TR-900 GSM/GPRS Module

Product Technical Specifications

Date	:	30 May 2011
Document Version	:	1.1
Our Reference	:	02000B33

CONFIDENTIAL

Document History

Revision	Date	Document History
1.0	20 Dec 2010	▪ Preliminary Release
1.1	30 May 2011	▪ Commercial Release ▪ Updated on contents and electrical characteristics ▪ Updated information on power consumption ▪ Updated TR-900 mechanical drawing
		▪
		▪

GENERAL NOTE

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1 Introduction

This document describes the hardware interface, including interface specifications, electrical and mechanical details, of the TR-900 module that connects to the cellular device application.

1.1 Reference Documents

S/N	Document
1	TR-900 AT Commands Guide
2	TR-900 Development Starter Kit User Guide

1.2 Abbreviations

The following abbreviations are used in this document:

Abbreviation	Description
ACM	Accumulated Call Meter
ADC	Analog Digital Convertor
AMR	Adaptive Multi-rate
AMR- FR	AMR Full-rate
ADN	Abbreviated Dialing Number
AOC	Advice of Charge
APN	Access Point Name
AT	ATtention
CLIP	Calling Line Identity Presentation
CSD	Circuit Switched Data
CUG	Closed User Group
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DCS	Data Coding Scheme
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi Frequency
DTR	Data Terminal Ready
EFR	Enhanced Full-rate

Abbreviation	Description
FR	Full-rate
GPIO	General Purpose Input Output
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half-rate
IP	Internet Protocol
kbps	kilo bit per second
MO	Mobile Originator
MS	Mobile Station
MT	Mobile Terminal
PDP	Packet Data Protocol
PDU	Packet Data Unit
PIN	Personal Identification Number
PPP	Point-to-Point Protocol
RF	Radio Frequency
RTS	Ready To Send
SAR	Specific Absorption Rate
SIM	Subscriber Identification Number
SMS	Short Messages Service
TCP	Transmission Control Protocol
TE	Terminal Equipment
UART	Universal Asynchronous Receiver Transmitter
UDP	User Data Protocol
USSD	Unstructured Supplementary Service Data
AB	Application Board of Customer

1.3 Safety Precautions

For your own safety, please follow the safety precautions listed below during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating the TR-900 Module. All manufacturers of these cellular terminals or mobile devices are advised to include the following safety precautions into all manuals provided with their terminal or mobile device, and pass this information to device users and operating personnel. Failure to comply may be dangerous or illegal.

Road safety

Do not use a mobile device while driving. Park the vehicle first or use a hand free earphone. It is illegal in some countries to use a mobile device while driving.

Switch off in aircraft

Cellular terminal or mobile devices can cause interference to aircraft electronics. Using them on aircraft is both illegal and dangerous.

Switch off when refuelling vehicle

Do not use the cellular terminal or mobile device at a refuelling station or near fuels or chemicals.

Forbidden Usage

Always switch off your cellular terminal or mobile device where it is forbidden to be used in any areas like a hospital.

Interference

All cellular terminals or mobile devices may be subjected to radio interference, which could affect their performance.

Emergency calls

As the GSM/GPRS module is based on GSM standard for radio signals and cellular networks, this connection cannot be guaranteed at all times under all conditions. It should never be entirely relied upon for essential communications such as an emergency call.

Note on compliance with international rules and regulations

The TR-900 module is a fully certified cellular radio engine. The module has been tested and certified for compliance to international safety and GSM standard requirements at the modular level.

Manufacturers of cellular terminal or mobile equipment incorporating the TR-900 are required to test their final products to ensure compliance to these EMC tests/requirements:

- ESD
- Radiated Spurious Emissions
- Conducted Emissions, if applicable
- Further tests if applicable

The module was not assessed against the essential requirement 'health'. Manufacturers of the final products are also responsible to ensure that their products are tested for compliance to any other health requirements that might be applicable.

A few other important notes regarding safety in implementation and usage of the module:

- The module shall be supplied by a Limited Power Supply (LPS) according to EN60950:2000.
- No necessary spacing (creepage and clearance distance) shall be reduced by installing the module into the final equipment.
- Provisions shall be made for fastening the module securely in the end product.

Instructions and equipment markings related to safety shall be in a language, which is acceptable in the country in which the equipment is to be installed.

1.4 Regulatory Requirement

1.4.1 Requirement for FCC Regulatory Compliance

The TR-900 module complies with part 22 and part 24 of the FCC rules. There certain operating condition to integrate TR-900 into the host platform into the mobile or fixed devices only to use the FCC Grants of the TR-900 module for the final products. The FCC label of the TR-900 shall be visible from the outside of the final products. If the FCC ID is not visible, the final product shall bear an exterior label stating "Contains Transmitter Module FCC ID: QPB-TR9000311" or "Contains FCC ID QPB-TR9000311".

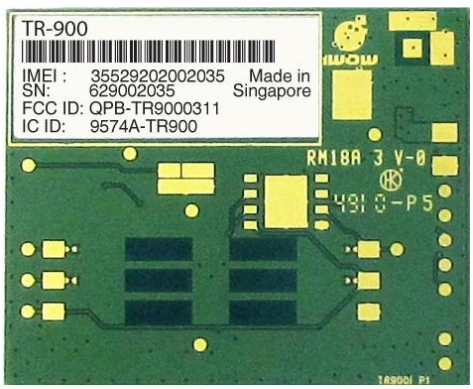


Figure 1: TR-900 Module with label

If the final product after integration is intended for portable use, a new application and FCC is required. It is mandatory to meet the SAR requirements for portable device.

Note:

TR-900 operation is subject to the following two conditions:

(1) this device may not cause harmful interference

(2) this device must accept any interference, including interference that may cause undesired operation.

WARNING:

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

1.4.2 RF Exposure Requirement

Based on the FCC radiation exposure limits, and the standards EN50385 and EN50383, a minimum safety operating distance between the device and human body must be maintained.

Note:

A 203mm (8inches) separation distance between the TR-900 and human body must be maintained at all times during device operation for mobile or fixed operating conditions. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Refer to section 4.22.4 for antenna's recommendation.

2 Technical Specifications

2.1 General Specifications

Feature	Description
Network Type	Quad-Band GSM/GPRS
Frequency Bands	Quad Band: GSM850 / EGSM900 / DCS1800 / PCS1900
Output Power	▪ GSM 850 / EGSM 900 : Class 4 (2W) ▪ DCS1800 / PCS1900: Class 1 (1W)
AT Command Interface	▪ Compliant to GSM 07.05 and GSM 07.07 recommendations ▪ iWOW Proprietary AT Commands
Physical Dimensions	▪ Dimensions: 38mm x 31mm x 3.5mm ▪ Weight: 6.4g (including of shielding)
Power Supply	▪ 3.4V to 4.2V

Operational Environmental	Description
Normal Operating Temperature	-20° C to +55° C
Extended Operating Temperature	-40° C to +85° C
Relative humidity	5 – 95%
Air pressure (altitude)	70 kPa to 106 kPa (-400m to 3000m)

2.2 GSM/ GPRS Specifications

Feature	Description
GSM Audio	▪ Telephony ▪ Emergency call ▪ Half Rate, Full Rate and Enhanced Full Rate (HR/FR/EFR) ▪ Adaptive Multi-rate (AMR) ▪ Hands-Free Operation ▪ Echo Cancellation (Enhanced AEC) ▪ Noise Reduction ▪ DTMF (encoding only)
Circuit Switched Data (CSD)	▪ Asynchronous, Transparent & Non-Transparent ▪ Max speed: up to 14.4kbps

Feature	Description
SMS	▪ Point-to-point (MO/MT) ▪ Cell Broadcast ▪ Text and PDU mode
Supplementary Services	▪ Call Forwarding, Barring, Waiting, Hold ▪ Multiparty ▪ Advice of Charge (AoC) ▪ Calling Line Identification Presentation (CLIP) ▪ Calling Line Identification Restriction (CLIR) ▪ Unstructured Supplementary Services (USSD) ▪ Closed User Group (CUG)
GPRS	▪ Multislot Class 12 ▪ Mobile Station Class B ▪ Coding Schemes MCS1 – MCS4 ▪ PBCCH Support ▪ PCCCH Support ▪ PPP Stack

2.3 RF Frequencies

RF functionalities comply with the GSM Phase II GSM 850/EGSM 900/DCS 1800/PCS 1900 recommendations. The frequencies covered are:

▪ Tx GSM850: (824 ~ 849 MHz)	▪ Rx GSM850: (869 ~ 894 MHz)
▪ Tx EGSM900: (880 ~ 915 MHz)	▪ Rx EGSM900: (925 ~ 960 MHz)
▪ Tx DCS1800: (1710 ~ 1785 MHz)	▪ Rx DCS1800: (1805 ~ 1880 MHz)
▪ Tx PCS1900: (1850 ~ 1910 MHz)	▪ Rx PCS1900: (1930 ~ 1990 MHz)

2.4 Baseband Functionalities

The Baseband is composed of an ARM, a DSP and an analog element (with audio signals, and ADC).

The core power supply is 1.2V and the digital power supply is 1.8V.

2.5 Interface Specifications

Feature	Description
60-pin Board-to-Board Connector	▪ Power Supply ▪ Back-up Battery ▪ Keypad ▪ 1 Serial Link UART ▪ USB 2.0 ▪ 1.8V/3V SIM ▪ SIM Detection ▪ Real time clock ▪ GPIOs ▪ Analog to Digital Converter ▪ Digital* & Analog Audio ▪ Reset ▪ Power On ▪ Battery Charging Interface* ▪ SPI with 2 Addresses* ▪ 2-Wire Bus*
Others	▪ UMC Antenna Connector and Antenna Pad ▪ On-Board SIM holder (Optional)

** For hardware reference only. These features are not enabled in the standard module firmware as it requires a certain level of firmware customization depending on its intended application. Please contact iWOW for more information.*

3 Functional Architecture

Figure 1 shows a block diagram of TR-900 module and illustrate the major functional components.

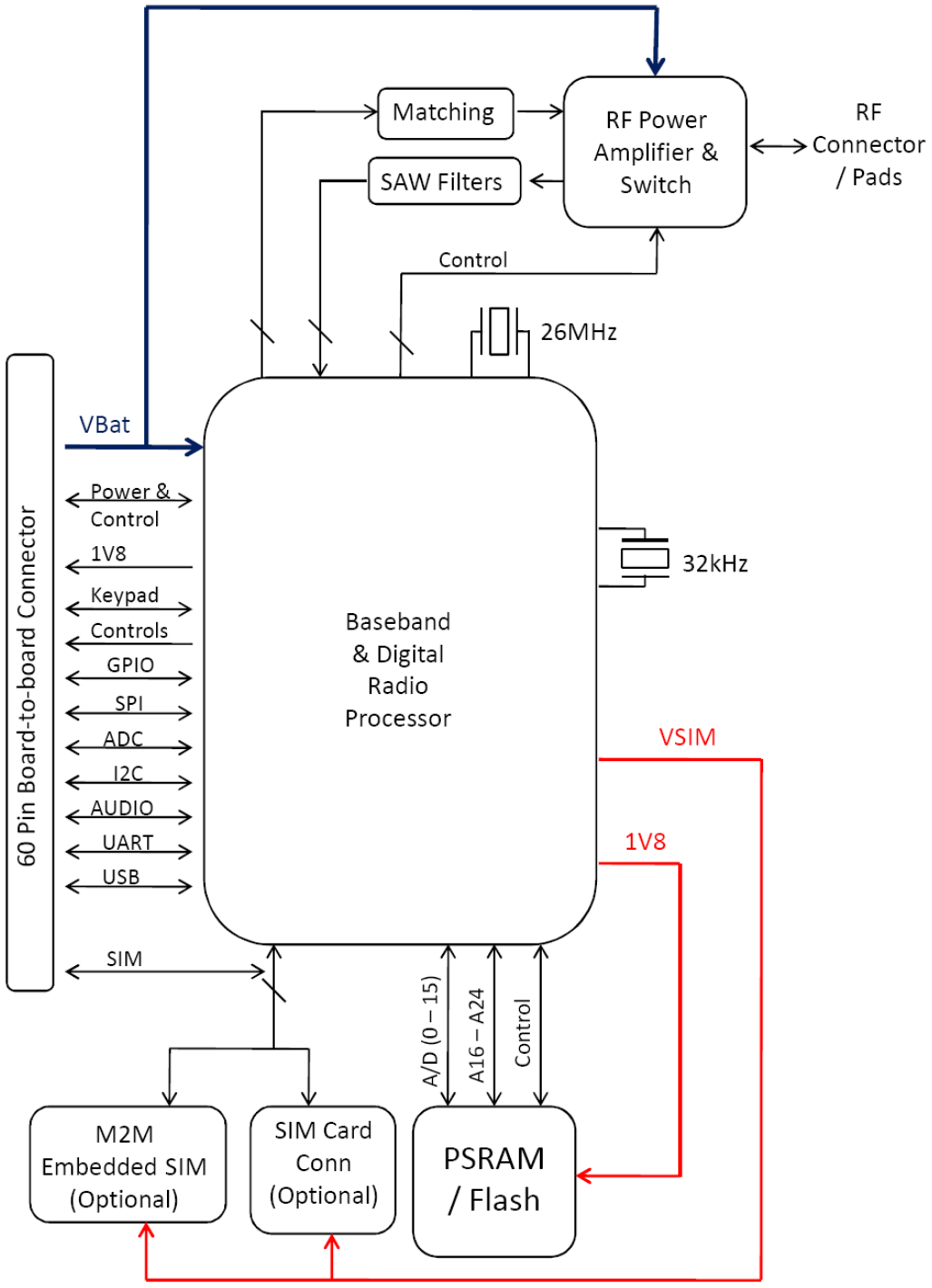


Figure 2: TR-900 Functional Architecture Block Diagram

4 INTERFACES

This section describes the available interfaces and their characteristics. All Pin Voltage are supplying at nominal 1.8V unless specified otherwise.

4.1 General-Purpose Connector (GPC)

The General-Purpose Connector (GPC) is provided to interface to the TR-900 module. The GPC is a 60-pin 0.5mm-pitch board-to-board socket from Astron with a part reference of **6091060-252-R**. The recommended mating part is **6090060-252-R** from Astron. Further information is available in http://www.astron.com.tw (part number: **6091XXX-25X-R** or **6090XXX-25X-R**)

4.1.1 On-Board GPC Pin Assignments

VBAT	60		1	VBAT
VBAT	59		2	VBAT
VCCS	58		3	GND
ICTL	57		4	NC
VIO	56		5	VBACKUP
ADCIN2	55		6	ADCIN1
USB_DP	54		7	VBUS
USB_DM	53		8	RFU
SPKPA	52		9	PWON
SPKNA	51		10	RESET
KBR0	50		11	KBC0
KBR1	49		12	KBC1
KBR2	48	**TR-900**	13	KBC2
KBR3	47	**GPC**	14	KBC3
KBR4	46		15	KBC4
SIMDTC	45		16	SIM_IO
VRSIM	44		17	SIM_CLK
SIM_RST	43		18	DSR
GPIO_4*	42		19	RI
SPI_CLK	41		20	GPIO_3*
SPI_MOSI	40		21	SPI_MISO
SPI_NCS1	39		22	SPI_NCS0
I2C_SCL	38		23	I2C_SDA
RXD	37		24	TXD
CTS	36		25	RTS
DTR	35		26	DCD
MCSI_TX	34		27	EARP
MCSI_RX	33		28	EARN
MCSI_FS	32		29	MICIP
MCSI_CK	31		30	MICIN

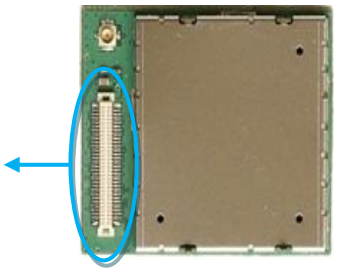


Figure 3: TR-900 GPC Pin Assignments

4.1.2 On-Board GPC Pin-Out description

Pin	Signal Name	Signal I/O	Description	Alternate Functions	Module Power up
1	VBAT	I	Power Supply Input	-	Input
2	VBAT	I	Power Supply Input	-	Input
3	GND	-	Ground	-	Not applicable
4	NC	-	NC	-	Not applicable
5	VBACKUP	O	Bulk Capacitor Connection for RTC	-	Output
6	ADCIN1	I	10-bit Analog-to-Digital input 1	-	Input
7	VBUS	I/O	USB VBUS power supply line	-	Input
8	RFU	I/O	Reserved for future use	-	Input
9	PWON	I	External switch-on event (ON/OFF)	-	Input, Pull Up Active
10	RESET	I	External RESET Input. (Test only) Internally pulled up by 100 kΩ	-	Pull up
11	KBC0	O	Keypad Matrix Column 0	-	Input, Pull Up Active
12	KBC1	O	Keypad Matrix Column 1	-	Input, Pull Up Active
13	KBC2	O	Keypad Matrix Column 2	-	Input, Pull Up Active
14	KBC3	O	Keypad Matrix Column 3	-	Input, Pull Up Active
15	KBC4	O	Keypad Matrix Column 4	GPIO_5*	Input, Pull Up Active
16	SIM_IO	I/O	SIM Data	-	Output LOW
17	SIM_CLK	O	SIM Clock	-	Output LOW
18	DSR	I	Data Set Ready (after boot-up)	GPIO_1*	Input, Pull Up Active
19	RI	I/O	Ring Indicator	GPIO_2*	Input, Pull Down Active
20	GPIO_3*	I/O	General Purpose IO		Input, Pull Down Active
21	SPI_MISO	I/O	SPI Data: Master in/ Slave out I = MSSPI serial data master-in O = MSSPI serial data slave-out	GPIO_6	Input, Pull Down Active
22	SPI_NCS0	I/O	SPI chip select 0 output	GPIO_7*	Input, Pull Down Active
23	I2C_SDA	I/O	Two wire interface serial bi-directional data	-	Input
24	TXD	I	DCE Data Receive (Transmit serial data)	-	Input, Pull Down Active
25	RTS	I	Request to send	-	Input, Pull Up Active
26	DCD	I/O	Data Carrier Detect	GPIO_8*	Input, Pull Down Active
27	EARP	O	Earphone positive output	-	
28	EARN	O	Earphone negative output	-	
29	MICIP	I	Microphone positive input	-	
30	MICIN	I	Microphone negative input	-	
31	MCSI_CK	I/O	MCSI Clock I/O	GPIO_9*	Input, Pull Down Active
32	MCSI_FS	I/O	MCSI Frame synchronization I/O	GPIO_10*	Input, Pull Down Active
33	MCSI_RX	I	MCSI receive data	GPIO_11*	Input, Pull Down Active
34	MCSI_TX	O	MCSI transmit data	GPIO_12*	Input, Pull Down Active
35	DTR	I	Data terminal ready	GPIO_13*	Input, Pull Down Active
36	CTS	O	Clear to send	-	Input, Pull Down Active
37	RXD	O	DCE Data Transmit (Receive serial data)	-	Input, Pull Up Active
38	I2C_SCL	I/O	Two wire interface Master serial clock	-	Input
39	SPI_NCS1	O	SPI chip select 1 output	GPIO_14	Input, Pull Down Active

Pin	Signal Name	Signal I/O	Description	Alternate Functions	Module Power up
40	SPI_MOSI	I/O	SPI data: Master out/Slave in O = SPI serial data master-out I = SPI serial data slave-in	GPIO_15	Input, Pull Down Active
41	SPI_CLK	I/O	SPI serial clock	GPIO_16	Input, Pull Down Active
42	GPIO_4*	I/O	General Purpose IO	-	Input, Pull Down Active
43	SIM_RST	O	SIM Reset	-	Output LOW
44	VRSIM	O	Power supply for 1.8V/3V SIM	-	
45	SIMDTC*	I	SIM Detection	-	Input, Pull Up Active
46	KBR4	I	Keypad Matrix Row 4	GPIO_17*	Input, Pull Up Active
47	KBR3	I	Keypad Matrix Row 3	-	Input, Pull Up Active
48	KBR2	I	Keypad Matrix Row 2	-	Input, Pull Up Active
49	KBR1	I	Keypad Matrix Row 1	-	Input, Pull Up Active
50	KBR0	I	Keypad Matrix Row 0	-	Input, Pull Up Active
51	SPKNA	O	Speaker negative output	-	
52	SPKPA	O	Speaker positive output	-	
53	USB_DM	I/O	USB data bus (negative terminal)	-	
54	USB_DP	I/O	USB data bus (positive terminal)	-	
55	ADCIN2	I	ADC input 2	-	Input
56	VIO	O	Internal Regulated Output voltage	-	
57	ICTL	O	Charger external transistor control (Charger)	-	
58	VCCS	I	Charge current sense	-	
59	VBAT	I	Power Supply Input	-	Input
60	VBAT	I	Power Supply Input	-	Input

** Interruptible IOs*

Note: Recommended to purchase mating connector from iWOW to ensure compatibility.

4.2 Power Supply and Ground – VBAT, GND

The power supply design is one of the key design areas for a GSM terminal due to the burst characteristics of GSM transmission. The supply must be able to deliver very high current peaks in a very short time during a GSM transmit burst, typically up to 2A. During these bursts, it is recommended that the voltage drop does not exceed 400mV. The voltage ripple should not exceed 50mV at frequencies up to 200 kHz and 2mV at frequencies above 200 kHz. This might cause the module to reset.

The supply to the module is provided from the dedicated VBAT pins of the GPC. The module's RF power amplifier is supplied directly from VBAT. Power to other parts of the module is regulated internally. The VBAT supply to the module must be externally regulated according to the supply input limits of the module.

All four legs of the shield must be soldered onto the target PCB. The ground connection of the target PCB has to go through a full ground plane on the PCB.

Pin Description

Signal	Pin Number	Type
VBAT	1,2,59,60	Power Supply Input
GND	3	Ground

Power Supply Voltage

The power supply voltage for VBATT is given below:

Power Supply	Parameters	Conditions	Min	Typ	Max	Unit
VBATT	Supply Voltages	Voltage measured at the VBATT pin of the connector. If voltage drops below 3.2V, the module will automatically power off.	3.2*	3.6	4.5	V
	Voltage Drop	Normal condition with max transmitter output			400	mV
	Voltage Ripple	Normal condition with max transmitter output			50	mV

*Note: * must be guaranteed to ensure compliance with the GSM certification requirements.*

If VBATT is kept at voltage levels lower than 3.2V, it will automatically power-off. During burst emissions in GSM/GPRS, the power supply must provide high current peaks of 2.0A.

4.3 Operating Modes

Operation Type	Mode	Description
Normal Operation	GSM IDLE	The module is registered to the network. Power consumption depends on the interval of the network paging.
	GSM CONNECTED	The module has established a call connection with the network. Power consumption depends on the network settings and coverage
	GPRS IDLE	The module is attached to the GPRS network. Power consumption depends on the network settings.
	GPRS DATA	The module sends and receives data from the network. Power consumption depends on the network settings and GPRS configurations.
	GSM/GPRS SLEEP	In order to extend the battery life of hand held devices, the module can enter into a sleep mode with AT$CSLEEP=1. When sleep mode is enable, the module will go into a deep sleep stage from idle when there is no activity for 10 sec. The module will wake up from the sleep mode if there are any activities.
	CHARGE	The module can perform battery charging in parallel with other normal operation
Reduced operation	POWER DOWN	The module can be power down with AT$CPOF=1. All activities will be terminated. Only real time clock is active in this mode. The module will go into power down mode automatically if the power supply falls below 3.2V.
	MINIMUM FUNCTION	The module enter into minimum functional mode with AT+CFUN=0. In this mode, the module will disconnect from network and power down SIM card.
	AIRPLANE	The module enter into airplane mode with AT+CFUN=4. The module disconnect from the network just like MINIMUM FUNCTION but keep the SIM active so that activity like accessing the phone book in SIM is still possible.
Battery Charging	CHARGE	The module performs battery charging in parallel with other operations.

4.3.1 Power Specs

Operating Mode	Conditions	Average	Burst	Unit
Power Down	VBATT = 3.6V	54	-	µA
Minimum Function	VBATT = 3.6V	1.2	-	mA
Airplane Mode	VBATT = 3.6V	1.3	-	mA
GSM/GPRS Idle	DRX = 2	21	-	mA
	DRX = 9	20	-	mA
GSM/GPRS Sleep	DRX = 2	3.1	-	mA
	DRX = 9	1.9	-	mA
GSM Connected	GSM 850, EGSM 900, PCL = 5	240	1280	mA
	GSM 850, EGSM 900, PCL = 19	85	210	mA
	DCS 1800, PCS 1900, PCL = 0	180	850	mA
	DCS 1800, PCS 1900, PCL = 15	80	190	mA
GPRS Data	GSM 850, EGSM 900, PCL = 5, Class 8	230	1330	mA
	GSM 850, EGSM 900, PCL = 5, Class 10	420	1550	mA
	DCS 1800, PCS 1900, PCL = 0, Class 8	180	800	mA
	DCS 1800, PCS 1900, PCL = 0, Class 10	300	900	mA

4.4 Backup Power Supply – VBACKUP

Backup capacitor can be connected to the module on VBACKUP via a series resistor of 470 ohms. It is used as a backup power supply to maintain the internal Real Time Clock (RTC). This feature is required to maintain the date and time in the module during powered-OFF to reduce power consumption.

Pin Description

Signal	Pin Number	Type	Description
VBACKUP	5	Supply output	Capacitor connection for RTC

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
Output voltage	Backup capacitor connected on VBACKUP	-	2.3	-	V
Capacitance		-	-	1	F

4.4.1 Application

If needed, to provide additional buffer to sustain the RTC functionality when VBAT has been removed, a backup capacitor can be connected on VBACKUP via a series resistor of 470 ohms..

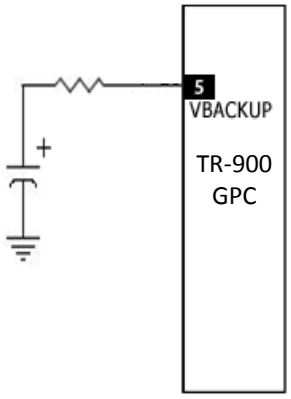


Figure 4: Example Voltage Backup connection

4.5 Battery-Charging Interface (BCI) – PCHG, ICTL, VCCS

This feature controls the charging of Lithium Polymer or Lithium-ion batteries. It can be used to perform functions such as battery pre-charging and battery charging. NOTE: BCI function is not available in default firmware.

Below shows an example of the charging circuit diagram with typical output current of 700mA. *For hardware reference only. This feature is not enabled in the standard module firmware as it requires a certain level of firmware customization depending on its intended application.*

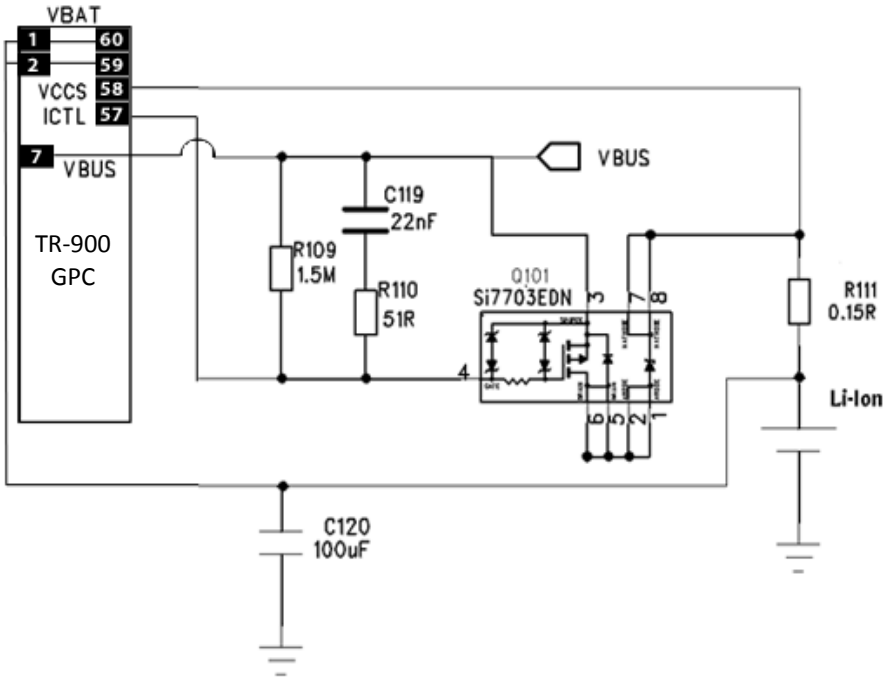


Figure 5: Charging Circuit Diagram Example

Note: *For charger voltage input, connect VBAT to relevant pins of charging IC*

Pin Description

Signal	Pin Number	Type	Description	Termination
ICTL	57	Analog Output	Charger external transistor control	Open
VCCS	58	Analog Input	Charging current sense	Open

Note: S*hort VCCS to VBAT to when not in use.*

4.6 Analog to Digital Converter (ADC) – ADCIN1, ADCIN2

The module provides two 10-bit ADC inputs, ADCIN1 and ADCIN2.

ADCIN1 and ADCIN2, respectively, can be also used as battery type sensing (BAT-TYPE) and battery temperature reading (BAT-TEMP) for Battery Charging Interface (BCI).

Pin Description

Signal	Pin Number	Type	Description
ADCIN1	6	Analog Input	ADC input 1
ADCIN2	55	Analog Input	ADC input 2

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
Resolution	-	-	10	-	Bits
Reference voltage	-	-	1.2	-	V
Differential non-linearity	-	-2	-	2	LSB
Integral non-linearity	Best Fitting	-2	-	2	LSB
Input Range	-	0		1.2	V
Input Resistance	-	1	-	-100	MKΩ

For hardware reference only. The BCI functions (BAT-TEMP and BAT-TYPE) are not enabled in the standard module firmware as it requires a certain level of firmware customization depending on its intended application. Please contact iWOW for more information.

4.7 Power ON Control - PWON

This input pin is used to switch the module ON. A switch-ON interruption is triggered in the module at the detection of a falling edge of this signal pin over a period of 40ms. A capacitor of value about 15nF can be placed close to the pin on the GPC to improve its ESD shielding.

Note: *The module should be properly switched OFF before all power supplies are removed. This is to avoid any unforeseen corruption of internal data.*

Pin Description

Signal	Pin Number	Type	Description
PWON	9	Input	External switch-on event

Electrical Characteristics

Parameters	Min	Nom	Max	Unit
High level input voltage, V_{IH}	1.495	-	-	V
Low level input voltage, V_{IL}	-	-	0.805	V

4.7.1 State Transitions

The following is the state transitions for the TR-900 module.

State	Description
Power-ON	Charged main supply or backup supply is plugged in.
Switch-OFF	Module is powered and switched from ACTIVE or SLEEP state to reach the OFF or BACKUP state.
Switch-ON	Module is powered on and awakened from the OFF state to reach the ACTIVE state.

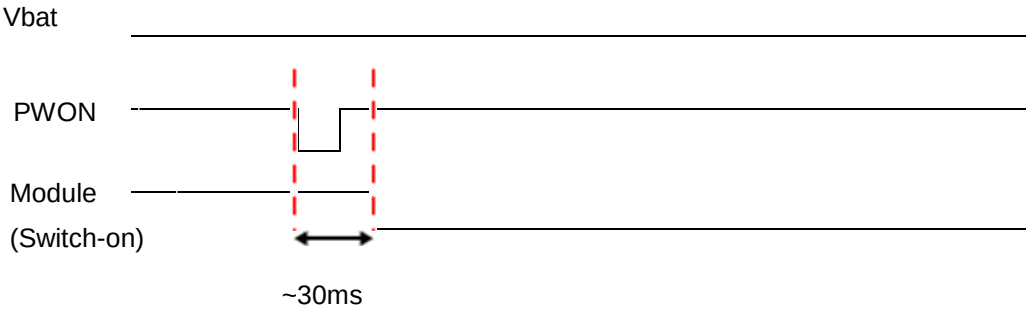
4.7.2 Switch-ON Condition

The module has to be in the OFF state. This condition will switch-ON the module:

- When a falling edge, after debouncing, is detected on the PWON pin. The PWON pin is debounced by embedded hardware. The debouncing time is approximately 30ms.

There are two cases when this switch-ON sequence does not happen:

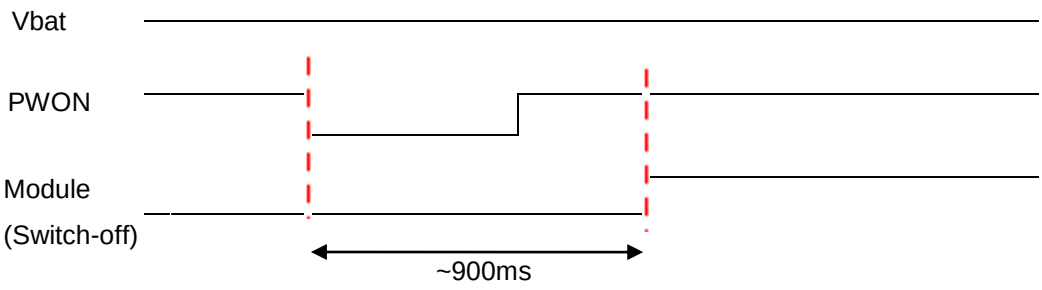
- When the main supply is under 3.2V.
- When the system is in BACKUP state (power is supplied via the VBACKUP pin only).



4.7.3 Switch-OFF Condition

The module has to be in the ON state. This condition will switch-OFF the module:

- A falling edge signal is detected on the PWON pin after debouncing and the signal remains low for a minimum period of 900ms. The PWON signal must be released back to high after the module has switched-OFF.
- When the level of the main supply VBATT decreases below 2.8V and below the level of the backup supply.



Note: *When the switch-OFF sequence is started, the sequence is completed even if a switch-ON condition occurs. In this event, data corruption may occur if flash writing is in progress.*

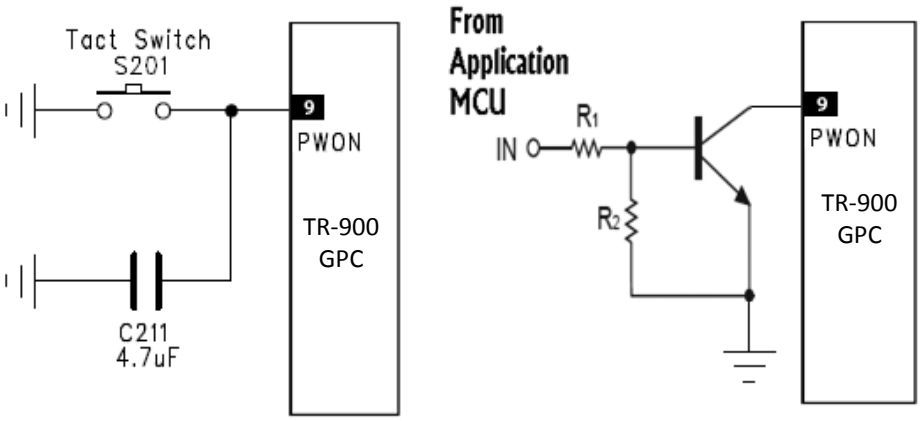


Figure 6. Example of the PWON Pin Connection Either By a Switch or Via an Open Collector Transistor

4.8 Reset Signal - RESET

This reset Pin 10 provides an unconditional hardware reset input to the module. A low level signal will trigger the reset of the module. When the pin is not used, it can be left unconnected. This pin is internally pulled up by a 20 kΩ resistor. A capacitor of value about 15nF can be placed close to the pin on the GPC to improve its ESD shielding.

The RESET signal has a 200K internal pull up resistor to VCC_1V8.

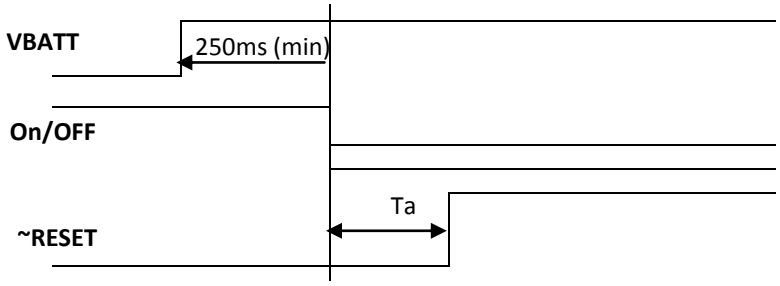


Figure 7. Reset Timing

Pin Description

Signal	Pin Number	Type	Description
RESET	10	Input(internally pulled up by 20 kΩ)	External Reset Input. For testing purpose only.

Parameters	Min	Nom	Max	Unit	Operating Mode
High level input voltage, V_{IH}	1.17	-	-	V	Reset Inactive
Low level input voltage, V_{IL}	-	-	0.63	V	Reset Activated

Note: *The hardware reset is to be used with caution. It may cause data loss in the volatile memory. It is designed for emergency where the module fails to respond for more than 30 sec.*

If the reset is used, it has to be driven by either a push button or an open collector/drain transistor as shown in the figures below.

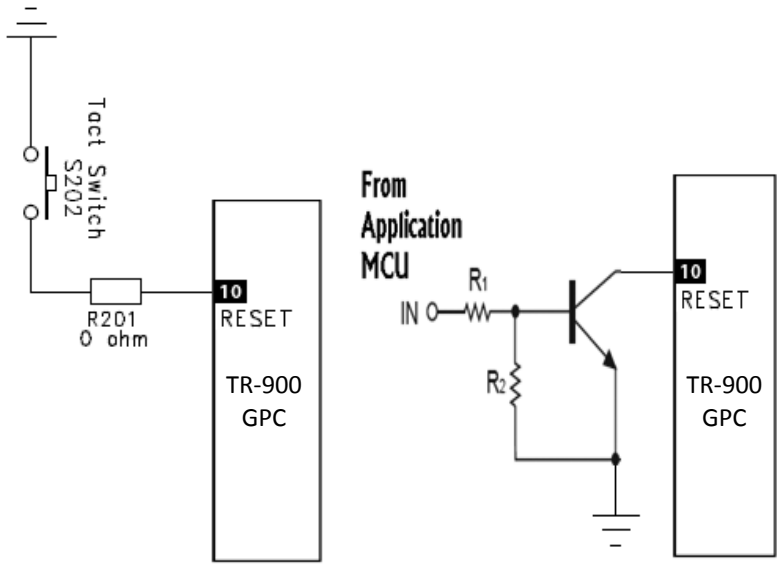


Figure 8.Example of ~RESET Pin Connection

4.9 Digital Supply Output - VIO

This internally regulated digital supply output can be used to supply external peripherals like a LED circuitry. It will only be available after the module is switched-ON and as such, this pin can be used to signalize the module's state, indicating whether it is in ON or OFF mode.

Pin Description

Signal	Pin Number	Type	Description
VIO	56	Supply output	Digital supply output

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
Output voltage, VOUT	ON mode	1.65	1.8	1.95	V
	LOW POWER mode	1.65	1.85	1.95	V
Rated output current, IOUT	ON mode	-	-	200	mA
	LOW POWER mode	-	-	1	mA

4.10 Subscriber Identity Module (SIM) Interface - SIMIO, SIMCLK, SIMRST, VRSIM, SIMDTC

The SIM card interface is composed of an internally dedicated voltage regulator and I/O level shifters. It is able to support both 1.8V and 3V SIM cards. It is recommended that the routing traces of the SIM interface lines be kept as short as possible. ESD diodes can be added to the signals connected to the SIM socket to prevent any ESD-related issues. The diodes shall be placed as close to the SIM socket as possible. Also, a decoupling capacitor of about 100nF should be added on the VRSIM line near the SIM socket. At any point of time, only one SIM card is to be connected as the same pins of both (SIM holder placed on top of the module, external SIM holder) are shorted.

Pin Description

Signal	Pin Number	Type	Description
SIMIO	16	Input/ Output	SIM Data
SIMCLK	17	Output	SIM Clock
SIMRST	43	Output	SIM Reset
VRSIM	44	Output	Power supply for 1.8V/3V SIM
SIMDTC	45	Input	SIM Card Detection

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
VRSIM	SIM 3V	2.7	2.85	2.95	V
	SIM 1.8V	1.65	1.8	1.95	V
SIMDTC, Low level input voltage, V_{IL}		-	-	0.54	V
SIMDTC, High level input voltage, V_{IH}		1.17	-	-	V
SIMDTC, Debouncing time (SIM-card insertion)		0.5	-	8	ms
SIMDTC, Debouncing time (SIM-card extraction)		0.5	-	8	ms

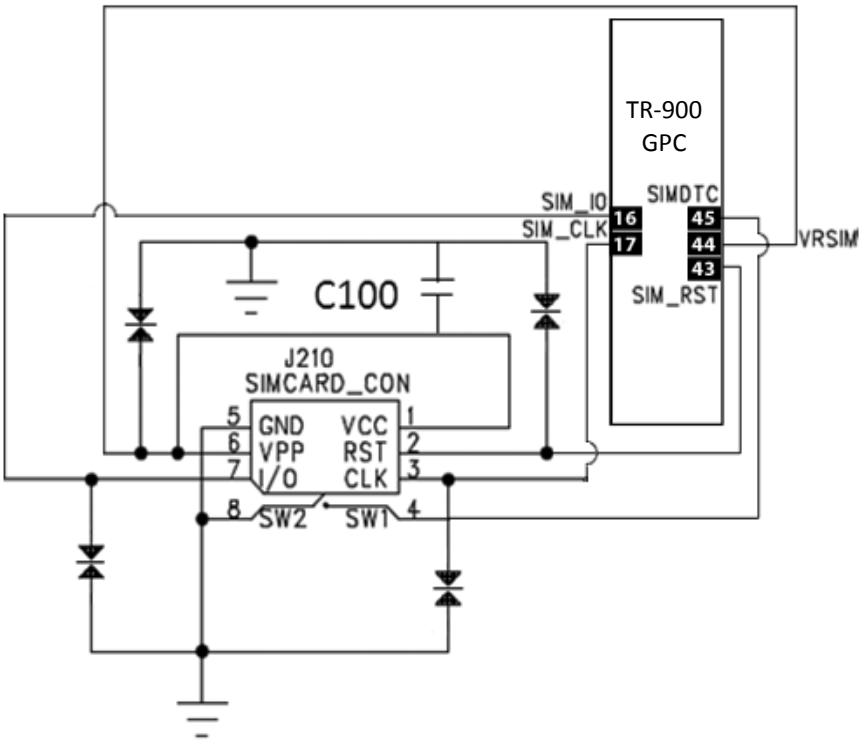


Figure 9. Example of a SIM Socket Implementation

4.10.1 SIM Detection

When a SIM card is inserted in the SIM cardholder, SIMDTC is tripped. After the debouncing, an interrupt is generated. The SIM-card presence detection logic must be active even when the system is in idle mode. The debouncing logic is based on the 32-kHz low-activity clock.

4.10.2 SIM Card Holder / SIM Chip

An optional SIM card holder / SIM Chip may be placed on top of the TR-900 module.

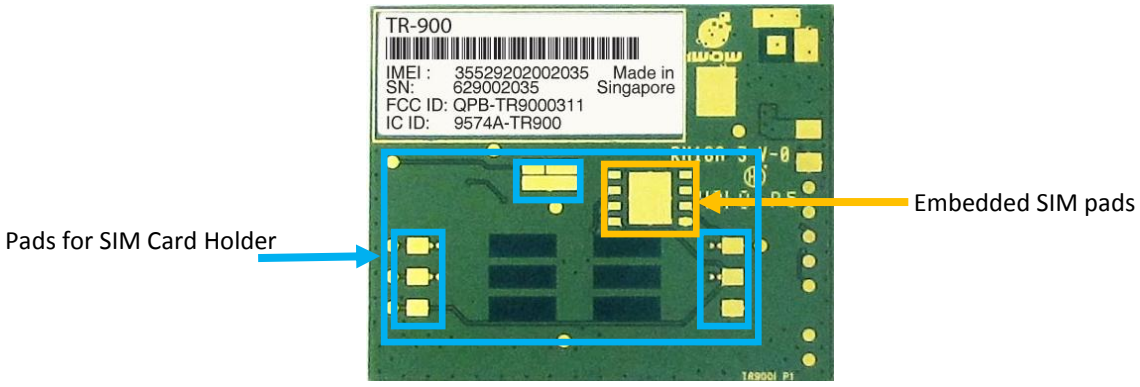


Figure 10. SIM Pad on TR-900

4.11 Serial Link (UART) Interfaces

4.11.1 Modem port - UART_TX, UART_RX, UART_CTS, UART_RTS, RI, DCD, DTR, DSR

These interfaces are assigned to the module communication with the application board using AT Commands.

The UART features are:

- 16C750 compatibility
- Baud rate from 300 bits/s up to 115200 bits/s with auto-bauding support feature

  Note: Default factory setting baudrate is set at 115200, unless other specified.
- Data bit: 5, 6, 7, or 8 bits
- Parity bit: even, odd, none
- Stop bit: 1, 1.5, 2 bit(s)
- RTS/CTS Hardware flow control
- Software flow control (XON/XOFF)

Pin Description

Signal	Pin Number	I/O	I/O Type	Reset State	Description
UART_TX	24	Input	1V8	1	DCE Data Receive
UART_RX	37	Output	1V8	0	DCE Data Transmit
UART_CTS	36	Output	1V8	0	Clear To Send. Hardware flow control
UART_RTS	25	Input	1V8	1	Ready To Send. Hardware flow

Signal	Pin Number	I/O	I/O Type	Reset State	Description
					control
RI	19	Output	1V8	1	Ring Indicator
DCD	26	Output	1V8	1	Data Carrier Detect
DTR	35	Input	1V8	1	Data Terminal Ready
DSR	18	Output	1V8	1	Data Set Ready

Note:

RI, DCD, DTR and DSR are not enabled in the standard module firmware. Please contact iWOW for more information. If RTS and CTS are not in use, it is recommended to connect the pins together.

4.12 Application

The block diagram below shows the possible UART connection.

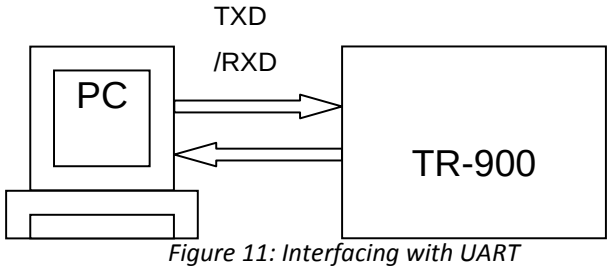


Figure 11: Interfacing with UART

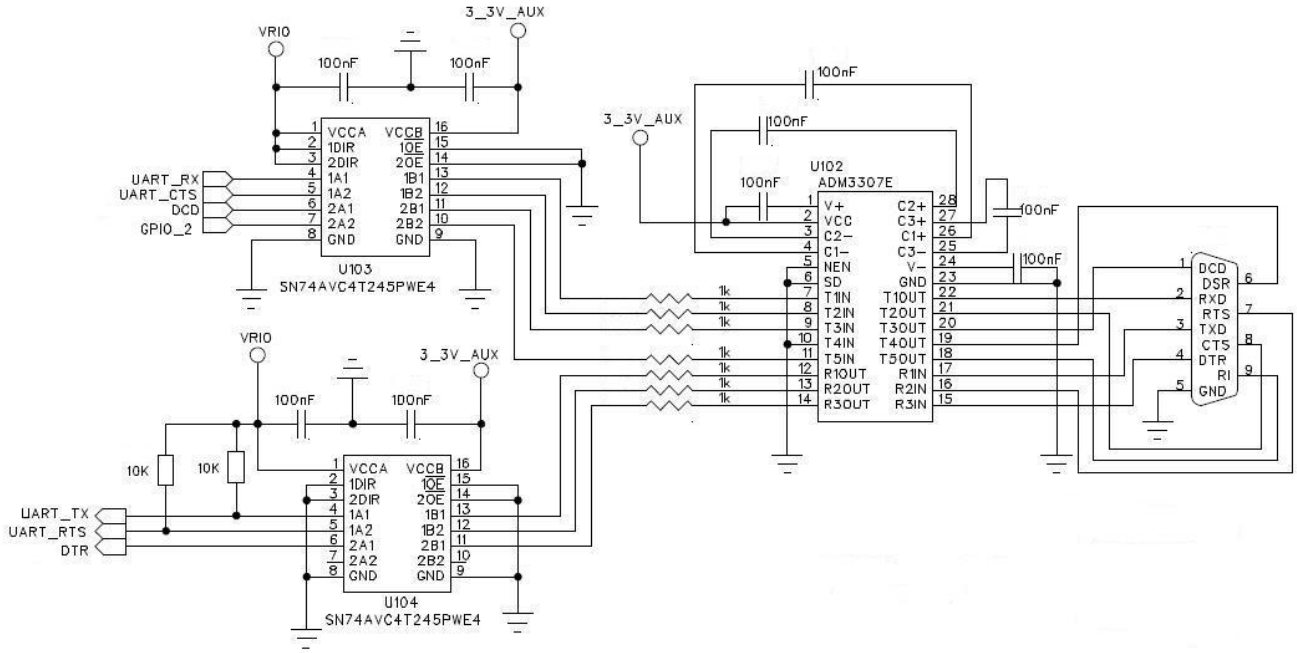


Figure 12: Level-shifter connection to RS232

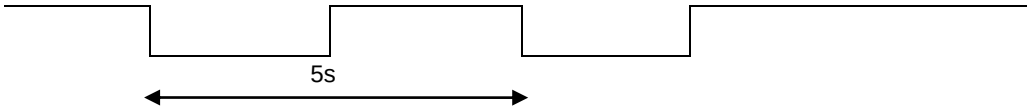
Data Set Ready (DSR) and RI can be implemented using GPIO 1,2 respectively by connecting the signals to a level shifter before interfacing with RS-232.

Do note that DCD, DTR and DSR can be set via AT-commands AT&C, AT&D and AT&S respectively.

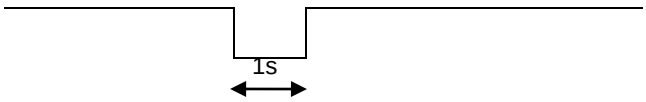
4.12.1 Ring Indicate - RI

The Ring Indicator (RI) is used for network activity indication. RI is defaulted at an active low signal and will toggle to indicate various activities as described below. When Voice, and Data calls are received, the RING indication is generated every 5 seconds and sent over RI Pin For unsolicited SMS indication, it will result in RI to go low for 1 second. Under circumstances where GSM network loss is encountered, RI will go low for 2seconds. After this period of 2s, the line must stay high for at least 4s before the next activity trigger.

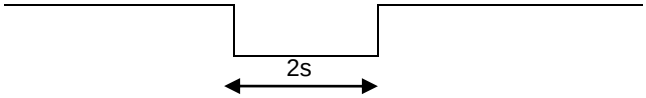
Figure below shows timing diagrams of supported activity indications.



Voice and Data call RING indication



Unsolicited SMS indication



GSM Network Loss Indication

4.13 USB Interface – VBUS, USB_DM, USB_DP

The USB interface supports a USB 2.0 Full Speed (12 Mbits/s) and low-speed (1.5 Mbits/s) operations. It is primarily intended for flashing of firmware and for use as command and data interface.

Note: *Connection of a 4.7µF Capacitor externally at VBUS for filtering is required.*

Pin Description

Signal	Pin Number	Type	Description
VBUS	7	Input/ Output	USB VBUS power supply line
USB_DM	53	Input/ Output	USB Data Bus (-ve)
USB_DP	54	Input/ Output	USB Data Bus (+ve)

4.13.1 Application

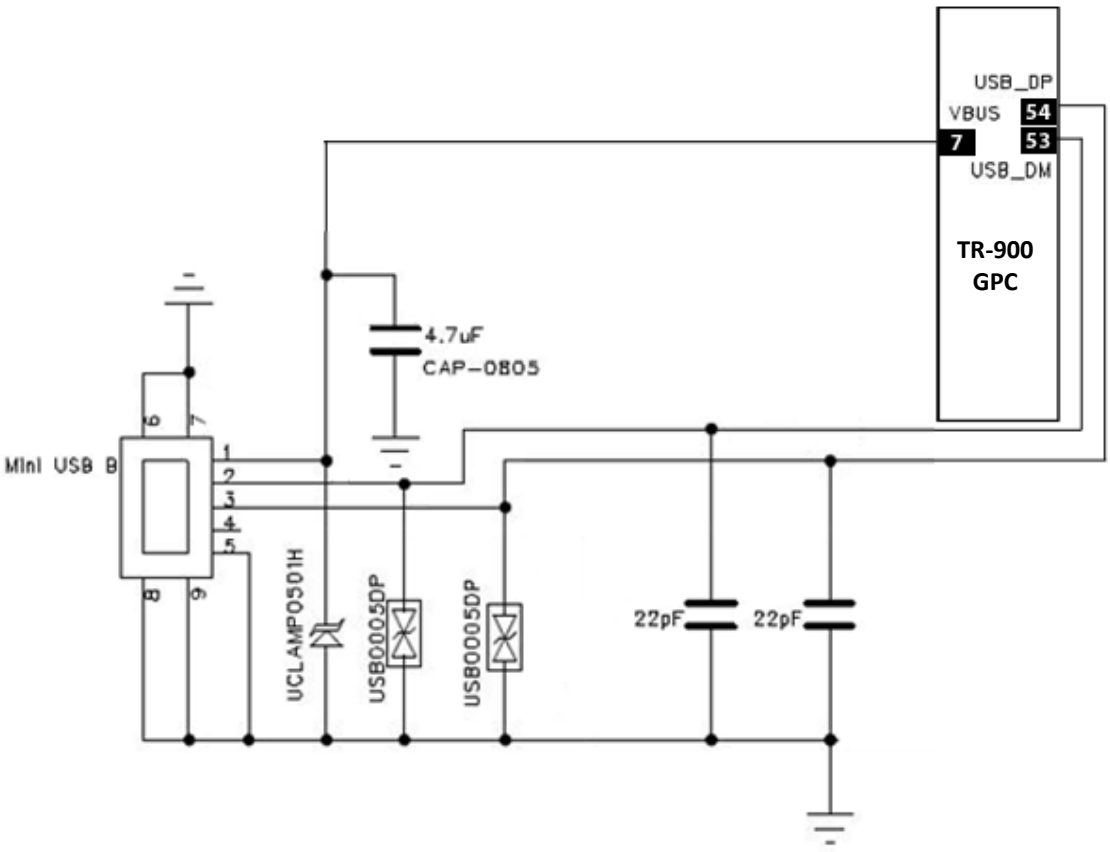


Figure 13: Example of USB implementation

4.14 Analog Audio Interfaces – MICIN, MICIP, EARN, EARP, SPKNA, SPKPA

4.14.1 Microphone input – MICIN, MICIP

The handset differential inputs MICIP and MICIN can be amplified by the differential handset microphone amplifier. The microphone reference voltage is at 2V. The audio gain of the microphone signal (MICP-MICN) is adjustable using AT command. AT$VTXG=<Level> where Level is from 0-100.

Pin Description

Signal	Pin Number	Type	Description
MICIP	29	Input	Microphone amplifier input (+ve)
MICIN	30	Input	Microphone amplifier input (-ve)

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
Maximum differential input range (MICIP – MICIN)	Input 3 dBm0	-	-	0.8	Vpp
Nominal reference level (MICIP – MICIN)	-	-	-10	-	dBm
Differential input resistance (MICIP – MICIN)	-	-	50	-	KΩ
Amplifier gain for (MICIP-MICIN) input	Differential MIC	-	-	39	dB
Recommended MIC Impedance		-	2k	-	Ohms
Recommended MIC Sensitivity		40	-	50	dB/PA
Recommended MIC SNR		-	-	50	dB

4.14.2 MIC Application

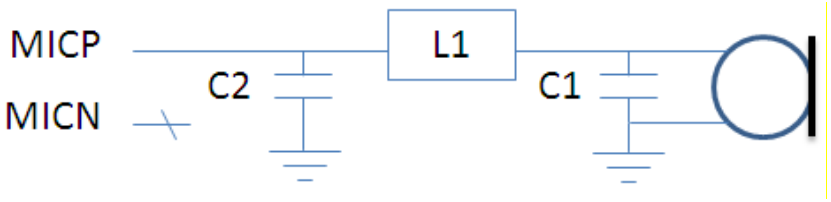
This section describes the two common approaches to microphone connection. Since this feature is exposed to the environment, provision for ESD protection is recommended. Typical characteristics of a microphone device which can be used: Impedance: ~2 kohm, sensitivity ~ 40-50 dB/PA and SNR >50 dB.

4.14.2.1 Differential Ended

Differential ended connection is the recommended implementation. The following diagram shows a proposed implementation. The traces need to be run in parallel and C1 placed near MIC while C2 placed near module pins. The capacitance values chosen may need to be optimized based on application, for GSM related EMI, this can be from 11 pF to 47 pF for an 0402 size. If not needed, these components may be unplaced.

4.14.2.2 Single-end

Single ended connection is not the recommended approach. The following diagram shows a possible implementation. C1 need to be placed near MIC while C2 and L1 placed IC pins. The capacitance values chosen may need to be optimized based on application, for GSM related EMI, C1 can be from 11 pF to 47 pF for a 0402 size while C2 and L1 need to be tuned according to the requirement. If not needed, capacitors may be unplaced and inductors replaced by zero ohms.



4.14.3 Earphone – EARN, ERNP

The earphone amplifier provides a full differential signal on the EARP and EARN terminals. The amplifier is capable of driving 100 mWrms into a 16 ohm load. The audio gain of earphone (EARP-EARN) is adjustable using AT command by AT$VRXG=<Level> where Level is 0-100. The default level is 50.

Pin Description

Signal	Pin Number	Type	Description
EARP	27	Output	Earphone amplifier output (+ve)
EARN	28	Output	Earphone amplifier output (-ve)

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
Power supply rejection	Mono Modes(GSM Voice)	90	100	-	dB
Maximum Output Swing at EARP-EARN	Load = OPEN	-	4.1	-	Vpp
		-		-	

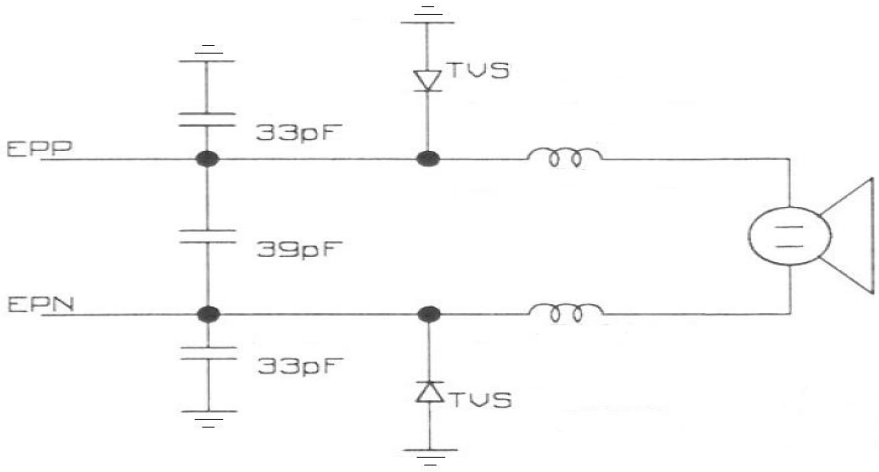


Figure 14: Example of earphone implementation

4.14.4 Speaker – SPKNA, SPKPA

The class D amplifier is capable of driving 700 mWrms into an 8 ohms load. Default switching frequency is 600 kHz.

Pin Description

Signal	Pin Number	Type	Description
SPKNA	51	Output	Speaker signal (-ve)
SPKPA	52	Output	Speaker signal (+ve)

Electrical Characteristic

Parameters	Min	Nom	Max	Unit
Output Load Resistance	-	8	-	Ω

4.14.5 Application

The connections to the speaker should run in parallel to the transducer and provisions for shunt capacitors are recommended for filtering RF and Digital Noise. Suggested values are 39 pF for EMI. Ensure that the voltage rating of the selected components can withstand operation at the maximum swing voltages in both directions, 16 volt parts should be sufficient. Since this feature is exposed to the environment, provision for ESD protection is recommended.

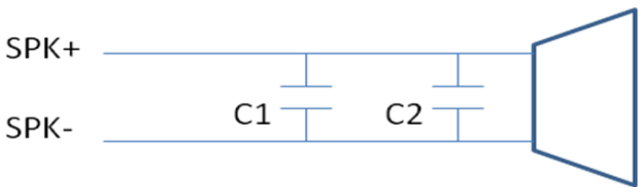


Figure 15: Speaker schematic

4.15 Digital Audio Interface – MCSI_CK, MCSI_FS, MCSI_RX, MCSI_TX

This Multi-Channel Socket interface (MCSI) is intended to support external digital voice interface with PCM-Codec connection (such as Bluetooth).

Pin Description

Signal	Pin Number	Type	Description
MCSI_CK	31	Input/Output	MCSI Clock I/O
MCSI_FS	32	Input/Output	MCSI Frame Synchronization
MCSI_RX	33	Input	MCSI Receive Data
MCSI_TX	34	Output	MCSI Transmit Data

For hardware reference only. This feature is not enabled in the standard module firmware as it requires a certain level of firmware customization depending on its intended application. Please contact iWOW for more information.

4.16 LED Pulse Generator – LPG

This interface produces electrical signal for a blinking LED indicating the status of the GSM Network activity.

Pin Description

Signal	Pin Number	Type	Description	Alternate Function
LPG	42	Output	Modem status signal	GPIO_4

Blinking Characteristics

Module Status	LED activity
In OFF mode	OFF
ON mode, not registered to network	Permanently ON
ON mode	Permanently ON
ON mode, registered to network, communication inactive	Slow Flashing On: 200ms, Off: 2s
ON mode, registered to network, communication in progress	Quick Flashing On: 200ms, Off: 600ms

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
High level input voltage, V_{IH}	-	1.26	-	1.89	V
Low level input voltage, V_{IL}	-	0	-	0.36	V
High level output voltage, V_{OH}	IO = 5mA	1.35	-	-	V
Low level output voltage, V_{OL}	IO = 5mA	-	-	0.5	V
Output current	-	-	5	-	mA

For hardware reference only. This feature is not enabled in the standard module firmware as it requires a certain level of firmware customization depending on its intended application. Please contact iWOW for more information.

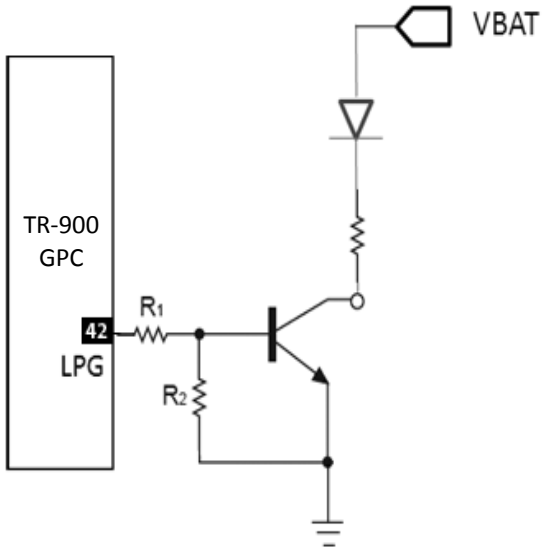


Figure 16: Example of an LED Driven by the LPG Output

4.17 General Purposes Input / Output ports – GPIO_1-GPIO_17

Each GPIO port can be configured individually as input or output ports through AT Commands.

Pin Description

Signal	Pin Number	Type	Alternate Function
GPIO_1	18	I/O	DSR
GPIO_2	19	I/O	RI
GPIO_3	20	I/O	BUZZER
GPIO_4	42	I/O	LPG
GPIO_5	15	I/O	KBC4
GPIO_6	21	I/O	SPI_MISO
GPIO_7	22	I/O	SPI_NCS
GPIO_8	26	I/O	DCD
GPIO_9	31	I/O	MCSI_CK
GPIO_10	32	I/O	MCSI_FS
GPIO_11	33	I/O	MCSI_RX
GPIO_12	34	I/O	MCSI_TX
GPIO_13	35	I/O	DTR
GPIO_14	39	I/O	SPI_NCS1
GPIO_15	40	I/O	SPI_MOSI
GPIO_16	41	I/O	SPI_CLK
GPIO_17	46	I/O	KBR4

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
High level input voltage, V_{IH}	-	1.26	-	1.89	V
Low level input voltage, V_{IL}	-	0	-	0.36	V
High level output voltage, V_{OH}	IO = 3mA	1.26	-	-	V
Low level output voltage, V_{OL}	IO = 3mA	-	-	0.45	V
Rated output current, I_{OL} / I_{OH}	-	-	3	-	mA

4.18 Keyboard Interface – KBC0-KBC4, KBR0-KBR4

The 10-pin keyboard interface includes 5 row inputs and 5 column outputs. The 5 output lines can alternatively be used as general purpose outputs while the 5 input lines can alternatively be used as general purpose inputs. Please contact iWOW directly for more information on the extended customization to this interface.

Pin Description

Signal	Pin Number	Type	Default Function
KBC0	11	Output	Keyboard column 0
KBC1	12	Output	Keyboard column 1
KBC2	13	Output	Keyboard column 2
KBC3	14	Output	Keyboard column 3
KBC4	15	Output	Keyboard column 4
KBR0	50	Input	Keyboard row 0
KBR1	49	Input (Internal pull-up)	Keyboard row 1
KBR2	48	Input (Internal pull-up)	Keyboard row 2
KBR3	47	Input (Internal pull-up)	Keyboard row 3
KBR4	46	Input (Internal pull-up)	Keyboard row 4

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
High level input voltage, V_{IH}	-	1.26	-	1.89	V
Low level input voltage, V_{IL}	-	0-	-	0.36	V
High level output voltage, V_{OH}	IO = 3mA	1.26	-	-	V
Low level output voltage, V_{OL}	IO = 3mA	-	-	0.45	V
Output current	-	-	3	-	mA

4.18.1 Implementation of a 5x5 keyboard

If a key button of the keyboard matrix is pressed, the corresponding row and column lines are shorted together. To allow key press detection, all input pins (KBR) are pulled up to VCC and all output pins (KBC) are driving a low level. Any action on a button will generate an interrupt through the input pin to the micro-controller that will, as answer, scan the column lines. The scanning is a digital one with the debouncing done in the module itself. A 33pF capacitor is recommended for each of the keypad input lines to eliminate ghosting effect. ESD diodes are also recommended to eliminate ESD issues.

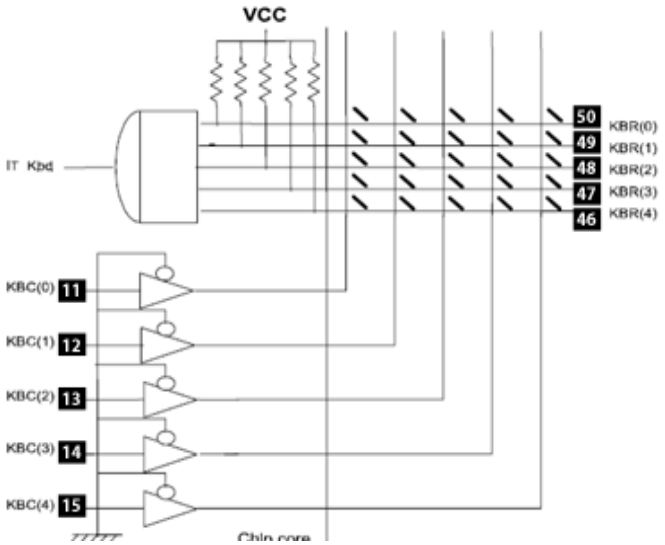


Figure 17: Keyboard Implementation Diagram

4.19 2-Wire Serial Interface – I2C_SDA, I2C_SCL

This is a half-duplex serial port using 2-line for data transmission consisting of SDA data signal and SDL clock signal. It can transfer at speeds up to 400Kbits/s (fast-mode).

Note: *Supports 1.8V I2C compliant devices.*

Pin Description

Signal	Pin Number	Type	Default Function
I2C_SDA	23	Input/ Output	2- wire interface serial bi-directional data
I2C_SCL	24	Input/ Output	2- wire interface Master serial clock

Electrical Characteristics

Parameters	Conditions	Min	Nom	Max	Unit
High level input voltage, (SDA and SCL), V_{IH}	-	-	-	1.8	V
Low level input voltage(SDA and SCL), V_{IL}	-	0	-	-	V

For hardware reference only. This feature is not enabled in the standard module firmware as it requires a certain level of firmware customization depending on its intended application. Please contact iWOW for more information.

4.20 Serial Parallel Interface (SPI) – SPI_CLK, SPI_MISO, SPI_MOSI, SPI_NCS0, SPI_NCS1

The SPI bus includes clock (SPI_CLK), I/O (SPI_MISO, SPI_MOSI) and chip select (SPI_NCS0, SPI_NCS1) signal.

Note: *Supports 1.8V SPI compliant devices.*

Pin Description

Signal	Pin Number	Type	Description	Termination
SPI_CLK	41	Input/ Output	SPI serial clock	Open
SPI_MISO	21	Input/ Output	SPI Data: Master in/ Slave out I = SPI serial data master-in O = SPI serial data slave-out	Open
SPI_MOSI	40	Input/ Output	SPI data: Master out/Slave in O = SPI serial data master-out I = SPI serial data slave-in	Open

4.20.1 SPI Address 0

Pin Description:

Signal	Pin Number	Type	Description	Termination
SPI_NCS0	22	Output	MSSPI chip select 0 output	Open

4.20.2 SPI Address 1

Pin Description:

Signal	Pin Number	Type	Description	Termination
SPI_NCS1	39	Output	MSSPI chip select 1 output	Open

For hardware reference only. This feature is not enabled in the standard module firmware as it requires a certain level of firmware customization depending on its intended application. Please contact iWOW for more information.

4.21 Buzzer Interface

The digital buzzer on pin 20 (shared function with GPIO_3) generates a modulated frequency signal for an external buzzer up to 5K Hz. Connection pin shall remain open when not used.

For hardware reference only. This feature is not enabled in the standard module firmware as it requires a certain level of firmware customization depending on its intended application. Please contact iWOW for more information.

4.22 RF interface

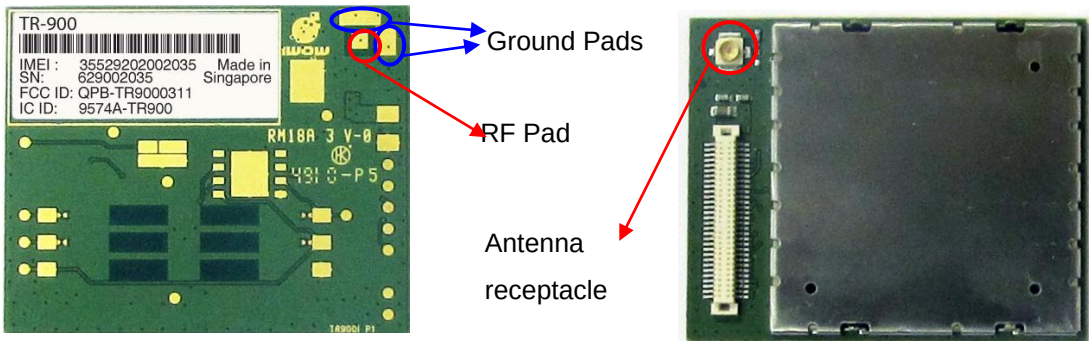
TR-900 RF interface has a characteristic impedance of 50Ω. The matching networks for an external antenna connection are not included in the module and should be placed on the application board. Two methods of RF connections are possible to the application board's antenna.

4.22.1 Coaxial Receptacle

An ultra-miniature coaxial receptacle is provided on the bottom side of the module (60-pin connector side). For this receptacle, Harwin's UMC-series connector is adopted. Its part reference is **MM9329-2700B**.

4.22.2 RF Pad for Coaxial Cable

An RF pad, along with two ground pads, is provided on the topside of the module (along iWOW logo) for direct connection to an antenna or coaxial cable. Please refer to the mechanical drawing for the location and dimensions of these pads.



4.22.3 RF Performance

Frequency Bands	RF Sensitivity (dBm) (Nominal)
GSM 850/EGSM 900	-104dBm
DCS1800/ PCS1900	-102dBm

4.22.4 Recommendations

The antenna must fulfill the following requirements below:

Frequency Bands	EGSM 900	DCS 2800	GSM 850	PCS 1900
TX Frequency	880 - 915 MHz	1710 - 1785 MHz	824 - 849 MHz	1850 - 1910 MHz
RX Frequency	925 - 960 MHz	1805 - 1880 MHz	869 - 894 MHz	1930 - 1990 MHz
Impedance	50 ohm			
VSWR Rx max	1.5 : 1			
VSWR Tx max	1.5 : 1			
Typical radiated gain	0 dBi in one direction at least			

The optimum operating frequency depends on the application. A dual-band or a quad band antenna must operate in the above frequency bands.

5 Electrical Characteristics

Parameter	Description	Min	Nom	Max	Unit
Supply Input:					
VBAT	Battery Input Voltage	3.2	3.8	4.5	V
IBBURSTB	Burst peak current	-	-	2.0	A
Regulated Output:					
VBOUTB	Output voltage	1.65	1.8	1.95	V
IBOUTB	Rated output current	-	-	200	mA
SIM Card Related:					
VSIM	Output voltage to 3V SIM card	2.7	2.85	2.95	V
V_{IL}	SIMDTC, Low level input voltage	-	-	0.54	V
V_{IH}	SIMDTC, High level input voltage	1.17	-	-	V
POWER ON/OFF Switch:					
VTBIHTB	High level input voltage 0.7VBAT	0.65*2.3	-	-	V
VTBILTB	Low level input voltage	-	-	0.35*2.3	V
Digital Signal Characteristic (GPIO,UART,LPG,Keyboard):					
VTBIHTB	High-level input voltage	1.10	-	1.89	V
VTBILTB	Low-level input voltage	0-	-	0.65	V
VTBOHTB	High-level output voltage at rated current	1.26	-	-	V
VTBOLTB	Low-level output voltage at rated current	-	-	0.45	V
ITBOHTB	Rated output high current	-	4	-	mA
ITBOLTB	Rated output low current	-	4	-	mA

***Note**: Due to the burst emission in GSM, the power supply (VBAT) must be able to handle high current peaks (2A max in EGSM band) in a short time.*

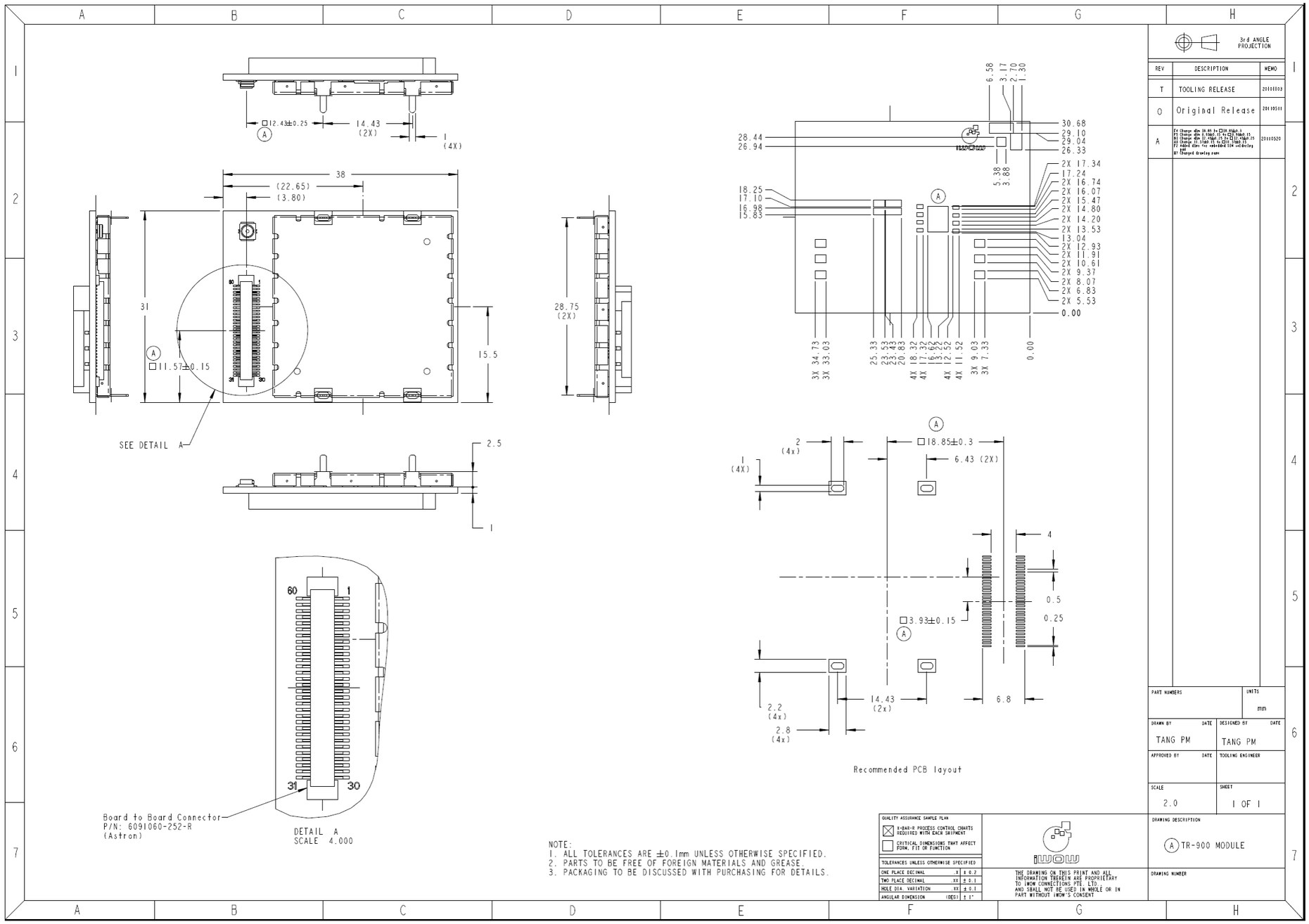
5.1 Absolute Maximum Ratings

Below list the absolute maximum ratings over operating free-air temperature:

Parameter	Rating
Supply voltage range, VBAT	-0.3 V to +5.5 V
Voltage on any input	-0.2 V to +2.0 V
Peak output current on VIO (Note)	1.8V
Peak output current on VSIM	15 mA
Free-air temperature range.	-30°C to 85 °C
Storage temperature range	-40 °C to 85 °C

Note: *iWOW reserved current usage for on-board features and future expansion. Customer requires more than 100mA, please contact iWOW.*

6 MECHANICAL DRAWING



7 SUPPORT/ CONTACT US

For distributor clients, please contact your respective distributor FAE.

For direct clients, please contact iWOW FAE (Technical Support Department) or email us at technicalsupport@iwow.com.sg.

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