Technoration India Pvt. Ltd.

TR800
Hardware Design

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2023-03-11	1.00	Origin	Sanjeet
2023-04-29	1.01	Increase RF band	Sanjeet

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1 Introduction

This document describes TR800 hardware interface in great detail. The document can help customer to quickly understand TR800 interface specifications, electrical and mechanical details. With the help of this document and other TR800 application notes, customer guide, customers can use TR800 to design various applications quickly.

1.1 TR800

TR800 module supports GSM/GPRS. Customer could choose different models of module to meet the various requirements. The detailed frequency bands are listed below:

Table 1: TR800 module frequency band list

Network Type	Frequency Band	Module
		TR800
GSM	GSM850	✓
	EGSM900	✓
	DCS1800	✓
	PCS1900	✓

The module size has 17.6*15.7*2.4 mm, which can meet almost all the space requirements in customers' applications.

1.2 Interface

TR800 provides the hardware interfaces, which are listed below:

- One 3 lines serial port, one full modem serial port, one download & debugging serial port
- Programmable GPIOs
- SIM card interface
- ADC interface

1.3 Functional Diagram

The following figure shows a functional diagram of TR800：

- GSM baseband
- GSM RF
- PMU
- Antenna Interface
- Other Interfaces

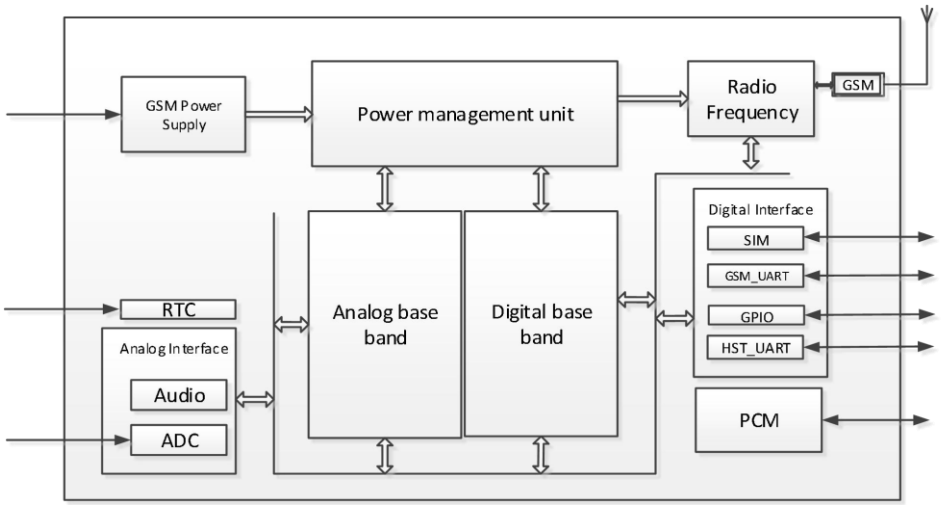


Figure 1: TR800 functional diagram

1.4 Key Features

Table 2: TR800 key features

Feature	Implementation
Power supply	Range: 3.4V ~4.2V, 3.8V recommended
Power saving	Typical power consumption in SLEEP Mode is: 860uA (AT+CFUN=4); 2mA (AT+CFUN=1)
Frequency band	Refer to Table 1
GSM type	Small Mobile Station
Transmission power	GSM/GPRS power grade: -- GSM 850 and EGSM900: 4 (2W) -- DCS1800 and PCS 1900: 1 (1W)
Temperature range	● Normal operation: -30℃ ~ +80℃ ● Extended operation temperature: -40℃ ~ +85℃ ● Storage temperature: -45℃ ~ +90℃

Data GPRS	● GPRS data downlink transfer: max 85.6 kbps ● GPRS data uplink transfer: max 85.6 kbps
SIM interface	Support SIM card: 1.8V, 3V
Serial port	● Default one full modem serial port ● Can be used for AT commands or data stream ● Support RTS/CTS hardware handshake and software ON/OFF flow control ● Multiplex ability according to GSM 07.10 Multiplexer Protocol ● Can be used for debugging and upgrading firmware
Physical characteristics	Size: 17.6*15.7*2.4 mm Weight: 1.37g
Firmware upgrade	DBG serial port

※ Note

Module is able to make and receive voice calls, data calls, SMS and make GPRS/UMTS/HSPA+/LTE traffic in -40℃ ~ +85℃. The performance will be reduced slightly from the 3GPP specifications if the temperature is outside the normal operating temperature range and still within the extreme operating temperature range.

1.5 Operation Mode

Table 3: GSM operation mode

Mode	Function	
Normal operation	GSM SLEEP	In this case, the current consumption of module will reduce to the minimal level. In sleep mode, the module can still receive paging message and SMS.
	GSM IDLE	Software is active. Module is registered to the GSM network, and the module is ready to communicate.
	GSM TALK	Connection between two subscribers is in progress. In this case, the power consumption depends on network settings and module configuration.
	GPRS STANDBY	Module is ready for GPRS data transfer, but no data is currently sent or received. In this case, power consumption depends on network settings and GPRS configuration.
	GPRS DATA	There is GPRS data transfer (PPP or TCP or UDP) in progress. In this case, power consumption is related with network settings (e.g. power control level); uplink/downlink data rates and GPRS configuration (e.g. used multi-slot settings).
Power off	Normal power off by sending AT command “AT+CPOWD=1” or using the PWRKEY. The power management unit shuts down the power supply for the internal part of the module. Only keep RTC power on. Software is not active. The serial port is not accessible. Power supply (connected to VBAT) remains applied.	

2 Package Information

2.1 Pin Out Diagram

TR800 has 45 pins, which provide all the hardware interface.

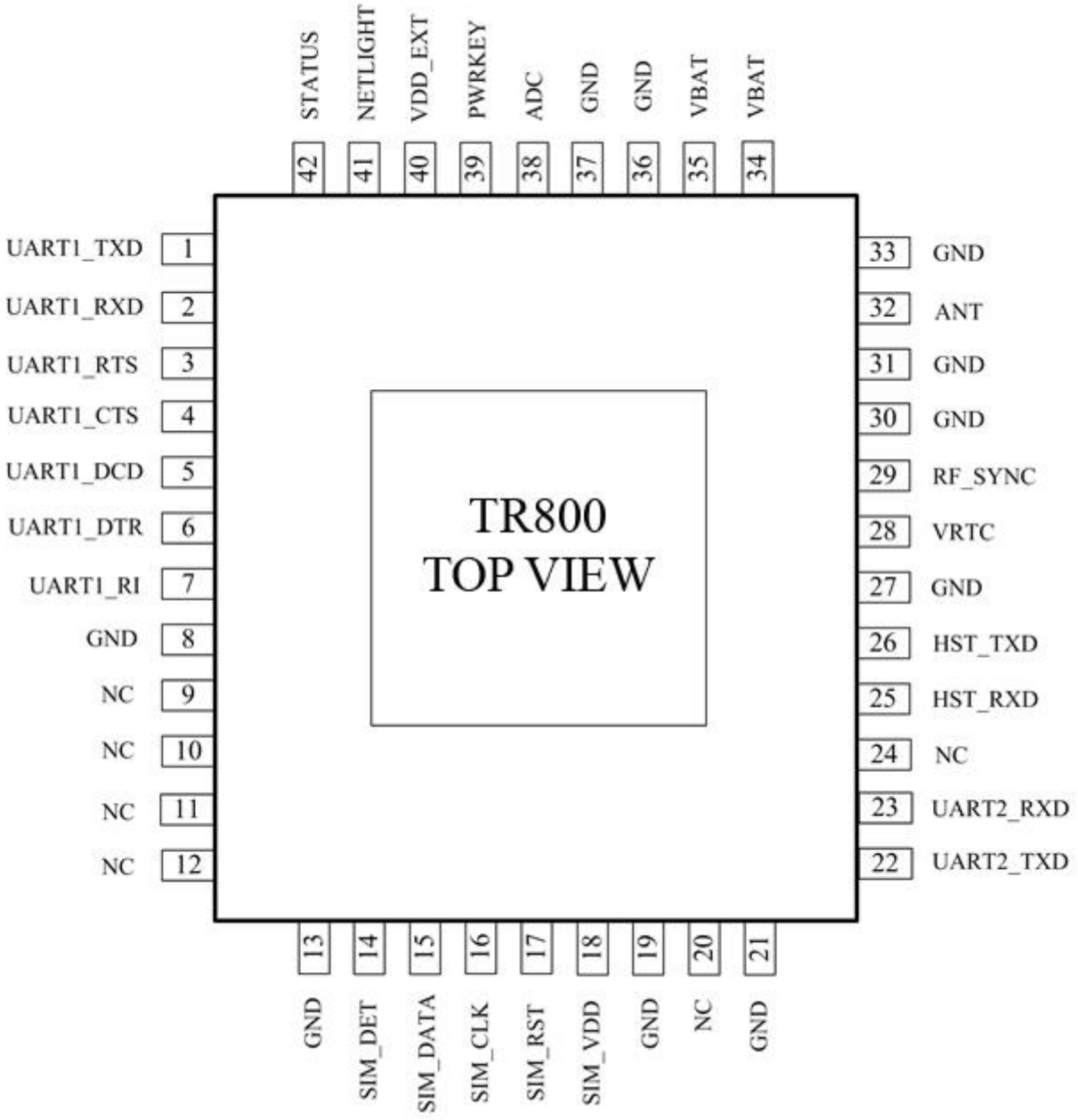


Figure 2: Pin out Diagram (Top view)

2.2 Pin Description

Table 4: Pin description

Pin name	Pin number	I/O	Description	Comment
Power supply				
VBAT	34，35	I	Power supply	3.4V ~4.2V
VDD_EXT	40	O	2.98V,50mA current output	If these pins are unused, keep open.
GND	8,13,19,21,27,30, 31,33,36,37		Ground	GND for VBAT recommend to use 40,41pin.
Power on/down				
PWRKEY	39	I	PWRKEY should be pulled low and then released to power on/down the module.	Internally pulled up to 2.6V.
VRTC				
VRTC	28	I/O	Power supply for RTC	Connect to the back-up battery.
GPIO				
NETLIGHT	41	O	Network status	If these pins are unused, keep open.
STATUS	42	O	Module status	
Serial port				
UART1_DTR	6	I	Data terminal ready	If these pins are unused, keep open.
UART1_RI	7	O	Ring indicator	
UART1_DCD	5	O	Data carrier detect	
UART1_CTS	4	O	Clear to send	
UART1_RTS	3	I	Request to send	
UART1_TXD	1	O	Transmit data	
UART1_RXD	2	I	Receive data	
UART2_TXD	22	O	Transmit data	
UART2_RXD	23	I	Receive data	
HST_RXD	25	I	Debug and download	If these pins are unused, reserved for testing
HST_TXD	26	O		
ADC				
ADC	38	I	10bit general analog to digital converter	If these pins are unused, keep open.
SIM card interface				
SIM1_VDD	18	O	1.8V/3V power supply for SIM card	All pins are reserved for TVS to protect against ESD.
SIM1_DATA	15	I/O	SIM data input/output	
SIM1_CLK	16	O	SIM clock	

SIM1_RST	17	O	SIM reset	
SIM1_DET	14	I	SIM card detection	Multifunction for SIM_DET and DTR, Default is DTR. Enabled by AT+CSDT command.
Antenna interface				
ANT	32	I/O	Connect to GSM antenna	
Synchronizing signal of RF				
RF_SYNC	29	O	Synchronizing signal of RF	If these pins are unused, keep open.
Other pins				
NC	9,10,11,12,20, 24			If these pins are unused, keep open.

2.3 Package Dimensions

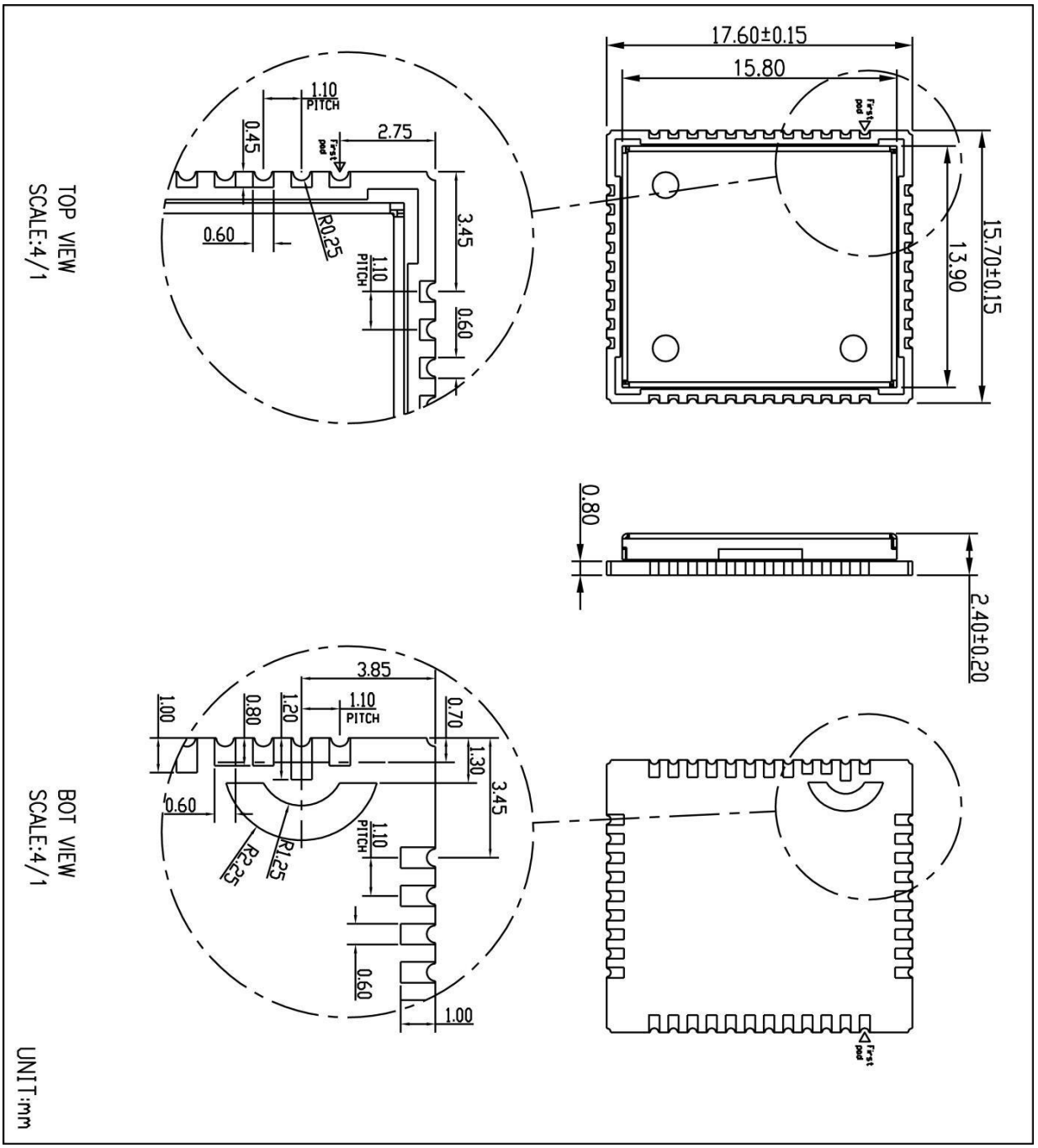


Figure 3: Dimensions of TR800 (Unit: mm)

2.4 Recommended PCB footprint

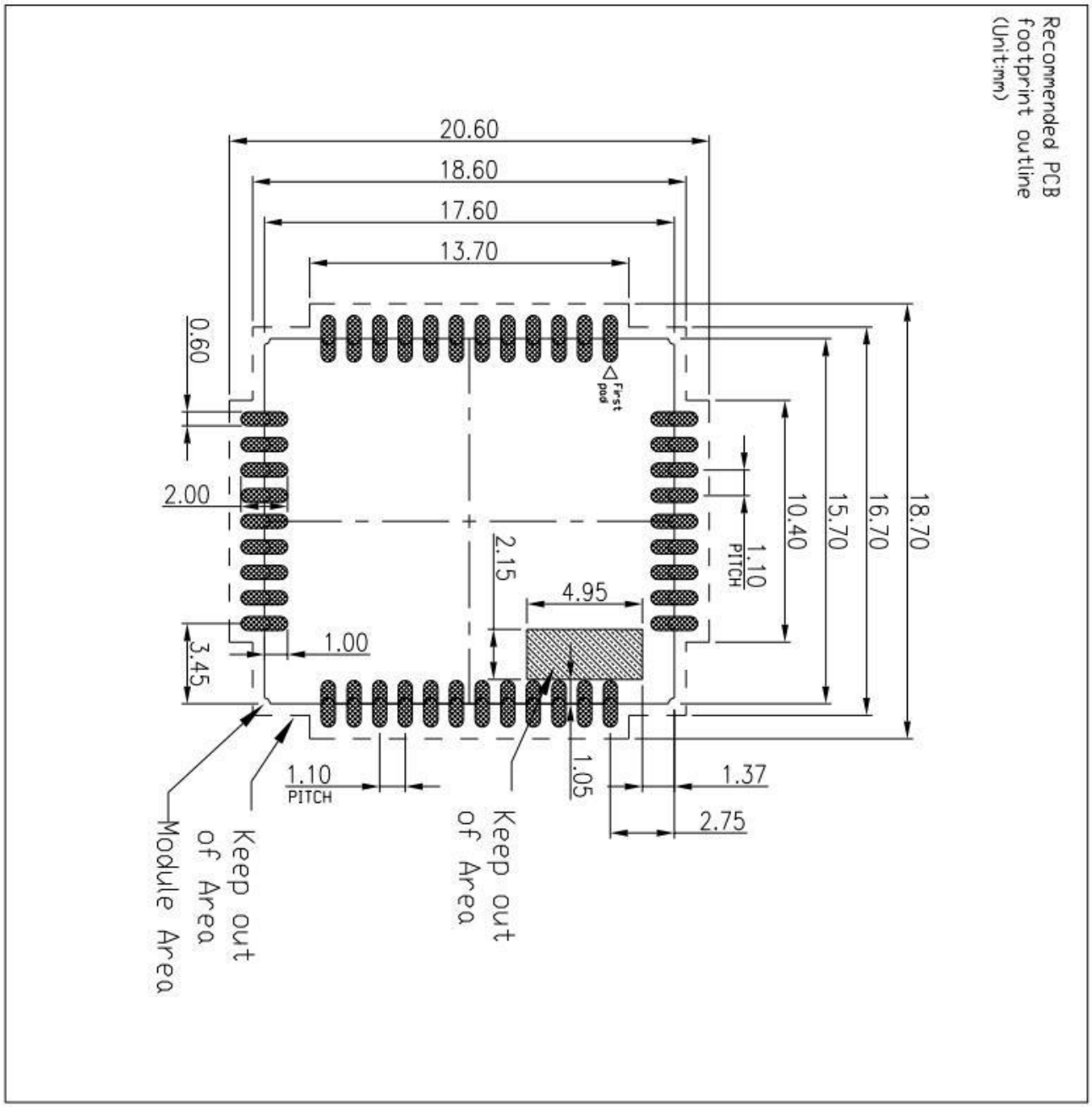


Figure 4: Recommended PCB footprint outline (Unit: mm)

2.5 SMT stencil

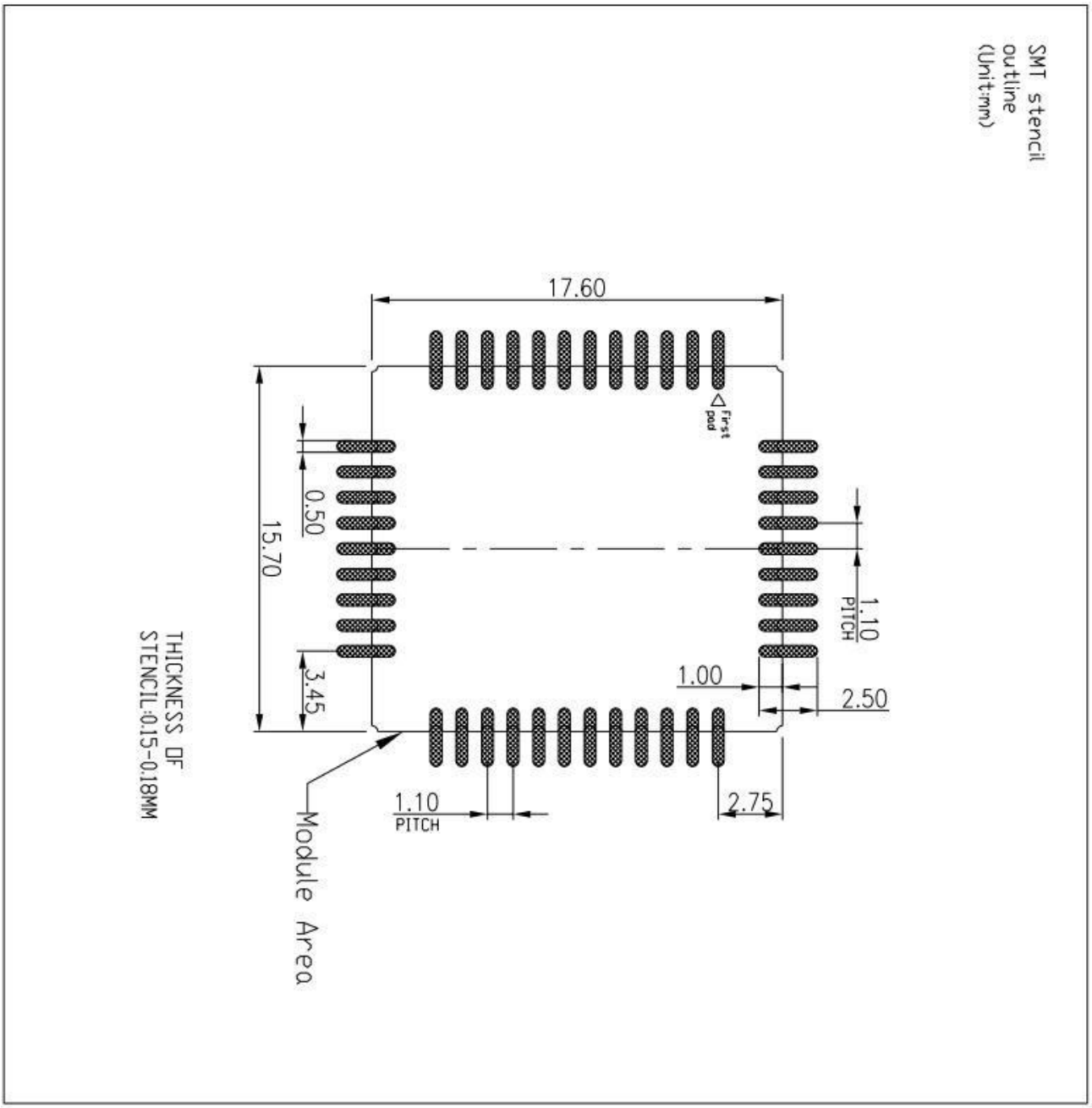


Figure 5: Recommended SMT stencil footprint outline (Unit: mm)

Recommended thickness of SMT stencil is: 0.13mm

3 Interface Application

3.1 Power Supply

3.1.1 Power Supply

VBAT has the range from 3.4V to 4.2V, recommended voltage is 3.8V. The transmitting burst will cause voltage drop in VBAT and the power supply must be able to provide sufficient current up to 2A.

For the VBAT input, 3 or 4 100uF Tantalum capacitor (Ca low ESR) and a 1uF~10uF Ceramics capacitor Cb are strongly recommended. Increase the 33pF and 10pF capacitors in parallel can effectively eliminate the high frequency interference. A TVS diode is strongly recommended, the diode can prevent chip from damaging by the voltage surge. These capacitors and TVS diode should be placed as close as possible to TR800 VBAT pins.

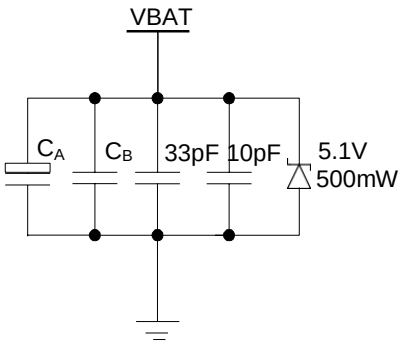


Figure 6: Reference circuit of the VBAT input

Table 5: Recommended TVS diode

No.	Manufacturer	Part Number	V_{RWM}	Package
1	JCET	ESDBW5V0A1	5V	DFN1006-2L
2	Prisemi	PESDHC2FD4V5BH	4.5V	DFN1006-2L
3	WAYON	WS05DPF-B	5V	DFN1006-2L
4	WILL	ESD5611N	5V	DFN1006-2L
5	WILL	ESD56151W05	5V	SOD-323
6	WAYON	WS4.5DPV	4.5V	DFN1610-2L

When designing the power supply in customers' application, pay special attention to power losses. Ensure

that the input voltage never drops below 3.4V even when current consumption rises to 2A in the transmit burst. If the power voltage drops below 3.4V, the module may be shut down automatically. The PCB traces from the VBAT pins to the power supply must be wide enough (at least 60mil) to decrease voltage drops in the transmit burst.

3.1.2 Reference circuit for power supply

DC input voltage is +5V, the reference circuit of LDO power supply as shown in figure below:

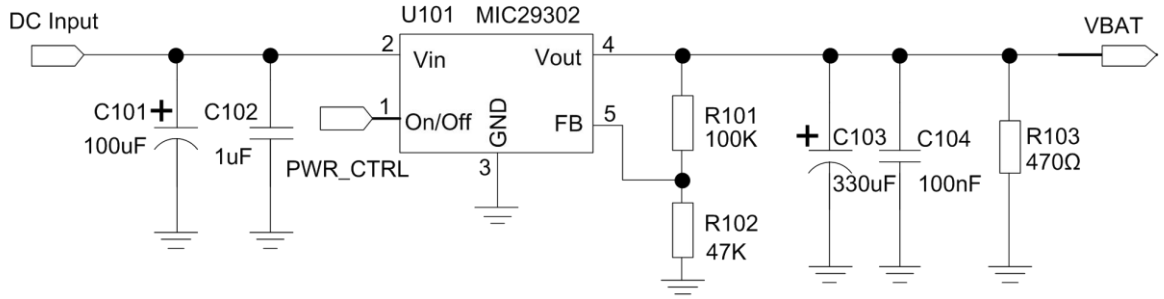


Figure 7: Reference circuit of the LDO power supply

If there is a high drop-out between the input (DC) and the desired output (VBAT), a DC-DC power supply will be preferable because of its better efficiency especially with the 2A peak current in burst mode of the module. The following figure is the reference circuit.

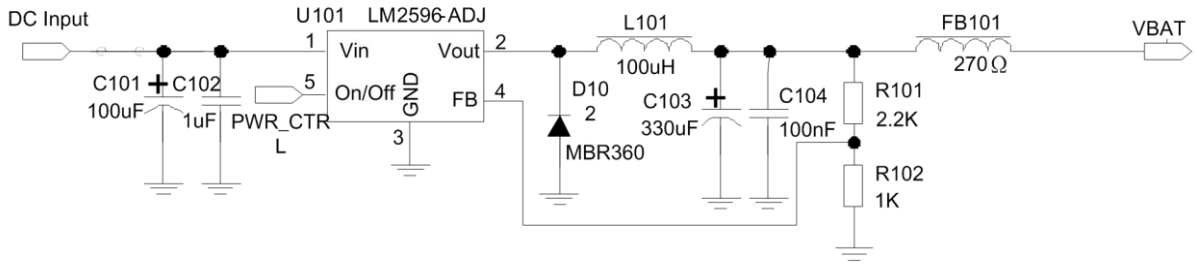


Figure 8: Reference circuit of the DC-DC power supply

The single 3.8V Li-ion cell battery can be connected to TR800 VBAT pins directly, as well as the Ni-Cd or Ni-MH battery, but must be pay attention to their maximum voltage cannot rise over the absolute maximum voltage of the module, or the module will damage. When battery is used, the total impedance between battery and VBAT pin should be less than 150mΩ.

3.2 Power on/off

3.2.1 Power on

Customer can power on module by pulling down the PWRKEY pin for at least 1.6 second and release. This pin has already pulled up to 2.6V in the module internal. Reference circuits are shown as below in Figure 9 and Figure 10.

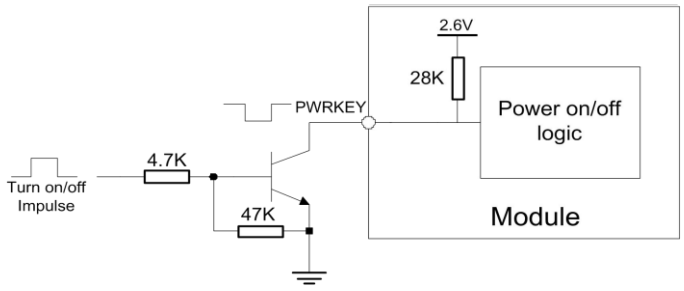


Figure 9: Powered on/down module using transistor

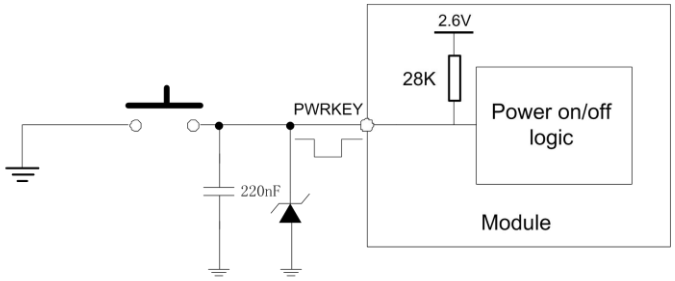


Figure 10: Powered on/down module using button

Table 6: Power on timing parameters

Symbol	Description	Min	Typ	Max	Unit
T1	Width of low pulse when power on	1.6	2	-	S
T2	VDD_EXT rising time	-	15	-	ms
T3	Time of UART function works normally	-	2.5	-	S
VIL	Low input voltage of PWRKEY	-		0.78	V
VIH	High input voltage of PWRKEY	1.82	-	-	V

※ Note

VDD_EXT will rise to 2.8V immediately after pressing the PWRKEY.

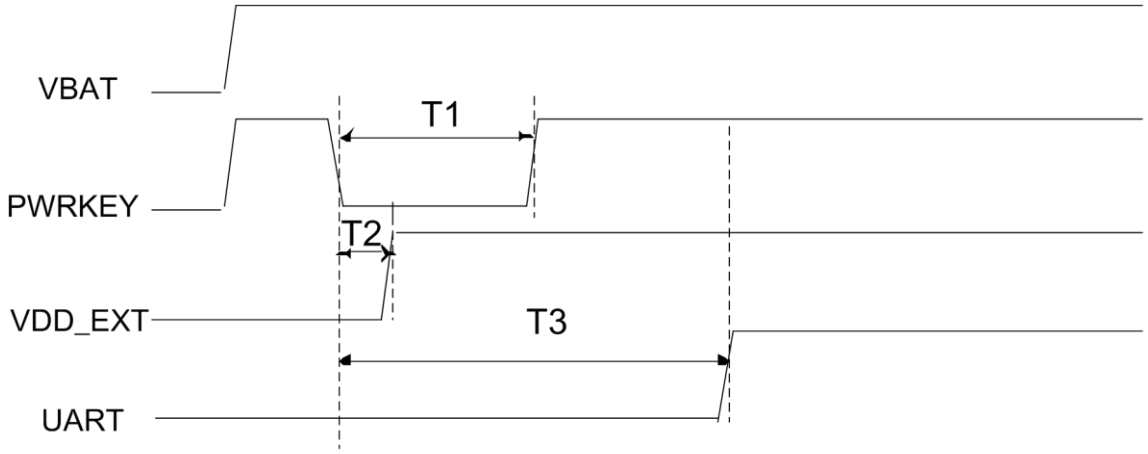


Figure 11: Timing of power on module

3.2.2 Power off

Module will be powered off in the following situations:

(1) Power off module by PWRKEY pin.

(2) Power off module by AT command.

3.2.3 Power off module by PWRKEY pin

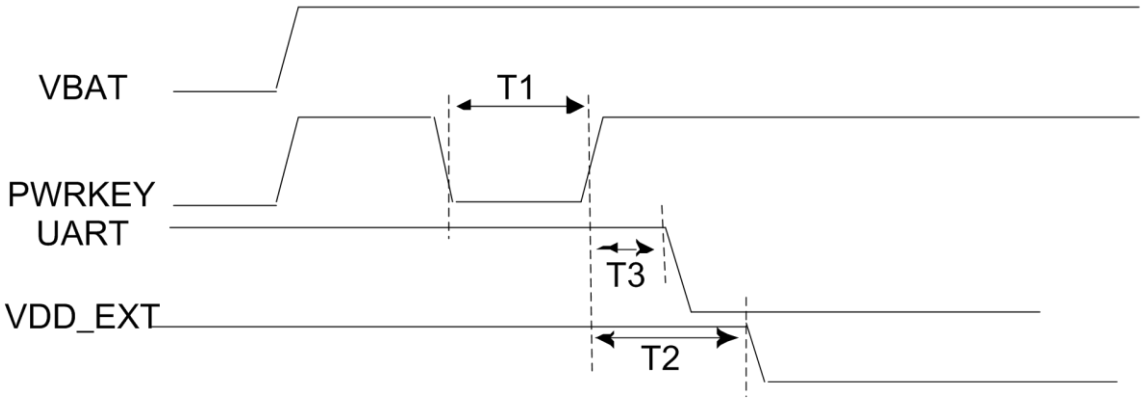


Figure 12: Timing of power off module by PWRKEY

Table 7: Power off timing parameters

Symbol	Description	Min	Typ	Max	Unit
T1	Width of low pulse when power off	800	1000	-	mS
T2	VDD_EXT falling time	-	1.2	-	S
T3	Time of UART out of function		1.2		S
VIL	Low input voltage of PWRKEY	-		0.78	V
VIH	High input voltage of PWRKEY	1.82		-	V

3.2.4 Power off module by AT command

Customer can use AT command “AT+CPOWD=1” to power off the module. This procedure makes the module log off from the network and allows the software to enter into a secure state to save data before completely shut down.

Module will enter power off mode and AT commands can’t be executed any more.

※ Note

For detail about AT command “AT+CPOWD”, please refer to document [1].

3.3 Power Saving Mode

TR800 has two power saving modes: Flight mode and sleep mode. AT command “AT+CSCLK=1” can be used to set module into sleep mode 1 or “AT+CSCLK=2” can be used to set module into sleep mode 2. In sleep mode, the current consumption is low. AT command “AT+CFUN=<fun>” can be used to set module into flight mode. When module set to flight mode and in sleep mode, the current of module is lowest.

3.3.1 Flight Mode

Flight mode minimizes the function to the lowest level, which means the current consumption also to the lowest level. The module is set to the mode by AT command “AT+CFUN=<fun>”, the command has two choice of the functionality levels to set different function.

- AT+CFUN=4： Flight mode.
- AT+CFUN=1： Full functionality (default).

After setting “AT+CFUN=4”, the module will into the flight mode, the RF function will be disabled. In this case, the serial port is still accessible, but partial AT commands and correlative to RF function will not be accessible.

When the module in the flight mode, it can recover to full functionality mode by the command “AT+CFUN=1”

※ Note

For detailed information about AT command “AT+CFUN+<fun>”,please refer to document[1].

3.3.2 Sleep Mode 1

After the customer set the module by “AT+CSCLK=1”, if the module in standby status and the DTR in high level, without any other interrupt (such as GPIO interrupt, voice or SMS), the module will enter sleep mode automatically. In this mode, the module can still receive paging or SMS from network but the serial port is not accessible.

When the module in sleep mode 1, the following methods can wake up it:

- Receive external interrupt.
- Receive a voice or data call from network.
- Receive a SMS from network.
- Pull down DTR pin.

※ Note

After Module has received incoming call or new SMS, serial port can report URC, but the serial port Cannot input AT command. Only after the DTR pin is pulled to low level, the serial port can input AT Command.

3.3.3 Sleep Mode 2

If the circuit are designed in 2 lines serial port, the customer can only use the sleep mode 2. After setting the module by “AT+CSCLK=2”, it will continuously monitor the serial port data signal. When there is no data input to the serial port on the module and there is no on other interrupts (such as GPIO interrupt, voice or SMS), the module will enter sleep mode 2 automatically. In this mode, the module can still receive paging orSMS from network.

When the module is in sleep mode 2, the following methods can wake up it:

- Receiving the data via the serial port.

- Receive external interrupt signal.
- Receive a voice or data call from network.
- Receive a SMS from network.

3.4 Serial Port

The module default provides a full functional serial port and a 2 lines serial port. The module is designed as a DCE (Data Communication Equipment). Based on the traditional DCE-DTE (Data Terminal Equipment) connection, the pin definitions are listed in Table 7:

Table 8: Serial port pin definition

	Pin name	Pin number	Function	
Serial port	UART1_DTR	6	Data terminal ready	If these pins are unused, keep open. 2.8V voltage range. DBG serial port for software upgrading, log data collecting and RF calibration.
	UART1_RI	7	Ring indicator	
	UART1_DCD	5	Data carrier detect	
	UART1_CTS	4	Clear to send	
	UART1_RTS	3	Request to send	
	UART1_TXD	1	Transmit data	
	UART1_RXD	2	Receive data	
	UART2_TXD	22	Transmit data	
	UART2_RXD	23	Receive data	
	HST_RXD	25	Receive data	
	HST_TXD	26	Transmit data	

※ Note

1) When the hardware flow control is required by customer, RTS, CTS must be connected to DTE.
2) Hardware flow control is disable by default, AT command “AT+IFC=2, 2” can enable hardware flow control.

Table 9: Serial port characteristics

Symbol	Min	Max	Unit
VIL	-	0.89	V
VIH	2.08	3.0	V
VOL	-	0.4	V
VOH	2.78	-	V

3.4.1 Serial port function

TR800 provides three serial ports, one main serial port, one download & debugging serial port and one auxiliary serial port.

Main serial port:

- Support modem device.
- Contain data lines TXD and RXD, status lines RTS and CTS, hardware flow control lines DTR, DCD and RI.
- The module supports the following baud rates:

1200, 2400, 4800, 9600, 14400, 19200, 28800, 33600, 38400, 57600, 115200, 230400, 460800, 921600bps, 115200bps by default.

The baud rate is 115200bps by default. Autobauding allows TR800 to automatically detect the baud rate of the host device. Pay more attention to the following requirements:

Synchronization between DTE and DCE:

- When DCE powers on with autobauding enabled, it is recommended to delay 2-3 seconds to send "AT" or "at" or "aT" or "At" to synchronize the baud rate.
- When DTE receives the "OK" response, which means DTE and DCE are correctly synchronized. For more information, please refer to AT command "AT+IPR".

Configuration of autobauding operation:

- The DTE serial port must be set at 8 data bits, no parity and 1 stop bit, no data flow control.
- When power on DTE under autobauding enable, the synchronization between DCE and DTE does not finish, the module cannot be detected and the URC such as "RDY", "+CFUN: 1" and "+CPIN: READY" will be reported.

Download & debugging serial port:

- DBG_TXD & DBG_RXD serial port for software upgrading, log data collecting and RF calibration.

Auxiliary serial port:

- AUX_TXD & AUX_RXD is a 3 lines auxiliary serial port.

3.4.2 Serial port interfaces

When customer uses the full modem serial port, please refer to Figure 13. The following figure shows the connection between module and client (DTE).

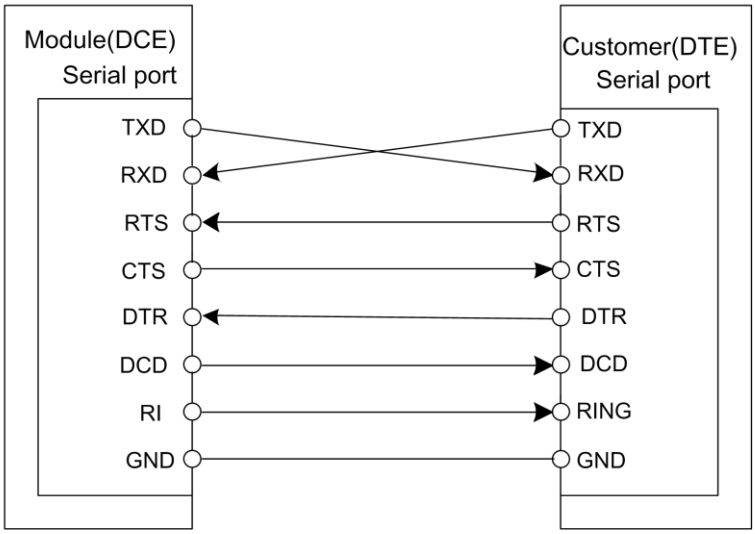


Figure 13: Connection of the serial interfaces

If the voltage of UART is 5V, the following reference circuits are recommended. TX level matching circuit and RX level matching circuit are listed here, the other pins please refer to Figure 14 and Figure 15.

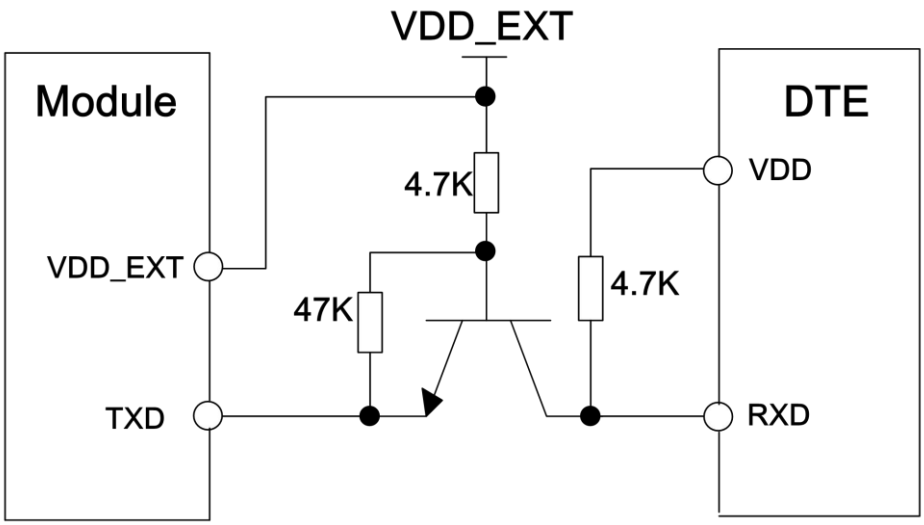


Figure 14: TX level matching circuit

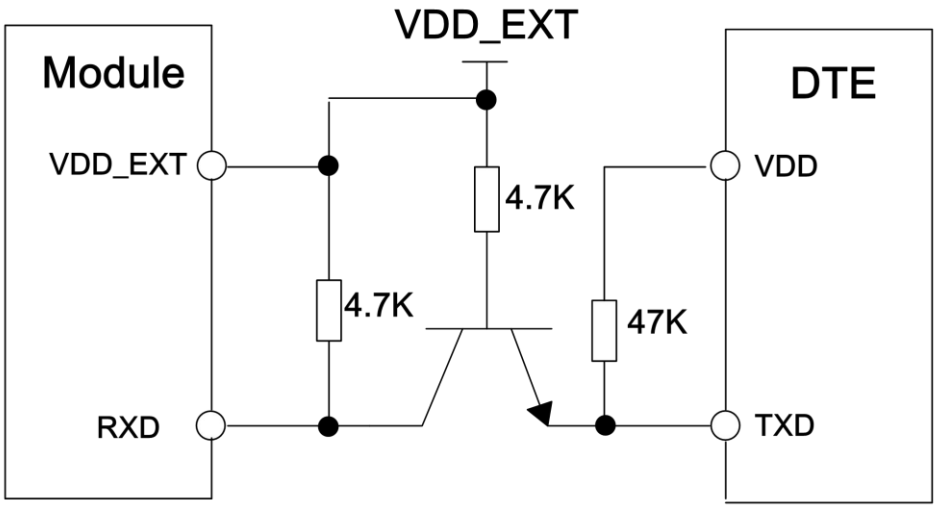


Figure 15: RX level matching circuit

3.4.3 RI signal behaviors

Table 10: RI signal behaviors

State	RI response
Standby	High
Voice call	The pin is changed to low, then: （1） Establish the call then changed to high. （2） Hang up the call then changed to high. （3） AT command “AT+ATH” to hang up then changes to high.
SMS	The pin is changed to low, and kept low for 120ms when a SMS is received. Then it is changed to high.
Others	For more details, please refer to document [2].

The behavior of the RI pin is shown in the following figure 16 when the module is used as a receiver.

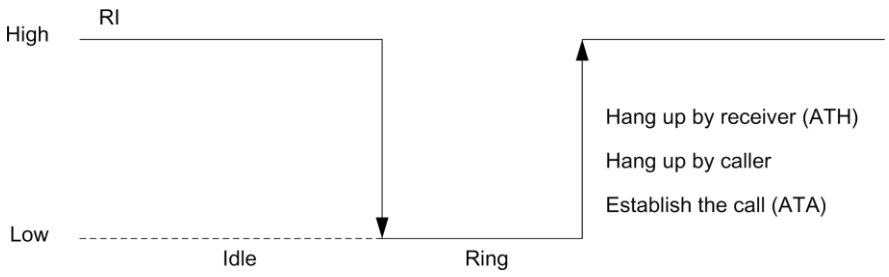


Figure 16: RI behavior of voice calling as a receiver

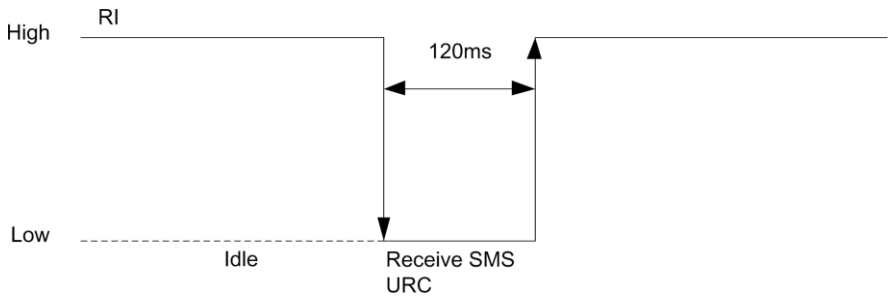


Figure 17: RI behavior of URC or receive SMS

If the module is used as caller, the RI will remain high. Please refer to the following figure.

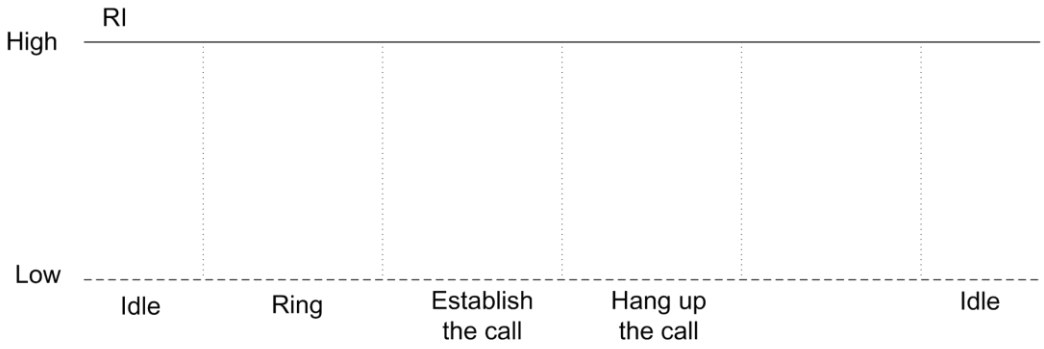


Figure 18: RI behavior as a caller

3.5 SIM Card Interface

The SIM interface complies with the GSM Phase 1 specification and the new GSM Phase 2+ specification and FAST 64kbps SIM card.
Both 1.8V and 3.0V SIM card are supported. The SIM interface is powered from an internal regulator in the module.

Table 11: SIM card pin definition

Pin name	Pin number	Function
SIM1_VDD	18	Voltage supply for SIM card. Support 1.8V or 3V SIM card depends on SIM card type
SIM1_DATA	15	SIM data input/output
SIM1_CLK	16	SIM clock
SIM1_RST	17	SIM reset
SIM1_DET	14	SIM card detection

It is recommended to use an ESD protection component such as ST (www.st.com) ESDA6V1-5W6 to protect SIM card. In figure 19, 22Ω resistor series in the port to match the resistance between the module and SIM card, SIM_DATA has internal 10K pull-up resistor. The SIM card peripheral components should be placed close to the SIM card holder. The reference circuit of the 8-pin SIM card holder is illustrated in the following figure 19.

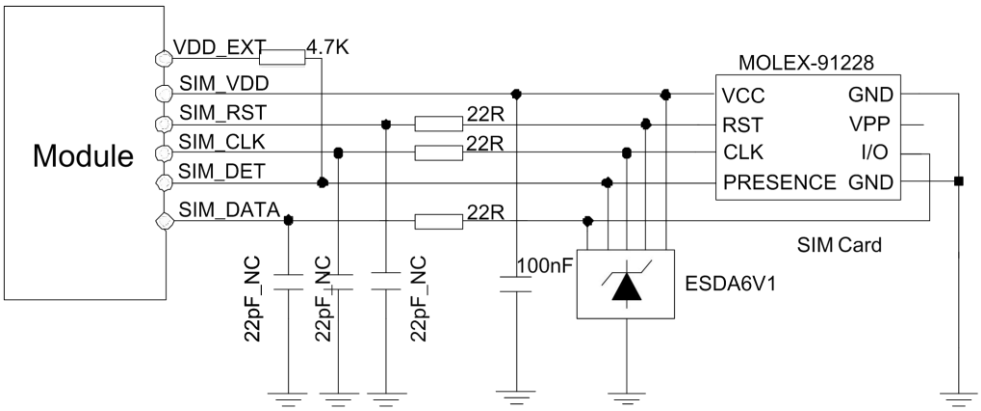


Figure 19: Reference circuit of the 8-pin SIM card holder

※ Note

Note 1:

Plug/Unplug the SIM card will affect the network login/logout, ensure the time interval more than 2 seconds every time or cannot detect the SIM card.

Note 2:

SIM_DET has multifunction with DTR, which DTR by default, either SIM_DET will work normally or DTR, if SIM_DET is required, it can be enabled by AT command.

If the SIM card detection function is not used, customer can keep the SIM_DET pin open. The reference circuit of 6-pin SIM card holder is illustrated in the following figure.

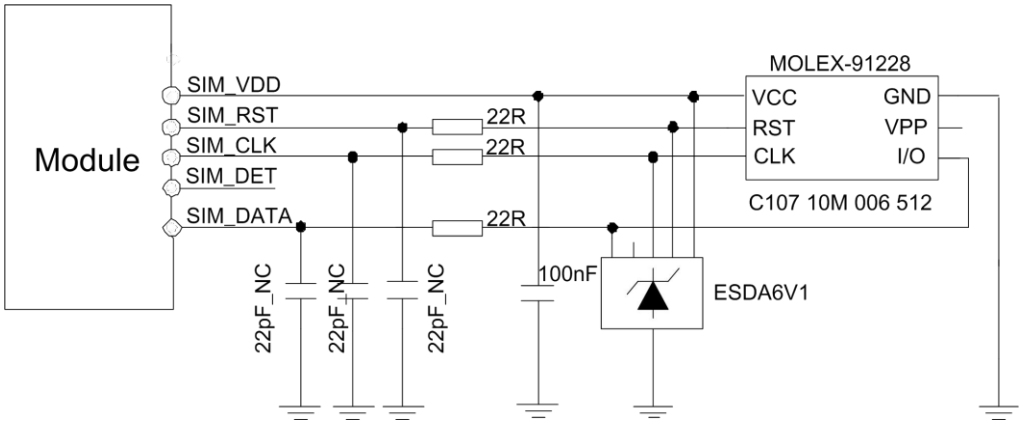


Figure 20: Reference circuit of the 6-pin SIM card holder

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

- 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
- Recommended to place a 100nF capacitor on SIM_VDD line and keep close to the SIM card holder
- Add some TVS which parasitic capacitance should not exceed 50pF, add 22Ω resistor to (SIM_RST/SIM_CLK/SIM_DATA) signal could enhance ESD protection

3.6 VRTC

When VBAT out of power, external back-up battery or LDO as the input to VRTC.
Table 12: VRTC voltage range

Parameter	Min	Typ	Max	Unit
Voltage range	2.99	3.1	3.39	V

Figure 21 and figure 22 are recommended circuit for VRTC.

- Back-up rechargeable battery

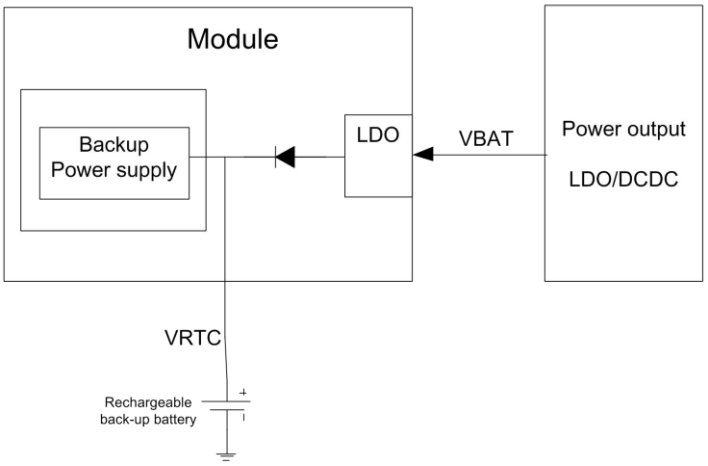


Figure 21: RTC rechargeable battery

- External power supply

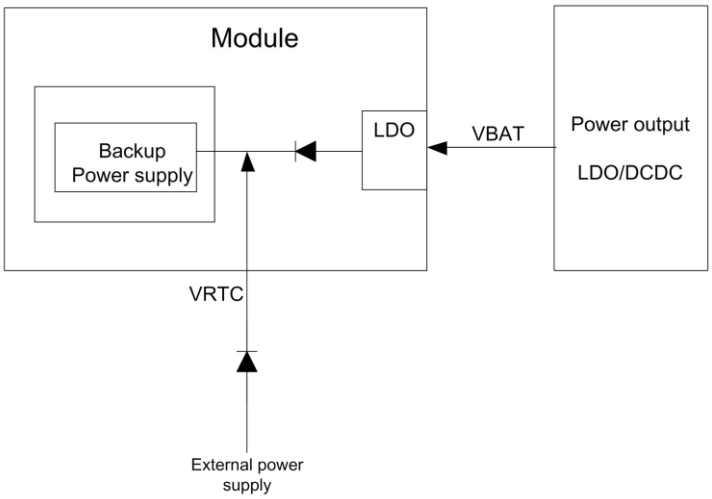


Figure 22: External power supply

3.7 ADC

Table 13: Pin definition of ADC

Pin name	Pin number	Description
ADC	9	Analog voltage input

TR800 provides one ADC, customer can use AT command “AT+CADC?” to read the voltage value.

※ Note

For details of this AT command , please refer to document [1].

Table 14: ADC specification

Parameter	Min	Typ	Max	Unit
Voltage range	0	-	1.85	V
ADC resolution	-	10	-	bits
ADC sampling rate	-	-	1.08	MHz
ADC precision		20	50	mV

3.8 Network Status Indication

Table 15: Pin definition of NETLIGHT

Pin name	Pin number	Description
NETLIGHT	41	Network Status Indication

The NETLIGHT pin can be used to drive a network status indication LED. The status of this pin is listed in following table:

Table 16: Status of NETLIGHT pin

Status	Behavior
Off	Powered off
64ms On/ 800ms Off	Not registered the network
64ms On/ 3000ms Off	Registered to the network
64ms On/ 300ms Off	GPRS communication is established

Reference circuit is recommended in the following figure:

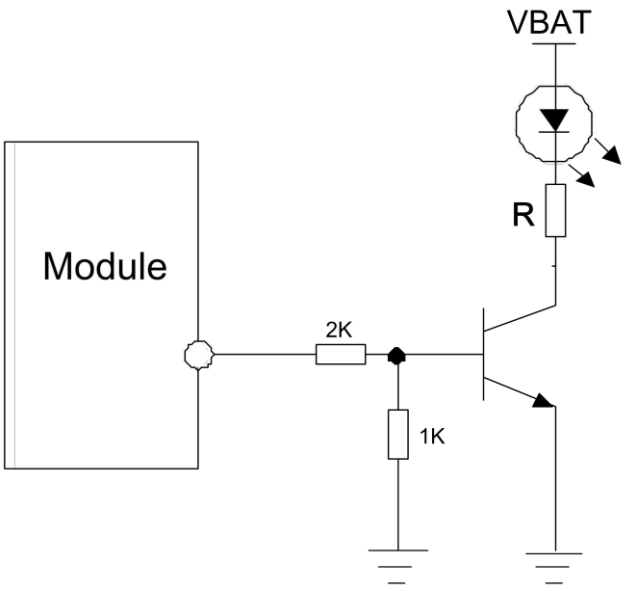


Figure 23: Reference circuit of NETLIGHT

3.9 module Status Indication

TR800 provides one PIN can be used to drive a module status indication MODULE IS POWER ON or POWER OFF . The status of this pin is listed in following table:

.

Table 17: Pin definition of audio interface

Pin name	Pin number	Description
STATUS	H	module Status POWER ON
	L	module Status POWER OFF

Reference circuit is recommended in the following figure:

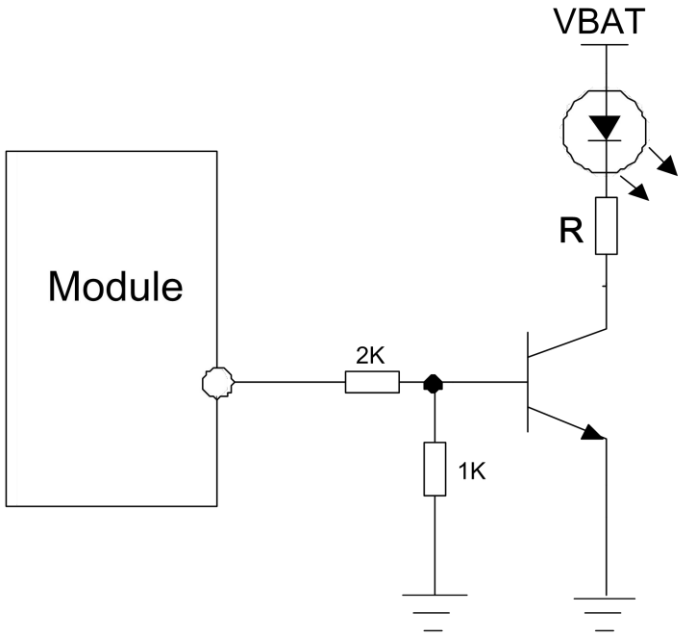


Figure 24: Reference circuit of status PIN

3.10 RF Synchronization Signal

RF_SYNC outputs a 220us high level signal before GSM burst to indicate the RF transmission. Pin definition is showed in the following table:

Table 18: RF_SYNC pin definition

Pin name	Pin number	Description
RF_SYNC	29	Transmit synchronization signal

The timing of RF_SYNC is shown as below:

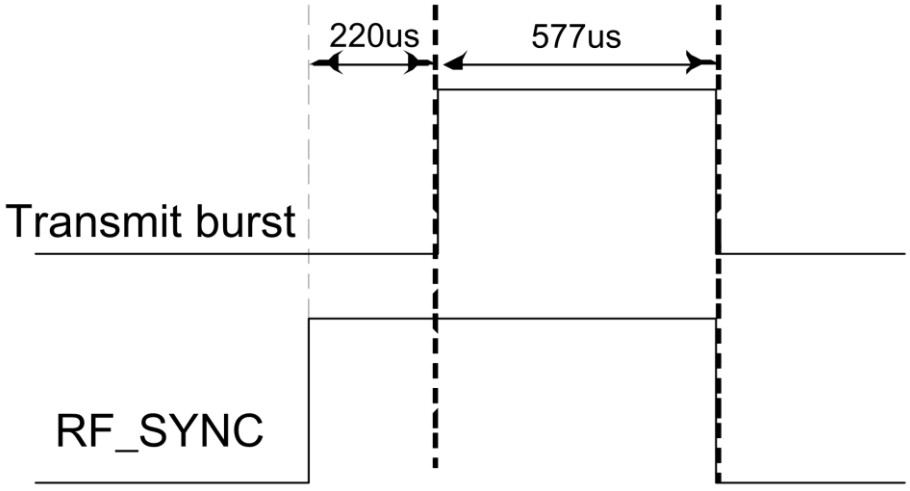


Figure 25: RF_SYNC signal during transmit burst

4 RF Parameter

4.1 GSM antenna interface:

The input impendence of the antenna should be 50Ω, and the VSWR should be less than 2.

※ Note

About the RF trace layout please refer to “AN_SMT Module_RF_Reference Design Guide”.

GSM antenna pin is ANT pin (Pin35), customer could use 50Ω microstrip line or stripline antenna connect to the module.

Add a RF connector and GSM antenna matching circuit for the debugging and certification testing, the reference circuit as shown in figure 29.

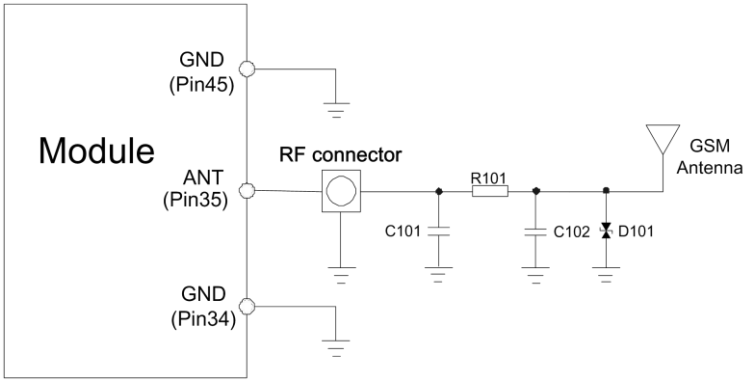


Figure 26: GSM antenna matching circuit

R101，C101，C102 are the matching circuit, the value should be defined by the antenna design. Normally R101 is 0Ω, D101 refer to the table 19, C101 and C102 are not mounted.

If the space between RF pin and antenna is not enough or the RF connector is not required in the design, the matching circuit should be designed as in the following figure:

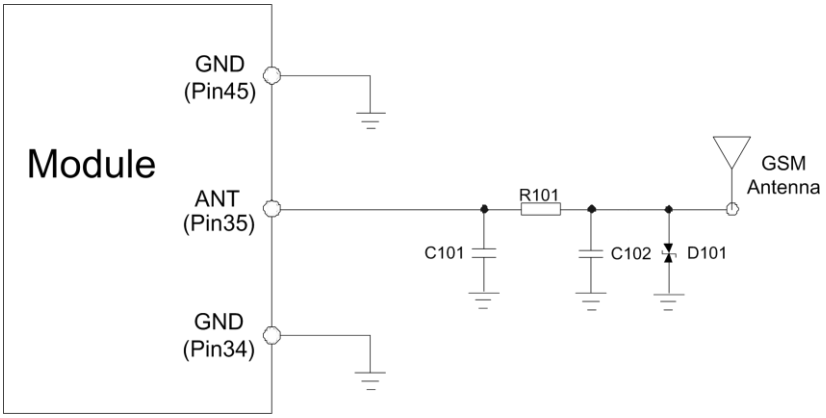


Figure 27: GSM antenna matching circuit without RF connector

Normally R101 is 0Ω, D101 refer to the table 19, C101 and C102 are not mounted.

Table 19: Recommended TVS component

Package	Type	Supplier
0201	LXES03AAA1-154	Murata
0402	LXES15AAA1-153	Murata

4.2 PCB Layout

This section will give some guidelines on PCB layout, in order to eliminate interfere or noise, shorten the development time.

4.2.1 Antenna Interface

- The length of trace between pin output and connector should be as short as possible.
- The RF trace should be 50Ω impedance.
- Do not trace RF signal across or parallel with other signals.

4.2.2 Power supply

- Not only VBAT but also return GND are very important in layout.
- The positive line of VBAT should be as short and wide as possible.
- The correct flow from source to VBAT pin should go through TVS diode then huge capacitor.
- Pin 42 and Pin 43 are GND signals, and shortest layout to GND of power source should be designed
- Drill the hole as many as possible around GND pins in the module to ensure the integrity of GND of PCB.

4.2.3 SIM card interface

- Ensure SIM card holder is far away from antenna or RF cable inside.
- Put SIM card holder near the module, as nearer as possible.
- Add ESD component to protect SIM_CLK, SIM_DATA, SIM_RST and SIM_VDD signals.
- DATA signal should be far away from the power supply and high-speed-frequency signal.
- The length of data signal should less than 100mm.

5 Electrical Specifications

5.1 Absolute Maximum Ratings

The absolute maximum ratings stated in following table are stress ratings under non-operating conditions. Stresses beyond any of these limits will cause permanent damage to TR800.
Table 20: Absolute maximum ratings

Parameter	Min	Typ	Max	Unit
VBAT	-	-	5	V
VRTC	-	-	3.39	V
VDD_EXT	-	-	2.98	V

5.2 Recommended Operating Conditions

Table 21: Recommended operation values

Parameter	Description	Min	Typ	Max	Unit
VBAT	Power supply voltage	3.4	3.8	4.2	V
VRTC	Backup power input	2.99	3.1	3.39	V

5.3 Digital Interface Characteristics

Table 22: Digital interface characteristics

Parameter	Description	Min	Typ	Max	Unit
VIH	High-level input voltage	2.08	-	3	V
VIL	Low-level input voltage	-	-	0.89	V
VOH	High-level output voltage	2.78	-	-	V
VOL	Low-level output voltage	-	-	0.4	V

5.4 SIM Card Interface Characteristics

Table 23: SIM card interface characteristics

Parameter	Description	Min	Typ	Max	Unit
VIH	High-level input voltage	0.7*SIM_VDD	-	SIM_VDD	V
VIL	Low-level input voltage	0	0	0.3*SIM_VDD	V
VOH	High-level output voltage	SIM_VDD -0.45	-	SIM_VDD	V
VOL	Low-level output voltage	0	0	0.45	V

5.5 SIM_VDD Characteristics

Table 24: SIM_VDD characteristics

Parameter	Description	Min	Typ	Max	Unit
VO	Output voltage	-	2.8	-	V
		-	1.8	-	
IO	Output current	-	-	10	mA

5.6 VDD_EXT Characteristics

Table 25: VDD_EXT characteristics

Parameter	Description	Min	Typ	Max	Unit
VO	Output voltage	2.78	2.80	2.98	V
IO	Output current	-	-	50	mA

5.7 AVDD Characteristics

Table 26: AVDD characteristics

Parameter	Description	Min	Typ	Max	Unit
VO	Output voltage	2.78	2.80	2.98	V
IO	Output current	-	-	50	mA

5.8 VRTC Characteristics

Table 27: VRTC characteristics

Parameter	Description	Min	Typ	Max	Unit
VO	Output voltage	2.78	3.1	3.39	V
IO	Output current	-	800	-	uA

5.9 Current Consumption (VBAT=3.8V)

Table 28: Module current consumption

Parameter	Description	Conditions	Min	Typ	Max	Unit
VBAT	Power supply voltage	Voltage must be between min. value and max. value	-	3.8	-	V
IVBAT	Average current	Power off mode	-	268	-	uA
		Sleep mode(AT+CFUN=4)：	-	836	-	uA
		Data mode GPRS (1Rx,4Tx):				
		GSM850	-	468.46	-	mA
		EGSM900	-	431.25	-	
		DCS1800	-	326.35	-	
		PCS1900	-	287.02	-	
		Data mode GPRS (3Rx,2Tx):				
		GSM850	-	363.55	-	mA
		EGSM900	-	324.34	-	
		DCS1800	-	260.61	-	
		PCS1900	-	222.56	-	
		Data mode GPRS (4Rx,1Tx):				
		GSM850	-	238.23	-	mA
		EGSM900	-	230	-	
		DCS1800	-	182	-	
		PCS1900	-	163.79	-	
IMAX	Peak current	During Tx burst	-	-	2.0	A

※ Note

In above table the current consumption value is the typical one of the module tested in laboratory. In the mass production stage, there may be differences among each individual.

5.10 Electro-Static Discharge

The ESD test results are shown in the following table.

Table 29: ESD characteristics

(Temperature: 25℃, Humidity: 45%, Testing on EVB with TVS)

Pin name	Contact discharge	Air discharge
VBAT/GND	±4KV	±8KV
ANT	±4KV	±8KV
TXD /RXD	±1KV	±2KV
SIM	±1KV	±2KV

5.11 Radio Characteristics

5.11.1 Module RF Output Power

The following table shows the module conducted output power, it is followed by the 3GPP TS 05.05
Table 30: GSM850 and EGSM900 conducted RF output power

GSM850, EGSM900			
PCL	Nominal output power (dBm)	Tolerance (dB) for conditions	
		Normal	Extreme
5	33	±2	±2.5
6	31	±3	±4
7	29	±3	±4
8	27	±3	±4
9	25	±3	±4
10	23	±3	±4
11	21	±3	±4
12	19	±3	±4
13	17	±3	±4
14	15	±3	±4
15	13	±3	±4
16	11	±5	±6

17	9	±5	±6
18	7	±5	±6
19	5	±5	±6

Table 31: DCS1800 and PCS1900 conducted RF output power

DCS1800, PCS1900			
PCL	Nominal output power (dBm)	Tolerance (dB) for conditions	
		Normal	Extreme
0	30	±2	±2.5
1	28	±3	±4
2	26	±3	±4
3	24	±3	±4
4	22	±3	±4
5	20	±3	±4
6	18	±3	±4
7	16	±3	±4
8	14	±3	±4
9	12	±4	±5
10	10	±4	±5
11	8	±4	±5
12	6	±4	±5
13	4	±4	±5
14	2	±5	±6
15	0	±5	±6

5.11.2 Module RF Receive Sensitivity

The following table shows the module's conducted receiving sensitivity.
Table 32: Conducted RF receive sensitivity

Frequency	Receive sensitivity (Typical)	Receive sensitivity (Max)
GSM850, EGSM900	< -108dBm	< -108dBm
DCS1800, PCS1900	< -107.5dBm	< -106.5dBm

5.11.3 Module Operating Frequencies

The following table shows the module's operating frequency range; it is followed by the 3GPP TS 05.05 technical specification requirement.
Table 33: Operating frequencies

Frequency	Receive	Transmit
GSM850	869 ~ 894MHz	824 ~ 849MHz
EGSM900	925 ~ 960MHz	880 ~ 915MHz
DCS1800	1805 ~ 1880MHz	1710 ~ 1785MHz
PCS1900	1930 ~ 1990MHz	1850 ~ 1910MHz

6 SMT Production Guide

6.1 Top and Bottom View of TR800

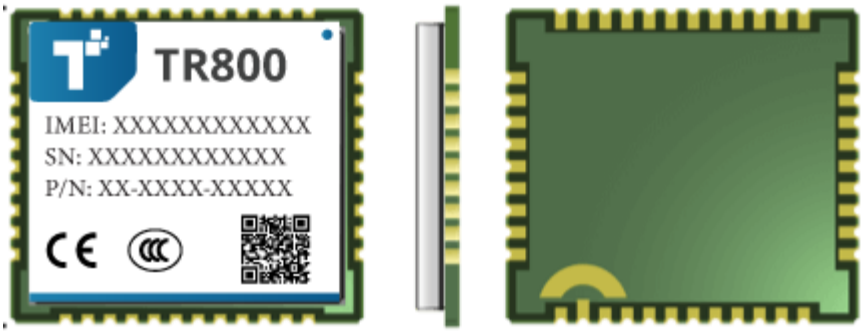


Figure 28: Top and bottom view of TR800

※ Note

The above is module design drawing, only for reference, please refer to the actual product.

6.2 Typical Solder Reflow Profile

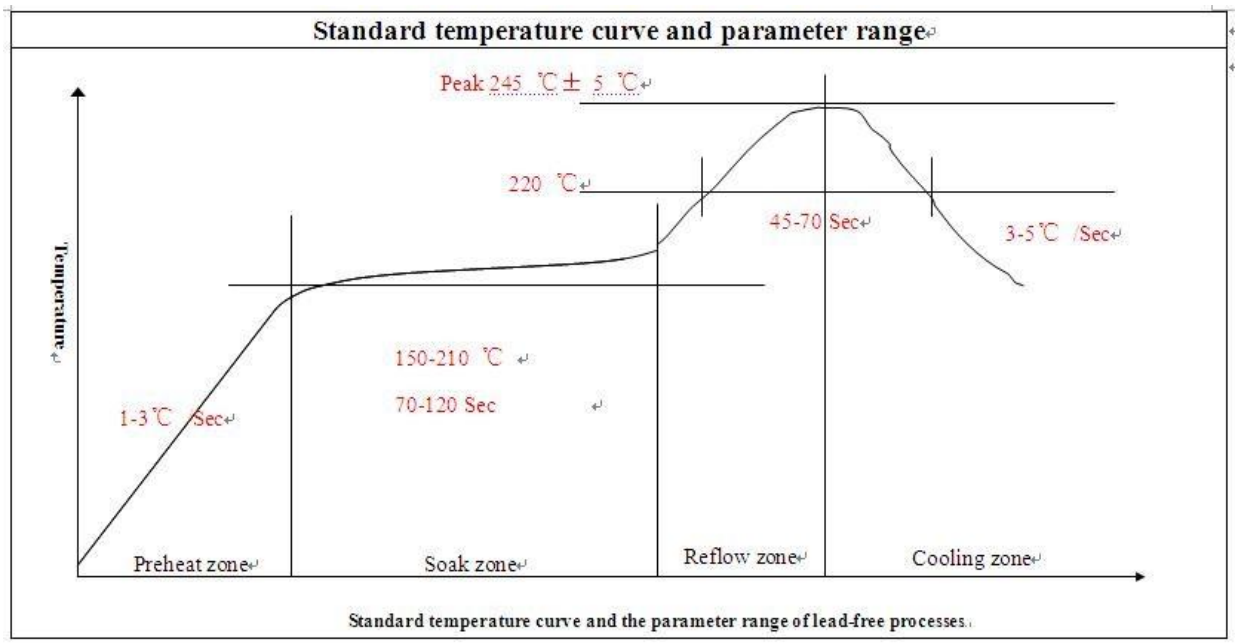


Figure 29: Typical solder reflow profile of lead-free processes

6.3 The Moisture Sensitivity Level

The moisture sensitivity level of TR800 module is 3.

The modules should be mounted within 168 hours after unpacking in the environmental conditions of temperature <30℃ and relative humidity of <60% (RH). It is necessary to bake the module if the above conditions are not met.

Table 34: Moisture sensitivity level and floor life

Moisture Sensitivity Level (MSL)	Floor Life (out of bag) at factory ambient≤30°C/60% RH or as stated
1	Unlimited at ≦30℃/85% RH
2	1 year
2a	4 weeks
3	168 hours
4	72 hours
5	48 hours
5a	24 hours
6	Mandatory bake before use. After bake, it must be reflowed within the time limit specified on the label.

※ Note

For product handling, storage, processing, IPC / JEDEC J-STD-033 must be followed.

6.4 Baking Requirements

TR800 modules are vacuum packaged, and guaranteed for 6 months storage without opening or leakage under the following conditions: the environment temperature is lower than 40℃, and the air humidity is less than 90%.

If the condition meets one of the following ones shown below, the TR800 modules should be baked sufficiently before re-flow soldering, and the baking condition is shown in below table; otherwise, the module will be at the risk of permanent damage during re-flow soldering.

- If the vacuum package is broken or leakage.
- If the vacuum package is opened after 6 months since it's been packed.
- If the vacuum package is opened within 6 months but out of its Floor Life at factory ambient≦

30℃/60%RH or as stated.

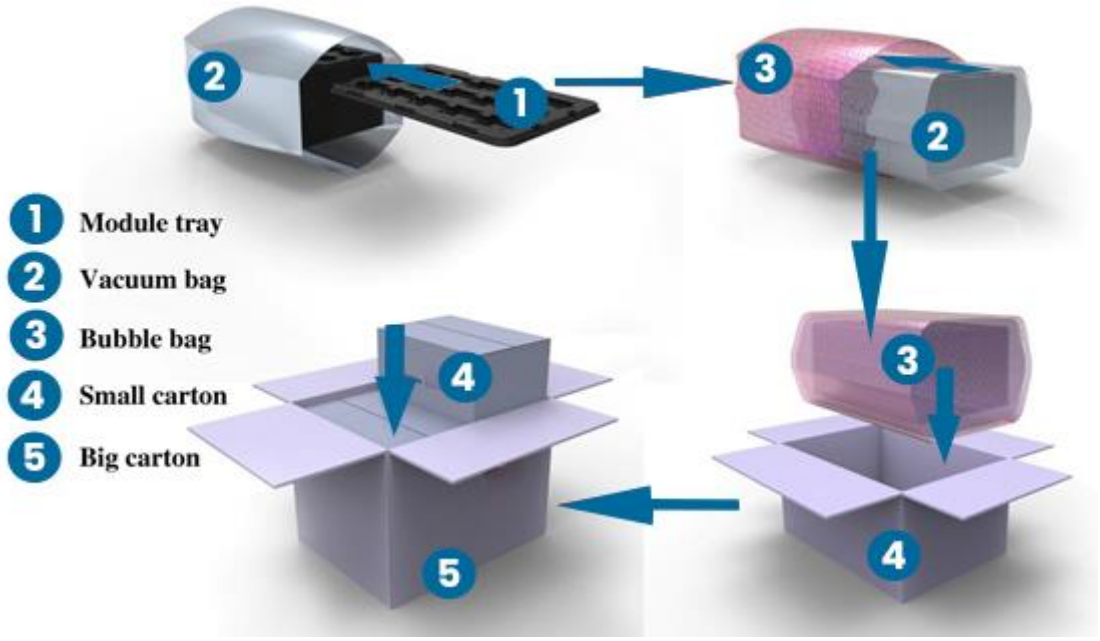
Table 35: Baking requirements

Baking temperature	Moisture	Time	Comment
40℃±5℃	<5%	192 hours	
120℃±5℃	<5%	6 hours	Not applicable for original tray

※ Note

Care should be taken if that plastic tray is not heat-resistant, if the baking temperature over 120℃, the modules should be taken out from the tray for baking, otherwise the tray may be damaged byhigh-temperature heating.

7 Packaging



TR800 module support tray packaging.

Figure 30: Packaging introduce

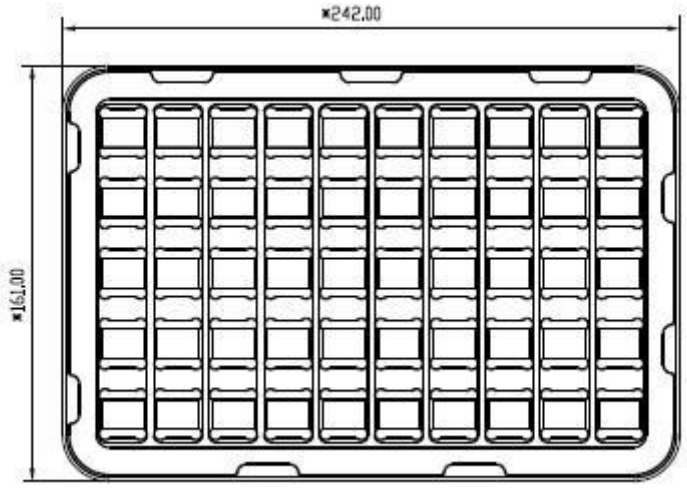


Figure 31: Module tray drawing

Table 36: Tray size

Length (±3mm)	Width (±3mm)	Number
242.0	161.0	50

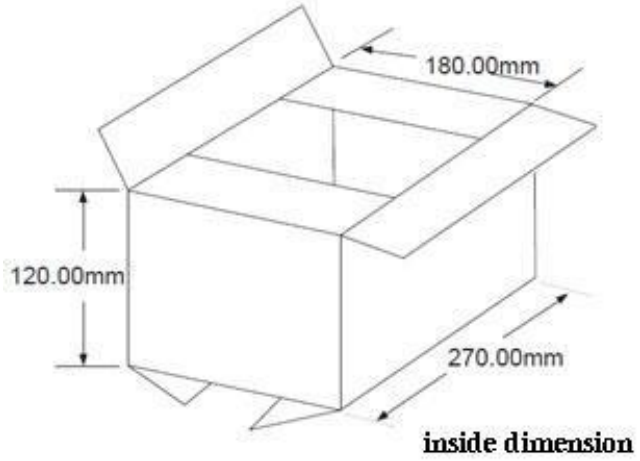


Figure 32: Small carton drawing

Table 37: Small carton size

Length (±10mm)	Width (±10mm)	Height (±10mm)	Number
270	180	120	50*20=1000

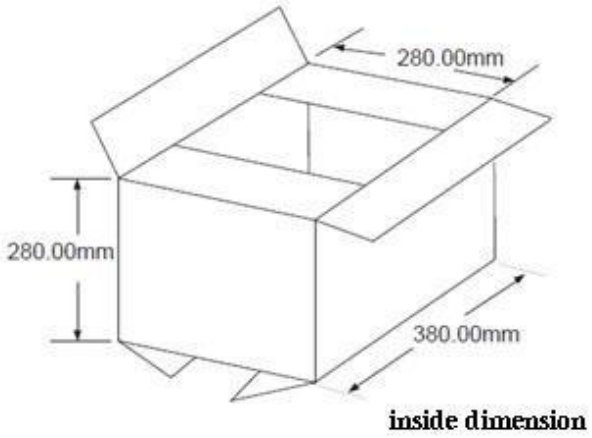


Figure 33: Big carton drawing

Table 38: Big carton size

Length (±10mm)	Width (±10mm)	Height (±10mm)	Number
270	180	120	50*20=1000

8 Appendix

8.1 Related Documents

Table 39: Related documents

SN	Document name	Remark
[1]	AT_Command_Manual	
[2]	Series UART Port Application Note_V1.01.doc	
[3]	Series_TCPIP_Application Note_V1.02	
[4]	ITU-T Draft new recommendation V.25ter：	Serial asynchronous automatic dialing and control
[5]	GSM 07.07：	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[6]	GSM 07.10：	Support GSM 07.10 multiplexing protocol
[7]	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)
[8]	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
[9]	GSM 11.11：	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[10]	GSM 03.38：	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[11]	GSM 11.10	Digital cellular telecommunications system (Phase 2)； Mobile Station (MS) conformance specification； Part 1： Conformance specification
[12]	AN_Serial Port	AN_Serial Port
[13]	NMEA Message Specification_V1.00	
[14]	EPO-II_Format_Protocol_Customer	EPO-II_Format and Protocol
[15]	RF_Design_Application Note	

[16]	AN_SMT Module_RF_Reference Design_Guide

8.2 Terms and Abbreviations

Table 40: Terms and abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate
CS	Coding Scheme
CTS	Clear to Send
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated
PAP	Password Authentication Protocol
PBCCH	Packet Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PDU	Protocol Data Unit
PPP	Point-to-point protocol
RF	Radio Frequency
RMS	Root Mean Square (value)
RX	Receive Direction
SIM	Subscriber Identification Module
SMS	Short Message Service
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
SINAD	Signal to Noise and Distortion Ratio
UART	Universal Asynchronous Receiver & Transmitter

URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
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

8.3 Safety Caution

Table 41: Safety caution

Marks	Requirement
	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 to not operate normally for 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. 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 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, for example no mobile fee or a invalid SIM card. While you are in this condition and need emergent help, please remember using 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.