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Y7080E Series&SIM7020G Compatible Design

LPWA Module

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1 Introduction

This document is targeted for customers to understand the differences between Y7080E Series and SIM7020G. Users can use Y7080E Series or SIM7020G module to design and develop applications quickly.

1.1 Product Outline

The physical dimension of Y7080E Series is 17.6mm×15.7mm×2.4 mm, and the physical dimension of SIM7020G is 17.6mm×15.7mm×2.3 mm.
The following table shows the differences frequency bands and interface of Y7080E Series and SIM7020G.

Table 1: Y7080E Series and SIM7020G Frequency Bands and air interface

Network Type	Band	Y7080E	Y7080E0-L	SIM7020G
	Category	NB1/NB2	NB1/NB2	NB1/NB2
LTE-FDD* HD-FDD	LTE-FDD B1			√
	LTE-FDD B2			√
	LTE-FDD B3	√	√	√
	LTE-FDD B4			√
	LTE-FDD B5	√	√	√
	LTE-FDD B8	√	√	√
	LTE-FDD B12			√
	LTE-FDD B13			√
	LTE-FDD B17			√
	LTE-FDD B18			√
	LTE-FDD B19			√
	LTE-FDD B20	√	√	√
	LTE-FDD B25			√
	LTE-FDD B26			√
	LTE-FDD B28	√	√	√
	LTE-FDD B66			√
	LTE-FDD B70			√
	LTE-FDD B71			√
	LTE-FDD B85			√

GNSS	GPS	⚑		
	GLONASS	⚑		
	BeiDou	⚑		
	Galileo	⚑		

NOTE

The BeiDou and GLONASS of Y7080E is not supported at the same time, please confirm the mode support by the module. Users can set the GNSS mode via AT command “AT+CGNSMOD”. For more information about these AT commands, please refer to Document [3].

2 Package Information

2.1 Pin Assignment Overview

The following table shows the pin assignment of Y7080E Series and SIM7020G.

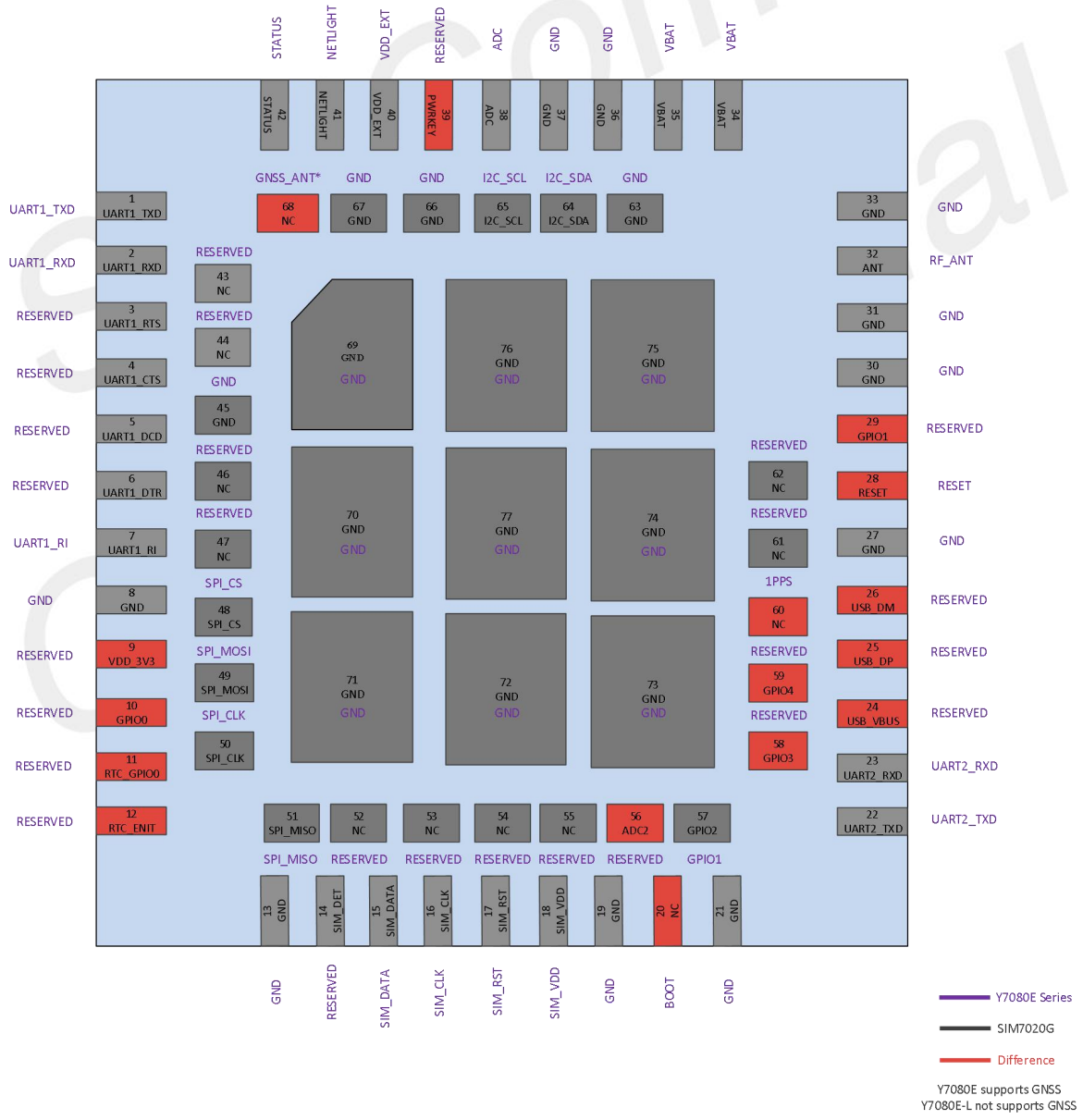

Figure 1: Pin assignment overview

2.2 Differences Overview

Table 2: The Differences overview

Functions	Y7080E	Y7080E-L	SIM7020G
Cellular technology	NB-IOT,GNSS	NB-IOT	NB-IOT
USB	Not Support	Not Support	USB
PWRKEY	Not Support	Not Support	Support
Download interface	UART1	UART1	UART2
Debug interface	UART2	UART2	UART2/USB(SET by AT command)
IO Power Domain	3.0V	3.0V	1.8V

2.3 Differences of Electronic Characteristic

Table 3: The Differences overview

Pin#	Y7080E Series			SIM7020G	
	PIN name	Voltage range		PIN name	Voltage range
		Y7080E	Y7080E-L		
34,35	VBAT	3.0V~4.2V	2.2V~4.2V	VBAT	2.1V~3.6V
1~7	UART1	3.0V	3.0V	UART1	1.8V
22,23	UART2	3.0V	3.0V	UART2	1.8V
25,26	RESERVED	\	\	USB	\
28	RESET	VBAT	VBAT	RESET	2.1V~3.6V
38	ADC	0~1.0V	0~1.0V	ADC	0.1V~1.4V
39	RESERVED	\	\	PWRKEY	2.1V~3.6V
40	VDD_EXT	3.0V	3.0V	VDD_EXT	1.8V
41	NETLIGHT	3.0V	3.0V	NETLIGHT	1.8V
42	STATUS	3.0V	3.0V	STATUS	1.8V

3 Recommended Footprint

3.1 Top and Bottom View

The following figures show top and bottom view of Y7080E Series and SIM7020G.
There are some differences for footprint.

Figure 2: Y7080E Series and SIM7020G top and bottom view

NOTE

Figure 2 is the effect diagrams of the module, for reference only. Please refer to the actual product for appearance.

3.2 Recommended Footprint

Y7080E Series and SIM7020G can use the same recommended footprint design.

The recommended footprint design for Y7080E Series and SIM7020G is shown as below.

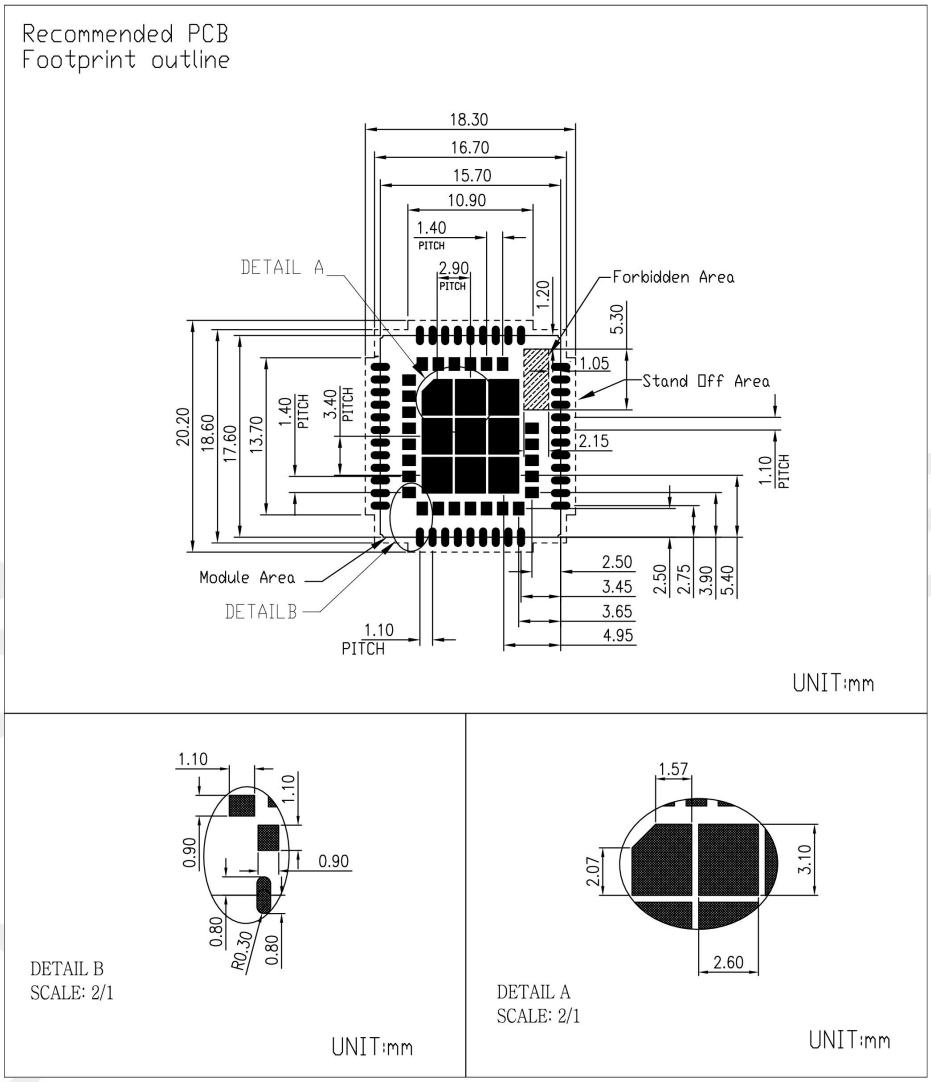

Figure 3: Recommended Stencil Design for Y7080E Series and SIM7020G (Unit: mm)

3.3 Recommended Stencil Design

It is strongly recommended that Y7080E Series and SIM7020G use the same recommended stencil design.

The recommended stencil design for Y7080E Series and SIM7020G is shown as below.

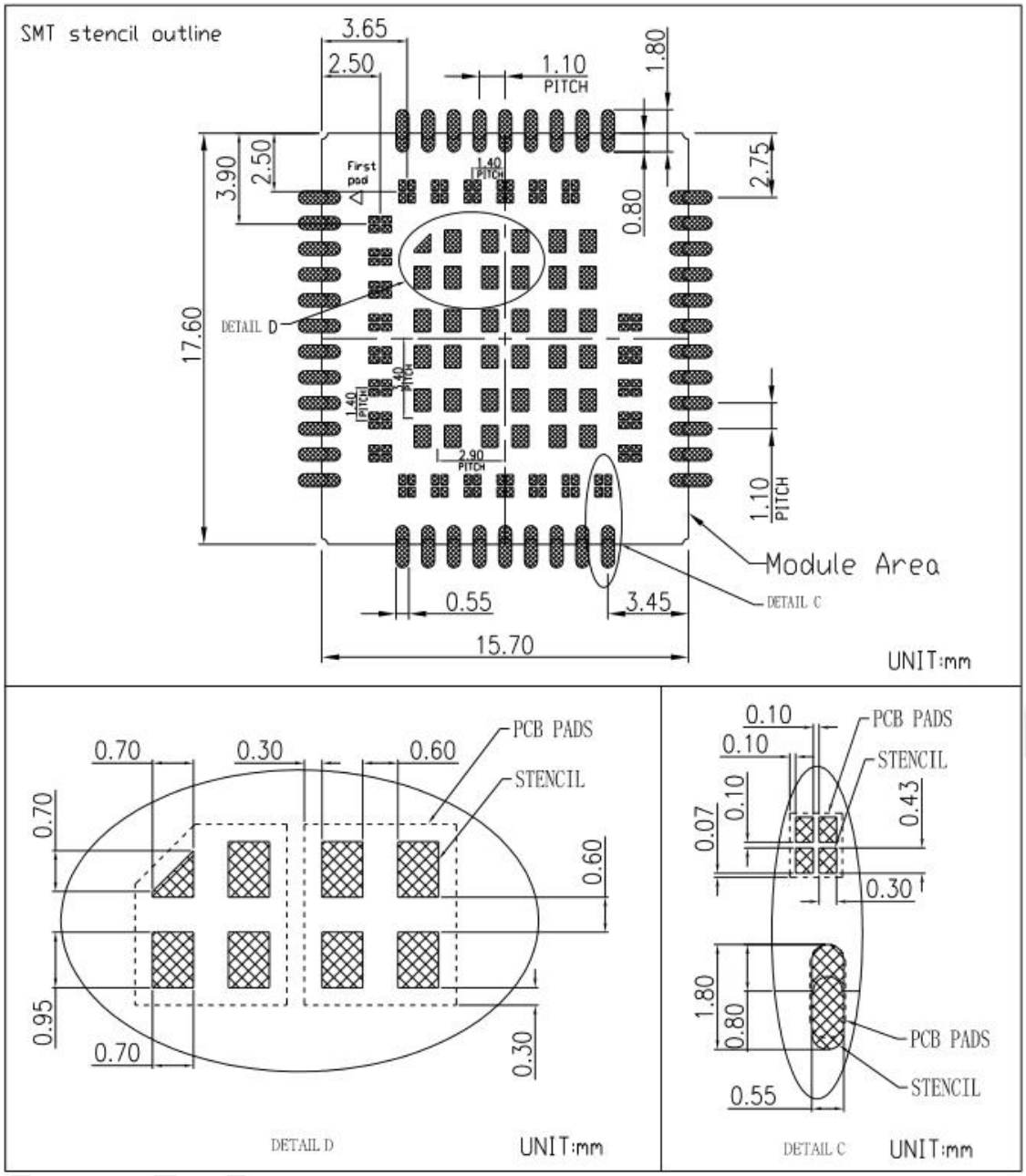

Figure 4: Recommended Stencil Design for Y7080E Series and SIM7020G (Unit: mm)

4 Hardware Reference Design

The chapter introduces compatible design between Y7080E Series and SIM7020G on main functionalities.

4.1 Power Supply

The power supply pins of Y7080E Series and SIM7020G include two VBAT pins (pin 34 and pin 35). VBAT pins directly supply the power to RF circuit and baseband circuit. Both VBAT pins of the module must be used together. The following figure is the reference design of the module VBAT power supply.

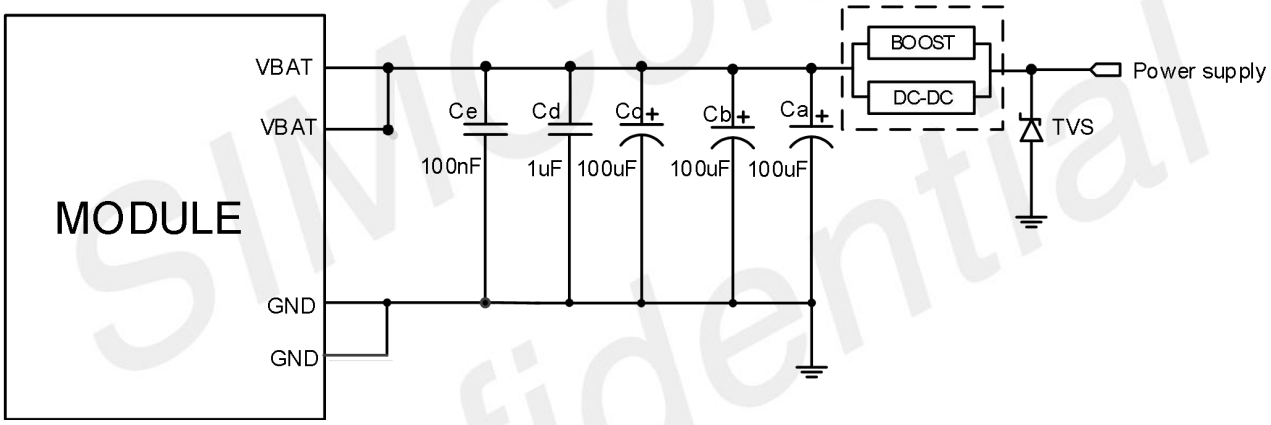

Figure 5: Power supply reference circuit

According to power supply type (battery or DC power), the reference design for power switching circuit in the above dashed box will be different. The details are illustrated in the table below.

Table 4: Power Supply Type and Power Switching Circuit Relationship

Power Supply Type	Y7080E (VBAT=3.0~4.2V)	(VBAT=3.0~4.2V)	SIM7020G (VBAT=2.1~3.6V)
Li-SOC12 Battery (2.0~3.6V)	Boost	Boost	Boost
Li-MnO2 Battery (1.8V~3.0V)	Boost	Boost	Boost
DC Power Supply	DC-DC	DC-DC	DC-DC

The VBAT has different input power range for Y7080E Series and SIM7020G. Please refer to the following table.

Table 5: The differences for VBAT power range

Module	VBAT power supply			VBAT power peak current
	Min	Typical	Max	MAX
Y7080E	3.0	3.3	4.2	500mA
Y7080E-L	2.2	3.3	4.2	500mA
SIM7020G	2.1	3.3	3.6	700mA

Power design for a module is important to its performance. The power supply of Y7080E Series should be able to provide sufficient current up to 500mA, and SIM7020G should be able to provide sufficient current up to 700mA.

NOTE

For the Y7080E, when VBAT supply is lower than 2.4V, the performance of individual indicators may not meet the 3GPP standard. For details information, please refer to each HD guide.

If the supply voltage exceeds the supply range of VBAT, the buck circuit should be used to meet the demand of power supply. When choosing buck chip, besides considering the maximum current output capability of IC to meet the demand of the module, it is also necessary to consider the low static power consumption of IC in PSM mode.

The following figure shows the recommended circuit.

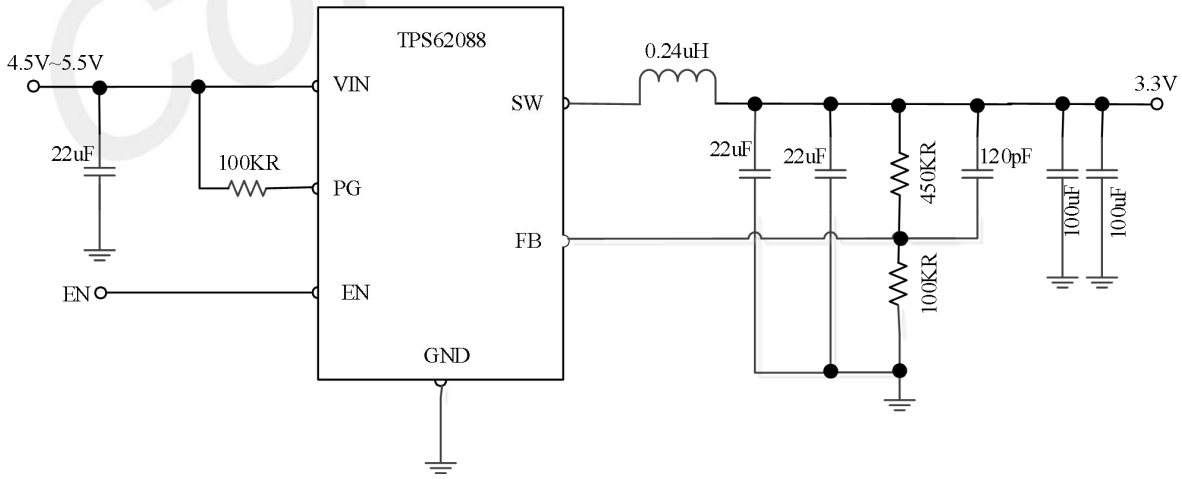

Figure 6: Power supply reference circuit

NOTE

The customer's circuit design must have the function that the master can control the power off of the module.

4.2 Power on/off circuit

The 39 pin of SIM7020G is PWRKEY, but it is RESERVED for Y7080E Series. SIM7020G can be turned on by driving the 39 pin to a low level. But the Y7080E is automatically turned on after power on, without a PWERKEY button.

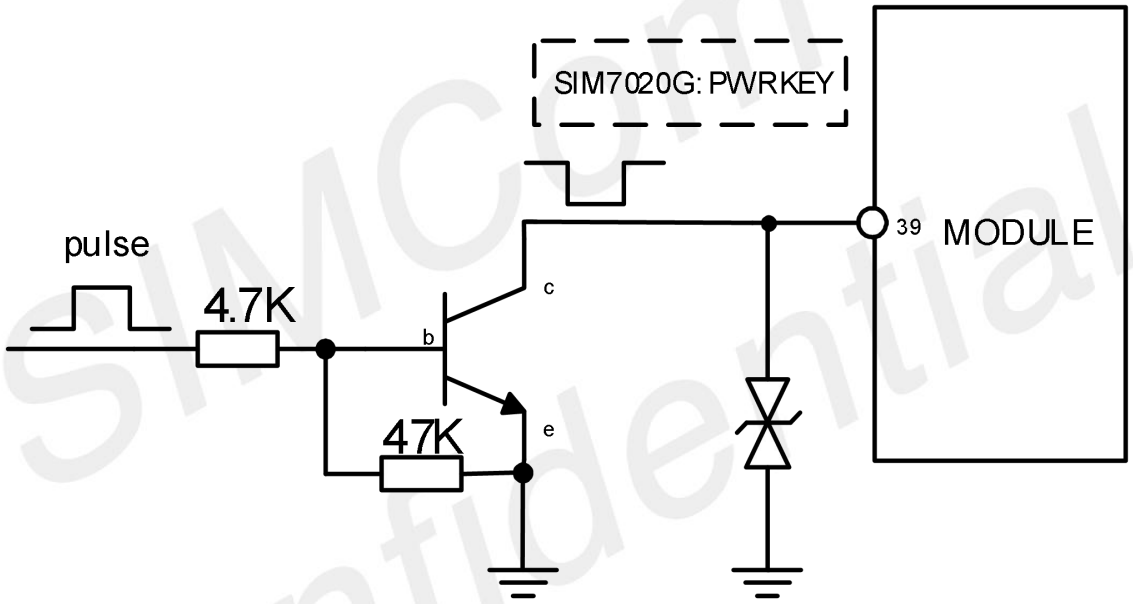

Figure 7: Power on/off reference circuit

The different electrical parameters of 39 pin is show as below.

Table 6: 39 pin electrical parameters

Table	SIM7020G			
	Min	Typ	Max	Unit
T_{on}	215	1000		ms
V_{IN}	0.7*VBAT	-	-	V
V_{IL}	-	-	0.3*VBAT	V

NOTE

For details information of the electrical parameters, please refer to each HD guide.

4.3 Reset Circuit

The 28 pin of Y7080E and SIM7020G is reset.
The SIM7020G can be reset by keeping the 28 pin low level, while the Y7080E can be reset by pulling the RESET pin to high level.

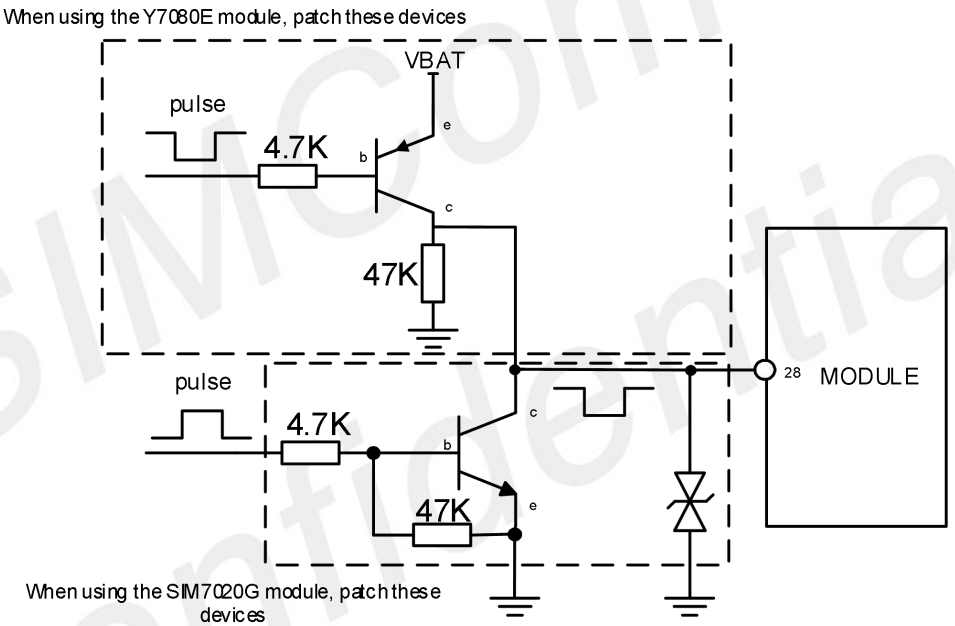

Figure 8: Reset reference circuit

Table 7: The RESET pin of SIM7020G electrical parameters

Symbol	Y7080E Series				SIM7020G			
	Min	Typ	Max	Unit	Min	Typ	Max	Unit
T_{reset}	50	-	-	ms	48	-	-	ms
V_{IN}	1.1	1.2	4.2	V	0.7*VBAT	-	-	V
V_{IL}	-	-	0.3	V	-	-	0.3*VBAT	V

Table 8: The effective duration of Y7080E

Symbol	Description	Min.	Typ.	Max.	Unit
T_{reset} (Mode 0)	Hold time of Wakeup high level	-	-	15	ms
	Hold time of Reset high level	20	-	-	
T_{reset} (Mode 1)	Hold time of Wakeup high level	-	-	5	s
	Hold time of Reset high level	6	-	-	
V_{Reset}	Input high level voltage on RESET pin	1.1	1.2	4.2	V

NOTE

The effective duration of Y7080E RESET pin restart can be set by "AT+RESETCTL". For details information of this function, please refer to the document [3].

4.4 UART Interface

The module is as the DCE (Data Communication Equipment) and the client PC is as the DTE (Data Terminal Equipment). AT commands are executed through UART interface.

Y7080E can provide 2 channels serial ports: one channel 2-wire serial port UART1, one channel DEBUG serial port UART2. UART1 can be used for AT command communication, firmware upgrade and calibration; UART2 can view the underlying log information for software debugging.

SIM7020G can provide 2 channels serial ports: one channel full-function serial port UART1, one channel DEBUG serial port UART2. UART1 can be used for AT command communication and calibration; UART2 can view the underlying log information for software debugging and firmware upgrade.

When the serial port of the module and serial port of MCU have the same voltage level, the serial port and GPIO of module can connect to the MCU directly. The reference design circuit is shown as following figure.

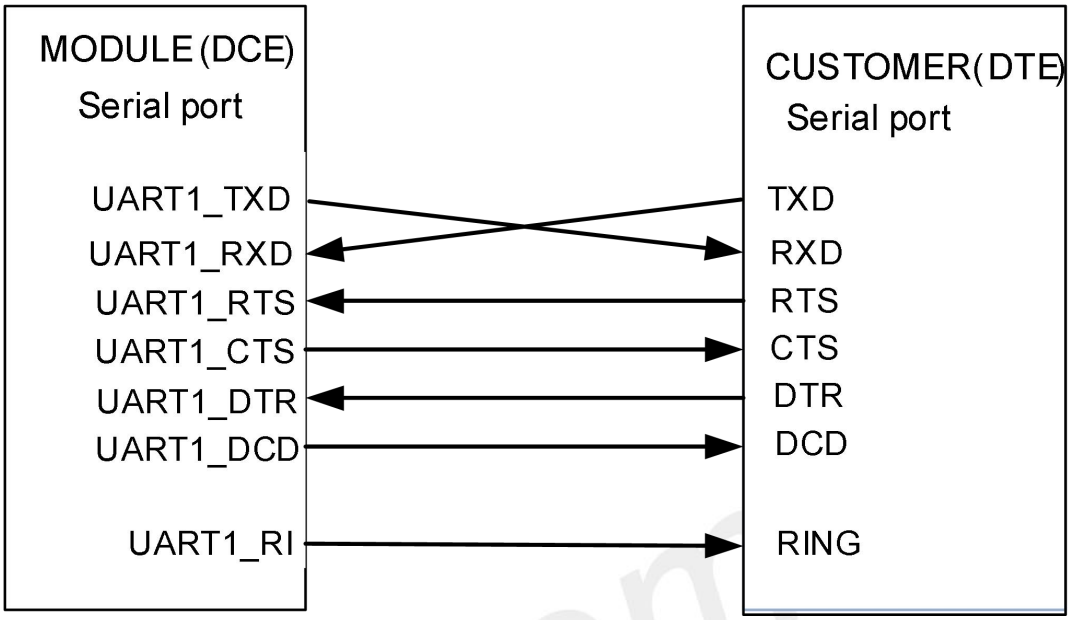

Figure 9: UART full modem circuit

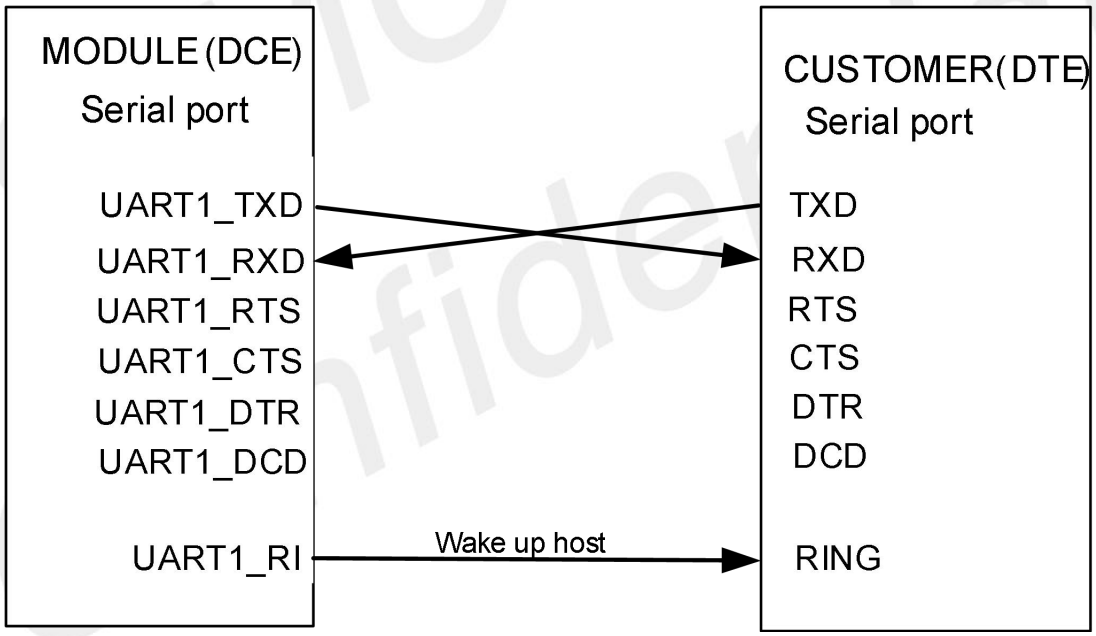

Figure 10: UART null modem circuit

When the serial port of MCU does not match the serial port of module, it is recommended to use voltage level translator to match the voltage level. The reference design circuit is shown as following figure.

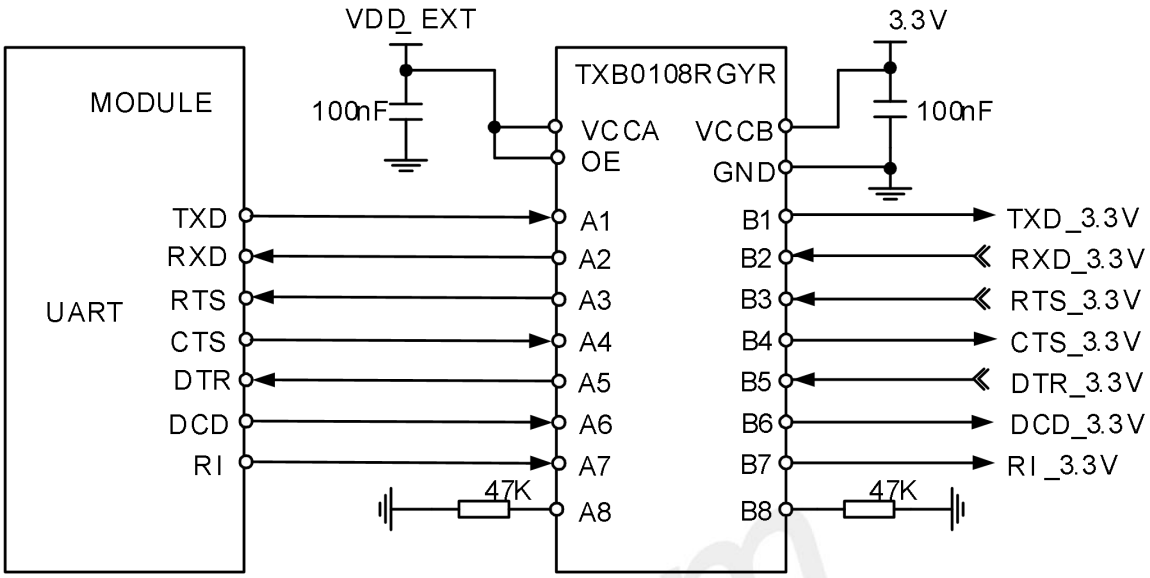

Figure 11: Reference circuit of level translator

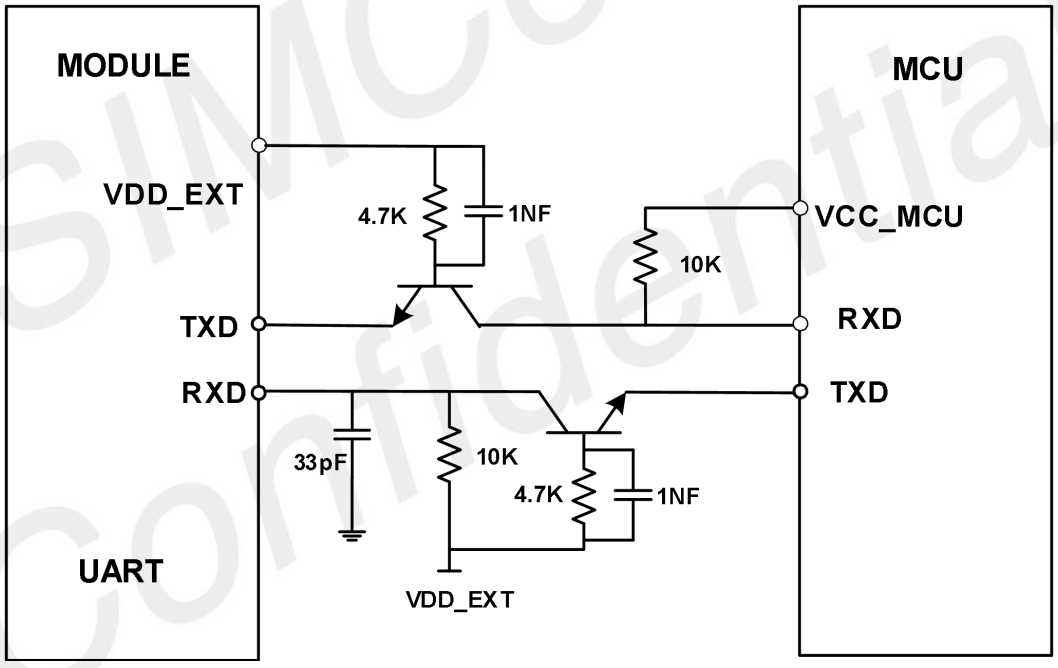

Figure 12: Reference circuit with Transistor

NOTE

When it uses the level shifter IC, the pull up resistance on TXD_3.3V, RTS_3.3V, DCD_3.3V and RI_3.3V should not be less than 47KΩ.

4.5 USIM Interface

Y7080E Series and SIM7020G can support 1.8V and 3.0V SIM card. Y7080E Series has a reserved position for eSIM inside, and customers can choose whether to install eSIM, while the SIM7020G not support.

The pin assignment of Y7080E and SIM7020G USIM interface are compatible with each other. A compatible design for 6-pin USIM interface is shown in the figure below:

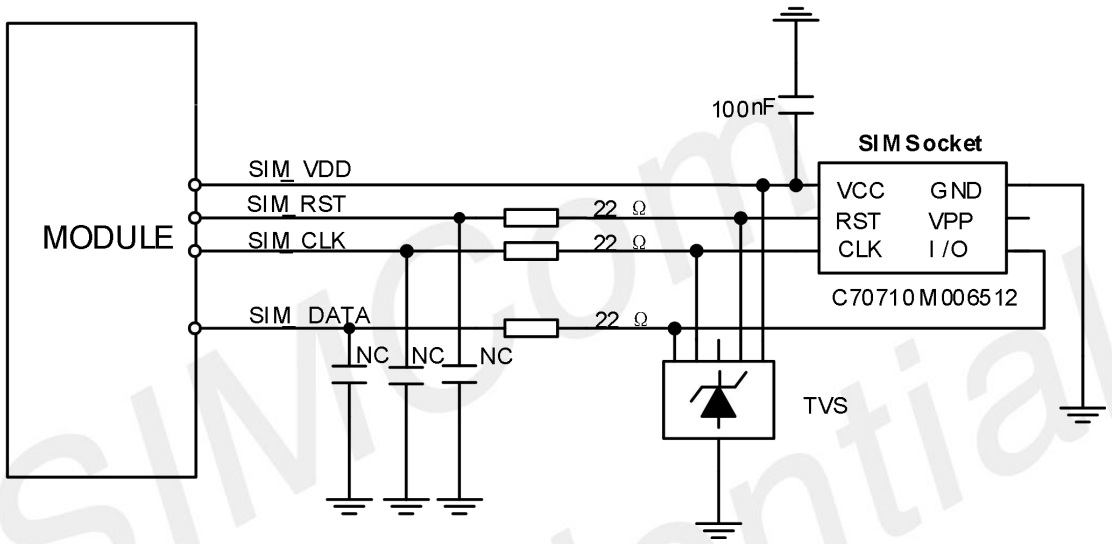

Figure 13: SIM interface reference circuit

SIM card signal could be interference by some high frequency signal, it is strongly recommended to follow these guidelines while designing:

- Add some TVS which parasitic capacitance should not exceed 15pF
- SIM card holder should be far away from GSM antenna
- SIM traces should keep away from RF lines, VBAT and high-speed signal lines, the traces should be as short as possible
- Keep SIM card holder's GND connect to main ground directly
- Shielding the SIM_CLK to prevent the interference to other signals

4.6 USB Interface

SIM7020G provide a USB interface, while the Y7080E does not. If use the Y7080E module, please disconnect the wire of USB. The reference design circuit is shown as following figure.

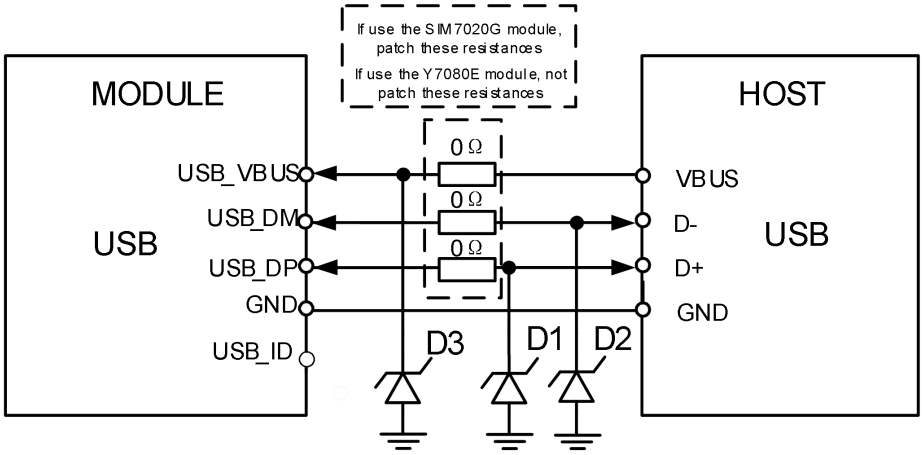

Figure 14: USB interface reference circuit

NOTE

If use the SIM7020G module, patch these three 0R resistances, if use the Y7080E module, please not patch these three resistances, make sure the Y7080E pin 24,25,26 keep float.

4.7 Network Status Indication

The pin assignment of Y7080E and SIM7020G network status indication are compatible with each other. The NETLIGHT pin is used to control Network Status LED, its reference circuit is shown in the following figure.

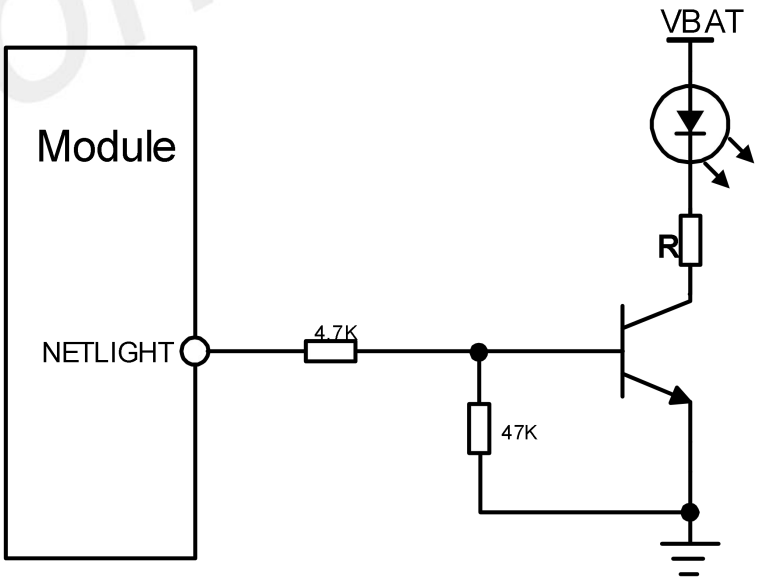

Figure 15: NETLIGHT reference circuit

The pin status of Y7080E and SIM7020G is shown as following table.

Table 9: Y7080E and SIM7020G NETLIGHT pin status

NETLIGHT pin status	Module status
64ms ON, 800ms OFF	No registered network
64ms ON, 3000ms OFF	Registered network (PS domain registration success)
64ms ON, 300ms OFF	Data transmit (PPP dial-up state and use of data services such as internal TCP/FTP/HTTP)
OFF	Power off or PSM mode

4.8 I2C Interface

The pin 64 and pin 5 of Y7080E is I2C, while the SIM7020G does not.
Y7080E provides an I2C interface with clock rate up to 400 kbps. Its operation voltage is 3.0V.
The following figure shows the I2C bus reference design.

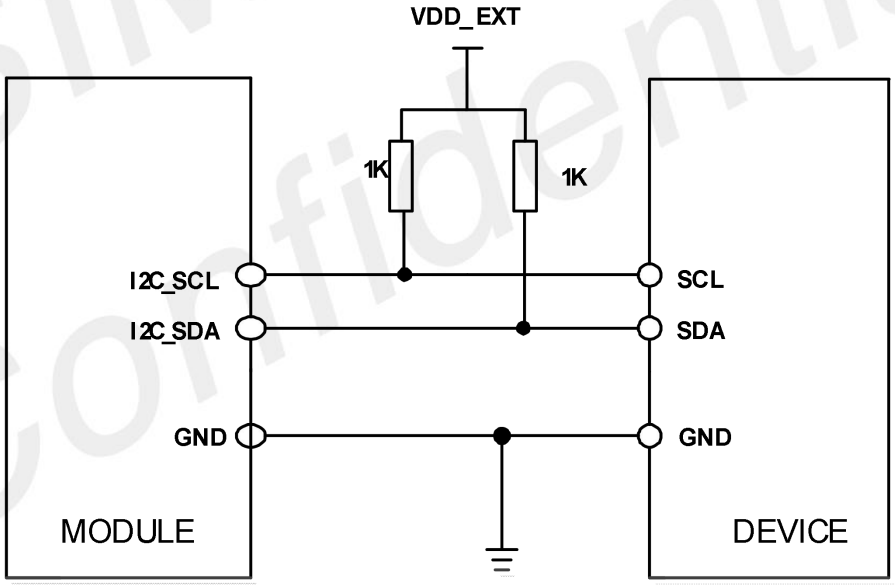

Figure 16: I2C reference circuit

4.9 ADC Interface

The pin assignment of Y7080E and SIM7020G ADC are compatible with each other.
They have different sampling scope. If the input voltage of ADC PIN exceeds its range, it is necessary to implement the resistance partial pressure on the hardware. The ADC electronic characteristic is shown as

follows.

Table 10: The Differences overview

Interface	Y7080E Series		SIM7020G	
	name	Voltage range	name	Voltage range
38	ADC	0~1V	ADC	0.1V~1.4V

4.10 RF Interface

Y7080E or SIM7020G provide a cellular antenna interface

Users should connect antennas to Y7080E's antenna pads through micro-strip line or other types of RF trace and the trace impedance must be controlled in 50Ω. SIMCom recommends that the total insertion loss between the antenna pads and antennas should meet the following requirements:

Table 11: Trace loss

Frequency	Loss
700MHz-960MHz	<0.5dB
1710MHz-2170MHz	<0.9dB
2300MHz-2650MHz	<1.2dB

To facilitate the antenna tuning and certification test, a RF connector and an antenna matching circuit should be added. The following figure is the recommended circuit.

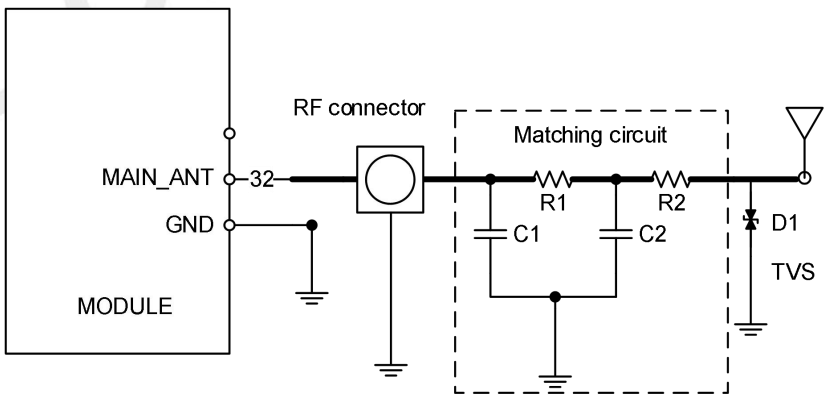

Figure 17: Antenna matching circuit (MAIN_ANT)

In above figure, the components R1, C1, C2 and R2 are used for antenna matching, the values of components can only be achieved after the antenna tuning and usually provided by antenna vendor. By

default, the R1, R2 are 0Ω resistors, and the C1, C2 are reserved for tuning. The component D1 is a TVS for ESD protection, and it is optional for users according to application environment.
The RF test connector is used for the conducted RF performance test, and should be placed as close as to the module's MAIN_ANT pin. The traces impedance between Y7080E and antenna must be controlled in 50 Ω.
Two TVS are recommended in the table below.

Table 12: Recommended TVS

Package	Part Number	Vender
0201	LXES03AAA1-154	Murata
0402	LXES15AAA1-153	Murata

4.11 GNSS

The Y7080E contains GNSS, but SIM7020G does not.

Y7080E merges GNSS (GPS/GLONASS/BD) satellite and network information to provide a high-availability solution that offers industry-leading accuracy and performance. This solution performs well, even in very challenging environmental conditions where conventional GNSS receivers fail, and provides a platform to enable wireless operators to address both location-based services and emergency mandates.

4.11.1 GNSS Technical specification

- Tracking sensitivity: -159 dBm (GPS+GLONASS)/-159 dBm (GPS+BD)
- Cold-start sensitivity: -145 dBm
- Accuracy (Open Sky): 0.4 m(GPS+BD)
- TTFF (Open Sky) : Hot start < 1 s, Cold start< 31 s
- Receiver Type: 16-channel, C/A Code
- GNSS L1 Frequency: 1575.42±1.023MHz
- GLONASS: 1597.5~1605.8 MHz
- BD: 1559.05~1563.14 MHz
- Galileo L1: 1575.42±1.023MHz
- Update rate: Default 1 Hz
- GNSS data format: NMEA-0183
- GNSS antenna: Passive/Active antenna

NOTE

If the antenna is active type, the power should be given by main board because there is no power supply on the GNSS antenna pad. If the antenna is passive, it is suggested that the external LNA should be used.

4.11.2 GNSS Application Guide

Users can adopt an active antenna or a passive antenna to Y7080E. If using a passive antenna, an external LNA is a must to get better performance. The following figures are the reference circuits.

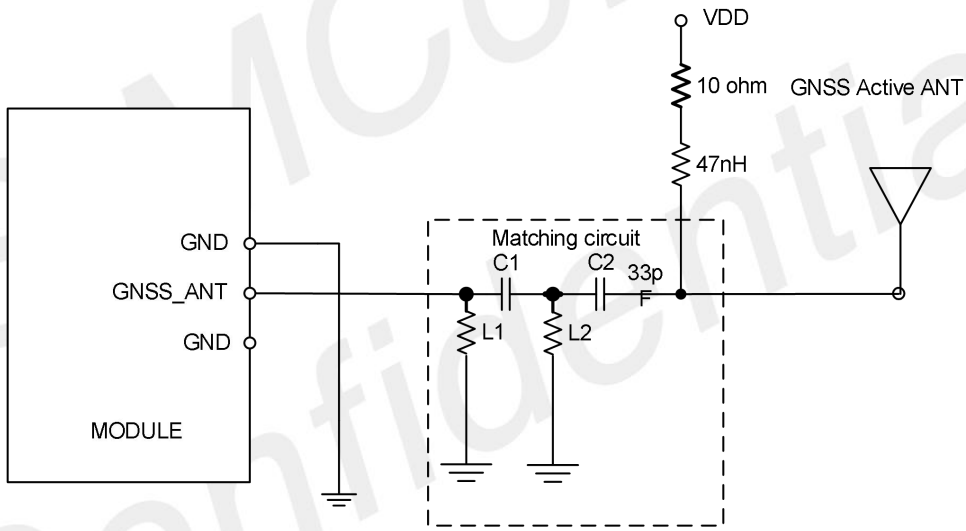

Figure 18: Active antenna circuit

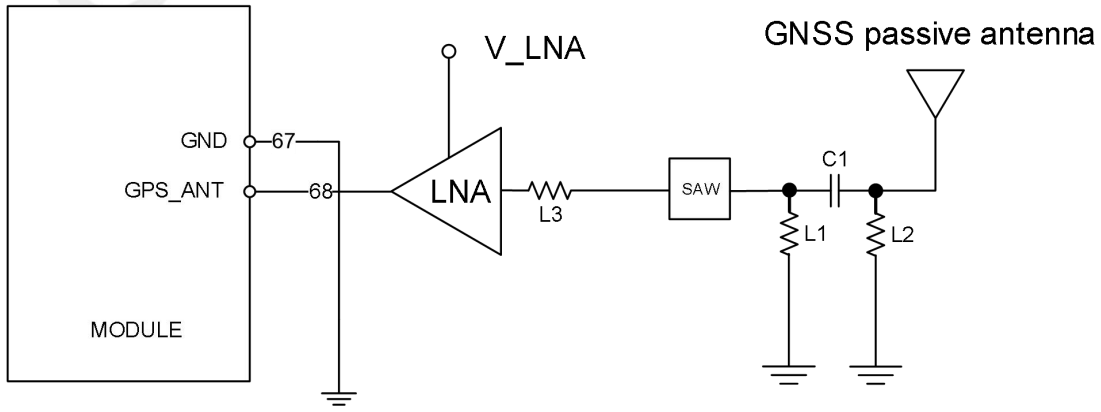

Figure 19: Passive antenna circuit (Default)

In above figures, the components C1, L1 and L2 are used for antenna matching. Usually, the values of the components can only be achieved after antenna tuning and usually provided by antenna vendor. C2 is used for DC blocking. L3 is the matching component of the external LNA, and the value of L3 is determined by the LNA characteristic and PCB layout. Both VDD of active antenna and V_LNA need external power supplies which should be considered according to active antenna and LNA characteristic. LDO/DCDC is recommended to get lower current consuming by shutting down active antennas and LNA when GNSS is not working.

GNSS can be tested by UART1. After GNSS is turned on, NMEA sentences can be obtained through UART1 automatically. NMEA sentences include GSV, GGA, RMC, GSA, and VTG. Before using GNSS, user should configure Y7080E in proper operating mode by AT command. Please refer to related documents for details. Y7080E can also get position location information through AT directly.

NOTE

1. GNSS is closed by default and can be started by “AT+CGNSPWR=1”. The AT command has two parameters, the first is on/off, and the second is GNSS mode. Default mode is standalone mode.
2. If the passive antenna is used, put the LNA close to the antenna.
3. Make sure there are no noise signals around GNSS antenna.

5 Appendix

5.1 Design check list

Table 13: Schematic Check List

NO.	Items
1	Insure the supply voltage for VBAT.
2	Insure the maximum supply current for VBAT is above its consumption when it is maximum power emission.
3	Insure the input signal for PWRKEY pin meet its electrical level match. It recommended use BJT to shift its level.
4	Insure the net connections of UART be correctness according to signal direction. Insure the signal for UART pins meet its electrical level match. It recommended use BJT or level shift IC to shift its level.
5	Insure USB port had used TVS to protect signal. And the junction capacity of TVS for DP/DM must be less than 3pf.
6	Insure SIM card signal had used TVS to protect. And the junction capacity of TVS must be less than 15pf.
7	The power supply of the active antenna should be controlled and closed.
8	Insure I2C signal had used resistors 1Kohm pull up to VDD_EXT if used.
9	Insure the signal for GPIO pins meet its electrical level match.
10	Insure the input signal never exceed the ADC range.
11	User must pull up DTR when module enters into sleep mode. Insure DTR can be controlled by host.
12	Suggesting to reserve test ports for VDD_EXT and BOOT_CFG. BOOT_CFG should keep open before boot up.
13	LTE main ANT should Keep TVS to prevent ESD destroyed. And the TVS should be Low junction capacitance.
14	LTE main ANT should have a PI type matching to debug antenna

Table 14: PCB Layout Check List

NO.	Items
1	Insure the capacitor placement for VBAT be near module pin.
2	Insure VBAT trace width be greater than 2mm. If NB only, insure VBAT trace width be greater than 1mm. And the VIA number must be enough for getting through the current.
3	Insure the return path GND of the power supply is good. Insure the connectivity between module GND and mother board GND is good.
4	Insure USB trance is protected by GND, and keep it far from interference source, such as power supply trace, RF trace and so on. Insure DM/DP trace is differential routing, and differential impedance is 90 ohm.
5	Insure ADC trance is protected by GND.
6	Insure SIM card signal trance is protected by GND. Especially SIM_CLK must be protected alone. And avoid signal trace branched Routing.
7	Insure TVS avoid bypass. The trace must go through TVS pad first, and then arrived module pad.
8	There should be enough ground around the RF line. RF lines Routing prohibit right angles and sharp angles, trying to trace circular or obtuse angle line.
9	The RF line reference GND should be complete. And avoid high speed lines crossing below it.
10	the GND side of the RF output pin should be not hot welding disk
11	The routing which is RF output PIN to antenna should be isolated from other high-speed lines. And the routing should be 50Ωimpedance control.

5.2 Related Documents

Table 15: Related Documents

NO.	Title	Description
[1]	Y7080E Hardware Design	Y7080E HD document
[2]	SIM7020G Hardware Design	SIM7020G HD document
[3]	Y70XX Series AT Command Manual	AT Command Manual
[4]	SIM7020G AT Command Manual	AT Command Manual

5.3 Terms and Abbreviations

Table 16: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
ARP	Antenna Reference Point
BD	BeiDou
BTS	Base Transceiver Station
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
DAM	Downloadable Application Module
DPO	Dynamic Power Optimization
DRX	Discontinuous Reception
e-DRX	Extended Discontinuous Reception
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HR	Half Rate
HSPA	High Speed Packet Access
I2C	Inter-Integrated Circuit
IMEI	International Mobile Equipment Identity
LTE	Long Term Evolution
NMEA	National Marine Electronics Association
PCB	Printed Circuit Board
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
SIM	Subscriber Identification Module
SMS	Short Message Service
SMPS	Switched-mode power supply

TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
UART	Universal Asynchronous Receiver & Transmitter
VSWR	Voltage Standing Wave Ratio
SIM	Universal subscriber identity module
UART	Universal asynchronous receiver transmitter
PSM	Power saving mode
SM	SIM phonebook
NC	Not connect

5.4 Safety Caution

Table 17: Safety Caution

Marks	Requirements
	When in a hospital or other health care facility, observe the restrictions about the use of mobiles. Switch the cellular terminal or mobile off, medical equipment may be sensitive and not operate normally due to RF energy interference.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Forgetting to think much of these instructions may impact the flight safety, or offend local legal action, or both.
	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres 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 sets, radios, computers or other electric equipment.
	Road safety comes first! Do not use a hand-held cellular terminal or mobile when 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 signals and cellular networks and cannot be guaranteed to connect in all conditions, especially with a mobile fee or an invalid SIM card. While you are in this condition and need emergent help, please remember to use emergency calls. In order to make or receive calls, 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 the cellular terminal or mobile.

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