



WISMO Quik Q2400 series

# Q2400 Customer Design Guidelines

Revision: 004  
Date: January 2006



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## **WISMO Quik Q2400 series**

# **Q2400 Customer Design Guidelines**

Reference: **WM\_PRJ\_Q24\_PTS\_004**

Revision: **004**

Date: **18th January 2006**



## Document Information

Revision	Date	History of the evolution	
001	28 Jan 04	Creation	
002	17 Dec 04	Update document legal mentions. Update Power Supply section Modification of RF connection mode Modification of figures and mechanical information due to change of module design	
003	07 Feb 05	Update SIM 1.8/3V and 3/5V management related paragraphs and diagrams	
003	25th July 2005	Update §2.1.3.2, §3.2.2, §4 for Lead free introduction( Update §1.1.1.3 for power supply voltage Update §1.1.1.4 for module capability Update §2.2.2.2 for two-wire interface	
004	18 <sup>th</sup> January 2006	Update §2.2.1 for serial resistor on digital I/O Update §2.2.5.1 for SIM_VCC capacitor Update §2.4 for battery type charging and software version Update §2.2.5 for Uart Input level in OFF state and serial resistors	

## Overview

This document gives recommendations for WISMO Quik Q2400 module integration in an application and particularly:

- The baseband design rules and typical implementation examples,
- The RF design rules and typical implementation examples
- The mechanical constraints for module fitting,
- The PCB routing recommendations,
- The Test and download recommendations.

It also gives some part references and suppliers.

Two versions of the WISMO Quik Q2400 module are available:

- **Q2400A**: E-GSM 900/1800 MHz version with 16 Mbits of Flash memory and 2 Mbits of SRAM (16/2),
- **Q2400B**: E-GSM 900/1800 MHz version with 32 Mbits of Flash memory and 4 Mbits of SRAM (32/4).

 Please be aware that some of the interfaces provided by the Q2400 module can not be handled when using the module driven by AT commands.



This symbol is used to indicate the interfaces not available with AT commands.

These functions have then to be managed externally i.e using the main processor of the application.

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## Caution

Information furnished herein by Wavecom are accurate and reliable. However no responsibility is assumed for its use. Please read carefully the safety precautions for a terminal based on WISMO Quik Q2400 Series.

General information about Wavecom and its range of products is available at the following internet address: <http://www.wavecom.com>

## Trademarks

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## Reference documents

- [1] WISMO Quik Q2400 Product Technical Specification  
WM\_PRJ\_Q24\_PTS\_003
- [2] AT Commands Interface Guide  
WM\_ASW\_OAT\_UGD\_00016

# 1 General description

## 1.1 General information

### 1.1.1 Module Features

WISMO Quik Q2400 module is a self-contained E-GSM 900/1800 dual-band module including the following features:

#### 1.1.1.1 Overall dimensions

- 58.4 x 32.2 x 3.9 mm.

#### 1.1.1.2 Power consumption

- 2 Watts E-GSM 900 radio section running under 3.6 Volts.
- 1 Watt GSM1800 radio section running under 3.6 Volts.

#### 1.1.1.3 Power supply voltage

- Digital section running under 2.8 Volts.
- 3V only SIM interface (for both 1.8 V and 5 V SIM interface with external adaptation, refer to § 2.2.6.2 and 2.2.6.3).

#### 1.1.1.4 Module capability

- Real Time Clock with calendar.
- Battery charge management.
- Echo Cancellation + noise reduction.
- Full GSM software stack.
- Complete shielding.
- Complete interfacing through a 60-pin connector:
  - Power supply,
  - Serial link,
  - Audio,
  - SIM card interface,
  - Keyboard,
  - LCD

### 1.1.2 Module external connection

WISMO Quik Q2400 module has two external connections:

- RF connection pads (to the antenna),
- 60-pin General Purpose Connector (GPC) to Digital, Keyboard, Audio and Supply.

### 1.1.3 Additional customizing functions

WISMO Quik Q2400 module is designed to fit in very small terminals and only some custom functions have to be added to make a complete dual-band solution:

- Keypad and LCD module,
- Earpiece and Microphone,
- Base connector,
- Battery,
- Antenna,
- SIM connector.

### 1.1.4 RoHS compliance

The Q2400 module is now compliant with RoHS (Restriction of Hazardous Substances in Electrical and Electronic Equipment) Directive 2002/95/EC which sets limits for the use of certain restricted hazardous substances. This directive states that "from 1st July 2006, new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE)".

Modules which are compliant with this directive are identified by the RoHS logo on their label.



## 2 Baseband design

Note:

Some of the WISMO interface signals are multiplexed in order to limit number of pins but this architecture implies some limitation.

For example in case of using SPI bus, 2-wire bus can not be used.

**Warning:**

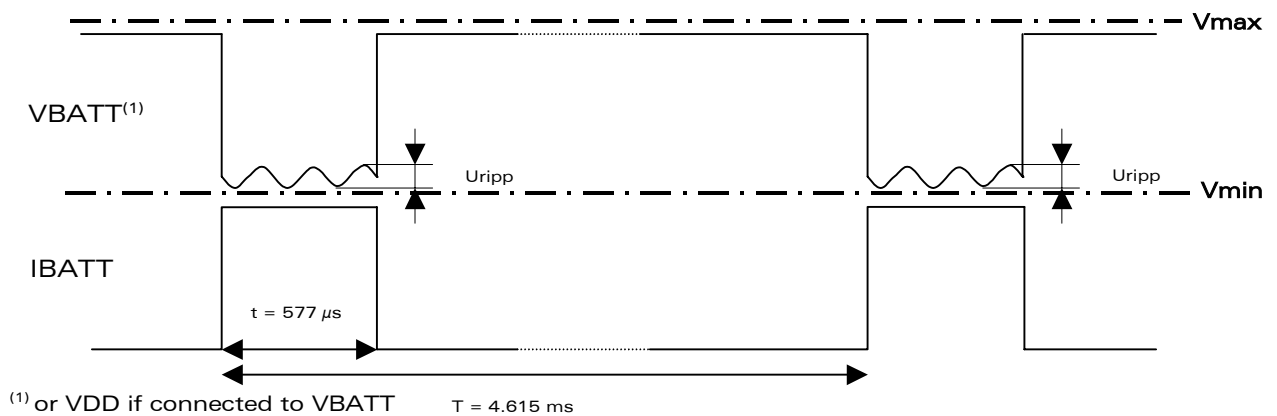
All external signals must be inactive when the WISMO module is OFF to avoid any damage when starting and allow WISMO module to start correctly.

### 2.1 Power supply and ground design rules

#### 2.1.1 Electrical constraints

The power supply is one of the key issues in the design of a GSM terminal. Due to the bursted emission in GSM, the power supply must be able to deliver high current peaks in a short time and assured that the voltage delivered to the module remains always under the limits specified in Table 2 hereafter, specially during burst while there is a drop of voltage (see Figure 1).

In communication mode, a GSM terminal emits 577  $\mu$ s radio bursts every 4.615ms.



**Figure 1: Typical power supply voltage in GSM mode**

Two different inputs are provided for the power supply:

- the first one, VBATT is used to supply the RF part,
- the second one, VDD is used to supply the baseband part.

The power supply voltage features given in the table hereafter will guarantee nominal functioning of the module.

	V <sub>MIN</sub>	V <sub>NOM</sub>	V <sub>MAX</sub>
VBATT	3.3 V (*)	3.6 V	4.5 V (**)
VDD	3.1 V		4.5 V

**Table 1: Power supply voltage**

(\*): This value has to be guaranteed during the burst (with 2.0 A Peak in GSM mode).

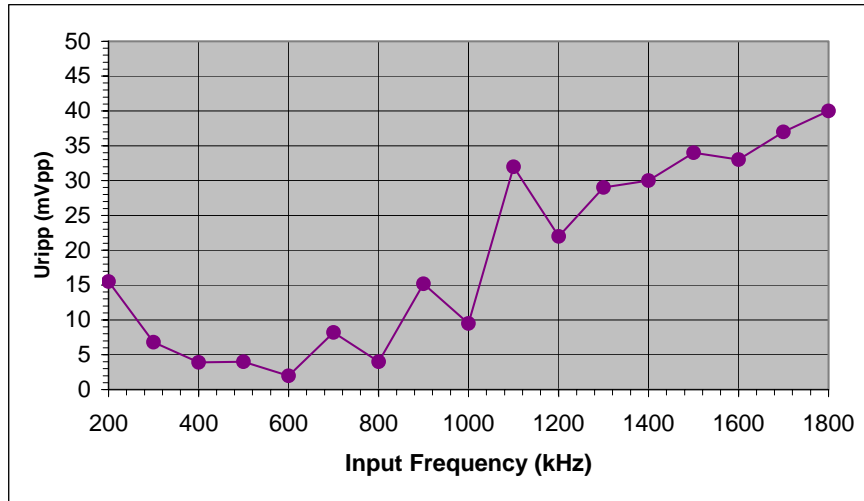
(\*\*): max operating Voltage Stationary Wave Ratio (VSWR) 2:1.

When the module is supplied with a battery, the total impedance (battery+contacts+protections+PCB) should be < 150 mΩ to limit voltage drop-out within emission burst.

As the radio power amplifier is directly connected to VBATT, the module is sensitive to any Alternative Current on lines. When a DC/DC converter is used, Wavecom recommends to set the converter frequency in such a way that the resulting voltage does not exceed the values in following table and Figure 2.

Freq. (kHz)	U <sub>ripp</sub> Max (mVpp)	Freq. (kHz)	U <sub>ripp</sub> Max (mVpp)	Freq. (kHz)	U <sub>ripp</sub> Max (mVpp)
<100	50	800	4	1500	34
200	15.5	900	15.2	1600	33
300	6.8	1000	9.5	1700	37
400	3.9	1100	32	1800	40
500	4	1200	22	>1900	40
600	2	1300	29		
700	8.2	1400	30		

**Table 2: Maximum voltage ripple (U<sub>ripp</sub>) vs Frequency in GSM & DCS**



for  $f < 100\text{kHz}$   $U_{ripp} \text{ Max} = 50\text{mVpp}$   
for  $f > 1800\text{kHz}$   $U_{ripp} \text{ Max} = 40 \text{mVpp}$

**Figure 2: Maximal voltage ripple (Uripp) vs Frequency in GSM & DCS**

**2.1.2 Design requirements**

**2.1.2.1 Risk**

VBATT supplies directly the RF components with 3.6 V. It is essential to keep a minimum voltage ripple at this connection in order to avoid any phase error. Insufficient power supply voltage could dramatically affect some RF performances:

- TX power of course and modulation spectrum,
- EMC performances (spurious emission),
- Emissions spectrum,
- Phase error and frequency error.

**2.1.2.2 General design rules**

A careful attention should be paid to:

- Quality of the power supply: capacity to deliver high peak current in a short time (burst emission), low ripple and low impedance.
- The battery charger line must support 800 mA to comply with the voltage level required for the product.
- The VBATT lines on the PCB must support peak currents with a voltage drop below the specified limit.

In order to test the supply tracks, a burst simulation circuit is shown hereafter. This circuit simulates burst emissions, equivalent to bursts generated when transmitting at full power.



### 2.1.3 PCB routing constraints

#### 2.1.3.1 Power supply routing constraints

- A ground plane must be provided on the PCB. This plane must not be parcelled out.
- Attention shall be paid to the power supply tracks and to the ground plane which supply the module. The tracks and the plane used must support current peaks.
- Since the maximum peak current can reach 2 A, Wavecom strongly recommends a large width for the layout of the power supply signal (to avoid voltage loss between the external power supply and the module supply. Filtering capacitors, near the module power supply, could also be added (refer to paragraph 2.1.3.3).
- The routing must be done in such a way that the total impedance line must be  $\leq 10 \text{ m}\Omega$  @ 217 Hz. This impedance must include the via impedances.
- Same care shall be taken when routing the ground supply.
- If these design rules are not followed, phase error (peak) and power loss could occur.

#### 2.1.3.2 Application ground plane and shielding connection

The ground connection is done through the shielding  $\Rightarrow$  the four legs have to be soldered to the ground plane (see Wavecom recommendation for lead free soldering in paragraph 5.3).

A ground plane must be available on the application board to provide efficient connection to the WISMO module shielding.

Best shielding performance will be achieved if the application ground plane is a complete layer of the application PCB:

- To ensure a good shielding of the module, a complete ground plane layer must be available, with no trade-off. Connections between other ground planes shall be done with vias.
- Without this ground plane, external Tx spurious or Rx blockings could appear.

It is strongly recommended to avoid routing any signals under the module.

#### 2.1.3.3 Decoupling of power supply signals

Decoupling capacitors on VBATT and VDD lines are imbedded in the module. So it should not be necessary to add decoupling capacitors close to the module.

However, in case of EMI/RFI problem, some signals like VBATT and charge line (CHG\_IN) may require some EMI/RFI decoupling: parallel 33 pF capacitor close to the module or a serial ferrite bead (or both to get better results).

In case a ferrite bead is used, the recommendation given for the power supply connection must be carefully followed (high current capacity and low impedance).

## 2.2 Digital I/O and peripheral implementation

### 2.2.1 Electrical information for digital I/O

All digital I/O comply with 3Volts CMOS.

To interface the WISMO Quik Q2400 module digital signals with other logics:

- 3.3 V logic: some serial resistors (more than 11 kΩ can be added on the lines,
- For higher voltage logics, a resistor bridge or a level shifter IC can be added.

### 2.2.2 LCD interface

The WISMO Quik Q2400 module can be connected to a LCD module driver through either a SPI bus or a two-wire interface.

#### 2.2.2.1 SPI bus

The SPI bus includes a CLK signal (SPI\_CLK), an I/O signal (SPI\_IO) and an EN signal (SPI\_EN) complying with SPI bus standard.

#### Typical implementation:

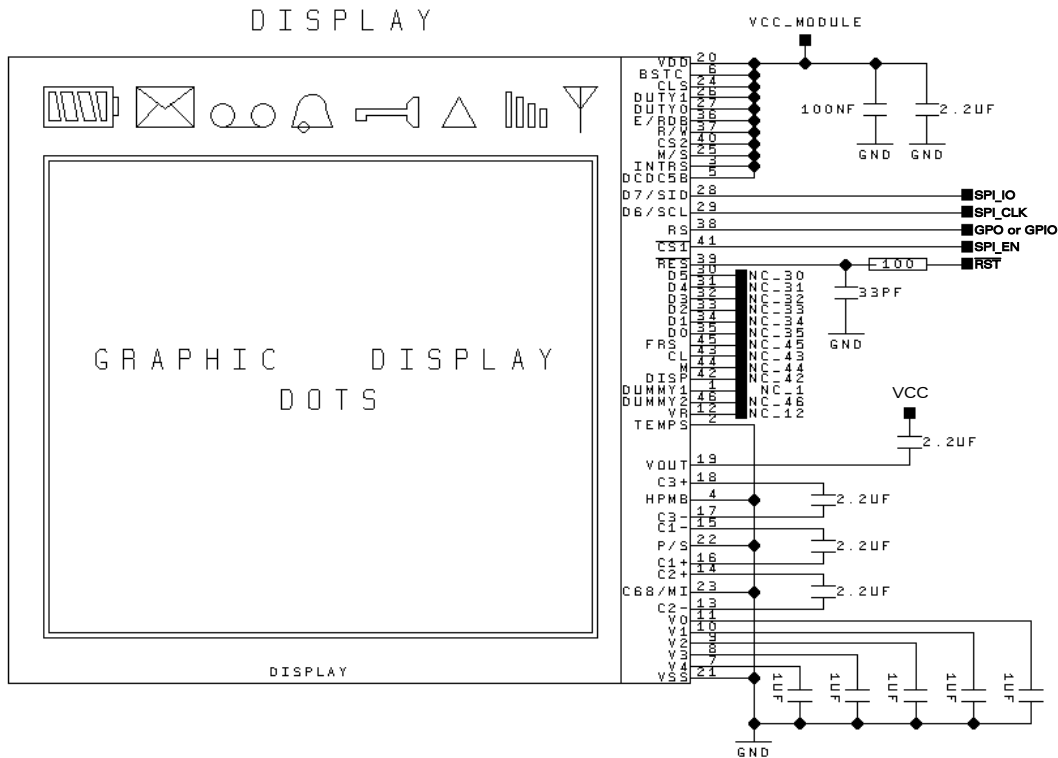


Figure 4: Example of SPI Bus typical implementation

**2.2.2.2 Two-wire interface**



The two-wire interface includes a CLK signal (SCL) and a DATA signal (SDA) complying with a standard 96 kHz interface. The maximum speed transfer is 400 kbits/s.

Note: The two-wire interface is reserved for future use. A software emulated version of this interface using GPIOs is available. See "AT Command Interface Guide" [2] for more information.

**2.2.3 SPI auxiliary bus**

A second SPI Chip Enable (called SPI\_AUX) can be used to add a SPI peripheral to the WISMO Quik Q2400 module.

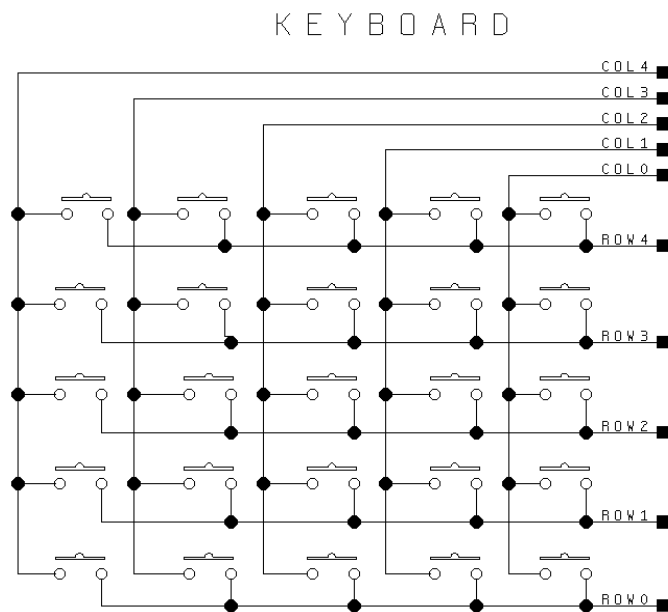
**2.2.4 Keyboard interface**

This interface provides 10 connections:

- 5 rows (ROW0 to ROW4),
- 5 columns (COL0 to COL4).

The scanning is a digital one, and the debouncing is done in the WISMO module. No discrete components like R, C (Resistor, Capacitor) are needed.

**Typical Implementation:**



**Figure 5: Example of keyboard implementation**

### 2.2.5 Main serial link (UART1)

A flexible 6-wire serial interface is available complying with V24 protocol signaling but not with V28 (electrical interface) due to a 2.8 Volts interface.

The signals are:

- TX data input (CT103/TX),
- RX data output (CT104/RX),
- Request To Send input (CT105/RTS),
- Clear To Send output (CT106/CTS),
- Data Terminal Ready input (CT108-2/DTR),
- Data Set Ready output (CT107/DSR).

**Note:** the WISMO Quik Q2400 module is a DCE (Data Communication Equipment).

The Q2400 module has been designed to allow a certain flexibility in the use of the serial interface signals. However, the use of TX, RX, CTS and RTS signals is mandatory which is not the case for DTR, DSR, DCD and RI signals which can be left disconnected if not used.

In particular, it is necessary to use RTS and CTS for hardware flow control in order to avoid data corruption during transmission.

The 2 additional signals are Data Carrier Detect (CT109/DCD) and Ring Indicator (CT125/RI).

To allow correct switch OFF for the module, the level shifter outputs (module side) or host processor outputs must be set at low level (0V) or in high impedance.

Typical implementation with a terminal:

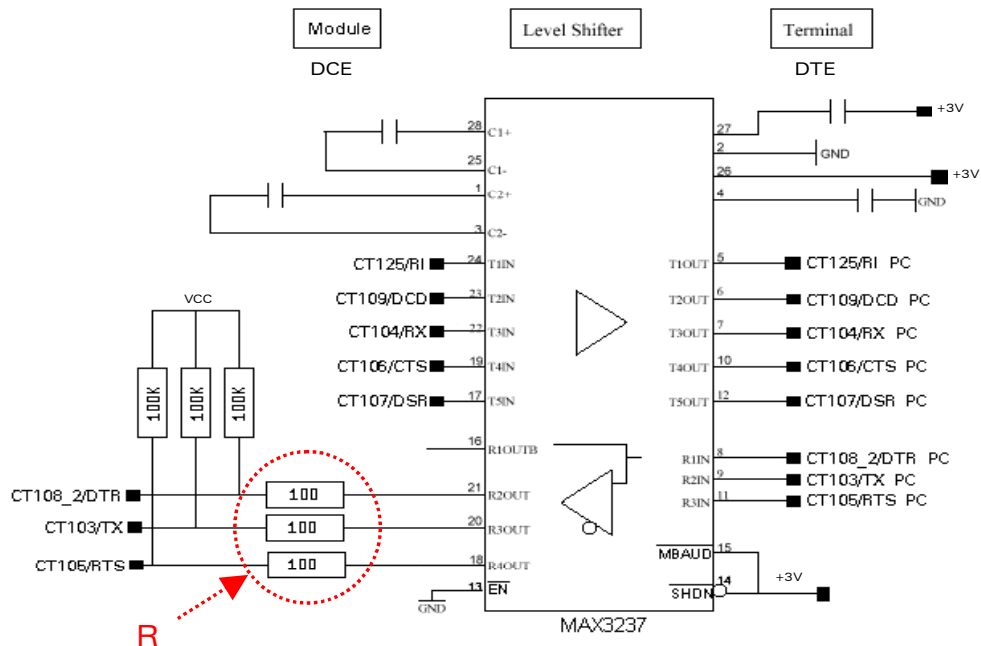


Figure 6: Example of RS232 level shifter implementation

Typical implementation with a microprocessor:

The figure above shows a typical implementation when the WISMO Quik Q2400 module is connected to a host microprocessor which is 2.8 V tolerant on the serial port signals.

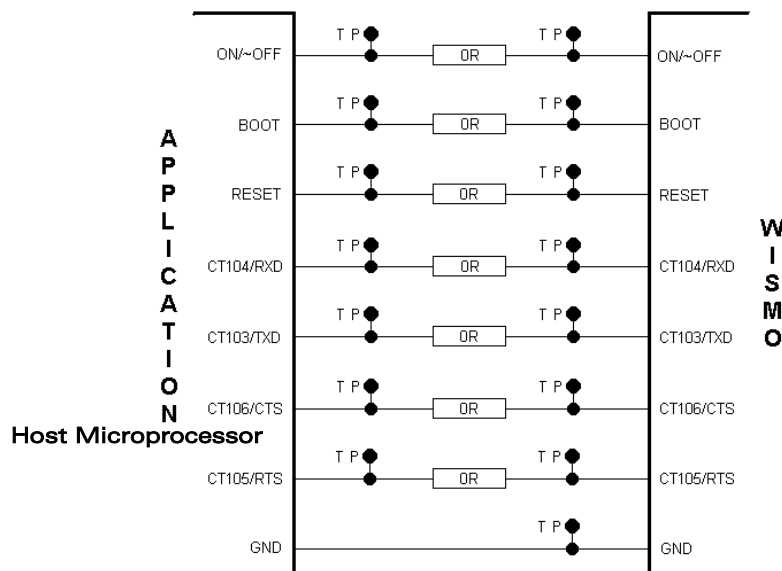


Figure 7: Example of Serial Link interface implementation

Typical values of serial resistors R for signals between application and WISMO Quik Q2400 (mainly CT103/TX) (see Figure 6)

UART baud rate	Host output voltage		
	<3.1V	3.2V	3.3V
9 600	R < 62 k $\Omega$	6.8 k $\Omega$ < R < 62 k $\Omega$	11 k $\Omega$ < R < 62 k $\Omega$
19 200	R < 30 k $\Omega$	6.8 k $\Omega$ < R < 30 k $\Omega$	11 k $\Omega$ < R < 30 k $\Omega$
38 400	R < 15 k $\Omega$	6.8 k $\Omega$ < R < 15 k $\Omega$	11 k $\Omega$ < R < 15 k $\Omega$
57 600	R < 10 k $\Omega$	6.8 k $\Omega$ < R < 10 k $\Omega$	Not supported
115 200	R < 5.1 k $\Omega$	Not supported	Not supported

The minimal value is determined to limit the current in the input pin of the Module and the maximal value is determined by its input capacitance, that is why some combination speed / voltage are incompatible.

**2.2.6 SIM interface**

**2.2.6.1 SIM 3V management**

The SIM interface controls a 3 V SIM card only.

Nevertheless, it is possible to manage 1.8V/3V or 3V/5V SIM cards using an external voltage level shifter controlled by the GPO0 output signal (refer to § 2.2.5.2 and 2.2.5.3).

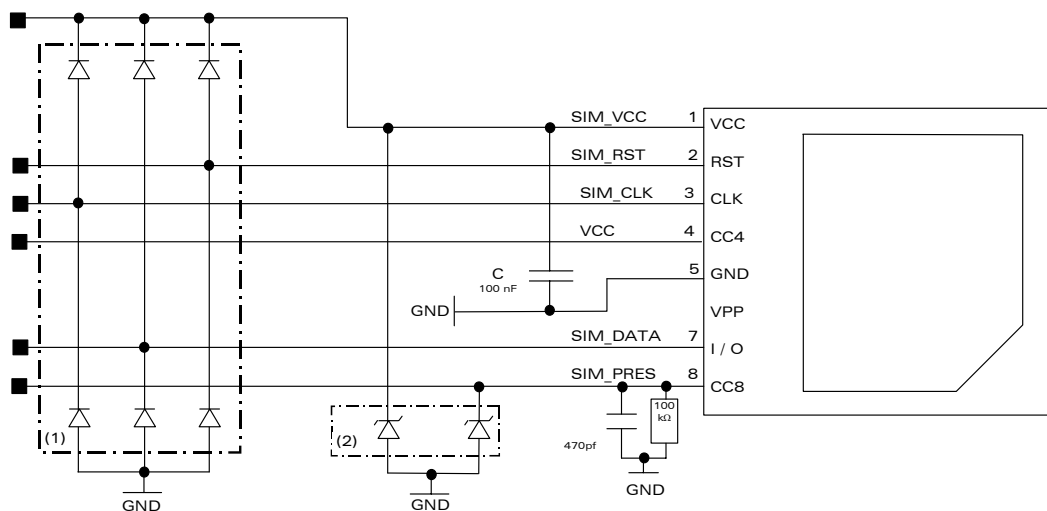
It is recommended to add Transient Voltage Suppressor diodes (TVS) on the signal connected to the SIM socket in order to prevent any Electrostatic Discharge.

TVS diodes with low capacitance (less than 10 pF) have to be connected on SIM\_CLK and SIM\_DATA signals to avoid any disturbance of the rising and falling edge.

These types of diodes are mandatory for the Full Type Approval. They shall be placed as close as possible to the SIM socket.

The following references can be used: DALC208SC6 from ST Microelectronics.

**Typical implementation with SIM detection:**



- (1) Recommended components: DALC208SC6 (SGS-THOMSON).
- (2) Recommended components: ESDA6V1SC6 (ST).

**Figure 8 : Example of 3V SIM Socket implementation**

**SIM socket connection:**

Signal	Pin number	Description
VCC	1	SIM_VCC
RST	2	SIM_RST
CLK	3	SIM_CLK
CC4	4	VCC module
GND	5	GROUND
VPP	6	Not connected
I/O	7	SIM_DATA
CC8	8	SIM_PRES with 100 k $\Omega$ pull down resistor

**Table 3: SIM socket pin description**

The capacitance value on the SIM\_VCC must not exceed 100nF.

It is nevertheless possible to use a capacitor value greater than 100nF and until 330nF on SIM\_VCC, if an additional capacitor with a minimum value of 27 $\mu$ F (ESR <100 m $\Omega$ , X5R ceramic) is placed between VCC output (pin 40) and the GND.

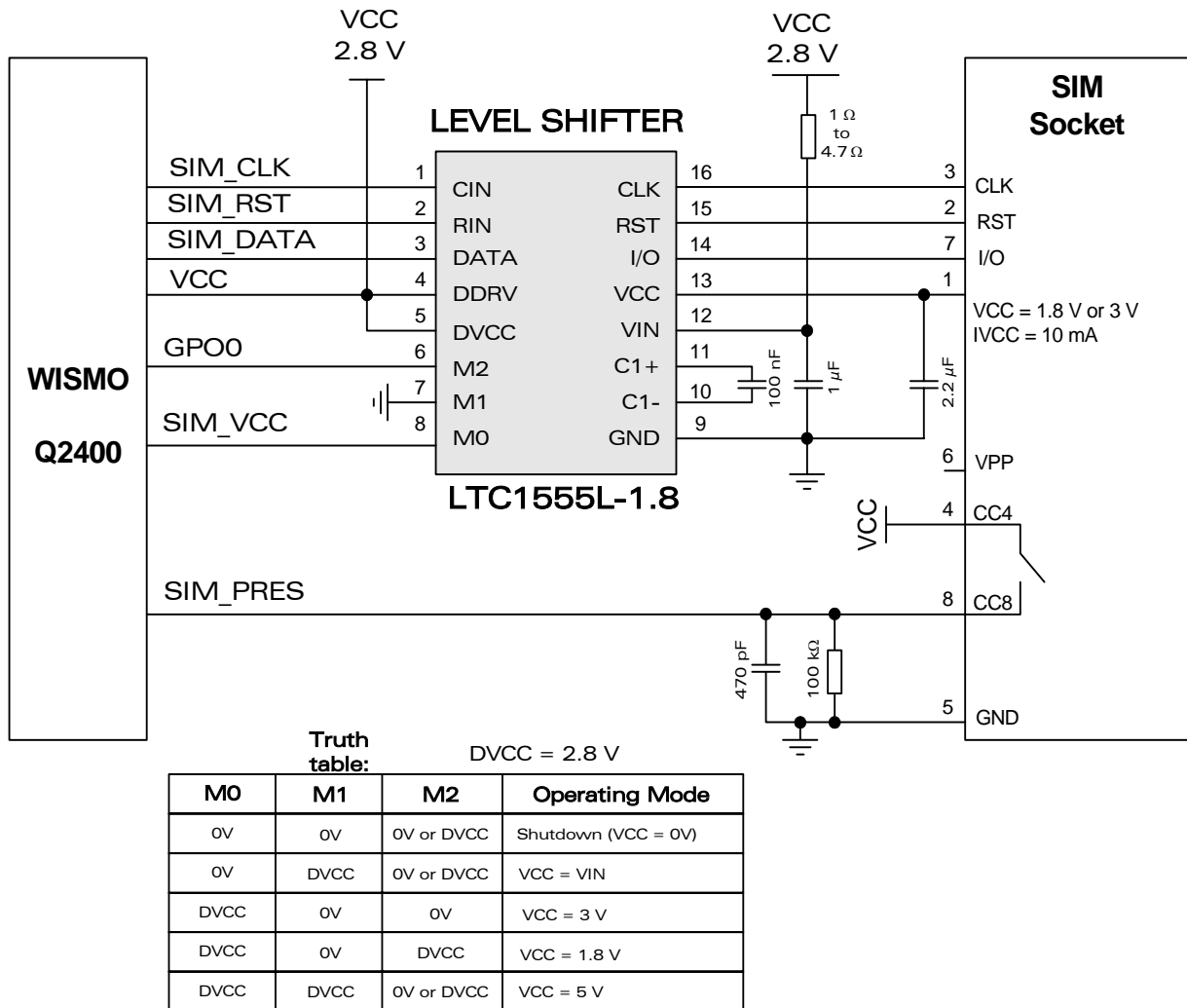
**2.2.6.2 SIM 1.8 V / 3 V management**

It is possible to manage 1.8 V and 3 V SIM cards using an external level shifter device (see Figure below).

In this case, depending on the type of SIM detected, the module firmware triggers the GPO0 output signal (pin #26) in order to properly set the external SIM driver level (1.8 V or 3 V).

As for 3 V SIM, it is recommended to add Transient Voltage Suppressors on the signals connected to the SIM socket (refer to Figure 8)

**Typical implementation:**



**Figure 9: Example of 1.8 V / 3 V SIM interface implementation**

**2.2.6.3 SIM 3 V / 5 V management**

It is possible to manage 3 V and 5 V SIM cards using an external level shifter device (see Figure below).

In this case, depending on the type of SIM detected, the module firmware triggers the GPO0 output signal (pin #26) in order to properly set the external SIM driver level (3 V or 5 V).

As for 3 V SIM, it is recommended to add Transient Voltage Suppressors on the signals connected to the SIM socket (refer to Figure 9).

Typical implementation:

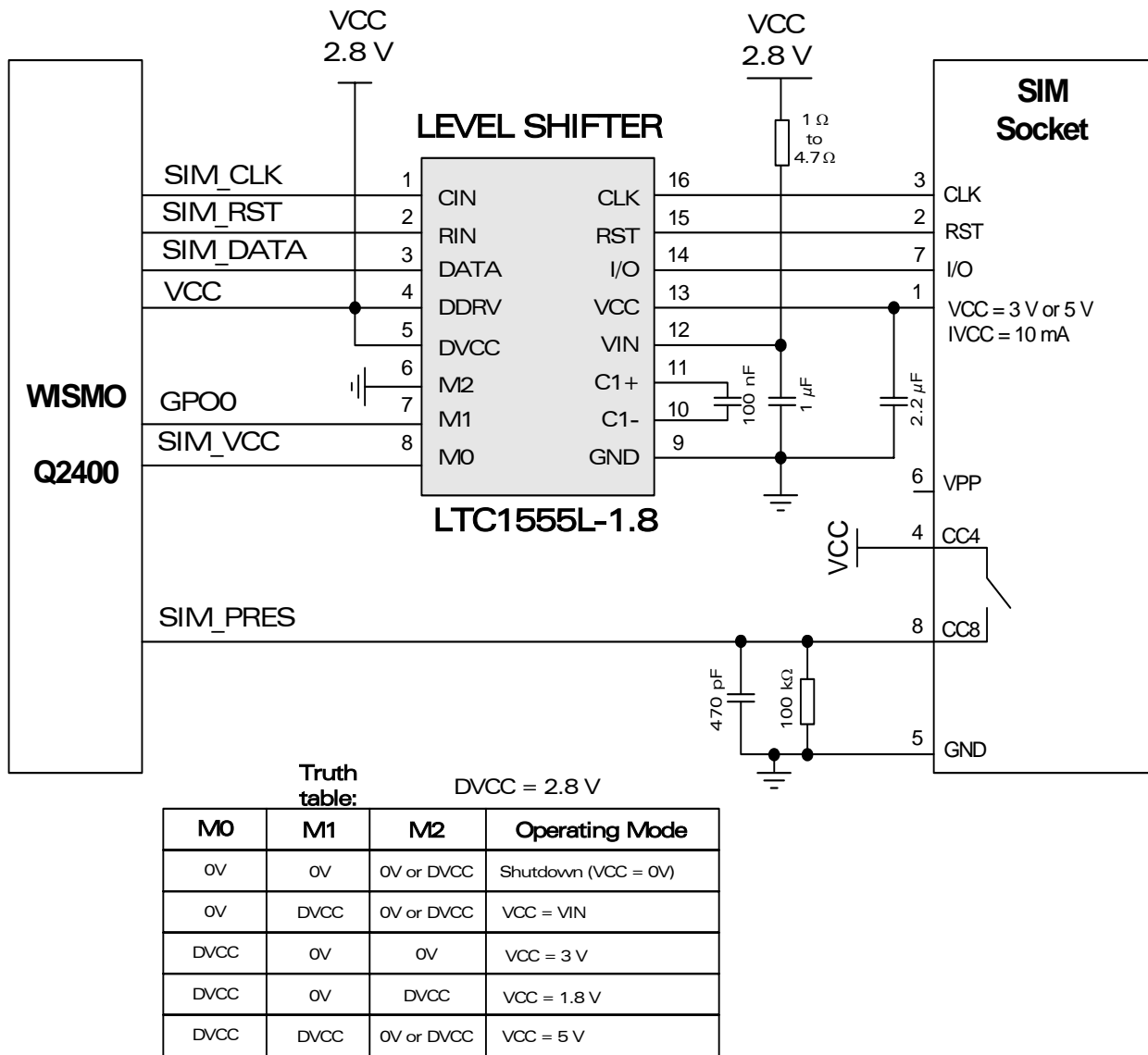


Figure 10: Example of 3 V / 5 V SIM interface implementation

**2.2.6.4 PCB constraints for SIM interface**

- For the SIM interface, length of the track between the WISMO module and the SIM connector should be as short as possible. Maximum length recommended is 10 cm.
- ESD protection is mandatory on the SIM lines if access from outside of the SIM connector is possible.

**2.3 Analog I/O implementation**

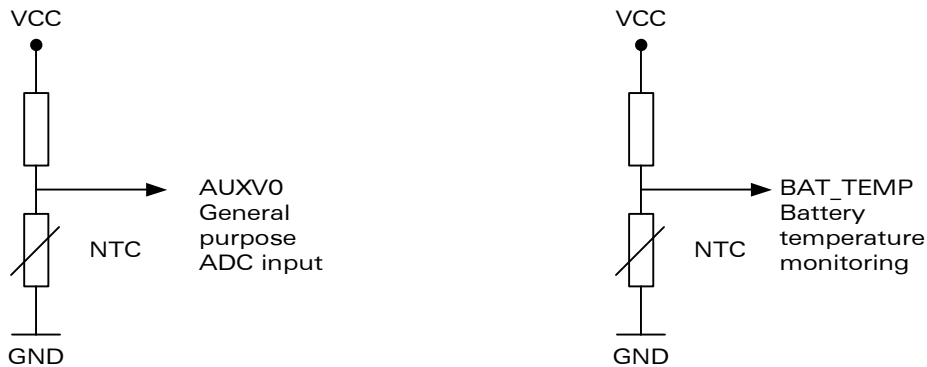
**2.3.1 Analog to Digital Converter (ADC) inputs**

Two Analog to Digital Converter are available on the WISMO Quik Q2400 module:

- The first one (AUXV0) is a general purpose converter,
- The second one (BAT\_TEMP) is used for battery temperature monitoring.

These converters have a 10-bit resolution, ranging from 0 to 2.8 V.

Typical application:



**Figure 11: Example of ADC input implementation**

### 2.3.2 Audio interface

Two different microphone inputs and two different speaker outputs are supported.

An echo cancellation feature, for hands-free application, is also available. In some cases, ESD protection must be added on the audio interface lines.

#### 2.3.2.1 Microphone inputs

##### 2.3.2.1.1 General

The MIC2 inputs already include the biasing for an electret microphone allowing an easy connection to a handset.

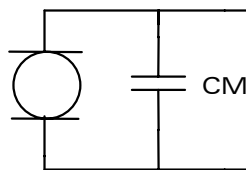
The MIC1 inputs do not include an internal bias. MIC1/SPK1 is then appropriate for a hands-free application or a handset with biasing external to the module.

##### 2.3.2.1.2 Recommended characteristics for the microphones

- 2 V – 0.5 mA.
- 2 k $\Omega$ .
- Sensitivity -40 to -50 dB.
- SNR > 50 dB.
- Frequency response compatible with the GSM specifications.

For possible references, see § 9.3.

**Microphone must be decoupled by a capacitor CM. This one must be as close as possible to the microphone. Some microphone manufacturers provide this capacitor directly soldered on the device**



**Figure 12: Microphone decoupling capacitor**

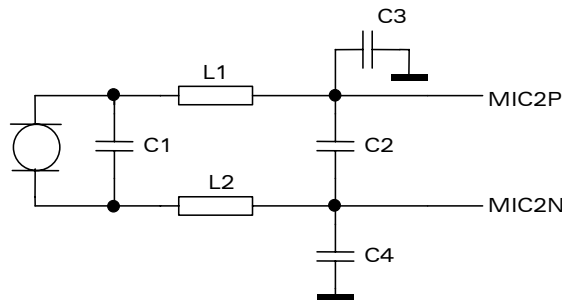
**2.3.2.1.3 Main microphone inputs (MIC2)**

The MIC2 inputs are differential ones. They already include the convenient biasing for an electret microphone (0.5 mA and 2 Volts). This electret microphone can be directly connected on these inputs.

The impedance of the microphone 2 has to be around 2 kΩ. These inputs are the standard ones for an handset design while MIC1 inputs can be connected to an external headset or a hands-free kit.

AC coupling is already embedded in the module.

Typical implementation:



**Figure 13 : Example of main microphone MIC2 implementation (differential connection)**

C1 = 33 pF to 47 pF

C2 = C3 = C4 = 47 pF to 100 pF

L1 = L2 = 100 nH

C1 has to be the nearest possible to the microphone. Microphone manufacturers provide this capacitor directly soldered on the microphone.

C2 has to be very close to the WISMO module connector.

L1, L2, C3 and C4 has to be put near the WISMO module connector and can be removed according to their environment (ground plane, shielding, etc...).

The best way is to plan all the components and to remove those which are not necessary to filter out the TDMA noise on the audio path.

**2.3.2.1.4 Auxiliary microphone inputs (MIC1)**

The MIC1 inputs are differential and they do not include internal bias. To use these inputs with an electret microphone, bias has to be generated outside the WISMO module according to the characteristic of this electret microphone. These inputs are the standard ones used for an external headset or a hands-free kit.

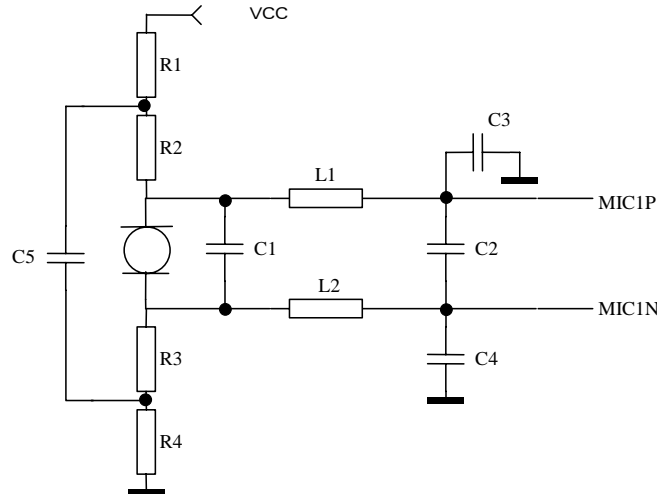
AC coupling is already embedded in the module.

**A/ Differential connection**

Impedance of the microphone input in differential mode:

- Module ON:  $R_{in} = 10 \text{ k}\Omega \pm 10 \%$
- Module OFF:  $R_{in} > 1 \text{ M}\Omega \pm 10 \%$

**Typical implementation:**



**Figure 14 : MIC1 inputs (differential connection)**

R1 = R4 = from 100 to 330  $\Omega$ .

R2 = R3 = usually between 1 k $\Omega$  and 3.3 k $\Omega$  as per the microphone characteristics.

C1 = 33 pF to 47 pF.

C2 = C3 = C4 = 47 F to 100 pF.

C5 = 47  $\mu$ F.

L1 = L2 = 100 nH.

R1 and R4 are used as a voltage supply filter with C5.

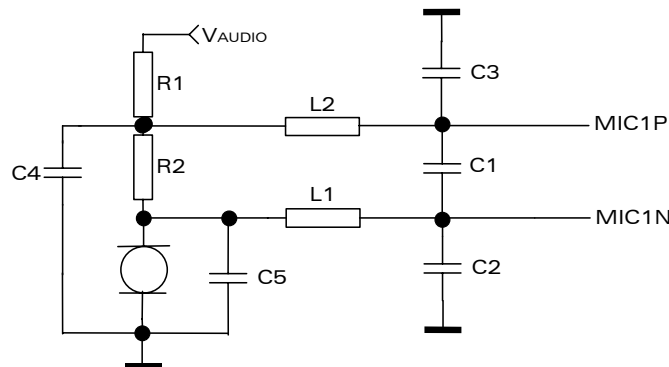
C1 has to be the nearest possible to the microphone. Microphone manufacturers provide this capacitor directly soldered on the microphone.

C2 has to be very close to the WISMO module connector.

L1, L2, C3 and C4 has to be put near the WISMO module connector and can be removed according to their environment (ground plane, shielding ...etc). The best way is to plan all the components and to remove those which are not necessary to filter out the TDMA noise on the audio path.

**B/ Single-ended connection**

Typical implementation:



**Figure 15: MIC1 inputs (single-ended connection)**

Note: V<sub>AUDIO</sub> must be very “clean” in single-ended connection (for example, VCC plus filter cell like RC or LC).

R1 = from 100 Ω to 330 Ω.

R2 = usually between 1 kΩ and 3.3 kΩ as per the V<sub>AUDIO</sub> voltage level and the microphone characteristics.

C1 = 10 pF to 33 pF.

C2 = C3 = C5 = 47 pF to 100 pF.

C4 = 47 μF.

L1 = L2 = 100 nH.

R1 is used as a voltage supply filter with C4.

C5 has to be the nearest possible to the microphone. Microphone manufacturers provide this capacitor directly soldered on the microphone.

C1, C2, C3 have to be very close to the WISMO module connector.

L1 and L2 has to be put near the WISMO module connector and can be removed according to their environment (ground plane, shielding ...etc). The best way is to plan all the components and to remove those which are not necessary to filter out the TDMA noise on the audio path.

**2.3.2.2 Speaker outputs**

**2.3.2.2.1 Common speaker output characteristics**

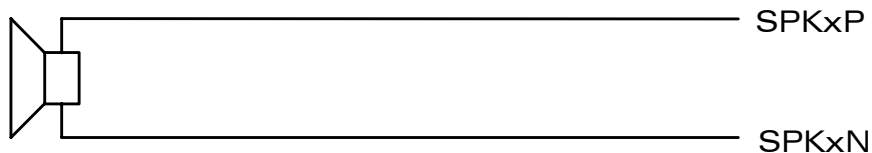
The connection can be differential or single-ended but using a differential connection to reject common mode noise and TDMA noise is strongly recommended. Moreover in single-ended mode, 1/2 of the power is lost.

When using a single-ended connection, be sure to have a very good ground plane, a very good filtering as well as shielding in order to avoid any disturbance on the audio path.

Speaker outputs SPK2 are push-pull amplifiers and can be loaded down to 150 Ω and up to 1 nF. These outputs are differential and the output power can be adjusted by step of 2 dB. The output can be directly connected to a speaker.

**Differential Connection:**

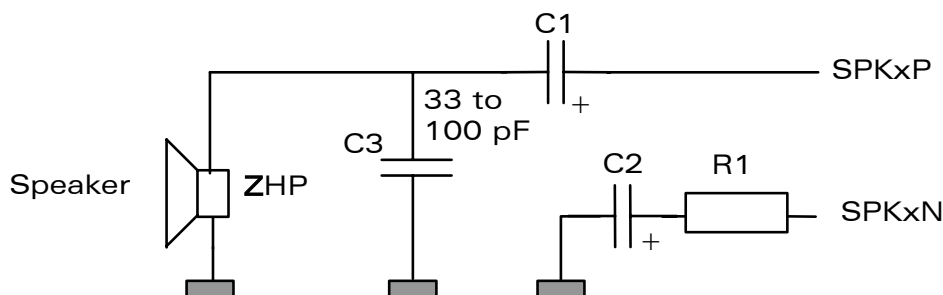
Impedance of the speaker amplifier output in differential mode :  $R \leq 1\Omega \pm 10\%$



**Figure 16: Speaker outputs (differential mode)**

**Single-ended Connection:**

Typical implementation:



**Figure 17: Speaker outputs (single-ended connection)**

C1 = from 4.7 μF to 47 μF as per the speaker characteristics and the output power.

C1=C2; R1= Speaker Impedance.

Nevertheless in a 32 Ω speaker case, you should use a cheaper and smaller solution : R1 = 82 Ω et C2 = 4.7 μF (ceramic).

**Recommended characteristics for the speaker:**

- Type: 10 mW, electro-magnetic.
- Impedance: 32 to 150  $\Omega$ .
- Sensitivity: 110 dB SPL min. (0 dB = 20  $\mu$ Pa).
- Frequency response compatible with the GSM specifications.

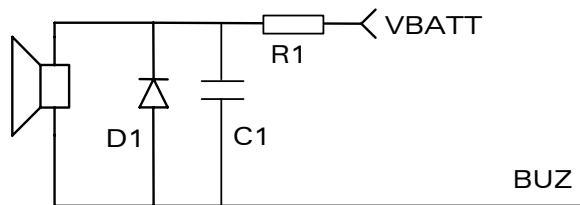
For possible references, see chapter § 9.4.

**2.3.2.3 Buzzer output**

The buzzer output (BUZ) is a digital one. A buzzer can be directly connected between this output and VBATT. The maximum current is 80 mA (PEAK).

A diode against transient peak voltage must be connected as described below.

**Typical implementation:**



**Figure 18: Example of buzzer implementation**

R1 must be chosen in order to limit the current at  $I_{PEAK}$  max (recommended values 10  $\Omega$  to 50  $\Omega$ ).

C1 = 0 to 100 nF (depending on the buzzer type).

**Recommended characteristics for the buzzer:**

- Type: electro-magnetic.
- Impedance: 7 to 30  $\Omega$ .
- Sensitivity: 90 dB SPL min @ 10 cm.

**2.3.2.4 Routing constraints**

To get better acoustic performances, basic recommendations are the following:

- The SPKxx lines must be routed in parallel, without any wire in between.
- The MICxx lines must be routed in parallel, without any wire in between.
- All the filtering components (RLC) must be placed as close as possible to the associated MICxx and SPKxx pins.

## 2.4 Battery charging interface

The WISMO Quik Q2400 module has a battery charging interface. The table below summarize the battery types supported according to the software version :

**Battery types supported versus software version**

Battery type	OS version	
	Before X55	X55 and after
Ni-Cd	Supported	Supported
Ni-Mh	Supported	Supported
Li-Ion	Not Supported	Supported

**Warning:**

**Trying to charge a Li-Ion battery with an OS version prior to X55 may cause a damage to the battery.**

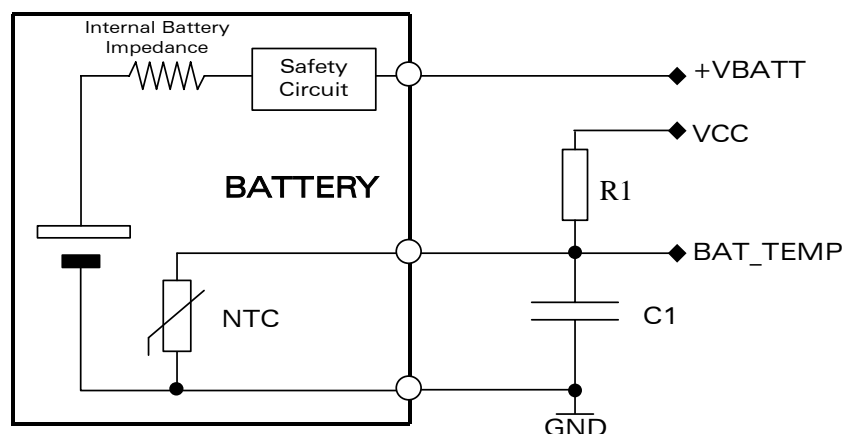
This circuit uses an interface which consists of a current source inputs (CHG\_IN) where the constant current has to flow in order to charge the battery.

This current value depends on the battery capacity. It is recommended to provide a current equal to the value of the capacity plus 50 mA. For a 550 mA battery the current will be 600 mA. The maximum current is 800 mA.

The WISMO Quik Q2400 module monitors the battery voltage to detect the end of the charge.

It also monitors the temperature of the battery (for security matters) through the BAT\_TEMP pin which has to be connected to a temperature sensor inside the battery pack (a NTC resistor for instance).

**Typical Implementation:**



**Figure 19: Example of battery implementation**

**How to choose R1 and C1:**▪ **How to choose R1:**

R1 has to be chosen to have a full range of BAT\_TEMP (from 0 V to 2.8 V) when the CTN value changes from the minimum to the maximum temperature.

▪ **How to choose C1:**

C1 has to be chosen to have a RC filter with a time constant lower than 2 ms.

**Calculation examples:**

$$CTN(+25\text{ }^{\circ}\text{C}) = 47\text{ k}\Omega$$

$$CTN(+55\text{ }^{\circ}\text{C}) = 10\text{ k}\Omega$$

$$CTN(-10\text{ }^{\circ}\text{C}) = 300\text{ k}\Omega$$

$$CTN(-10\text{ }^{\circ}\text{C}) \times VCC = (CTN(-10\text{ }^{\circ}\text{C}) + R1) \times BAT\_TEMP\text{ (full range)}$$

$$R1 = 47\text{ k}\Omega \Rightarrow BAT\_TEMP(-20\text{ }^{\circ}\text{C}) = 2.42\text{ V}$$

$$BAT\_TEMP(+55\text{ }^{\circ}\text{C}) = 0.49\text{ V}$$

$$R(-20\text{ }^{\circ}\text{C}) = R1 // CTN(-10\text{ }^{\circ}\text{C}) = 40\text{ k}\Omega$$

$$R(+55\text{ }^{\circ}\text{C}) = 8\text{ k}\Omega$$

With C= 10 nF:

▪  $RC(-20\text{ }^{\circ}\text{C}) = 400\text{ }\mu\text{s}$

▪  $RC(+55\text{ }^{\circ}\text{C}) = 80\text{ }\mu\text{s}$

**2.5 ON / ~OFF**

This input is used to switch ON or OFF the WISMO module. A high level signal has to be provided on the pin ON/~OFF to switch ON the module. The level of the voltage of this signal has to be maintained between 2.4 V and VDD during a minimum of 1 s. This signal can be left at high level until switch OFF.

## 2.6 BOOT signal (optional)

This input can be used to download a software in the Flash memory of the WISMO module.

The internal boot procedure is started when this pin is low during the reset of the module.

In normal mode this pin has to be left open.

In Internal boot mode, low level has to be set through a 1 k $\Omega$  resistor.

If used, this input has to be driven by an open collector or an open drain output.

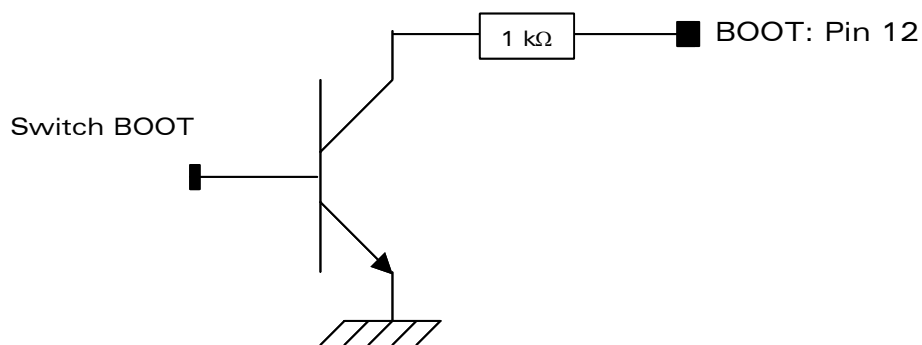


Figure 20: BOOT pin connection

- If Switch BOOT = 1, Boot pin 12 = 0, for download mode
- If Switch BOOT = 0, Boot pin 12 = 1, for normal mode

## 2.7 Reset signal (~RST)

This signal is used to force a reset procedure by providing low level during at least 500  $\mu$ s.

This signal has to be considered as an emergency reset only.

A reset procedure is already driven by an internal hardware during the power-up sequence.

This signal can also be used to provide a reset to an external device. It then behaves as an output.

If no external reset is necessary this input can be left open. If used (emergency reset), it has to be driven by an open collector or an open drain output.

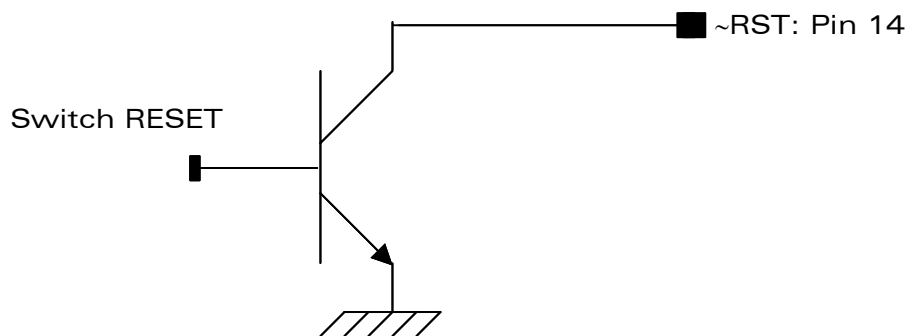


Figure 21: ~RST pin connection

- If Switch RESET = 1, ~RST pin 14 = 0, for Module Reset
- If Switch RESET = 0, ~RST pin 14 = 1, for normal mode

## 2.8 External interrupt (~INTR)

The WISMO Quik Q2400 module provides an external interrupt input (~INTR).

This input is very sensitive and an interrupt is activated on high to low edge.

If this signal is not used, it can be left open. If used this input has to be driven by an open collector or an open drain.

This input is used for instance to power OFF automatically the module.

## 2.9 VCC output

This output can be used to power some external functions. VCC has to be used as a digital power supply. This power supply is available when the module is on.

Parameter	Condition	Min	Max	Unit
Output voltage	I = 10 mA	2.74	2.86	V
Output Current			10	mA

Table 4: VCC output operating conditions

## 2.10 VCC\_RTC (Real Time Clock Supply)

### 2.10.1 General

VCC\_RTC input is used to provide a back-up power supply for the internal Real Time Clock.

The RTC is supported by the module when powered on but a back-up power supply is needed to save date and time information when the module is switched off.

If the RTC is not used this pin can be left open.

Back-up Power Supply can be provided by:

- a capacitor,
- a super capacitor,
- a non rechargeable battery,
- a battery cell with regulator.

### 2.10.2 Typical implementation

#### 2.10.2.1 Capacitor

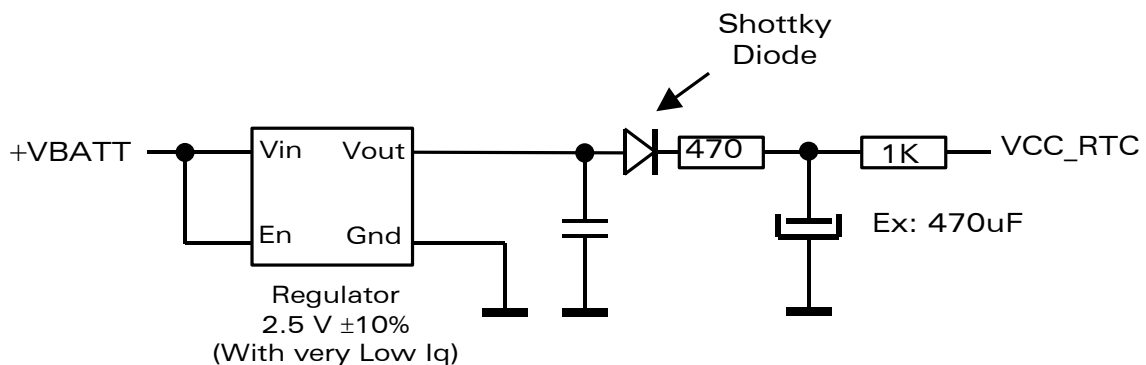
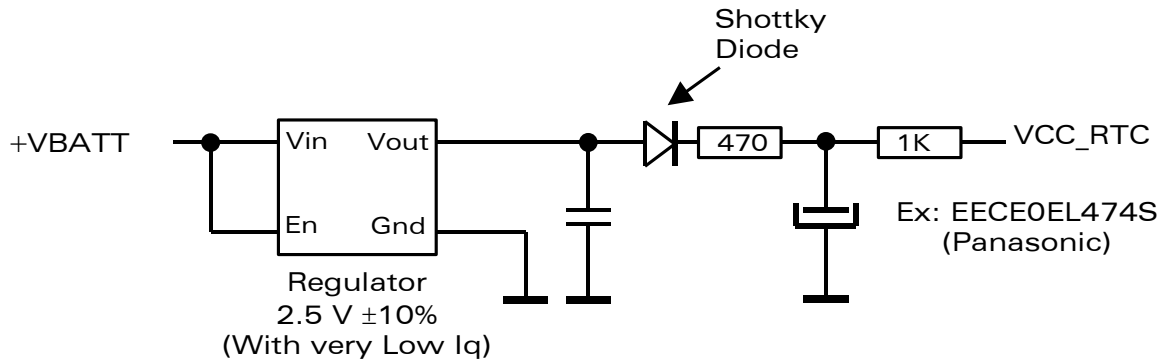


Figure 22: RTC Supplied by a capacitor

Estimated range with 470 µF Capacitor: ~30 seconds.

**2.10.2.2 Super capacitor**

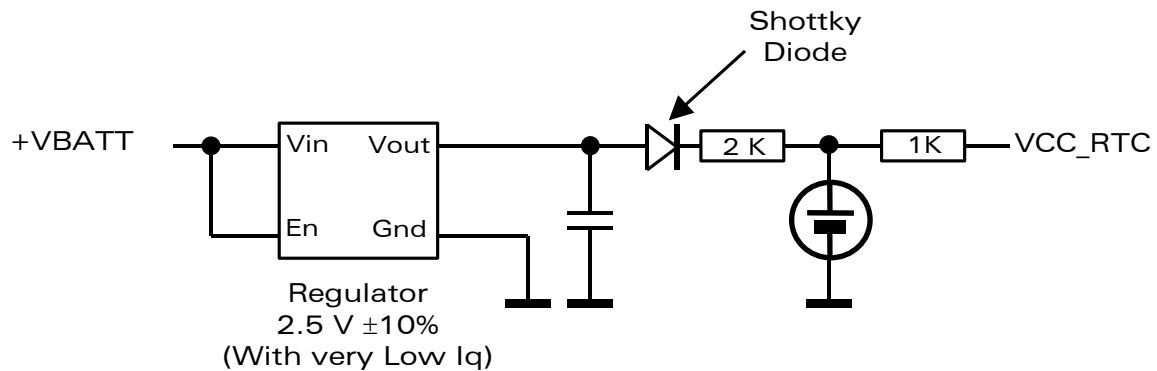


**Figure 23: RTC supplied by a super capacitor**

Estimated range with 0.47 Farad Gold Capacitor: 2 hours min.

Note: the Gold Capacitor maximum voltage is 2.5 V.

**2.10.2.3 Battery cell with regulator**



**Figure 24: Battery cell with regulator**

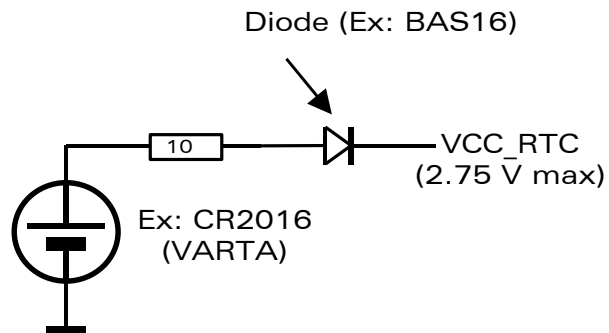
Estimated range with 2 mAh rechargeable battery: ~3 days.

**Warning:**

Before battery cell assembly insure that cell voltage is lower than 2.75V to avoid any damage to the WISMO module.

### 2.10.2.4 Non rechargeable battery

This is the less recommended solution.



**Figure 25: Non rechargeable battery**

Estimated range with 85 mAh battery: 4000 h minimum.

Note: The "non rechargeable battery" is always active, except when the module is ON.

### 3 Radio design

#### 3.1 Antenna characteristics

WAVECOM recommends to use an antenna with the following characteristics:

Characteristic	Q2400	
	E-GSM 900	DCS 1800
Frequency TX	880 to 915 MHz	1710 to 1785 MHz
Frequency RX	925 to 960 MHz	1805 to 1880 MHz
Impedance	50 ohms	
VSWR	Rx max	1.5 :1
	Tx max	1.5 :1
Typical radiated gain	0 dBi in one direction at least	

Table 5: Recommended antenna characteristics

Frequency depends on application. A dual-Band antenna shall work in all these frequency bands.

#### 3.2 Antenna implementation

The impedance is 50  $\Omega$  nominal and the DC impedance is 0  $\Omega$ .

##### 3.2.1 Recommendations

Antenna sub-system and integration in the application is a major issue.

Attention should be paid to:

- the design of the antenna line on the application PCB,
- the antenna connector (type + losses),
- the antenna choice.

These elements could affect GSM performances such as sensitivity and emitted power.

The antenna should be isolated as much as possible from the digital circuitry (including the interface signals)  $\Rightarrow$  it is strongly recommended to shield the terminal.

On terminals including the antenna, a poor shielding could dramatically affect the sensitivity of the terminal. Moreover, the power emitted through the antenna could affect the application.

##### **Warning:**

Wavecom strongly recommends to work with an antenna manufacturer either to develop an antenna adapted to the application or to adapt an existing solution to the application. The antenna adaptation (mechanical and electrical adaptation) is one of the key issues in the design of a GSM terminal.

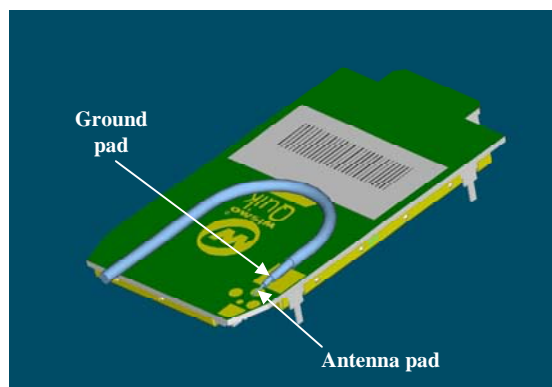
- As a general recommendation, all components or chips operated at high frequencies (microprocessors, memories, DC/DC converter), or other active RF parts shall not be placed too close to the module. In such a case, correct supply and ground decoupling areas shall be designed and validated.
- One shall avoid placing components around the RF connection and close to the RF line (between the module and the antenna).
- RF lines and cables shall be as short as possible.
- The coaxial cable shall not be placed close to devices operated at low frequencies.
- Some signals like VBATT and charger line may require some EMI/RFI decoupling: parallel 33 pF capacitor close to the module, or a serial ferrite bead (or both to get better results). In case a ferrite bead is used, the recommendations given for the power supply connection must be carefully followed (high current capacity and low impedance).

### 3.2.2 RF connection

The antenna is connected to the module through a 50  $\Omega$  coaxial cable. The coaxial cable must be connected to both the "Antenna pad" (or Round pad) and the "Ground pad" (see Figure 26).

It is recommended to use a RG178 coaxial cable with the following stripping and mounting guidelines:

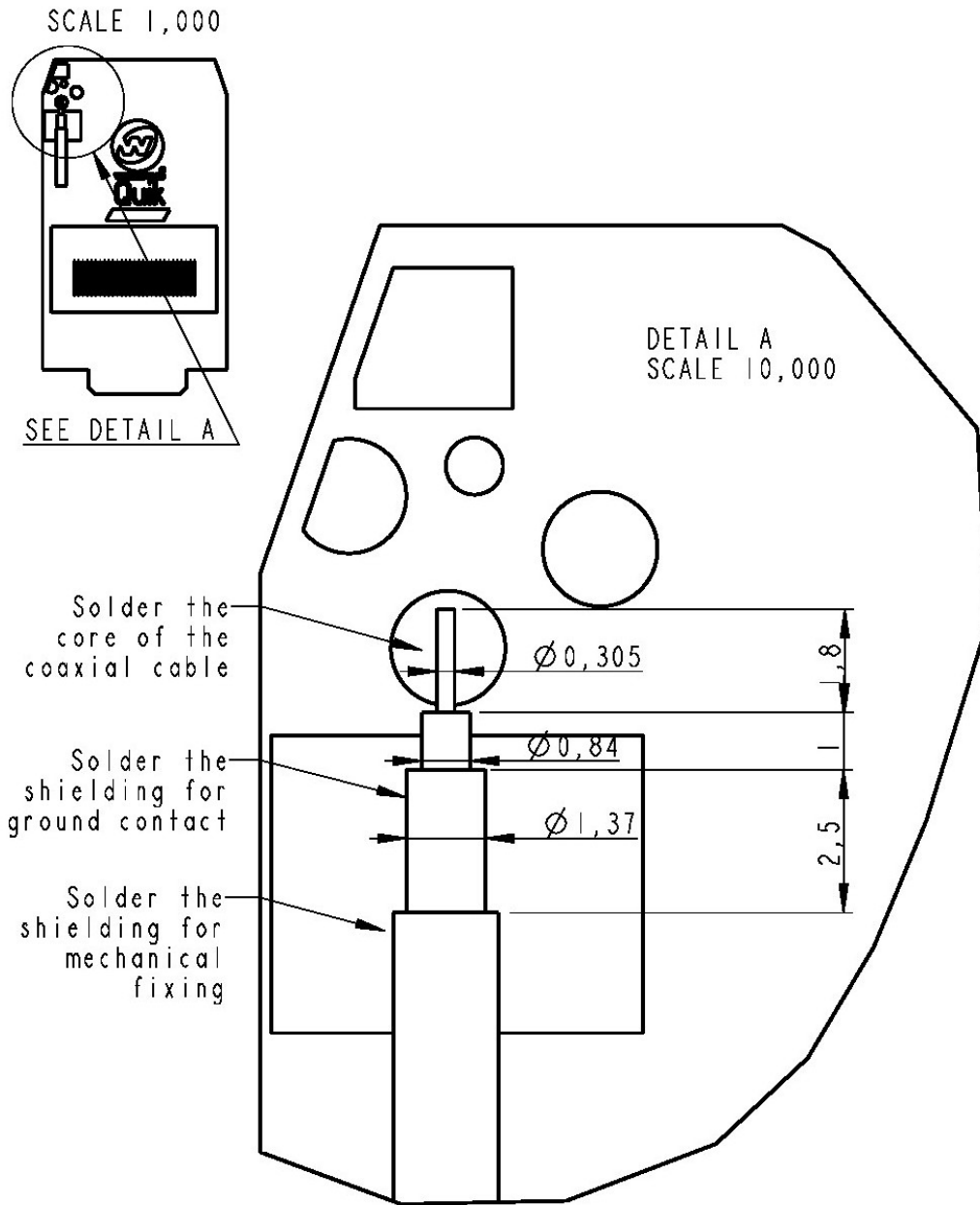
1. The antenna cable and connector should be chosen in order to minimize losses in the frequency bands used for E-GSM 900MHz and DCS 1800.
2. To get a good ground connection, the ground of the cable must be connected to the ground pad, as shown in Figure 26.



**Figure 26: Antenna connection**

3. Antenna cable preparation is shown in Figure 27

Note: For the assembly of RF cable on the Module see Wavecom recommendation for manual lead free soldering in paragraph 5.3.



**Figure 27: Antenna cable preparation (drawing not to scale)**

Note:

- The WISMO Quik Q2400 does not include any antenna switch for a car kit but this function can be implemented externally and it can be driven using a GPIO.
- 0.5 dB can be considered as a maximum value for loss between the module and an external connector.

## 4 Mechanical specifications

Attention should be paid to:

- Antenna cable integration (bending, length, position, etc),
- Legs of the module to be soldered on the Ground plane (*see Wavecom recommendation for lead free soldering in paragraph 5.3*).

Figure 28 gives the overall dimension of the module, taking into account the PCB dimension and placement tolerances.

It is important to assure that no component or mechanical element will enter in contact with the module even in case of vibration or manipulation of the final product.

These contacts may produce bad electrical connection on the 60-pin general purpose connector.

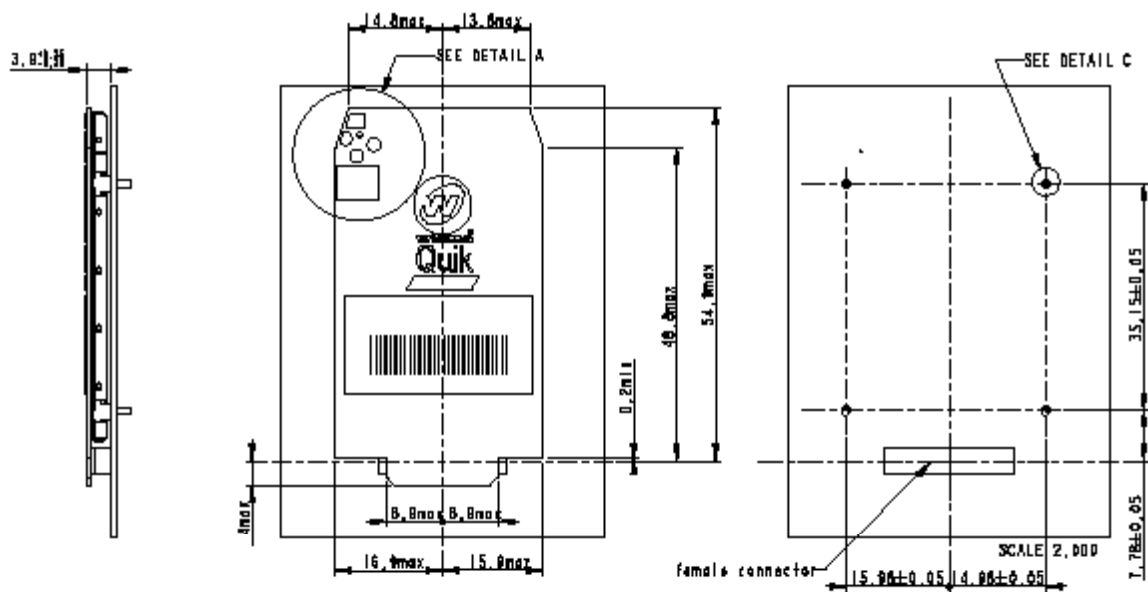


Figure 28: Maximum bulk occupied on the application board

## 5 PCB design

### 5.1 General design rules

Clocks and other high frequency digital signals (e.g. parallel and serial buses) should be routed as far as possible from the WISMO analog signals.

If the application design makes it possible, all analog signals should be separated from digital signals by a ground line on the PCB.

It is recommended to protect clock signals with a ground belt.

Refer to the following paragraphs for other constraints:

- 2.1.3 for the Power Supply,
- 2.2.6.4 for the SIM interface,
- 2.3.2.4 for the audio interface.

### 5.2 Design rules for application manufacturing

The WISMO Quik Q2400 module does not support any reflow soldering.

### 5.3 Recommendation for lead free soldering

In order to maintain the RoHS status of the module, Wavecom recommend, for the assembly of the module on the mother board and the assembly of RF cable on the Module to use *lead free solder wire and flux*.

*For example:*

- Solder Wire : Kester 245 Cored 58 (Sn96.5Ag3Cu0.5)
- Flux : Kester 952-D6.

### 5.4 Power supply

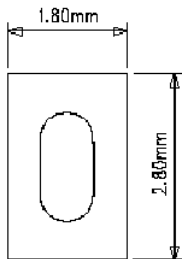
Refer to § 2.1.3.

**5.5 Pads design**

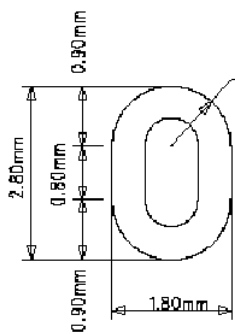
**CHIPS & BORING DIAMETER**

of the WISMO QUIK mechanical insertion pins

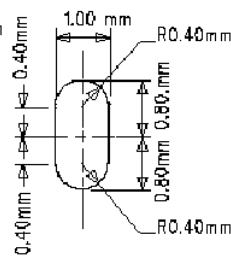
**CASE N 1**  
To be used in priority



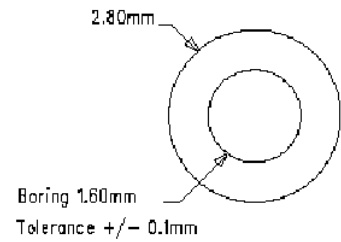
**CASE N 2**  
on specific request



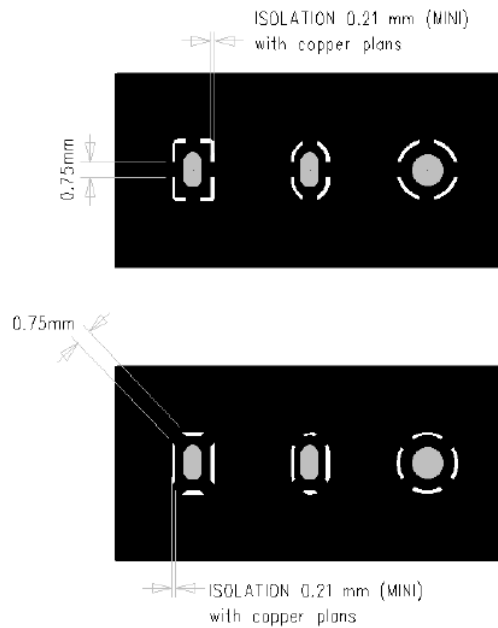
Tolerance +/- 0.1mm  
1.00 mm reamer



**CASE N 3**  
Other



**THERMAL BRAKES DEFINITION**



**Figure 29: Pads design**

## 6 EMC recommendations

The EMC tests have to be performed as soon as possible on the application to detect any possible problem.

When designing, special attention should be paid to:

- Possible spurious emission radiated by the application to the RF receiver in the receiver band
- ESD protection on SIM (if accessible from outside), serial link, etc. Refer to paragraph 2.2.6 SIM interface.
- Length of the SIM interface lines (preferably <10cm)
- EMC protection on audio input/output (filters against 900 MHz emissions), refer to paragraph 2.3.2 audio interface.
- Bias of the Microphone inputs, refer to paragraph 2.3.2 audio interface.
- Ground plane : WAVECOM recommends to have a common ground plane for analog / digital / RF grounds.
- Metallic case or plastic casing with conductive paint are recommended

**Note :**

The module does not include any protection against overvoltage.

## 7 Firmware upgrade

### 7.1 Recommendations

The WISMO Quik Q2400 module firmware is stored in flash memory and it can easily be upgraded.

**⚠ Warning:**

The application must allow the WISMO serial link signals + the BOOT, the RESET and the ON/~OFF module signals to be easily accessed thus allowing the module firmware to be upgraded.

Two upgrade procedures are available:

- Nominal upgrade procedure,
- Backup procedure.

### 7.2 Nominal upgrade procedure

The firmware file can be downloaded into the modem using the Xmodem protocol.

To enter this mode, the AT+WDWL command (see description in the AT command manual) has to be sent.

The necessary serial signals to proceed with the Xmodem downloading are:

Rx, Tx, RTS, CTS and GND.

### 7.3 Backup procedure

In case the nominal upgrade mode is not possible (due to critical corruption on the flash memory), a backup procedure is also available. It requires a WAVECOM specific software to download the firmware file into the modem.

This tool has to run on a PC connected to the serial bus of the modem.

The necessary signals to proceed with the downloading are: Rx, Tx, RTS, CTS and GND.

Prior to running the WAVECOM downloader, the modem has to be set in download mode.

For this, the BOOT signal has to be set to low while powering ON (or resetting) the modem.

**Advise** : To reduce the time of the download, it's possible to change the speed of the serial link at 115200 bits/s. for that, you have to execute the AT command below :

- 1) AT+IPR=115200
- 2) AT+WDWL
- 3) file transfer
- 4) AT+CFUN=1 (reset of the module)

Make attention that after the last command (AT+CFUN=1), the speed of the serial link depends on the configuration of the binary file downloaded in the module.

## 8 Embedded testability

As for the upgrade procedure, the first thing to be checked is the possibility to download easily a new software version or a test software in the module. The necessary signals to proceed with the downloading are: RX, TX, RTS, CTS, BOOT, ON/OFF, RESET and GND.

Prior to running the Wavecom downloader, the module has to be set in download mode. For this, the BOOT signal has to be set to low while powering ON (or resetting) the modem.

### Typical implementation:

The first of the following diagrams specifies the way to route the specified signals from the module to a connector on which will be connected the data cable. This diagram has to be implemented on the application board.

The second diagram gives a typical data cable electrical scheme.

On the application Board:

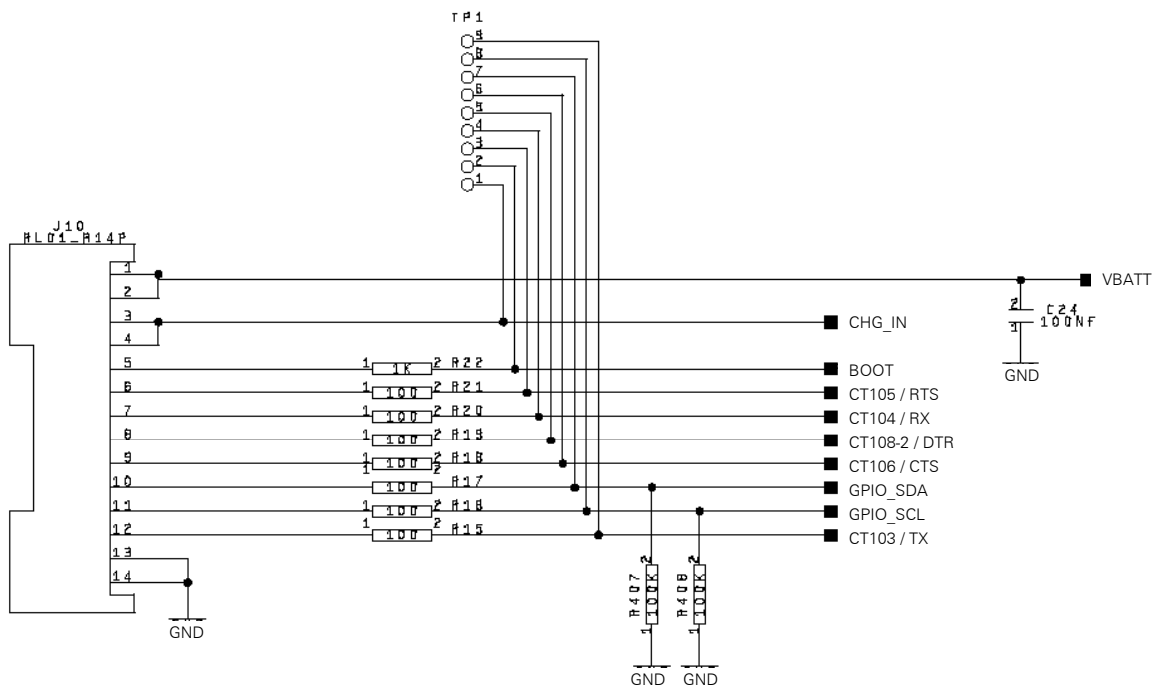
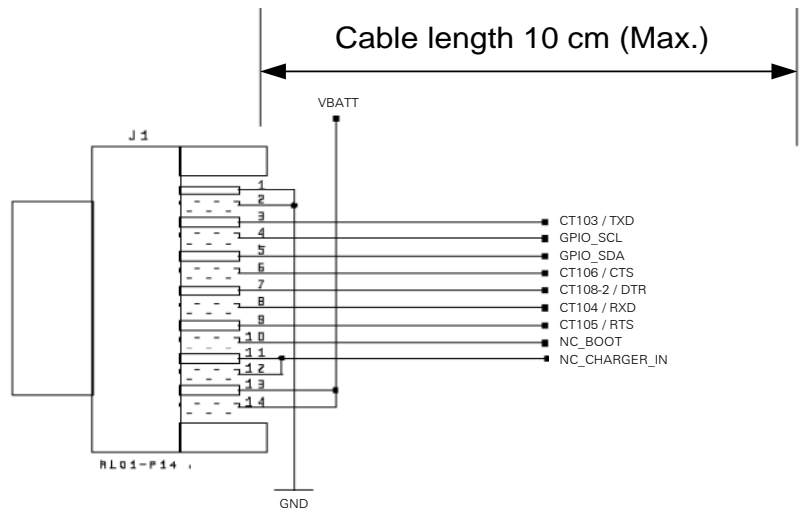


Figure 30: Example of serial link routing for downloading



**Figure 31: Download cable schematic (1/2)**

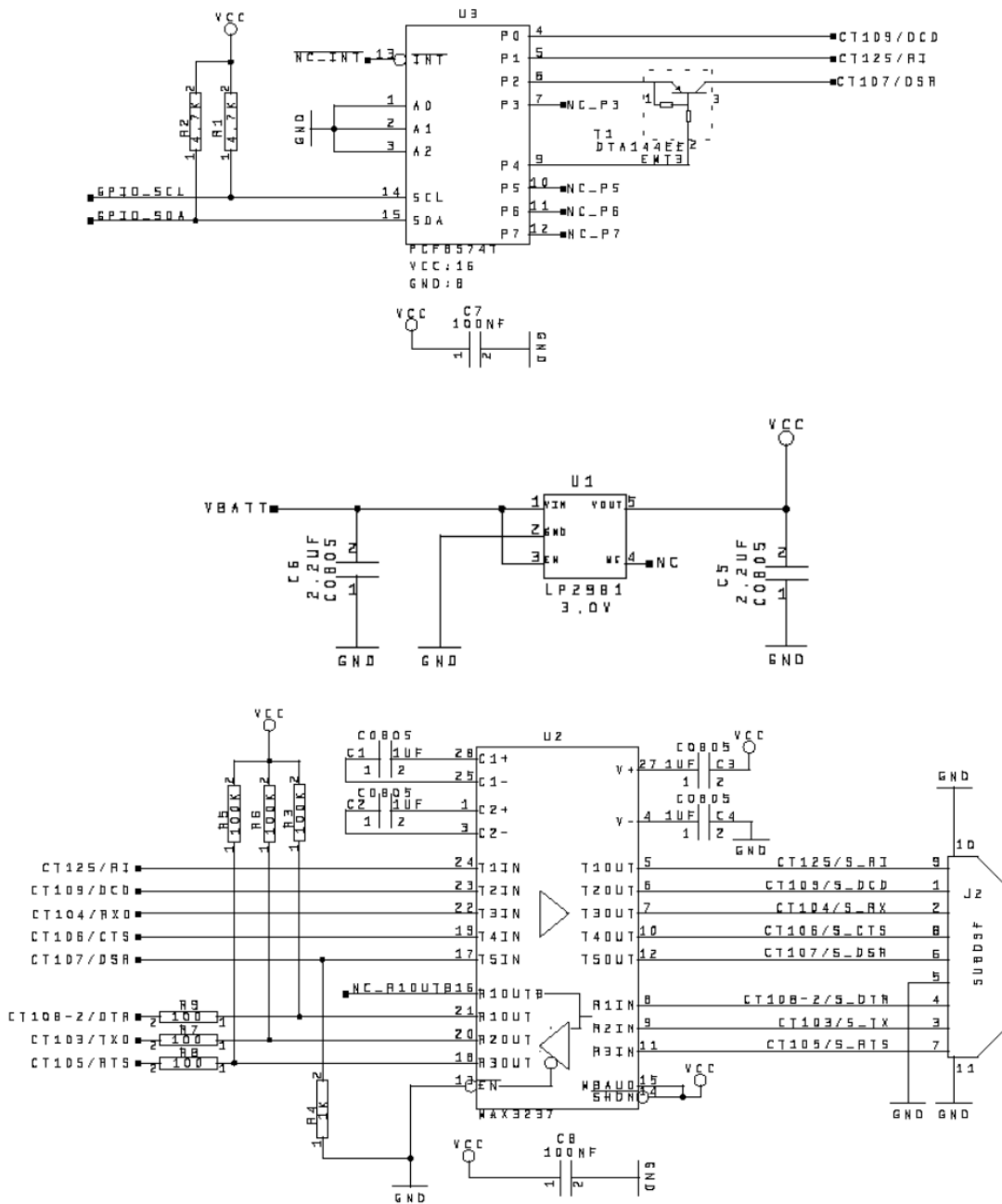


Figure 32: Download cable schematic (2/2)

## 9 Part references and suppliers

### 9.1 General purpose connector

The GPC is a 60-pin connector with 0.5mm pitch from KYOCERA / AVX group with the following reference:

**14 5087 060 930 861.**

The matting connector has the following reference :

**24 5087 060 X00 861**, X=2 or 9.

The stacking height is 3.0 mm.

For further details see GPC data sheets in appendix. More information is also available from <http://www.avxcorp.com>

### 9.2 SIM card reader

- ITT CANNON CCM03 series (see <http://www.ittcannon.com> )
- AMPHENOL C707 series (see <http://www.amphenol.com> )
- JAE (see <http://www.jae.com> )

Drawer type:

- MOLEX 99228-0002 (connector) / MOLEX 91236-0002 (holder) (see <http://www.molex.com> )

### 9.3 Microphone

Possible suppliers:

- HOSIDEN
- PANASONIC

## 9.4 Speaker

Possible suppliers:

- SANYO
- HOSIDEN
- PRIMO
- PHILIPS

## 9.5 Antenna cable

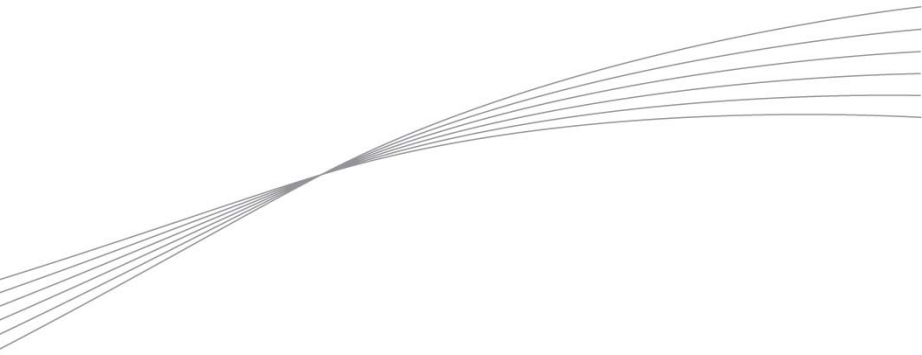
The following cable reference has been qualified for being mounted on WISMO Quik Q2400 module:

- RG178

## 9.6 GSM antenna

GSM antennas and support for antenna adaptation can be obtained from manufacturers such as:

- ALLGON (<http://www.allgon.com> )
- MOTECO (<http://www.moteco.com> )
- GALTRONICS (<http://www.galtronics.com> )



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