WISMO Pac P3100 series
Product Specifications

Reference : WM_PRJ_WM3-2_PTS_002
Level : 002
Date : 14th March 2002

Document Information

Level	Date	History of the evolution	Writer
001	10th April 2001	Creation based on WM_PRJ_WM3-2_PTS_001Rel 004, with latest technical evolutions of WISMO3-2. Add 900/1900 information. Add "AT" symbol for features limitation.	C. NAVARRE
002	14th March 2002	Complete update. Add : Parallel Bus Second Serial Link CSUSR signal PWM output Change product reference. Add of "Design guideline" chapter.	Coordinated by F. FERREIRA, with the help of : M. NAU C. NAVARRE F. HUET

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Contents

Cautions

Information provided herein by Wavecom is accurate and reliable. However no responsibility is assumed for its use. Please read carefully the safety precautions for a terminal based on WISMO Pac P3100 series.

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Overview

This document defines and specifies the WISMO Pac P3100 Series.

Four versions of the WISMO Pac P3100 module are available:

- **P3103A**: EGSM/GPRS **900/1800 MHz** version with **16 Mb** of Flash memory and **2 Mb** of SRAM (16/2).
- **P3103B**: EGSM/GPRS **900/1800 MHz** version with **32 Mb** of Flash memory and **4 Mb** SRAM (32/4).
- **P3113A**: EGSM/GPRS **900/1900 MHz** version with **16 Mb** of Flash memory and **2 Mb** of SRAM (16/2).
- **P3113B**: EGSM/GPRS **900/1900 MHz** version with **32 Mb** of Flash memory and **4 Mb** of SRAM (32/4).

In this document, the words “P3100” or “P3100 series” are referring to the products listed here-above.

Reference Documents

[1] Wavecom Acceptance and Verification Plan
WAVE Plan, Release 1.4

[2] WISMO Pac P3100 Series Manufacturing Guide
WM_PRJ_WM3-2_PTS_007_001

[3] AT Commands Interface Guide
WM_SW_OAT_IFS_001_002

[4] AT Software Release Note
Relnote8c-1

[5] WISMO Pac P3100 Starter Kit
WM_PRJ_WM3-2_PTS_005_002

1 General Description

1.1 General information

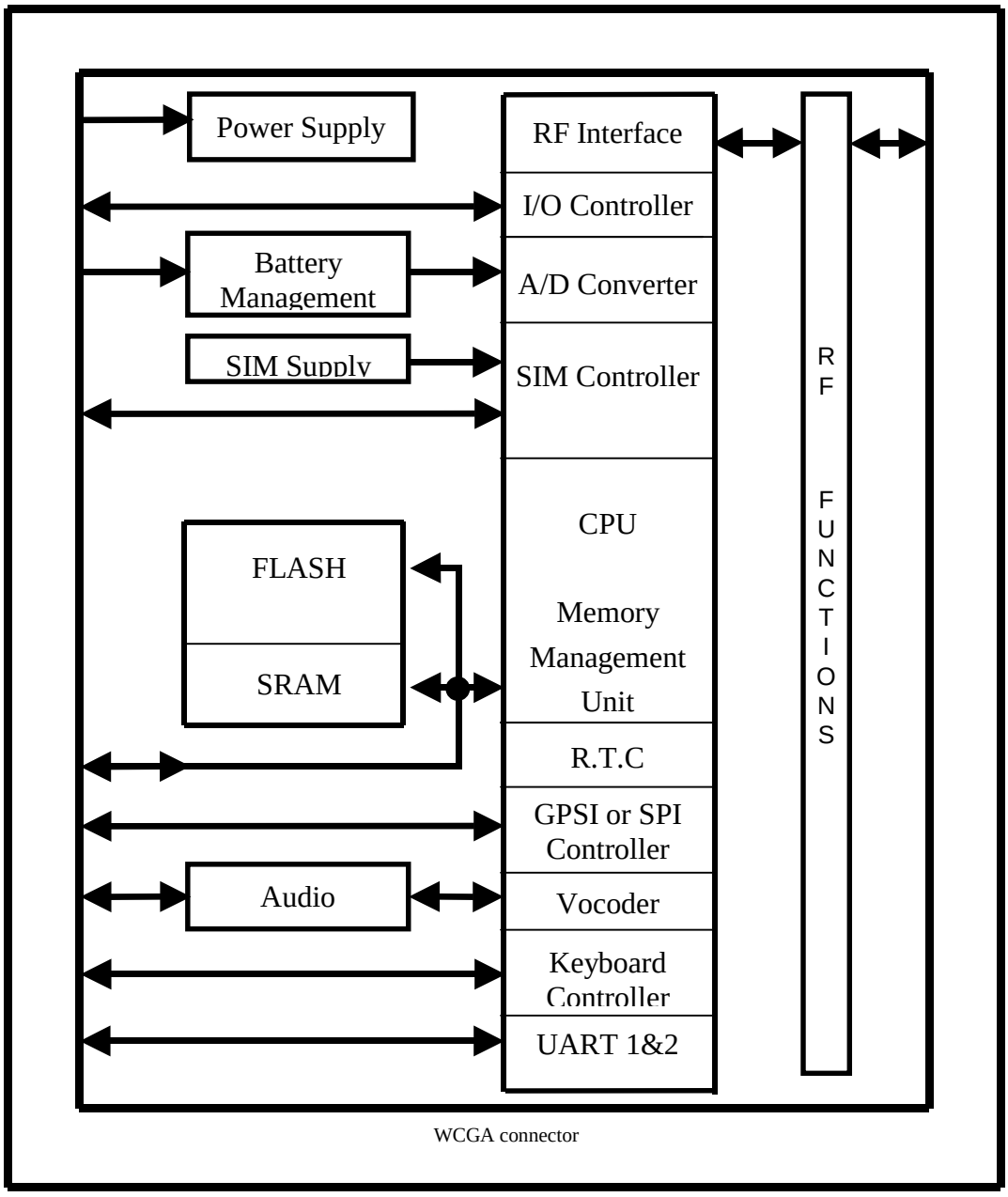
WISMO Pac P3100 series are a range of self-contained EGSM/GPRS 900/1800 (or 900/1900) dual band modules offering the following features :

- 45.2 x 32.8 x 4.95 mm external dimensions
- 2 Watts EGSM 900 radio section running under 3,6 Volts
- 1 Watt GSM1800/1900 radio section running under 3,6 Volts
- Digital section running under 2,8 Volts
- 3 V only SIM interface
- Real Time Clock with calendar
- Full GSM/GPRS dual-band software
- Hardware GPRS Class 2 capable
- Complete shielding
- Complete interfacing through an external SMD connection :
  - Power supply
  - Serial link
  - Audio
  - SIM card interface
  - Keyboard
  - LCD (not available with AT commands)
- Battery charge management
- Echo cancellation

The P3100 series are designed to fit in a very small terminal and only some custom functions have to be added to make a complete Dual Band handset :

- Keypad and LCD module
- Earpiece and Microphone
- Battery
- Antenna switch
- SIM connector

1.2 Functional description



1.2.1 RF functionalities

1.2.1.1 RF Architecture

The RF part is based on a specific dual band chip and includes :

- 2 dedicated down-converters.
- 1 FI demodulator
- All local RF & IF VCO
- PLL
- Transmit loop (modulator, down mixer, phase frequency comparator)
- 2 Power Amplifiers

WISMO Pac P3100 series does not include any RF switch for a car kit antenna connection. If a dual antenna connection is required in the application, the RF switch has to be placed externally to the WISMO module on the application mother board.

The WISMO Pac P3100 series RF is defined as :

- Class 4 for EGSM 900.
- Class 1 for GSM 1800 and GSM 1900.

1.2.1.2 RF Frequencies

The RF functionalities comply with the Phase II EGSM 900/GSM 1800 or GSM 1900 recommendation. The frequencies are :

- Rx (EGSM 900) : 925 to 960 MHz
- Tx (EGSM 900) : 880 to 915 MHz

- Rx (GSM 1800) : 1805 to 1880 MHz
- Tx (GSM 1800) : 1710 to 1785 MHz

- Rx (GSM 1900) : 1930 to 1990 MHz
- Tx (GSM 1900) : 1850 to 1910 MHz

1.2.1.3 RF performances

RF performances are compliant with the ETSI recommendation 05.05 and 11.10.

The main parameters are :

Receiver

- EGSM 900 Sensitivity: < -102 dBm
- GSM 1800/1900 Sensitivity: < -102 dBm
- Selectivity @ 200 kHz: > +9 dBc
- Selectivity @ 400 kHz: > +41 dBc
- Dynamic range: 62 dB
- Intermodulation: > -43 dBm
- Co-channel rejection: ≥ 9 dBc

Transmitter

- Maximum output power (EGSM 900): 33 dBm +/- 2 dB
- Maximum output power (GSM 1800/1900): 30 dBm +/- 2 dB
- Minimum output power (EGSM 900): 5 dBm +/- 5 dB
- Minimum output power (GSM 1800/1900): 0 dBm +/- 5 dB
- H2 level: < -30 dBm
- H3 level: < -30 dBm
- Phase error at peak power: < 5 ° RMS
- Frequency error: +/- 0.1 ppm max

1.2.2 Baseband functionalities

The digital part of WISMO Pac P3100 Series is based on a PHILIPS-VLSI chip (ONE C GSM Kernel). This chipset is using a 0,25 µm mixed technology CMOS, which allows massive integration as well as low current consumption.

1.3 Firmware

WISMO Pac is designed to be integrated into various types of applications such as personal communication devices, including Mobile Phones and Personal Digital Assistants.

For applications using an external processor to control the module, the firmware offers a software interface based on AT commands. With this standard software, some interfaces of the module might not be available.

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.

2 Interfaces

**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.**

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 Interface connector

A WCGA (Wavecom Column Gird Array) reflow connector is provided to interface the WISMO Pac P3100 Series with a mother board supporting peripherals such as LCD module, keypad, SIM card reader, battery connection...

The P3100 Series WCGA connector supports 222 pins.

The antenna connection is available through one pin of the WCGA interface. The RF output impedance is 50 Ω and the mother board design must follow this constraint.

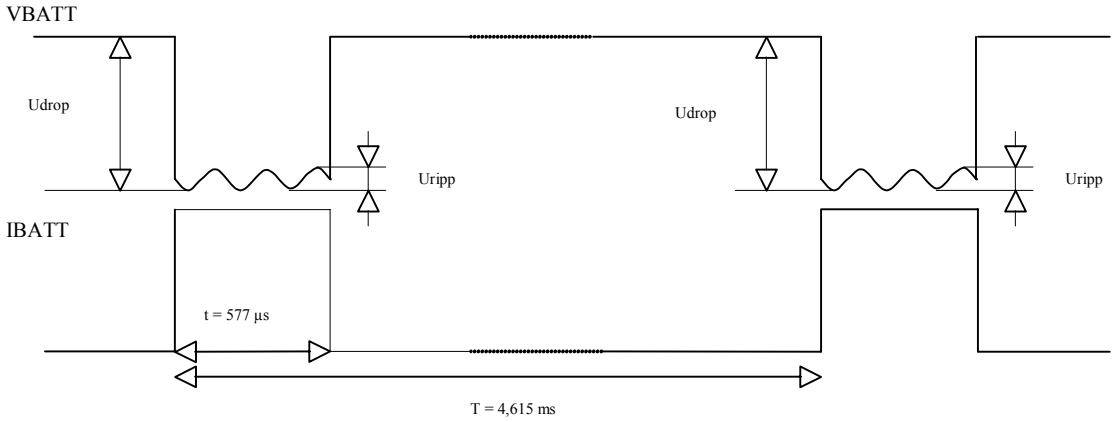
WCGA is a 1.00 / 1.27 mm pitch package (see Mechanical specifications, section 4).

Caution : the P3100 Series support a 2,8 V digital interface.

2.2 Power supply

The power supply is one of the key issue 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. During these peaks the ripple (U_{ripp}) and the drop (U_{drop}) on the supply voltage must not exceed a certain limit.

In communication mode, a GSM terminal emits 577µs radio bursts every 4.615ms.



VBATT is used to supply both Baseband and RF parts. The P3100 may be directly connected to a Li-Ion battery. The internal impedance of the battery must be lower than 150 mΩ to limit voltage drop-out within emission burst (max. drop 0.3 V @ 2W).

Battery internal impedance must take into account the internal impedance of the battery cell, the protection circuit impedance, the "packaging" impedance (contacts) and the PCB track impedance up to the P3100 module pin.

RF Supply: 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. The RF Power Amplifier current (2.0 A peak in GSM mode, with a 50Ω RF output) flows with a ratio of 1/8 of the time (around 577µs every 4.615ms). The rising time is around 10µs.

BASEBAND Supply: VBATT supplies the LDO regulators of the module.

Power Supply Voltage

	V_{MIN}	V_{NOM}	V_{MAX}	Ripple max
VBATT	3.3 V (*)	3.6 V	4.5 V	50 mV for f<200 kHz 2mV for f>200 kHz

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

2.2.1 Power consumption

Following information are given assuming a 50 Ω RF output.

Power consumption in OFF mode

	Conditions	I_{NOM}	I_{MAX}
VBATT	Off	5 µA	10 µA

Power consumption in EGSM 900 mode

	Conditions	I_{NOM}	I_{MAX}
VBATT	During TX bursts @PCL5	1.7 A peak	2.0 A peak
VBATT	During RX bursts	75 mA peak	80 mA peak
VBATT	Average @PCL5	350 mA	400 mA
VBATT	Average @PCL8	260 mA	300 mA
VBATT	Average Idle mode (module in handset applications)	3 mA	6.5 mA
VBATT	Average Idle mode (module driven by AT commands, UART running)	12 mA	16 mA

Power Control Level : PCL5=2W typ. ; PCL8=0,5W typ.

Power consumption in GSM 1800 mode

	Conditions	I_{NOM}	I_{MAX}
VBATT	During TX bursts @PCL0	1.3 A peak	1.7 A peak
VBATT	During RX bursts	75 mA peak	80 mA peak
VBATT	Average @PCL0	320 mA	350 mA
VBATT	Average @PCL3	230 mA	280 mA
VBATT	Average Idle mode (module in handset applications)	3 mA	6.5 mA
VBATT	Average Idle mode (module driven by AT commands, UART running)	12 mA	16 mA

Power Control Level : PCL0=1W typ. ; PCL3=0,25W typ.

The P3100 is able to monitor the voltage of the battery to give a rough indication of its remaining capacity and to control charge process.

Power Supply Pinout

Signal	Pin number
VBATT	A17, B17, A18, B18
GND	A1 to A16 ; A19 to A35 Z1 to Z11 ; Z13 to Z35 O34 ; P34 ; R34 ; S34 B35 to P35 ; R35 to Y35 C18 to K18 ; P18 to Y18 C17 ; S17 ; V17 ; Y17 B15 ; B16 ; Y15 ; Y16 E1 ; H1 ; L1 ; O1 ; Q1 ; W1 ; B2 ; Y2

2.3 Electrical information for digital I/O

All digital I/O are supplied in 2.8 V and comply with 3 V CMOS.

Operating conditions

Parameter	I/O type	Min	Max	Condition
V_{IL}	CMOS	-0.5 V	0.8 V	
V_{IH}	CMOS	2.1 V	3.0 V	
V_{OL}	1X		0.2 V	I_{OL} = -1 mA
	2X		0.2 V	I_{OL} = -2 mA
	3X		0.2 V	I_{OL} = -3 mA
V_{OH}	1X	2.6 V		I_{OH} = 1 mA
	2X	2.6 V		I_{OH} = 2 mA
	3X	2.6 V		I_{OH} = 3 mA

2.4 SPI Bus

The WISMO Pac P3100 Series offers a dual SPI bus using 4 signals.

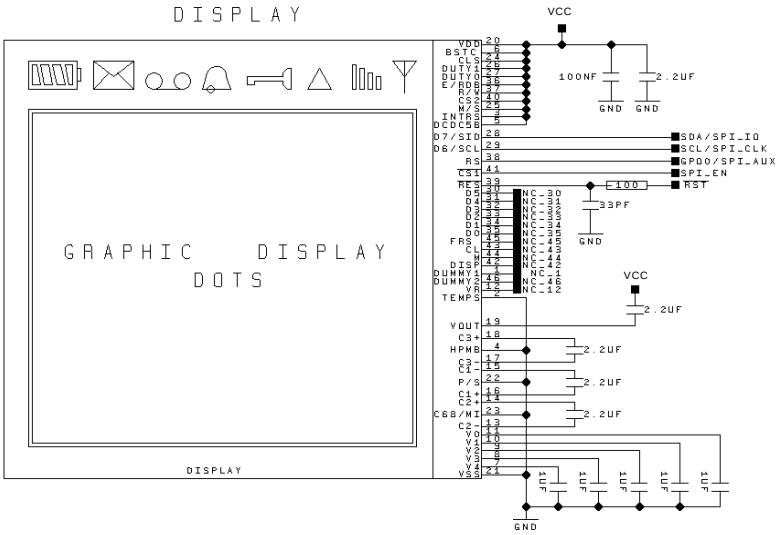
The SPI bus includes a clock signal (SPI_CLK), a data signal (SPI_IO) and two chip enable signals (SPI_EN and SPI_AUX) complying with SPI bus standard. The maximum transfer speed is 3.25 Mb/s.

This bus can typically be used to drive a LCD.

Pin description

Signal	Pin number	I/O	I/O type	Description	Multiplexed with
SPI_CLK	P1	O	1X	SPI Serial Clock	SCL
SPI_IO	Q2	I/O	CMOS / 1X	SPI Data	SDA
SPI_EN	P2	O	1X	SPI Enable	LCDEN
SPI_AUX	O2	O	3x	SPI Aux. Enable	GPO0

Typical implementation :



2.5 Two-wire Bus Interface

The 2-wire bus includes a CLK signal and a DATA signal complying with a standard 400 kHz 2-wire bus.

As SPI bus, it can be used to drive a LCD.

Pin description

Signal	Pin number	I/O	I/O type	Description	Multiplexed with
SCL	P1	O	1X	Serial Clock	SPI-CLK
SDA	Q2	I/O	CMOS / 1X	Serial Data	SPI_IO

For 2-wire bus compliance, 2 pull-up resistors must be added on the application board on the SDA and SCL signals (between 2.2 kΩ and 4.7 kΩ).

2.6 Parallel Bus

The WISMO Pac P3100 Series offers a parallel bus base on 13 wires.

The LCD parallel bus includes the control signals (/RD, /WR, A2, LCDEN, CSUSR) and an 8 bits data bus. LCDEN signal is a chip enable dedicated to drive a LCD and CSUSR a chip select that can be used to drive any standard parallel peripheral device.

Pin description

Signal	Pin Number	I/O	I/O type	Description	Multiplexed with
/RD	Y3	O	CMOS/3x	Read operation	
/WR	Y12	O	CMOS/3x	Write operation	
A2	Y1	O	CMOS/3x	Data/Command Selection	
LCDEN	P2	O	CMOS/1x Tri-state	LCD Enable	SPI_EN
CSUSR	I2	O	CMOS/2x	Chip Select User	GPIO5
D0	Y4	I/O	CMOS/3x	Data Bus	
D1	Y5	I/O	CMOS/3x	Data Bus	
D2	Y6	I/O	CMOS/3x	Data Bus	
D3	Y7	I/O	CMOS/3x	Data Bus	
D4	Y8	I/O	CMOS/3x	Data Bus	
D5	Y9	I/O	CMOS/3x	Data Bus	
D6	Y10	I/O	CMOS/3x	Data Bus	
D7	Y11	I/O	CMOS/3x	Data Bus	

2.7 PWM Output

One PWM interface is available on WISMOP3100.

- Frequency range : 397 Hz to 101563 Hz
- Duty cycle mode 1 : 0 % to 99,2 % by 1/128 step
- Duty cycle mode 2 : 0 % to 99,6 % by 1/256 step

Pin description

Signal	Pin number	I/O	I/O type	Description	Multiplexed with
PWM1	I1	O	2X	PWM output	GPIO4

2.8 Keyboard interface

☞ Warning :

An AT command allows to get the input key code (see +CMER command description). This code has then to be managed by the application.

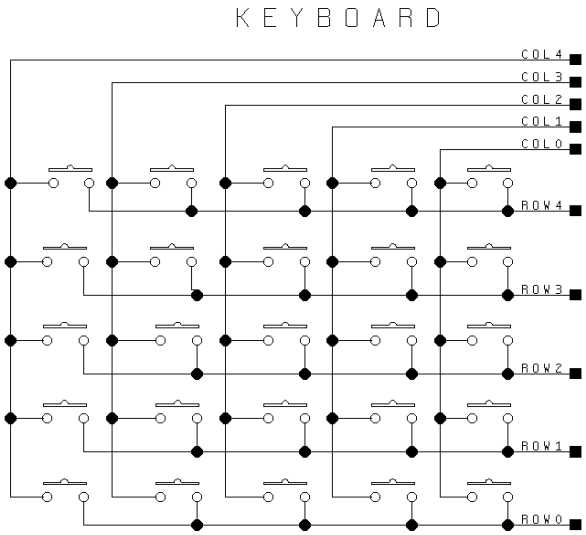
This interface provides 10 connections : 5 rows (R0 to R4) and 5 columns (C0 to C4).

Digital scanning and debouncing are done within the P3100 module. No discrete components like R,C (Resistor, Capacitor) are needed.

Pin description

Signal	Pin number	I/O	I/O type	Description
ROW0	T2	I/O	CMOS / 1X	Row scan
ROW1	S1	I/O	CMOS / 1X	Row scan
ROW2	R2	I/O	CMOS / 1X	Row scan
ROW3	S2	I/O	CMOS / 1X	Row scan
ROW4	R1	I/O	CMOS / 1X	Row scan
COL0	U1	I/O	CMOS / 1X	Column scan
COL1	V2	I/O	CMOS / 1X	Column scan
COL2	V1	I/O	CMOS / 1X	Column scan
COL3	T1	I/O	CMOS / 1X	Column scan
COL4	U2	I/O	CMOS / 1X	Column scan

Typical Implementation :



2.9 Serial Link, Uart1

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

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

The set of RS232 signals can be required for GSM DATA services application and is generated by the general purpose I/O provided by the P3100 series. The 2 additional signals are Data Carrier Detect (CT109/DCD) and Ring Indicator (CT125/RI).

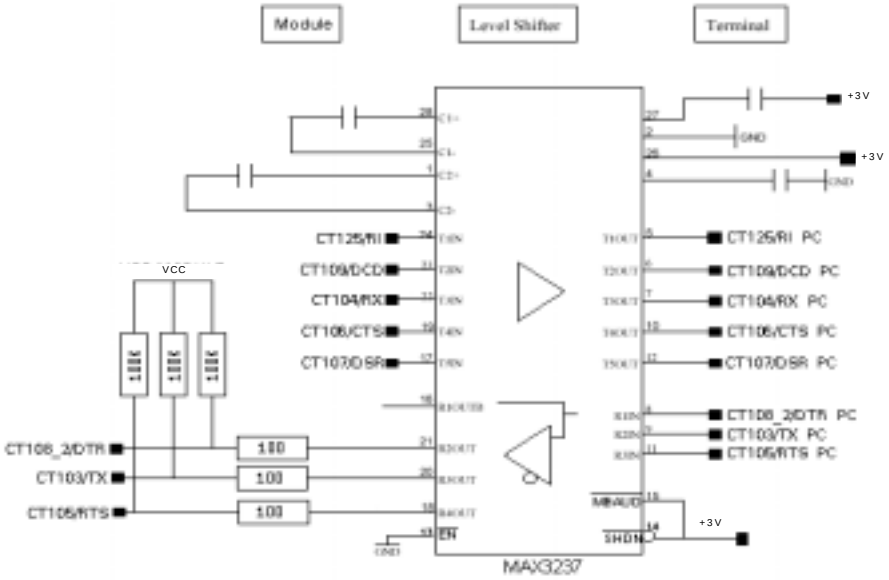
Pin description

Signal	Pin number	I/O	I/O type	Description	Multiplexed with
CT103 / TX	D2	I	CMOS	Transmit serial data	
CT104 / RX	D1	O	1X	Receive serial data	
CT105 / RTS	C1	I	CMOS	Ready To Send	
CT106 / CTS	E2	O	1X	Clear To Send	
CT107 / DSR	C2	O	1X	Data Set Ready	
CT108-2 / DTR	B1	I	CMOS	Data Terminal Ready	
CT109 / DCD	G2	O	2X	Data Carrier Detect	GPO1 / RXD2
CT125 / RI	H2	O	2X	Ring Indicator	GPIO6

The rising time and falling time of the reception signals (mainly CT103) have to be less than 200 ns.

The P3100 Series have been designed to be operated using all the serial interface signals. In particular, it is necessary to use RTS and CTS for hardware flow control in order to avoid data corruption during transmission.

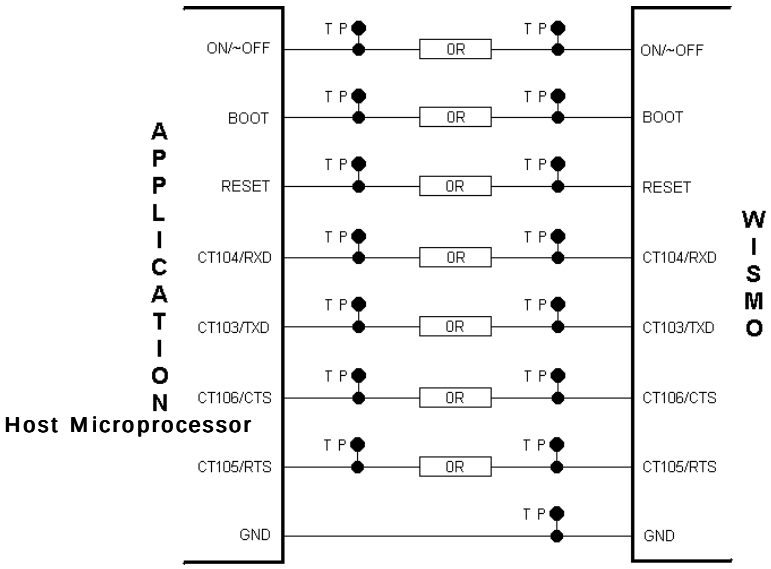
2.9.1 Typical implementation



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.

Possible implementation



2.10 Serial link, Uart2

For future applications (e.g. Bluetooth connectivity) a second serial interface will be available.

Pin description

Signal	Pin number	I/O	I/O type	Description	Multiplexed with
CT103 / TXD2	F1	I	CMOS	Transmit serial data	GPI
CT104 / RXD2	G2	O	3X	Receive serial data	DCD / GPO1
CT105 / RTS2	K2	I	CMOS	Ready To Send	GPIO1
CT106 / CTS2	J1	O	2X	Clear To Send	GPIO2

2.11 SIM interface

2.11.1 General description

5 signals are available :

- SIMVCC : SIM power supply.
- SIMRST : reset.
- SIMCLK : clock.
- SIMDATA : I/O port.
- SIMPRES : SIM card detect.

The SIM interface controls 3V SIM cards only. To support 3V/5V or 5V only SIM cards, an external SIM driver is required (specific level shifter).

This interface is fully compliant with GSM 11.11 and 11.12 recommendations concerning SIM functions.

It is recommended to add Transient Voltage Suppressor diodes on the signal connected to the SIM socket in order to prevent any Electrostatic Discharge. TVS diodes with low capacitance (less than 10pF) have to be connected on SIMCLK and SIMDATA 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.

2.11.2 Signal description

Pin description

Signal	Pin number	I/O	I/O type	Description	Multiplexed with
SIMCLK	M2	O	2X	SIM Clock	
SIMRST	N1	O	2X	SIM Reset	
SIMDATA	M1	I/O	CMOS / 3X	SIM Data	
SIMVCC	N2	O	Supply	SIM Power Supply	
SIMPRES	L2	I	CMOS	SIM Card Detect	GPIO7

Electrical Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
SIMDATA V_{IH}	I_{IH} = ± 20µA	0.7xSIMVCC			V
SIMDATA V_{IL}	I_{IL} = 1mA			0.3xSIMVCC	V
SIMRST, SIMDATA SIMCLK V_{OH}	Source current = 20µA	SIMVCC – 0.1V			V
SIMRST, SIMDATA SIMCLK V_{OL}	Sink current = -200µA			0.1	V
SIMVCC* Output Voltage	I_{SIMVCC} <= 6mA	2.70	2.80	2.85	V
SIMCLK Rise/Fall Time	Loaded with 30pF			50	ns
SIMRST, SIMDATA Rise/Fall Time	Loaded with 30pF			1	µs
SIMCLK Frequency	Loaded with 30pF			3.25	MHz

*assuming a 3V interface.

Note for SIMPRES connection:

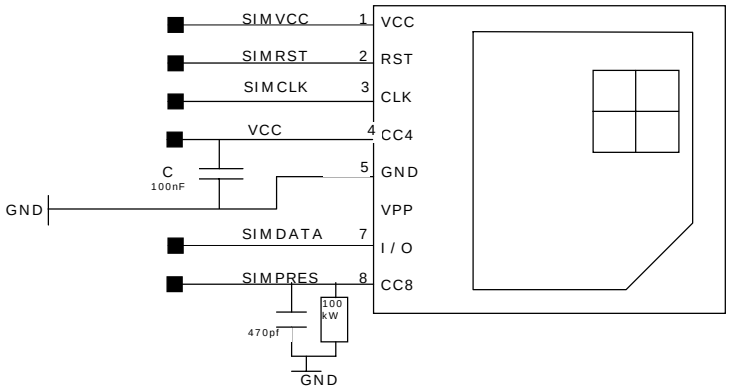
- When not used it has to be tied to VCC.
- When used, a low to high transition means that the SIM card is inserted and a high to low transition means that the SIM card is removed.

2.11.3 SIM socket connection

SIM socket pin description

SIM connector	Signal
1- VCC	SIMVCC
2- RST	SIMRST
3 - CLK	SIMCLK
4 - CC4	VCC
5 - GND	GROUND
6 - VPP	Not connected
7 - I/O	SIMDATA
8 - CC8	SIMPRES with 100 kΩ pull down resistor

Typical implementation with SIM detection :



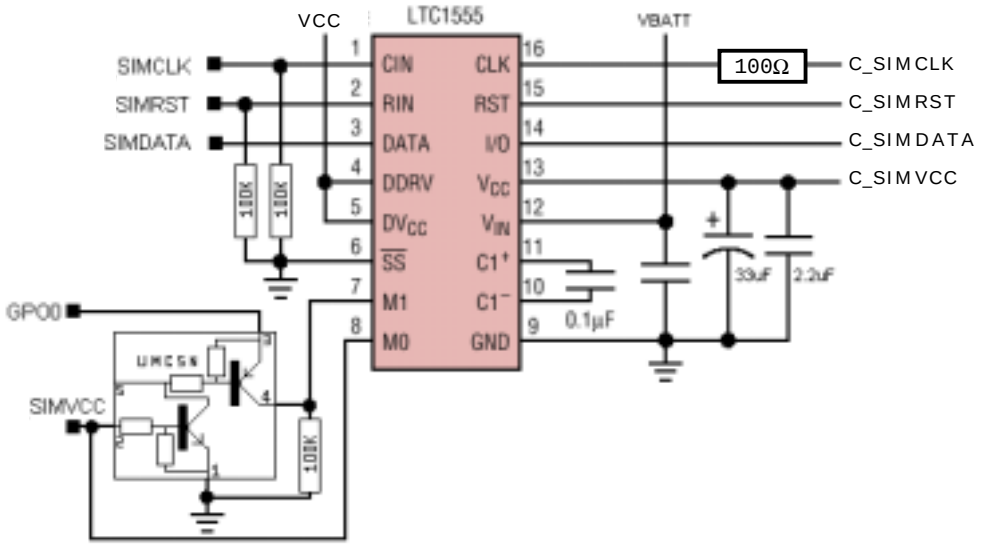
2.11.4 SIM 3V/5V management

It is possible to manage dual voltage (3V/5V) or 5V only SIM cards with a P3100 using an external level shifter.

For applications using an external SIM driver, the firmware of the module automatically triggers the GPO0 output signal to set the SIM driver level (3V or 5V). This is done depending on the type of SIM detected. If GPO0 is used for SIM voltage management, it must not be used for anything else (SPI auxiliary interface or any other general-purpose use).

Typical implementation :

Module Level Shifter SIM Connector



2.12 General Purpose Input/Output

The P3100 provides 8 General Purpose I/O, 2 General Purpose Outputs and 1 General Purpose Input. They are used to control any external device such as a LCD, backlight, or LED.

Pin description

Signal	Pin number	I/O	I/O type	Description	Multiplexed with
GPIO0	K1	I/O	CMOS / 2X	General Purpose I/O	
GPIO2	J1	I/O	CMOS / 2X	General Purpose I/O	CTS2
GPIO3	J2	I/O	CMOS / 2X	General Purpose I/O	
GPIO4	I1	I/O	CMOS / 2X	General Purpose I/O	PWM1
GPIO5	I2	I/O	CMOS / 2X	General Purpose I/O	CSUSR
GPI	F1	I	CMOS	General Purpose I	TXD2

The GPIOs and GPOs that are not used are set to 0 by reset procedure.

The following GPIOs are not available in case of module running with the AT commands firmware :

AT

Signal	Pin number	I/O	I/O type	Description	Multiplexed with
GPO0	O2	O	3X	General Purpose Output (Used as SIM 3V_5V with the AT commands firmware)	SPI_AUX
GPO1	G2	O	3X	General Purpose Output (Used as DCD with the AT commands firmware)	DCD / RXD2
GPIO1	K2	I/O	CMOS / 2X	General Purpose I/O (Used as Flash LED with the AT commands firmware)	RTS2
GPIO6	H2	I/O	CMOS / 2X	General Purpose I/O	RI
GPIO7	L2	I/O	CMOS / 2X	General Purpose I/O	SIMPRES

2.13 Analog to Digital Converter (ADC)

An Analog to Digital converter is available on the P3100 Series. This converter has a 10 bits resolution, ranging from 0 to 2.8 V.

Pin description

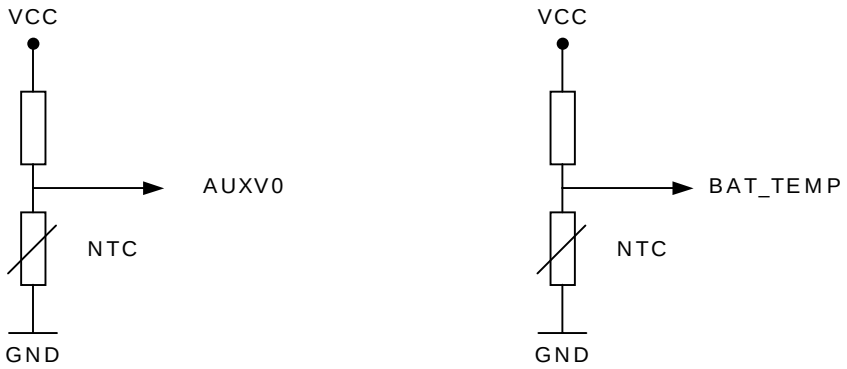
Signal	Pin number	I/O	I/O type	Description
AUXV0	B12	I	Analog	A/D converter

Electrical Characteristics

Parameter	Min	Max	Unit
Resolution	10		bits
Sampling Rate	90.3		Ksps/s
Input signal range	0	2.8	V
ADC Accuracy		1.0	%
Input Impedance (R)	10		MΩ
Input Impedance (C)		100	nF

Note : to reduce noise perturbations, AUXV0 input is protected by an RC filter (R = 4.7 kΩ, C = 100 nF)

Typical application



2.14 Audio interface

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

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

2.14.1 Microphone inputs

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 handsfree system or a handset with biasing external to the module.

2.14.1.1 Common microphone inputs characteristics

The connection can be either differential or single-ended but using a differential connection in order to reject common mode noise and TDMA noise is strongly recommended. 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.

2.14.1.1.1 Microphone gain

The gain of MIC inputs is internally adjusted through AT+VGT command.

In case of an AT command application, the gain can be tuned from :

- +30.3 dB to +51,3 dB with 3.0 dB steps using controller 1
- –6.5 dB to +10 dB with 0.5 dB steps using controller 2
- +30,3 dB to +51,3 dB with 0.5 dB steps using controller 2

Microphone gain vs Max input voltage (using controller 1)

Transmit Gain (dB)	Max Vin (mVrms)	AT+VGT
+ 30.3	43.80	0 to 31
+ 33.3	31.01	32 to 63
+ 36.3	21.95	64 to 95
+ 39.3	15.54	96 to 127
+ 42.3	11.00	128 to 159
+ 45.3	7.79	160 to 191
+ 48.3	5.51	192 to 223
+ 51.3	3.90	224 to 255

Microphone gain vs Max input voltage (using controller 2)

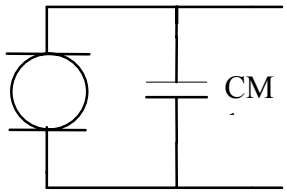
Transmit Gain (dB)	Max Vin (mVrms)	AT+VGT
- 6.5	3031	128 to 243
-6.0	2861	224
...	...	...
0.0	1434	0
...	...	...
+9.5	480	19
+10.0	454	20
+ 30.3	43.80	21 to 60
+ 30.8	41.36	61
...	...	...
+ 50.8	4.14	101
+ 51.3	3.90	102 to 127

2.14.1.1.2 Recommended characteristics for the microphone

- Type : Electret
- Impedance : 2.0 KΩ to 2.2 kΩ
- Sensitivity : -40 to –50dB (0dB = 1V/Pa)
- SNR > 50 dB min
- Frequency response compatible with the GSM specifications

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

- E-GSM 900 CM = 33 pF to 47 pF
- GSM 1800 or 1900 CM = 10 pF to 18 pF
- Dual Band CM = 33pF to 47 pF in parallel with 10 pF to 18 pF

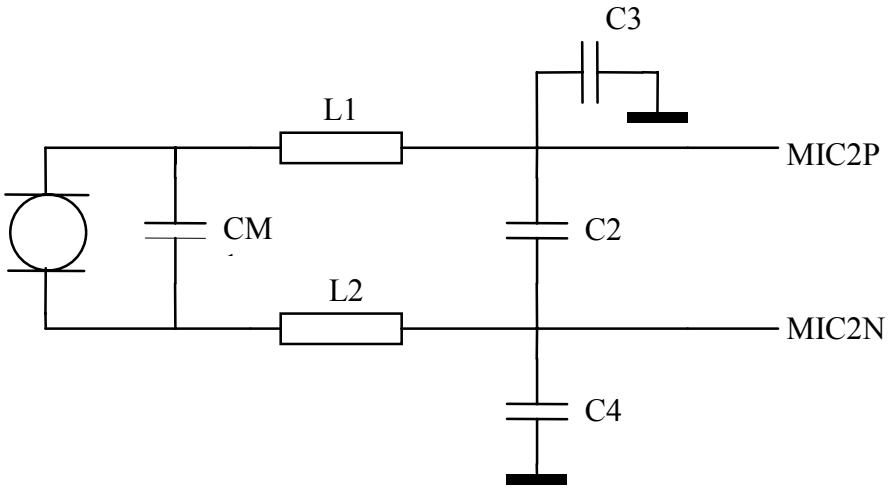


2.14.1.2 Microphone 2 inputs

The MIC2 inputs are differential ones and include the convenient biasing for an electret microphone (0,5 mA and 2 Volts). This electret microphone can be directly connected on these inputs. AC coupling is embedded within the module.

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

Typical implementation :



C2=C3=C4 = 22 pF to 100 pF
L1 = L2 = 100 nH

C2 has to be as close as possible to the module MIC2 pin.

L1, L2, C3 and C4 should be put close to the module but they can be removed according to their environment (ground plane, shielding, ...). A good solution could be to place these components footprints on the design and remove those not necessary for good performance with the TDMA noise on the audio path.

Pin description

Signal	Pin number	I/O	I/O type	Description
MIC2P	B4	I	Analog	Microphone 2 positive input
MIC2N	B5	I	Analog	Microphone 2 negative input

2.14.1.3 Microphone 1 inputs

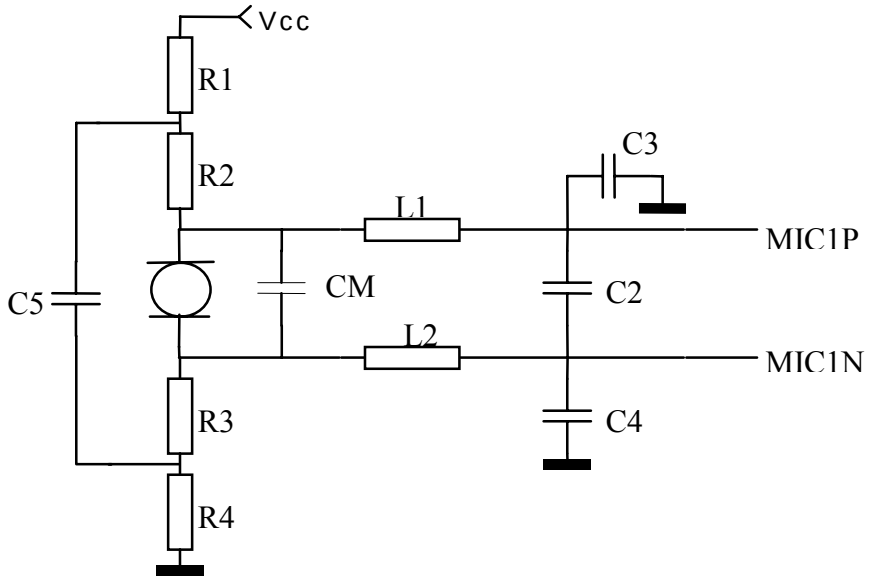
The MIC1 inputs are differential and do not include internal bias. To use these inputs with an electret microphone, bias has to be generated outside the P3100 module according to the characteristics of this electret microphone. These inputs are the standard ones used for an external headset or a handsfree kit.

2.14.1.3.1 Differential connection

Impedance of the microphone input in differential mode :

- Module ON : Rin = 10 kΩ +/-30%
- Module OFF : Rin > 10 MΩ

Typical Implementation :



R1 = R4 = 100 Ω to 330 Ω
R2 = R3 = usually between 1 kΩ and 3.3 kΩ as per microphone characteristics.
C2 = C3 = C4 = 22 pF to 100 pF
C5 = 15 µF to 47 µF
L1 = L2 = 100 nH

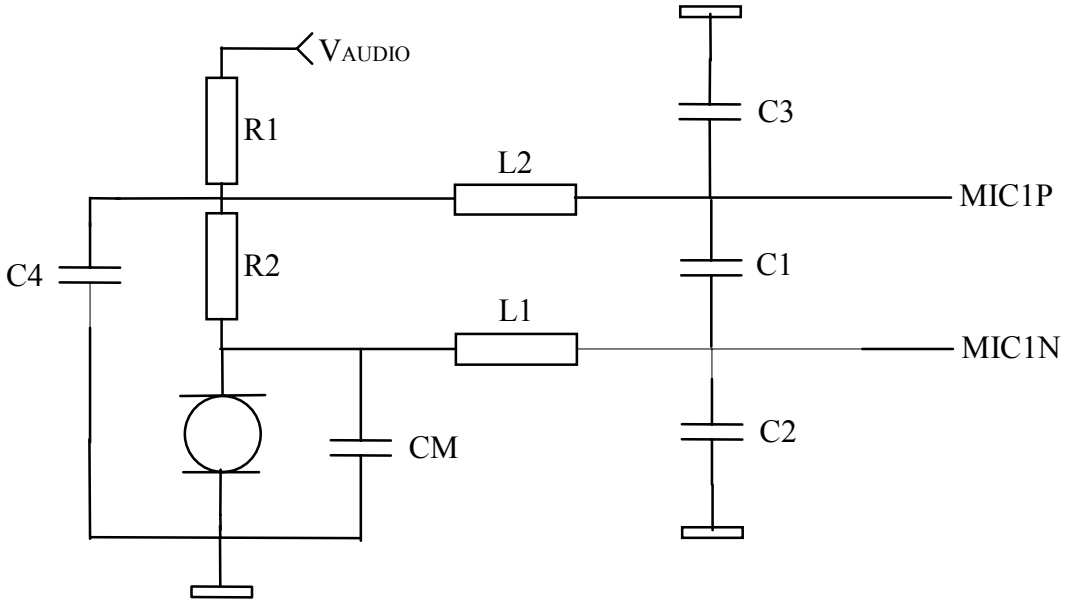
R1 and R4 are used as a supply voltage filter with C5.

C2 has to be as close as possible to the module MIC1 pin.

L1, L2, C3 and C4 should be put close to the P3100 module but they can be removed according to their environment (ground plane, shielding, ...). A good solution could be to place these components footprints on the design and remove those not necessary for good performance with the TDMA noise on the audio path.

2.14.1.3.2 Single-ended connection

Typical Implementation :



Vaudio must be very “clean” to avoid bad performance in case of single-ended implementation. Vaudio could be Vcc with RC or LC filter cell for example.

R1 = 100 Ω to 330 Ω
R2 depending on the Vaudio level and microphone characteristics (usually between 1 kΩ and 3.3 kΩ.
C1 = C2 = C3 = 22 pF to 100 pF
C4 = 15 µF to 47 µF
L1 = L2 = 100 nH

R1 is used as a voltage supply filter with C4.

R1, R2, C4 and C5 have to be as close as possible to the microphone (PCB tracks from the module connector to these devices must be as straight and parallel as possible).

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

L1, and L2 has to be put close to the module connector and they 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.

2.14.1.3.3 Pin description

Pin description

Signal	Pin number	I/O	I/O type	Description
MIC1P	B7	I	Analog	Microphone 1 positive input
MIC1N	B6	I	Analog	Microphone 1 negative input

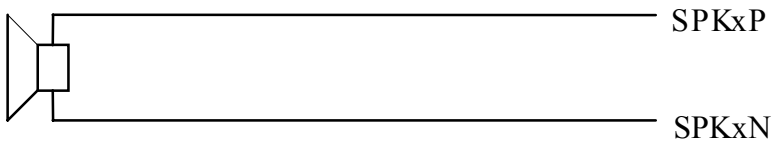
2.14.2 Speaker outputs

2.14.2.1 Common speaker outputs 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. 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.

2.14.2.1.1 Differential connection

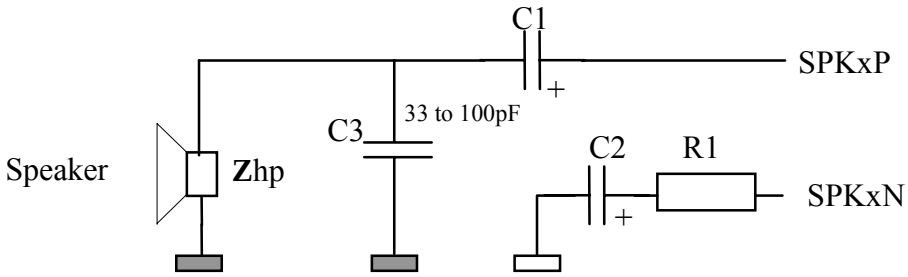
Typical Implementation :



The connection between the P3100 pins and the speaker must be designed to keep the serial impedance lower than 3 Ω in differential mode.

2.14.2.1.2 Single-ended connection

Typical implementation :



4.7 µF < C1 < 47 µF (depending on speaker characteristics and output power)
C1=C2
R1 = Zhp

Using a single-ended connection includes losing of the output power (- 6 dB) compared to a differential connection.

The connection between the P3100 module pins and the speaker must be designed to keep the serial impedance lower than 1.5 Ω in differential mode.

2.14.2.1.3 Speaker gain

The gain of SPK outputs is internally adjusted.

In case of an AT commands based application, the gain can be tuned using AT+VGR command.

Speaker gain vs Max output voltage

Receive Gain (dB) (*)	Max output level (Vrms)	AT+VGR	Max.speaker load (Ω)
+ 1.7	1.741	0 to 15	150
- 0.3	1.383	16 to 31	50
- 2.3	1.099	32 to 47	32
- 4.3	0.873	48 to 63	32
- 6.3	0.693	64 to 79	32
- 8.3	0.551	80 to 95	32
- 10.3	0.437	96 to 111	32
- 12.3	0.347	112 to 127	32
- 14.3	0.276	128 to 143	32
- 16.3	0.219	144 to 159	32
- 18.3	0.174	160 to 175	32
- 20.3	0.138	176 to 191	32
- 22.3	0.110	192 to 207	32
- 24.3	0.087	208 to 223	32
- 26.3	0.069	224 to 255	32

(*) analog gain

2.14.2.1.4 Recommended characteristics for the speaker

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

2.14.2.2 Speaker 2 Outputs

Pin description

Signal	Pin Number	I/O	I/O type	Description
SPK2P	B8	O	Analog	Speaker 2 positive output
SPK2N	B9	O	Analog	Speaker 2 negative output

2.14.2.3 Speaker 1 Outputs

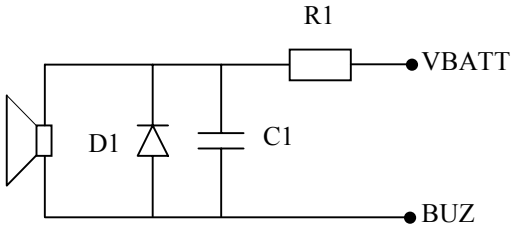
Pin description

Signal	Pin number	I/O	I/O type	Description
SPK1P	B11	O	Analog	Speaker 1 positive output
SPK1N	B10	O	Analog	Speaker 1 negative output

2.14.3 Buzzer Output

The buzzer output is a digital one. A buzzer can be directly connected between this output and VBATT. The maximum peak current is 80 mA and the maximum average current is 40 mA. A diode against transient peak voltage must be added as described below.

Typical Implementation :



R1 must be chosen in order to limit the current at I_{PEAK} max.

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

Recommended characteristics for the buzzer :

- Type : electro-magnetic.
- Impedance : 7 to 30 Ω
- Sensitivity : 90 dB SPL min @ 10 cm
- Current : 60 to 90 mA

Pin description

Signal	Pin number	I/O	I/O type	Description
BUZZER	B14	O	Open Collector	Buzzer output

Operating conditions

Parameter	Condition	Min	Max	Unit
V_{OL}	Imoy = 40mA		0.6	V
I_{PEAK}	VBATT = VBATTmax		80	mA
$I_{AVERAGE}$	VBATT = VBATTmax		40	mA

2.15 Battery charging interface

2.15.1 General Description

2.15.1.1 Hardware description

The P3100 series include the necessary hardware and signals to manage the battery charge. For this, a current generator must be connected on the CHG_IN pins. The generator current intensity 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 600mA. The maximum accepted current is 800 mA. The P3100 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). The module is also able to monitor the battery voltage to detect the end of the charge.

Associated with AT standard software or a customized software (e.g.: handset application), these hardware functions permit to manage entirely the battery charge operation.

Pin description

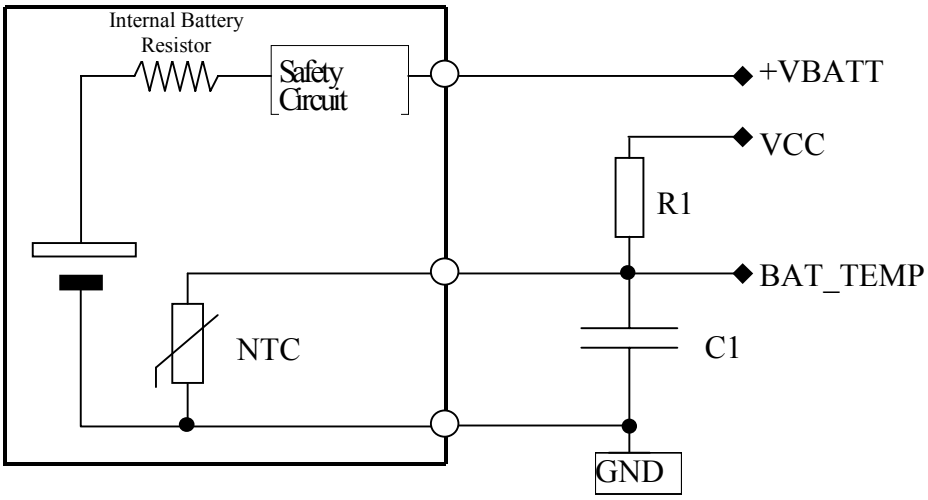
Signal	Pin number	I/O	I/O type	Description
CHG_IN	X1, X2	I	Analog	Current source input
BAT_TEMP	B13	I	Analog	A/D converter

Electrical Characteristics

Parameter	Min	Max	Unit
BAT_TEMP Resolution	10		bits
BAT_TEMP Sampling rate	90.3		Ksps/s
BAT_TEMP Input signal range	0	2.8	VPP
BAT_TEMP Accuracy		1.0	%
BAT_TEMP Input Impedance (R)	10		MΩ
BAT_TEMP Input Impedance (C)		100	nF
CHG_IN Voltage (for I=Imax)	4.6*	5.0	V
CHG_IN Current		800	mA
Note : to reduce noise perturbations, BAT_TEMP input is protected by an RC filter (R = 4.7 kΩ, C = 100 nF)			

* For a 4.2 V Li-Ion battery

Typical Implementation :



How to define R1 and C1

How to choose R1

R1 has to be chosen to have a full range of BAT-TEMP (from 0 to 2.8 V) when the NTC 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

VCC=2.8 V
$NTC_{25°C}$ = 47 kΩ
$NTC_{55°C}$ = 10 kΩ
$NTC_{-10°C}$ = 300 kΩ
$NTC_{-10°C}$ x VCC = ($NTC_{-10°C}$ + R1) x $BAT\text{-}TEMP_{full\ range}$

R1= 47 kΩ ⇨ $BAT\text{-}TEMP_{-10°C}$ = 2.42V ; $BAT\text{-}TEMP_{55°C}$ = 0.49V

$R_{-10°C}$ = R1//$NTC_{-10°C}$ = 40 kΩ $R_{+55°C}$ = 8 kΩ

With C1 = 10 nF :
$RC_{-10°C}$ = 400 µs
$RC_{+55°C}$ = 80 µs

2.15.1.2 Software description

The charging algorithm depends on the battery type. In both situations (AT commands or customized software as handset application), designer must develop must develop his own charging algorithm and battery charge management (charge start and stop, temperature check, .etc). Standard Wavecom AT software offers basic functions to completely control the charging operation.

WARNING :

Wrong battery charging management and/or algorithm may cause battery and/or module damage.

Example : typical Li-ion battery charging procedure

A constant current source has to be provided through CHG_IN input in order to charge the Li-ion battery, and BAT_TEMP input has to be connected to a battery temperature sensor (within the battery or on the application board). During this procedure the voltage of the battery is accurately monitored.

The Li-ion charging involves two phases. During the first phase, the battery is charged with a constant current until its voltage reaches 4.1 V (value depending on the battery type ; recommended in battery specification). During the second phase the constant current is pulsed by the module. The width and the frequency of the pulse change during this phase in order to ensure a safety charge. The battery is considered as fully charged when, after a pulse, the voltage remains at a 4.1 V (refer to battery manufacturer recommendation) during more than 10 s.

The Li-ion battery must have an included safety circuit to avoid any discharge or overcharge. This circuit is delivered by the manufacturer inside the battery pack. The impedance of this safety circuit has to be the lowest possible in order to reduce the voltage drop-out. This drop-out is due to the RF Power Amplifier current (up to 2.0 A). A maximum of 150 mΩ is required. The timer within the battery safety circuit must be designed (by the battery manufacturer) with a delay of 1.2 s minimum between overvoltage measurements before safety cut-out.

2.16 ON / ~OFF

This input is used to switch ON or OFF the P3100.

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 VBATT during a minimum of 1 s. This signal can be left at high level until switch off.

Pin description

Signal	Pin number	I/O	I/O type	Description
ON/~OFF	Y14	I	CMOS	Power control signal

Electrical Characteristics

Parameter	Min	Typ	Max	Unit
Input Impedance (R)		50		kΩ
Input Impedance (C)		33		nF

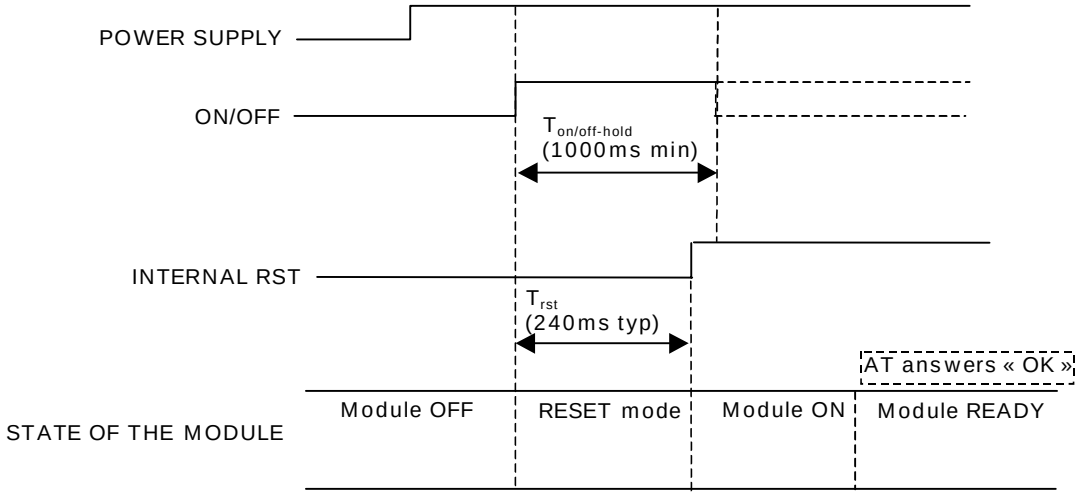
Operating conditions

Parameter	I/O type	Min	Max	Unit
V_{IL}		0 V	0.6 V	V
V_{IH}		2.4 V	VBATT+0.5V	V

2.16.1 Operating sequences

2.16.1.1 Power ON

Once the module supplied, the application must set the ON/~OFF signal to high to start the module power ON sequence. The ON/~OFF signal must be hold for 1 s minimum. After this time, an internal mechanism keeps it on hold. During the power ON sequence, an internal reset is automatically performed by the module for 240 ms (typical). During this phase, any external reset should be avoided.



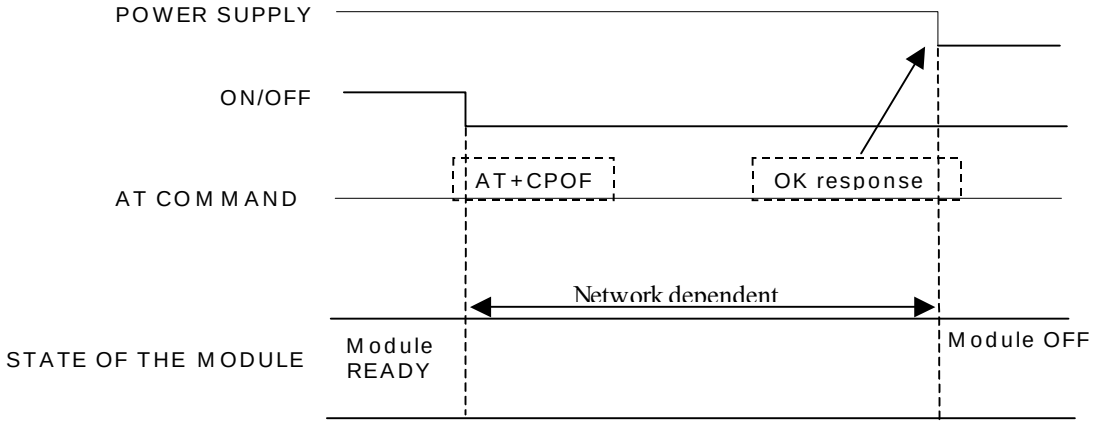
In case of an AT application which sends an “AT” request, the AT interface answers « OK » to the application once the initialization is complete.

Another solution is to use the +WIND command to get an unsolicited status from the module.

For further details, please check the AT commands manual (+WIND).

2.16.1.2 Power Off

To properly power OFF the module, the AT command application must set the ON/OFF signal to low or release it (high impedance) and then send the AT+CPOF command to de-register from the network and switch off the module. Once the « OK » response is issued by the module, the power supply can be switched off.

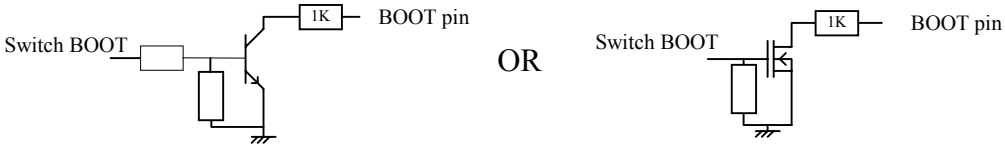


2.17 BOOT

This input must be used to download the software in the Flash memory of the module.

The internal boot procedure is started when this pin is low during the reset of the P3100.

In Internal boot mode low level has to be set through a 1 kΩ resistor. If used, this input has to be driven by an open collector or an open drain.



- If Switch BOOT = 1, Boot pin = 0 ⇨ Download mode.
- If Switch BOOT = 0, Boot pin = 1 ⇨ Normal mode.

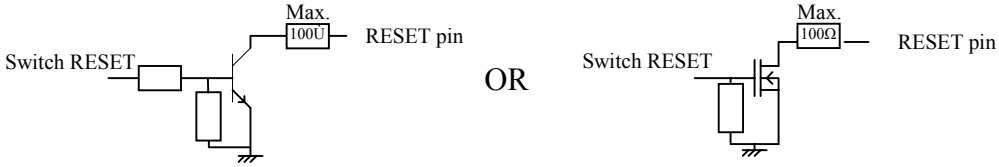
Pin description

Signal	Pin number	I/O	I/O type	Description
BOOT	G1	I	CMOS	Enable for Flash downloading

2.18 Reset signal (~RST)

This signal is used to force a reset procedure by providing low level during at least 500 µs. This signal has to be considered as an emergency reset only : a reset procedure is automatically 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.



Pin description

Signal	Pin number	I/O	I/O type	Description
~RST	W2	I/O	Schmitt	Reset

Electrical Characteristics

Parameter	Min	Typ	Unit
Input Impedance (R)	2.2	4.7	kΩ
Input Impedance (C)		10	nF

Operating conditions

Parameter	Min	Max	Condition
$*V_{T-}$	1.1 V	1.4 V	
$*V_{T+}$	1.7 V	2.2 V	
V_{OL}		0.4 V	I_{OL} = -50 µA
V_{OH}	2.0 V		I_{OH} = 50 µA

* V_{T-}, V_{T+} : Hysterisis thresholds

Additional comments on RESET :

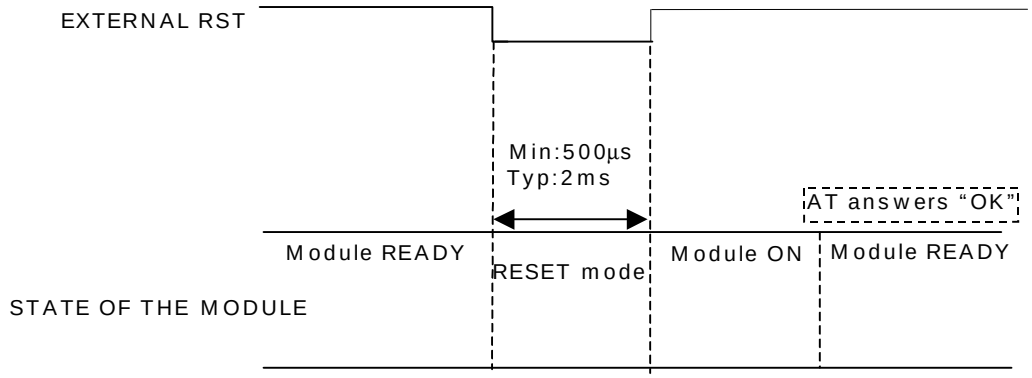
The Reset process is activated either by external ~RST signal OR by an internal signal (coming from a Reset generator). This automatic reset is activated at Power up.

The module remains in Reset mode as long as the ~RST signal is held low. This signal should be used only for “Emergency” reset.

A software reset is always preferred to a hardware reset.

2.18.1 Reset Sequence

To activate the “emergency” reset sequence, the ~RST signal has to be set at low level for 500 µs minimum.



In case of an AT application which sends an “AT” request, the AT interface answers « OK » to the application once the reset procedure is complete.

Another solution is to use the +WIND command to get an unsolicited status from the module.

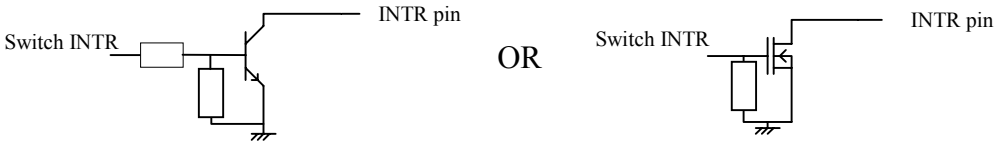
For further details, please check the AT commands manual (+WIND).

2.19 External Interrupt (~INTR)

The P3100 series provide an external interrupt input.

An interrupt is activated on high to low edge and detection of a transition is very sensitive.

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.



Pin description

Signal	Pin number	I/O	I/O type	Description
~INTR	F2	I	CMOS	External Interrupt

Electrical characteristics (To be confirmed)

Parameter	Min	Max	Unit
V_{IL}	-0.5V	0.7V	Volt
V_{IH}	2.2V	3.0V	Volt

2.20 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.

Pin description

Signal	Pin number	I/O	I/O type	Description
VCC	Z12	O	Supply	Digital supply for external digital devices

Operating conditions

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

2.21 Real time clock supply

VCC_RTC is used to provide a back-up power supply for the internal Real Time Clock.

The RTC is supported by the P3100 series when powered on but a back-up power supply is needed to save date and hour when the module is switched off.

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

Pin description

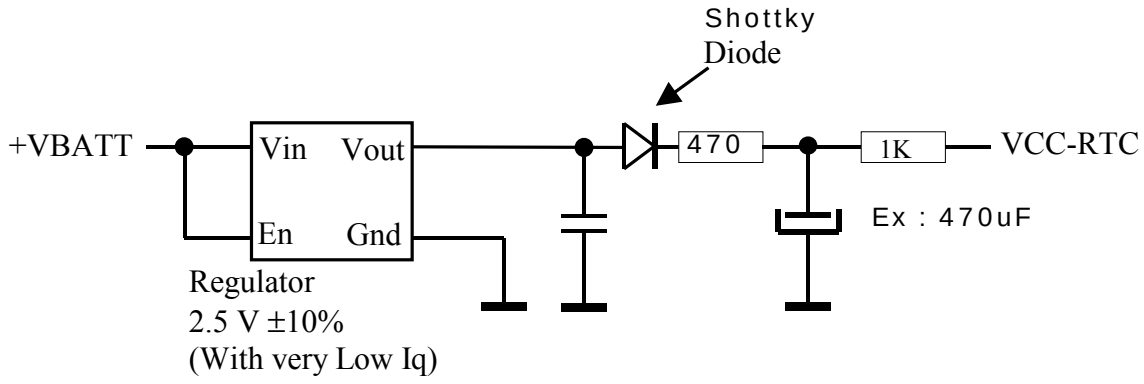
Signal	Pin number	I/O	I/O type	Description
VCC_RTC	B3	I/O	Supply	RTC Back-up supply

Operating conditions

Parameter	Condition	Min	Max	Unit
Input voltage		2.0	2.75	V
Input current	VCC=0V; t°C = 25°C VCC_RTC=2.5V ;		3	µA
Input current	VCC=0V; t°:-20°C / 55°C VCC_RTC=2.5V ;		5	µA
Output voltage		2.4	2.75	V
Output current			2	mA

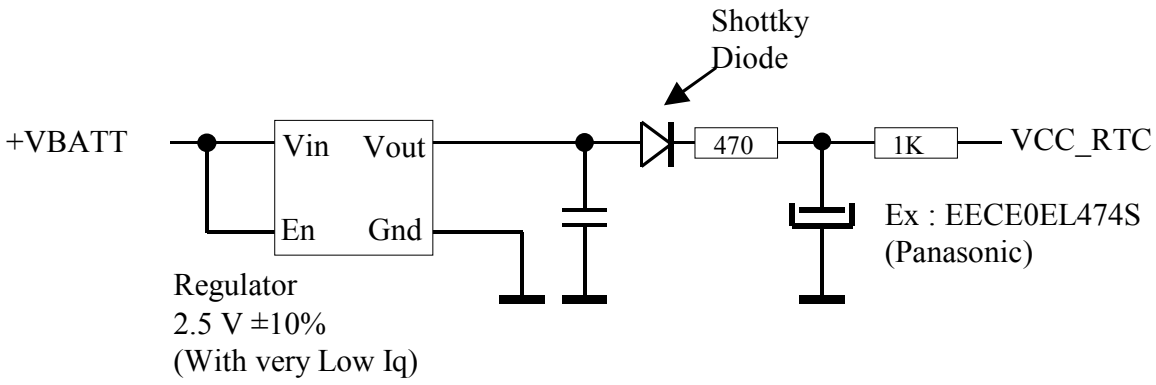
2.21.1 Typical implementation

2.21.1.1 Capacitor



Estimated range with 470 µF Capacitor : ~30 seconds.

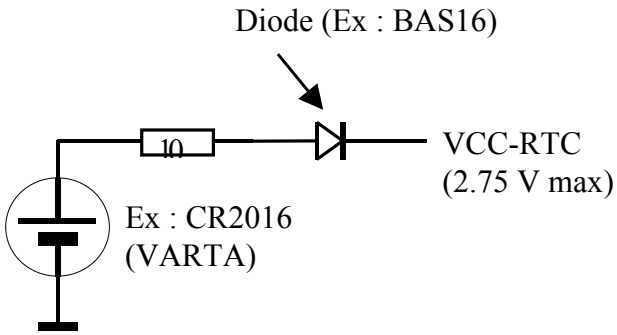
2.21.1.2 Super Capacitor



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

Note : the Gold Capacitor maximum voltage is 2.5 V.

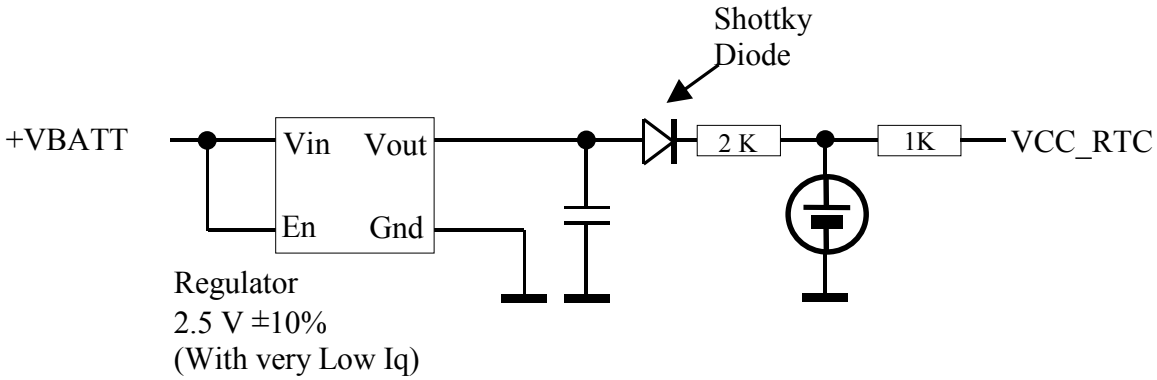
2.21.1.3 Non Rechargeable battery



Estimated range with 85 mAh battery : 4000 h minimum

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

2.21.1.4 Battery cell with regulator



Estimated range with 2 mAh battery 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.

2.22 RF interface

2.22.1 RF connection

The RF connection is allowed through a pin of the WCGA connector.

Pin description

Signal	Pin number	I/O	I/O type	Description
Antenna	Q35		RF 50 Ω	RF output pin (internally AC coupled)
GND	O34, O35, P34, P35, R34, R35, S34, S35		GND	GND pins for RF 50 Ω adaptation.

The impedance is 50 Ohms nominal within EGSM 900, GSM 1800 and GSM 1900 RF bandwidth.

The P3100 series does not include any antenna switch for a car kit but this function can be implemented externally and driven through a GPIO.

2.22.2 Antenna specifications

Antenna must fulfil following requirements :

- Frequency bands : dual band E-GSM 900 MHz – GSM 1800 MHz / GSM 1900 MHz

	EGSM 900	GSM 1800	GSM 1900
Frequency RX	925 to 960 MHz	1805 to 1880 MHz	1930 to 1990 MHz
Frequency TX	880 to 915 MHz	1710 to 1785 MHz	1850 to 1910 MHz

- Impedance : 50 Ω
- VSWR TX max 2 :1 / RX max 2 :1 (within specified Vbatt range, see § 2.2)
- Typical radiated gain : 0dBi

3 Pin out description

3.1 Power Supply

Pin #	Name	I/O	Description	Comment
A18	+VBATT	I	Battery Input	High current.
B18	+VBATT	I	Battery Input	High current
A17	+VBATT	I	Battery Input	High current
B17	+VBATT	I	Battery Input	High current
Z12	VCC	O	2.8V digital supply output	10mA max.
Y13	VPP	I	Flash programming supply	Tied to Vcc (Pin Z12)
B3	VCC_RTC	I/O	RTC back-up supply	Iout = 2 mA max

3.2 Ground Pins

Pin #	Name
A1 to A16 and A19 to A35	GND
Z1 to Z11 and Z13 to Z35	GND
O34, P34, R34, S 34	GND
B35 to P35 and R35 to Y35	GND
C18 to K18 and P18 to Y18	GND
C17, S17, V17, Y17	GND
B15, B16, Y15, Y16	GND
E1, H1, L1, O1, Q1, W1, B2, Y2	GND

3.3 Baseband Interface

3.3.1 System Control Pins

Pin #	Name	I/O	I/O type	Description	Comment
W2	~RST	I/O	SCHMITT	Reset	Active low
G1	BOOT	I	CMOS	BOOT	Pull down through 1 kΩ for Flash downloading
Y14	ON/~OFF	I	CMOS	Power ON/OFF control	
F2	~INTR	I	CMOS	External interrupt	Active low. 100 kΩ Pull-up inside

3.3.2 Parallel Bus Pins

Pin #	Name	I/O	I/O type	Description	Comment
Y3	/RD	O	CMOS/3x	Read operation	
Y12	/WR	O	CMOS/3x	Write operation	
Y1	A2	O	CMOS/3x	Data/Command Selection	
P2	LCDEN	O	CMOS/1x Tri-state	LCD Enable	Multiplexed with SPI_EN
I2	CSUSR	O	CMOS/2x	Chip Select User	Multiplexed with GPIO5
Y4	D0	I/O	CMOS/3x	Data Bus	
Y5	D1	I/O	CMOS/3x	Data Bus	
Y6	D2	I/O	CMOS/3x	Data Bus	
Y7	D3	I/O	CMOS/3x	Data Bus	
Y8	D4	I/O	CMOS/3x	Data Bus	
Y9	D5	I/O	CMOS/3x	Data Bus	
Y10	D6	I/O	CMOS/3x	Data Bus	
Y11	D7	I/O	CMOS/3x	Data Bus	

3.3.3 General Purpose Input & Output Pins

Pin #	Name	I/O	I/O type	Description	Comment
K1	GPIO0	I/O	CMOS/2X	General Purpose I/O	
K2	GPIO1	I/O	CMOS/2X	General Purpose I/O	Multiplexed with RTS2
J1	GPIO2	I/O	CMOS/2X	General Purpose I/O	Multiplexed with CTS2
J2	GPIO3	I/O	CMOS/2X	General Purpose I/O	
I1	GPIO4	I/O	CMOS/2X	General Purpose I/O	Multiplexed with PWM1
I2	GPIO5	I/O	CMOS/2X	General Purpose I/O	Multiplexed with CSUSR
H2	GPIO6	I/O	CMOS/2X	General Purpose I/O	Multiplexed with RI
L2	GPIO7	I/O	CMOS/2X	General Purpose I/O	Multiplexed with SIMPRESI
O2	GPO0	O	3X	General Purpose Output	Multiplexed with SPI-AUX
G2	GPO1	O	3X	General Purpose Output	Multiplexed with DCD and RXD2
F1	GPI	I	CMOS	General Purpose Input	Multiplexed with TXD2 100 kΩ Pull-down inside

3.3.4 SIM Card Pins

Pin #	Name	I/O	I/O type	Description	Comment
N1	SIMRST	O	2 X	Reset for SIM interface	
N2	SIMVCC	O	Supply	SIM card supply	6mA max
M1	SIMDATA	I/O	CMOS / 3X	I/O for SIM interface	
M2	SIMCLK	O	2 X	Clock for SIM interface	
L2	SIMPRES	I	CMOS	SIM Card Detect	Multiplexed with GPIO7 Tied to VCC if not used

3.3.5 Keyboard Pins

Pin #	Name	I/O	I/O type	Description	Comment
T2	ROW0	I/O	CMOS/1X	Keyboard Row	
S1	ROW1	I/O	CMOS/1X	Keyboard Row	
R2	ROW2	I/O	CMOS/1X	Keyboard Row	
S2	ROW3	I/O	CMOS/1X	Keyboard Row	
R1	ROW4	I/O	CMOS/1X	Keyboard Row	
U1	COL0	I/O	CMOS/1X	Keyboard Column	
V2	COL1	I/O	CMOS/1X	Keyboard Column	
V1	COL2	I/O	CMOS/1X	Keyboard Column	
T1	COL3	I/O	CMOS/1X	Keyboard Column	
U2	COL4	I/O	CMOS/1X	Keyboard Column	

3.3.6 SPI Bus Pins

Pin #	Name	I/O	I/O type	Description	Comment
P1	SPI_CLK	O	1X	GPSI clock or SPI clock	Multiplexed with SCL
Q2	SPI_IO	I/O	CMOS/1X	GPSI Data or SPI Data	Multiplexed with SDA
P2	SPI_EN	O	1X	SPI Enable	Multiplexed with LCDEN
O2	SPI-AUX	O	3X	Auxiliary SPI Enable	Multiplexed with GPO0

3.3.7 Two-wire Bus Pins

Pin #	Name	I/O	I/O type	Description	Comment
P1	SCL	O	1X	GPSI clock or SPI clock	Multiplexed with SPI_CLK
Q2	SDA	I/O	CMOS/1X	GPSI Data or SPI Data	Multiplexed with SPI_IO

3.3.8 Serial Link, Uart1 Pins

Pin #	Name	I/O	I/O type	Description	Comment
E2	CT106/CTS	O	1X	RS232 interface Clear To Send	
D1	CT104/RX	O	1X	RS232 interface Receive	
D2	CT103/TX	I	CMOS	RS232 interface Transmit	Pull up to VCC with 100 kΩ when not used
C1	CT105/RTS	I	CMOS	RS232 interface Request To Send	Pull up to VCC with 100 kΩ when not used
C2	CT107/DSR	O	1X	RS232 interface Data Set Ready	
B1	CT108-2/DTR	I	CMOS	RS232 interface Data Terminal Ready	Pull up to VCC with 100 kΩ when not used
H2	RI	O	2X	RS232 interface Ring Indicator	Multiplexed with GPIO6
G2	DCD	O	3X	RS232 interface Data Carrier Detect	Multiplexed with GPO1 and RXD2

3.3.9 Serial Link, Uart2 Pins

Pin #	Name	I/O	I/O type	Description	Comment
F1	CT103/TXD2	I	CMOS	RS232 interface Transmit	Multiplexed with GPI
G2	CT104/RXD2	O	3X	RS232 interface Receive	Multiplexed with DCD and GPO1
K2	CT105/RTS2	I	CMOS	RS232 interface Request To Send	Multiplexed with GPIO1
J1	CT106/CTS2	O	2X	C RS232 interface Clear To Send	Multiplexed with GPIO2

3.3.10 Audio Pins

Pin #	Name	I/O	I/O type	Description	Comment
B4	MIC2P	I	Analog	Microphone 2 positive input	
B5	MIC2N	I	Analog	Microphone 2 negative input	
B6	MIC1N	I	Analog	Microphone 1 negative input	
B7	MIC1P	I	Analog	Microphone 1 positive input	
B8	SPK2P	O	Analog	Speaker 2 positive output	
B9	SPK2N	O	Analog	Speaker 2 negative output	
B10	SPK1N	O	Analog	Speaker 1 negative output	
B11	SPK1P	O	Analog	Speaker 1 positive output	
B14	BUZZER	O	Open Collector	Buzzer output	80mA peak max

3.3.11 ADC Pins

Pin #	Name	I/O	I/O type	Description	Comment
B12	AUXV0	I	Analog	Auxiliary ADC input 0	Tied to GND if not used
B13	BAT_TEMP	I	Analog	ADC input for battery temperature measurement	Tied to GND if not used

3.3.12 Charger Pins

Pin #	Name	I/O	I/O type	Description	Comment
X1	CHG-IN	I	Supply	Supply for battery charging	High current (0.8 A max)
X2	CHG-IN	I	Supply	Supply for battery charging	High current (0.8 A max)

3.3.13 PWM Pin

Pin #	Name	I/O	I/O type	Description	Comment
I1	PWM1	O	2X	PWM output	Multiplexed with GPIO4

3.4 Antenna Interface

Pin #	Name	I/O	I/O type	Description	Comment
Q35	Antenna		RF 50 Ω	Antenna connection	
O34,O35 P34, P35 R34, R35 S34, S35	GND GND GND GND		GND GND GND GND		These connections to GND must be done with much care for RF performances

3.5 Reserved pins

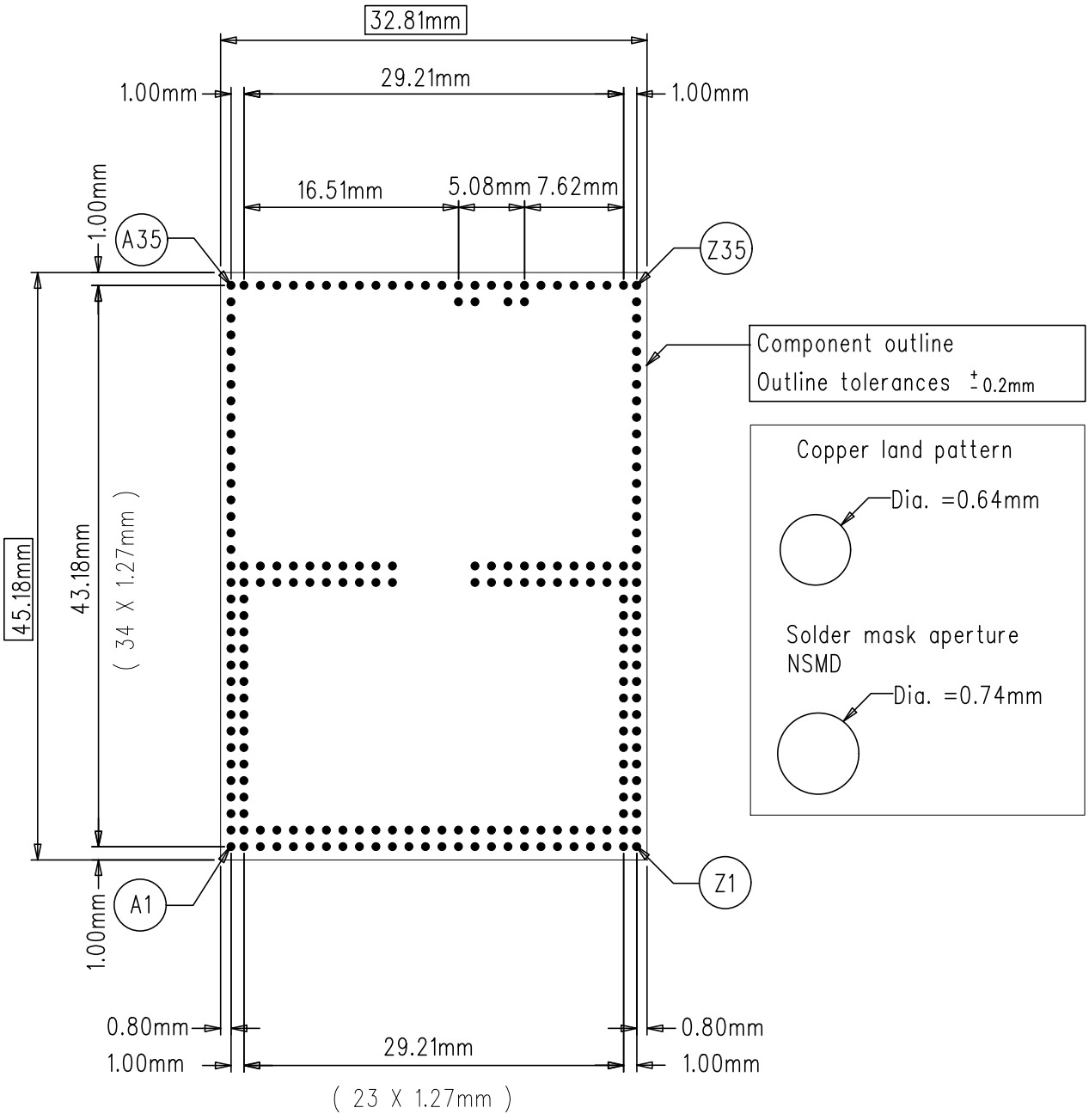
These pins are reserved for the module manufacturing process or for future evolutions and should be left floating on customer application board.

3.5.1 Reserved pins for P3100 series manufacturing process

Pin #	Comment
D17 to G17	Not used (left floating)
H17 to K17	Not used (left floating)
L17 to O17 and L18 to O18	Not used (left floating)
P17 to R17	Not used (left floating)
T17, U 17	Not used (left floating)
W17, X17	Not used (left floating)

3.6 P3100 Footprint

Drawing on following page shows the P3100 Footprint.



WISMO PAC P3100 series

FOOT PRINT

DATE : 14/02/02

ETABLI : HER / ASC

APPROUVE : FFE

wavecom

SCALE : 2

4 Mechanical specifications

4.1 Physical characteristics

Dimensions (typ.)	: 45.2 x 32.8 x 4.95 mm
Weight	: 11 g +/- 0.5 g
Co-planarity	: 0.15 mm maximum

The next page shows a mechanical overview with the P3100 modules pin-out. For detailed information, please refer to the mechanical drawing.

4.2 Interface Connector

The P3100 series connector is a custom connector designed by Wavecom.

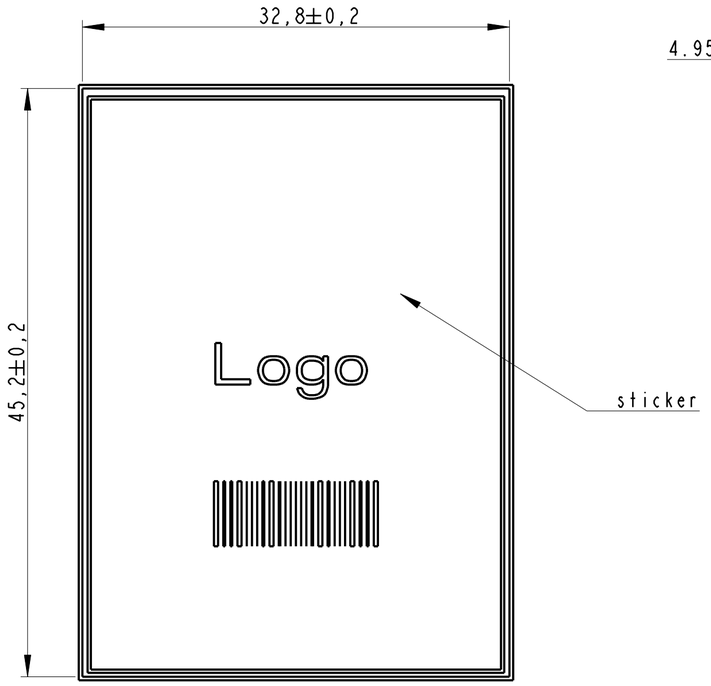
This connector has been designed to interface the module with the application, supporting a reflow soldering for the assembly on the application board.

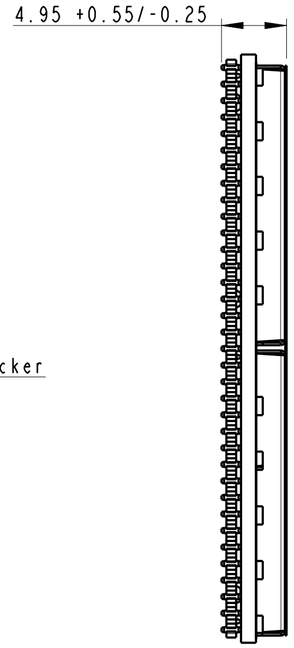
A specific application note describes the process constraints for the assembly on a board [2].

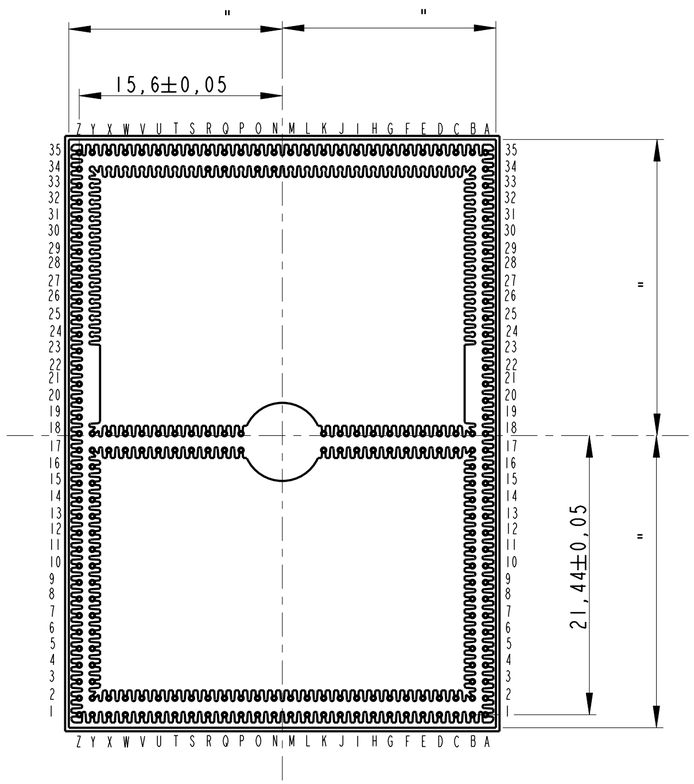
4.3 Mechanical drawings

Following pages present P3100 mechanical drawings :

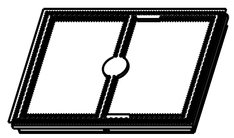
- P3100 general mechanical drawing
- P3100 assembly mechanical constraints
- P3100 dismantling mechanical constraints



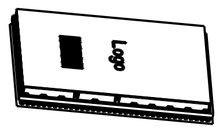




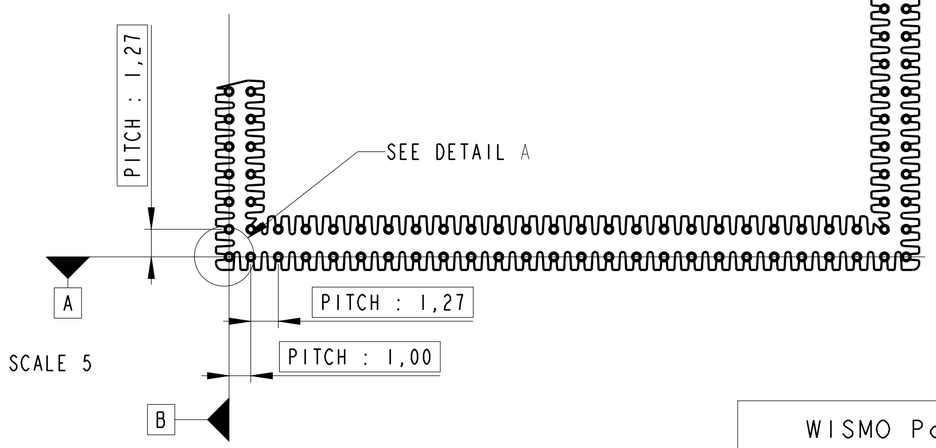
connector details



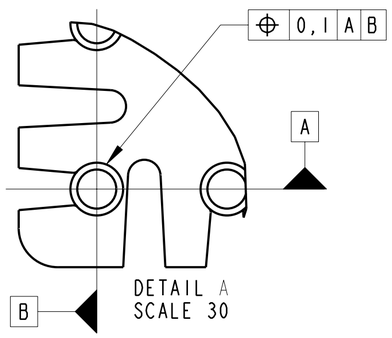
ECHELLE 1



ECHELLE 1,000



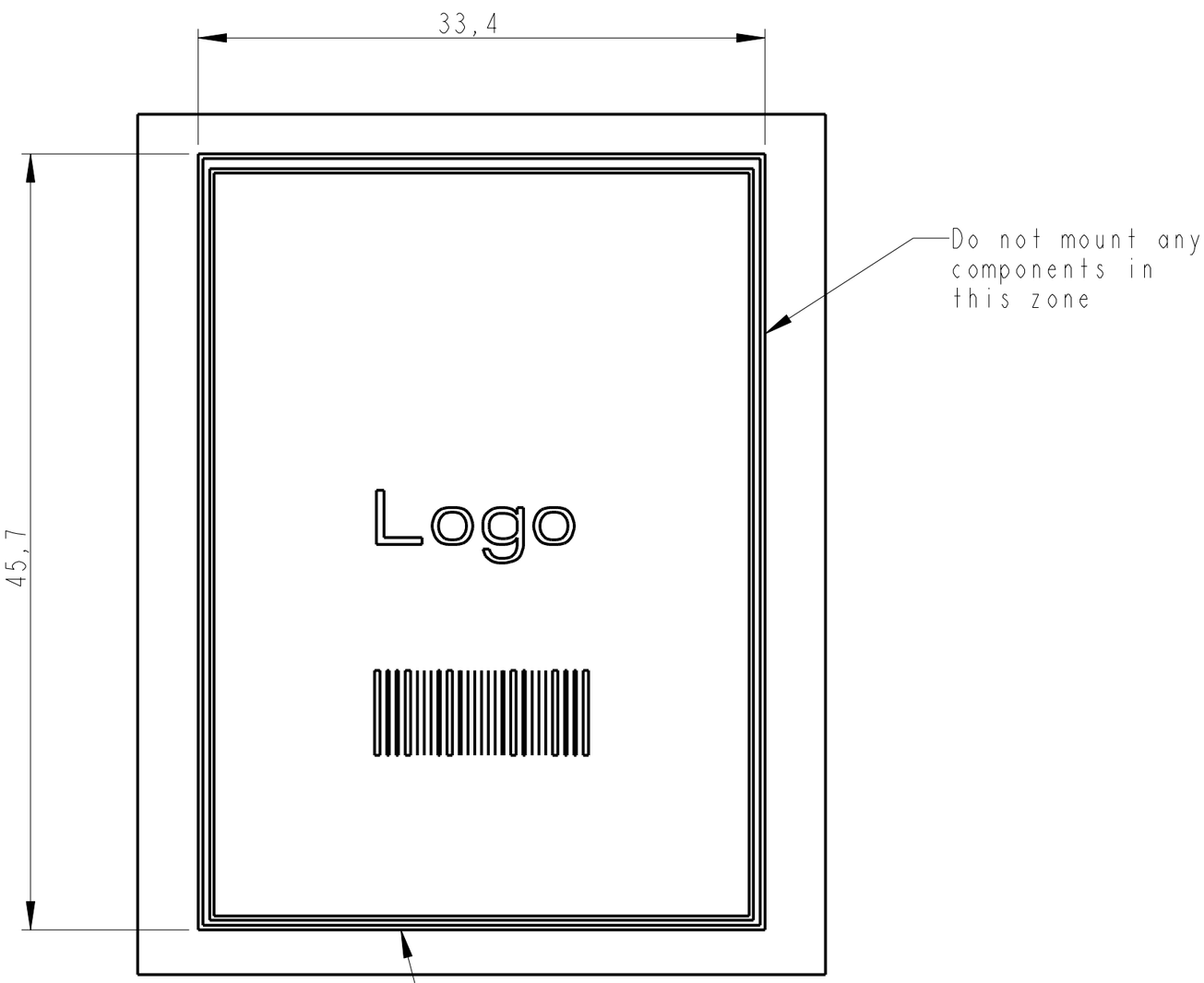
SCALE 5



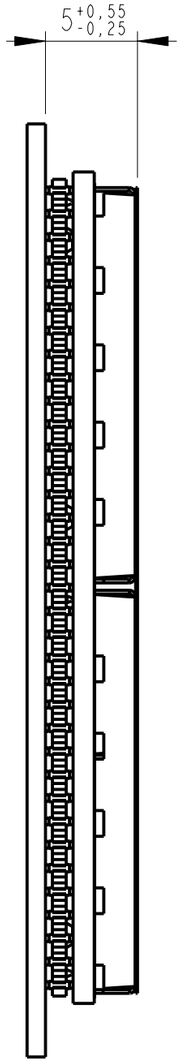
DETAIL A
SCALE 30

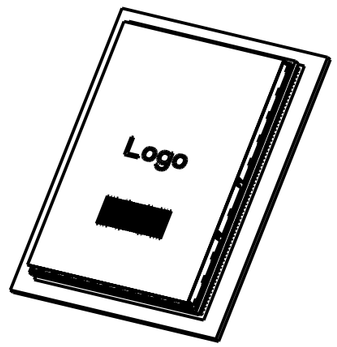
Creation	08/03/02	JPM	JJO	Production	A
MODIFICATION	DATE	AUTHOR	RESP.	STATUS	IND

WISMO Pac P3100		SCALE:3,000	FORMAT: A2
MODULE	WM-2-9728-X-004-A		A
WAVECOM	AUTHOR MLC	FOLIO:	IND.



SCALE 3,000



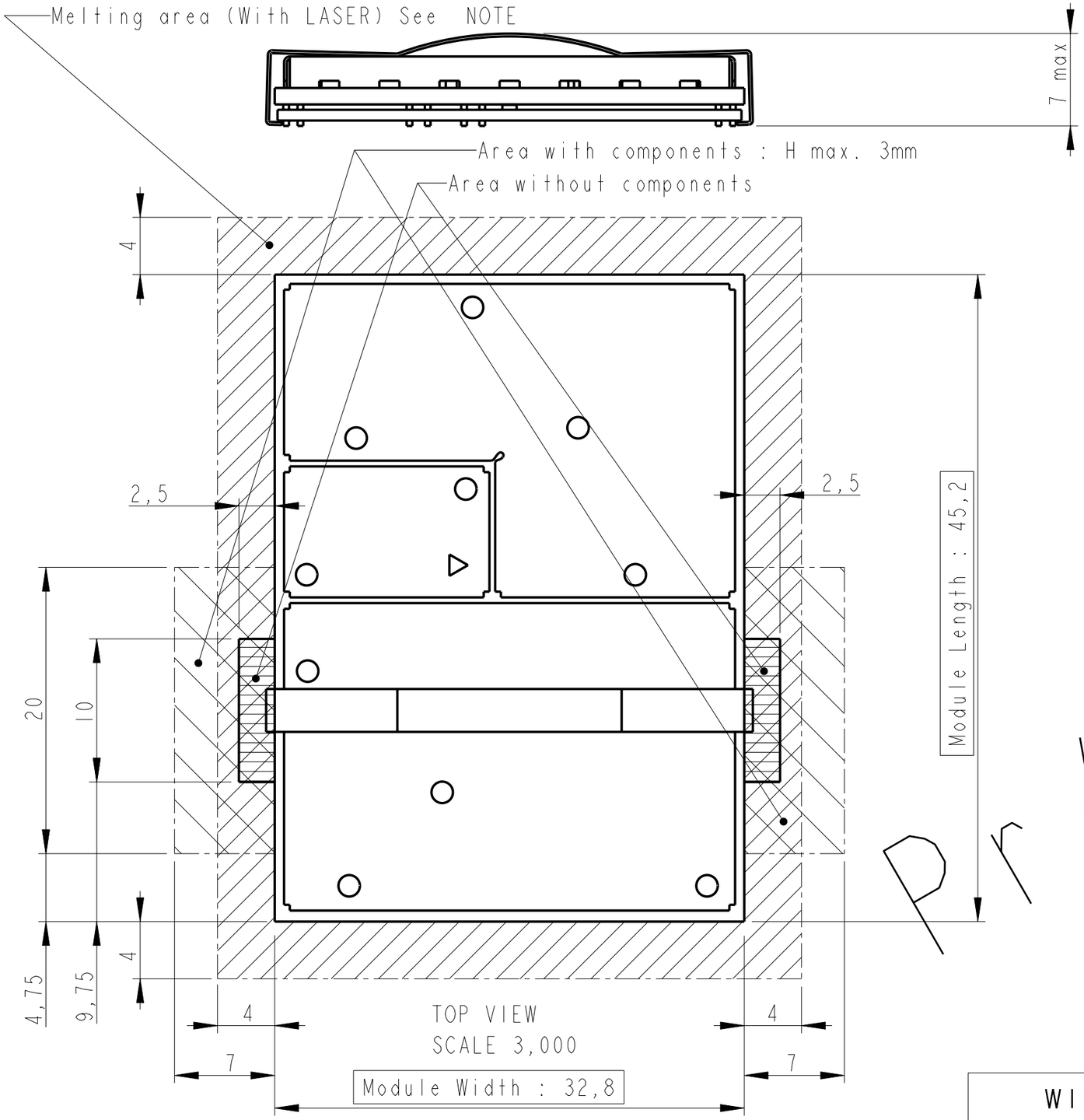


SCALE 1,000

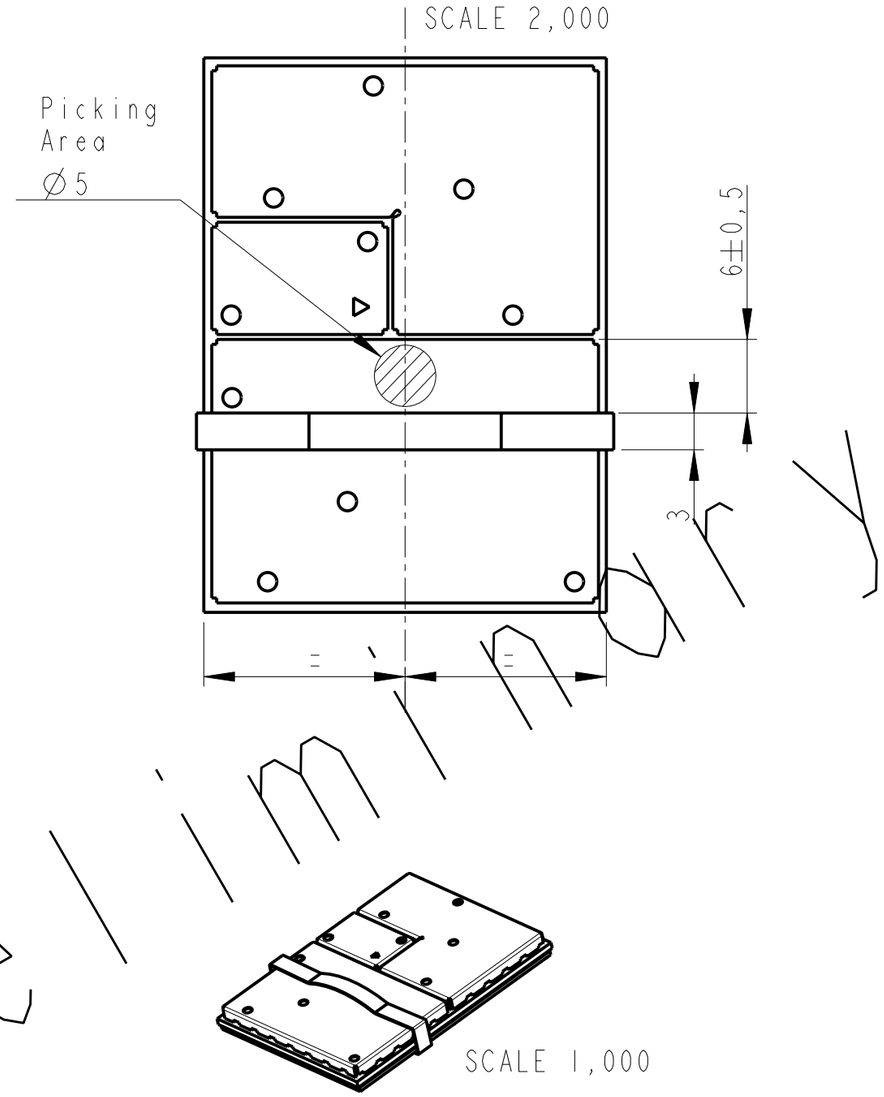
maximum zone generated by :
dimensional tolerances
automatic positioning tolerances
angular +/- 0.09°
linear +/- 0.05mm

Creation	08/03/02	JPM	JJO	Production	A
MODIFICATION	DATE	AUTHOR	RESP.	STATUS	IND

WISMO Pac P3100			SCALE 3,000
ASSEMBLY REQUIRED VOLUME	DOC.	FOLIO: 1/1	FORMAT : A3
	WM-3-9728-X-001-A		
WAVECOM	AUTEUR : JPM		
	RESPONS : JJO		A
PRO/ENGINEER			IND.



NOTE : Components eventualy placed in this zone must be complient with multi reflow process



NOTA : General Tolérances : +/- 0,2mm

text modif.	08/03/02	JPM	JJO	Preliminary	02
Creation	12/12/01	JPM	JJO	Preliminary	01
MODIFICATION	DATE	AUTHOR	RESP.	STATUS	IND

WISMO Pac P3100	TOL.GEN.: SEE NOTA		SCALE: SEE DETAILS
DISMANTLING_CONSTRAINTS	DOC.	FOLIO: 1/1	FORMAT : A3
	WM-3-9728-V-011-A		
WAVECOM	AUTEUR : JPM		02
	RESPONS : JJO		00
PRO/ENGINEER			IND.

5 Environmental constraints

		ENVIRONMENTAL CLASSES		
TYPE OF TEST	STANDARDS	STORAGE Class 1.2	TRANSPORTATION Class 2.3	OPERATING (PORT USE) Class 7.3
Cold	IEC 68-2.1 Ab test	-25° C 72 h	-40° C 72 h	-20° C (GSM) 16 h -10° C (DCS) 16 h
Dry heat	IEC 68-2.2 Bb test	+70° C 72 h	+70° C 72 h	+55° C 16 h
Change of temperature	IEC 68-2.14 Na/Nb test		-40° / +30° C 5 cycles t1 = 3 h	-20° / +30° C (GSM) 3 cycles -10° / +30° C (DCS) 3 cycles t1 = 3 h
Damp heat cyclic	IEC 68-2.30 Db test	+30° C 2 cycles 90% - 100% RH variant 1	+40° C 2 cycles 90% - 100% RH variant 1	+40° C 2 cycles 90% - 100% RH variant 1
Damp heat	IEC 68-2.56 Cb test	+30° C 4 days	+40° C 4 days	+40° C 4 days
Sinusoidal vibration	IEC 68-2.6 Fc test	5 - 62 Hz : 5 mm / s 62 - 200Hz : 2 m / s2 3 x 5 sweep cycles		
Random vibration wide band	IEC 68-3.36 Fdb test		5 - 20 Hz : 0.96 m2 / s3 20 - 500Hz : - 3 dB / oct 3 x 10 min	10 -12 Hz : 0.96 m2 / s3 12 - 150Hz : - 3 dB / oct 3 x 30 min

Electro-Static Discharge (ESD) :

According to the norm **IEC 1000–4-2 Part 4**, the maximum ESD level supported by the P3100 series is 1 kV for all the pins including the antenna connector.

Humidity:

According to **IPC/JEDEC J-STD-033**, the moisture class of the P3100 series is **level 3**. The floor life from the opening of the sealed bag is 168 hours.

Reflow soldering:

The WISMO Pac P3100 series support only 1 reflow soldering.

6 Design Guidelines

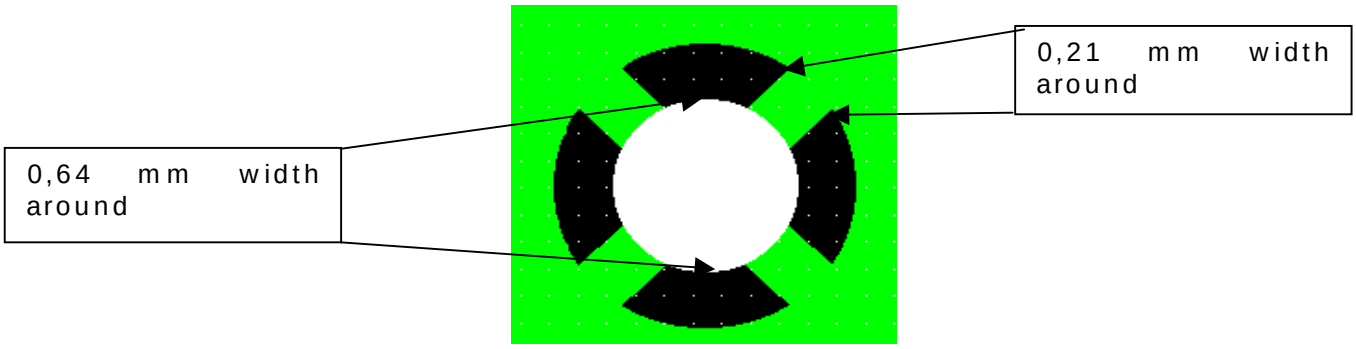
The following paragraphs give general guidelines to design an application using a module of the P3100 series.

6.1 General design rules

Clock 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.

6.1.1 Thermal pads



6.1.2 Power Supply

The power supply is one of the key issues in the design of a GSM terminal.

A weak power supply design could affect in particular :

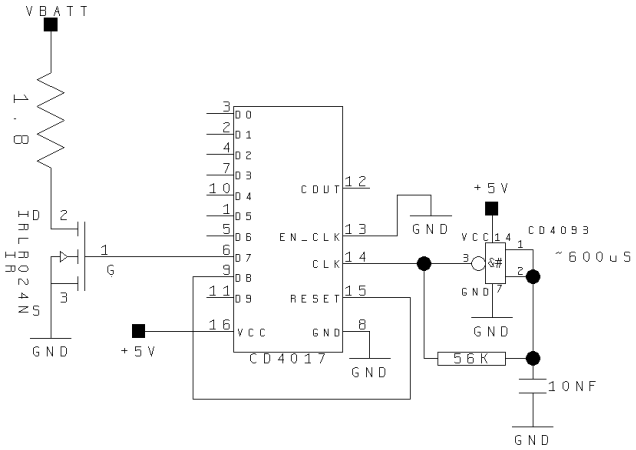
- EMC performances
- Spurious emission
- Phase and frequency error

Careful attention should be paid to :

- **Quality of the power supply : linear regulation (recommended) or PWM converter (usable) are preferred for low noise. PFM or PSM systems must be avoided.**
- **Capacity to deliver high current peaks in a short time (bursted radio emission).**

- The battery charger line must support 800mA to comply with the voltage level required for the product.
- The VBATT line must support peak currents with a voltage drop below the specified limit (see § 2.2).

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



- Attention shall be paid to the ground track or the ground plane which supplies the module. The track or the plane used must support current peaks as for the VBATT track.
- If the ground track between the module and the power supply, is a ground plane, it must not be parceled out.

6.1.3 Shielding connection and application ground plane

A ground plane must be available on the application board to provide efficient connection to the P3100 series shielding :

- The top side shielding of P3100 series is achieved through the top metallic cover connected to the P3100 internal ground plane. This one is connected through the WCGA connector to the application ground plane.
- The bottom side shielding of P3100 series is achieved through the GND pins of the WCGA connector.

Best shielding performance will be achieved if the application ground plane is a complete layer of the application PCB. It is strongly recommended to avoid routing any signals under the module.

6.1.4 Audio

To have better acoustic performances, basic recommendations are the followings :

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

6.1.5 SIM

- 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.

6.1.6 EMC

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, serial link, ...
- EMC protection on audio input/output
- Bias of the Microphone inputs
- Length of the SIM interface lines
- Ground plane on the application board must be designed with care
- Use a common ground plane for all signals (analog / digital / RF).
- Metallic case or plastic casing with conductive paint are recommended

Note : the P3100 does not include any protection against overvoltage.

6.2 RF design rules

6.2.1 Antenna

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

Attention should be paid to :

- Design of the antenna line on the application PCB.
- Antenna connector (type + losses)
- 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) ⇨ it is strongly recommended to shield the terminal.

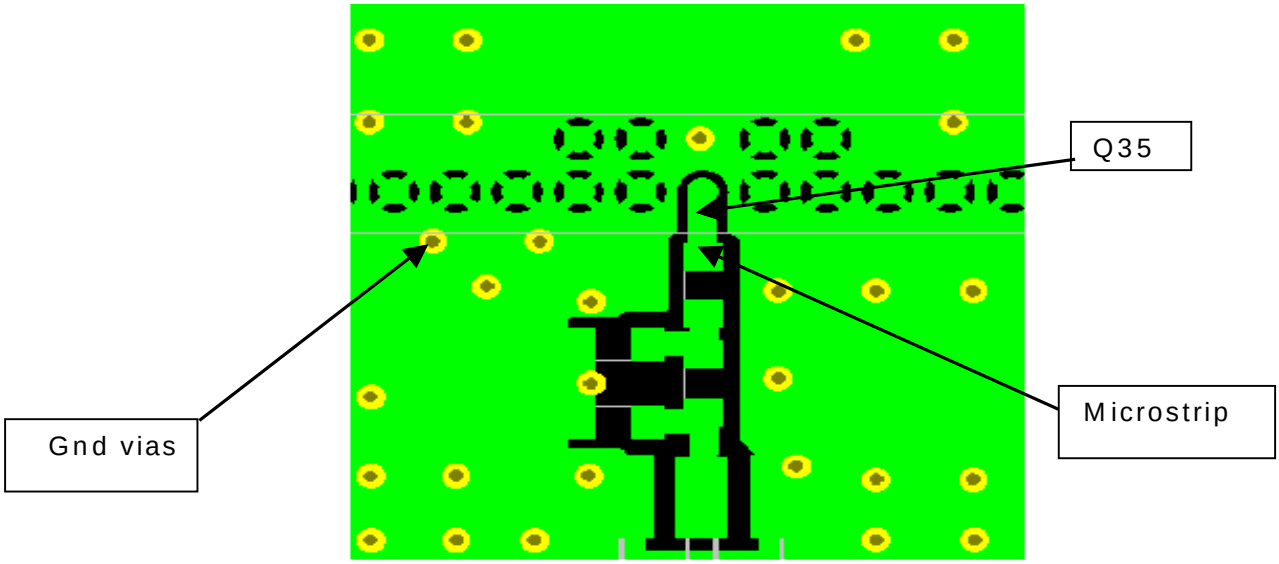
On terminals including the antenna, a poor shielding could dramatically affect the sensitivity of the terminal. Moreover, the power emitted through the antenna could affect the application.

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.
- If a coaxial cable is used, it 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 33pF 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).

6.2.2 RF connection



RF connection to the antenna connector.

- Wavecom strongly recommends additional matching components between the antenna and the RF output of the P3100 module (pin Q35). Typically, four components can be required to ensure a proper transmission of the maximum output power and to reduce the voltage ripple. The topology is a PI structure plus a serial element; the components to be used are capacitors or inductors depending on the antenna matching.
- The RF connection should be short enough to minimize losses and must have a characteristic impedance of 50 Ohms until F ≥ 2 GHz. A micro strip line, as above, or a strip line can be used.
- The matching circuit is recommended for the applications including an antenna like mobile phones and wireless PDAs. If the pad is 50 Ohms and is connected to an 50 Ohms antenna, the matching circuitry is not needed.
- For a better ESD (Electrical Static Discharge) protection, one shall use a shock coil to the ground placed as close as possible to the RF connector.

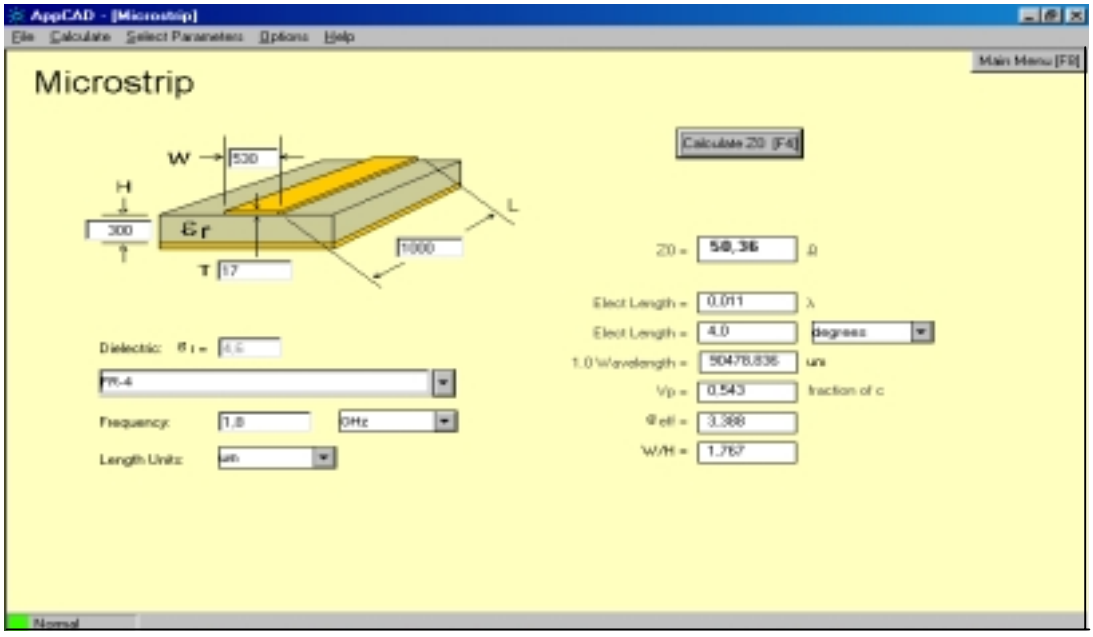
6.2.3 Example for 50 Ohms line calculation

- for a FR4 substrate with relative dielectric permitivity of εr = 4,6
- bottom or inside layer is used as a ground plane
- height of dielectric (between RF line and ground plane) = 300 µm
- height of metal in the RF line = 17 µm

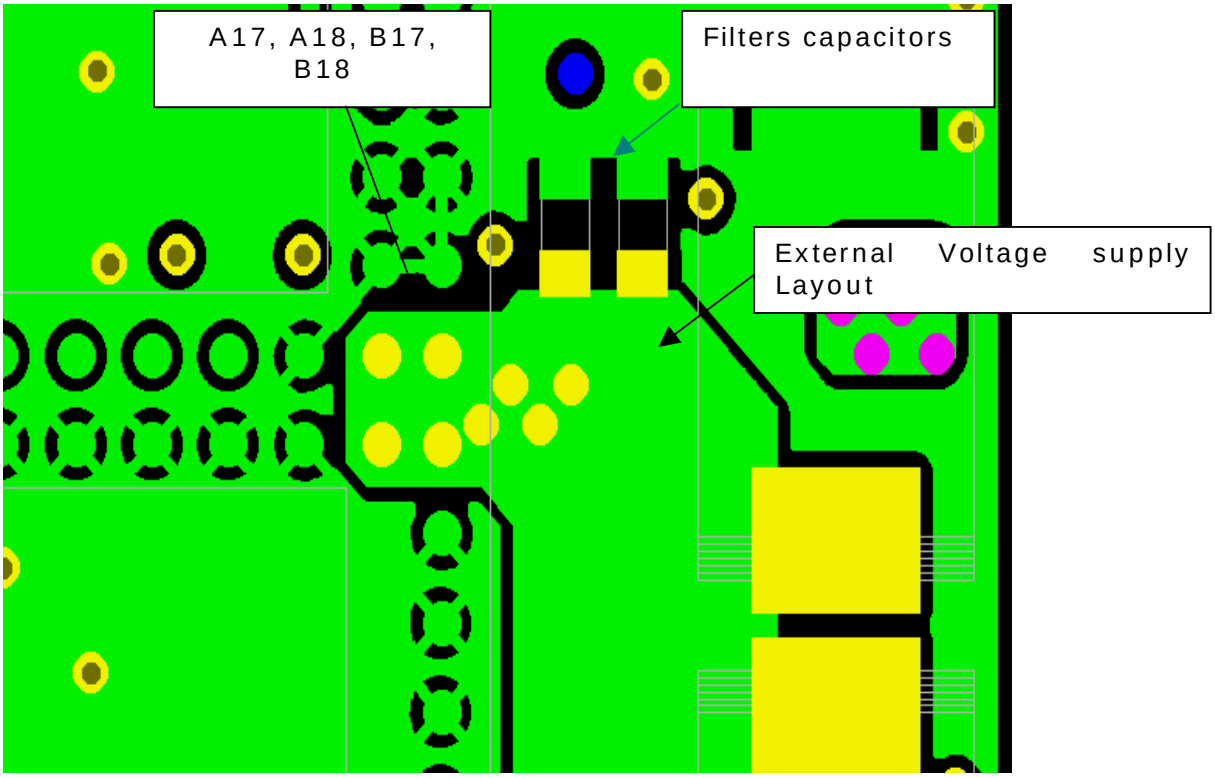
⇨ width of the RF line is 530 µm.

A (Freeware) software for RF line impedance calculation can be downloaded from Agilent web site:

- AppCAD: http://www.agilent.com/view/rf



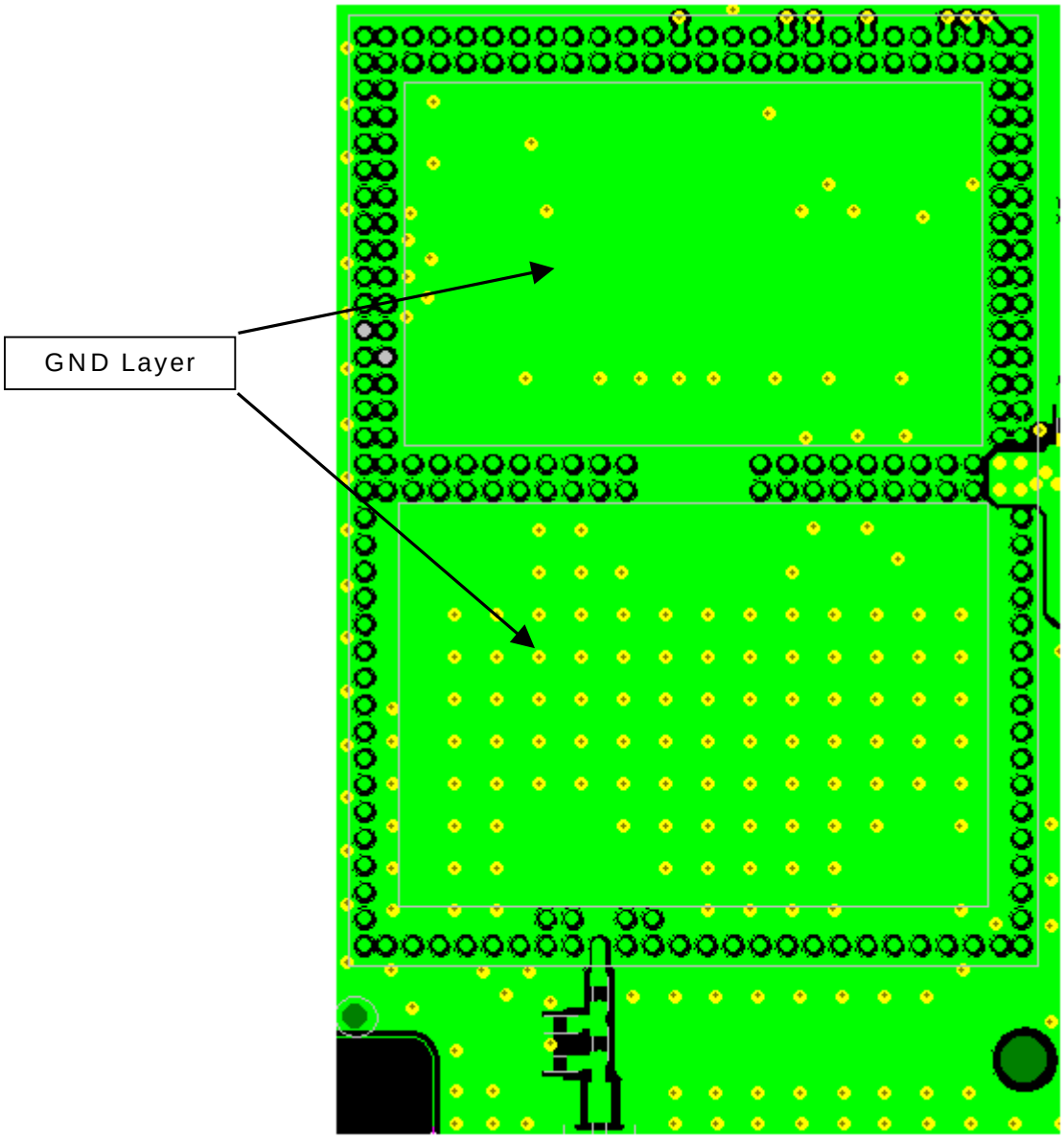
6.2.4 Power supply connection



- Since the maximum peak current can reach 2A, 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). Pins A17, A18, B17 and B18 should be gathered in a same piece of copper, as above. Filters capacitors, near the module power supply, could also be added.
- The routing must be done in such a way that the total impedance line must be ≤ 10 mΩ @ 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.

6.2.5 Ground screen

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



6.3 Mechanical integration

Please refer to the mechanical drawings pages 59, 61, 62 and 63.

6.4 Firmware upgrade

The firmware of the module is stored in flash memory and it can therefore be easily upgraded.

In order to follow the regular evolutions of the GPRS standard and to offer state-of-the-art software, Wavecom recommends that the application designed around a WISMO (or WISMO based product) allows easy firmware upgrades on the module. Therefore, the application shall either allow a direct access to the WISMO serial link through an external connector or implement any mechanism allowing the WISMO firmware to be downloaded using the Wavecom downloader.

Nominal upgrade procedure

The firmware upgrade procedure requires a Wavecom specific software to download the new binary file into the module.

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

The necessary signals to proceed with the downloading are: RX, TX, RTS, CTS 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.

Another option is to download the firmware using the Xmodem protocol (see AT commands interface guide).

6.5 Parts references & suppliers

This section contains a list of recommended parts and manufacturers for the peripheral devices to be used with the P3100 series.

6.5.1 SIM Card Reader

- ITT CANNON (see http://www.ittcannon.com)
- AMPHENOL (see http://www.amphenol.com)
- JAE (see http://www.jae.com)

Drawer type :

- MOLEX (see http://www.molex.com)

6.5.2 Microphone

The microphone selected must comply with the GSM recommendations in terms of frequency response.

Possible suppliers:

- HOSIDEN (see http://www.hosiden.co.jp/)
- PANASONIC (see http://www.panasonic.com/industrial/components/)

6.5.3 Speaker

The speaker selected must comply with the GSM recommendations in terms of frequency response.

Possible suppliers:

- SANYO (see http://www.sanyo.com/industrial/components/)
- HOSIDEN (see http://www.hosiden.co.jp/)
- PRIMO (see http://www.primo.com.sg/)
- PHILIPS (see http://www.semiconductors.philips.com/)

6.5.4 Buzzer

- SAMBU (see http://www.sambuco.co.kr/)

6.6 Antenna

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

- ALLGON (see http://www.allgon.com)
- MOTECO (see http://www.moteco.com)
- AMPHENOL (see http://www.amphenol.com)
- GALTRONICS (see http://www.galtronics.com)
- RADIALL / LARSEN (see http://www.larsenantennas.com/)
- RANGESTAR (see http://www.rangestar.com/)

7 Appendix

7.1 Wavecom acceptance tests

The WISMO Pac P3100 Series complies with Wavecom standard acceptance test plan (See [1]).

7.2 GSM ETSI Recommendations

The WISMO Pac P3100 Series are compliant with the following GSM ETSI recommendations:

Specification Reference	Title
GSM900/1800/1900 ph2 Radio	ETSI GSM 05.05 v7.1.0 release 1998
GSM ph2 Link-Management	ETSI GSM 03.06, 04.08, 05.05, 05.08, 05.10, 07.01 and GT 01 v4.2.1
GSM ph2 Link-Management	ETSI GSM 03.06, 04.08, 05.05, 05.08, 05.10, 07.01 and GT 01 v4.2.1
GSM ph2 Layer 2	ETSI GSM 04.06 and GT 01 v4.2.1
GSM900 ph2 Layer 3	ETSI GSM 04.08 and GT 01 v4.2.1
GSM1800 ph2 Layer 3	ETSI GSM 04.08 and GT 01 v4.2.1
GSM900/GSM1800 Multiband	ETSI GSM 02.07, 03.22, 04.08, 04.13, 05.05, 05.08 and GT 01 v4.2.1
GSM ph2 SIM	ETSI GSM 11.11, 11.12 and GT 01 v4.2.1
GSM ph2 Teleservices	ETSI GSM 03.50 and GT 01 v4.2.1
GSM ph2 Miscellaneous	ETSI GSM 02.07, 03.40, 03.41, 04.08, 04.10, 04.11, 06.10, 06.11, 06.12, 06.31, 06.32, 07.01, 09.07 and GT 01 v4.2.1
GSM1800 ph2 Miscellaneous	ETSI GSM 02.07, 03.40, 03.41, 04.08, 04.10, 04.11, 06.10, 06.11, 06.12, 06.31, 06.32, 07.01, 09.07 and GT 01 v4.2.1
GSM1900 ph2+	EN 300 919 V7.1.0 (1999-07) European standard (Telecommunications series) Digital cellular telecommunications system (phase2+)

7.3 Safety recommendations (for information only)

IMPORTANT
FOR THE EFFICIENT AND SAFE OPERATION OF
YOUR APPLICATION BASED ON THE P3100 SERIES MODULE
PLEASE READ THIS INFORMATION CAREFULLY

7.3.1 RF safety

7.3.1.1 General

Your application using the P3100 is based on the GSM standard for cellular technology. The GSM standard is spread all over the world. It covers Europe, Asia and some parts of America and Africa. This is the most used telecommunication standard.

Your GSM terminal is actually a low power radio transmitter and receiver. It sends out and receives radio frequency energy. When you use your GSM application, the cellular system which handles your calls controls both the radio frequency and the power level of your cellular modem.

7.3.1.2 Exposure to RF energy

There has been some public concern about possible health effects of using GSM terminals. Although research on health effects from RF energy has focused on the current RF technology for many years, scientists have begun research regarding newer radio technologies, such as GSM. After existing research had been reviewed, and after compliance to all applicable safety standards had been tested, it has been concluded that the product was fitted for use.

If you are concerned about exposure to RF energy there are things you can do to minimize exposure. Obviously, limiting the duration of your calls will reduce your exposure to RF energy. In addition, you can reduce RF exposure by operating your cellular terminal efficiently by following the below guidelines.

7.3.1.3 Efficient terminal operation

For your GSM terminal to operate at the lowest power level, consistent with satisfactory call quality :

If your terminal has an extendible antenna, extend it fully. Some models allow you to place a call with the antenna retracted. However your GSM terminal operates more efficiently with the antenna fully extended.

Do not hold the antenna when the terminal is « IN USE ». Holding the antenna affects call quality and may cause the modem to operate at a higher power level than needed.

7.3.1.4 Antenna care and replacement

Do not use the GSM terminal with a damaged antenna. If a damaged antenna comes into contact with the skin, a minor burn may result. Replace a damaged antenna immediately. Consult your manual to see if you may change the antenna yourself. If so, use only a manufacturer-approved antenna. Otherwise, have your antenna repaired by a qualified technician.

Use only the supplied or approved antenna. Unauthorized antennas, modifications or attachments could damage the terminal and may contravene local RF emission regulations or invalidate type approval.

7.3.2 General safety

7.3.2.1 Driving

Check the laws and the regulations regarding the use of cellular devices in the area where you have to drive as you always have to comply with them. When using your GSM terminal while driving, please :

- give full attention to driving,
- pull off the road and park before making or answering a call if driving conditions so require.

7.3.2.2 Electronic devices

Most electronic equipment, for example in hospitals and motor vehicles is shielded from RF energy. However RF energy may affect some improperly shielded electronic equipment.

7.3.2.3 Vehicle electronic equipment

Check your vehicle manufacturer representative to determine if any on-board electronic equipment is adequately shielded from RF energy.

7.3.2.4 Medical electronic equipment

Consult the manufacturer of any personal medical devices (such as pacemakers, hearing aids, etc...) to determine if they are adequately shielded from external RF energy.

Turn your terminal **OFF** in health care facilities when any regulations posted in the area instruct you to do so. Hospitals or health care facilities may be using RF monitoring equipment.

7.3.2.5 Aircraft

Turn your terminal OFF before boarding any aircraft.

- Use it on the ground only with crew permission.
- Do not use it in the air.

To prevent possible interference with aircraft systems, Federal Aviation Administration (FAA) regulations require you to have permission from a crew member to use your terminal while the aircraft is on the ground. To prevent interference with cellular systems, local RF regulations prohibit using your modem while airborne.

7.3.2.6 Children

Do not allow children to play with your GSM terminal. It is not a toy. Children could hurt themselves or others (by poking themselves or others in the eye with the antenna, for example). Children could damage the modem, or make calls that increase your modem bills.

7.3.2.7 Blasting areas

To avoid interfering with blasting operations, turn your unit **OFF** when in a « blasting area » or in areas posted : « turn off two-way radio ». Construction crew often use remote control RF devices to set off explosives.

7.3.2.8 Potentially explosive atmospheres

Turn your terminal **OFF** when in any area with a potentially explosive atmosphere. It is rare, but your modem or its accessories could generate sparks. Sparks in such areas could cause an explosion or fire resulting in bodily injuries or even death.

Areas with a potentially explosive atmosphere are often, but not always, clearly marked. They include fuelling areas such as petrol stations ; below decks on boats ; fuel or chemical transfer or storage facilities ; and areas where the air contains chemicals or particles, such as grain, dust, or metal powders.

Do not transport or store flammable gas, liquid, or explosives, in the compartment of your vehicle which contains your terminal or accessories.

Before using your terminal in a vehicle powered by liquefied petroleum gas (such as propane or butane) ensure that the vehicle complies with the relevant fire and safety regulations of the country in which the vehicle is to be used.