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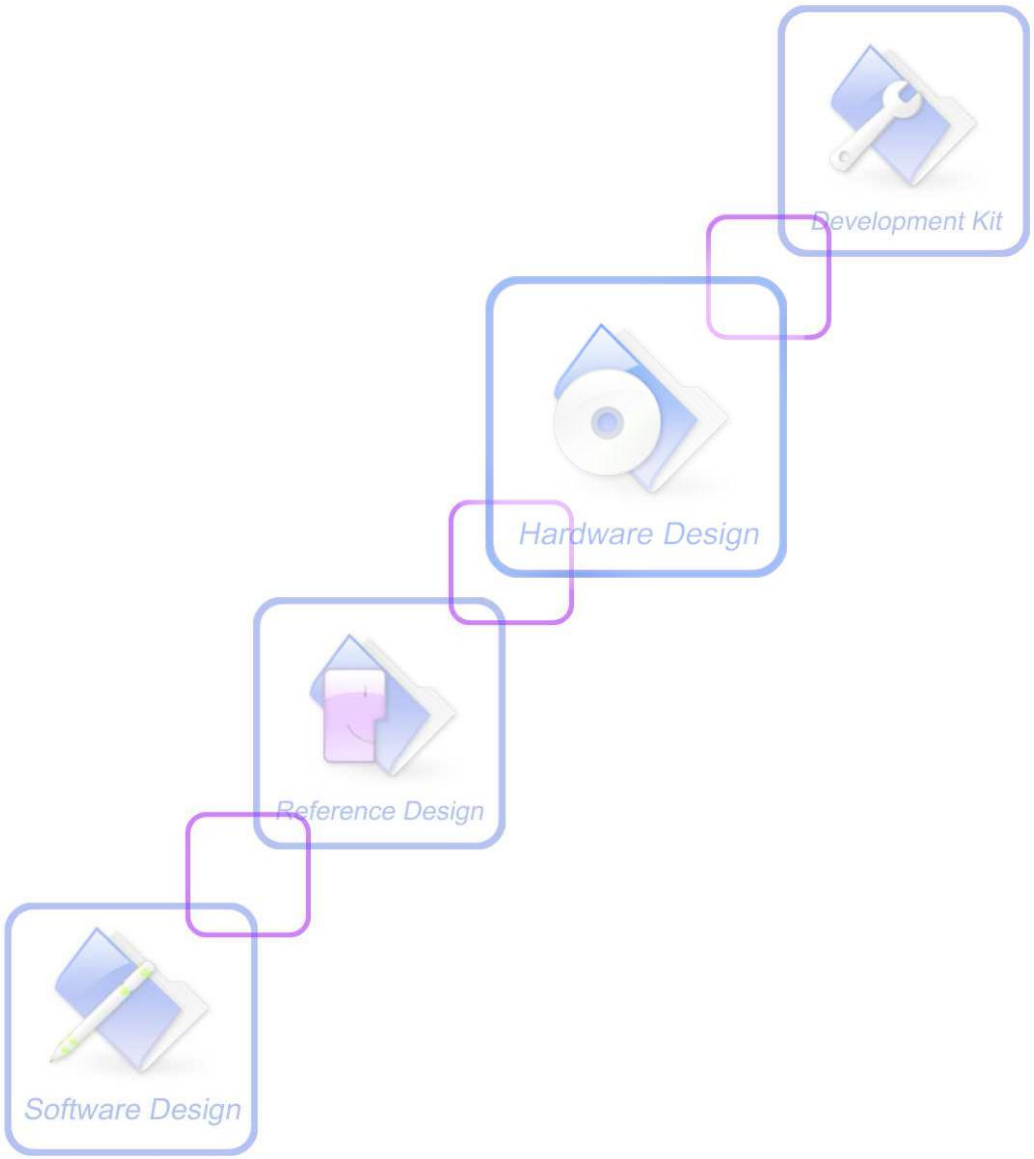
G3524_HD_EN_V1.01



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Revision history

Revision	Date	Description of change	Author
2013-07-02	1.00	Initial	Bao
2017-3-15	1.01		bao

1 Introduction

This document defines Module G3524 and describes its hardware interface which are connected with the customer application and the air interface.

This document can help customers quickly understand the interface specifications, electrical and mechanical details of G3524. Associated with application notes and user guide, customers can use G3524 to design and set up mobile applications quickly.

1.1 Related documents

Table 1：Related documents

SN	Document name	Remark
[1]	ITU-T Draft new recommendation V.25ter:	Serial asynchronous automatic dialing and control
[2]	GSM 07.07:	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[3]	GSM 07.10:	Support GSM 07.10 multiplexing protocol
[4]	GSM 07.05:	Digital cellular telecommunications (Phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[5]	GSM 11.14:	Digital cellular telecommunications system (Phase 2+); Specification of the SIM Application Toolkit for the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[6]	GSM 11.11:	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[7]	GSM 03.38:	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[8]	GSM 11.10	Digital cellular telecommunications system (Phase 2) ； Mobile Station (MS) conformance specification ； Part 1: Conformance specification
[9]	AN_Serial Port	AN_Serial Port

1.2 Terms and abbreviations

Table 2: Terms and abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate
ARP	Antenna Reference Point
ASIC	Application Specific Integrated Circuit
BER	Bit Error Rate
BTS	Base Transceiver Station
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DAC	Digital-to-Analog Converter
DRX	Discontinuous Reception
DSP	Digital Signal Processor
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
kbps	Kilo bits per second
LED	Light Emitting Diode
Li-Ion	Lithium-Ion
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated
PAP	Password Authentication Protocol

PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit
PPP	Point-to-point protocol
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
RX	Receive Direction
SIM	Subscriber Identification Module
SMS	Short Message Service
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
UART	Universal Asynchronous Receiver & Transmitter
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value
Inorm	Normal Current
Imax	Maximum Load Current
Phonebook abbreviations	
FD	SIM fix dialing phonebook
LD	SIM last dialing phonebook (list of numbers most recently dialed)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ON	SIM (or ME) own numbers (MSISDNs) list
RC	Mobile Equipment list of received calls
SM	SIM phonebook
NC	Not connect

1.3 Safety caution

The following safety precautions must be observed during all phases of the operation, such as usage, service or repair of any cellular terminal or mobile incorporating G3524 module. Manufacturers of the ellular terminal should send the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. If not so, KingcomTek does not take on any liability for customer failure to comply with these precautions.

	When in a hospital or other health care facility, observe the restrictions about the use of mobile. Switch the cellular terminal or mobile off. Medical equipment may be sensitive to not operate normally for RF energy interference.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Forget to think much of these instructions may lead to the flight safety or offend against local legal action, or both.
	Do not operate the cellular terminal or mobile in the presence of flammable gas or fume. Switch off the cellular terminal when you are near petrol station, fuel depot, chemical plant or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmosphere can constitute a safety hazard.
	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. RF interference can occur if it is used close to TV set, radio, computer or other electric equipment.
	Road safety comes first! Do not use a hand-held cellular terminal or mobile while driving a vehicle, unless it is securely mounted in a holder for hands-free operation. Before making a call with a hand-held terminal or mobile, park the vehicle.
	GSM cellular terminals or mobiles operate over radio frequency signal and cellular network and cannot be guaranteed to connect in all conditions, for example no mobile fee or an invalid SIM card. While you are in this condition and need emergent help, Please Remember using emergency call. In order to make or receive call, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency call if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may have to deactivate those features before you can make an emergency call. Also, some networks require that a valid SIM card be properly inserted in cellular terminal or mobile.

2 Product concept

G3524 is a Quad-band GSM/GPRS engine that works at frequencies of GSM850MHz, GSM900MHz,

DCS1800MHz and PCS1900MHz. The G3524 features GPRS multi-slot class 12 and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. For more details about GPRS multi-slot classes and coding schemes, please refer to Appendix A and Appendix B.

With a tiny profile of 19.9mm×23.6mm×2.65mm, the module can meet the requirements of almost all M2M applications, including Tracking and Tracing, Industrial PDA, Wireless POS, Intelligent Measurement, Remote Controlling, etc.

G3524 is an SMD type module with LCC package, which can be embedded in customer applications. It provides abundant hardware interfaces between the module and customer's host board.

The module is designed with power saving technique so that the current consumption is as low as 1.3 mA in SLEEP mode when DRX is 5.

G3524 is integrated with Internet service protocols, which are TCP/IP, UDP, FTP and PPP. Extended AT commands have been developed for customer to use these Internet service protocols easily.

2.1 Key features

Table 3: Module key features

Feature	Implementation
Power supply	Single supply voltage 3.3V ~ 4.2V Typical supply voltage 4V
Power saving	Typical power consumption in SLEEP mode: 1.2 mA @ DRX=5 1.1 mA @ DRX=9
Frequency bands	● Quad-band: GSM850, GSM900, DCS1800, PCS1900 ● The module can search these frequency bands automatically ● The frequency bands can be set by AT command ● Compliant with GSM Phase 2/2+
GSM class	Small MS
Transmitting power	● Class 4 (2W)：EGSM 900 / GSM850 ● Class 1 (1W)：DCS 1800 / PCS1900
GPRS connectivity	● GPRS multi-slot class 10 （default） ● GPRS multi-slot class 8 (configurable)
Temperature range	● Normal operation:-20°C ~ +80°C * ● Restricted operation:-30°C ~ -20°C and +80°C ~ +85°C ● Storage temperature:-35°C ~ +90°C

DATA GPRS: CSD:	● GPRS data downlink transfer: max. 85.6 kbps ● GPRS data uplink transfer: max. 85.6 kbps ● Coding schemes: CS-1, CS-2, CS-3 and CS-4 ● Support the protocols PAP (Password Authentication Protocol) usually used for PPP connections ● Internet service protocols TCP/IP ● Support Packet Switched Broadcast Control Channel (PBCCH) ● CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps non-transparent ● Unstructured Supplementary Services Data (USSD) support
SMS	● Text and PDU mode ● SMS storage: SIM card
SIM interface	Support SIM card: 1.8V, 3V
Audio features	Speech codec modes: ● Half Rate (ETS 06.20) ● Full Rate (ETS 06.10) ● Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) ● Adaptive multi rate (AMR) ● Noise Reduction ● Embedded one amplifier of class K with maximum driving power up to 2W
UART interface	UART Port: ● Seven lines on UART port interface ● Support autobauding from 4800 bps to 115200 bps ● Use for AT command, GPRS data and CSD data ● Multiplexing function Debug Port: ● Two lines on debug UART port interface： DBG_TXD and DBG_RXD ● Debug Port only used for software debugging
Phonebook management	Support phonebook types:SM, FD, LD, ON,.
SIM Application Toolkit	Support SAT class 3, GSM 11.14 Release 99
Real time clock	Implemented
Physical characteristics	Size:23.6mm x 19.9mm x 2.2 mm
Firmware upgrade	Firmware upgrade via UART Port
Antenna interface	Connected via 50 Ohm antenna pad

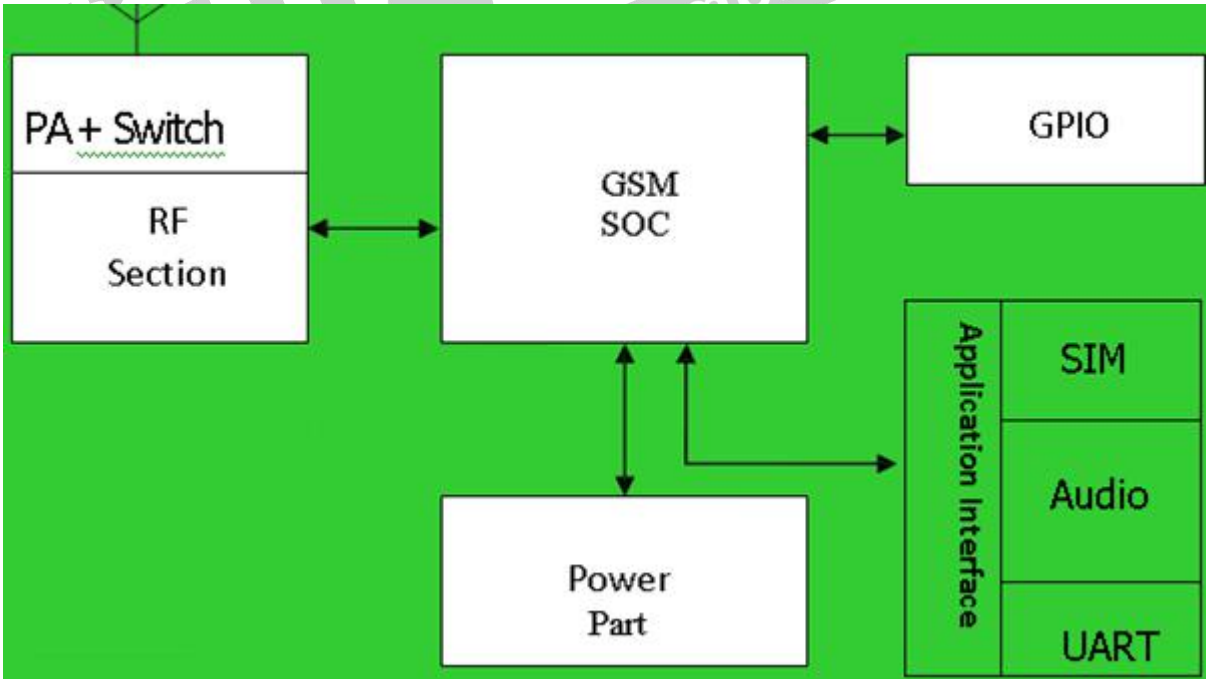
Table 4: Coding schemes and maximum net data rates over air interface

Coding scheme	1 Timeslot	2 Timeslot	4 Timeslot
CS-1:	9.05kbps	18.1kbps	36.2kbps
CS-2:	13.4kbps	26.8kbps	53.6kbps
CS-3:	15.6kbps	31.2kbps	62.4kbps
CS-4:	21.4kbps	42.8kbps	85.6kbps

2.2 Functional diagram

The following figure shows a block diagram of the G3524 module and illustrates the major functional parts:

- Power management
- Baseband
- The GSM radio frequency part
- The Peripheral interface
  - —SIM interface
  - —Audio interface
  - —UART interface
  - —Power supply
  - —RF interface
  - —Turn on/off interface
  - —RTC interface



3 Application interface

The module is equipped with 42 pin SMT pad and it adopts LCC package. Detailed descriptions on Sub-interfaces included in these pads are given in the following chapters:

Power supply
Turn on/off
Power saving
RTC
UART interfaces
Audio interfaces
SIM interface

3.1 Pin

3.1.1 Pin assignment

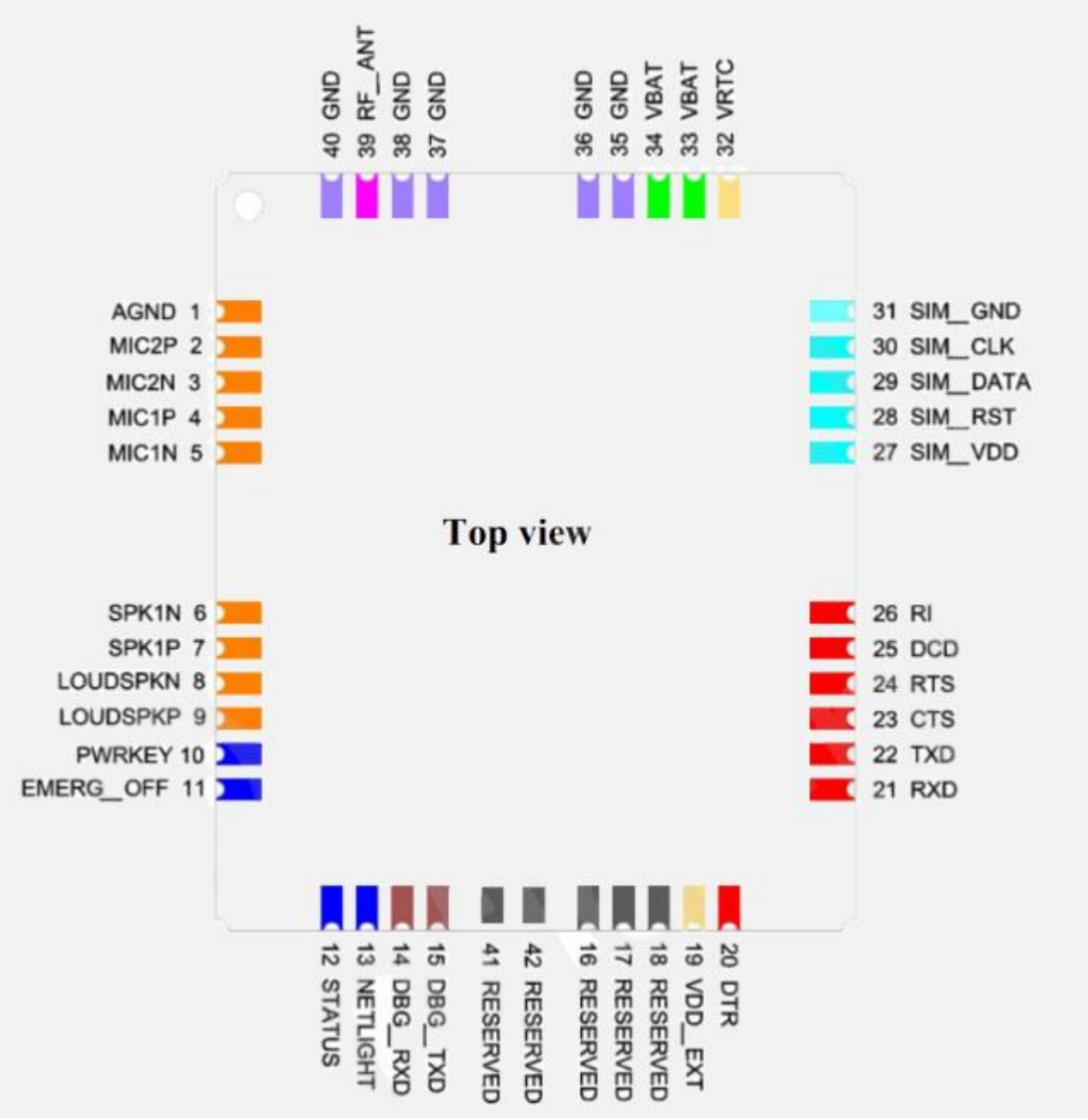


Table 5：G3524 pin assignment

PIN NO.	PIN NAME	PIN NO.	I/O
1	GND	21	TXD
2	MIC2P	22	RXD
3	MIC2N	23	CTS
4	MIC1P	24	RTS
5	MIC1N	25	DCD
6	SPK1N	26	RI
7	SPK1P	27	SIM_VDD

8	LOUDSPKN	28	SIM_RST
9	LOUDSPKP	29	SIM_DATA
10	PWRKEY	30	SIM_CLK
11	EMERG_OFF(RST)	31	GND
12	STSTUS	32	VRTC
13	NETLIGHT	33	VBAT
14	DBG_RXD	34	VBAT
15	DBG_TXD	35	GND
16	RESERVED	36	GND
17	RESERVED	37	GND
18	RESERVED	38	GND
19	VDD_EXT	39	ANT
20	DTR	40	GND

3.1.2 Pin description

Table 6: Pin description

Power supply					
PIN NAME	**Pin No.**	**I/O**	**DESCRIPTION**	**DC CHARACTERISTICS**	**COMMENT**
VBAT	33,34	I	Main power supply of module: VBAT=3.3V~4.2V	Vmax= 4.2V Vmin=3.3V Vnorm=4.0V	Make sure that supply sufficient current in a transmitting burst which typically rises
VRTC	32	I/O	Power supply for RTC when VBAT is not supplied for the system. Charge for backup battery or golden capacitor when the VBAT is supplied.	VImax=3.3V VImin=1.5V VInorm=2.8V VOmax=2.85V VOmin=2.6V VOnorm=2.8V Iout(max)= 1mA Iin=2.6~5 uA	If unused, keep this pin open.
VDD_EXT	19	O	Supply 2.8V voltage for external circuit.	Vmax=2.9V Vmin=2.7V Vnorm=2.8V Imax=20mA	1. If unused, keep this pin open. 2. Recommended to add a
GND	1,31,35,36, 37,38,40		Ground		
Turn on/off					
PWRKEY	10	I	Power on/off key. PWRKEY should be pulled down for a moment to turn on or turn off the system.	VILmax=0.1×VBAT VIHmin=0.6×VBAT VImax=VBAT	Pulled up to VBAT internally.
Emergency shutdown					

EMERG OFF	11	I	Emergency off. Pulled down for at least 20ms, which will turn off the module in case of emergency. Use it only when normal shutdown through PWRKEY or AT command cannot perform well.	VILmax=0.4V VIHmin=2.2V V_{open}max=2.8V	Open drain/collector driver required in cellular device application. If unused, keep this pin open.
Module indicator					
STATUS	12	O	Indicate module's operating status. High level indicates module is power-on and low level indicates power-down.	VOHmin=0.85×VBAT VOLmax=0.15×VBAT	If unused, keep this pin open.
Audio interface					
MIC1P	4	I	Channel 1 positive and negative voice-band input		If unused, keep these pins open.
MIC1N	5				
SPK1P	7	O	Channel 1 positive and negative voice-band output		If unused, keep these pins open.
SPK1N	6				
MIC2P	2	I	Channel 2 positive and negative voice-band input		If unused, keep these pins open.
MIC2N	3				
LOUDSPKN	8	O	Channel 1 positive and negative voice-band output		If unused, keep these pins open.
LOUDSPKP	9				
Net status indicator					
NETLIGHT	13	O	Network status indication	VOHmin=0.85×VBAT VOLmax=0.15×VBAT	If unused, keep this pin open.
Main UART port					
DTR	20	I	Data terminal ready	VILmin=-0.3V VILmax=0.25×VDD_EXT VIHmin=0.75×VDD_EXT VIHmax=VDD_EXT+0.3V VOHmin=0.85×VDD_EXT VOLmax=0.15×VDD_EXT	If only use TXD, RXD and GND to communicate, recommended keeping other pins open, except RTS. Pull down RTS.
RXD	21	I	Receive data		
TXD	22	O	Transmit data		
CTS	23	O	Clear to send		
RTS	24	I	Request to send		
DCD	25	O	Data carrier detection		
RI	26	O	Ring indicator		
Module indicator					
DBG_RXD	14	I	UART interface for debugging only.	VILmin=-0.3V VILmax=0.25×VDD_EXT VIHmin=0.75×VDD_EXT VIHmax=	If unused, keep this pin open. If unused, keep this pin open.

DBG_TXD	15	O			
SIM interface					
SIM_VDD	27	O	Power supply for card SIM	The voltage can be selected by software automatically. Either1.8V or 3V	1. All signals of SIM interface should be protected against ESD with a TVS diode array. 2. Maximum trace length is 200mm from the module pad to SIM card holder.
SIM_RST	28	O	SIM reset	3V： VOLmax=0.36V VOHmin=0.9×SIM_VDD 1.8V: VOLmax=0.2×SIM_VDD VOHmin=0.9×SIM_VDD	
SIM_DATA	29	I/O	SIM data	3V： VOLmax=0.4V VOHmin=SIM_VDD-0.4V 1.8V: VOLmax=0.15×SIM_VDD VOHmin= SIM_VDD-0.4V	
SIM_CLK	30	O	SIM clock	3V： VOLmax=0.4V VOHmin=0.9×SIM_VDD 1.8V: VOLmax=0.12×SIM_VDD VOHmin= 0.9×SIM_VDD	
RF interface					
RF_ANT	39	I/O	RF antenna pad	Impedance of 50Ω	

3.2 Power supply

3.2.1 Power features of module

The power supply is one of the key issues in the designing GSM terminals. Due to the 577us radio burst emission in GSM every 4.615ms, power supply must be able to deliver high current peaks in a burst period. During these peaks, drops on the supply voltage must not exceed minimum working voltage of module.
For the G3524 module, the max current consumption could reach to 2A during a transmit burst. It will cause a large voltage drop on the VBAT. In order to ensure stable operation of the module, it is recommended that the max voltage drop during the transmit burst does not exceed 400mV.

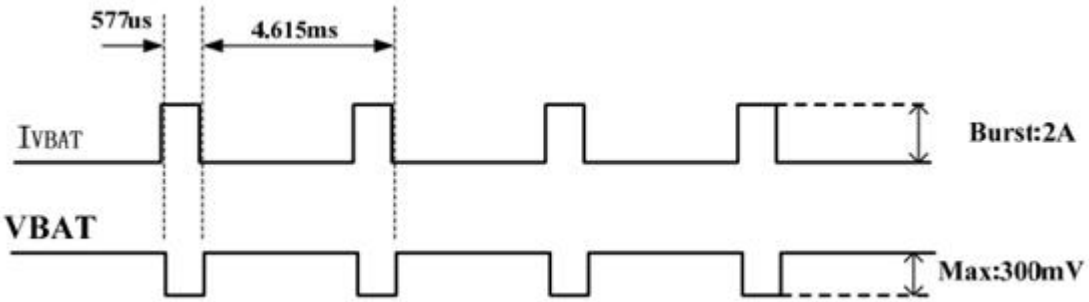


Figure 1：Voltage ripple during transmitting

3.2.2 Decrease supply voltage drop

The power supply rang of the module is 3.3V to 4.2V. Make sure that the input voltage will never drop below 3.3V even in a transmitting burst. If the power voltage drops below 3.3V, the module could turn off automatically. For better power performance, it is recommended to place a 100uF tantalum capacitor with low ESR (ESR=0.7Ω) and ceramic capacitors 100nF, 33pF and 10 pF near the VBAT pin. The reference circuit is illustrated in Figure 4.
The VBAT route should be wide enough to ensure that there is not too much voltage drop occurring during transmit burst. The width of trace should be no less than 2mm and the principle of the VBAT route is the longer route, the wider trace.

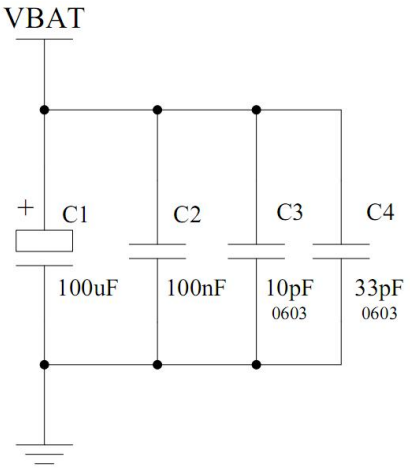


Figure 2：Reference circuit for the VBAT input

3.2.3 Reference design for power supply

The power design for the module is very important, since the performance of power supply for the module largely depends on the power source. The power supply is capable of providing the sufficient current up to 2A at least. If the voltage drop between the input and output is not too high, it is suggested to use a LDO as module's power supply. If there is a big voltage difference between the input source and the desired output (VBAT), a switcher power converter is prefer to use as a power supply.

The following figure shows a reference design for +5V input power source. The designed output for the power supply is 4.16V and the maximum load current is 3A. In addition, in order to get a stable output voltage, a zener diode is placed close to the pins of VBAT. As to the zener diode, it is suggested to use a zener diode which reverse zener voltage is 5.1V and dissipation power is more than 1 Watt.

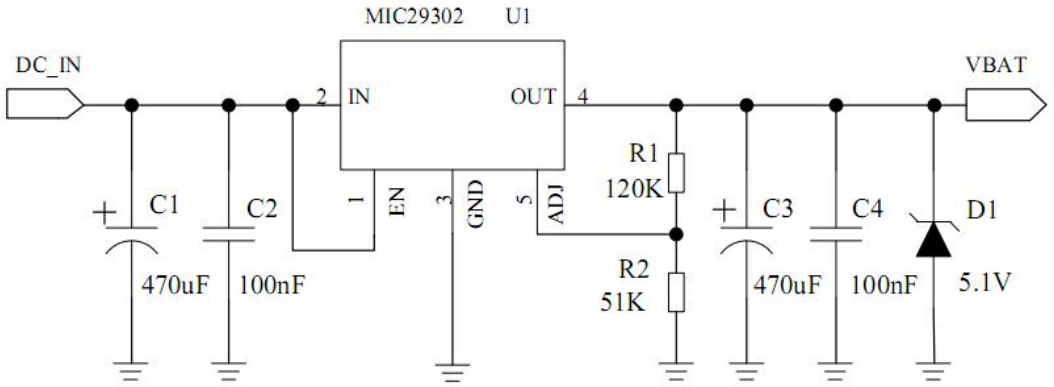


Figure 3：Reference circuit for power supply

3.2.4 Monitor power supply

To monitor the supply voltage, the "AT+CBC" command can be used which includes three parameters: charging status, remaining battery capacity and voltage value (in mV). It returns the 0-100 percent of battery capacity and actual value measured between VBAT and GND. The voltage is automatically measured in period of 5s. The displayed voltage (in mV) is averaged over the last measuring period before the "AT+CBC" command is executed.

3.3 Power on and down scenarios

3.3.1 Power on the module using the PWRKEY pin

The module can be turned on through the PWRKEY pin. Customer can turn on the module by driving the pin PWRKEY to a low level voltage and after STATUS pin outputs a high level, PWRKEY pin can be released. Customer can monitor the level of the STATUS pin to judge whether the module is power-on or not.

An open collector driver circuit is suggested to control the PWRKEY. A simple reference circuit is illustrated in

Figure 6.

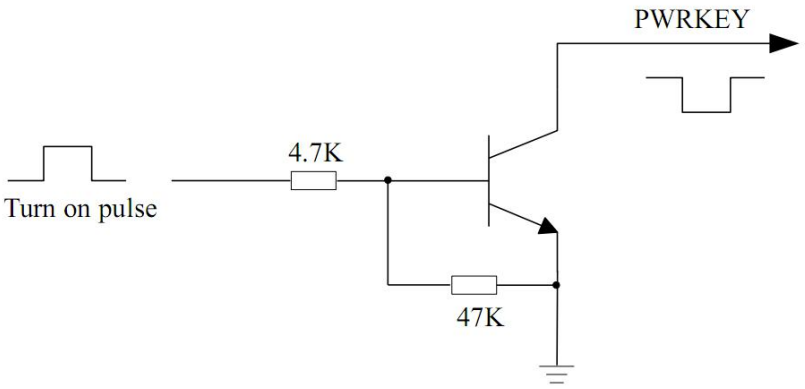


Figure 4： Turn on the module using driving circuit

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. When pressing the key, electrostatic strike may generate from finger. A reference circuit is showed in Figure 7.

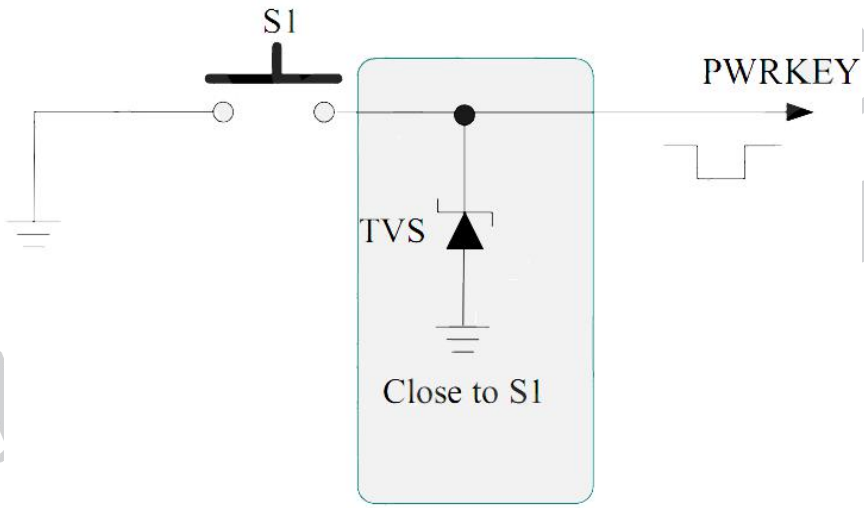


Figure 5： Turn on the module using keystroke

The power-on scenarios is illustrated as the following figure.

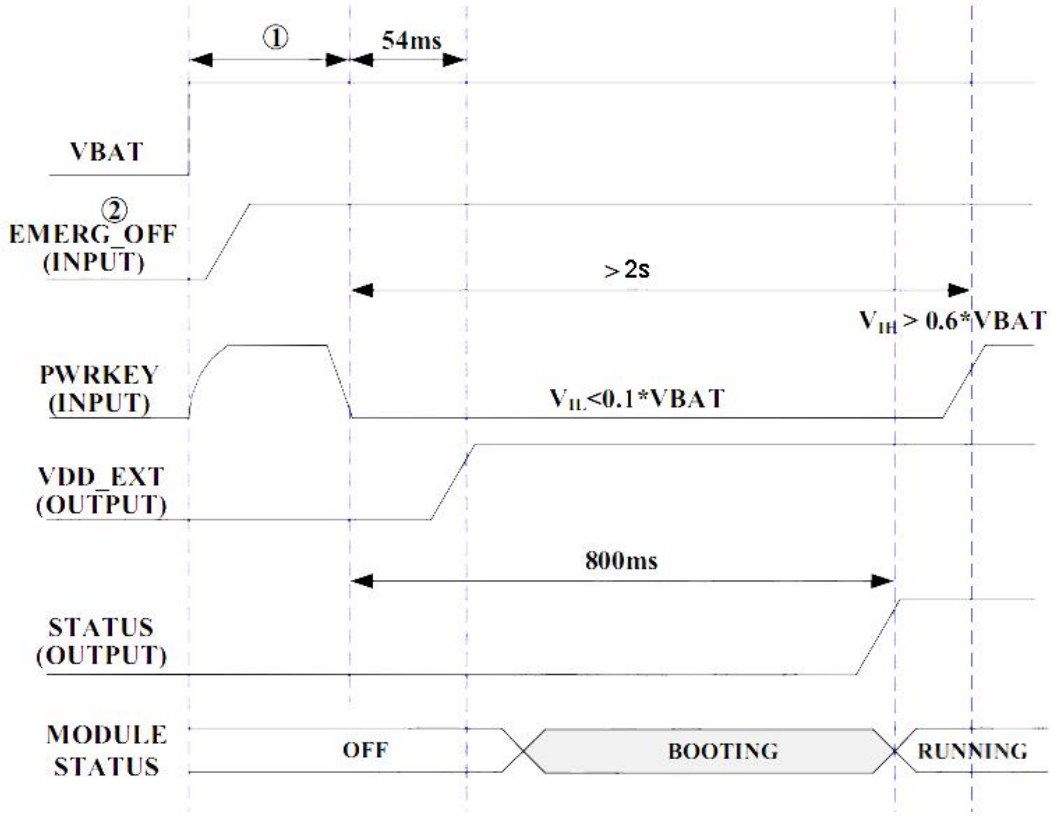


Figure 6：Turn on the module using keystroke

① Make sure that VBAT is stable before pulling down PWRKEY pin. The time between them is recommended 30ms.

② Keep the EMERG_OFF pin open if not used.

Note: Customer can monitor the voltage level of the STATUS pin to judge whether the module is power-on. After the STATUS pin goes to high level, PWRKEY can be released. If the STATUS pin is ignored, pull the PWRKEY pin to low level for more than 2 seconds to turn on the module.

3.3.2 Power down

3.3.2.1. Power down module using the PWRKEY pin

Customer's application can turn off the module by driving the PWRKEY to a low level voltage for certain time. The power-down scenarios is illustrated in Figure 7.

The power-down procedure causes the module to log off from the network and allows the software to save important data before completely disconnecting the power supply, thus it is a safe way.

After that moment, no further AT commands can be executed. Then the module enters the POWER DOWN mode, only the RTC is still active. The POWER DOWN mode can also be indicated by the STATUS pin, which is a low level voltage in this mode.

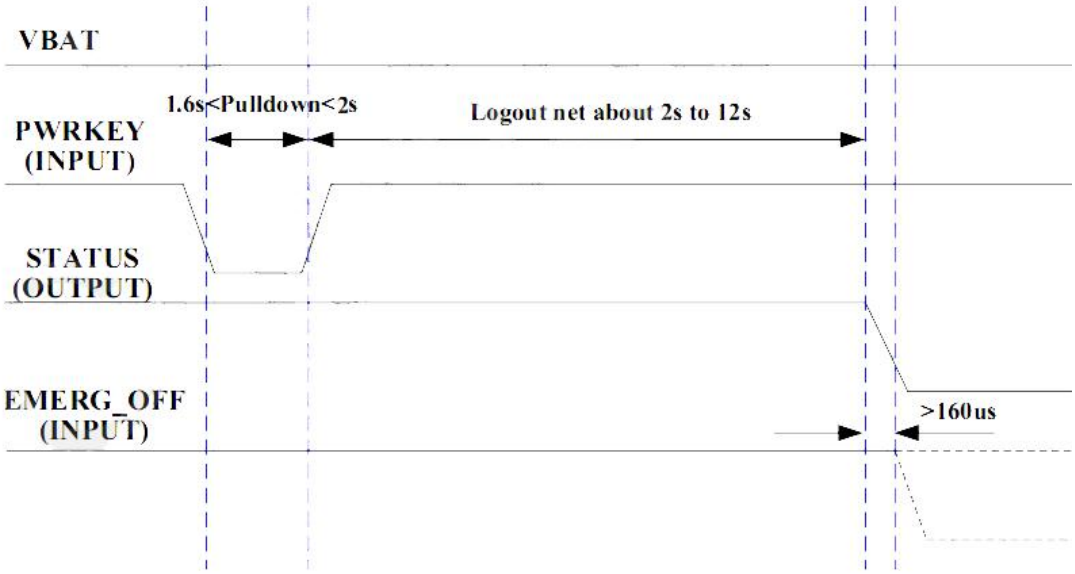


Figure 7： Timing of turning off the module

3.3.2.2 Emergency shutdown using EMERG_OFF pin

The module can be shut down by driving the pin EMERG_OFF to a low level voltage over 20ms and then releasing it. The EMERG_OFF line can be driven by an Open Drain / Collector driver or a button. The circuit is illustrated as the following figures.

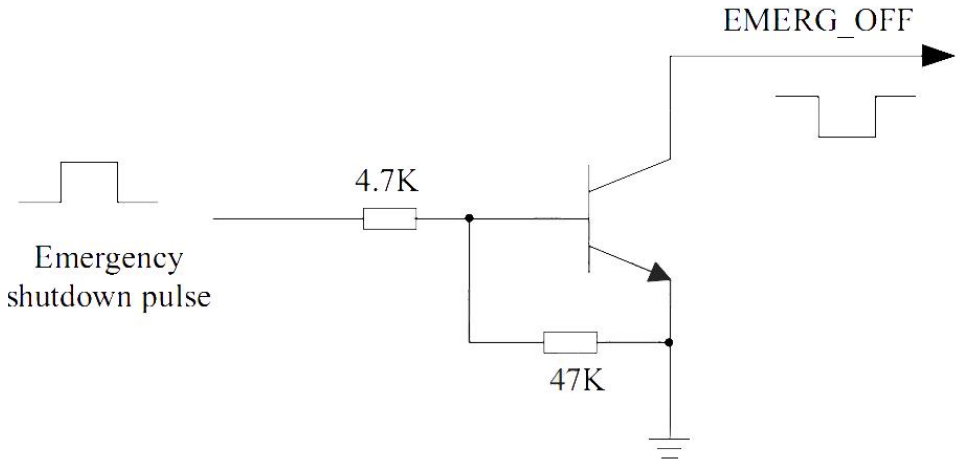


Figure 8： Reference circuit for EMERG_OFF by using driving circuit

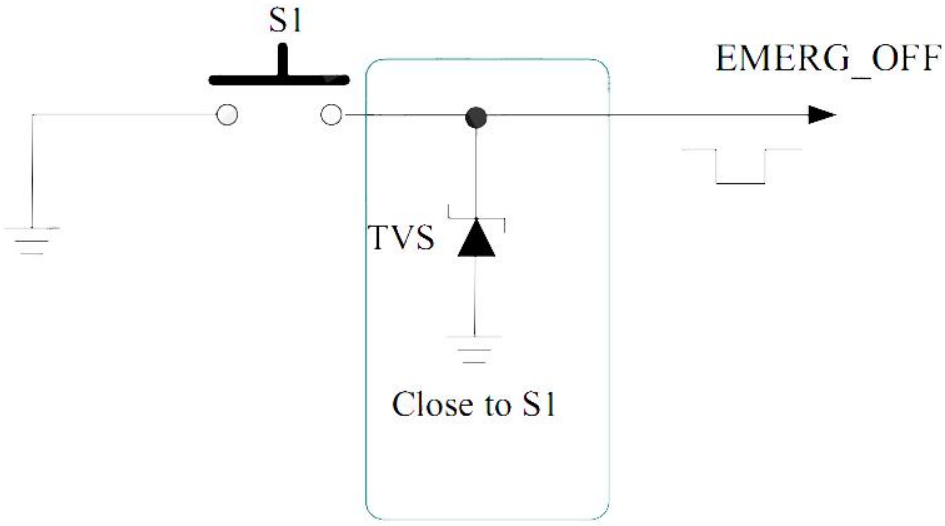


Figure 9：Reference circuit for EMERG_OFF by using button

Be cautious to use the pin EMERG_OFF. It should only be used under emergent situation. For instance, if the module is unresponsive or abnormal, the pin EMERG_OFF could be used to shut down the system. Although turning off the module by EMERG_OFF is fully tested and nothing wrong detected, this operation is still a big risk as it could cause destroying of the code or data area of the flash memory in the module. Therefore, it is recommended that PWRKEY or AT command should always be the preferential way to turn off the system.

3.4 Restart

Customer's application can restart the module by driving the PWRKEY to a low level voltage for certain time, which is similar to the way of turning on module. Before restarting the module, at least 500ms should be delayed after detecting the low level of STATUS. The restart timing is illustrated as the following figure.

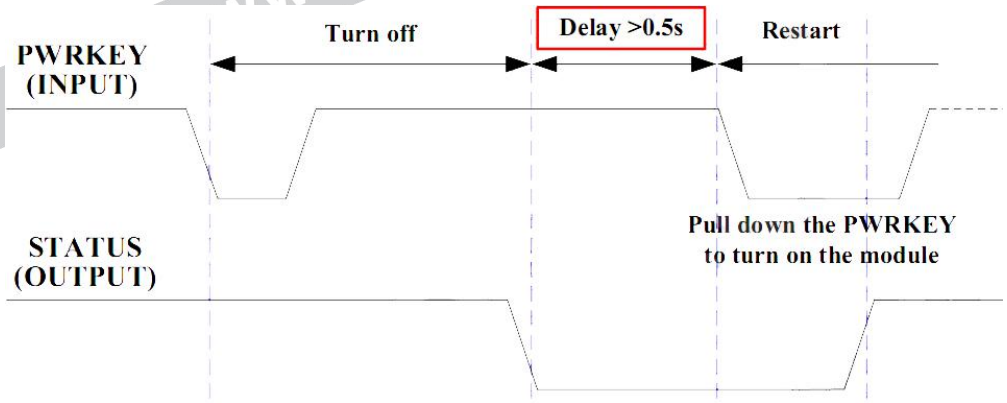


Figure 10：Timing of restarting system

The module can also be restarted by the PWRKEY after emergency shutdown.

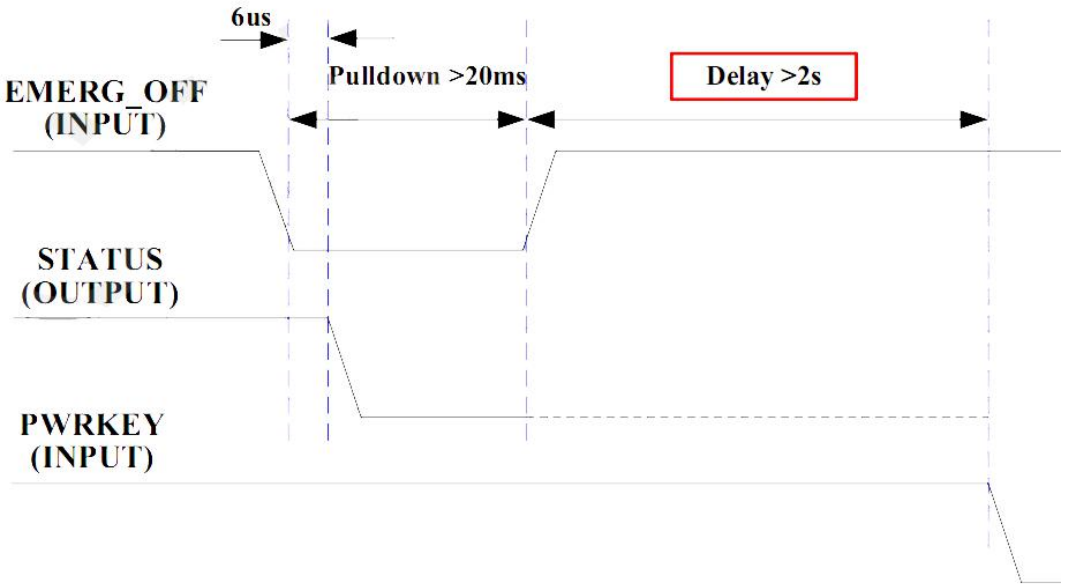


Figure 11： Timing of restarting system after emergency shutdown

3.5 Power saving

Upon system requirement, there are several actions to drive the module to enter low current consumption status. For example, DTR hardware interface signal can be used to lead system to SLEEP mode.

3.5.1 Sleep mode

Customer's application can control the module to enter or exit from the SLEEP mode through pin DTR. When DTR is set to high level, and there is no on-air or hardware interrupt such as GPIO interrupt or data on UART port, the module will enter SLEEP mode automatically. In this mode, the module can still receive voice, SMS or GPRS paging from network but the UART port is not accessible.

3.5.2 Wake up the module from SLEEP mode

When the module is in the SLEEP mode, the following methods can wake up the module.

If the DTR Pin is set low, it would wake up the module from the SLEEP mode. The UART port will be active within 20ms after DTR is changed to low level.
Receiving a voice or data call from network wakes up module.
Receiving an SMS from network wakes up the module.

Note: DTR pin should be held low level during communication between the module and DTE.

3.6 Summary of state transitions

Table 7: Summary of state transition

Current mode	Next mode		
	Power down	Normal mode	Sleep mode
Power down		Use PWRKEY	
Normal mode	use PWRKEY pin, or use EMERG_OFF pin		pull DTR up
Sleep mode	Use PWRKEY pin, or use EMERG_OFF pin	Pull DTR down or incoming call or SMS or GPRS	

3.7 RTC backup

The RTC (Real Time Clock) can be supplied by an external capacitor or battery (rechargeable or non-chargeable) through the pin VRTC. A 1.5 K resistor has been integrated in the module for current limiting. A coin-cell battery or a super-cap can be used to backup power supply for RTC.
The following figures show various sample circuits for RTC backup.

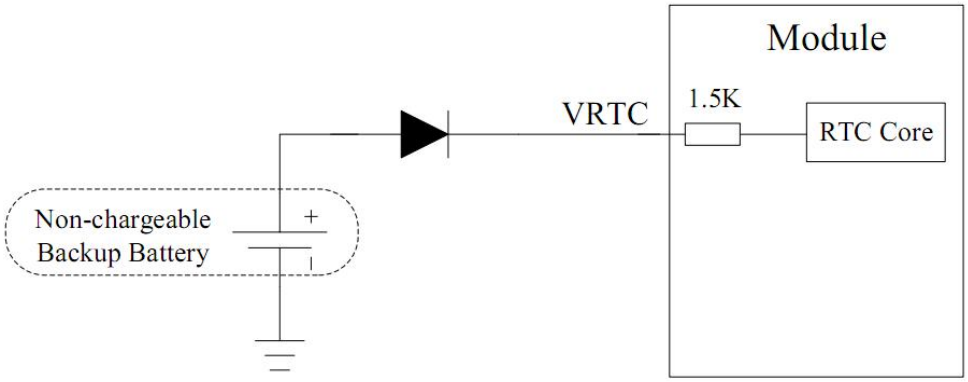


Figure 12：RTC supply from non-chargeable battery

Figure 13：RTC supply from rechargeable battery

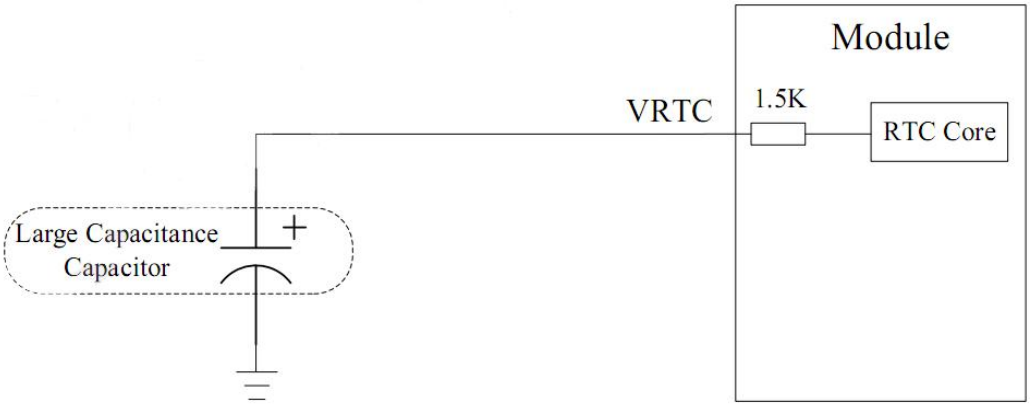


Figure 14：RTC supply from capacitor

Coin-type rechargeable capacitor such as XH414H-IV01E from Seiko can be used.

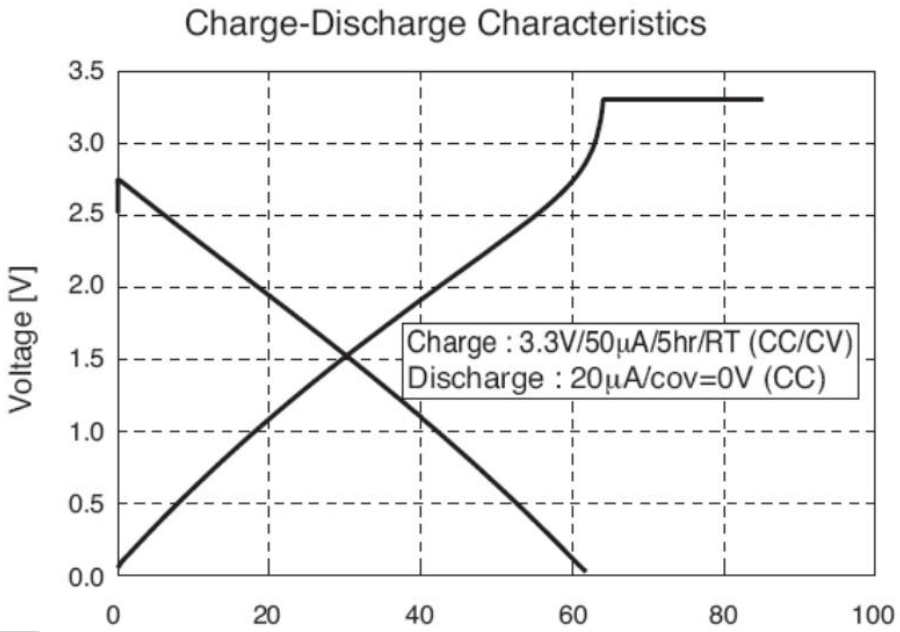


Figure 15：Seiko XH414H-IV01E Charge Characteristics

3.8 Serial interfaces

The module provides two serial ports: UART and Debug Port. The module is designed as a DCE(Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. Autobauding function supports baud rate from 4800bps to 115200bps.

The UART Port:
TXD: Send data to RXD of DTE
RXD: Receive data from TXD of DTE
RTS: Requests to send
CTS: Clear to send

DTR: DTE is ready and inform DCE (this pin can wake the module up)

RI: Ring indicator (when the call, SMS, data of the module are coming, the module will output signal to inform DTE)

DCD: Data carrier detection (the valid of this pin demonstrates the communication link is set up)

The Debug Port

DBG_TXD: Send data to the COM port of a debugging computer

DBG_RXD: Receive data from the COM port of a debugging computer

The logic levels are described in the following table.

Table 8: Logic levels of the UART interface

Parameter	Min	Max	Unit
V_{IL}	0	0.25×VDD_EXT	V
V_{IH}	0.75×VDD_EXT	VDD_EXT+0.3	V
V_{OL}	0	0.15×VDD_EXT	V
V_{OH}	0.85×VDD_EXT	VDD_EXT	V

Table 9: Logic levels of the UART interface

Parameter	Min	Max	
Debug Port	DBG_RXD	14	Receive data of the debug port
	DBG_TXD	15	Transmit data of the debug port
UART Port	DTR	20	Data terminal ready
	RXD	21	Receive data of the UART port
	TXD	22	Transmit data of the UART port
	CTS	23	Clear to send
	RTS	24	Request to send
	DCD	25	Data carrier detection
	RI	26	Ring indicator

3.8.1 UART Port

3.8.1.1 The features of UART Port.

Seven lines on UART interface

Contain data lines TXD and RXD, hardware flow control lines RTS and CTS, other control lines DTR, DCD and RI

Used for AT command, GPRS data, etc. Multiplexing function is supported on the UART Port. So far only the basic mode of multiplexing is available.

Support the communication baud rates as the following:
4800,9600,14400,19200,28800,38400,57600,115200.

The default setting is autobauding mode. Support the following baud rates for autobauding function: 4800, 9600,

19200, 38400, 57600, 115200.

Autobauding allows the module to detect the baud rate by receiving the string “AT” or “at” from the host or PC automatically, which gives module flexibility without considering which baud rate is used by the host controller. Autobauding is enabled by default. To take advantage of the autobauding mode, special attention should be paid according to the following requirements:

3.8.1.2. The connection of UART

The connection between module and host via UART port is very flexible. Three connection styles are illustrated as below.

UART Port connection is shown as below when it is applied in modulation-demodulation.

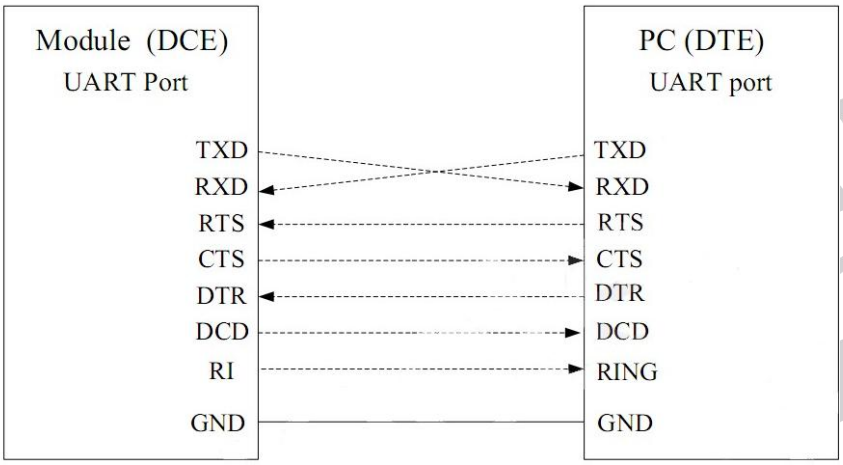


Figure 16：Connection of all functional UART port

Three lines connection is shown as below.

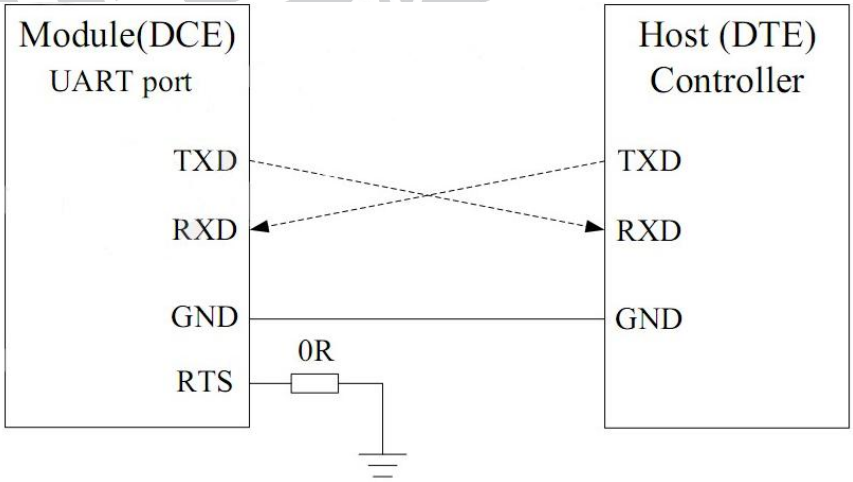


Figure 17：Connection of three lines UART port

UART Port with hardware flow control is shown as below. This connection will enhance the reliability of the mass data communication.

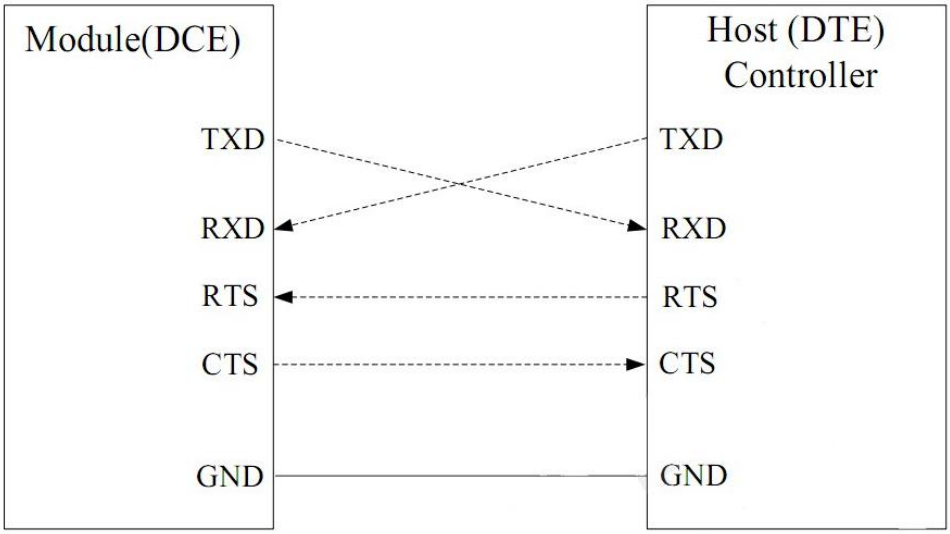


Figure 18： Connection of UART port associated hardware flow control

3.8.1.3. Firmware upgrade

The TXD, RXD can be used to upgrade software. The PWRKEY pin must be pulled down before the firmware upgrades. Please refer to the following figures for firmware upgrade.

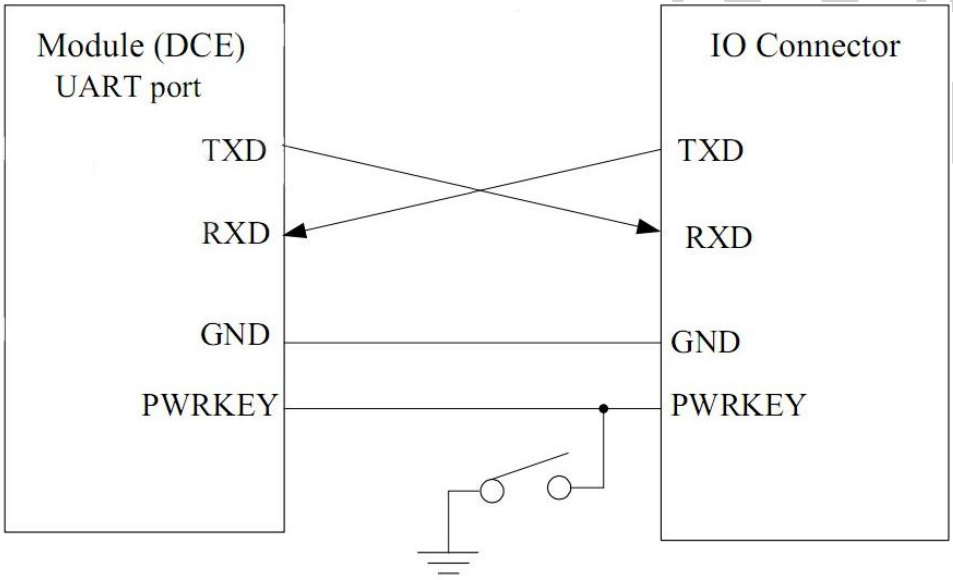


Figure 19： Connection of firmware upgrade

3.8.2 UART Port

Two lines: DBG_TXD and DBG_RXD

It outputs log information automatically.

Debug Port is only used for software debugging and its baud rate must be configured as 460800bps.

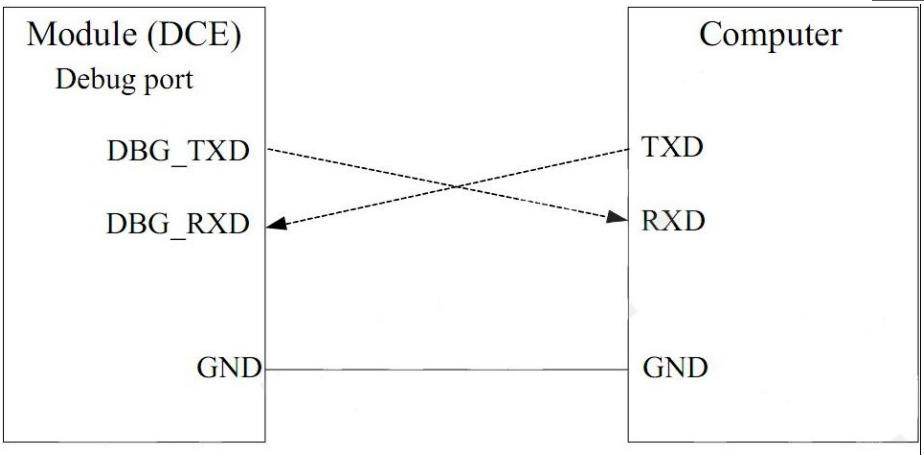


Figure 20：Connection of software debug

3.8.3 UART Application

The reference design of 3.3V level match is shown as below. When the peripheral MCU/ARM system is 3V, the divider resistor should be changed from 5.6K to 10K.

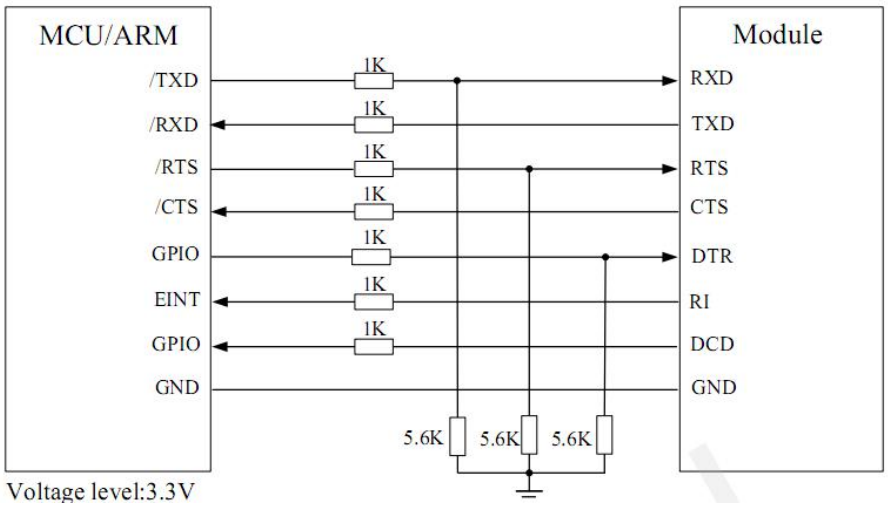


Figure 21：3.3V level match circuit

The reference design of 5V level match is shown as below. The construction of dotted line can refer to the construction of solid line. Please pay attention to direction of connection. Input dotted line of module should refer to input solid line of the module. Output dotted line of module should refer to output solid line of the module.

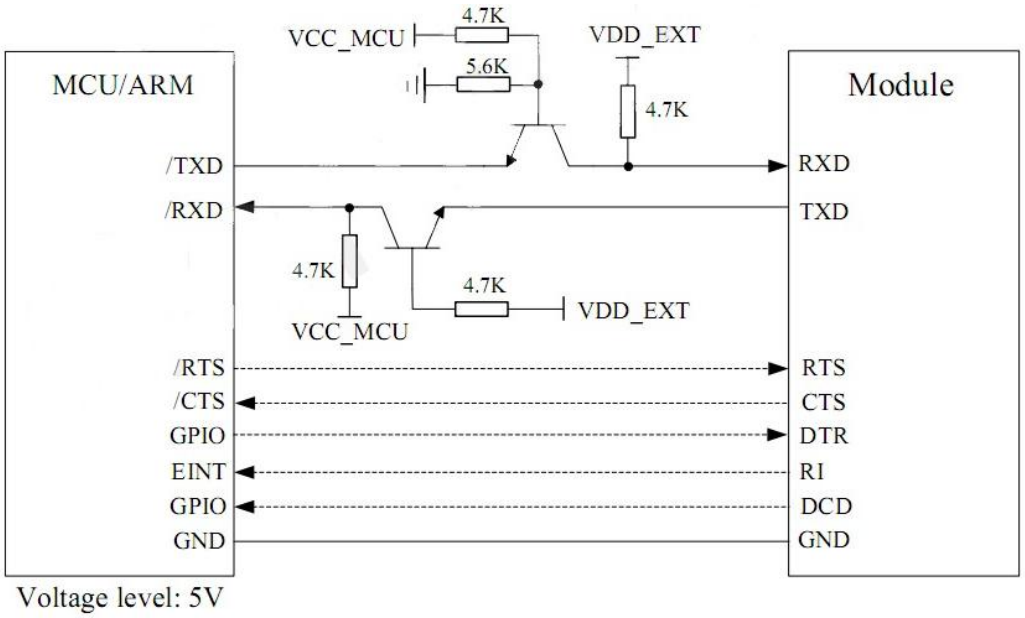


Figure 22：5V level match circuit

The following picture is an example of connection between module and PC. A RS_232 level shifter IC or circuit must be inserted between module and PC, since UART ports do not support the RS_232 level, while support the CMOS level only.

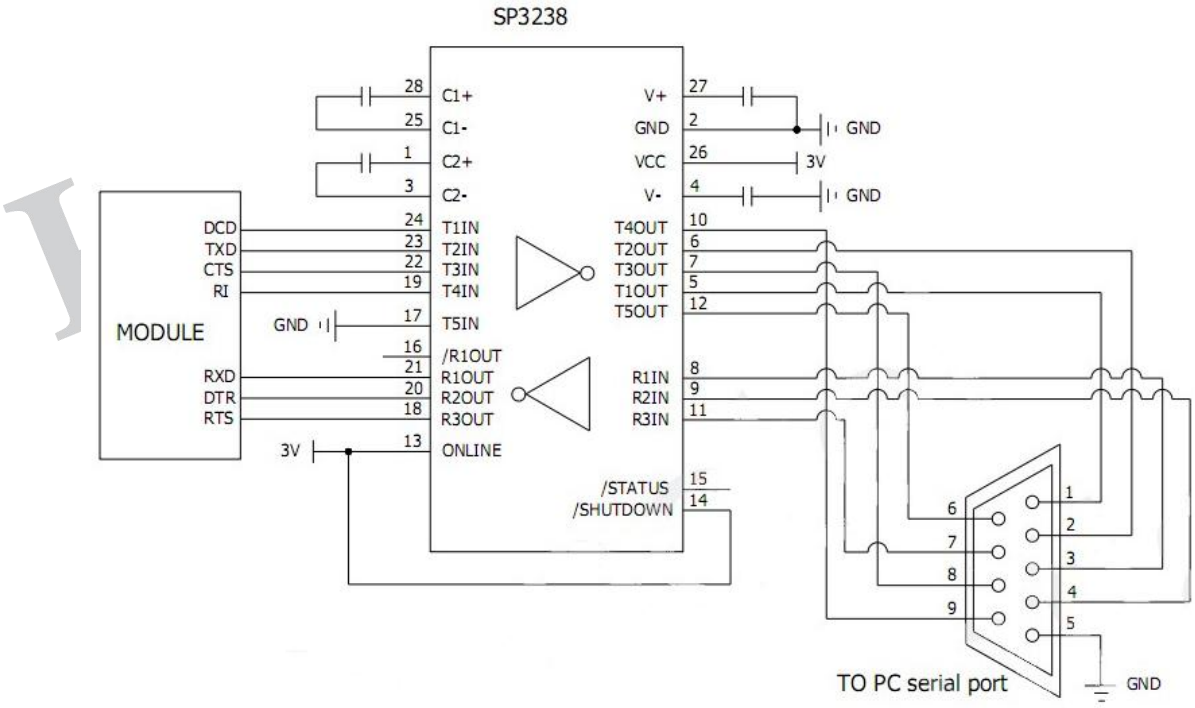


Figure 23：RS232 level match circuit

3.9 Audio interfaces

The module provides two analogy input channels and two analogy output channels.

Table 10: Pin definition of Audio interface

Interface	Name	Pin	Function
AIN1/AOUT1	MIC1P	4	Channel 1 Microphone positive input
	MIC1N	5	Channel 1 Microphone negative input
	SPK1N	6	Channel 1 Audio negative output
	SPK1P	7	Channel 1 Audio positive output
AIN2/AOUT2	MIC2P	2	Channel 2 Microphone positive input
	MIC2N	3	Channel 2 Microphone negative input
	AGND	1	Cooperate with LOUDSPKP
	LOUDSPKP	9	Channel 2 Audio positive output
	LOUDSPKN	8	Channel 2 Audio negative output

AIN1 and AIN2 can be used for input of microphone and line. An electret microphone is usually used. AIN1 and AIN2 are both differential input channels.

AOUT1 is used for output of the receiver. This channel is typically used for a receiver built into a handset. AOUT1 channel is a differential channel. If it is used as a speaker, an amplifier should be employed.

AOUT2 is used for loud speaker output as it is embedded an amplifier of class AB whose maximum drive power is 800mW. AOUT2 is a differential channel.

AOUT2 also can be used for output of earphone, which can be used as a single-ended channel. LOUDSPKP and AGND can establish a pseudo differential mode.

AOUT2 also can be used for output of earphone, which can be used as a single-ended channel. LOUDSPKP and AGND can establish a pseudo differential mode.

Table 11: AOUT2 output characteristics

Item	Condition	Min	Type	Max	Unit
RMS power	8ohm load VBAT=4.2V THD+N=1%		800		mW
	8ohm load VBAT=3.7V THD+N=1%		700		mW
Gain adjustment range		0		18	dB
Gain adjustment steps			3		dB

3.9.1 Decrease TDD noise and other noise

The 33pF capacitor is applied for filtering out 900MHz RF interference when the module is transmitting at GSM900MHz. Without placing this capacitor, TDD noise could be heard. Moreover, the 10pF capacitor here is for filtering out 1800MHz RF interference. However, the resonant frequency point of a capacitor largely depends on the material and production technique. Therefore, customer would have to discuss with its capacitor vendor to choose the most suitable capacitor for filtering out GSM850MHz, GSM900MHz, DCS1800MHz and CS1900MHz separately.

The severity degree of the RF interference in the voice channel during GSM transmitting period 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, customer can have a choice based on 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 interfaces. Audio alignment should be as short as possible.

In order to decrease radio or other signal interference, the position of RF antenna should be kept away from audio interface and audio alignment. Power alignment and audio alignment should not be parallel, and power alignment should be far away from audio alignment.

The differential audio traces have to be placed according to the differential signal layout rule.

3.9.2 Microphone interfaces design

AIN1/IN2 channels come with internal bias supply for external electret microphone. A reference circuit is shown in Figure 24.

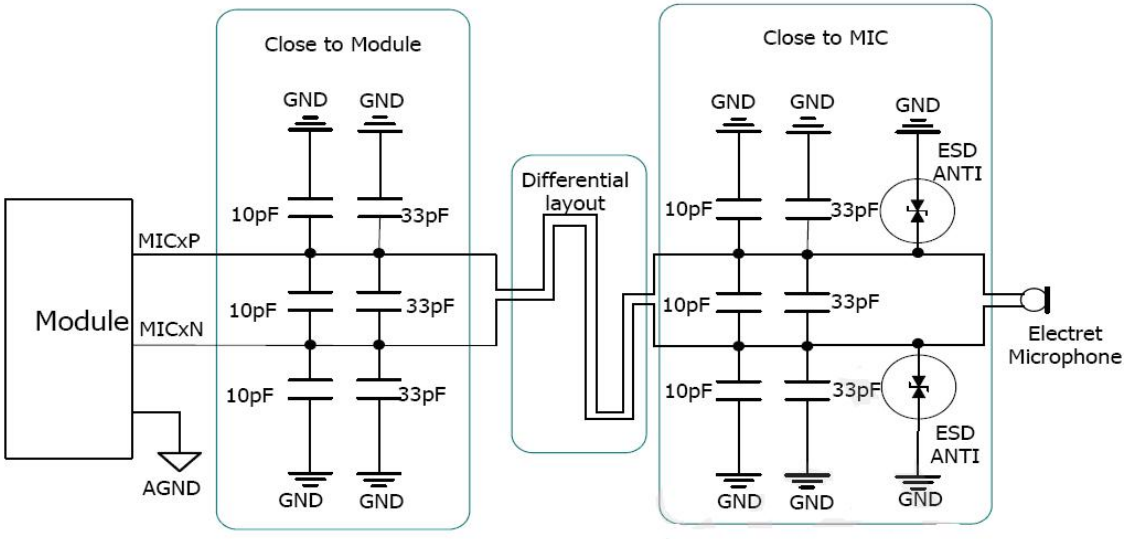


Figure 24： Microphone interface design of AIN1&AIN2

3.9.3 Receiver interface design

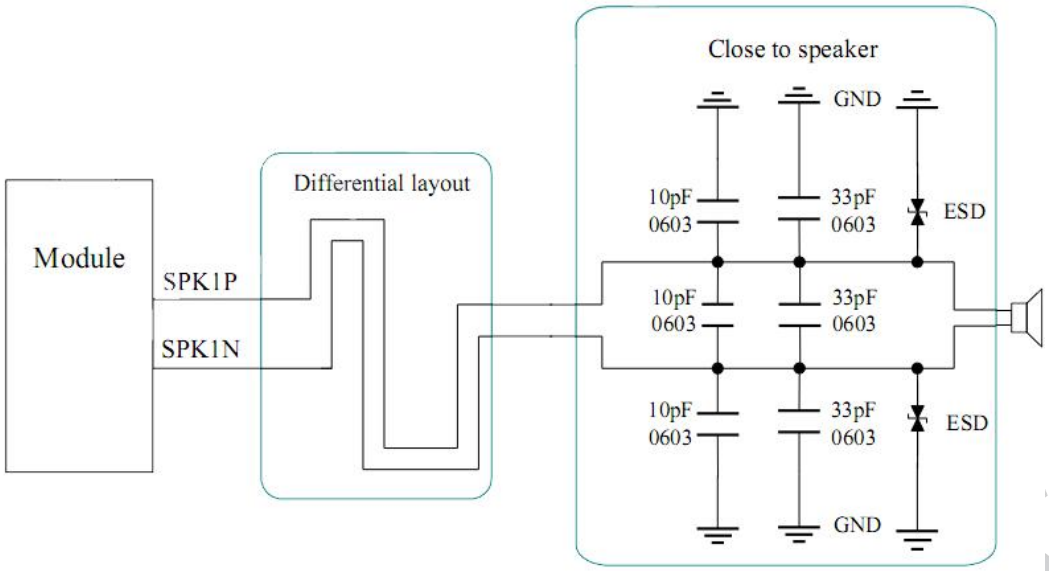


Figure 25：Receiver interface design of AOUT1

3.9.4 Earphone interface design

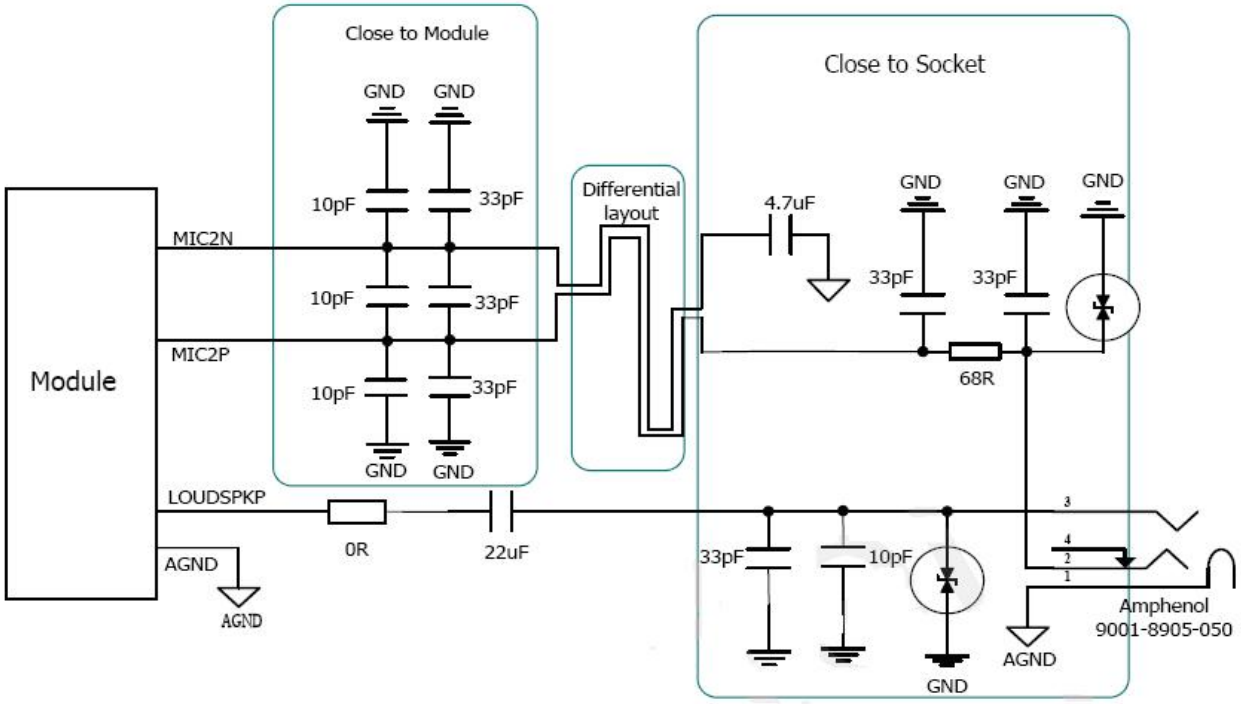


Figure 26：Earphone interface design

3.9.5 Loud speaker interface design

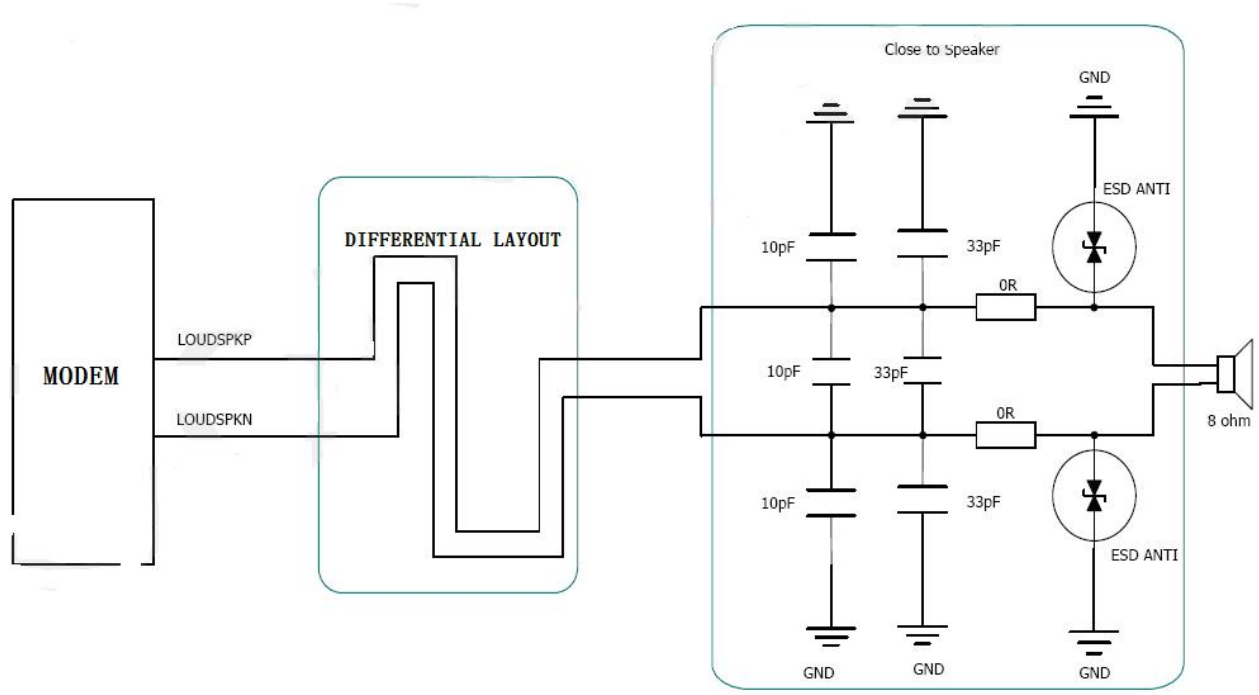


Figure 27：Loud speaker interface design

3.9.6 Audio characteristics

Table 12: Typical electret microphone characteristics

Parameter	Min	Typ	Max	unit
Working Voltage	1.2	1.5	2.0	V
Working Current	200		500	uA
External Microphone Load Resistance		2.2		k Ohm

Table 13: Typical speaker characteristics

Parameter			Min	Typ	Max	unit
Normal Output(AOUT1)	Single Ended	Load Resistance	28	32		Ohm
		Ref level	0		2.4	Vpp
	Differential	Load Resistance	28	32		Ohm
		Ref level	0		4.8	Vpp
Auxiliary Output(AOUT2)	Single Ended	Load Resistance	0	8		Ohm
		Ref level	0		2×VBAT	Vpp
	Differential	Load Resistance				Ohm
		Ref level	0		4×VBAT	Vpp

3.10 SIM card interface

3.10.1 SIM card application

The SIM interface supports the functionality of the GSM Phase 1 specification and also supports the functionality of the new GSM Phase 2+ specification for FAST 64 kbps SIM card, which is intended for use with a SIM application Tool-kit.

The SIM interface is powered from an internal regulator in the module. Both 1.8V and 3.0V SIM Cards are supported.

Table 14: Pin definition of the SIM interface

Name	Pin	Function
SIM_VDD	27	Supply power for SIM Card. Automatic detection of SIM card voltage. 3.0V±10% and 1.8V±10%. Maximum supply current is around 10mA.
SIM_RST	28	SIM Card reset
SIM_DATA	29	SIM Card data I/O
SIM_CLK	30	SIM Card clock
SIM_GND	31	SIM Card ground

The reference circuit using a 6-pin SIM card holder is illustrated as the following figure.

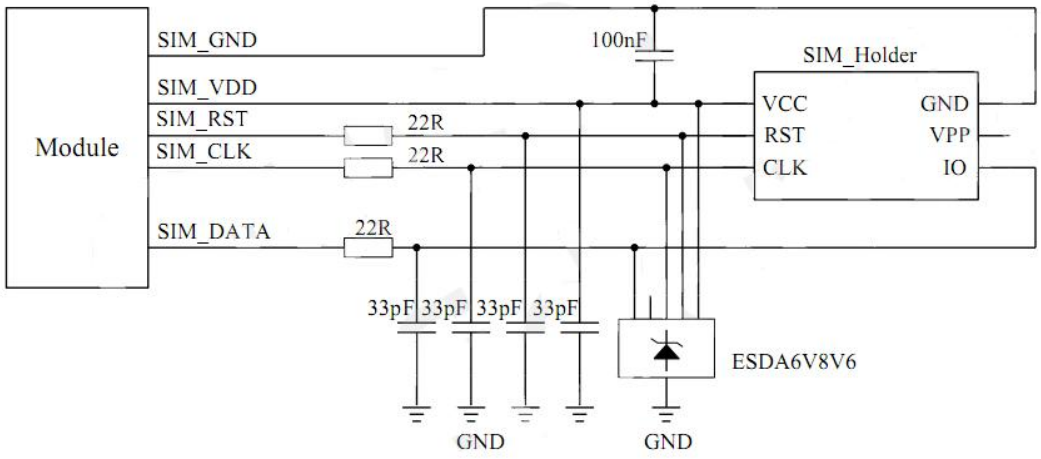


Figure 28： Reference circuit of the 6 pins SIM card

The following design rules can optimize the SIM interface performance and protect the SIM card effectively. The rules should be taken into account in designing the circuit.

Place the SIM card holder close to module as close as possible. Ensure the trace length of SIM signals keeps less than 200mm.

Keep the SIM signals far away from VBAT power and RF trace.

The width of SIM_VDD and SIM_GND trace is not less than 0.5mm. Place a bypass capacitor close to SIM card power pin. The value of capacitor is less than 1uF.

To avoid possible cross-talk from the SIM_CLK signal to the SIM_DATA signal be careful that both traces are not placed closely next to each other. The traces of SIM_CLK, SIM_DATA and SIM_RST are recommended to be around with GND independently.

3.10.2 6 Pin SIM cassette

For 6-pin SIM card holder, it is recommended to use Amphenol C707 10M006 512 2. Please visit http://www.amphenol.com for more information.

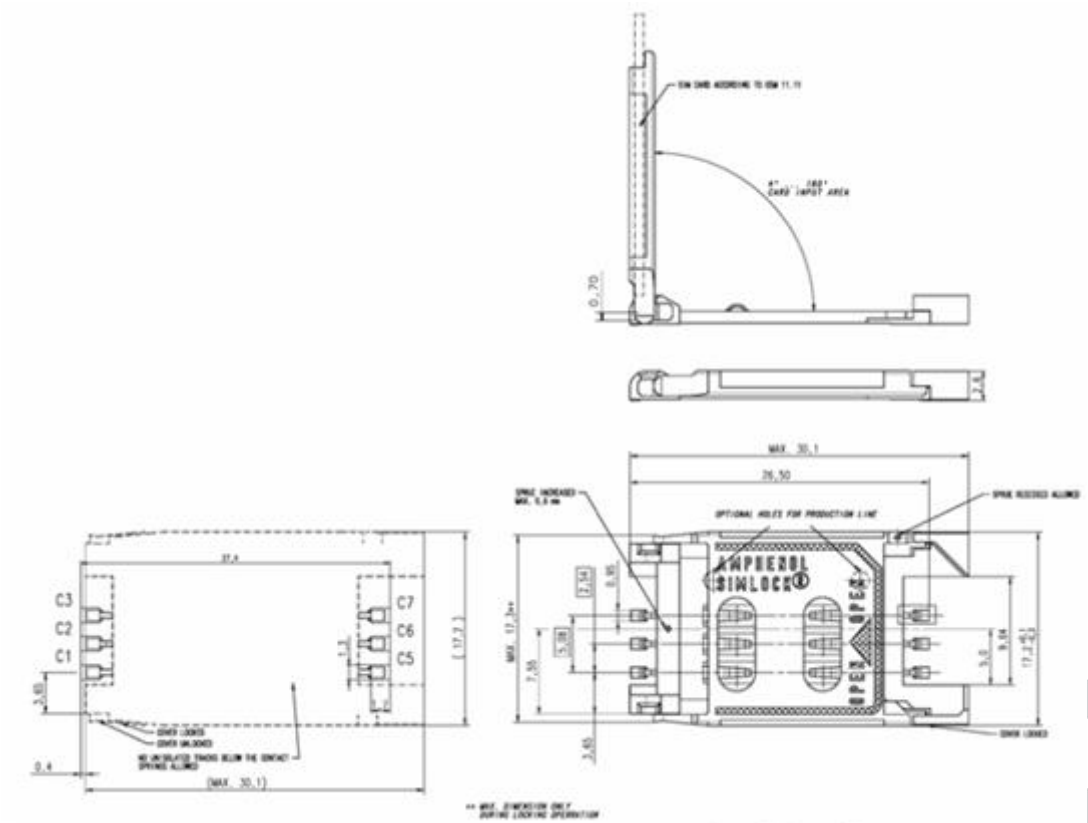


Figure 29： Amphenol C707 10M006 512 2 SIM card holder

Table 15: Pin description of Amphenol SIM card holder

Pin	Name	Function
C1	SIM_VDD	SIM Card Power Supply
C2	SIM_RST	SIM Card Reset
C3	SIM_CLK	SIM Card Clock
C5	GND	Ground
C6	VPP	Not Connect
C7	SIM_DATA	SIM Card data I/O

4 Antenna interface

The Pin 39 is the RF antenna pad. The RF interface has an impedance of 50Ω.

Table 16: Pin definition of the Antenna interface

Name	Pin	Function
GND	37	ground
GND	38	ground
RF_ANT	39	RF antenna pad
GND	40	ground

4.1 RF reference design

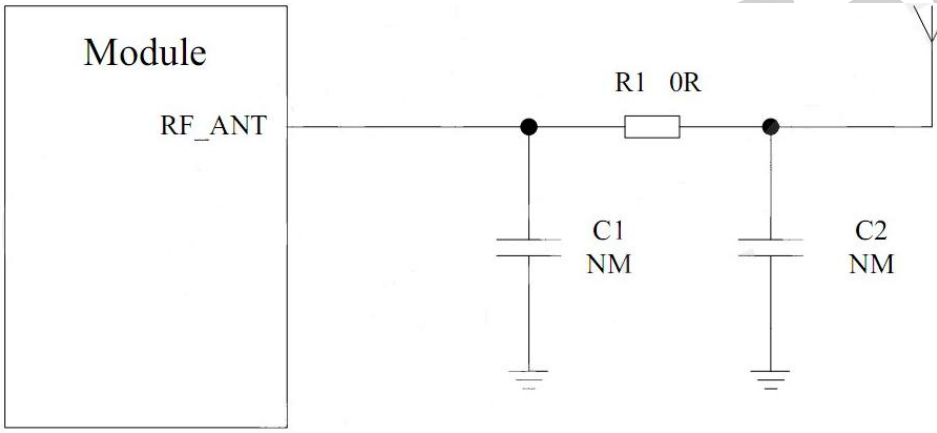


Figure 30： Reference circuit of RF

G3524 provides an RF antenna PAD for customer's antenna connection. The RF trace in host PCB connected to the module RF antenna pad should be micro-strip line or other types of RF trace, whose characteristic impendence should be close to 50Ω. G3524 comes with grounding pads which are next to the antenna pad in order to give a better grounding.

To minimize the loss on the RF trace and RF cable, take design into account carefully. It is recommended that the insertion loss should meet the following requirements:

GSM850/EGSM900 is <1dB.
DCS1800/PCS1900 is <1.5dB.

4.2 RF output power

Table 17: The module conducted RF output power

Frequency	Max	Min
GSM850	33dBm±2dB	5dBm±5dB
EGSM900	33dBm±2dB	5dBm±5dB
DCS1800	33dBm±2dB	5dBm±5dB
PCS1900	33dBm±2dB	5dBm±5dB

Note: In GPRS 4 slots TX mode, the max output power is reduced by 2.5dB. This design conforms to the GSM specification as described in section 13.16 of 3GPP TS 51.010-1.

4.3 RF receiving sensitivity

Table 18: The module conducted RF receiving sensitivity

Frequency	Receive sensitivity
GSM850	< -107dBm
EGSM900	< -107dBm
DCS1800	< -107dBm
PCS1900	< -107dBm

4.4 Operating frequencies

Table 19: The module operating frequencies

Frequency	Receive	Transmit	ARFCH
GSM850	869~894MHz	824~849MHz	128~251
EGSM900	925~960MHz	880~915MHz	0~124, 975~1023
DCS1800	1805~1880MHz	1710~1785MHz	512~885
PCS1900	1930~1990MHz	1850~1910MHz	512~810

5 Mechanical dimensions

This chapter describes the mechanical dimensions of the module.

5.1 Mechanical dimensions of module

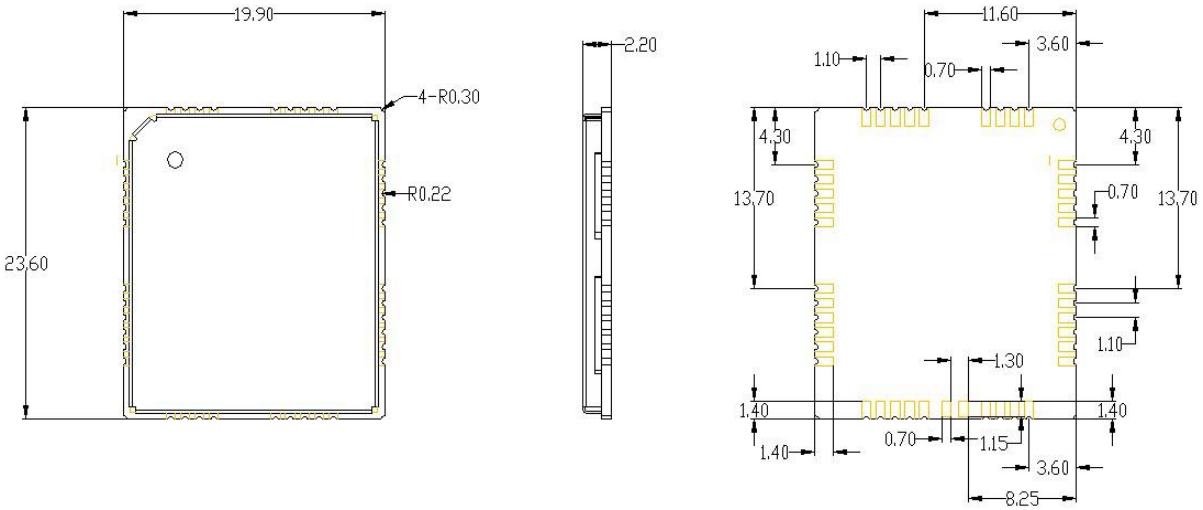


Figure 31：G3524 top and side dimensions（Unit: mm）

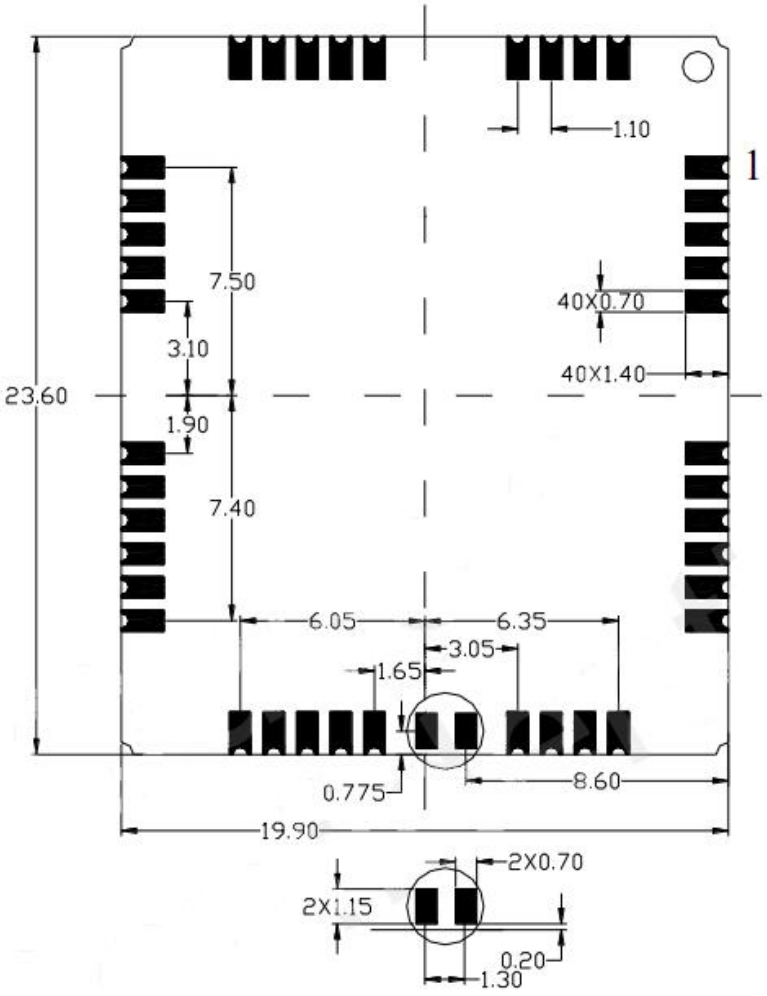


Figure 32：G3524 bottom dimensions（Unit: mm）

5.2 Footprint of recommendation

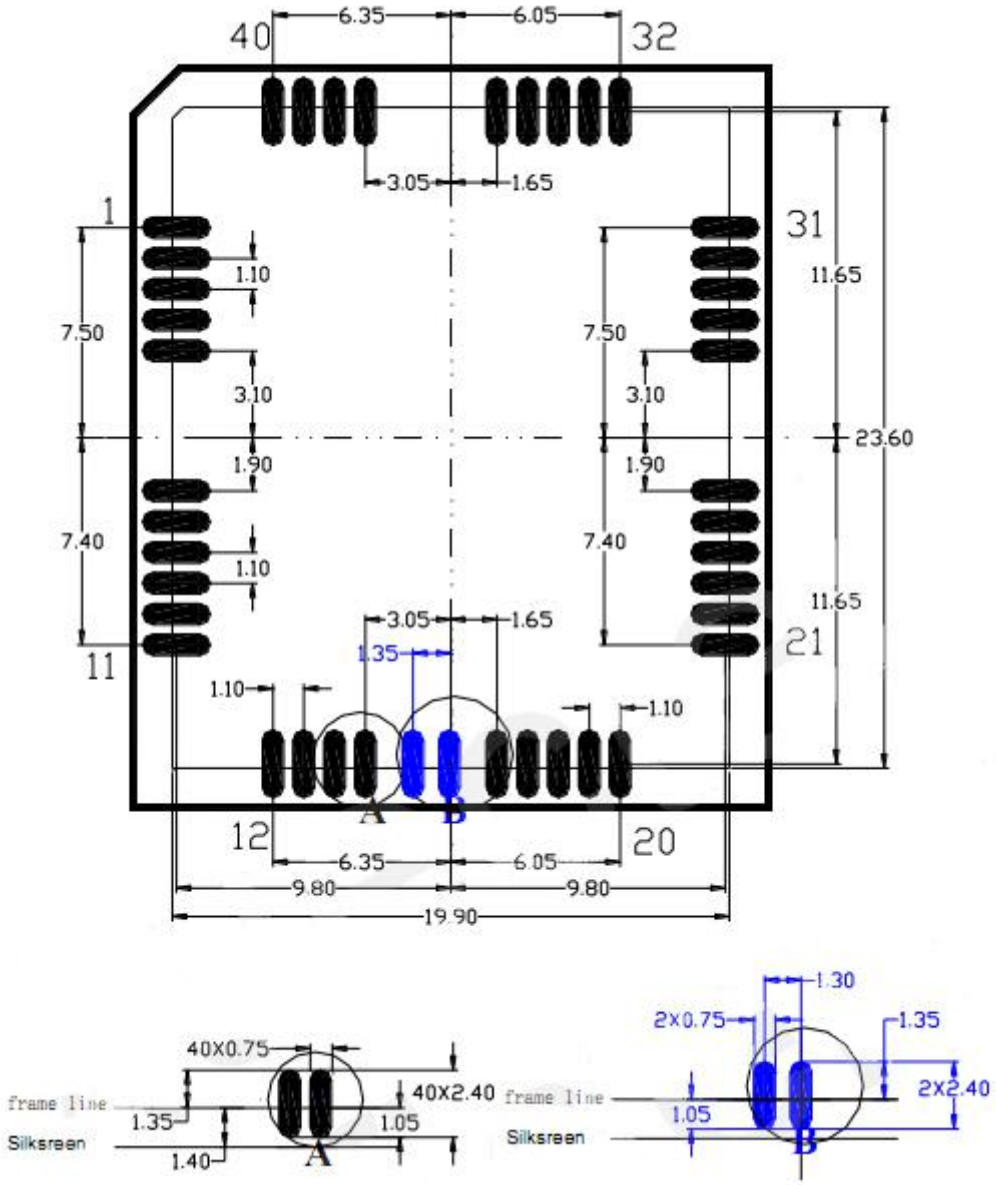


Figure 33： Footprint of recommendation（Unit: mm）

Note：

1. The blue pads are used for reserved pins customs can design the PCB decal without them.

2. To maintain the module, keep about 3mm away between the module and other components in host PCB.

5.3 Top view of the module

Figure 34： Top view of the module

5.4 Bottom view of the module

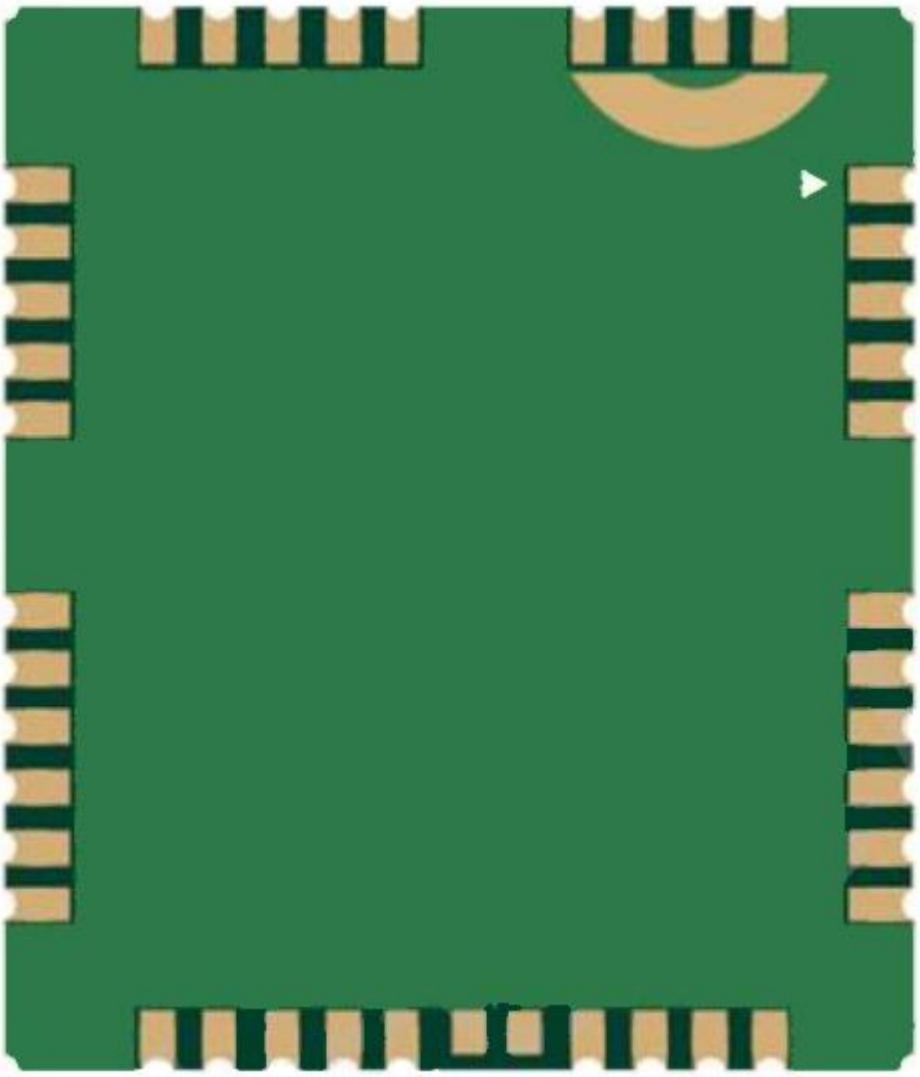


Figure 35： Bottom view of the module

Add：

Kingcom Technology Limited
418 Guiping Road , Xuhui District, Shanghai, Room 703
Tel :021-31756099
Fax:021-31756089
E-mail：support@kingcomchina.com