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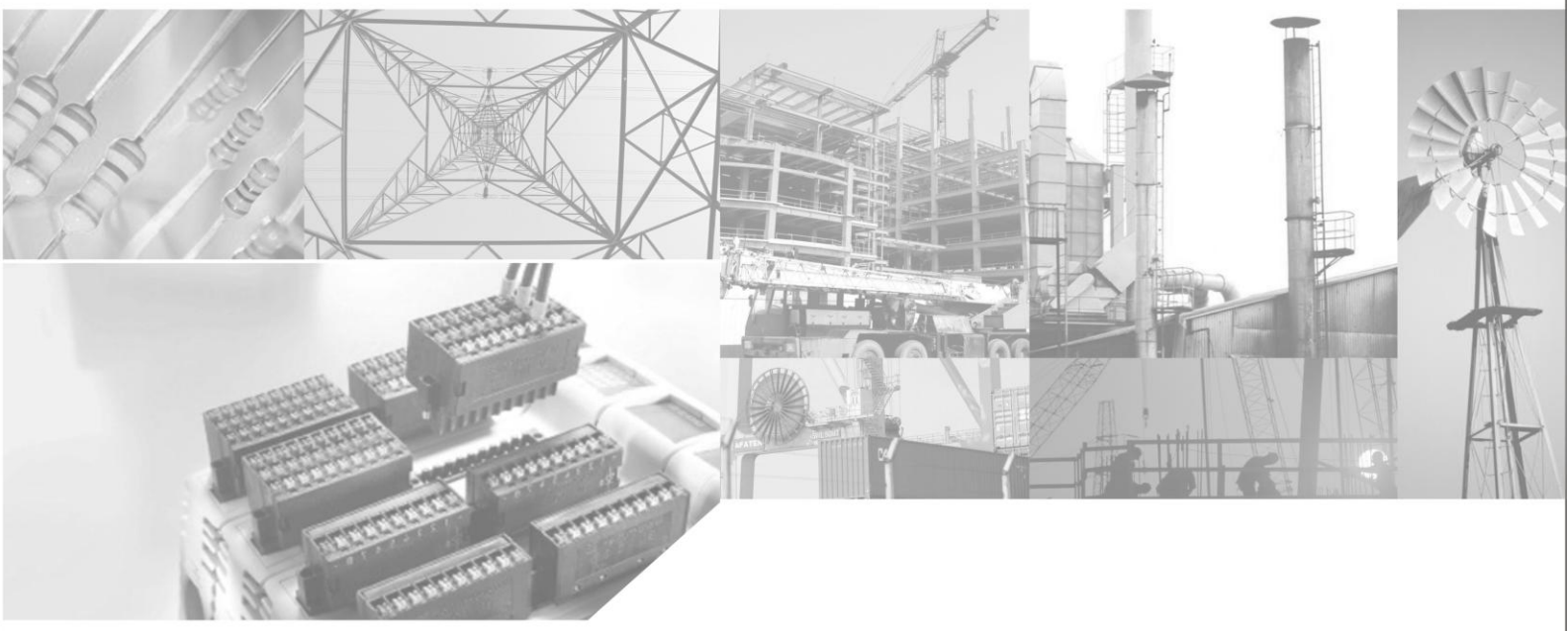
M660
GPRS Module
User Manual



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Document History

Revision History		
Version	**Remarks**	**Date Issue**
V3.0	Modified Version	2013-9
V3.1	Change receive sensitivity index	2013-10
V3.2	Change 24pin definition	2013-11

1. Introduction

This document describes the hardware features of M660, and guides for the relevant application design.

2. General Description

With the ultra-compact design, M660 is intended to be used in a wide range of applications, including industrial and consumer devices. M660 is a GSM/GPRS module with EDGE of downlink. It features with voice, SMS, and data services.

3. Simplified Block Diagram

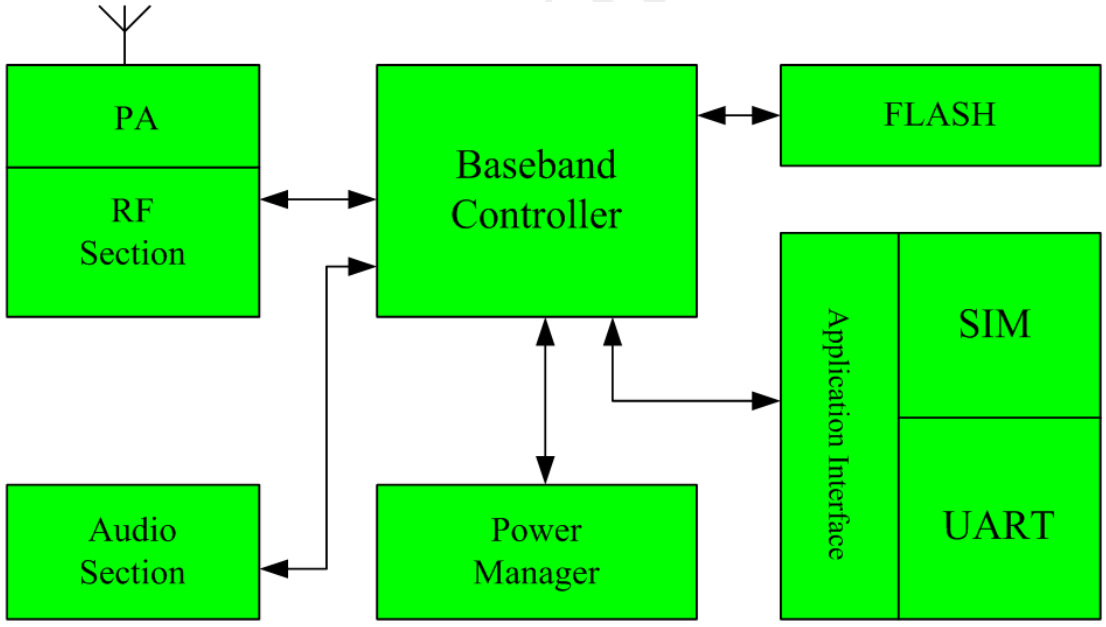


Figure 1 M660 Block Diagram

4. Key Features

Table1 M660 Key Features

Feature	Implementation
Frequency Bands	850/900/1800/1900 MHz Quad-band Compliant with GSM/GPRS Phase2/2+
Sensitivity	< -107dBm
Transmit Power	850/900 Class4(2W)
	1800/1900 Class1(1W)
AT	GSM07.07
	Extended AT commands
Audio CODEC	FR、EFR、HR、AMR
SMS	TEXT/PDU
	Point-to-point / cell broadcast
DATA	GPRS:Class 12
Supplementary Service	Call forwarding（CFB, CFNA, CFU）
	Call waiting & Call hold
	Multiparty call
	USSD
CPU	ARM7-EJ@260MHz, 32Mbits SRAM, 16~32Mbits Nor Flash
Open Resources	16Mbits RAM, 0.3~16Mbits Flash
Interfaces	UART, SIM
Operational Temperature	-40℃～+85℃
Operating Voltage	3.5V～4.3V（typical 3.9V）
Peak Current	Max 1.8A
Power Consumption	< 2mA @DRX5 (Sleep mode)

5. Product Specifications

5.1 Variants

Variants	Frequencies	Packages
M660-QUAD-AA0/A00	850/900/1800/1900MHz Quad-band	**28 Pin** LCC

5.2 Dimension & Package

Physical Characteristics	
Dimensions	22mm*18.4mm*2.7mm (Length*Width*Thickness)
Weight	2.2 g
Package	**28 Pin** LCC

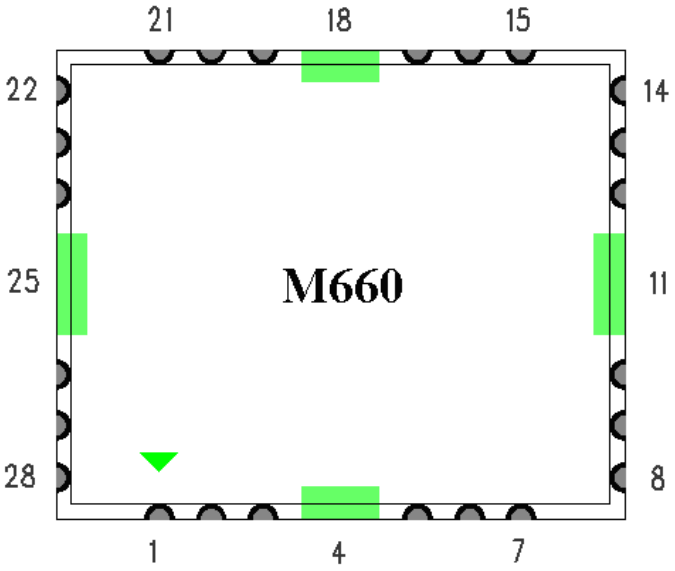


Figure 2 M660 Sketch

5.3 Pin Description

Table2 M660 pin definition

M660				
Pin	**Signal**	**I/O**	**Function**	**Note**
1	VSIM	PWR	SIM supply voltage	1.8/3.0V compatible.
2	SIM_CLK	DO	SIM clock	
3	SIM_DATA	DIO	SIM data	5KΩ internal pull-up
4	GND	PWR	GND	
5	SIM_RST	DO	SIM reset	Prompted by module
6	MICP	AI	MIC+	Vi ≤ 200mVpp
7	MICN	AI	MIC-	Vi ≤ 200mVpp
8	EAR-L	AO	Earpiece output L	Signal Ended Output. Can drive a 16Ω/32Ω earpiece directly.
9	EAR-R	AO	Earpiece output R	Signal Ended Output. Can drive a 16Ω/32Ω earpiece directly.
10	DTR	DI	Data Terminal Ready	Can be used to control sleep mode.
11	GND	PWR	GND	
12	RING	DO	Output for RING indicator	Can be used to indicate an incoming voice call or SMS.
13	VCCIO	PWR	2.8V power output	Can be used to power the level translators. Imax=5mA
14	Reserved		Reserved	
15	Reserved		Reserved	
16	URXD1	DI	Serial data input of module	V.24: TXD
17	UTXD1	DO	Serial data output of module	V.24: RXD
18	GND	PWR	GND	
19	RESET	DI	Reset input	Active low > 60mS
20	BACK_LIGHT	DO	Status LED	2.8V/4mA output Can drive a LED directly
21	ON/OFF	DI	Switch the module on/off	Low level pulse triggered
22	ANT	I/O	Antenna interface	A 50ohm antenna expected
23	GND	PWR	GND	
24	Reserved		Reserved	
25	GND	PWR	GND	
26	VBAT	PWR	Main power supply	3.5V~4.3V (**typical 3.9V**)
27	VBAT	PWR	Main power supply	
28	GND	PWR	GND	

5.4 PCB foot print

Recommended foot print:

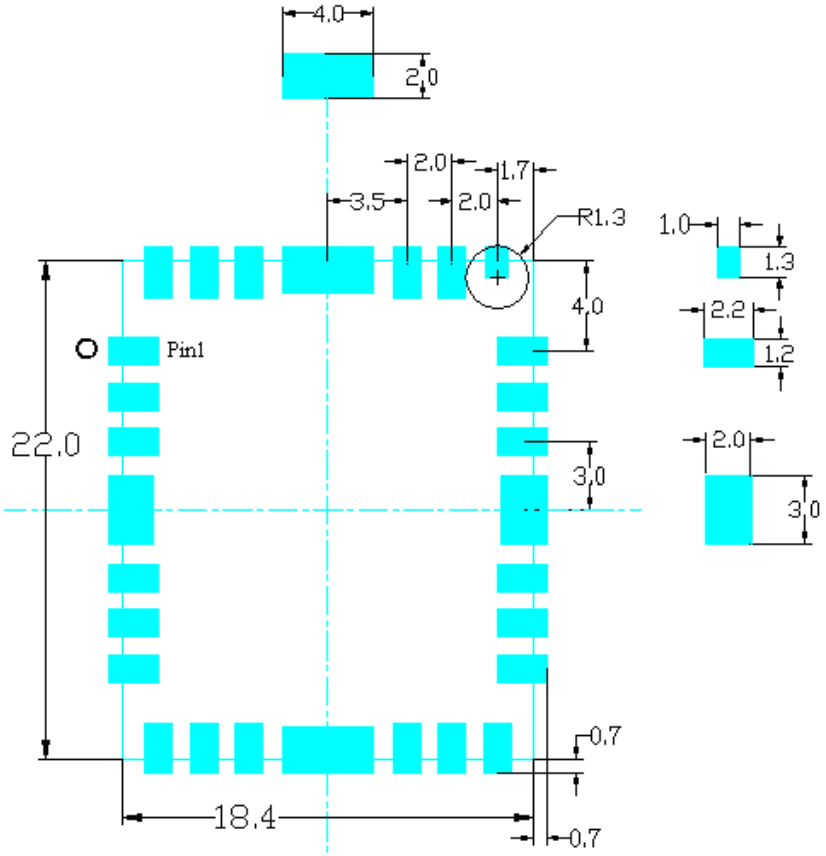


Figure 3 Recommended foot print of M660 (all dimensions in millimeters)

Note:

- Every other pitch not specified is 2.0mm.
- The circle on the top-right with a 1.3mm radius, defines a keep-out region, under which any copper or wire is inhibited, due to the RF test point here needs to be surrounded by restricted area filled with air.
- There may be some masks on the bottom of the module PCB, created by hollowing the solder resist layer, causing reveal of copper. To avoid short circuits, it is recommended to cover the application PCB with a silkscreen block at the area under the module, but excluding soldering area.

6. Application Interface

6.1 Power Supply Requirements

Table3 Power Supply and ON/OFF Control

Signal	I/O	Function	Note
VCCIO	PWR	2.8V power output	Can be used to power the level translators. Imax=5mA
RESET	DI	Reset input	Active low > 60mS.
ON/OFF	DI	Switch the module on/off	Low level pulse triggered.
VBAT	PWR	Main Power Supply	3.5V~4.3V(typical 3.9V)

6.1.1 Power Supply Basic Design Rules

VBAT is the main power supply for internal base band and radio PA of the module, in a range of 3.5V-4.3V. A 3.9V voltage is preferable.

The performance of power supply issued, is a critical path to module's performance and stability. The GSM bursts can cause current peaks up to **1.8A**, therefore large bypass capacitors are expected to reduce voltage drops during the bursts. The biggest current occurs when the received signal is very low. It's very important to ensure that the voltage of supply rail never drops below 3.5V while any burst occurs.

Figure 4 shows how the GSM bursts and voltage drops.

Figure 5 shows how the capacitor helps to improve peak current performance.

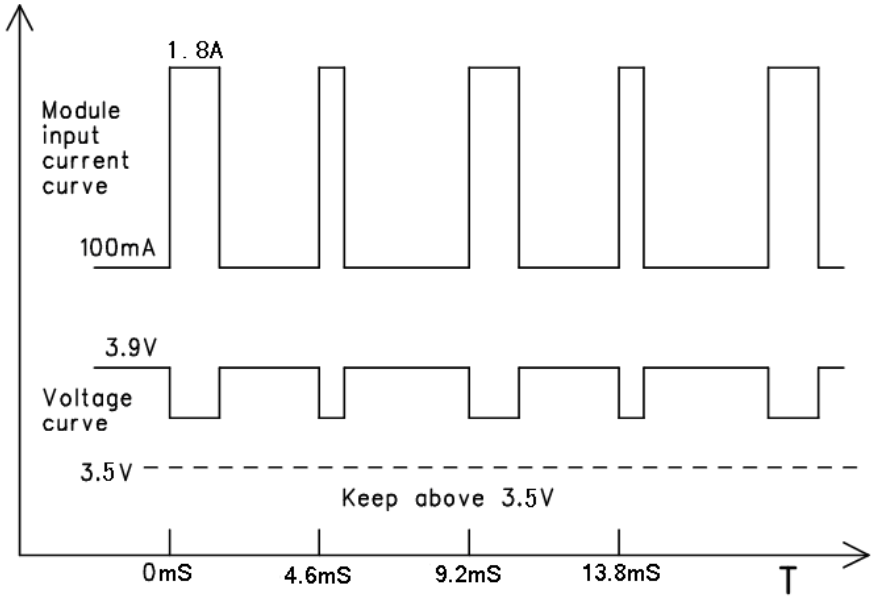
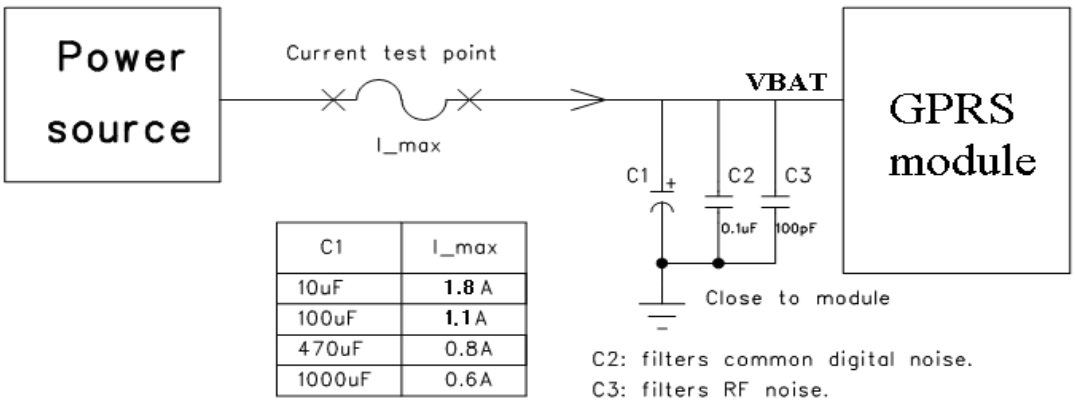


Figure 4 Burst Caused Current Peaks and Voltage Drops



C1	I_max
10uF	**1.8** A
100uF	**1.1** A
470uF	0.8A
1000uF	0.6A

Figure 5 Test Circuit and Peak Current

Results may vary depending on the ESR of capacitors, and the impedance of power source.

- A low ESR 1000uF aluminum capacitor for C1 can be selected. As an alternative, a 470uF tantalum capacitor is also suited. In case of Li-Ion cell battery used, 220uF or even 100uF tantalum capacitor may be applicable because of the battery's low internal impedance and the ability to provide high transient current.
- Use a low impedance power source, and keep the resistance of the power supply lines as low as possible.

- The power source should be able to output an average current greater than 1A.
- Some small capacitors, with values of 0.1uF, 100pF, 33pF, placed close to the module's power pin, are very helpful to suppress high frequency disturbances.
- The voltage range of power supply must never be exceeded. Over-voltage can even destroy the module permanently.
- Ensure the trace for VBAT to be wide enough, in order to pass the current peaks without significant voltage drops. The width of 2mm is preferable.

6.1.2 Extended Design Rules for Power Supply

6.1.2.1 Power Control

A controlled power supply is preferable if used in harsh conditions. RESET pin may be not functioning under strong disturbance. The output enable pin of LDO or DC/DC chipset could be used for emergency power control of the module, as shown in Figure 6.

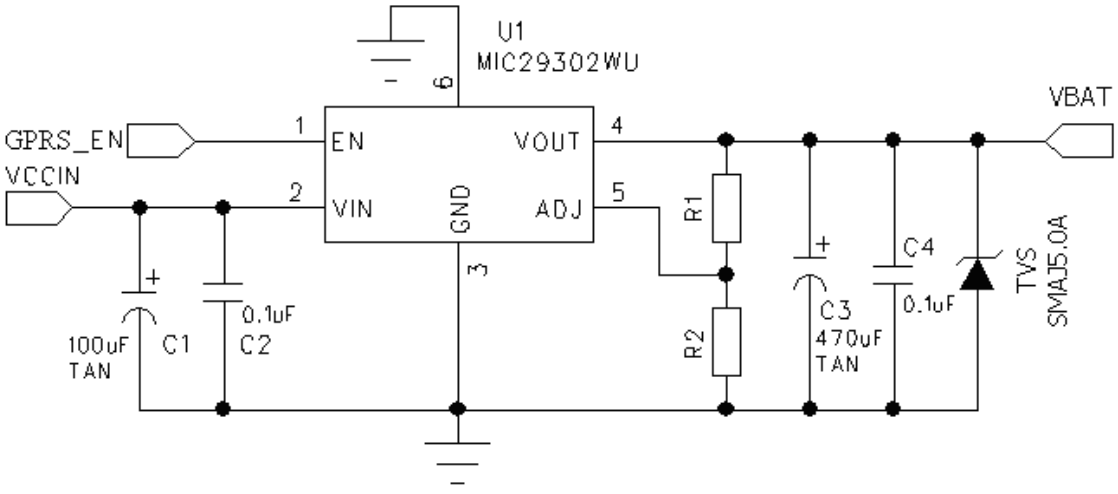


Figure 6 Using LDO's enable pin for emergency power control

The alternative way is to use a P-MOSFET to control the module's power, as shown in Figure 7. The GPRS_EN signal is routed to host GPIO, controlling the ON/OFF of the P-MOSFET. The host can cut off and then switch on the power supply in case of abnormal conditions, such as no response from the module or the disconnection of GPRS.

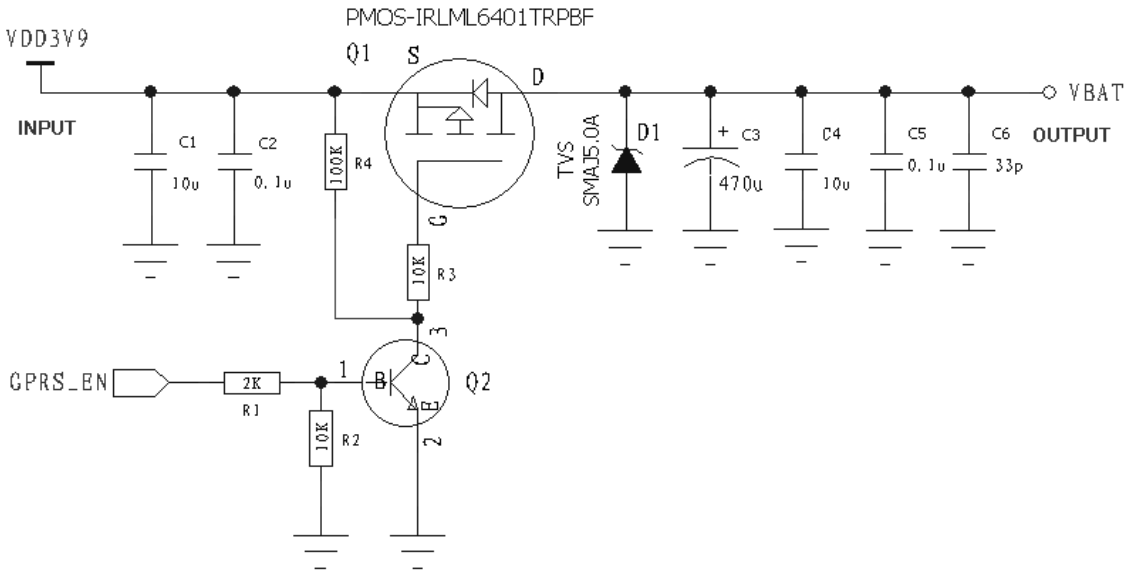


Figure 7 Using PMOS for power control

Q2 is for eliminating the need for a high enough voltage level of the host GPIO. In case that the GPIO can output a high voltage greater than VDD3V9 - $|V_{GS(th)}|$, where $V_{GS(th)}$ is the Gate Threshold Voltage, Q2 is not needed.

Reference components:

Q1: IRML6401

Q2: MMBT3904

C4: 470uF tantalum capacitor rated at 6.3V; or 1000uF aluminum capacitor.

It's strongly recommended to place a TVS diode on VBAT to ground, in order to absorb the power surges subjected. The SMAJ5.0A from Vishay can be as a choice.

6.1.2.2 Power Separating

As described in section 6.1.1, the GSM device works in burst mode generating voltage drops on power supply. And furthermore this results in a 217Hz TDD noise through power (One of the way generating noise. Another way is through RF radiation). Analog parts, especially the audio circuits, are subjected to this noise, known as a "buzz noise" in GSM systems. To prevent other parts from being affected, it's better to use separated power supplies. The module shall be supplied by an independent power, like a DC/DC or LDO.

The inductor used in Reference Design (b), should be a power inductor and have a very low

resistance. The value of 10uH, with average current ability>1.2A and low DC resistance, is recommended.

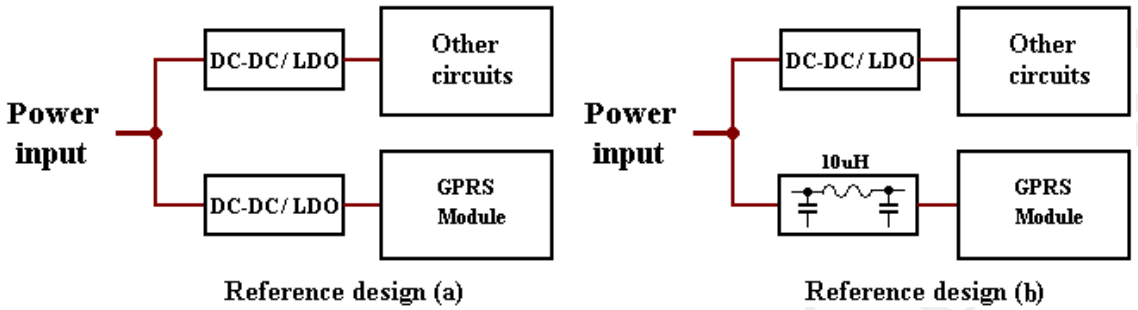


Figure 8 Using separated power supply for module

Never use a diode to make the drop voltage between a higher input and module power. It will obviously decrease the module performances, or result in unexpected restarts, due to the forward voltage of diode will vary greatly in different temperature and current.

6.1.2.3 EMC Considerations for Power Supply

Place transient overvoltage protection components like TVS diode on power supply, to absorb the power surges. SMAJ5.0A could be a choice.

6.1.2.4 Power-on Sequence

Prior to turning on the module, turn on the host MCU and finish the UART initialization. Otherwise conflictions may occur during initialization, due to unstable conditions.

6.2 ON/OFF Procedure

ON/OFF is a low level pulse active input, used to turn on or off the module.

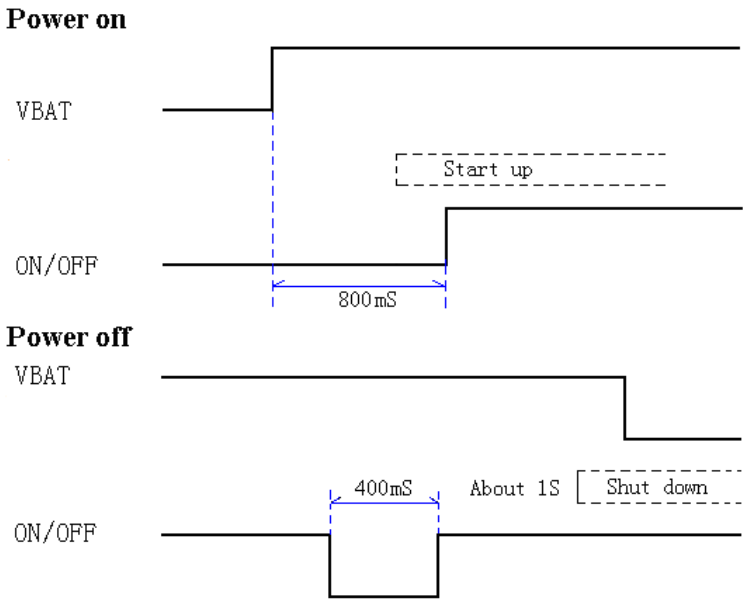


Figure 9 Turning on /off the module using ON/OFF

6.2.1 Turning on the module

While the module is off, drive the ON/OFF pin to ground for at least **600mS** (800mS is recommended) and then release, the module will start. An unsolicited message will be sent to host through AT port ("+EIND: 1"), indicating the powering up of the module and the AT commands can respond.

It's recommended to drive the ON/OFF to low before applying the VBAT to module. **300mS** (400mS is recommended) later from the VBAT applied, release the ON/OFF. Therefore the module starts up. The simplest way to power on the module, is to directly tie the ON/OFF to ground, issuing to an auto-power-on feature.

After the module is operating, keep ON/OFF being high level.

6.2.2 Turning off the module

While the module is on, drive the ON/OFF pin to ground for at least **500mS** and then release, the module will try to detach to network and normally 1 second later it will shut down. Another approach to turn off the module is with AT command.

Figure 10 shows a reference circuits for ON/OFF control with inverted control logic.

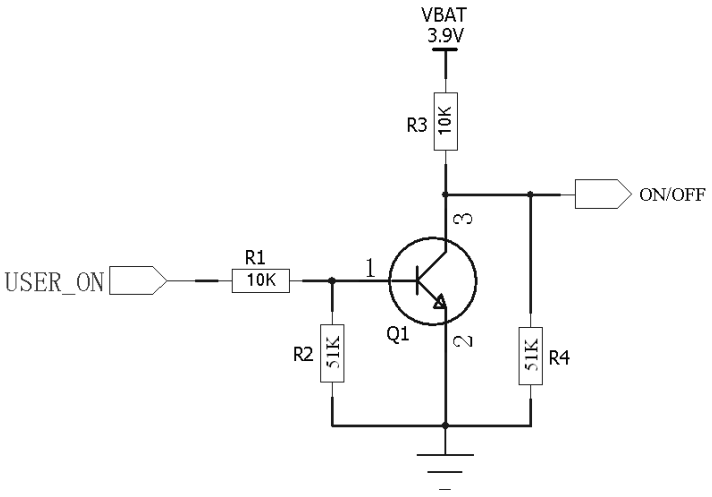


Figure 10 Reference circuit for ON/OFF control

Reference Components:

Q1: MMBT3904, or to use digital transistor with bias resistors built in, like DTC123/114

The combination of R3 and R4, should limit the high voltage of ON/OFF less than 3.0V.

Note:

- If the host itself is not initialized before turning on the module, some abnormal conditions on IO or UART may affect the power on procedure.
- The better way to rescue the module from abnormal condition, is to apply a power OFF-ON procedure, rather than using the ON/OFF control signal. In fact ON/OFF signal is software-dependent.

6.2.3 RESET

Pull the RESET signal to low level for at least 60mS to reset the module. A pull-up resistor is internally included. Reset pin can be left open if not used.

6.2.4 VCCIO

VCCIO is provided to power the level translators, with a 2.8V / 5mA output.

VCCIO can also be used to monitor the on/off state of module. It outputs 2.8V high level while the module is on, and low level while the module is off.

6.3 UART

6.3.1 Basic Descriptions of UART

Table4 UART

Signal	I/O	Function	Note
URXD1	DI	Serial input of module	
UTXD1	DO	Serial output of module	
DTR	DI	Signal for controlling sleep mode	
RING	DO	Ringing output	

UART1 is for AT commands, data sending/receiving, firmware updating, etc.

As a DCE device, the module is connected to DTE as shown in Figure 11.

Supported baud rates are 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400bps, and the default is **115200**.

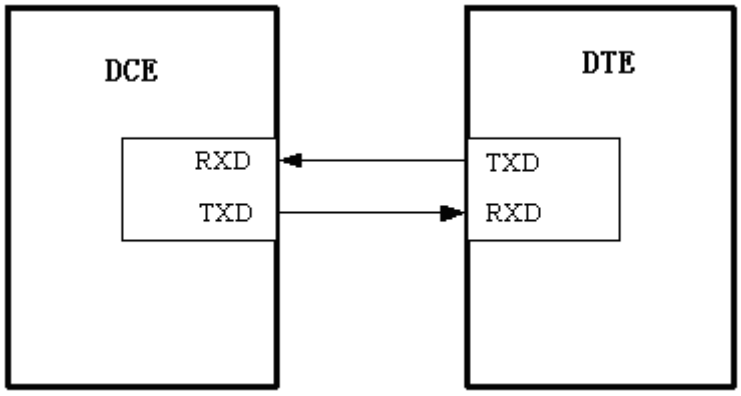


Figure 11 Connection between DCE (module) and DTE

The UART of M660 works at **2.8V** CMOS logic level. The voltages for input high level should **not** exceed 3.0V.

6.3.2 Level Translators for UART

If the UART is interfacing with a MCU that has 3.3V logic levels, resistors should be connected in series with the signals.

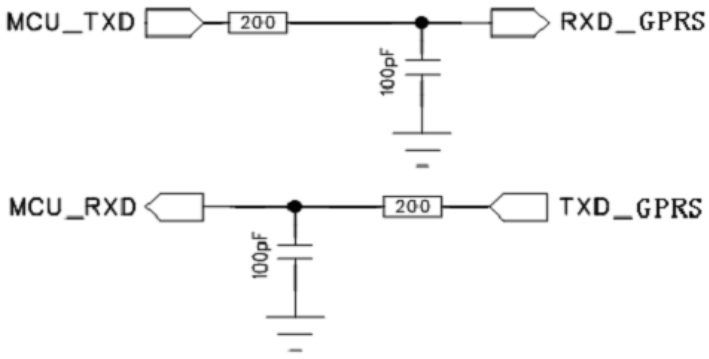


Figure 12 Interfacing with 3.3V logic levels of MCU

If the UART is interfacing with a MCU that has 5V logic levels, general level translators are required, for both inputs and outputs. As shown in Figure 13.

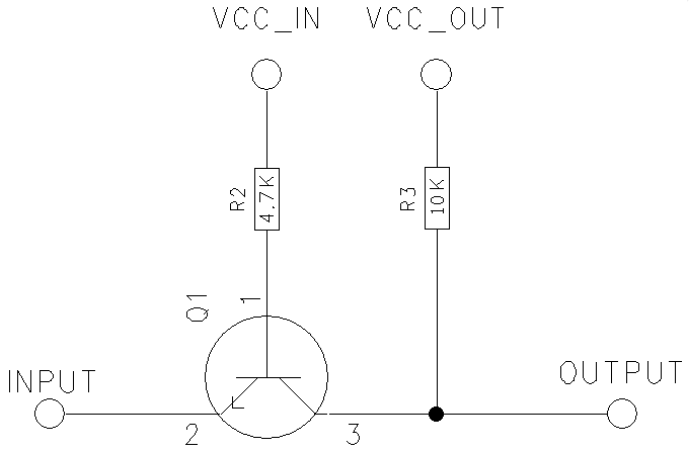


Figure 13 Interfacing with 5V logic levels of MCU

Reference components:

R2: 2K-10K. The higher rate the UART works at, the smaller value used

R3: 4.7K-10K. The higher rate the UART works at, the smaller value used

Q1: MMBT3904 or MMBT2222. High-speed transistors preferred.

Used for 5V logic -> 2.8V logic:

While this circuit used between MCU TXD and module URXD1, the INPUT signal is connected to MCU TXD, and OUTPUT connected to module URXD1. VCC_IN powered from 5V and VCC_OUT powered from 2.8V (module's VCCIO can be used). This applies to DTR control as well.

Used for 2.8V logic -> 5V logic:

It can be used between module UTXD1 and MCU RXD as well, with INPUT connected to module UTXD1, and OUTPUT connected to MCU RXD. VCC_IN powered from 2.8V (module's VCCIO) and VCC_OUT powered from 5V. This applies to RING signal as well.

Note:

Avoid sparks and glitches on UART signals while the module is in a turning on procedure.

Avoid sending any data to UART during the beginning of 2 seconds after the module being turned on.

6.4 Sleep mode

6.4.1 DTR

Generally DTR is used for sleep mode control. For details, see AT commands manual. Based on the setting of the selected mode, pulling DTR low will bring the module into relevant power saving mode. Working in this mode, the power consumption is around 2mA, depending on the DRX setting of network.

In sleep mode, the module can also respond to the incoming call, SMS, and GPRS data. The host MCU can also control the module to exit sleep mode by controlling DTR.

The controlling of sleep mode:

1) Keep DTR high in normal working mode. Activate the sleep mode by using the AT command AT+ENPWRSAVE=1.
2) Pull DTR low, the module will enter sleep mode, but only after process and pending data finished.
3) UART is not available in sleep mode.
4) In sleep mode, the module can be woken up by the events of incoming voice call, received data, or SMS. Meanwhile the module will send out the unsolicited messages by the interface of RING or UART.

   Upon receipt of the unsolicited messages, the host MCU should pull DTR high firstly, otherwise the module will resume sleep mode shortly. And then the host MCU can process the voice call, received data, or SMS. After processing is finished, pull DTR low again to put the module into sleep mode.

5) Pull DTR high, the module will exit from sleep mode actively, and furthermore enable the UART. Thus the voice call, received data, or SMS can be processed through UART. After processing finished pull it low again, to take the module back to sleep mode.

6.4.2 RING

1) Once the incoming voice call, the module sends out “ring” message through UART and meanwhile outputs 250mS low pulses at 4S period on RING signal. See Figure 14.

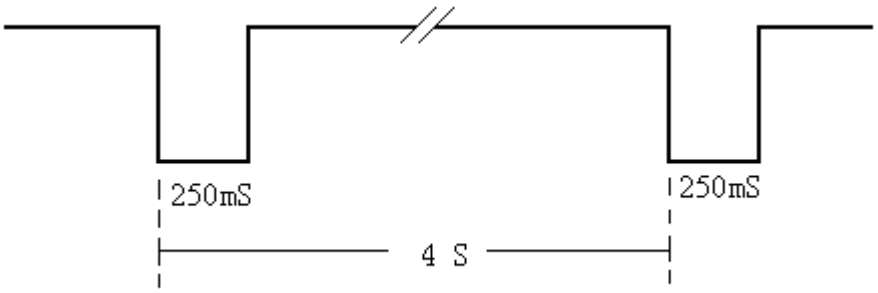


Figure 14 RING indicator for incoming call

2) Upon receipt of SMS, the module outputs one 600mS low pulse. See Figure 15.

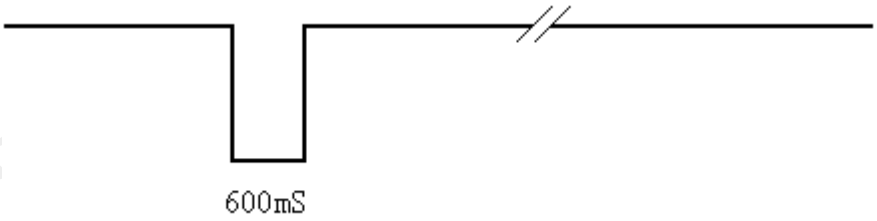


Figure 15 RING Indicator for SMS

6.5 SIM interface

Table5 SIM Interface

Signal	I/O	Function	Note
VSIM	PWR	SIM supply voltage	1.8/3.0V
SIM_CLK	DO	SIM clock	
SIM_RST	DO	SIM reset	
SIM_DATA	DIO	SIM data	Internal pull up

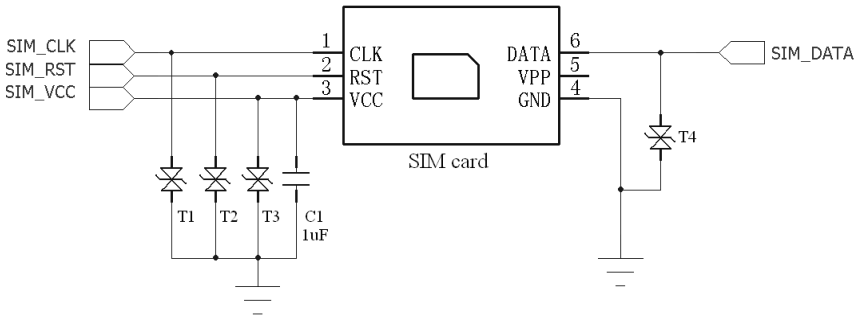
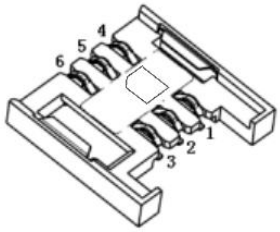


Figure 16a Reference design of SIM interface



Pin1=VCC, Pin2=RST, Pin3=CLK, Pin4=GND, Pin5=VPP, Pin6=DATA

Figure 16b a sample of SIM card socket

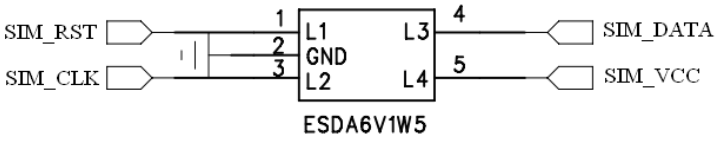


Figure 16c the recommended ESD diode array

M660 SIM interface is 3V/1.8V compatible. VSIM is for SIM power and can supply a 30mA current.

SIM_DATA is internally pulled up with a 5KΩ resistor. External pull-up resistor is not needed.

SIM_CLK can work at several frequencies, but at 3.25MHz typically.

ESD protectors, such as ESD diodes or ESD Varistors, are recommended on the SIM signals, especially in automotive electronics or other applications with badly ESD. The total equivalent capacitance on any SIM signal, include the junction capacitance of the ESD diode and the distributed capacitance of PCB trace, can't be higher than 120pF.

If the SIM card is installed in a closed case without human touch or ESD, 22~33pF MLCC capacitors can replace the ESD diodes for cost down.

SIM card is sensitive to GSM TDD noise and RF interference. So, the rule is very important in the PCB design, listed as the following.

- The antenna should be installed a long distance away from the SIM card and SIM card traces, especially to the build-in antenna.
- The PCB traces of SIM should be as short as possible and shielded with GND copper.
- The ESD diodes or small capacitors should be closed to SIM card.

Note:

Small capacitors and the junction capacitance of the ESD diode are to avoid the interference from/to antenna, ensuring the correct SIM access and good RF performance.

6.6 Running LED Indicator

Table6 Running Indicator

Signal	I/O	Function	Note
BACK_LIGHT	DO	Running Status	Can drive a LED directly

The various blink behaviors of LED indicate different of module status.

It can output a 4mA current and 2.8V voltage, therefore a LED can be directly connected to this pin with a resistor in series. For better luminance, drive the LED with a transistor instead, see Figure 17.

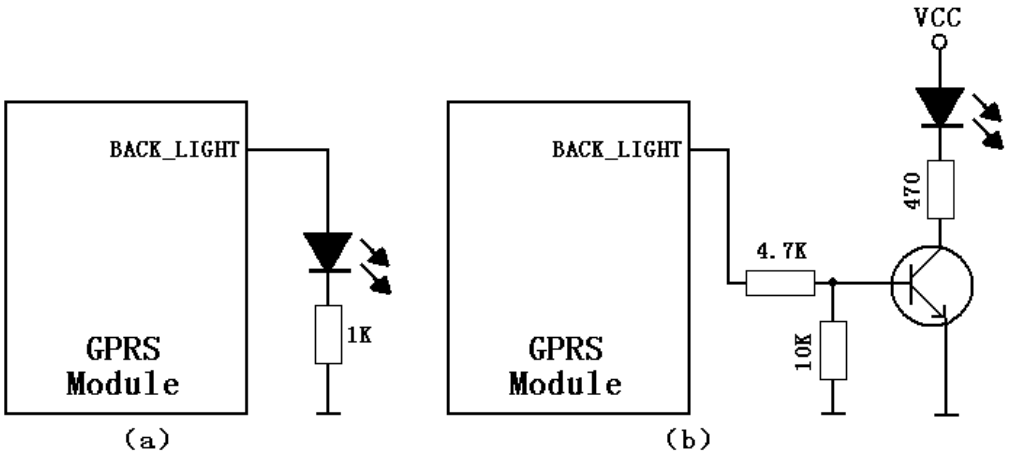


Figure 17 LED Indicator

6.7 Audio Interface

Table7 Audio Interface

Signal	I/O	Function	Note
MICP	AI	MIC+ input	Vpp ≤ 200mV
MICN	AI	MIC- input	Vpp ≤ 200mV
EAR-L	AO	Earpiece output L	Can drive a 16Ω/32Ω earpiece directly
EAR-R	AO	Earpiece output R	Can drive a 16Ω/32Ω earpiece directly

For reference audio interface see Figure 18. The peak-peak voltage routed to MIC+/MIC- should not exceed 200mV. AGC circuit is integrated inside the module. Electret microphone is suited.

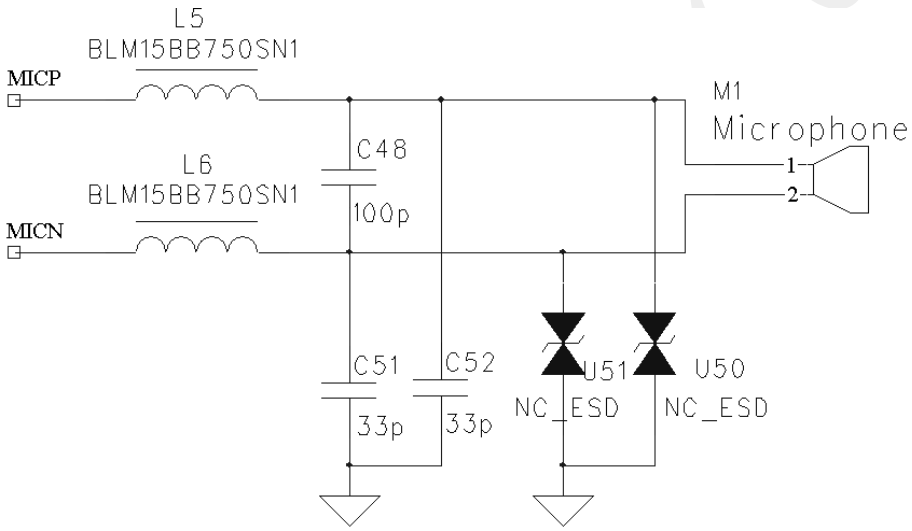


Figure 18 Reference design of microphone interface

A bias voltage for microphone is provided through MICP and MICN, as shown in Figure 19. But if an amplifier is used between the microphone and module, capacitors like C1 and C2, should be placed between the outputs of amplifier and module, to block the bias voltage.

For a peak-peak voltage greater than 200mV, an attenuation circuit comprised of R1-R4 should be used.

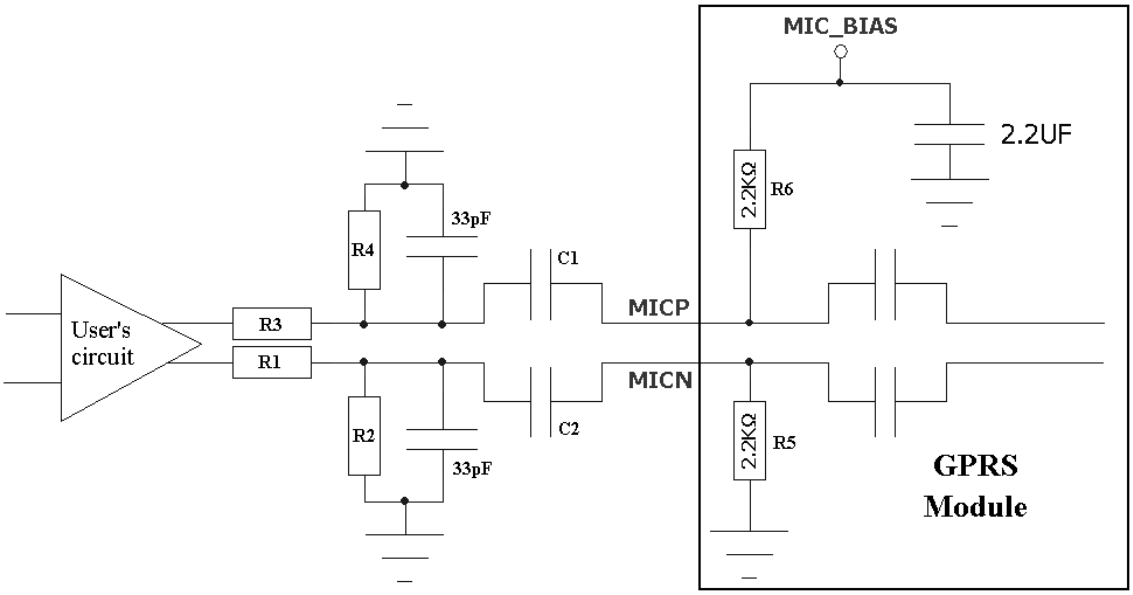


Figure 19 Reference design for MIC interface

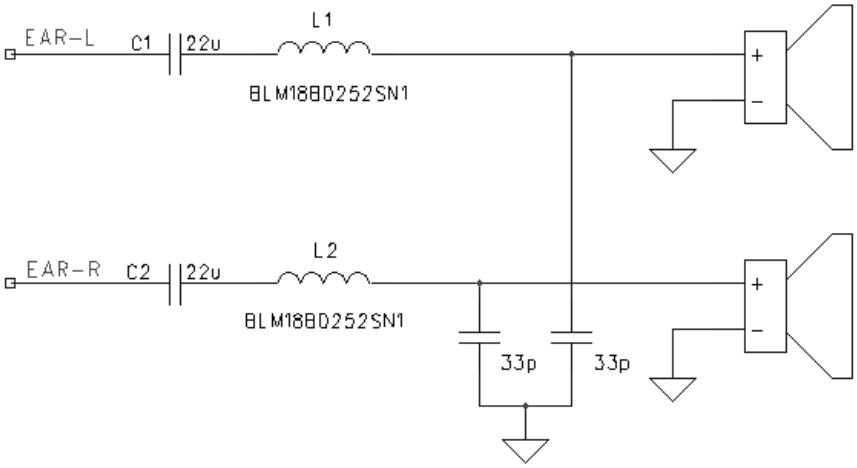


Figure 20 Reference design for Ear interface

Figure 20 shows a reference design for earpiece interface. A 16Ω/32Ω earpiece can be directly driven by the module. To pass the low frequency audio, use large capacitors for C1 and C2.

If an external amplifier is used for driving the speakers, 1uF~4.7uF coupling capacitors should be used to block the DC voltage, as shown in Figure 21.

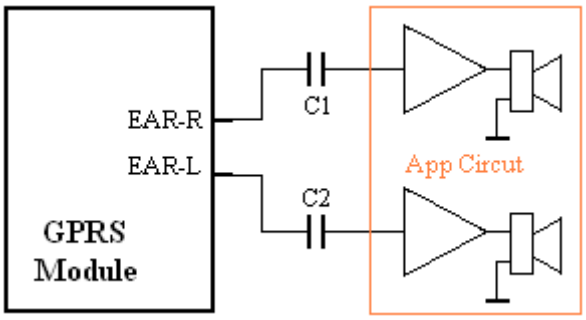


Figure 21 Using capacitors to couple audio outputs

As the description of TDD noise before, the GSM radio frequency is modulated at 217Hz. The 217Hz and its derivative frequency is well within audio band, therefore a TDD noise often affect the audio performance through power and air. Some small capacitors between 27pF-100pF and ferrite beads, placed on the audio path can attenuate TDD noise.

For Suppressing the TDD noise, differential audio interface is preferable. The PCB trace of audio signal should be routed as differential line.

In particular, the microphone interface is a pair of small signal, peak-peak voltage <200mV, must comply the rule of differential line. The microphone interface should be routed as short as possible.

6.8 Antenna Interface

A 50Ω antenna is required. VSWR < 1.5. The antenna should be well matched to achieve best performance. It should be installed far away from high speed logic circuits, DC/DC power, or any other strong disturbing sources.

ESD protection is built in module. For special ESD protection, a ESD diode can be placed close to the antenna. But ensure to use a low junction capacitance one. The junction capacitance should be less than 0.5pF, otherwise the RF signal will be attenuated. RCLAMP0521P from Semtech, or ESD5V3U1U from Infineon, can be used here. See Figure 22.

The trace between the antenna pad of module and the antenna connector, should have a 50Ω characteristic impedance, and be as short as possible. The trace should be surrounded by ground copper. Place plenty of via holes to connect this ground copper to main ground plane, at the copper edge.

If the trace between the module and connector has to be longer, or built-in antenna is used, a π-type matching circuit should be needed, as shown in Figure 22. The types and values of C1, L1, and L2 should be verified by testing using network analyzer instrument. If the characteristic impedance is well matched, and VSWR requirement is met, just use a 0Ω resistor for C1 and leave L1, L2 un-installed.

Avoid any other traces crossing the antenna trace on neighboring layer.

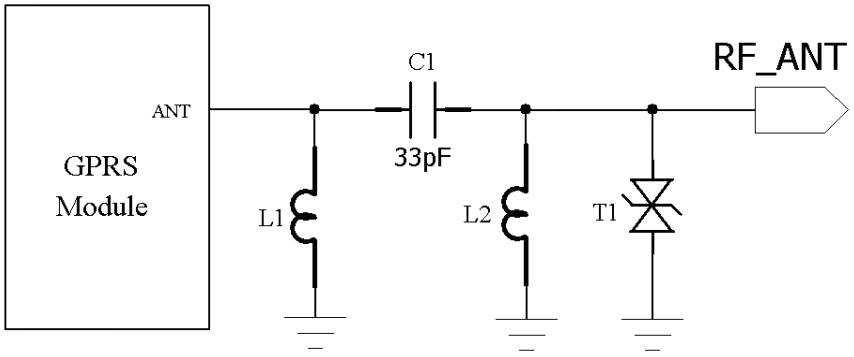


Figure 22 Reference design for antenna interface

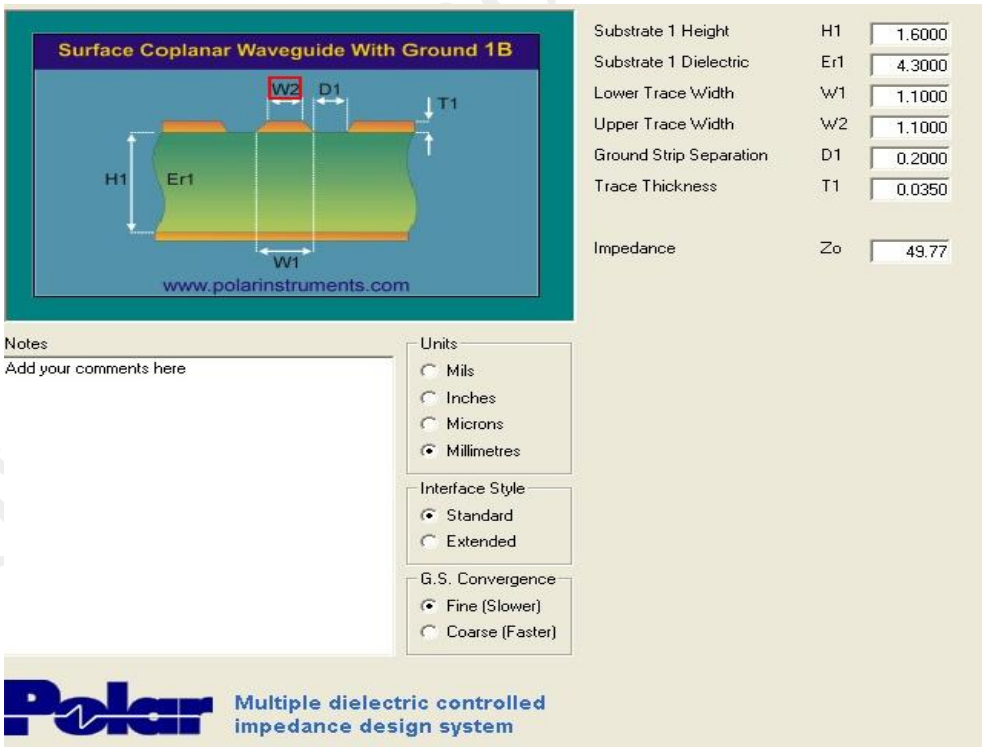


Figure 23 Reference parameters for 50Ω trace on a 1.6mm double layer PCB

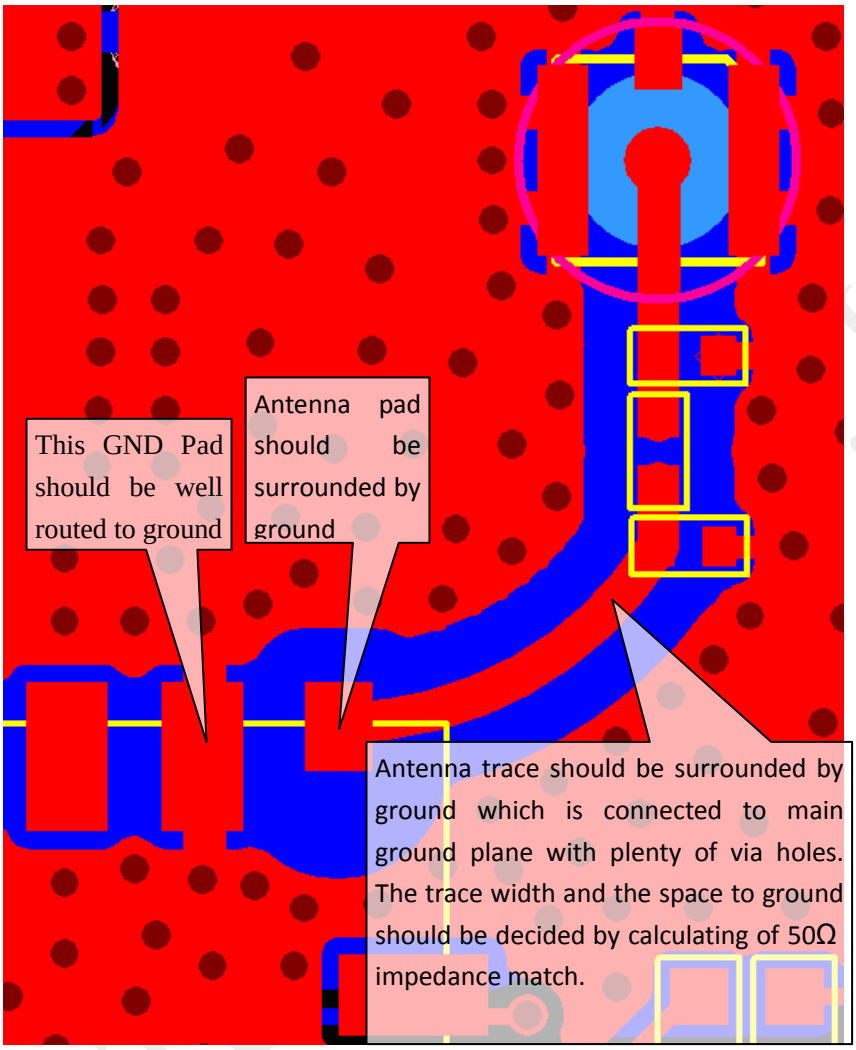


Figure 24 Reference layout for antenna interface

7. Mounting the Module onto the Application Board

M660 is compatible with industrial standard reflow profile for lead-free SMT process.

The reflow profile is process dependent, so the following recommendation is just a start point guideline:

- Only one flow is supported.
- Quality of the solder joint depends on the solder volume. Minimum of 0.15mm stencil thickness is recommended.
- Use bigger aperture size of the stencil than actual pad size.
- Use a low-residue, no-clean type solder paste.

8. Package

M660 modules are packaged in sealed bags on delivery to guarantee a long shelf life. Package the modules again in case of opening for any reasons.

If exposed in air for more than 48 hours at conditions not worse than 30℃/60% RH, a baking procedure should be done before SMT. Or, if the indication card shows humidity greater than 20%, the baking procedure is also required.

The baking should last for at least 24 hours at 90℃.

9. Terms and Abbreviations

ADC	Analog-Digital Converter
AGC	Automatic Gain Control
AMR	Acknowledged multirate (speech coder)
CSD	Circuit Switched Data
CPU	Central Processing Unit
DCE	Data Communication Equipment
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EFR	Enhanced Full Rate
EMC	Electromagnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electronic Static Discharge
FR	Full Rate
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
LED	Light Emitting Diode
PCB	Printed Circuit Board
RAM	Random Access Memory
RF	Radio Frequency
SIM	Subscriber Identification Module
SMS	Short Message Service
SMT	Surface Mounted Technology
SRAM	Static Random Access Memory

TDMA	Time Division Multiple Access
UART	Universal asynchronous receiver-transmitter
Varistor	Voltage Dependent Resistor
VSWR	Voltage Standing Wave Ratio

Warning Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try correct the interference by one or more of the following measures:

- Reorient the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into and outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

You are cautioned that changes or modifications not expressly approved by the party responsible for compliance could void your authority to operate the equipment.

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: 1) this device may not cause harmful interference, and 2) this device must accept any interference received, including interference that may cause undesired operation.

Important announcement

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

IMPORTANT NOTE:

This module is intended for OEM integrator. The OEM integrator is still responsible for the FCC compliance requirement of the end product, which integrates this module.

20cm minimum distance has to be able to be maintained between the antenna and the users for the host this module is integrated into. Under such configuration, the FCC radiation exposure limits set forth for an population/uncontrolled environment can be satisfied.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

USERS MANUAL OF THE END PRODUCT:

In the users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment. If the size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the users manual: This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile-only exposure condition must not exceed 2dBi in the cellular band and 2dBi in the PCS band.

A user manual with the end product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

The end product with an embedded M660 Module may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

Note: If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements of FCC Part 2.1093.