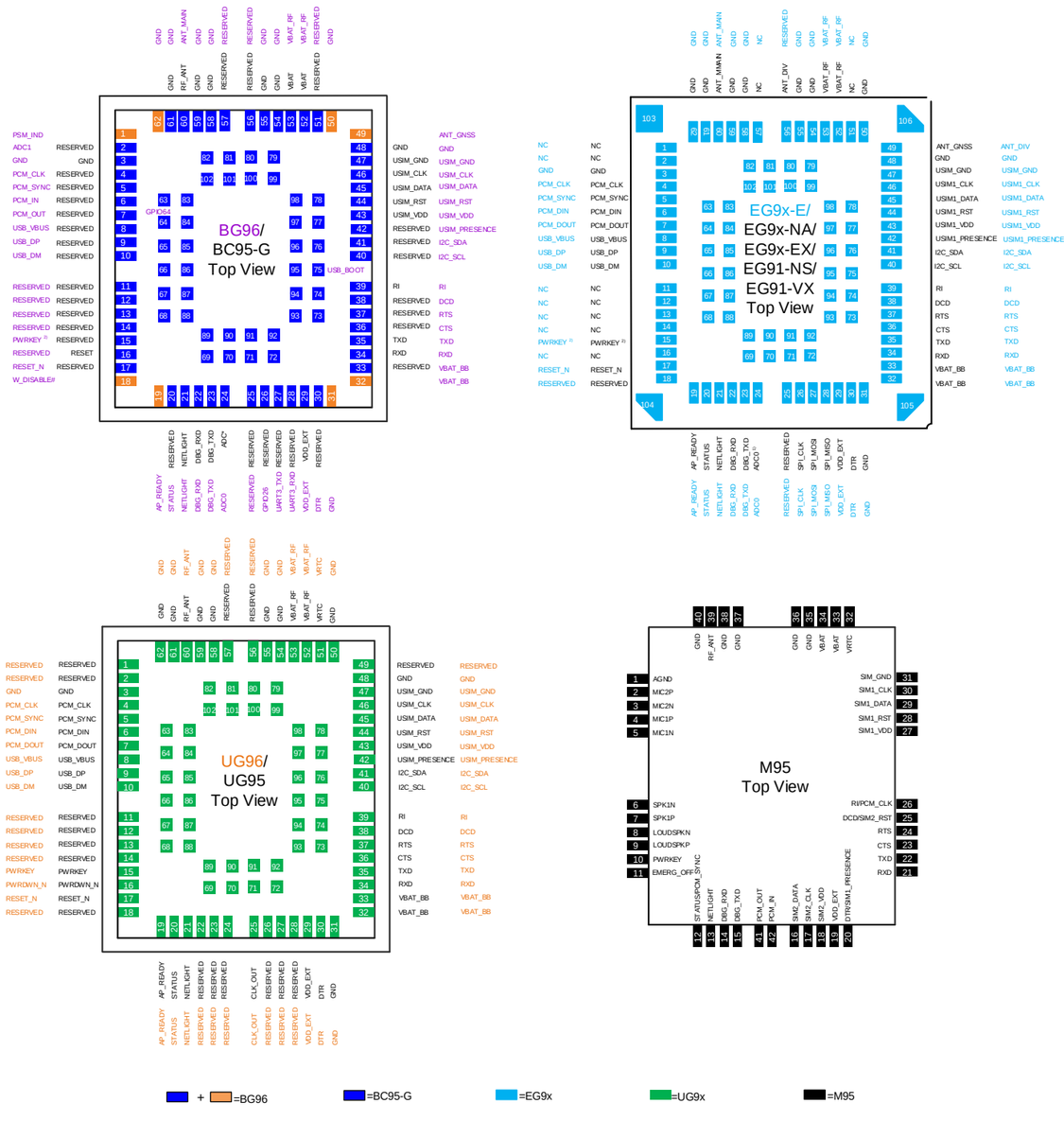


Figure 1: BG96&BC95-G&EG9x&UG9x&M95 Pin Assignment

NOTES

1. Definition of pin 49 and 56 are different among EG91-E and EG91-NA/-NS/-VX/-EX, EG95-E and EG95-NA/-EX. For more details about these pins with different functions, please refer to ***Table 4***.
2. [1)] ADC function is under development for EG91-VX.
3. [2)] PWRKEY is internally pulled up to an internal voltage in the Qualcomm chipset, and its output voltage is the internal voltage minus a diode drop in the chipset. Therefore, the expected output voltage of PWRKEY is 0.8V.
4. Pin 41 and 42 of M95 are the additional pins as compared with BG96, BC95-G, EG9x and UG9x.
5. "*" means under development.

3 Pin Description

This chapter describes the pin definition of M95, BG96, BC95-G, EG9x and UG9x as well as the pin comparison among them.

Table 3: I/O Parameters Definition

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

Table 4: Pin Comparison among M95, BG96, BC95-G, EG9x and UG9x

M95				BG96				BC95-G				EG9x				UG9x			
Pin No.	Pin Name	IO	Description	Pin No.	Pin Name	IO	Description	Pin No.	Pin Name	IO	Description	Pin No.	Pin Name	IO	Description	Pin No.	Pin Name	IO	Description
/	/	/	/	1	PSM_IND	DO	Power saving mode Indicator 1.8V power domain	/	/	/	/	1	NC	/	/	1	RESERVED	/	/
/	/	/	/	2	ADC1	AI	General-purpose analog to digital converter interface. 0.3~1.8V.	1	RESERVED	/	/	2	NC	/	/	2	RESERVED	/	/
1	AGND	/	Ground	3	GND	/	Ground	2	GND	/	Ground	3	GND	/	Ground	3	GND	/	Ground

2	MIC2P	AI	Channel 2 Microphone positive input	4	PCM_CLK	DO	PCM clock output. 1.8V power domain.	3	RESERVED	/	/	4	PCM_CLK	DO	PCM clock output. 1.8V power domain.	4	PCM_ CLK	DO	PCM clock output. 1.8V power domain.
3	MIC2N	AI	Channel 2 Microphone negative input	5	PCM_ SYNC	DO	PCM frame synchronization output. 1.8V power domain.	4	RESERVED	/	/	5	PCM_ SYNC	DO	PCM frame synchronization output. 1.8V power domain.	5	PCM_ SYNC	DO	PCM frame synchronization output. 1.8V power domain.
4	MIC1P	AI	Channel 1 Microphone positive input	6	PCM_IN	IO	PCM data input. 1.8V power domain.	5	RESERVED	/	/	6	PCM_DIN	IO	PCM data input. 1.8V power domain.	6	PCM_IN	DI	PCM data input. 1.8V power domain.
5	MIC1N	AI	Channel 1 Microphone negative input	7	PCM_OUT	IO	PCM data output. 1.8V power domain.	6	RESERVED	/	/	7	PCM_DOUT	IO	PCM data output. 1.8V power domain.	7	PCM_ OUT	DO	PCM data output. 1.8V power domain.
/	/	/	/	8	USB_VBUS	PI	USB detection. 3.0V~5.25V.	7	RESERVED	/	/	8	USB_VBUS	PI	USB detection. 3.0~5.25V.	8	USB_ VBUS	PI	USB detection. 3.0~5.25V.
/	/	/	/	9	USB_DP	IO	USB differential data bus (+). 90Ω differential impedance.	8	RESERVED	/	/	9	USB_DP	IO	USB differential data bus (+). 90Ω differential impedance.	9	USB_DP	IO	USB differential data bus (+). 90Ω differential impedance.
/	/	/	/	10	USB_DM	IO	USB differential data bus (-). 90Ω differential impedance.	9	RESERVED	/	/	10	USB_DM	IO	USB differential data bus (-). 90Ω differential impedance.	10	USB_DM	IO	USB differential data bus (-). 90Ω differential impedance.
6	SPK1N	AO	Channel 1 audio negative output	11	RESERVED	/	/	10	RESERVED	/	/	11	NC	/	/	11	RESERVED	/	/
7	SPK1P	AO	Channel 1 audio positive output	12	RESREVED	/	/	11	RESREVED	/	/	12	NC	/	/	12	RESREVED	/	/
8	LOUDSPKN	AO	Channel 2 audio negative output	13	RESERVED	/	/	12	RESREVED	/	/	13	NC	/	/	13	RESERVED	/	/
9	LOUDSPKP	AO	Channel 2 audio positive output	14	RESERVED	/	/	13	RESREVED	/	/	14	NC	/	/	14	RESERVED	/	/
10	PWRKEY	DI	Turn on/off the module. Pull up to VBAT.	15	PWRKEY [5]	DI	Turn on/off the module	14	RESREVED	/	/	15	PWRKEY [5]	DI	Turn on/off the module	15	PWRKEY	DI	Turn on the module
11	EMERG_ OFF	DI	Emergency off. Pulling down for at least 40ms will turn off the module in case of emergency. Use it only when shutting down via PWRKEY or AT	16	RESERVED	/	/	15	RESET	DI	Reset signal of the module	16	NC	/	/	16	PWRDWN_N	DI	Turn off the module

			command cannot be implemented.															
/	/	/	/	17	RESET_N	DI	Reset signal of the module. 1.8V power domain.	16	RESERVED	/	/	17	RESET_N	DI	Reset signal of the module. 1.8V power domain.	17	RESET_N	DI	Reset signal of the module
/	/	/	/	18	W_ DISABLE#	DI	Airplane mode control 1.8V power domain	/	/	/	/	18	RESERVED	/	/	18	RESERVED	/	/
/	/	/	/	19	AP_READY	DI	Application processor Sleep state detection. 1.8V power domain.	/	/	/	/	19	AP_ READY	DI	Application processor sleep state detection. 1.8V power domain.	19	AP_ READY	DI	Application processor sleep state detection. 1.8V power domain.
12	STATUS/ PCM_ SYNC [1)]	DO	Indicate the module's operation status. PCM synchronization signal. These functions can be switched through AT command. 2.8V power domain.	20	STATUS	DO	Indicate the module's operation status. 1.8V power domain.	17	RESERVED	/	/	20	STATUS	DO	Indicate the module's operation status. 1.8V power domain.	20	STATUS	DO	Indicate the module's operation status. 1.8V power domain.
13	NETLIGHT	DO	Indicate the module's network activity status. 2.8V power domain	21	NETLIGHT	DO	Indicate the module's network activity status. 1.8V power domain.	18	NETLIGHT	DO	Indicate the module's network activity status. 3.0V power domain.	21	NETLIGHT	DO	Indicate the module's network activity status. 1.8V power domain.	21	NETLIGHT	DO	Indicate the module's network activity status. 1.8V power domain.
14	DBG_RXD	DI	Receive data. 2.8V power domain	22	DBG_RXD	DI	Receive data. 1.8V power domain	19	DBG_RXD	DI	Receive data. 3.0V power domain	22	DBG_RXD	DI	Receive data. 1.8V power domain	22	RESERVED	/	/
15	DBG_TXD	DO	Transmit data. 2.8V power domain	23	DBG_TXD	DO	Transmit data. 1.8V power domain.	20	DBG_TXD	DO	Transmit data. 3.0V power domain.	23	DBG_TXD	DO	Transmit data. 1.8V power domain.	23	RESERVED	/	/
/	/	/	/	24	ADC0	AI	General-purpose analog to digital converter interface	21	ADC*	AI	General-purpose analog to digital converter interface	24	ADC0 [6)]	AI	General-purpose analog to digital Converter interface. Voltage range: 0.3V to 1.8V	24	RESERVED	/	/
41	PCM_OUT	DO	PCM serial data output. 2.8V power domain.	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
42	PCM_IN	DI	PCM serial data input. 2.8V power domain.	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
/	/	/	/	25	RESERVED	/	/	22	RESERVED	/	/	25	RESERVED	/	/	25	CLK_OUT	DO	Clock output
16	SIM2_DATA	IO	Data signal of	26	GPIO26	DO	General-purpose	23	RESERVED	/	/	26	SPI_CLK	DO	Clock signal for SPI	26	RESERVED	/	/

			(U)SIM2 card. 1.8V/3.0V				input and output 1.8V power domain								Interface. 1.8V power domain.				
17	SIM2_CLK	DO	Clock signal of (U)SIM2 card. 1.8V/3.0V	27	UART3_TXD	DO	Transmit data. 1.8V power domain.	24	RESERVED	/	/	27	SPI_MOSI	DO	Master output slave input SPI interface. 1.8V power domain.	27	RESERVED	/	/
18	SIM2_VDD	PO	Power supply for (U)SIM2 card. 1.8V/3.0V.	28	UART3_RXD	DI	Receive data. 1.8V power domain.	25	RESERVED	/	/	28	SPI_MISO	DI	Master input slave output SPI interface 1.8V power domain	28	RESERVED	/	/
19	VDD_EXT	PO	Provide 2.8V for external circuit	29	VDD_EXT	PO	Provide 1.8V for external circuit	26	VDD_EXT	PO	Provide 3.0V for external circuit	29	VDD_EXT	PO	Provide 1.8V for external circuit	29	VDD_EXT	PO	Provide 1.8V for external circuit
20	DTR/SIM1_PRESENCE [2]	DI	Data terminal ready/ (U)SIM1 card insertion detection. These functions can be switched through AT command. 2.8V power domain.	30	DTR	DI	Data terminal ready. Sleep mode control. 1.8V power domain.	27	RESERVED	/	/	30	DTR	DI	Data terminal ready. Sleep mode control. 1.8V power domain.	30	DTR	DI	Data terminal ready. Sleep mode control. 1.8V power domain.
/	/	/	/	31	GND	/	Ground	/	/	/	/	31	GND	/	Ground	31	GND	/	Ground
/	/	/	/	32	VBAT_BB	PI	Power supply for module's baseband part. 3.3V~4.3V; 3.8V typ.	/	/	/	/	32	VBAT_BB	PI	Power supply for module's baseband part. 3.3V~4.3V	32	VBAT_BB	PI	Power supply for module's baseband part. 3.3V~4.3V
/	/	/	/	33	VBAT_BB	PI	Power supply for module's baseband part. 3.3V~4.3V; 3.8V typ.	28	RESERVED	/	/	33	VBAT_BB	PI	Power supply for module's baseband part. 3.3V~4.3V	33	VBAT_BB	PI	Power supply for module's baseband part. 3.3V~4.3V
21	RXD	DI	Receive data. 2.8V power domain	34	RXD	DI	Receive data. 1.8V power domain.	29	RXD	DI	Receive data. 3.0V power domain.	34	RXD	DI	Receive data. 1.8V power domain.	34	RXD	DI	Receive data. 1.8V power domain.
22	TXD	DO	Transmit data. 2.8V power domain	35	TXD	DO	Transmit data. 1.8V power domain.	30	TXD	DO	Transmit data. 3.0V power domain.	35	TXD	DO	Transmit data. 1.8V power domain.	35	TXD	DO	Transmit data. 1.8V power domain.
23	CTS	DO	Clear to send. 2.8V power domain	36	CTS	DO	Clear to send. 1.8V power domain.	31	RESERVED	/	/	36	CTS	DO	Clear to send. 1.8V power domain.	36	CTS	DO	Clear to send. 1.8V power domain.
24	RTS	DI	Request to send. 2.8V power domain	37	RTS	DI	Request to send. 1.8V power domain.	32	RESERVED	/	/	37	RTS	DI	Request to send. 1.8V power domain.	37	RTS	DI	Request to send. 1.8V power domain.
25	DCD/ SIM2_RST [3]	DO	Data carrier detection/ Reset signal of (U)SIM2 card. 2.8V power domain	38	DCD	DO	Data carrier detection. 1.8V power domain.	33	RESERVED	/	/	38	DCD	DO	Data carrier detection. 1.8V power domain.	38	DCD	DO	Data carrier detection. 1.8V power domain.
26	RI/ PCM_CLK [4]	DO	Ring indicator/PCM clock signal.	39	RI	DO	Ring indicator. 1.8V power domain.	34	RI	DO	Ring indicator 3.0V power domain.	39	RI	DO	Ring indicator. 1.8V power domain.	39	RI	DO	Ring indicator. 1.8V power domain.

			These functions can be switched through AT command. 2.8V power domain															
/	/	/	/	40	I2C_SCL	OD	I2C serial clock. Used for external codec. Pull up to 1.8V only	35	RESERVED	/	/	40	I2C_SCL	OD	I2C serial clock. Used for external codec. Pull up to 1.8V only	40	I2C_SCL	OD	I2C serial clock. Used for external codec. Pull up to 1.8V only
/	/	/	/	41	I2C_SDA	OD	I2C serial data. Used for external codec. Pull up to 1.8V only	36	RESERVED	/	/	41	I2C_SDA	OD	I2C serial data. Used for external codec. Pull up to 1.8V only	41	I2C_SDA	OD	I2C serial data. Used for external codec. Pull up to 1.8V only
/	/	/	/	42	USIM_ PRESENCE	DI	(U)SIM card insertion detection	37	RESERVED	/	/	42	USIM1_ PRESENCE	DI	(U)SIM card insertion detection 1.8V power domain	42	USIM_ PRESENCE	DI	(U)SIM card insertion Detection 1.8V power domain
27	SIM1_VDD	PO	Power supply for (U)SIM1 card. 1.8V/3.0V	43	USIM_VDD	PO	Power supply for (U)SIM card. 1.8V/3.0V	38	USIM_VDD	PO	Power supply for USIM card. 1.8V/3.0V	43	USIM1_VDD	PO	Power supply for (U)SIM card. 1.8V/3.0V	43	USIM_VDD	PO	Power supply for (U)SIM card. 1.8V/3.0V
28	SIM1_RST	DO	Reset signal of (U)SIM1 card. 1.8V/3.0V	44	USIM_RST	DO	Reset signal of (U)SIM card. 1.8V/3.0V	39	USIM_RST	DO	Reset signal of USIM card. 1.8V/3.0V	44	USIM1_RST	DO	Reset signal of (U)SIM card. 1.8V/3.0V	44	USIM_RST	DO	Reset signal of (U)SIM card. 1.8V/3.0V
29	SIM1_DATA	IO	Data signal of (U)SIM1 card. 1.8V/3.0V	45	USIM_DATA	IO	Data signal of (U)SIM card. 1.8V/3.0V	40	USIM_ DATA	IO	Data signal of USIM card. 1.8V/3.0V	45	USIM1_ DATA	IO	Data signal of (U)SIM card. 1.8V/3.0V	45	USIM_DATA	IO	Data signal of (U)SIM card. 1.8V/3.0V
30	SIM1_CLK	DO	Clock signal of (U)SIM1 card. 1.8V/3.0V	46	USIM_CLK	DO	Clock signal of (U)SIM card. 1.8V/3.0V	41	USIM_ CLK	DO	Clock signal of USIM card. 1.8V/3.0V	46	USIM1_CLK	DO	Clock signal of (U)SIM card. 1.8V/3.0V	46	USIM_CLK	DO	Clock signal of (U)SIM card. 1.8V/3.0V
31	SIM1_GND	/	Specified ground for (U)SIM1 card	47	USIM_ GND	/	Specified ground for (U)SIM card	42	USIM_ GND	/	Specified ground for USIM card	47	USIM_ GND	/	Specified ground for (U)SIM card	47	USIM_ GND	/	Specified ground for (U)SIM card
/	/	/	/	48	GND	/	Ground	43	GND	/	Ground	48	GND	/	Ground	48	GND	/	Ground
/	/	/	/	49	ANT_GNSS	AI	GNSS antenna interface	/	/	/	/	49	ANT_GNSS (EG91-NA/ -NS/-VX/-EX, EG95-NA/-EX)/ ANT_DIV (EG91-E/ EG95-E)	AI	**EG91-NA/-NS/ -VX/-EX, EG95-NA/-EX:** GNSS antenna interface **EG91-E/EG95-E:** Receive diversity antenna pad	49	RESERVED	/	/
/	/	/	/	50	GND	/	Ground	/	/	/	/	50	GND	/	Ground	50	GND	/	Ground
32	VRTC	PI/PO	$V_O$max=3.0V	51	RESERVED	/	/	44	RESERVED	/	/	51	NC	/	/	51	VRTC	PI/	Vnorm=1.8V when

			$V_O$min=2.0V Iin≈10uA															PO	VBAT≥3.3V. V_I=1.0V~1.9V at I_{IN}max=2uA when VBAT is not applied.
33	VBAT	PI	Main power supply of module. 3.3V~4.6V; 4.0V typ.	52	VBAT_RF	PI	Power supply for module's RF part. 3.3V~4.3V; 3.8V typ.	45	VBAT	PI	Main power supply of module. 3.1V~4.2V; 3.6V typ.	52	VBAT_RF	PI	Power supply for module's RF part. 3.3V~4.3V; 3.8V typ.	52	VBAT_RF	PI	Power supply for module's RF part. 3.3V~4.3V; 3.8V typ.
34	VBAT	PI	Main power supply of module. 3.3V~4.6V; 4.0V typ.	53	VBAT_RF	PI	Power supply for module's RF part. 3.3V~4.3V; 3.8V typ.	46	VBAT	PI	Main power supply of module. 3.1V~4.2V; 3.6V typ.	53	VBAT_RF	PI	Power supply for module's RF part. 3.3V~4.3V; 3.8V typ.	53	VBAT_RF	PI	Power supply for module's RF part. 3.3V~4.3V; 3.8V typ.
35	GND	/	Ground	54	GND	/	Ground	47	GND	/	Ground	54	GND	/	Ground	54	GND	/	Ground
36	GND	/	Ground	55	GND	/	Ground	48	GND	/	Ground	55	GND	/	Ground	55	GND	/	Ground
/	/	/	/	56	RESERVED	/	/	49	RESERVED	/	/	56	ANT_DIV (EG91-NA/ -NS/-VX/-EX, EG95-NA/ -EX)/ RESERVED (EG91-E, EG95-E)		**EG91-NA/-NS/ -VX/-EX, EG95-NA/-EX:** Receive diversity antenna pad **EG91-E/EG95-E:** Reserved	56	RESERVED	/	/
/	/	/	/	57	RESERVED	/	/	50	RESERVED	/	/	57	NC	/	/	57	RESERVED	/	/
37	GND	/	Ground	58	GND	/	Ground	51	GND	/	Ground	58	GND	/	Ground	58	GND	/	Ground
38	GND	/	Ground	59	GND	/	Ground	52	GND	/	Ground	59	GND	/	Ground	59	GND	/	Ground
39	RF_ANT	IO	RF antenna	60	ANT_MAIN	IO	Main antenna interface	53	RF_ANT	IO	RF antenna	60	ANT_MAIN	IO	Main antenna interface	60	RF_ANT	IO	RF antenna
40	GND	/	Ground	61	GND	/	Ground	54	GND	/	Ground	61	GND	/	Ground	61	GND	/	Ground
/	/	/	/	62	GND	/	Ground	/	/	/	/	62	GND	/	Ground	62	GND	/	Ground
/	/	/	/	63	RESERVED	/	/	55	RESERVED	/	/	63	NC	/	/	63	RESERVED	/	/
/	/	/	/	64	GPIO64	IO	General-purpose input and output 1.8V power domain	56	RESERVED	/	/	64	NC	/	/	64	RESERVED	/	/
/	/	/	/	75	USB_BOOT	DI	Force the module to boot from USB port. 1.8V power domain	67	RESERVED	/	/	75	USB_BOOT	DI	Force the module to boot from USB port. 1.8V power domain	75	RESERVED	/	/
/	/	/	/	83	RESERVED	/	/	83	RESERVED	/	/	83	USIM2_ PRESENCE	DI	(U)SIM card insertion detection 1.8V power domain	83	RESERVED	/	/

/	/	/	/	84	RESERVED	/	/	84	RESERVED	/	/	84	USIM2_CLK	DO	Clock signal of (U)SIM card. 1.8V/3.0V	84	RESERVED	/	/
/	/	/	/	85	RESERVED	/	/	85	RESERVED	/	/	85	USIM2_RST	DO	Reset signal of (U)SIM card. 1.8V/3.0V	85	RESERVED	/	/
/	/	/	/	86	RESERVED	/	/	86	RESERVED	/	/	86	USIM2_DATA	IO	Data signal of (U)SIM card. 1.8V/3.0V.	86	RESERVED	/	/
/	/	/	/	87	RESERVED	/	/	87	RESERVED	/	/	87	USIM2_VDD	PO	Power supply for (U)SIM card. 1.8V/3.0V.	87	RESERVED	/	/
/	/	/	/	65, 66, 76~78, 88, 92~99	RESERVED	/	/	57~58, 68~70, 80, 84~91	RESERVED	/	/	65~66, 76~78, 88, 92~99	NC	/	/	65~66, 76~78, 88, 92~99	RESERVED	/	/
/	/	/	/	67~74, 79~82, 89~91, 100~102	GND	/	Ground	59~66, 71~74, 81~83, 92~94	GND	/	Ground	67~74, 79~82, 89~91, 100~106	GND	/	Ground	67~74, 79~82, 89~91, 100~106	GND	/	Ground

NOTES

1. Keep all reserved and unused pins unconnected.
2. All GND pins should be connected to ground.
3. The AGND pin of M95 should be routed as single-ended to main ground when analog audio is used in single-ended application. Otherwise, it can be connected to GND directly.
4. The green pins are the additional pins of M95 as compared with BG96, BC95-G, EG9x and UG9x.
5. "*" means under development.
6. [1] The STATUS pin of M95 can be multiplexed as PCM_SYNC pin. For more details, please refer to ***document [7]***.
7. [2] DTR pin of M95 can be multiplexed as SIM1_PRESENCE pin via AT command. For more details, please refer to ***document [7]***.
8. [3] The DCD pin of M95 can be multiplexed as SIM2_RST pin. For more details, please refer to ***document [7]***.
9. [4] The RI pin of M95 can be multiplexed as PCM_CLK pin. For more details, please refer to ***document [7]***.
10. [5] PWRKEY is internally pulled up to an internal voltage in the Qualcomm chipset, and its output voltage is the internal voltage minus a diode drop in the chipset. Therefore, the expected output voltage of PWRKEY is 0.8V.
11. [6] ADC function is under development for EG91-VX.

4 Hardware Reference Design

The following chapters describe the compatible design among BG96, BC95-G, EG9x, UG9x and M95 2.0 on main functionalities.

4.1. Power Supply

4.1.1. Reference Design for Power Supply

Power design for a module is critical to its performance. The power supply of EG9x, UG9x and M95 should be able to provide sufficient current up to 2.0A, while BG96 and BC95-G are LPWA modules requiring low quiescent and leakage current.

If the voltage drop between the input and output is not too high, it is suggested that an LDO should be used to supply power for these modules. 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 of +5V input power source of EG9x, UG9x and M95. The typical output of the power supply is about 3.8V and the maximum load current is 3.0A.

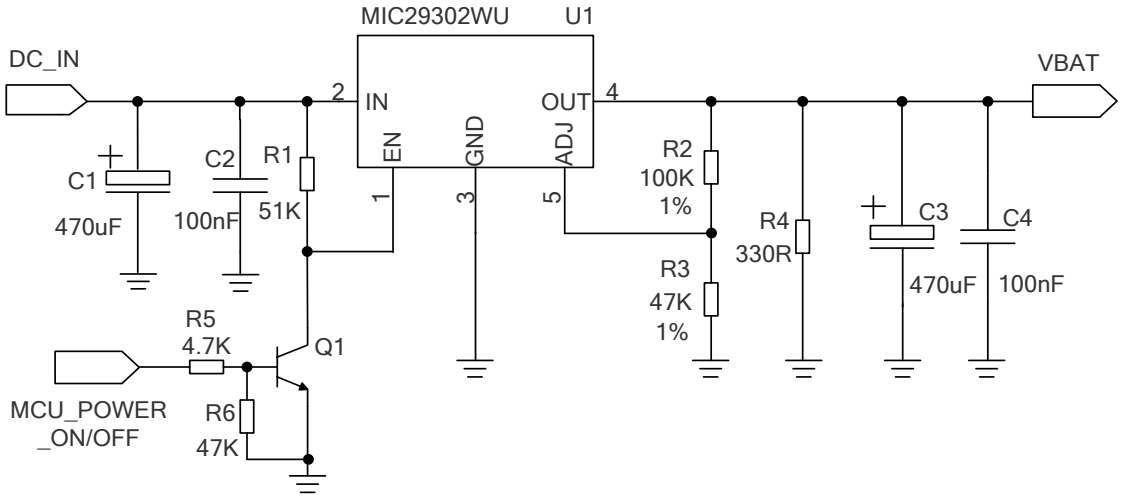


Figure 2: Reference Circuit of Power Supply (EG9x/UG9x/M95)

The following figure shows a reference design of power supply of BC95-G. A low quiescent current LDO, being capable of providing input current of at least 0.8A, can be applied as the power supply. Meanwhile, Li-SOCI2 batteries can also be used to supply power for the module. Power supply of the module ranges from 3.1V to 4.2V. Please ensure that the input voltage never drops below 3.1V even in burst transmission. If the power voltage drops below 3.1V, the module will not work normally.

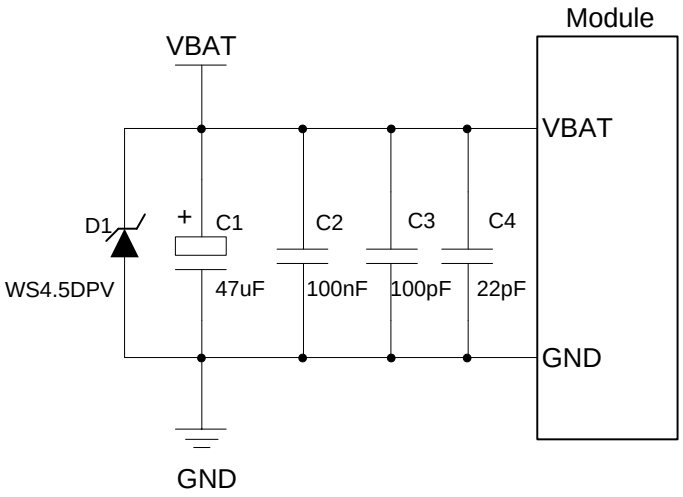


Figure 3: Reference Circuit of Power Supply (BC95-G)

Special attention should be paid to the power supply of BG96 module. If the customers' application environment is only under Cat M1/Cat NB1, select a DC-DC chip or LDO chip with ultra-low leakage current and current output of not less than 1.0A. If the customers' application environment requires Cat M1/Cat NB1/2G, the current output of DC-DC chip or LDO chip cannot be lower than 2.0A and should be with low leakage current because the module needs more current when transmitting in 2G condition.

4.1.2. Reduce Voltage Drop

The power supply range is 3.3V~4.3V for BG96/EG9x/UG9x, 3.1V~4.2V for BC95-G, and 3.3V~4.6V for M95, respectively. Please make sure that the input voltage never drop below and exceed the requirements of these modules, and the typical power supply is 3.8V for BG96/EG9x/UG9x, 3.6V for BC95-G, and 4.0V for M95. The VBAT to BG96/EG9x/UG9x module's VBAT_BB and VBAT_RF pins should be divided into two separated paths in star structure.

In addition, in order to avoid the damage caused by electric surge and ESD, it is suggested that a TVS diode with low reverse stand-off voltage V_{RWM}, low leakage current, low clamping voltage V_C and high reverse peak pulse current I_{PP} should be used.

The following figure shows a reference design of VBAT for BG96, EG9x and UG9x. Since BC95-G and M95 have two pins for VBAT input, and this is different from BG96/EG9x/UG9x, thus it is not recommended to mount C1~C4 for them. VBAT_RF pins of BG96/EG9x/UG9x are compatible with that of BC95-G and M95.

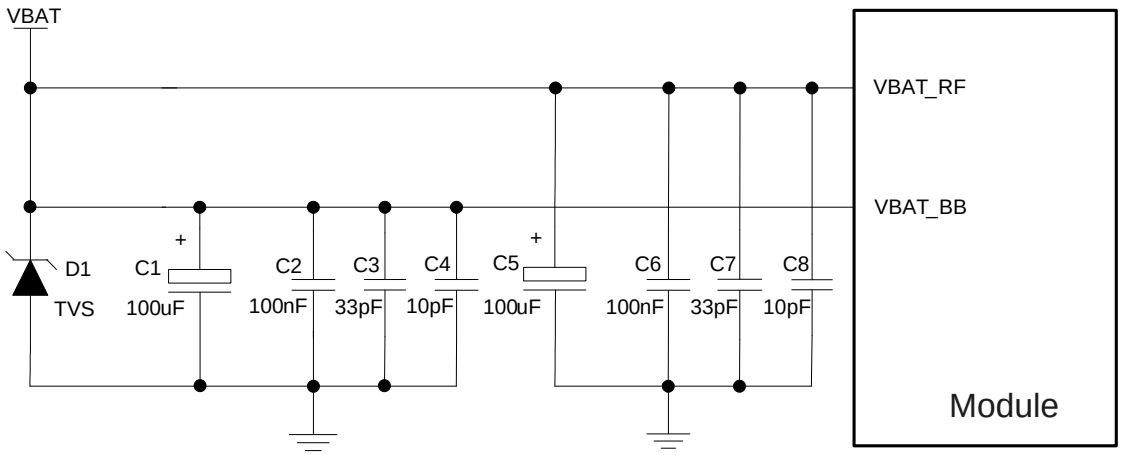


Figure 4: Reference Circuit of VBAT (BG96/EG9x/UG9x)

4.2. Turn-on

The turn-on method of BG96 is the same as EG9x, UG9x and M95. BG96/EG9x/UG9x/M95 modules are powered on after pressing PWRKEY for a certain time. BC95-G module can be automatically turned on by supplying power source to VBAT pins.

BG96 and EG9x modules' PWRKEY pin is internally pulled up to an internal voltage in the Qualcomm chipset, and its output voltage is the internal voltage minus a diode drop in the chipset. Therefore, the expected output voltage of PWRKEY is 0.8V.

The following is a reference design for the turn-on circuit of BG96, EG9x, UG9x and M95.

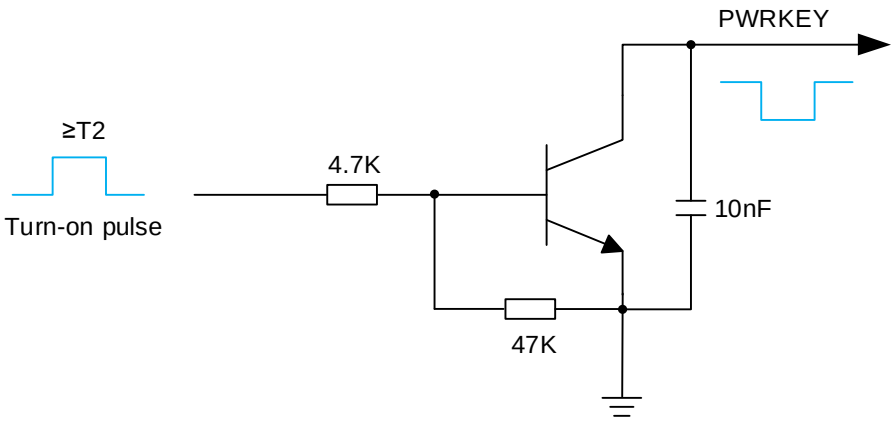


Figure 5: PWRKEY Driving Circuit for Module Turn-on (BG96/EG9x/UG9x/M95)

The power-on scenarios of BG96, EG9x, UG9x and M95 are illustrated in the figure below.

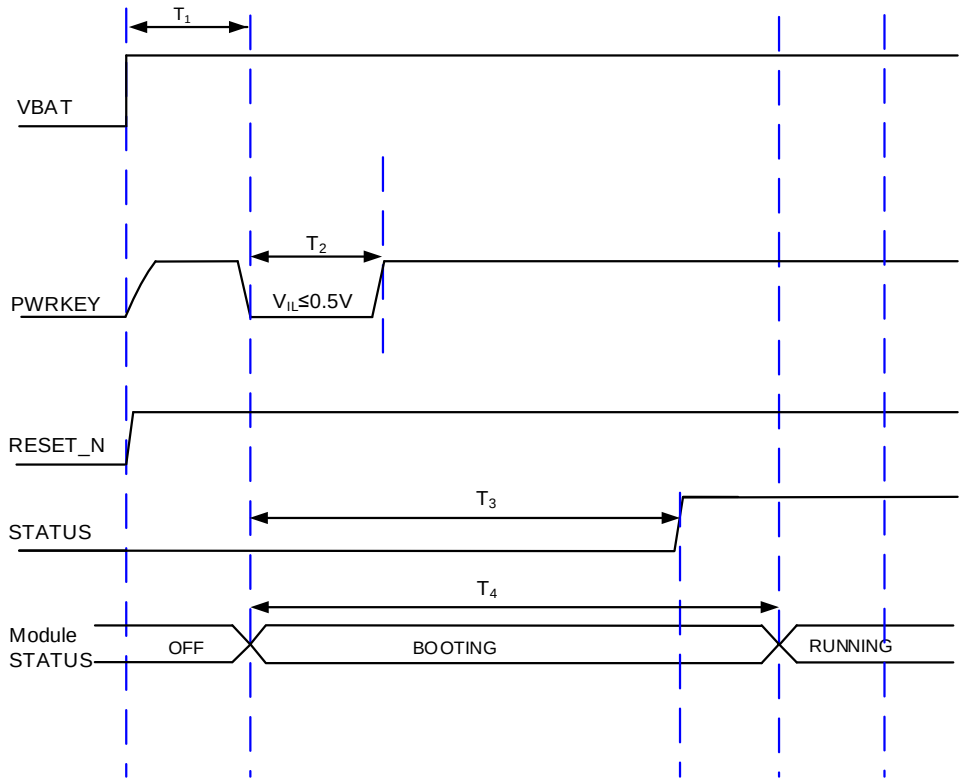


Figure 6: Power-on Scenarios (BG96/EG9x/UG9x/M95)

The power-on timing of BG96, EG9x, UG9x and M95 are illustrated in the table below.

Table 5: Power-on Timing of BG96/EG9x/UG9x/M95

Module	T_1	T_2	T_3	T_4
BG96	≥30ms	≥500ms	≥4.8s	≥4.9s
EG9x	≥30ms	≥500ms	≥10s	/
UG9x	≥30ms	≥100ms	≥2.3s	≥3.5s
M95	≥100ms	≥1s	≥0.8s	/

NOTE

Make sure that VBAT is stable before pulling down PWRKEY pin, and T_1 is recommended to be more than 30ms.

The power-on scenario of BC95-G module is illustrated in the figure below.

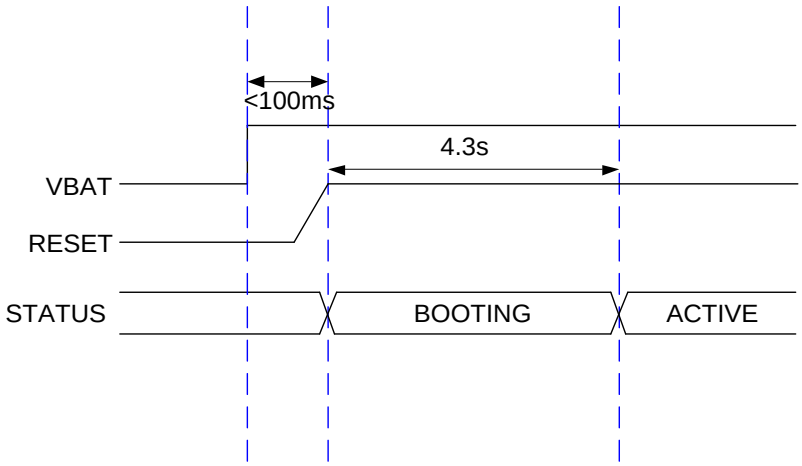


Figure 7: Power-on Scenario (BC95-G)

4.3. Turn-off

4.3.1. Turn off Module via AT Command (BG96/EG9x/UG9x/M95)

There are several ways to turn off BG96/EG9x/UG9x/M95 modules. It is recommended to turn off the module through **AT+QPOWD** command, which a safe way. The command will let the module log out from the network and allow the firmware to save important data before completely disconnecting the power supply.

The power-off scenarios of BG96/EG9x/UG9x/M95 are illustrated in the figure below.

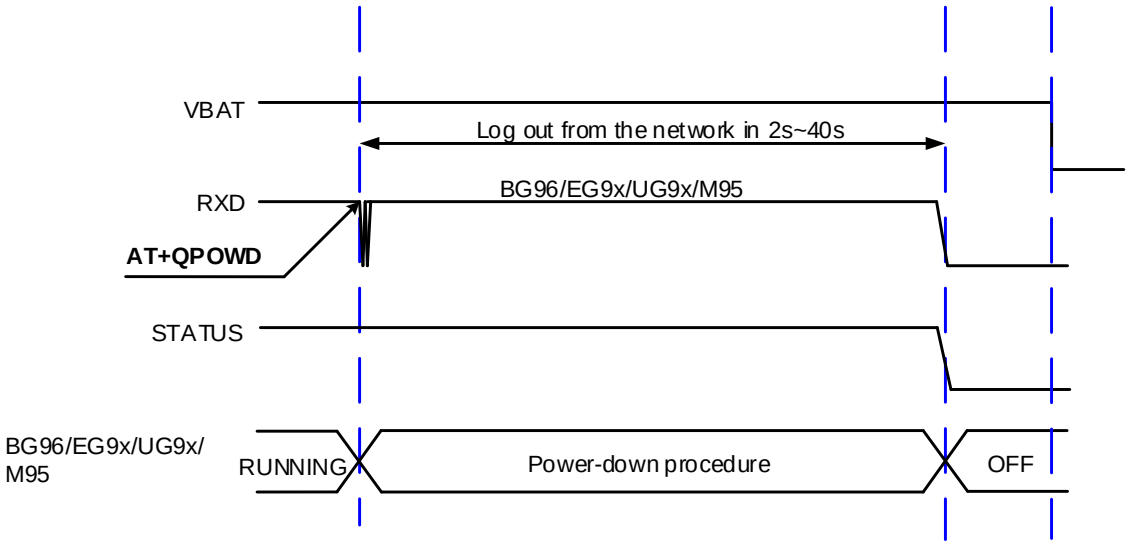


Figure 8: Power-off Scenarios through AT Command (BG96/EG9x/UG9x/M95)

4.3.2. Turn off Module by PWRKEY Pin and VBAT (BG96/EG9x/M95/BC95-G)

It is a safe way to turn off BG96/EG9x/M95 module by driving PWRKEY to a low level voltage for a certain time. And BC95-G can be turned off by shutting down the VBAT power supply.

The power-off scenarios of BG96/EG9x/M95 by PWRKEY are illustrated in the figure below.

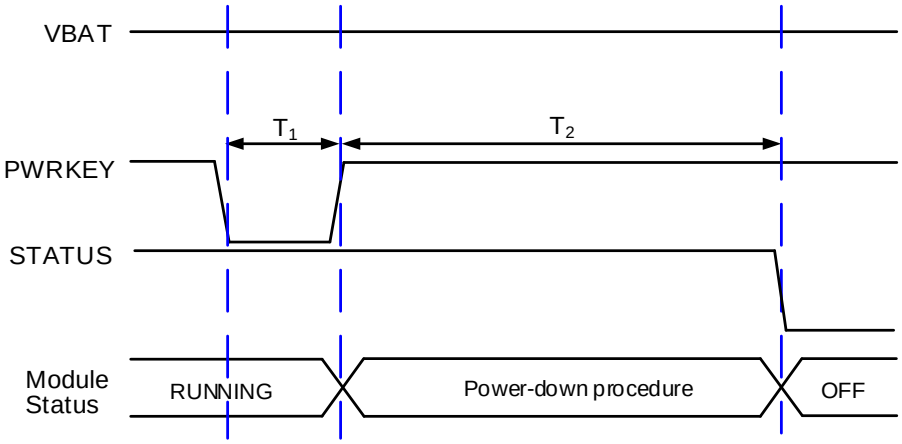


Figure 9: Power-off Scenarios by PWRKEY (BG96/EG9x/M95)

The power-off timing by PWRKEY of BG96/EG9x/M95 is illustrated in the table below.

Table 6: Power-off Timing by PWRKEY of BG96/EG9x/M95

Module	T_1	T_2
BG96	≥650ms	≥2s
EG9x	≥650ms	≥30s
M95	0.7s<T1<1s	2s<T2<12s

The power-off scenario of BC95-G by VBAT is illustrated in the figure below.

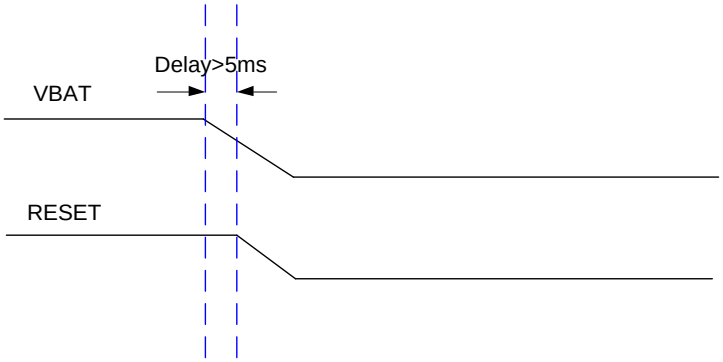


Figure 10: Power-off Scenario by VBAT (BC95-G)

4.3.3. Emergency Shutdown (UG9x/M95)

UG9x can be shut down by PWRDWN_N, and M95 can be shut down by EMERG_OFF. The pin PWRDWN_N and EMERG_OFF should only be used under emergent situations. Although turning off the module by PWRDWN_N and EMERG_OFF are fully tested and nothing wrong detected, this operation is still a big risk as it could reduce the service life of (U)SIM card or the module.

The following figure is a reference design for the emergency shutdown circuit for UG9x and M95.

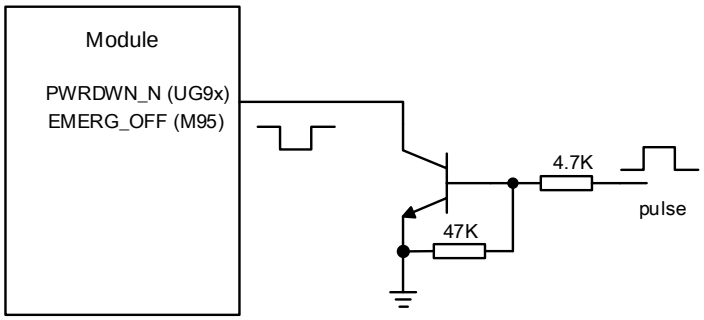


Figure 11: Driving Circuit of Emergency Shutdown Circuit (UG9x/M95)

The emergency shutdown scenarios of UG9x/M95 are illustrated in the figure below.

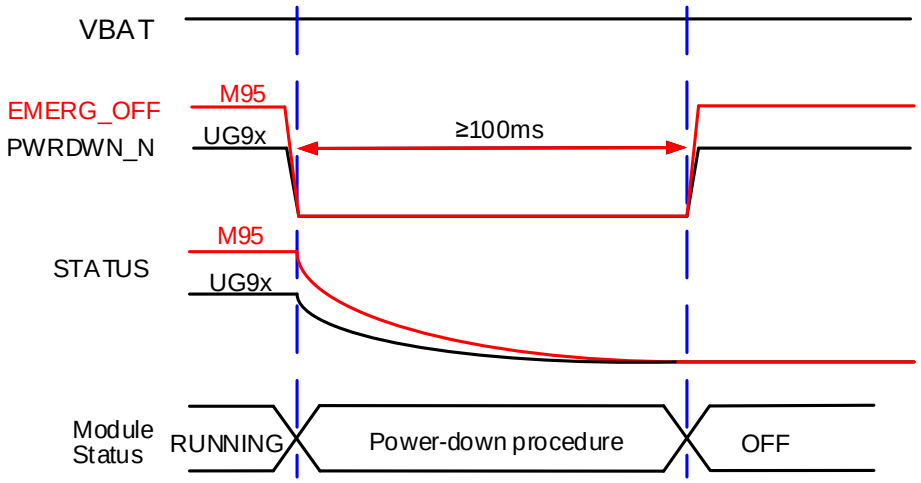


Figure 12: Emergency Shutdown Scenarios (UG9x/M95)

NOTES

1. The parts marked in red in the above figure are for M95.
2. The parts marked in black in the above figure are for UG9x.

4.4. Reset

BG96/BC95-G/EG9x/UG9x modules can be reset by driving RESET_N pin to a low level voltage for a certain time. And BC95-G module can also be reset by using command **AT+NRB**, please refer to ***document [10]*** for more details.

M95 module can be reset by driving the PWRKEY to a low level voltage for a certain time, which is similar to the way of turning on module.

The recommended circuits of controlling RESET_N for BG96/BC95-G/EG9x/UG9x are shown below and are similar to the PWRKEY control circuit. An open drain/collector driver or button can be used to control the RESET_N pin.

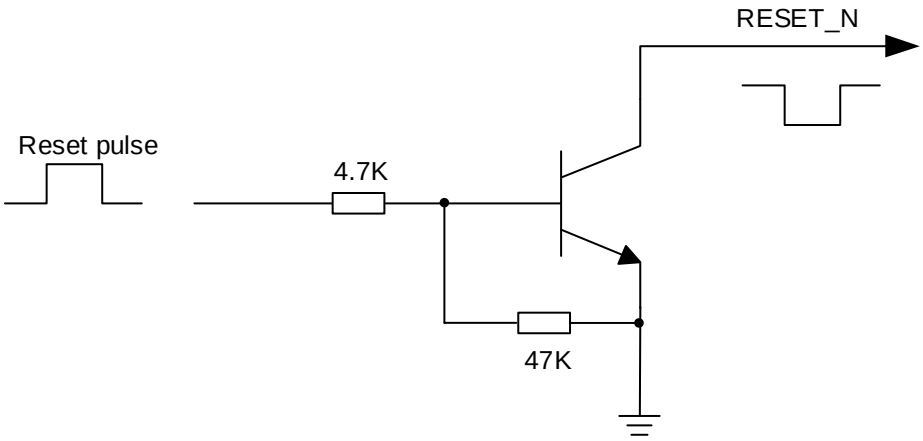


Figure 13: Reference Circuit of RESET_N by Using Driving Circuit (BG96/BC95-G/EG9x/UG9x)

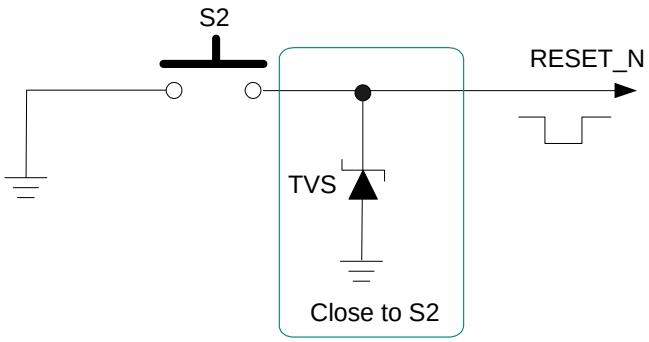


Figure 14: Reference Circuit of RESET_N by Using Button (BG96/BC95-G/EG9x/UG9x)

NOTES

1. For BG96/EG9x modules, the reset pulse duration range is 150ms~460ms.
2. For BC95-G/UG9x modules, the reset pulse duration range is more than 100ms and RESET_N pin is released after that.

The reset scenarios of BG96/EG9x modules are illustrated in the figure below.

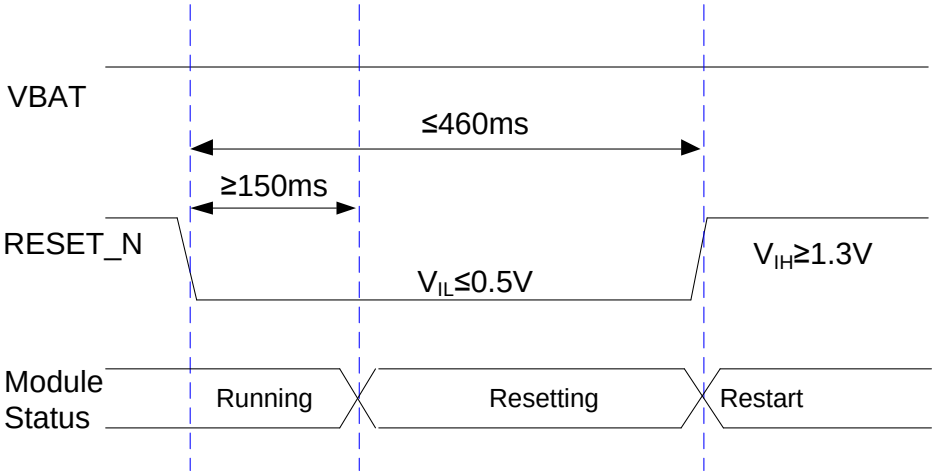


Figure 15: Reset Scenarios (BG96/EG9x)

The reset scenario of UG9x module is illustrated in the figure below.

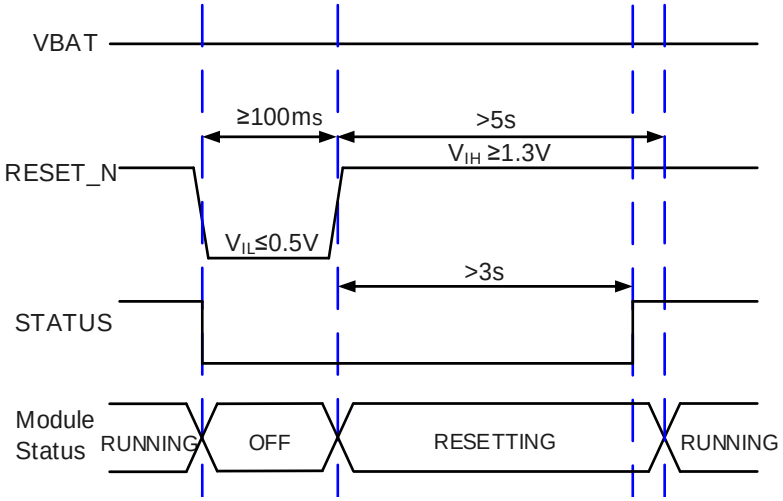


Figure 16: Reset Scenarios (UG9x)

NOTES

1. Use RESET_N only when turning off the module by **AT+QPOWD** command and PWRKEY pin both failed.
2. Please ensure that there is no large capacitor on PWRKEY and RESET_N pins.

The reset scenario of M95 is illustrated in the figure below. In order to make the internal LDOs discharge completely after turning off the module, it is recommended to delay about 500ms before restarting the module.

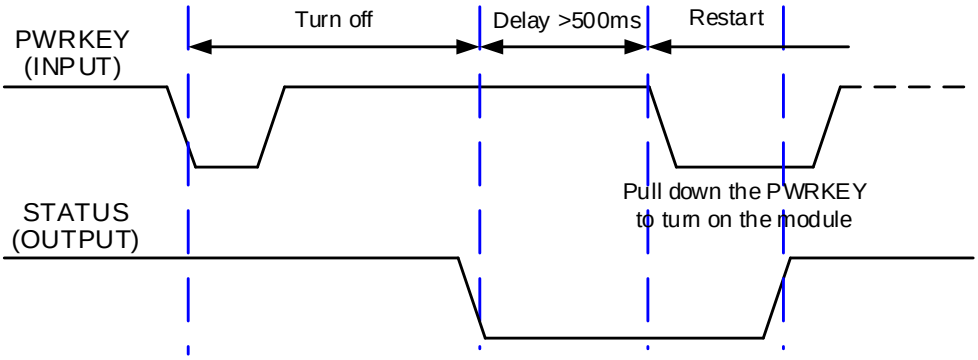


Figure 17: Reset Scenario (M95)

M95 can also be restarted by PWRKEY after emergency shutdown.

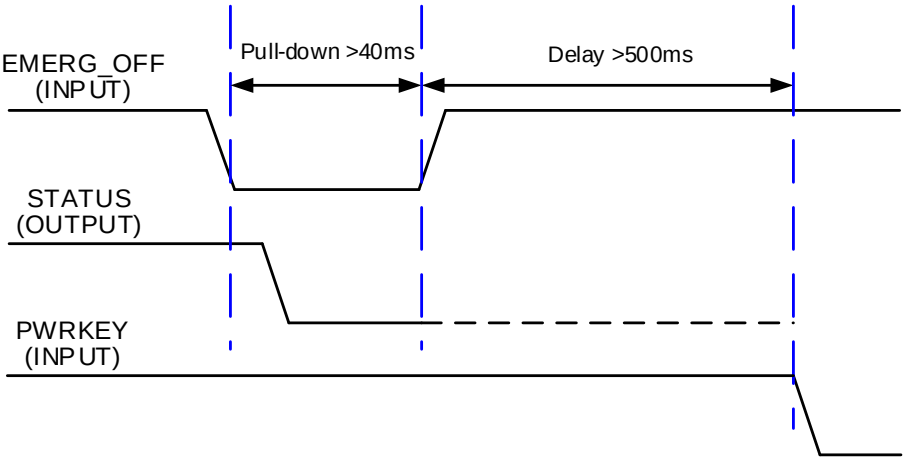


Figure 18: Reset Scenario after Emergency Shutdown (M95)

4.5. Network Status Indication

BG96/BC95-G/EG9x/UG9x/M95 provides one network status indication pin: NETLIGHT. The pin is used to drive a network status indication LED. A reference circuit is shown in the following figure.

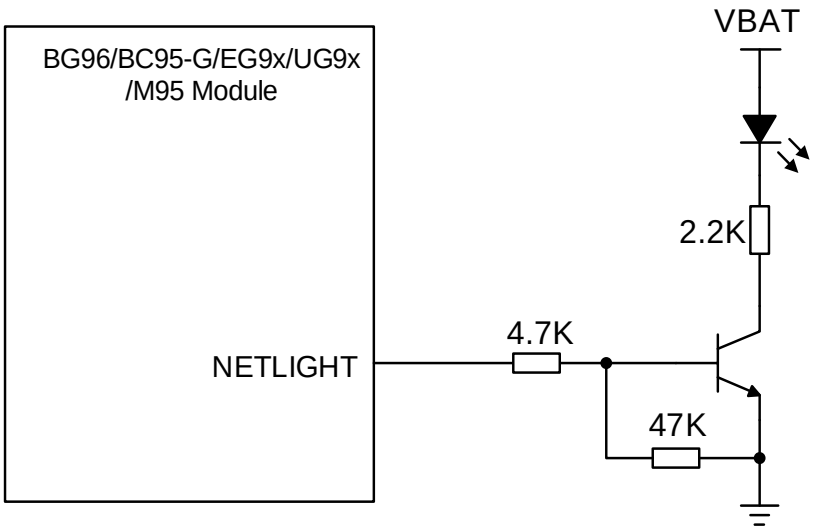


Figure 19: Reference Circuit of NETLIGHT

4.6. Operation Status Indication

BG96/EG9x/UG9x/M95 provides a STATUS pin to indicate module's operation status, while BC95-G does not have this pin. It will output high level when the module is powered on. The following figure shows a reference circuit for STATUS.

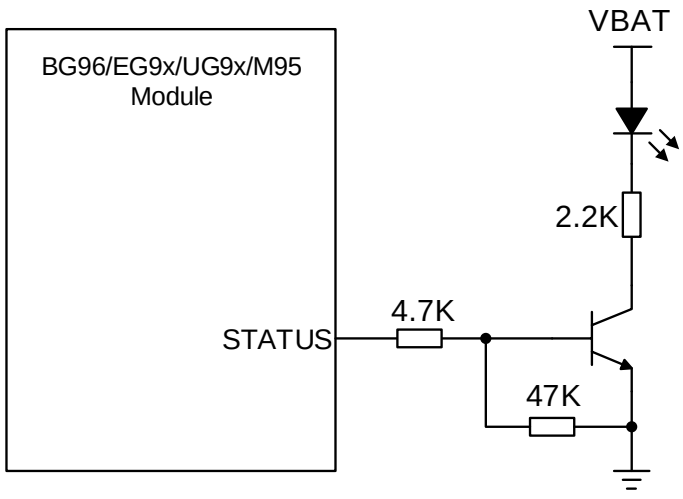


Figure 20: Reference Circuit of STATUS

4.7. (U)SIM Interface(s)

BG96/BC95-G/UG9x supports one 1.8V/3.0V (U)SIM interface, and EG9x/M95 supports two. The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements. BG96/BC95-G/EG9x/UG9x supports (U)SIM card, while BC95-G only support USIM card and does not have USIM_PRESENCE pin.

The following figure shows a reference design for (U)SIM interface with a 6-pin (U)SIM card connector.

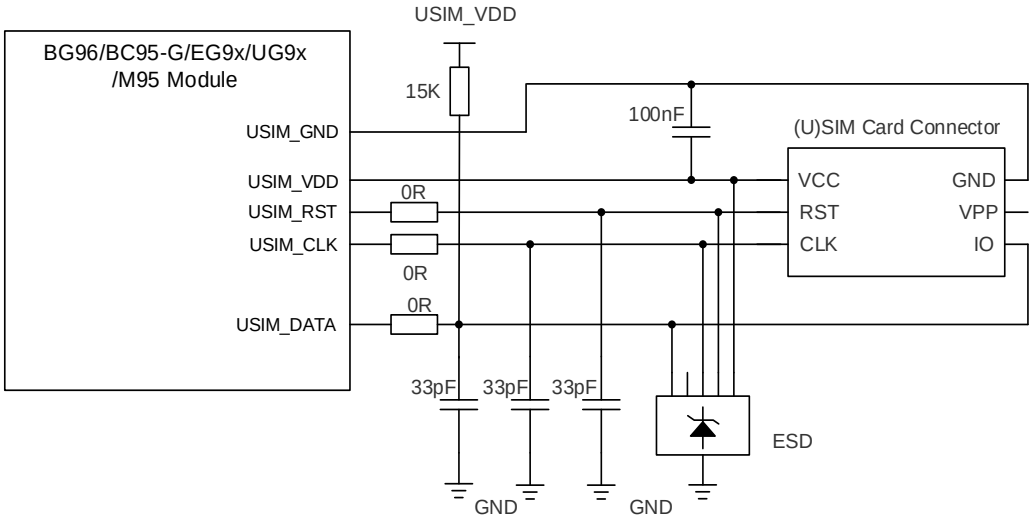


Figure 21: Reference Circuit of (U)SIM Interface with a 6-Pin (U)SIM Card Connector

If (U)SIM card detection function is used, keep USIM_PRESENCE pin connected. The following figure shows a reference design for (U)SIM interface with (U)SIM card detection function for BG96/EG9x/UG9x/M95 modules.

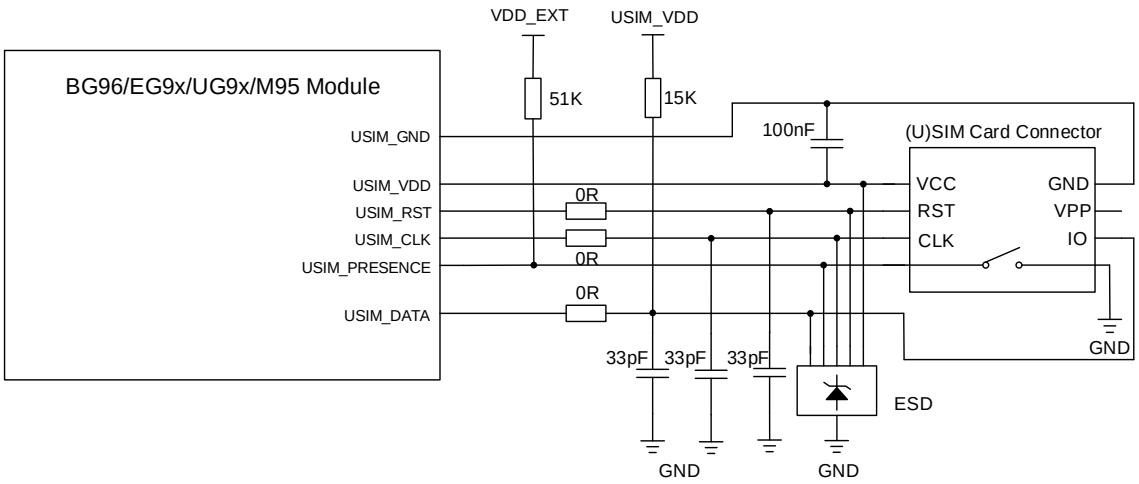


Figure 22: Reference Design of (U)SIM Card Interface with (U)SIM Card Detection

In order to enhance the reliability and availability of the (U)SIM card in applications, 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 as less than 200mm as possible.
- Keep (U)SIM card signals away from RF and VBAT traces.
- Assure the ground between the module and the (U)SIM card connector short and wide. Keep the trace width of ground and USIM_VDD no less than 0.5mm to maintain the same electric potential. Make sure the bypass capacitor between USIM_VDD and USIM_GND less than 1uF, and place it as close to (U)SIM card connector as possible. If the system ground plane is complete, USIM_GND can be connected to the system ground directly.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground. USIM_RST should also be ground shielded.
- In order to offer good ESD protection, it is recommended to add a TVS diode array with parasitic capacitance not exceeding 15pF. In order to facilitate debugging, it is recommended to reserve series resistors for the (U)SIM signals of the module. The 33pF capacitors are used for filtering interference of GSM 900MHz. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace and sensitive occasion are applied, and should be placed close to the (U)SIM card connector.

4.8. UART Interface(s)

BG96/BC95-G/EG9x/UG9x/M95 can communicate with application processor via UART interface(s).

BG96 provides three UART interfaces: main UART, UART2 and UART3. Main UART is also called UART1, it supports hardware flow control and is used for data transmission and AT command communication. UART2 is used for debugging and log output. UART3 is used for GNSS data and NMEA sentence output.

BC95-G provides two UART interfaces: main UART and debug UART. The module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection.

UG9x provides one UART interface with hardware flow control. It supports 300bps~921600bps baud rates, and the default is autobauding 4800bps~115200bps. This interface can be used for data transmission, AT communication and firmware upgrade.

EG9x provides two UART interfaces: main UART and debug UART. The main UART supports RTS and CTS hardware flow control. The debug UART is used for Linux console and log output.

M95 provides two UART interfaces: main UART and debug UART. The module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment)

connection.

Since the UART interface level vary among BG96, BC95-G, EG9x, UG9x and M95 modules. A level translator should be used if customers' application is equipped with a 3.3V UART interface. A level translator TXS0108EPWR provided by *Texas Instruments* is recommended. The following figure shows a reference design. For details, please refer to ***document [1] ~ [7]***.

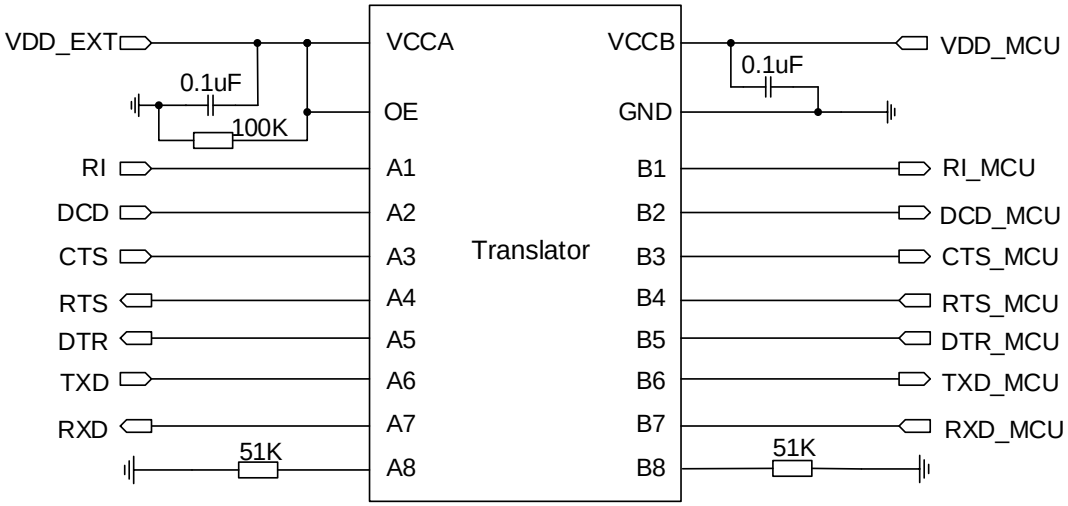


Figure 23: Reference Design of UART Interface(s)

Please visit http://www.ti.com for more information.

Another example with transistor translation circuit is shown as below. The circuit design of dotted line section can refer to that of solid line section, in terms of both module input and output circuit designs, but please pay attention to the direction of connection.

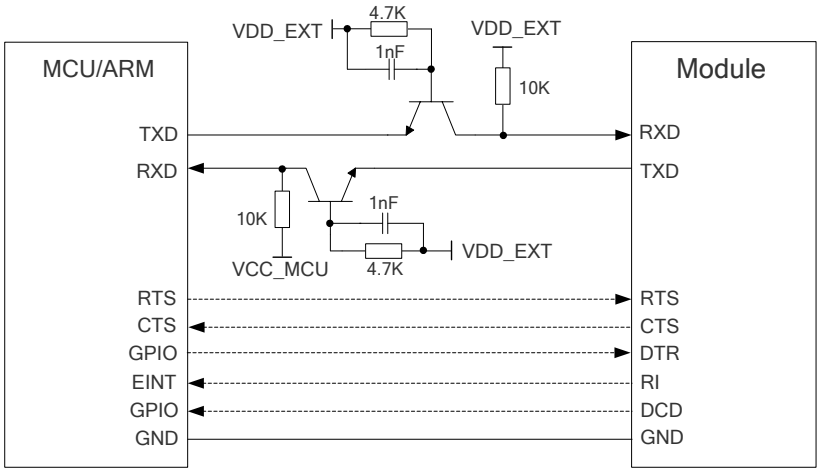


Figure 24: Reference Circuit with Transistor Circuit

NOTE

Transistor circuit solution is not suitable for applications with high baud rates exceeding 460Kbps.

4.9. USB Interface

BG96/EG9x/UG9x 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 interface supports USB devices only.

BC95-G and M95 modules do not support USB interface.

The following figure shows a reference design of USB interface when application processor communicates with BG96/EG9x/UG9x module via USB interface.

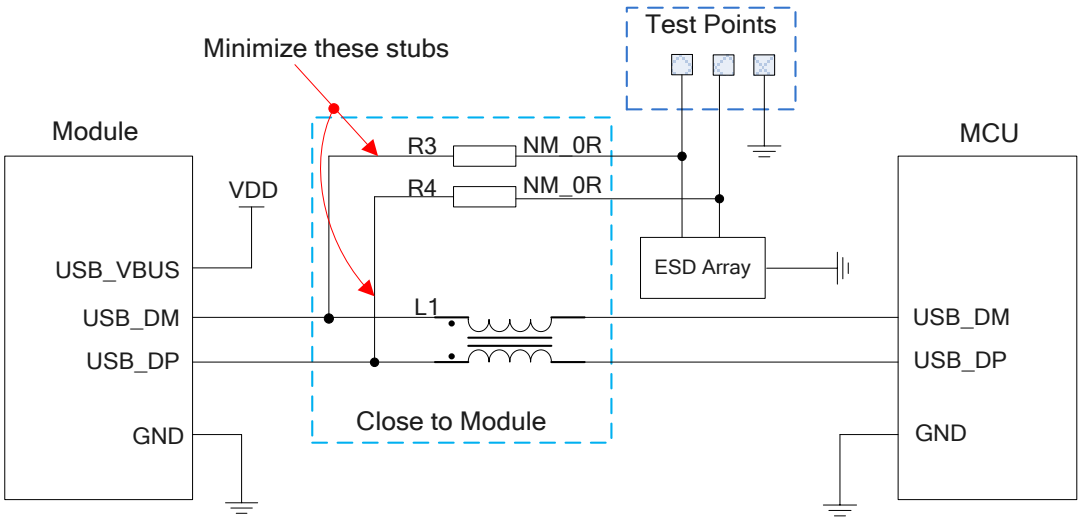


Figure 25: Reference Design of USB Interface (BG96/EG9x/UG9x)

4.10. PCM and I2C Interfaces

BG96/EG9x/UG9x modules provide one PCM digital interface and one I2C interface. A reference design of PCM and I2C interfaces with an external codec IC is shown below.

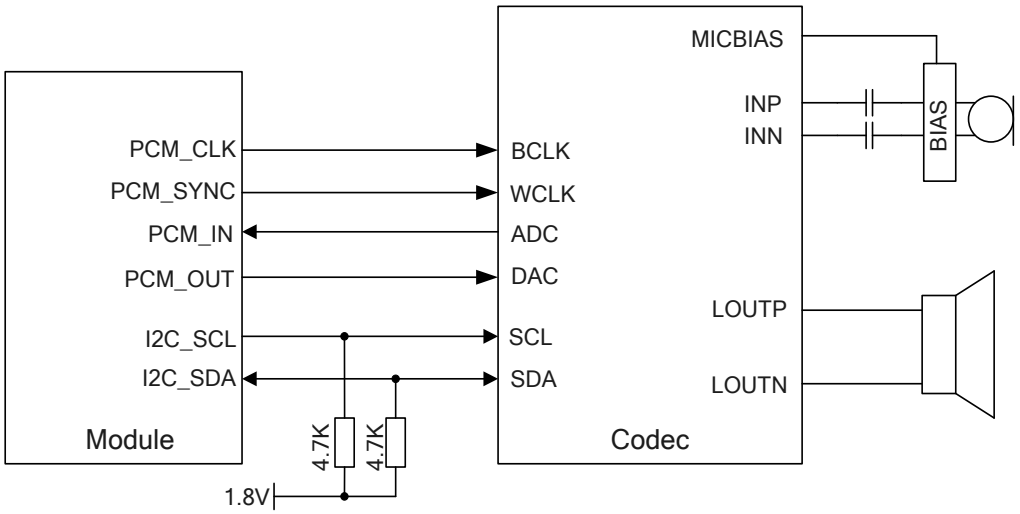


Figure 26: Reference Design of PCM Application with Audio Codec (BG96/EG9x/UG9x)

M95 provides two analog input channels, two analog output channels and one PCM interface. The following figure shows the reference design of audio interfaces.

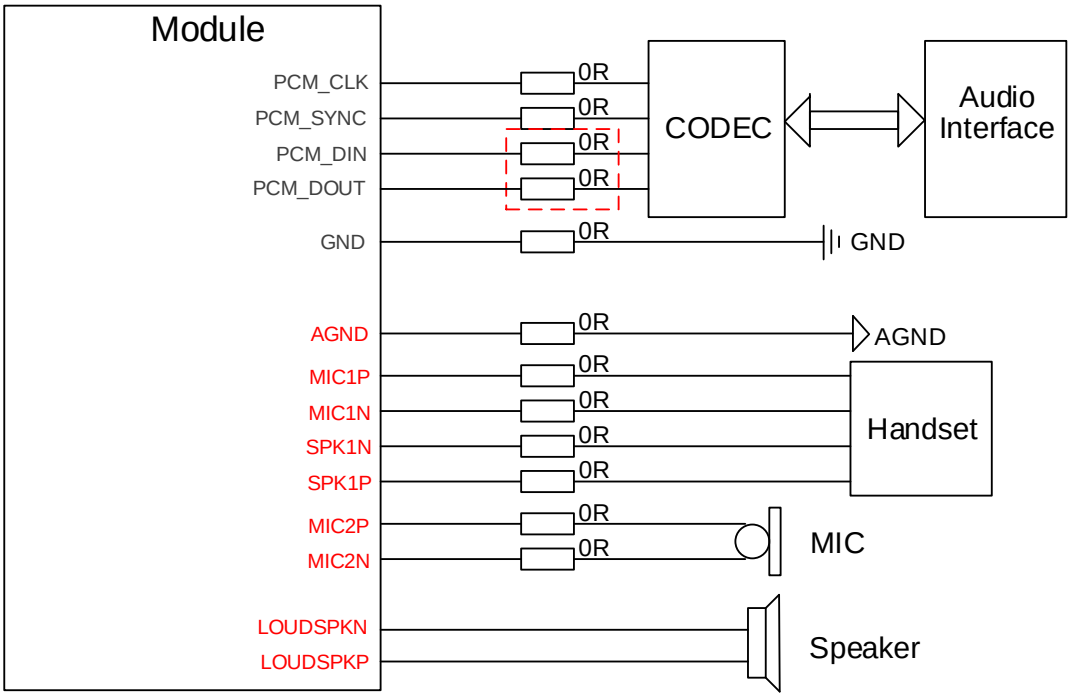


Figure 27: Reference Design of Audio Interfaces (M95)

BC95-G does not support PCM and I2C interfaces.

For more details about the PCM and I2C interfaces of BG96/EG9x/UG9x/M95, please refer to ***document [1]***, ***[3]~[7]***.

4.11. RF Antenna Interface(s)

ANT_MAIN of BG96 and RF_ANT of BC95-G/EG9x/UG9x/M95 are compatible. The RF antenna port has an impedance of 50Ω. A reference circuit for the interface is shown below. In order to achieve better RF performance, a π-type matching circuit should be reserved, and π-type matching components (R1/C1/C2) should be placed as close the antenna as possible. By default, the resistance of R1 is 0Ω and capacitors C1&C2 are not mounted.

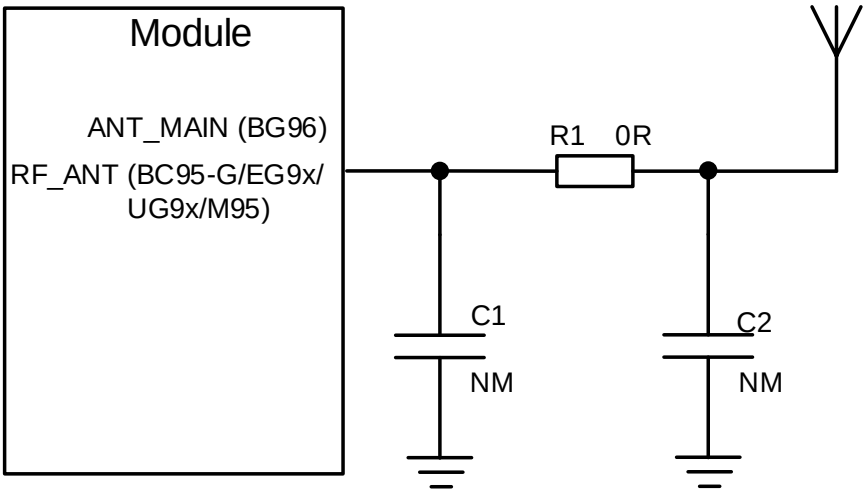


Figure 28: Reference Circuit of RF Interface(s)

BC95-G/UG9x/M95 modules do not have GNSS function. BG96, EG91-NA/-NS/-VX/-EX and EG95-NA/-EX modules support GNSS function which has ANT_GNSS interface. A reference design for ANT_GNSS antenna interface of BG96, EG91-NA/-NS/-VX/-EX and EG95-NA/-EX is shown as below.

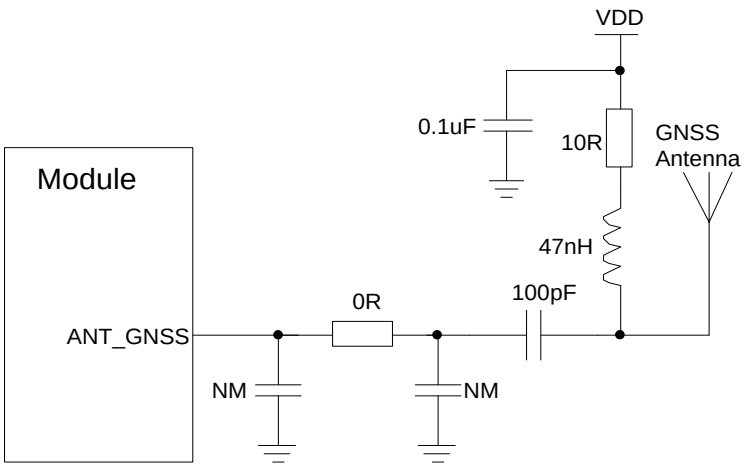


Figure 29: Reference Circuit of ANT_GNSS Interface (BG96, EG91-NA/-NS/-VX/-EX and EG95-NA/-EX)

NOTES

1. An external LDO can be selected to supply power according to the active antenna requirement.
2. If module is designed with a passive antenna, then the VDD circuit is not needed.

EG9x module supports receive diversity function which has ANT_DIV interface. A reference design for ANT_DIV antenna interface of EG9x is shown as below.

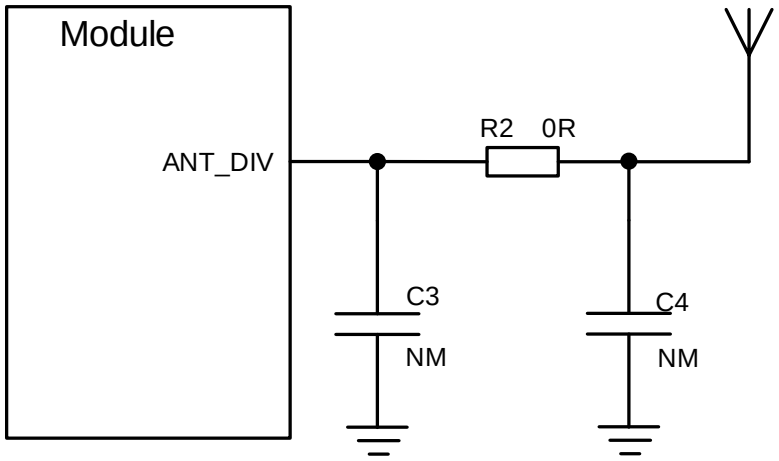


Figure 30: Reference Design for ANT_DIV Interface (EG9x)

5 Recommended Footprint and Stencil Design

This chapter mainly introduces the recommended footprint and stencil design for BG96, BC95-G, EG9x, UG9x and M95 modules. All dimensions are measured in mm, and the tolerances for dimensions without tolerance values are ±0.05mm.

5.1. Recommended Compatible Footprint

The following figure shows the bottom views of BG96, BC95-G, EG9x, UG95, UG96 and M95.

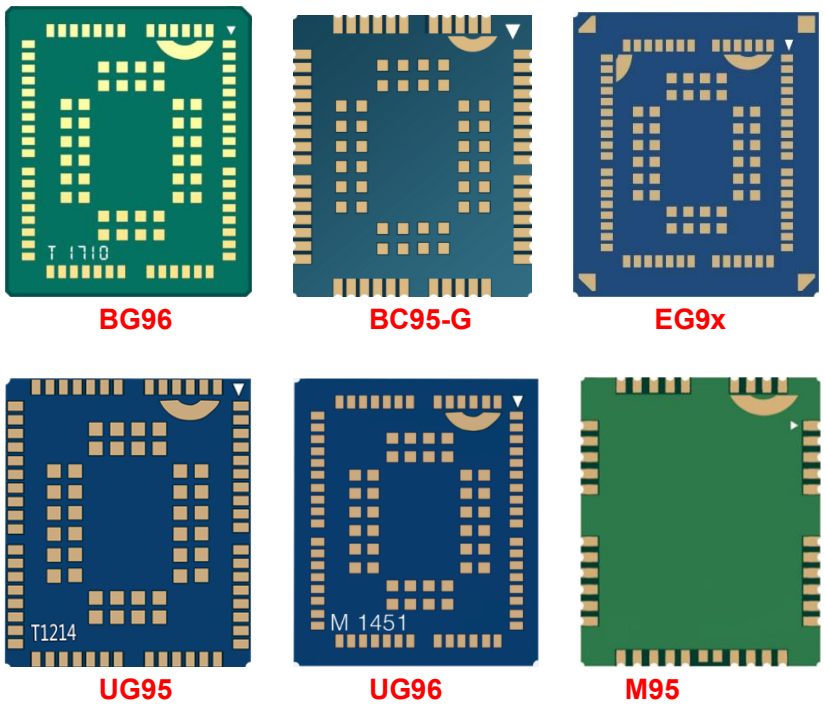


Figure 31: Bottom Views of BG96/BC95-G/EG9x/UG95/UG96/M95

The following figure shows the recommended compatible footprint of BG96/BC95-G/EG9x/UG9x/M95.

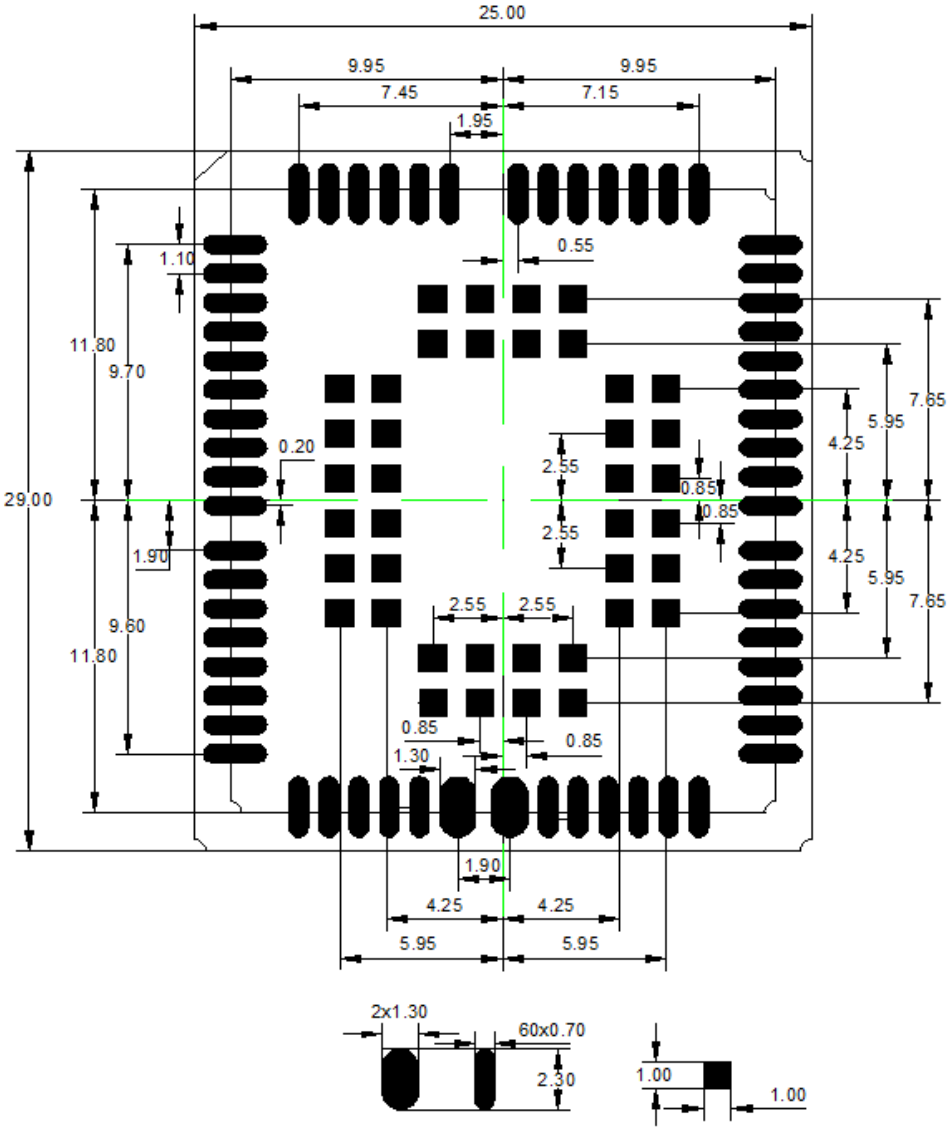


Figure 32: Recommended Footprint of BG96/BC95-G/EG9x/UG9x/M95

5.2. Recommended Stencil Design

In order to ensure the module soldering quality, the thickness of stencil is recommended to be 0.13mm~0.15mm for BG96, EG9x and UG9x, 0.18mm~0.2mm for BC95-G and M95. For more details, please refer to ***document [8]***.

For the stencil design of BG96/BC95-G/EG9x/UG9x and M95 modules, please refer to ***document [8]***.

5.3. Installation Sketch Map

The following figure shows the sketch map of installation for BG96, BC95-G, EG9x, UG9x and M95.

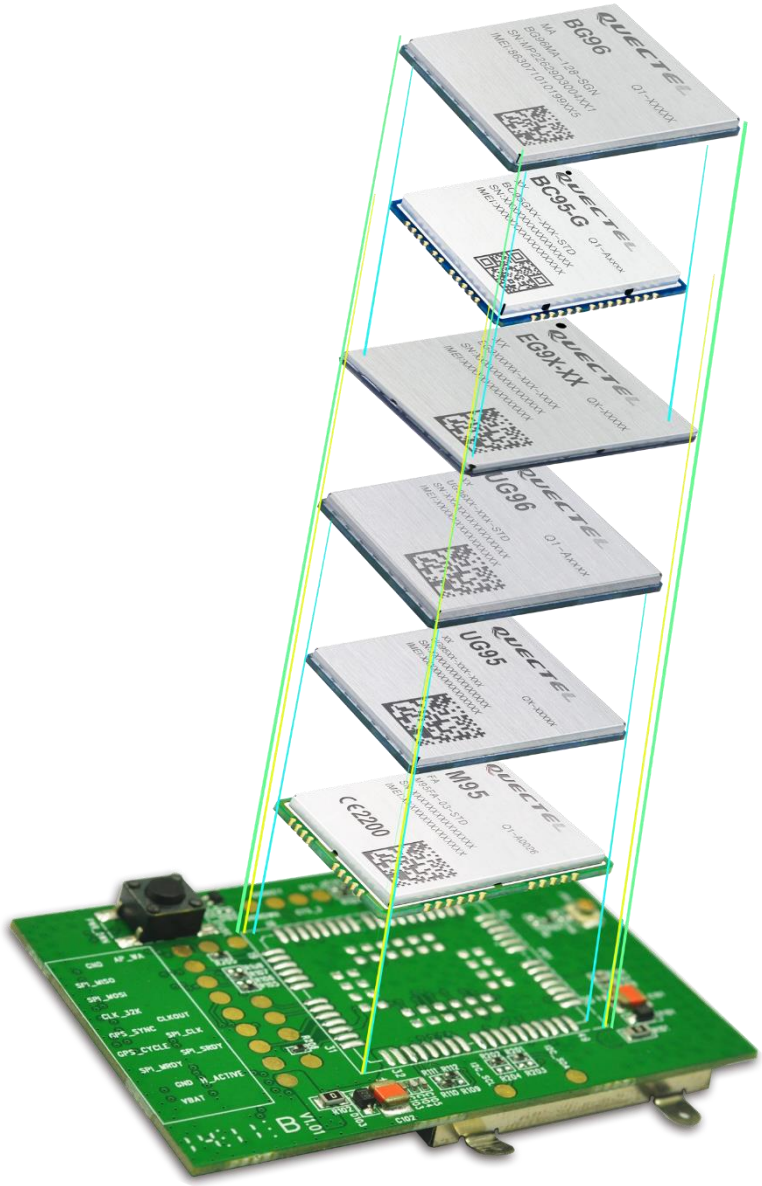


Figure 33: Installation Sketch Map for BG96/BC95-G/EG9x/UG9x/M95

6 Manufacturing and Packaging

6.1. 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.

It is suggested that the peak reflow temperature is 238ºC~245ºC, and the absolute maximum reflow temperature is 245ºC. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

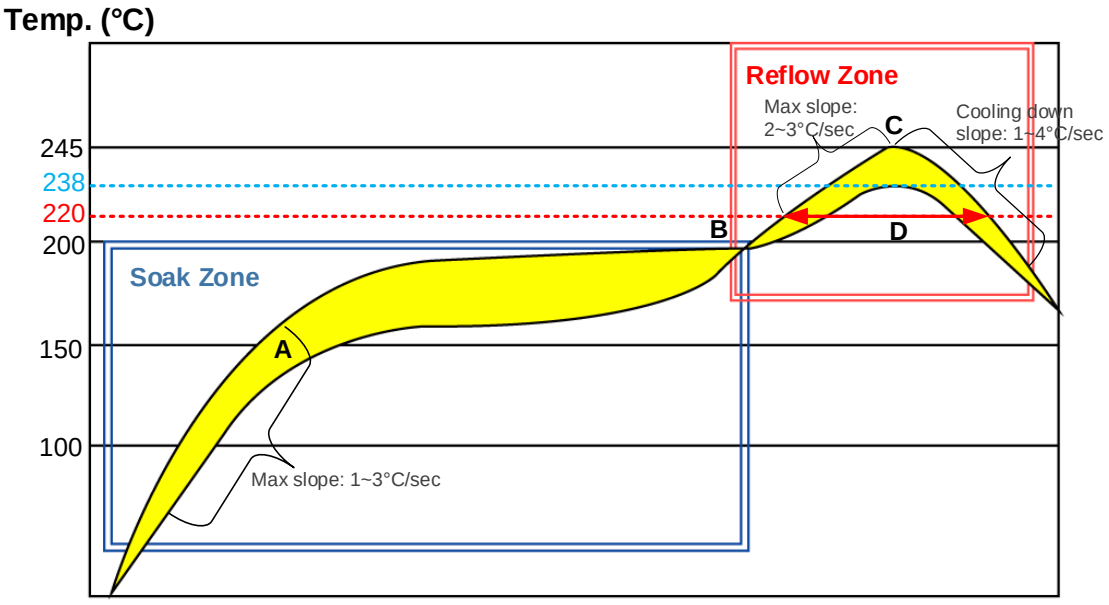


Figure 34: Reflow Soldering Thermal Profile

Table 7: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1 to 3°C/sec
Soak time (between A and B: 150°C and 200°C)	60 to 120 sec
Reflow Zone	
Max slope	2 to 3°C/sec
Reflow time (D: over 220°C)	40 to 60 sec
Max temperature	238°C ~ 245°C
Cooling down slope	1 to 4°C/sec
Reflow Cycle	
Max reflow cycle	1

NOTES

For BC95-G, UG9x and M95 modules:

- During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding can may become rusted.
- The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the 2D barcode is still readable, although white rust may be found.

6.2. Packaging

Modules are stored inside a vacuum-sealed bag which is ESD protected. The bag should not be opened until the devices are ready to be soldered onto the application. The following figures show the packaging details of BG96/BC95-G/EG9x/UG9x/M95 modules, measured in mm.

6.2.1. BG96 Packaging

The reel is 330mm in diameter and each reel contains 250 modules.

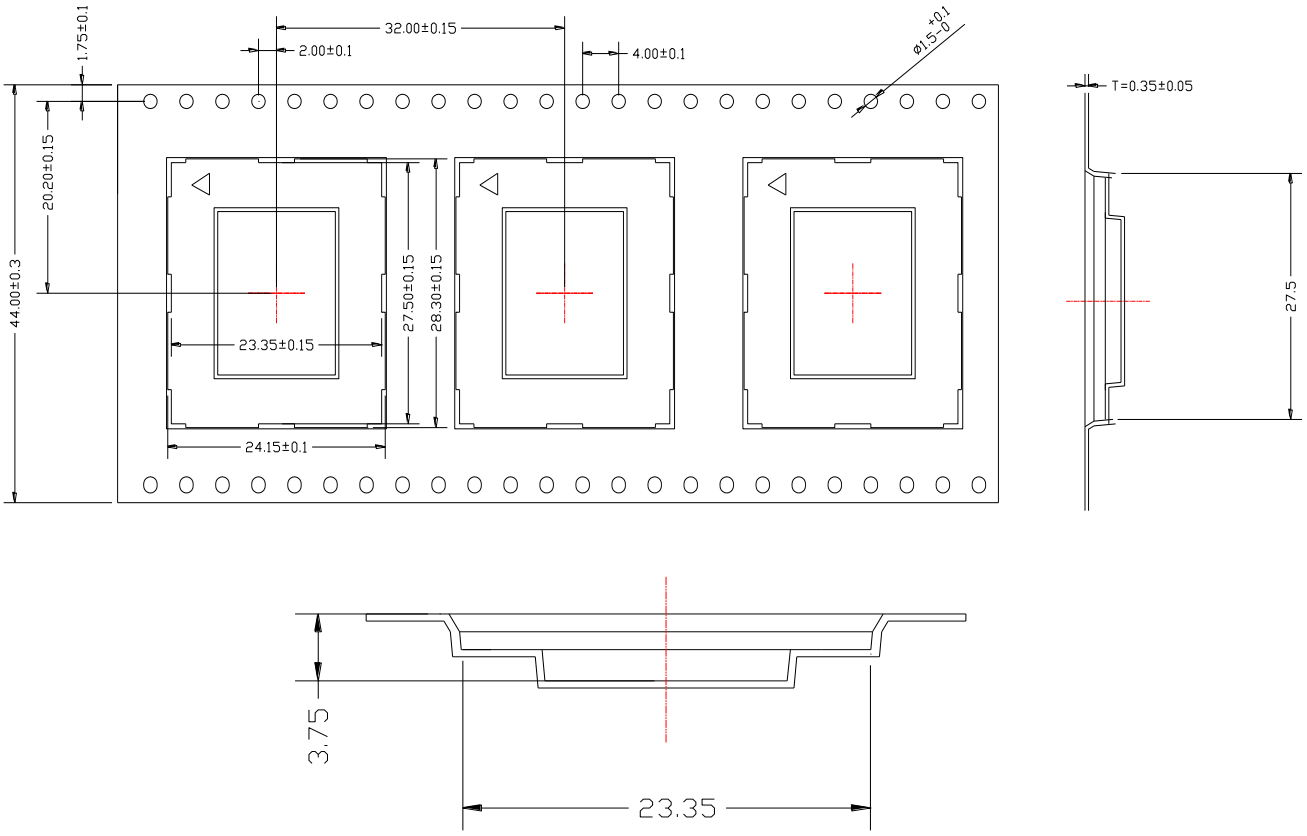


Figure 35: Tape Dimensions of BG96

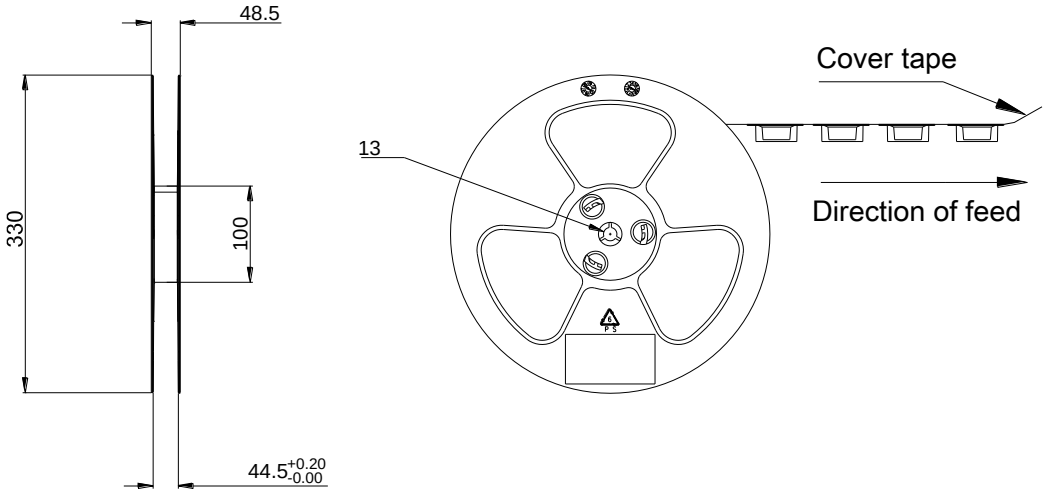


Figure 36: Reel Dimensions of BG96

6.2.2. BC95-G Packaging

The reel is 330mm in diameter and each reel contains 250 modules.

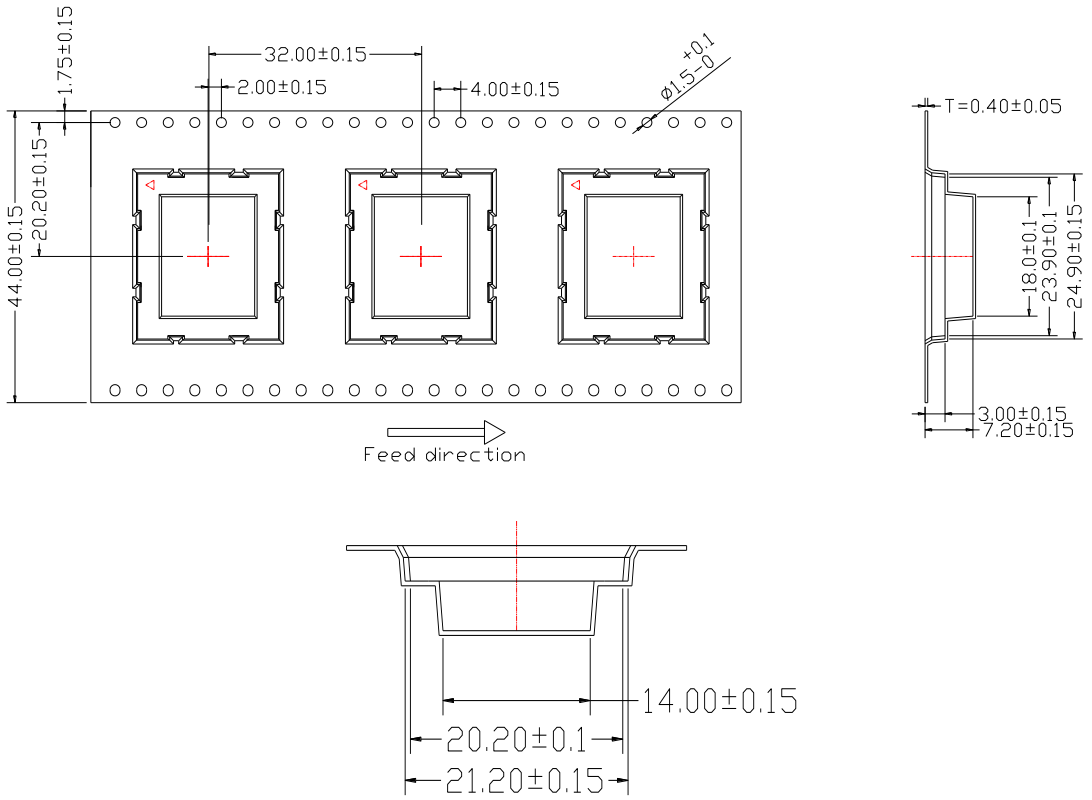
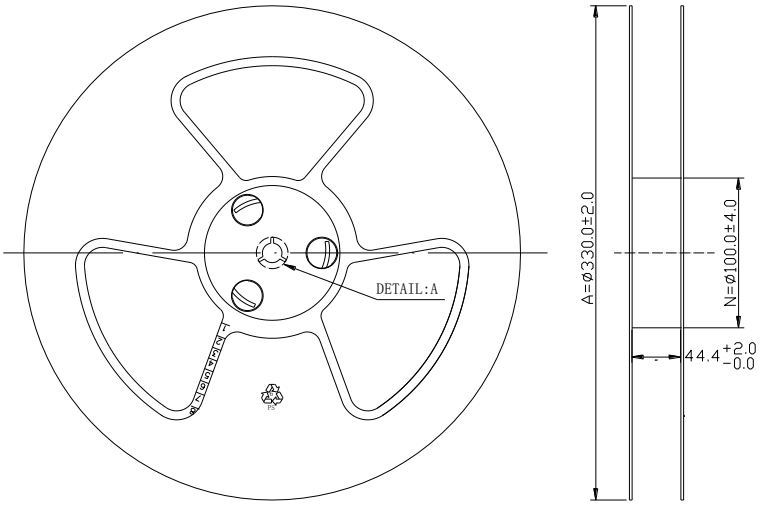


Figure 37: Tape Dimensions of BC95-G



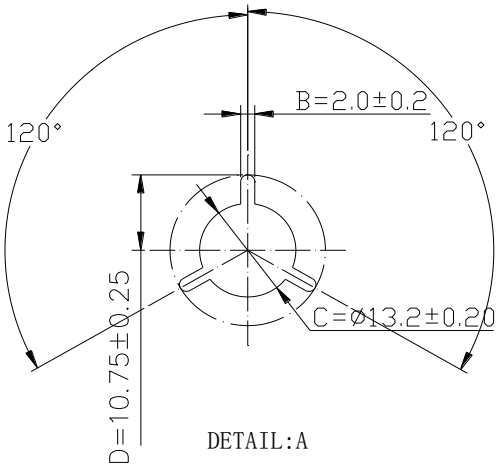


Figure 38: Reel Dimensions of BC95-G

6.2.3. EG9x Packaging

The reel is 330mm in diameter and each reel contains 250pcs modules.

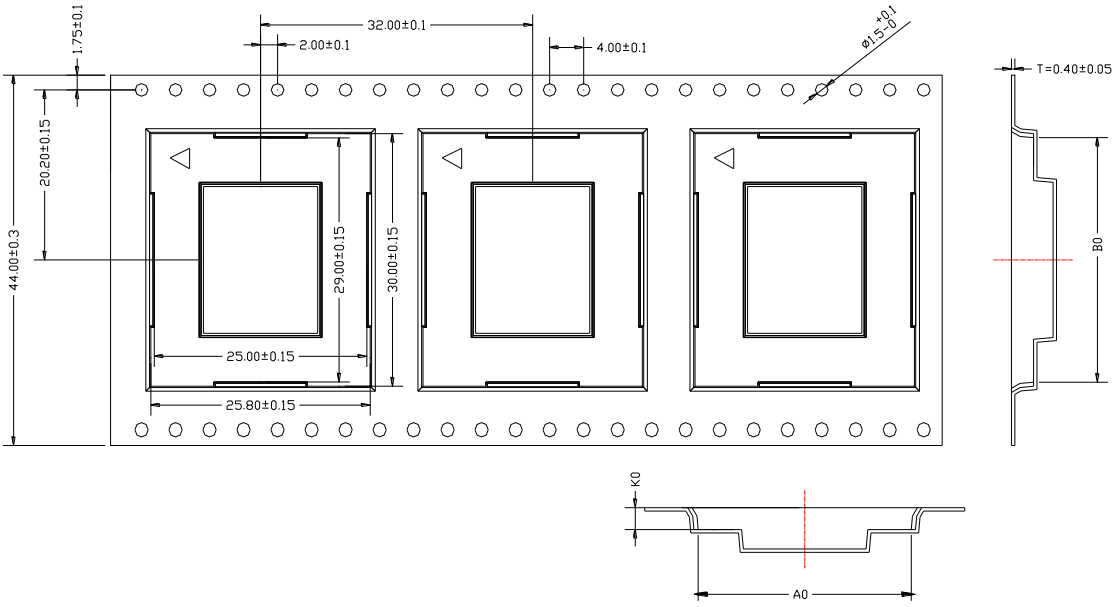


Figure 39: Tape Dimensions of EG9x

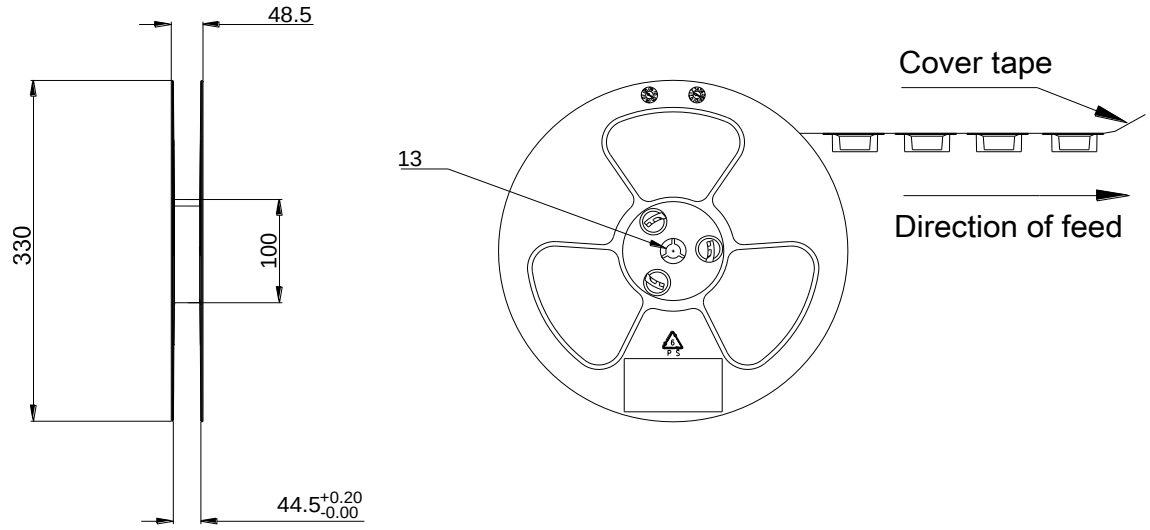


Figure 40: Reel Dimensions of EG9x

6.2.4. UG95 Packaging

The reel is 330mm in diameter and each reel contains 250 modules.

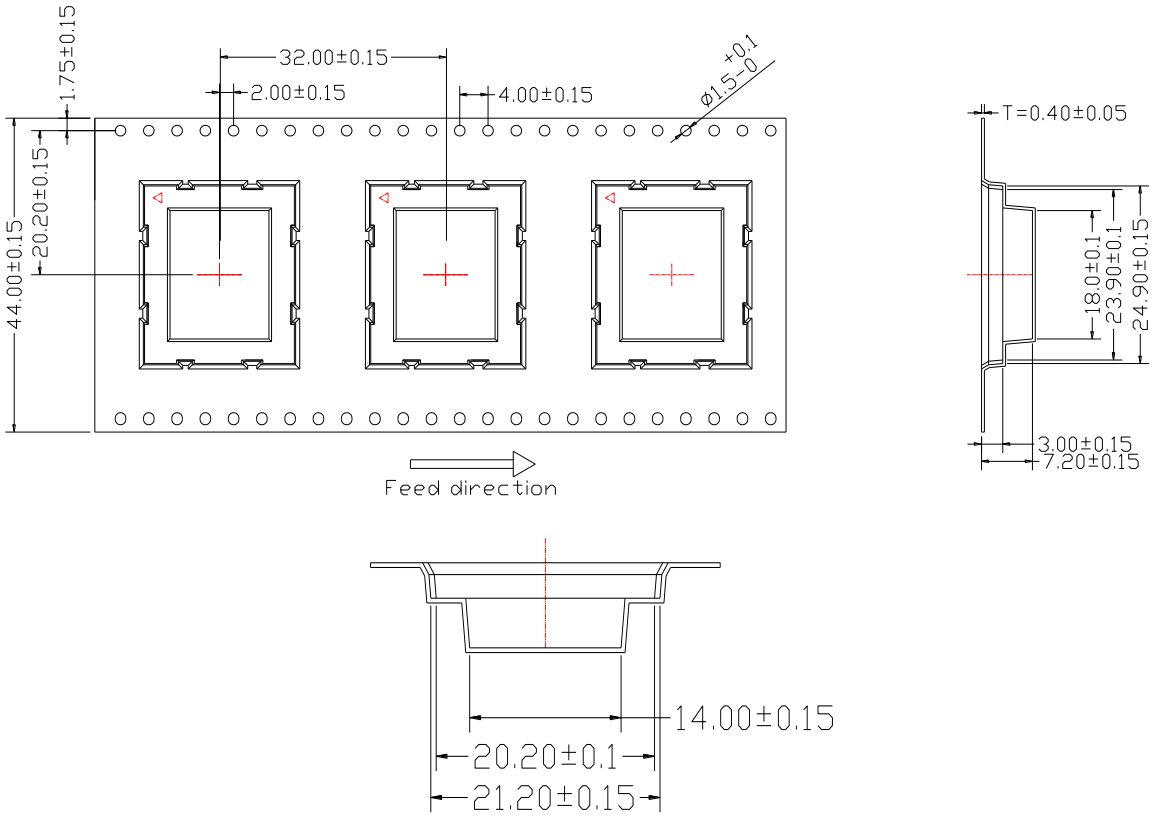


Figure 41: Tape Dimensions of UG95

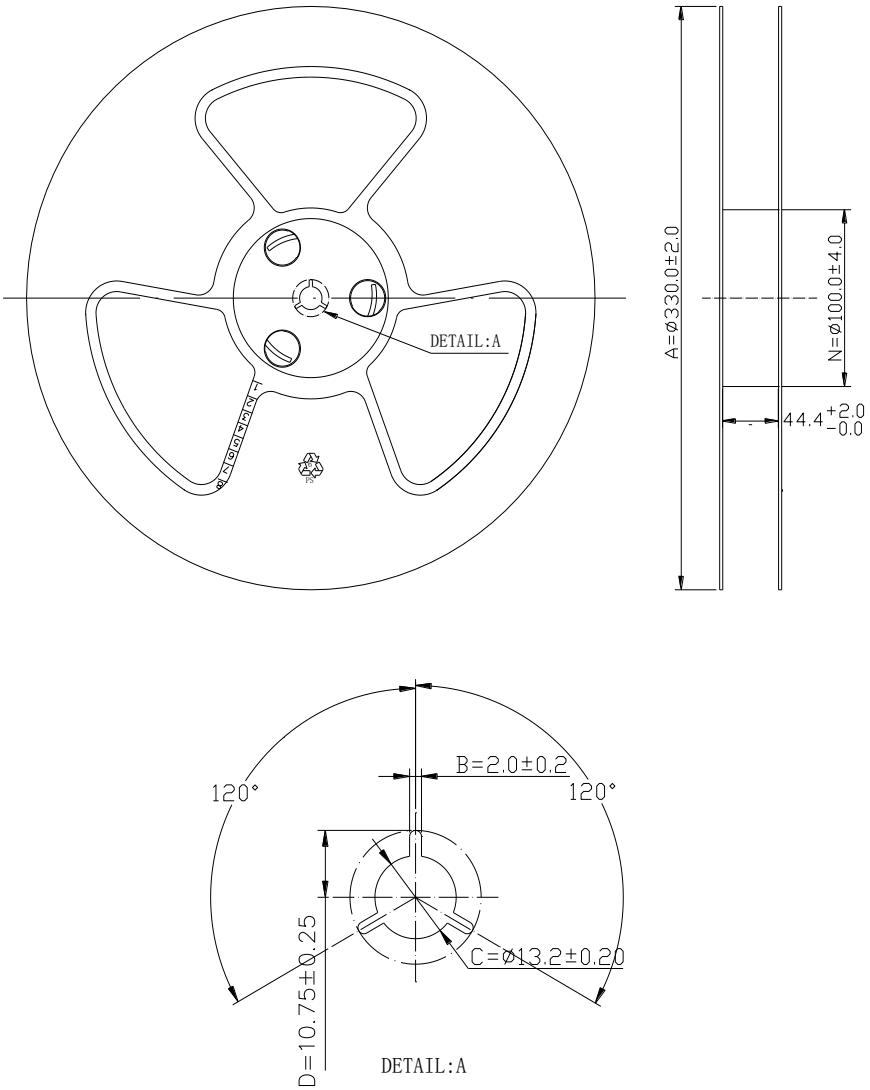


Figure 42: Reel Dimensions of UG95

6.2.5. UG96 Packaging

The reel is 330mm in diameter and each reel contains 250 modules.

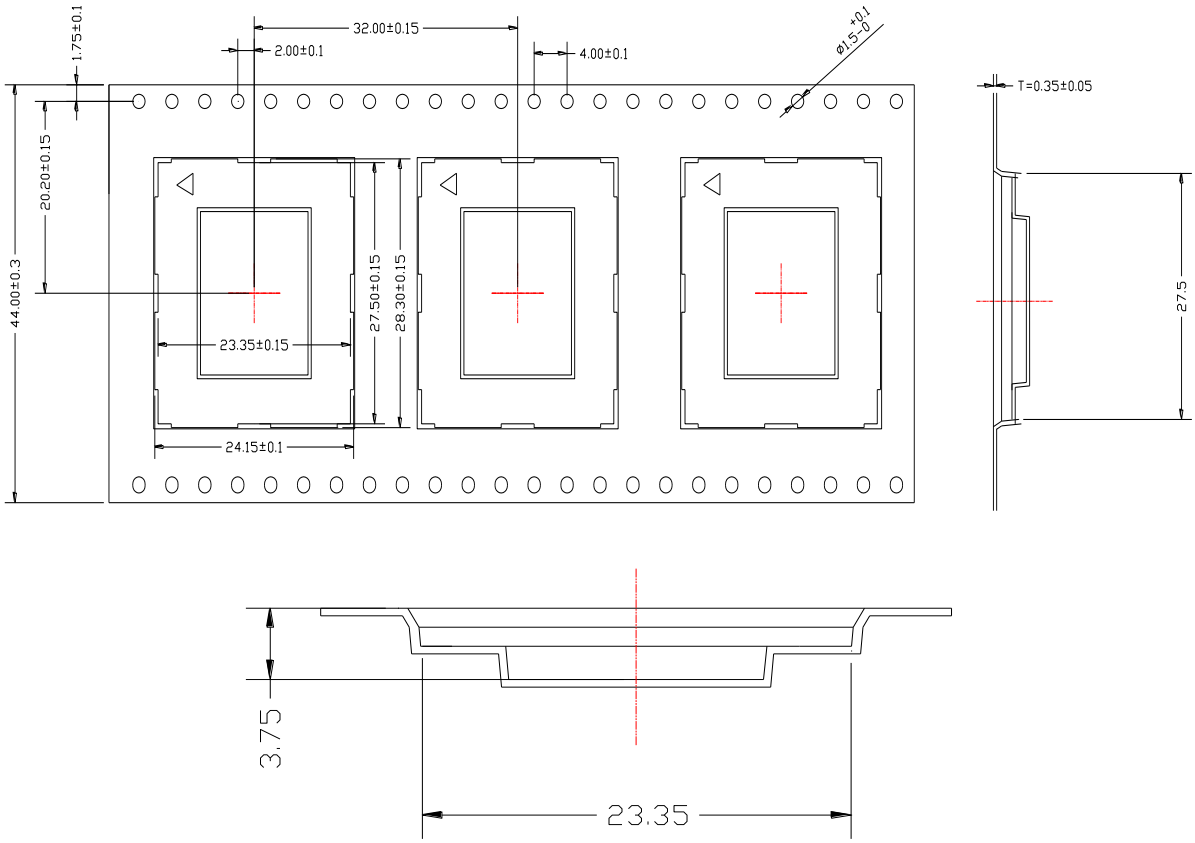


Figure 43: Tape Dimensions of UG96

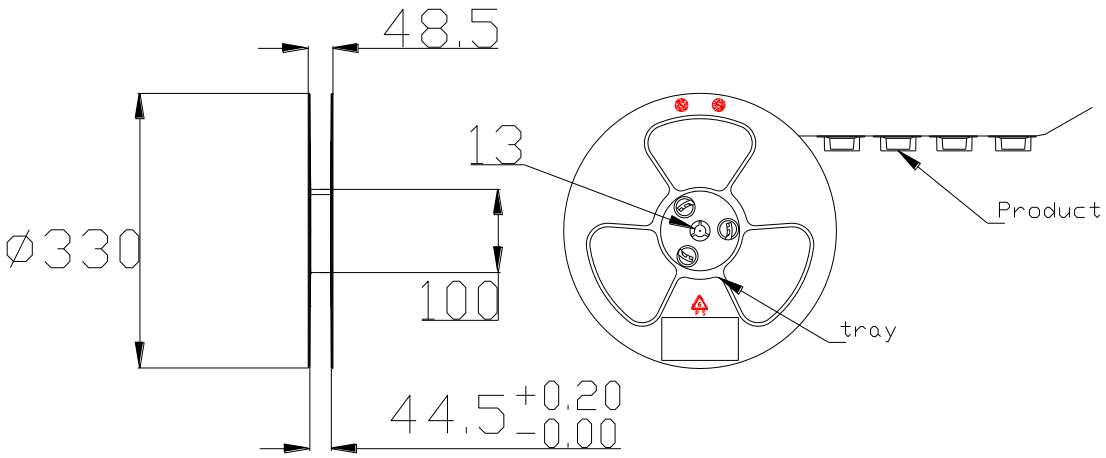


Figure 44: Reel Dimensions of UG96

6.2.6. M95 Packaging

The reel is 330mm in diameter and each reel contains 250 modules.

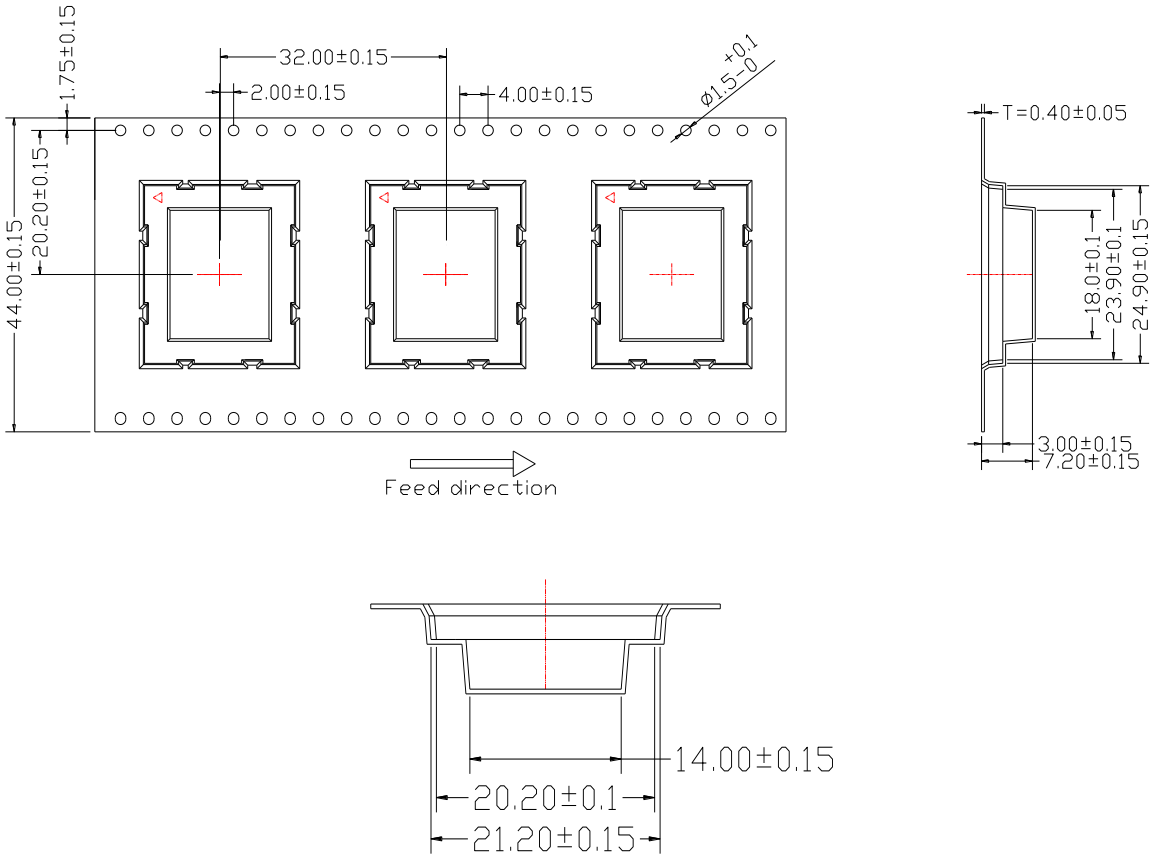
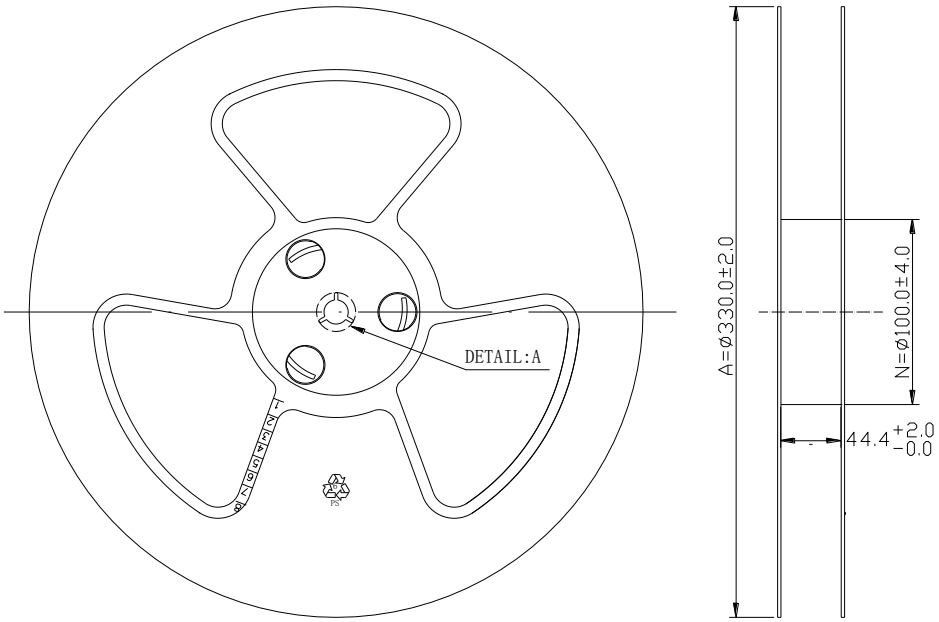


Figure 45: Tape Dimensions of M95



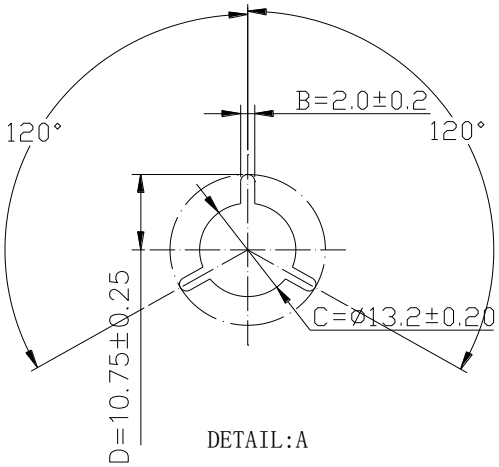


Figure 46: Reel Dimensions of M95

Table 8: Reel Packaging Specifications of BG96/BC95-G/EG9x/UG9x/M95

Model Name	MOQ for MP	Minimum Package: 250pcs	Minimum Package × 4=1000pcs
BG96	250pcs	Size: 370mm × 350mm × 56mm N.W: 1.0kg G.W: 1.71kg	Size: 380mm × 250mm × 365mm N.W: 4.0kg G.W: 7.16kg
BC95-G	250pcs	Size: 370mm × 350mm × 56mm N.W: 0.5kg G.W: 1.20kg	Size: 380mm × 250mm × 365mm N.W: 2.0kg G.W: 5.15kg
EG9x	250pcs	Size: 365mm × 354mm × 56mm N.W: 1.04kg G.W: 1.68kg	Size: 380mm × 250mm × 365mm N.W: 4.18kg G.W: 8.05kg
UG95	250pcs	Size: 370mm × 350mm × 56mm N.W: 0.61kg G.W: 1.35kg	Size: 380mm × 250mm × 365mm N.W: 2.45kg G.W: 6.28kg
UG96	250pcs	Size: 370mm × 350mm × 56mm N.W: 0.73kg G.W: 1.48kg	Size: 380mm × 250mm × 365mm N.W: 2.93kg G.W: 6.48kg
M95	250pcs	Size: 370mm × 350mm × 56mm N.W: 0.59kg G.W: 1.30kg	Size: 380mm × 250mm × 365mm N.W: 2.36kg G.W: 5.86kg

7 Appendix A References

Table 9: Related Documents

SN	Document Name	Remark
[1]	Quectel_BG96_Hardware_Design	BG96 Hardware Design
[2]	Quectel_BC95-G_Hardware_Design	BC95-G Hardware Design
[3]	Quectel_EG91_Hardware_Design	EG91 Hardware Design
[4]	Quectel_EG95_Hardware_Design	EG95 Hardware Design
[5]	Quectel_UG95_Hardware_Design	UG95 Hardware Design
[6]	Quectel_UG96_Hardware_Design	UG96 Hardware Design
[7]	Quectel_M95_Hardware_Design	M95 Hardware Design
[8]	Quectel_Module_Secondary_SMT_User_Guide	Module Secondary SMT User Guide
[9]	Quectel_WCDMA_UGxx_AT_Commands_Manual	AT Commands Manual for UG95 and UG96 Modules
[10]	Quectel_BC95-G_AT_Commands_Manual	BC95-G AT Commands Manual

Table 10: Terms and Abbreviations

Abbreviation	Description
DTE	Data Terminal Equipment
EDGE	Enhanced Data rates for GSM Evolution
EGPRS	Enhanced GPRS
ESD	Electrostatic Discharge
FDD	Frequency Division Duplex
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service

GSM	Global System for Mobile Communications
HSPA	High Speed Packet Access
LDO	Low Dropout Regulator
LED	Light Emitting Diode
LGA	Land Grid Array
LTE	Long Term Evolution
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
RF	Radio Frequency
SMS	Short Message Service
SWD	Serial Wire Debug
TDD	Time Division Duplexing
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
(U)SIM	(Universal) Subscriber Identity Module