



WISMO2C

Hardware Specifications

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0.5	12/08/99	SIM and connector update	PBE
0.6	15/09/99	Battery connection example	JMB
		Boot resistor modification	
		SIM max current update	
0.7	23/09/99	General Update	PBE
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Cautions:

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 WISMO2C.

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1 Introduction

1.1 Scope

This document defines and specifies the second generation dual band module called WISMO2C and available under two versions :

- WISMO2C-G900/1800 for dual band E-GSM 900 / GSM 1800 MHz
- WISMO2C-G900/1900 for dual band E-GSM 900 / GSM 1900 MHz

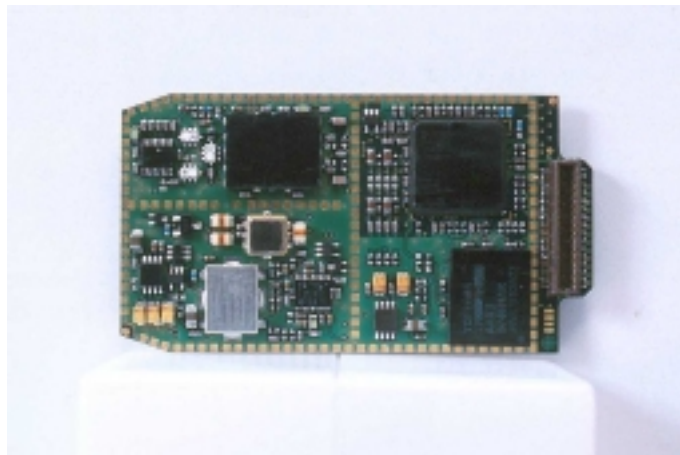


Figure 1 : WISMO2C (bottom view without shielding)

2 General description

2.1 General information

WISMO2C is a self-contained E-GSM 900 / GSM 1800 (or E-GSM 900 / GSM 1900) dual band module including the following features :

- 58.3 x 32.2 x 6.0 mm external dimensions
- 2 Watts EGSM radio section running under 3,6 Volts
- 1 Watt GSM1800/GSM1900 radio section running under 3,6 Volts
- Digital section under 2.8 Volts
- 3V SIM interface
- Real Time Clock with calendar
- Battery charger
- Echo Cancellation
- Full GSM software stack
- Complete shielding
- Complete interfacing :
 - Power supply
 - Serial link
 - Audio
 - SIM card
 - Keyboard (not fully available with AT commands)
 - LCD (not available with AT commands)

WISMO2C has two external connections :

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

WISMO2C 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 switch
- SIM connector
- Application processor

2.2 RF functionalities

The RF functionalities comply with the Phase II GSM900/GSM1800 or GSM1900 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

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

- ◇ 2 dedicated down-converters.
- ◇ 1 FI demodulator
- ◇ 1 VCO
- ◇ Transmit loop (modulator, down mixer, phase frequency comparator)
- ◇ 2 power amplifiers

2.3 Baseband functionalities

The digital part of the WISMO2C is composed of a PHILIPS-VLSI chip (ONE C GSM Kernel). This chipset is using a 0,35 μ m mixed technology CMOS, which allows massive integration as well as low current consumption.

2.4 Firmware

WISMO2C is designed to be integrated into various types of applications such as handsets or vertical applications (telemetry, multimedia, automotive,...).

For handsets, the firmware is customised by Wavecom. For vertical applications, the firmware offers a set of AT commands to control the module. With this standard software, some interfaces of the module are not available since they are dependent on the peripheral devices connected to the module. They are the LCD interface, the SPI bus, the battery charging interface.

3 Interfaces

3.1 Functional description

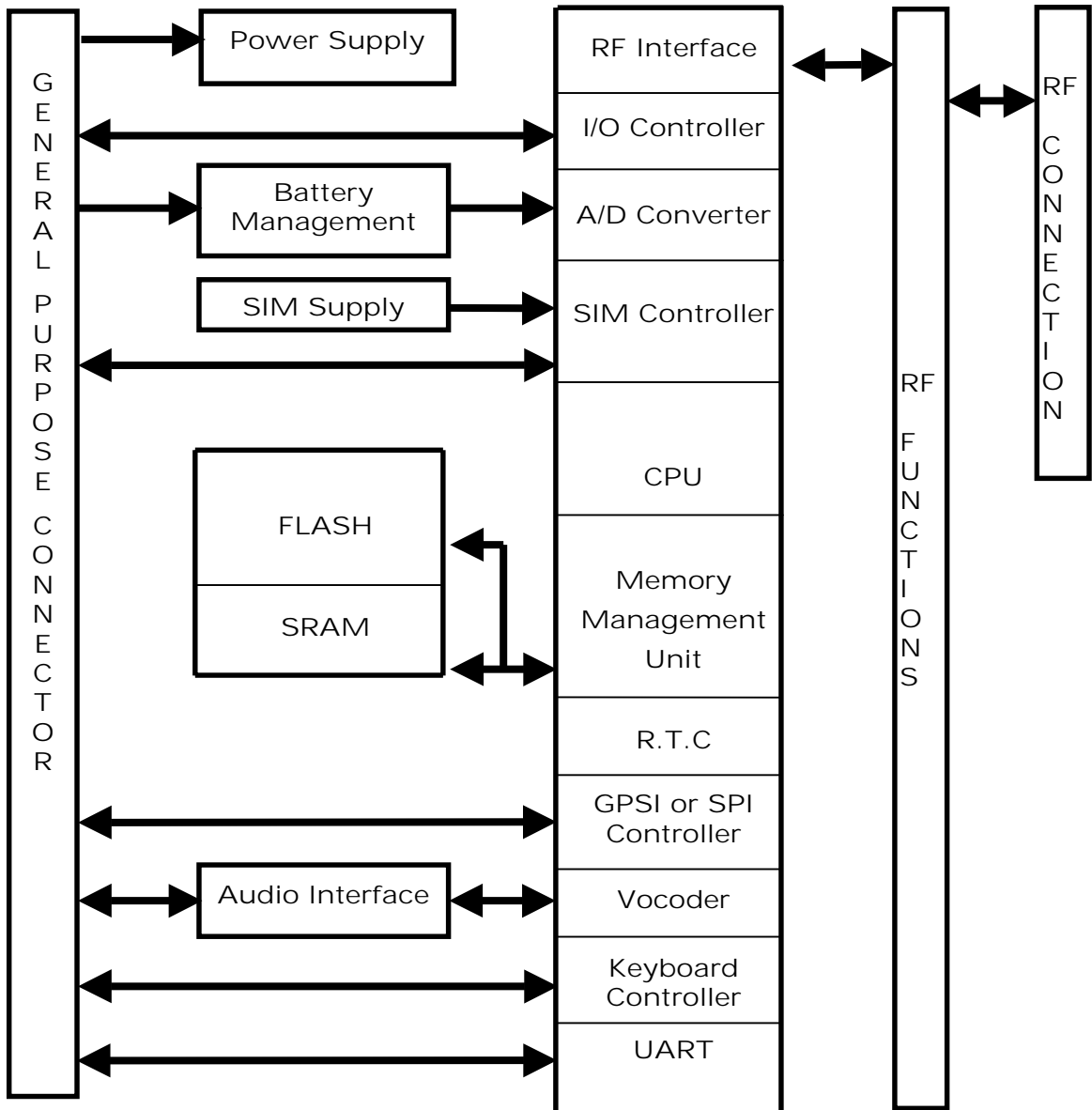



Figure 2 : Functional architecture

3.2 General Purpose Connector (GPC)

A 60 pins connector¹ is provided to interface the WISMO2C with a board containing either a LCD module, or a keyboard, or a SIM connector, or a battery connection...

The interfaces available on the GPC are described in the next paragraphs.

⚠ Please be aware that some of these interfaces can not be handled when using the WISMO2C driven by AT commands : LCD interface, SPI bus, battery charging interface.

The  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.

3.2.1 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.

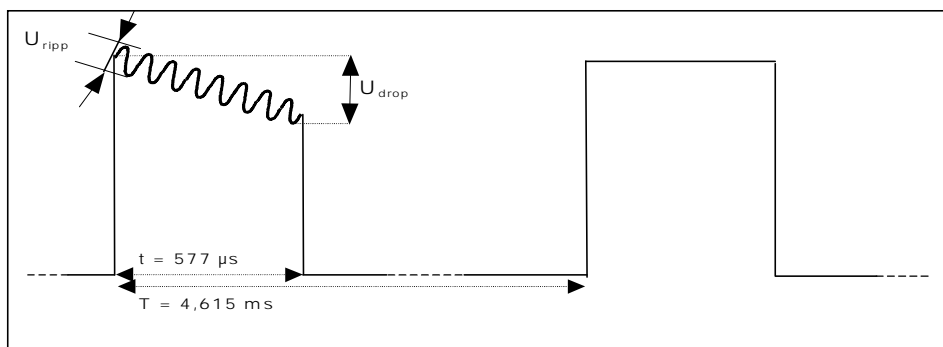


Figure 3 : bursted emission principle

¹ The communication interface connector is a 60 pins connector with 0.5mm pitch from KYOCERA / AVX group with the following reference (see chapter connectors reference for further details):

14 5087 060 930 861.

The matting connector has the following reference :

24 5087 060 X00 861.

Two different inputs are provided for the power supply. The first one, VBATT is used to supply the RF part and VDD, the second one is used to supply the baseband part. The module WISMO2C may be directly connected to a 3 NiMH cells battery (in this case, the impedance should be lower than 150 mOhms : 0.3V max @ 2W max).

Notes :

- It is possible to connect VBATT to VDD.
- In case of separate power supplies, they have to be in the same state i.e both active or inactive at the same time. The advantage of this configuration is a possible gain in stand by time by supplying the base-band part with a lower voltage (3.1V min).

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 (2.0A peak in GSM mode) flows with a ratio of 1/8 of the time (around 577µs every 4.615ms). The rising time is around 10µs.

VDD : supplies the +2.8V ballast regulators of the WISMO2C. It is essential to keep the voltage over 3.1 volts.

The WISMO2C shielding case is the grounding. The ground has to be connected on the mother board through a complete layer on the PCB.

Power Supply Voltage

	V _{MIN}	V _{NOM}	V _{MAX}	Ripple max
VBATT (for WISMO2C-G900/1800)	3.3 V (*)	3.6 V	4.5 V (**)	50 mVpp for freq<200kHz 2 mVpp for freq>200kHz
VBATT (for WISMO2C-G900/1900)	3.4 V (*)	3.6 V	4.5 V (**)	50 mVpp for freq<200kHz 2 mVpp for freq>200kHz
VDD	3.1 V		4.5 V	100 mVpp

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

(**) : max operating Voltage Stationnary Wave Ratio (VSWR) 2:1

When supplying the module with a battery, the characteristics should be :

- Total impedance (battery+protections+PCB)<150 mOhms

**Power consumption in OFF mode
(module supplied, OFF state, no software running)**

	Conditions	I _{NOM}	I _{MAX}
Overall consumption	Off	50 μ A	100 μ A

Power consumption in EGSM 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*	270 mA	320 mA
VBATT	Average @ PCL8*	180 mA	200 mA
VBATT	Average Idle mode	100 μ A	300 μ A
VDD	Average TCH/FS mode	85 mA	100 mA
VDD	Average Idle mode (module in handset applications)	3 mA**	6 mA**
VDD	Average Idle mode (module driven by AT commands, UART running)	12 mA	16 mA
Overall consumption	Average communication @ PCL5*	355 mA	420 mA
	Average Idle mode (module in handset applications)	3.1 mA	6.3 mA
	Average Idle mode (module driven by AT commands, UART running)	12.1 mA	16.3 mA

(*) : PCL : Power Control Level.

PCL5 : 2W emission requested (max. power)

PCL8 : 0.5W emission requested

(**) : Informative value

Power consumption in GSM1800 or GSM1900 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*	240 mA	270 mA
VBATT	Average @ PCL3*	150 mA	180 mA
VBATT	Average Idle mode	100 µA	300 µA
VDD	Average TCH/FS mode	85 mA	100 mA
VDD	Average Idle mode (module in handset applications)	3 mA**	6 mA**
VDD	Average Idle mode (module driven by AT commands, UART running)	12 mA	16 mA
VDD	Average Idle mode	3 mA	6 mA
Overall consumption	Average communication @ PCL0*	325 mA	370 mA
	Average Idle mode (module in handset applications)	3.1 mA	6.3 mA
	Average Idle mode (module driven by AT commands, UART running)	12.1 mA	16.3 mA

(*) : PCL : Power Control Level.

PCL0 : 1W emission requested (max. power)

PCL3 : 0.25W emission requested

(**) : Informative value

Power Supply Pinout

Signal	Pin number
VBATT	55, 57, 58, 59 60
VDD	11
GND	Shielding

The grounding connection is done through the shielding ⇒ the four legs have to be soldered to the ground plane.

3.2.2 Digital I/O

All digital I/O comply with 3Volts 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	$I_{OL} = -1 \text{ mA}$
	2X		0.2 V	$I_{OL} = -2 \text{ mA}$
	3X		0.2 V	$I_{OL} = -3 \text{ mA}$
V_{OH}	1X	2.6 V		$I_{OH} = 1 \text{ mA}$
	2X	2.6 V		$I_{OH} = 2 \text{ mA}$
	3X	2.6 V		$I_{OH} = 3 \text{ mA}$

To interface the WISMO2C digital signals with other logics :

- 3V logic : some serial resistors (between 2.2K and 4.7Kohms) can be added on the lines
- 3.3V logic : some serial resistors (between 4.7K and 10Kohms) can be added on the lines.
- For higher voltage logics, a resistor bridge can be added.



3.2.3 LCD interface

The WISMO2C can be connected to a LCD module driver through either a SPI bus or a two wires interface.

3.2.3.1 SPI bus

The SPI bus includes a CLK signal, an IO signal and an EN signal complying with SPI bus standard. The maximum speed transfer is 3.25Mb/s.

Pin description

Signal	Pin number	I/O	I/O type	Description
SPI_CLK	10	O	1X	SPI Serial Clock
SPI_IO	8	I/O	CMOS / 1X	SPI Data
SPI_EN	28	O	1X	SPI Enable

3.2.3.2 Two wires interface

The two wires interface includes a CLK signal and a DATA signal complying with a standard 96KHz interface. The maximum speed transfer is 400Kb/s.

Pin description

Signal	Pin number	I/O	I/O type	Description
SCL	10	O	1X	Serial Clock
SDA	8	I/O	CMOS / 1X	Data



3.2.4 SPI Auxiliar bus

A second SPI Chip Enable (called SPI_AUX) has to be used to add a SPI peripheral to the Wismo2C. The maximum speed transfer is 3.25Mb/s.

Pin description

Signal	Pin number	I/O	I/O type	Description
SPI_CLK	10	O	1X	SPI Serial Clock
SPI_IO	8	I/O	CMOS / 1X	SPI Data
SPI_AUX	26	O	1X	SPI Aux. Enable

3.2.5 Keyboard interface

Warning :

This interface is not FULLY available with AT commands :

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

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

The scanning is a digital one , and the debouncing is done in the WISMO2C. No discrete components like R,C (Resistor, Capacitor) are needed.

Pin description

Signal	Pin number	I/O	I/O type	Description
ROW0	13	I/O	CMOS / 1X	Row scan
ROW1	15	I/O	CMOS / 1X	Row scan
ROW2	17	I/O	CMOS / 1X	Row scan
ROW3	19	I/O	CMOS / 1X	Row scan
ROW4	21	I/O	CMOS / 1X	Row scan
COL0	23	I/O	CMOS / 1X	Column scan
COL1	25	I/O	CMOS / 1X	Column scan
COL2	27	I/O	CMOS / 1X	Column scan
COL3	29	I/O	CMOS / 1X	Column scan
COL4	31	I/O	CMOS / 1X	Column scan

3.2.6 Serial link

A flexible 6 wires 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 (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 WISMO2C. 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
CT103 / TX	39	I	CMOS	Transmit serial data
CT104 / RX	32	O	1X	Receive serial data
CT105 / RTS	30	I	CMOS	Ready To Send
CT106 / CTS	37	O	1X	Clear To Send
CT107 / DSR	36	O	1X	Data Set Ready
CT108-2 / DTR	34	I	CMOS	Data Terminal Ready
CT109 / DCD	51	O	CMOS / 2X	Data Carrier Detect
CT125 / RI	54	O	CMOS / 2X	Ring Indicator
CT102/GND	Shielding legs			Ground

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

Note :

The WISMO2C has been designed to be operated using all the serial signals. In particular, it is necessary to use the RTS/CTS hardware flow control signals in order not to lose data.

3.2.7 SIM interface

3.2.7.1 General Description

5 signals exist :

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

The SIM interface controls a 3V SIMs (and a 5V SIMs through an external SIM driver). This interface is fully compliant with GSM 11.11 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.

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

Pin description

Signal	Pin number	I/O	I/O type	Description
SIMCLK	3	O	2X	SIM Clock
SIMRST	5	O	2X	SIM Reset
SIMDATA	7	I/O	CMOS / 3X	SIM Data
SIMVCC	9	O		SIM Power Supply
SIMPRES	50	I	CMOS	SIM Card Detect

Electrical Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
SIMDATA V_{IH}	$I_{IH} = \pm 20\mu A$	$0.7 \times SIMVCC$			V
SIMDATA V_{IL}	$I_{IL} = 1mA$			$0.3 \times SIMVCC$	V
SIMRST, SIMDATA SIMCLK V_{OH}	Source current = $20\mu A$	$SIMVCC - 0.1V$			V
SIMRST, SIMDATA SIMCLK V_{OL}	Sink current = $-200\mu A$			0.1	V
SIMVCC* Output Voltage	$I_{SIMVCC} \leq 6mA$	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

(*) : given for the 3V interface. An external SIM driver is needed to handle 5V SIMs.

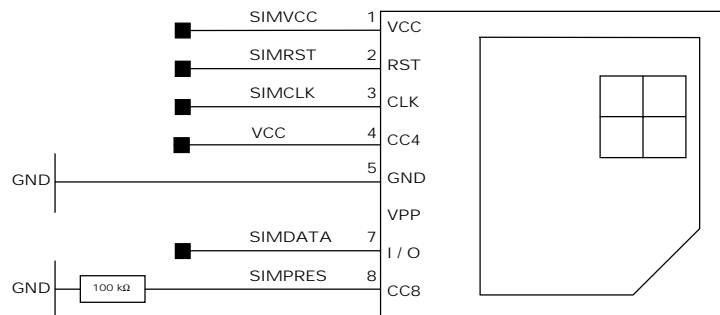
Note :

When not used **SIMPRES** 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.

SIM socket pin description

Signal	Pin number	Description
VCC	1	SIMVCC
RST	2	SIMRST
CLK	3	SIMCLK
CC4	4	VCC module
GND	5	GROUND
VPP	6	Not connected
I/O	7	SIMDATA
CC8	8	SIMPRES with 100k Ω pull down resistor


Figure 4 : SIM socket
3.2.7.2 SIM 3/5V management

The WISMO2C module is designed to interface with 3V SIMs only². Nevertheless, it is possible to manage 3V and 5V SIMs using an external level shifter (see application notes in appendix). 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 (3V or 5V).

² Most of the GSM operators have been providing 3V SIMs since 1998.

3.2.8 General Purpose Input/Output

The WISMO2C provides 6 General Purpose I/O, 3 General Purpose Outputs and 1 General Purpose Input. They are used to control any external device such as a LCD or a Keyboard backlight.

Pin description

Signal	Pin number	I/O	I/O type	Description
GPI00	24	I/O	CMOS / 2X	General Purpose I/O
GPI04	53	I/O	CMOS / 2X	General Purpose I/O
GPI05	35	I/O	CMOS / 2X	General Purpose I/O
GPO1	22	O	3X	General Purpose O
GPO2	20	O	1X	General Purpose O
GPI	18	I	CMOS	General Purpose I

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

Signal	Pin number	I/O	I/O type	Description	Comments
GPI01	52	I/O	CMOS / 2X	General Purpose I/O	FLASH LED(*)
GPI02	54	I/O	CMOS / 2X	General Purpose I/O	RI
GPI03	51	I/O	CMOS / 2X	General Purpose I/O	DCD
GPO0	26	O	3X	General Purpose O	SIM 3V/5V

(*) The FLASH LED signal can be used to drive an LED according to the module activity status.

LED status	WISMO2C status	
OFF	Module in download mode or module OFF	
ON	Permanent	Module switched ON, not registered on the network
	Slow flash LED ON for 200ms, OFF for 2s	Module switched ON, registered on the network
	Quick flash LED ON for 200ms, OFF for 600ms	Module switched ON, registered on the network, communication in progress

3.2.9 Analog to Digital Converter

Analog to Digital converter input is provided by the WISMO2C. This converter is a 10 bits one, ranging from 0 to 2.8V .

Pin description

Signal	Pin number	I/O	I/O type	Description
AUXV0	33	I	Analog	A/D converter

Electrical Characteristics

Parameter	Min	Max	Unit
Resolution	10		bits
Sampling rate	90.3		Ksps
Input signal range	0	2.8V	V
ADC Reference Accuracy	0.75	2	%
Integral Accuracy	+/- 1		LSB
Differential Accuracy	+/- 1		LSB
Input Impedance (R)	10		MΩ
Input Impedance (C)		50	pF

3.2.10 Audio

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

The WISMO2C also includes an echo cancellation feature which allows handsfree function.

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

The MIC1 inputs does not include an internal bias. MIC1/SPK1 is then appropriate for a handsfree system or a handset with biasing external to the module.

3.2.10.1 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.

Internal audio filter characteristics :

Frequency	Gain
0-150 Hz	< -22dB
150-180 Hz	< -11dB
180-200 Hz	< -3dB
200-3700 Hz	0dB
>4000 Hz	< -60dB

The gain of MIC inputs is internally adjusted. The gain can be tuned from 30dB to 51dB using an AT command.

Microphone gain vs Max input voltage

Transmit Gain (dB)	Max Vin (mVrms)	AT+VGT(*)
30	43.8	0 to 31
33	31.01	32 to 63
36	21.95	64 to 95
39	15.54	96 to 127
42	11	128 to 159
45	7.79	160 to 191
48	5.51	192 to 223
51	3.9	224 to 255

(*) control of the transmit gain by AT commands (for WISMO2C driven by AT commands)

Recommended characteristics for the microphone:

- 2V – 0.5mA
- 2 KOhms
- Sensitivity -40 to -50dB
- SNR > 50dB
- Frequency response compatible with the GSM specifications

For possible references, see chapter *connectors and peripheral devices references*.

3.2.10.2 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.

Speaker outputs SPK2 are push-pull amplifiers and can be loaded down to 150 Ohms and up to 1nF (see details in table *Speaker gain vs Max output voltage*). These outputs are differential and the output power can be adjusted by step of 2dB. The output can be directly connected to a speaker.

3.2.10.2.1 Differential Connection

Impedance of the speaker amplifier output in differential mode :

- $R \leq 1\Omega \pm 10\%$

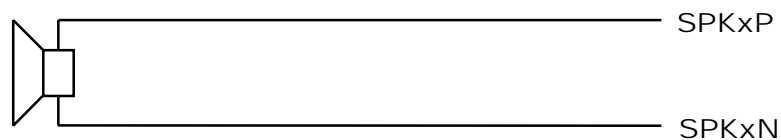


Figure 5 : SPK outputs (differential connection)

3.2.10.2.2 Single-ended Connection

Typical implementation:

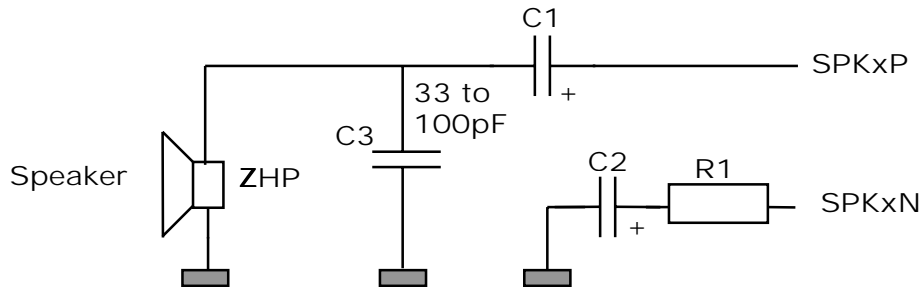


Figure 6 : SPK outputs (single-ended connection)

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

C1=C2

R1=Zhp

Using a single-ended connection also includes losing half of the output power compared to a differential connection.

Nevertheless in a 32 Ohms speaker case, you should use a cheaper and smaller solution : R1 = 82 Ohm and C2 = 4.7 μ F (ceramic)

The gain of SPK outputs is internally adjusted. The gain can be tuned using an AT command.

Speaker gain vs Max output voltage

Receive Gain (dB) (*)	Max output level (Vrms)	AT+VGR (**)	Max.speaker load (Ω)
6	1.65	0 to 15	150
4	1.31	16 to 31	50
2	1.04	32 to 47	32
0	0.829	48 to 63	32
-2	0.659	64 to 79	32
-4	0.523	80 to 95	32
-6	0.416	96 to 111	32
-8	0.330	112 to 127	32
-10	0.262	128 to 143	32
-12	0.208	144 to 159	32
-14	0.165	160 to 175	32
-16	0.131	176 to 191	32
-18	0.104	192 to 207	32
-20	0.083	208 to 223	32
-22	0.066	224 to 239	32
-24	0.052	240 to 255	32

(*) analog gain : might not be significant

(**) control of the receive gain by AT commands (for WISMO2C driven by AT commands)

Recommended characteristics for the speaker:

- 150 Ohms³ / 1nF
- 10mW
- 110dB
- Frequency response compatible with the GSM specifications

For possible references, see chapter *connectors and peripheral devices references*.

³ 32 Ohms for handsets

3.2.10.3 Microphone inputs

3.2.10.3.1 Microphone 2 Inputs

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 2kΩ. These inputs are the standard ones for an handset design while MIC1 inputs can be connected to an external headset or a handsfree kit.

Typical implementation:

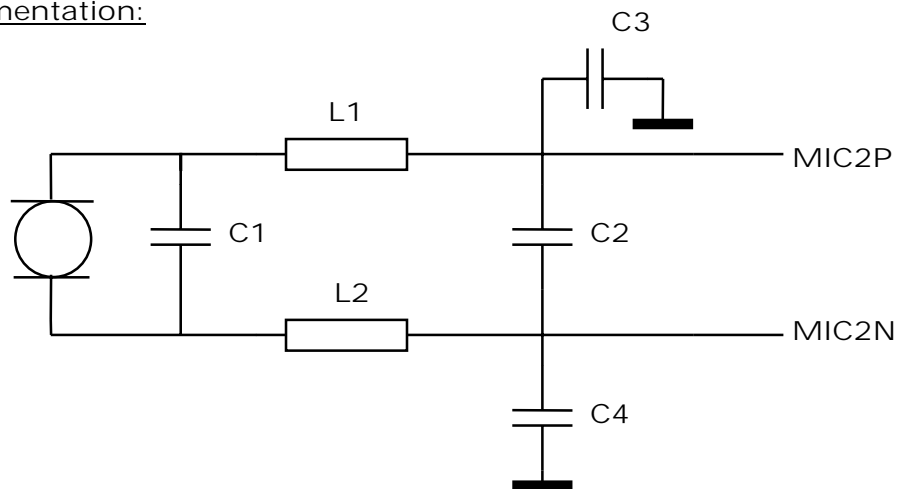


Figure 7 : MIC2 inputs (differential connection)

C1 = 10pF to 33pF

C2 = C3 = C4 = 47pF to 100pF

L1 = L2 = 100nH

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 WISMO2C connector.

L1, L2, C3 and C4 has to be put near the WISMO2C 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.

Pin description

Signal	Pin #	I/O	I/O type	Description
MIC2P	46	I	Analog	Microphone 2 positive input
MIC2N	48	I	Analog	Microphone 2 negative input

3.2.10.3.2 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 WISMO2C module according to the characteristic of this electret microphone. These inputs are the standard ones used for an external headset or a handsfree kit.

3.2.10.3.2.1 Differential connection

Impedance of the microphone input in differential mode :

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

Typical implementation:

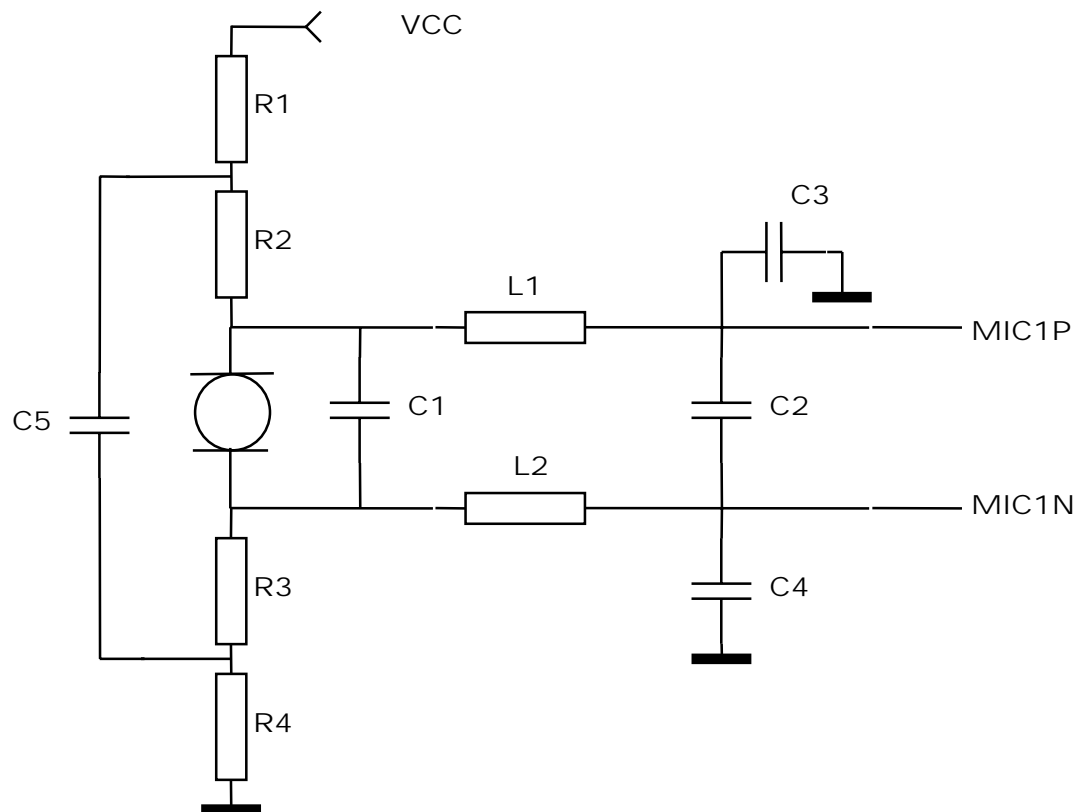


Figure 8 : MIC1 inputs (differential connection)

$R1 = R4 =$ from 100 to 330 Ω

$R2 = R3 =$ usually between 1K Ω and 3.3K Ω as per the microphone characteristics

$C1 =$ 10pF to 33pF

$C2 = C3 = C4 =$ 47pF to 100pF

$C5 =$ 47 μ F

$L1 = L2 =$ 100nH

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 WISMO2C connector.
 L1, L2, C3 and C4 has to be put near the WISMO2C 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.

3.2.10.3.2.2 *Single-ended connection*

Typical implementation:

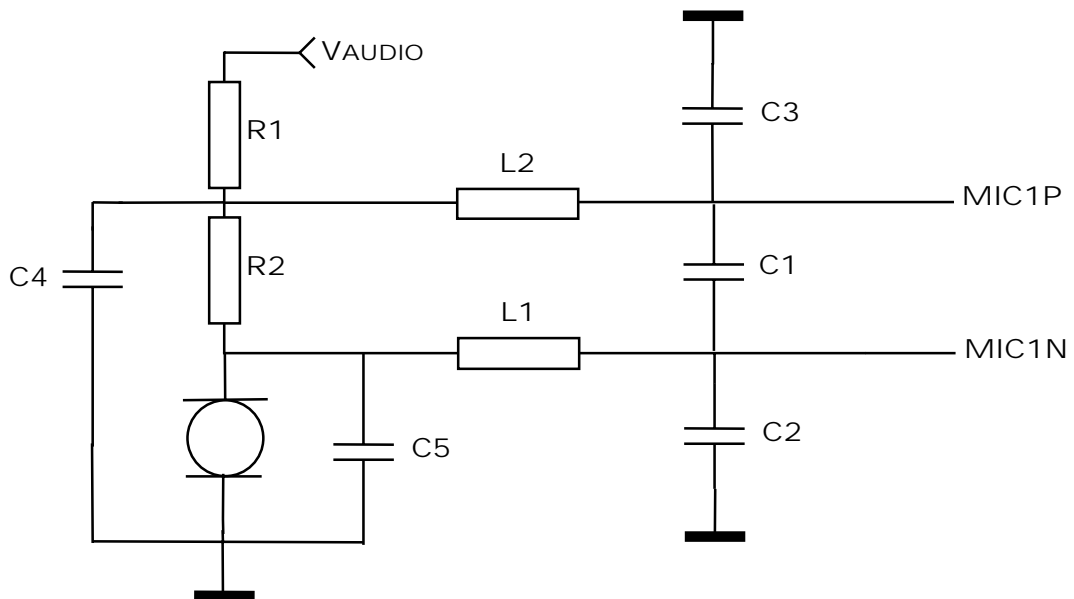


Figure 9 : MIC1 inputs (single-ended connection)

Note : VAUDIO must be very "clean" in single-ended connection (for example, VCC plus filter cell like RC or LC).

R1 = from 100 to 330Ω

R2 = usually between 1KΩ and 3.3KΩ as per the VAUDIO voltage level and the microphone characteristics

C1 = 10pF to 33pF

C2 = C3 = C5 = 47pF to 100pF

C4 = 47μF

L1 = L2 = 100nH

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 WISMO2C connector.

L1, and L2 has to be put near the WISMO2C 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.

Pin description

Signal	Pin #	I/O	I/O type	Description
MIC1P	42	I	Analog	Microphone 1 positive input
MIC1N	44	I	Analog	Microphone 1 negative input

3.2.10.4 Speaker outputs

3.2.10.4.1 Speaker 2 Outputs

Pin description

Signal	Pin #	I/O	I/O type	Description
SPK2P	45	O	Analog	Speaker 2 positive output
SPK2N	47	O	Analog	Speaker 2 negative output

3.2.10.4.2 Speaker 1 Outputs

Pin description

Signal	Pin #	I/O	I/O type	Description
SPK2P	41	O	Analog	Speaker 1 positive output
SPK2N	43	O	Analog	Speaker 1 negative output

3.2.10.5 Buzzer Output

The buzzer output 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 current must be connected as described below.

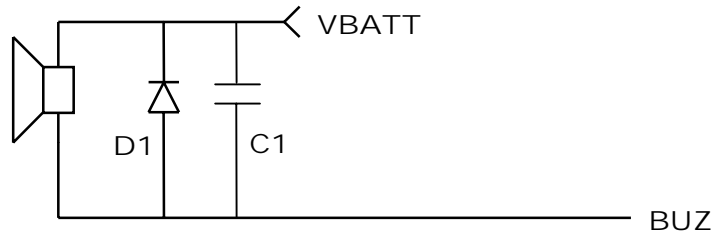


Figure 10 : Buzzer connection

C1 : depends on the buzzer type.

Pin description

Signal	Pin #	I/O	I/O type	Description
BUZ	49	O	Analog	Buzzer output

Operating conditions

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



3.2.11 Battery charging interface

The WISMO2C module supports two different battery charging circuits. One is to proceed fast charge for NiMH or NiCd batteries and the other to proceed fast charge for Li-ion batteries. These two circuits use the same interface which consists in 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 50mA. For a 550mA battery the current will be 600mA. The maximum current is 800mA.

The WISMO2C module monitors the battery voltage to detect the end of the charge. WISMO2C also monitors the temperature of the battery through the BAT_TEMP pin which has to be connected to a temperature sensor inside the battery (a NTC resistor for instance).

Pin description

Signal	Pin number	I/O	I/O type	Description
CHG_IN	1, 2, 4	I	Analog	Current source input
BAT_TEMP	38	I	Analog	A/D converter

Electrical Characteristics

Parameter	Min	Max	Typ	Unit
BAT_TEMP resolution	10			bits
BAT_TEMP sampling rate	90.3			Ksps/s
BAT_TEMP Input Impedance (R)	4.7			kΩ
BAT_TEMP Input Impedance (C)		100		nF
CHG_IN Voltage (for I=Imax)	+VBATT max + 0.7V	TBD*		V
CHG_IN Current		800		mA
BAT_TEMP Input signal range			2.8	V

* To be parametrized as per battery manufacturer

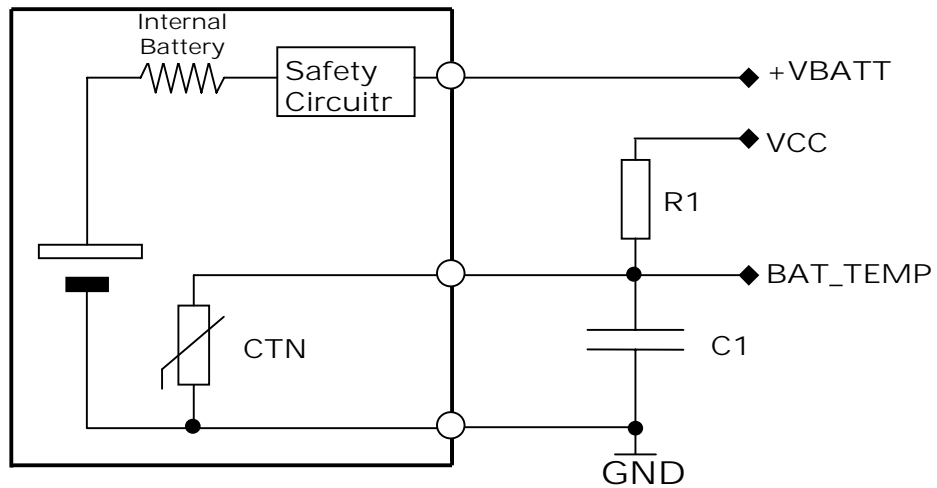


Figure 11 : Connection examples

Electrical Characteristics

Parameter	Min	Max	Typ	Unit
BAT_TEMP resolution	10			bits
BAT_TEMP sampling rate	90.3			Ksps/s
BAT_TEMP Input Impedance (R)	4.7			kΩ
BAT_TEMP Input Impedance (C)		100		nF
CHG_IN Voltage (for I=Imax)	+VBATT max + 0.7V	TBD*		V
CHG_IN Current		800		mA
BAT_TEMP Input signal range			2.8	V

* To be parametrized as per battery manufacturer

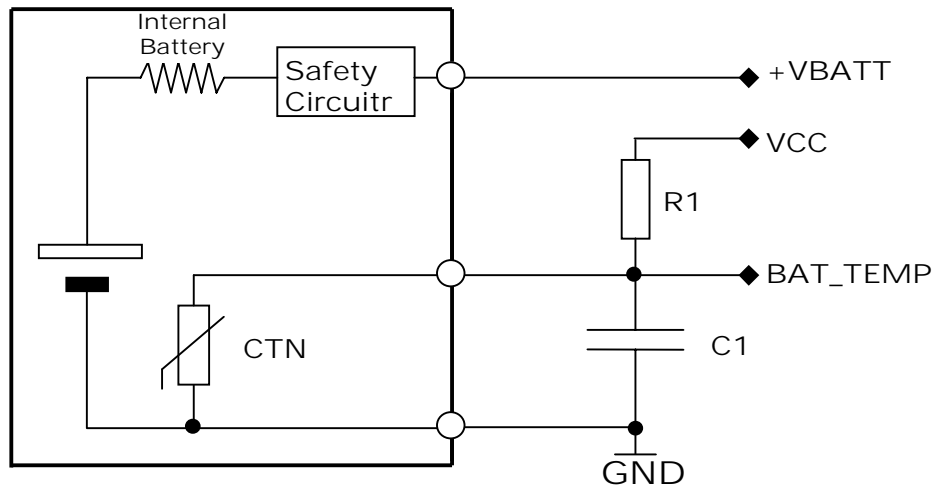


Figure 12 : Connection examples

3.2.11.1 NiMH charging procedure

A constant current source has to be provided through **CHG_IN** input in order to charge NiMH battery and **BAT_TEMP** input has to be connected to a battery temperature sensor. During this procedure, the voltage of the battery and the temperature are monitored. The charge ending is detected by different criterion.

- 1) **$\Delta\theta/\Delta T$** . When the variation of the temperature of the battery increases over 1°C/min* the fast charge is stopped. This is the main criteria.
- 2) **$-\Delta V$** . When the voltage of the battery decreases more than 5mV* per cell the fast charge is stopped. This is a safety criteria for NiMH battery but the main one for NiCd battery.
- 3) **Max Time**. When the battery is charged for more than 90min* the fast charge is stopped. This is a safety criteria.
- 4) **Max Voltage**. When the voltage of the battery reaches a maximum voltage which depends on the number of battery cells (from 4.8V to 5.1V for a 3 cells NiMH battery as per the battery manufacturer*.) the fast charge is stopped. This is a safety criteria.
- 5) **Max Temperature**. When the temperature of the battery reaches 50°C* the fast charge is stopped. This is a safety criteria.

(*) : To be parametrized as per battery manufacturer

3.2.11.2 Li-ion 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. 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 4.1V*. 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 4.1V* during more than 10s.

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 drop-out of the voltage. This drop-out is due to the RF Power Amplifier current (up to 2.0A). A maximum of 150mΩ is required.

(*) : To be parametrized as per battery manufacturer

3.2.11.3 How to define R1 and C1

How to choose R1:

R1 has to be chosen to have a full range of BAT-TEMP (from 0V to 2.8V) 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 2ms.

Calculation examples :

$$CTN(25^{\circ}C) = 47K$$

$$CTN(55^{\circ}C) = 10K$$

$$CTN(-10^{\circ}C) = 300K$$

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

$$R1 = 47K \Rightarrow BAT-TEMP(-20^{\circ}C) = 2.42V$$

$$BAT-TEMP(55^{\circ}C) = 0.49V$$

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

$$R(+55^{\circ}C) = 8K$$

With C = 10nF ::

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

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

3.2.12 ON / ~OFF

This input is used to switch ON or OFF the WISMO2C 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 2.4V and VDD during a minimum of 500ms. This signal can be left at high level until switch off.

To be able to switch OFF the module, the pin ON/OFF has to be released. Through the firmware, the module can be switched off (using the CPOF command).

Pin description

Signal	Pin number	I/O	I/O type	Description
ON/~OFF	6	I	CMOS	Module Power ON

Electrical Characteristics

Parameter	Min	Max	Unit
Input Impedance (R)	10		k Ω
Input Impedance (C)		50	pF

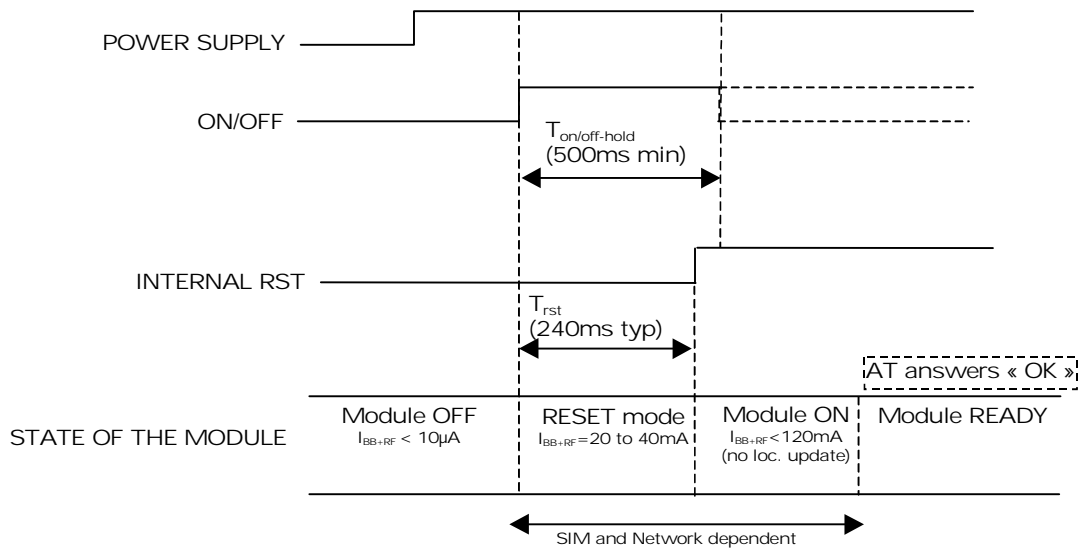
Operating conditions

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

3.2.12.1 Operating sequences

3.2.12.1.1 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 500ms 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 240ms (typical). During this phase, any external reset should be avoided. Once the initialisation is complete (timing is SIM and network dependent) the AT interface answers « OK » to the application⁴. For further details, please check the AT commands manual (+WIND, +WAIP)



I_{BB+RF} = overall current consumption (Base Band + RF part)

Figure 13 : Power-ON sequence (no PIN code activated)

⁴ For this, the application has to send AT+. If the application manages hardware flow control, the AT command can be sent during the initialisation phase. Another solution is to use the +WIND command to get an unsolicited status from the module.

3.2.12.1.2 Power OFF

To properly power OFF the module, the application must set the ON/OFF signal to low 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.

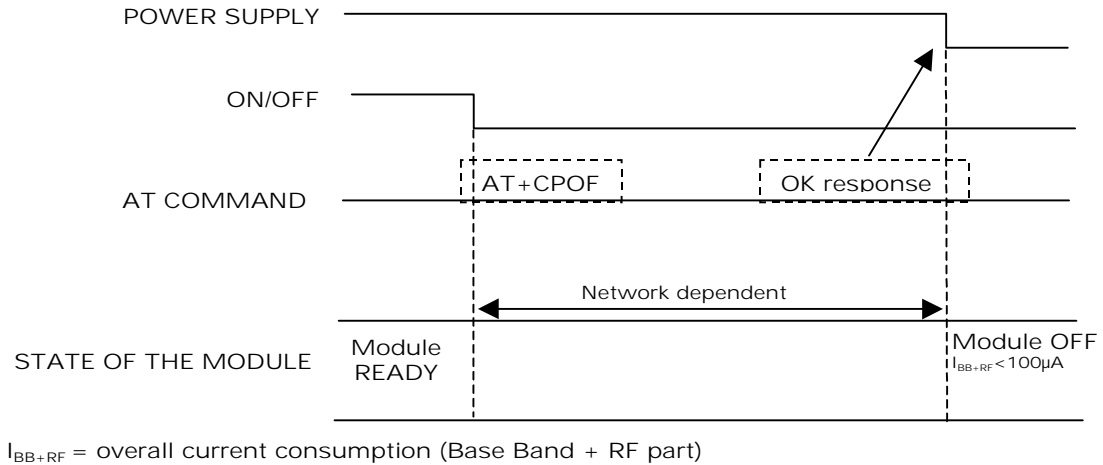


Figure 14 : Power-OFF sequence

3.2.13 BOOT (optional)

This input can be used to download a software in the Flash ROM of the WISMO2C module. For the applications based on AT commands this is a backup download procedure only (see chapter on firmware download for details on the nominal procedure). 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 1KΩ resistor. If used, this input has to be driven by an open collector or an open drain.

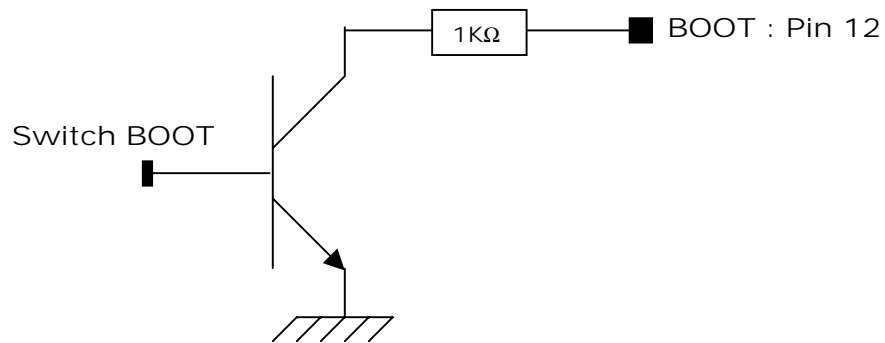


Figure 15 : BOOT pin connection

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

Pin description

Signal	Pin number	I/O	I/O type	Description
BOOT	12	I	CMOS	Flash Loading

3.2.14 Reset signal (~RST)

This signal is used to force a reset procedure by providing low level during at least 100µs. 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.

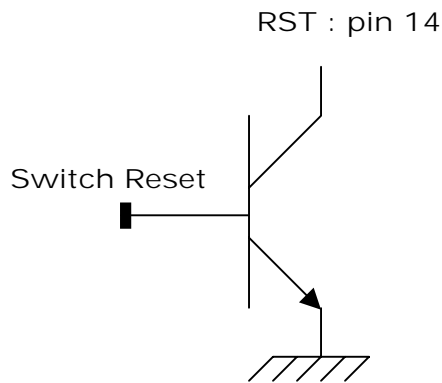


Figure 16 : RST pin connection

- If Switch Reset = 1, Reset pin 14 = 0
- If Switch Reset = 0, Reset pin 14 = 1

Pin description

Signal	Pin number	I/O	I/O type	Description
~RST	14	I/O		Module Reset

Electrical Characteristics

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

Operating conditions

Parameter	Min	Max	Condition
*V _{T-}	1.1V	1.2 V	
*V _{T+}	1.7V	1.9 V	
V _{OL}		0.4 V	I _{OL} = -50 μA
V _{OH}	2.0 V		I _{OH} = 50 μA

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

Additional comments on RESET:

The RESET process is activated either by the 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" resets.

A software reset will be preferred to a HW reset.

3.2.14.1 Reset sequence

To activate the « emergency » reset sequence, the ~RST signal has to be set to low for 100μs minimum. As soon as the reset is complete, the AT interface answers « OK » to the application⁵.

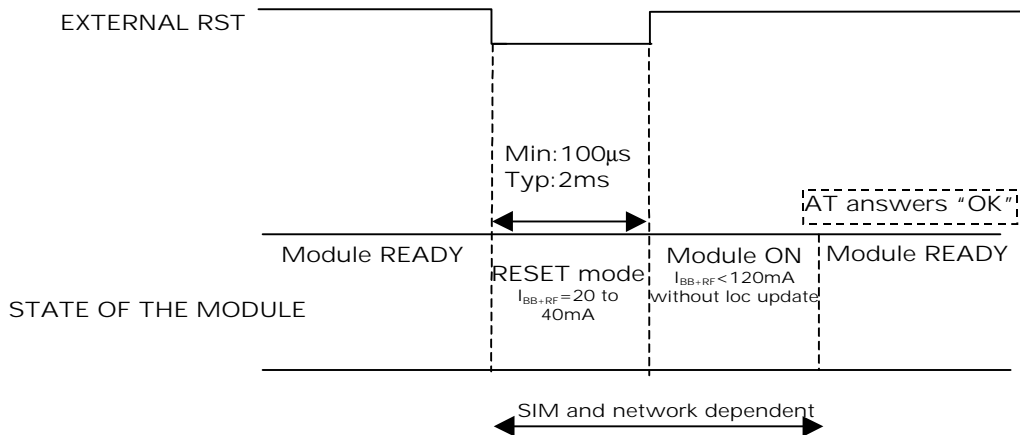


Figure 17 : reset sequence

⁵ For this, the application has to send AT+J. If the application manages hardware flow control, the AT command can be sent during the initialisation phase. Another solution is to use the +WIND command to get an unsolicited status from the module.

3.2.15 External Interrupt (~INTR)

The WISMO2C provides an external interrupt input (not managed in the standard AT commands firmware). 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.

Pin description

Signal	Pin number	I/O	I/O type	Description
~INTR	16	I	CMOS	External Interrupt

Electrical characteristics

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

3.2.16 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	40	O	Supply	Digital supply

Operating conditions

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

3.2.17 VCC_RTC (Real Time Clock)

This pin is used as 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 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	56	I/O	Supply	RTC Back-up supply

Operating conditions

Parameter	Condition	Min	Max	Unit
Input voltage		2	2.8	V
Input Current	VCC=0V; t° = 25°C VCC_RTC=2.5V		3	µA
Input Current	VCC=0V; t°: -20°C / 55°C VCC_RTC=2.5V		10	µA
Output voltage		2.4	2.9	V
Output current			2	mA

Application example

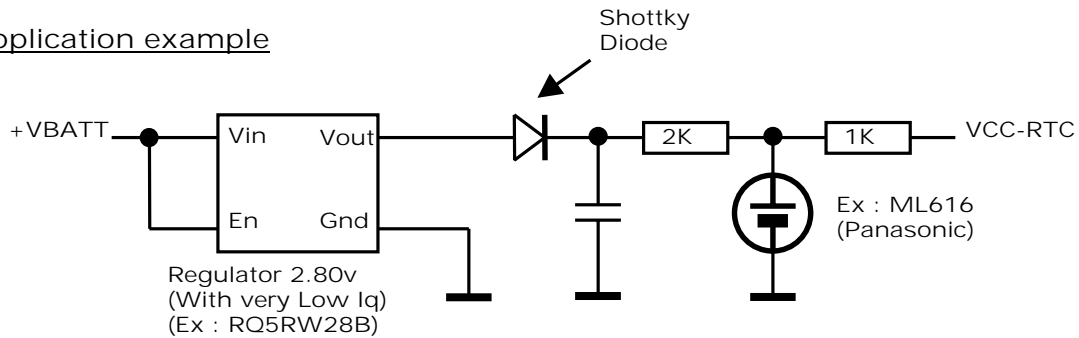
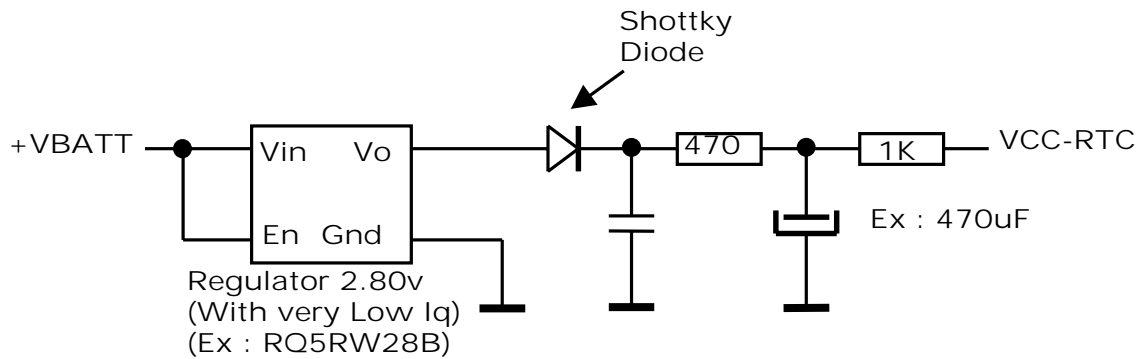
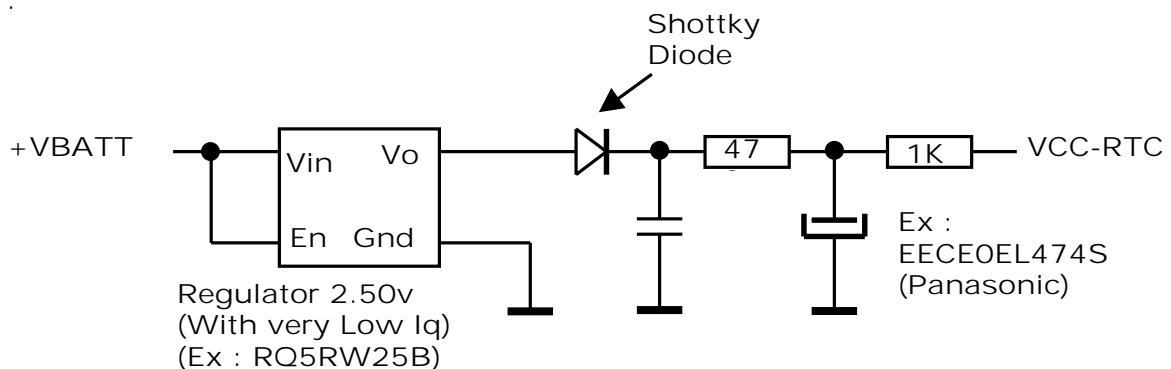


Figure 18 : VCC-RTC implementation example



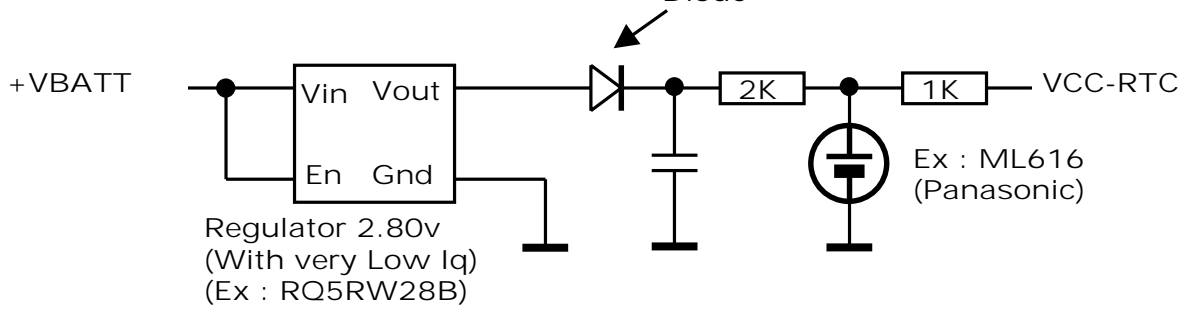
Charge capacity with 470µF Capacitor : 30 seconds min (Estimation)

Figure 19 : Back-up RTC (capacitor)



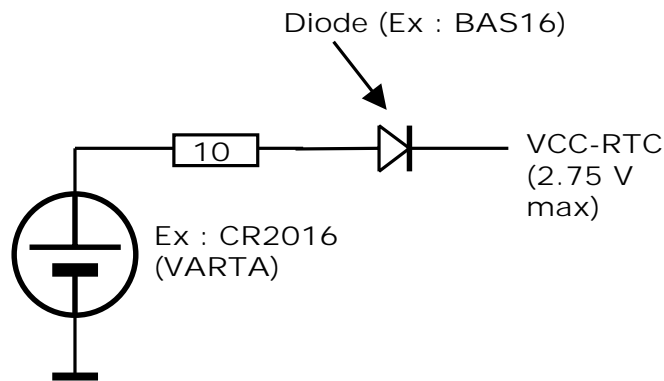
Charge capacity with 0.47 Farad Gold Capacitor : 2 Hours min (Estimation)
Note: The Gold Capacitor max. voltage is 2.5v.

Figure 20 : Back-up RTC (super capacitor)



Charge capacity with 2mAH Rechargeable Battery : 3 Days (Estimation)

Figure 21 : Back-up RTC (Rechargeable Battery)



Charge capacity with 85mAH Capacitor : 4000 Hours min (Estimation)
Note: The "non rechargeable battery" is always in active mode except when the module is ON.

Figure 22 : Back-up RTC (non Rechargeable Battery)

3.3 RF interface

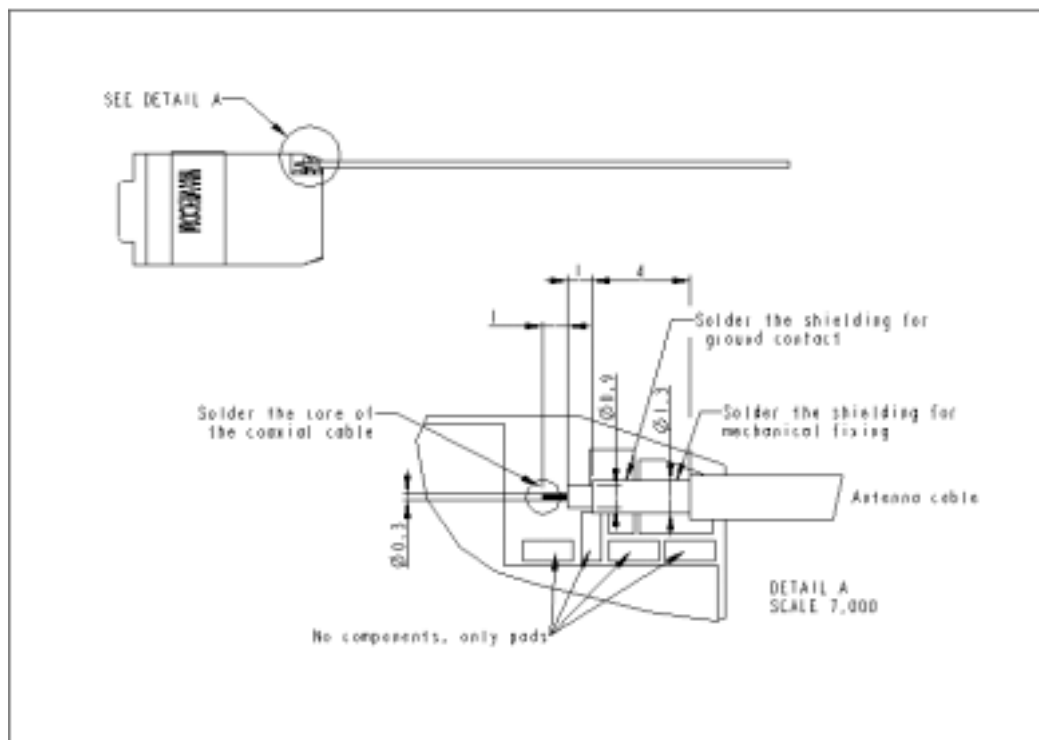
The impedance is 50 Ohms nominal and the DC impedance is 0 Ohm.

3.3.1 RF connection

Two land patterns set on the PCB support the RF connection which can be used by the application through spring contacts or a soldered RF cable.

Since no standard spring contact is available for WISMO2C, this solution requires a specific part to be developed.

The soldered solution will preferably be based on a RG178 coaxial cable with the following stripping and mounting guidelines :



REP :CABLE-DROIT-MOONLE
ECHELLE :1,000 TYPE :ASSEM NOM :8211-138-3997-SMALL-GSM TAILLE :A4

Figure 23 : antenna cable mounting guidelines

Notes :

- The WISMO2C does not support an antenna switch for a car kit but this function can be implemented externally and it can be driven using a GPIO.
- The antenna cable and connector should be chosen in order to minimise losses in the frequency bands used for GSM900 (900 MHz) and GSM1800/GSM1900 (1.8GHz/1.9GHz).
- 0.5dB can be considered as a maximum value for loss between the module and an external connector.

3.3.2 RF performances

RF performances are compliant with the ETSI recommendation 05.05 and 11.10 (Normal MS requirements)

The main parameters are :

- Receiver:
 - EGSM Sensitivity : < -104 dBm
 - GSM1800/GSM1900 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): 33 dBm +/- 2 dB
 - Maximum output power (GSM1800/GSM1900) : 30 dBm +/- 2 dB
 - Minimum output power (EGSM) : 5 dBm +/- 5 dB
 - Minimum output power (GSM1800/GSM1900) : 0 dBm +/- 5 dB
 - H2 level : < -30 dBm
 - H3 level : < -30 dBm
 - Noise in 925 - 935 MHz : < -67 dBm
 - Noise in 935 - 960 MHz : < -79 dBm
 - Noise in 1805 - 1880 MHz (GSM1800 band) : < -71 dBm
 - Noise in 1930 - 1990 MHz (GSM1900 band) : < -71 dBm
 - Phase error at peak power : < 5 ° RMS
 - Frequency error : +/- 0.1 ppm max

3.3.3 Antenna specifications

The antenna must fulfill the 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
- Typical radiated gain : 0dBi

4 Technical specifications

4.1 Interfaces

Pin #	Name	I/O	I/O type	Description	Comment
1	CHG_IN	I	Supply	Supply for battery charging	High current
2	CHG_IN	I	Supply	Supply for battery charging	High current
3	SIMCLK	O	2 X	Clock for SIM interface	
4	CHG_IN	I	Supply	Supply for battery charging	High current
5	SIMRST	O	2 X	Reset for SIM interface	
6	ON/~OFF	I	CMOS	Power ON/OFF control	
7	SIMDATA	I/O	CMOS / 3X	I/O for SIM interface	
8	SDA/SPI_IO	I/O	CMOS/1X	GPSI or SPI Data	
9	SIMVCC	O	Supply	SIM card supply	6mA max
10	SCL/SPI_CLK	O	1X	GPSI or SPI clock	
11	VDD	I	Supply	Low power supply	3.1V minimum or connected to VBATT
12	BOOT	I	CMOS	BOOT	Pull down through 1K for Flash downloading
13	ROW0	I/O	CMOS/1X	Keyboard Row	
14	~RST	I/O	SCHMITT	Module Reset	Active low
15	ROW1	I/O	CMOS/1X	Keyboard Row	
16	~INTR	I	CMOS	External interrupt	Active low. 100K Pull-up inside
17	ROW2	I/O	CMOS/1X	Keyboard Row	
18	GPI	I	CMOS	General Purpose Input	100K Pull-down inside
19	ROW3	I/O	CMOS/1X	Keyboard Row	
20	GPO2	O	1X	General Purpose Output	
21	ROW4	I/O	CMOS/1X	Keyboard Row	
22	GPO1	I/O	3X	General Purpose Output	
23	COL0	I/O	CMOS/1X	Keyboard Column	
24	GPI00	I/O	CMOS/2X	General Purpose I/O	
25	COL1	I/O	CMOS/1X	Keyboard Column	
26	GPO0 or SPI_AUX	O	3X	General Purpose Output or SPI Aux enable	

				SIM 3V / 5V	
27	COL2	I/O	CMOS/1X	Keyboard Column	
28	SPI_EN	O	1X	SPI enable	
29	COL3	I/O	CMOS/1X	Keyboard Column	
30	CT105/RTS	I	CMOS	RS232 interface Request To Send	Pull up to VCC with 100K Ω when not used
31	COL4	I/O	CMOS/1X	Keyboard Column	
32	CT104/RX	O	1X	RS232 interface - Receive	
33	AUXV0	I	Analog	Auxiliar ADC input 0	Can be tied to GND if not used
34	CT108-2/DTR	I	CMOS	RS232 interface Data Terminal Ready	Pull up to VCC with 100K Ω when not used
35	GPIO5	I/O	CMOS / 2X	General Purpose I/O	
36	CT107/DSR	O	1X	RS232 interface Data Set Ready	
37	CT106/CTS	O	1X	RS232 interface Clear To Send	
38	BAT_TEMP	I	Analog	ADC input for battery temperature measurement	Can be tied to GND if not used
39	CT103/TX	I	CMOS	RS232 interface - Transmit	Pull up to VCC with 100 K Ω when not used
40	VCC	O	Supply	2.8V digital supply output	10mA max.
41	SPK1P	O	Analog	Speaker 1 positive output	
42	MIC1P	I	Analog	Microphone 1 positive input	
43	SPK1N	O	Analog	Speaker 1 negative output	
44	MIC1N	I	Analog	Microphone 1negative input	
45	SPK2P	O	Analog	Speaker 2 positive output	
46	MIC2P	I	Analog	Microphone 2 positive input	
47	SPK2N	O	Analog	Speaker 2 negative output	
48	MIC2N	I	Analog	Microphone 2 negative input	
49	BUZ	O	Analog	Buzzer output	80mA max
50	SIMPRES	I	CMOS	SIM Card Detect	Tied to VCC when not used
51	GPIO3 or CT109 / DCD	I/O O	CMOS/2X	General Purpose I/O RS232 - Data Carrier Detect	
52	GPIO1 FLASH LED	I/O	CMOS/2X	General Purpose I/O Module State	Handset application

					AT command appl.
53	GPIO4	I/O	CMOS/2X	General Purpose I/O	
54	GPIO2 or CT125 / RI	I/O O	CMOS/2X	General Purpose I/O RS232 - Ring Indicator	
55	+VBATT		Supply	Battery Input	High current
56	VCC_RTC	I/O	Supply	RTC back-up supply	
57	+VBATT		Supply	Battery Input	High current
58	+VBATT		Supply	Battery Input	High current
59	+VBATT		Supply	Battery Input	High current
60	+VBATT		Supply	Battery Input	High current

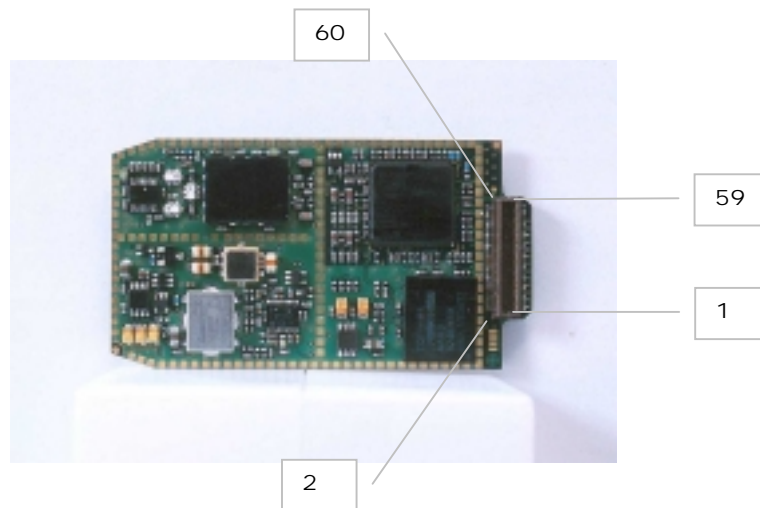


Figure 24 : WISMO2C pin position (bottom view)

4.2 Climatic and mechanical environments

Conditions	Temperature range
Operating / Full GSM specifications compliant	-20°C to +55°C
Storage	-30°C to +85°C

WISMO2C		ENVIRONNEMENTAL 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 (GSM900) 16 h -10° C (GSM1800/1900) 16h
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 (GSM900) 3 cycles -10° / +30° C (GSM1800/1900): 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

4.3 Mechanical specifications

4.3.1 Physical characteristics

The WISMO2C module has a complete self-contained shield.

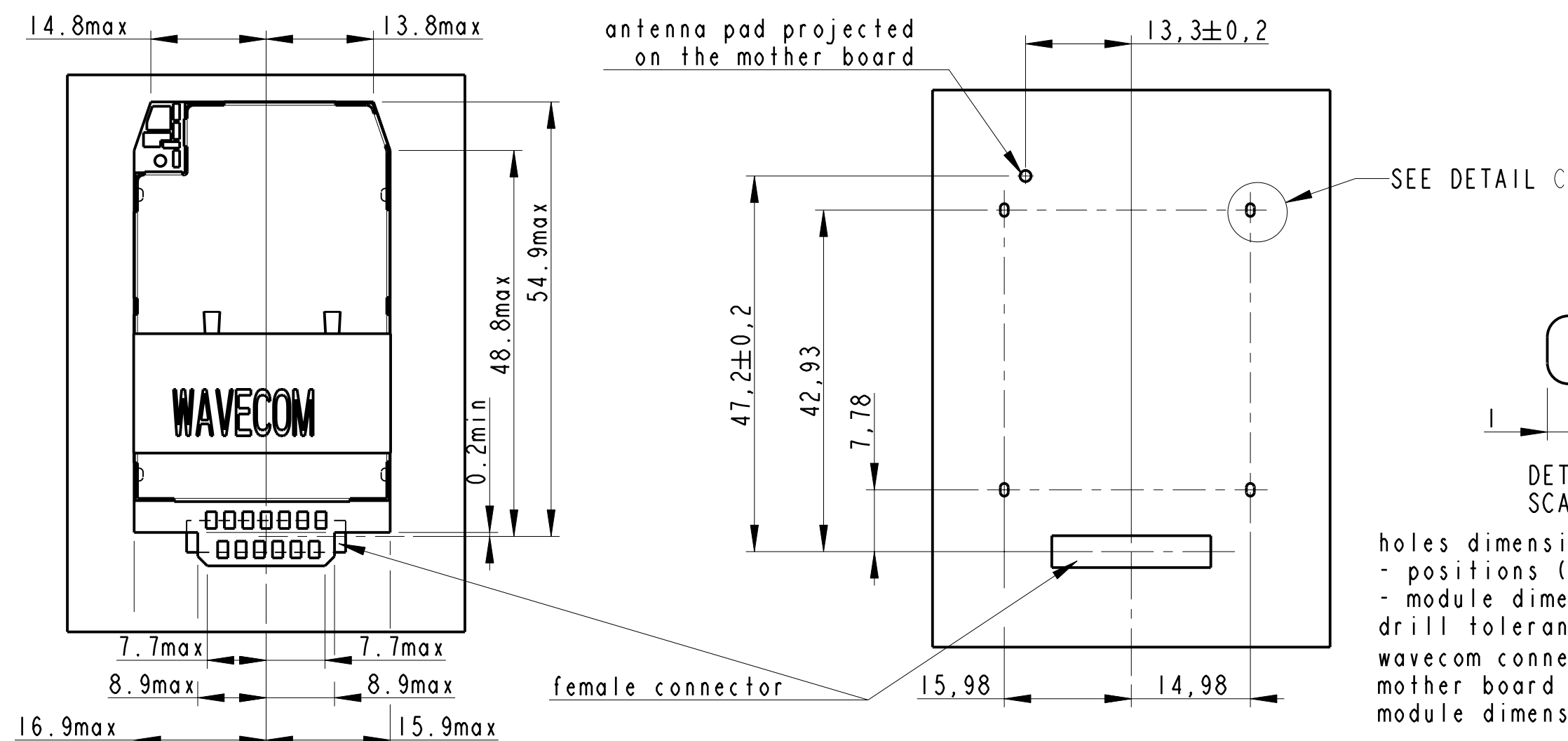
Dimensions : 58.3 x 32.2 x 6.0 mm

Weight : 20 g

4.3.2 Mechanical drawings

The next page gives the mechanical specifications of WISMO2C.

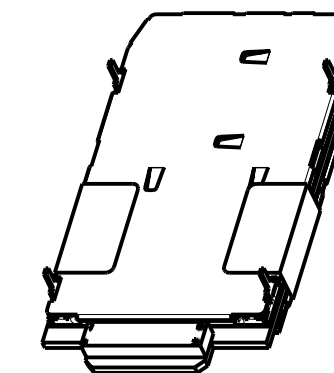
MAXIMUM BULK OCCUPIED ON THE MOTHER BOARD



holes dimensions are assuming tolerances of
 - positions (connectors and module)
 - module dimensions
 drill tolerances on the mother board have to be added
 wavecom connector position: +/-0.1mm
 mother board connector position: +/-0.1mm
 module dimensions + module position (linear & angular): +/-0.3mm

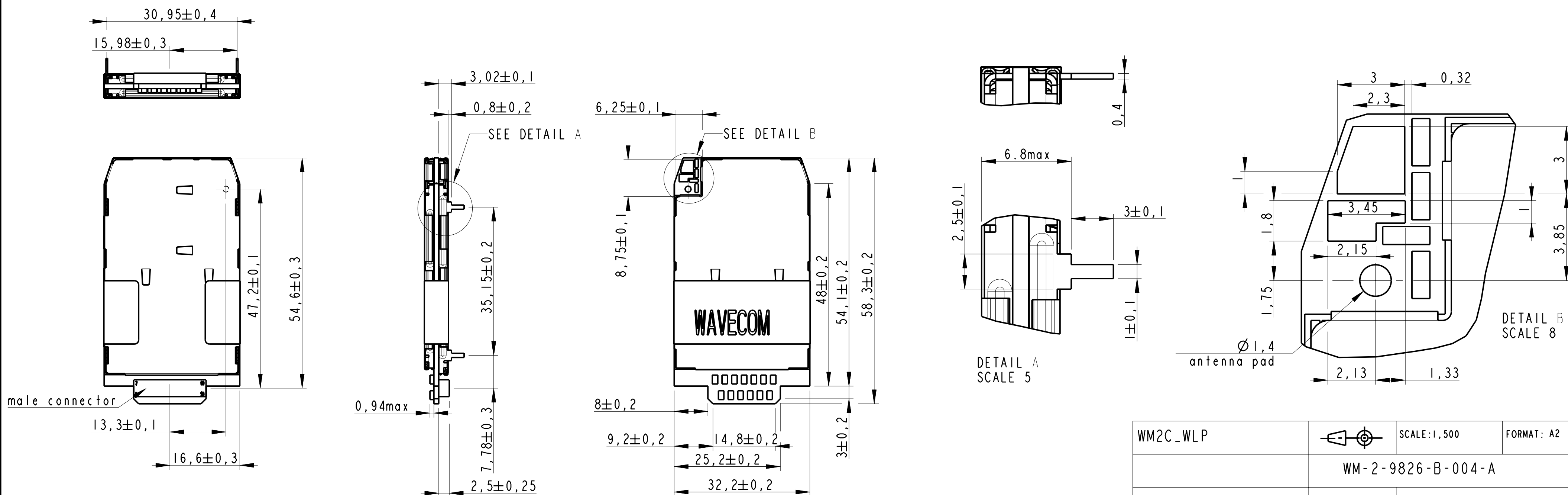


SCALE 1



SCALE 1

MODULE DIMENSIONS



Creation	23-03-00	T. OGER	Preliminary
MODIFICATION	DATE	AUTHOR	STATUS

WM2C_WLP		SCALE:1,500	FORMAT: A2
WM-2-9826-B-004-A			00
WAVECOM	AUTHOR T. OGER	FOLIO: 1/1	IND.

5 Connectors and peripheral devices references

5.1 General Purpose Connector

The GPC is a 60 pins 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 861⁶.

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>

⁶ X=2 or 9

5.2 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>)

5.3 Microphone

Possible references :

- HOSIDEN KUF3323
- HOSIDEN KUF4323
- PANASONIC WM64

5.4 Speaker

Possible references :

- SANYO M15X0080

5.5 Antenna Cable

The following cable reference has been qualified for being mounted on WISMO2C :

- RG178

5.6 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>)
- AMPHENOL (<http://www.amphenol.com>)
- GALTRONICS (<http://www.galtronics.com>)
- RADIAL / LARSEN (<http://www.larsenantennas.com/>)
- RANGESTAR (<http://www.rangestar.com/>)

6 Design Guidelines

The following paragraphs aims giving general design guidelines.

6.1 HARDWARE and RF

6.1.1 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 (if accessible from outside), serial link,...
- EMC protection on audio input/output (filters against 900MHz emissions)
- Bias of the Microphone inputs
- Length of the SIM interface lines (preferably <10cm)
- 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.

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
- the emissions spectrum
- the phase error and frequency error

Warning:

Careful attention should be paid to :

- **Quality of the power supply : low ripple, PFM or PSM systems should be avoided (PWM converter preferred).**
- **Capacity to deliver high current peaks in a short time (pulsed radio emission).**

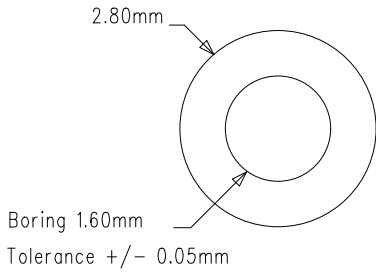
6.1.3 Layout requirement

CHIPS & BORING DIAMETER

of the WISMO 1B,2A,2C MODULES mechanical insertion pins

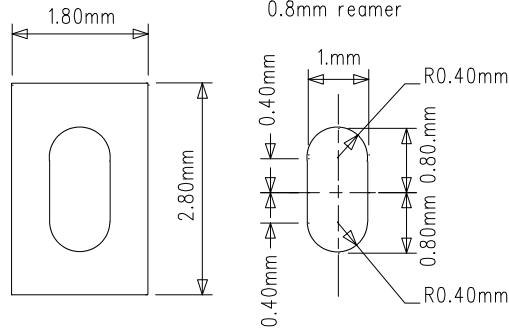
CASE N 1

To be used in priority



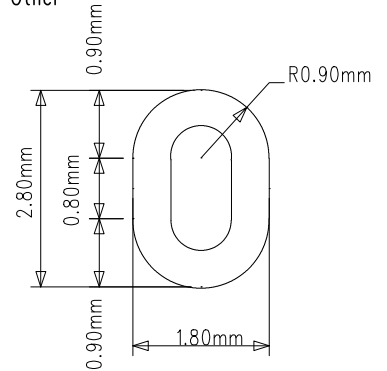
CASE N 2

on specific request



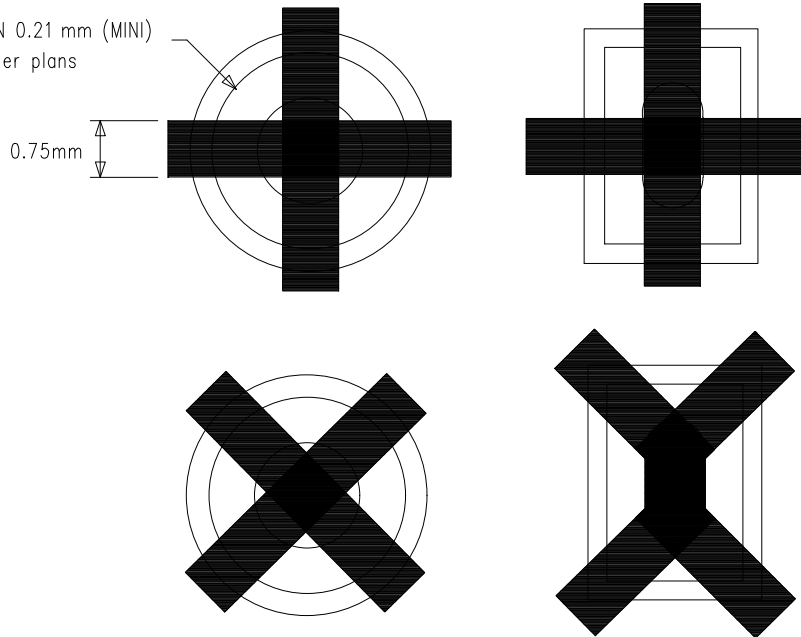
CASE N 3

Other



THERMAL BRAKES DEFINITION

ISOLATION 0.21 mm (MINI)
with copper plans



NORMALISATION INDUSTRIELLE

ETABLI : HER

DATE : 02/07/00

APPROUVE :

SECTION : 1545

WAVECOM

CHIPS & BORING DIAMETER
OF THE WISMO 1B,2A,2C
MECHANICAL INSERTION PINS

6.1.4 Antenna

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

Attention should be paid to :

- Choice of the antenna cable (type, length, performances, thermal resistance, etc)
- Antenna connector (type + losses)
- ◆ 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.

6.2 Mechanical integration

Attention should be paid to :

- Antenna cable integration (bending, length, position, etc)
- Legs of the module to be soldered on the Ground plane

6.3 Firmware upgrade

The WISMO2C firmware is stored in flash memory and it can easily be upgraded.

Two upgrade procedures are available:

6.3.1 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.

6.3.2 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.

7 Appendix

7.1 Wavecom acceptance test

These tests are Wavecom internal qualification tests. They are performed on a Wavecom evaluation platform (module on test board).

Test	Applied standard	Acceptance criteria
Performance Test	ETSI recommendation for GSM900/GSM1800 (and GSM900/GSM1900) communication.	Full conformity to the recommendation regarding the main RF parameters.
Cooking Test	-	The test continues even after the Cooking Test milestone has been reached
Stress Test	Therma shocks IEC 68-2-14.	Full conformity to the recommendation regarding the main parameters.
Vibration Test	Sinusoidal vibration IEC 68-2-6.	No performance degradation or mechanical degradation is allowed after test.
Vibration Test	Random vibration IEC 68-2-36.	No performance degradation or mechanical degradation is allowed after test.
Shock Test	IEC 68-2-27.	No performance degradation or mechanical degradation is allowed after test.
Bump Test	IEC 68-2-29.	No performance degradation or mechanical degradation is allowed after test.
Humidity Test	Corrosion test IEC 68-2-3.	No visible degradation of the product, both visual and fonctionnal. The unit is tested at room temperature and must be fully operative for the main RF parameters.
Warehouse Tet	Low temperance IEC 68-2-1.	Under normal condition (room temperature) after the test, the unit must behave in full conformity with the main RF parameters specification.
Warehouse Test	High temperature IEC 68-2-2.	Under normal condition (room temperature) after the test, the unit must behave in full conformity with the main RF parameters specification.
Dust Test1	MIL-STD-810D, method 510-3.	No visible dust in the visible areas. No more than 50 dust particules in the cabinet of the product. The unit, tested at room temperature must be fully operative.
Light Test1	UV radiation and temperature EDF HN60E03.	Visual inspection on the discoloration and other degradation effects such as cracks in the material of the unit after the test.
Fall Test1	IEC 68-2-32.	Only minor casing degradation is allowed, with a maximum dimension change of 1mm. The unit must remain fully operative and full specification for the main RF parameters.
Electro Static Discharge Test	IEC 1000-4-2.	No performance degradation allowed after the test.
Salt Mist Test	IEC 68-2-11	After the test, visual inspection on the unit.
Atmosphere Test	Flowing mixed gas corrosion. IEC 68-2-60	After the test, visual inspection on the unit and inside.
Marking Test	EN 60 950	After the test, visual inspection on the unit. No degradation is allowed on the marking.

7.2 Reference documents

GSM ETSI recommendations for Phase I and Phase II.

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 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 GSM APPLICATION BASED ON WISMO2C
PLEASE READ THIS INFORMATION CAREFULLY**

7.3.1 RF safety

7.3.1.1 General

Your GSM terminal⁷ 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

⁷ based on WISMO2C

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 fueling 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.

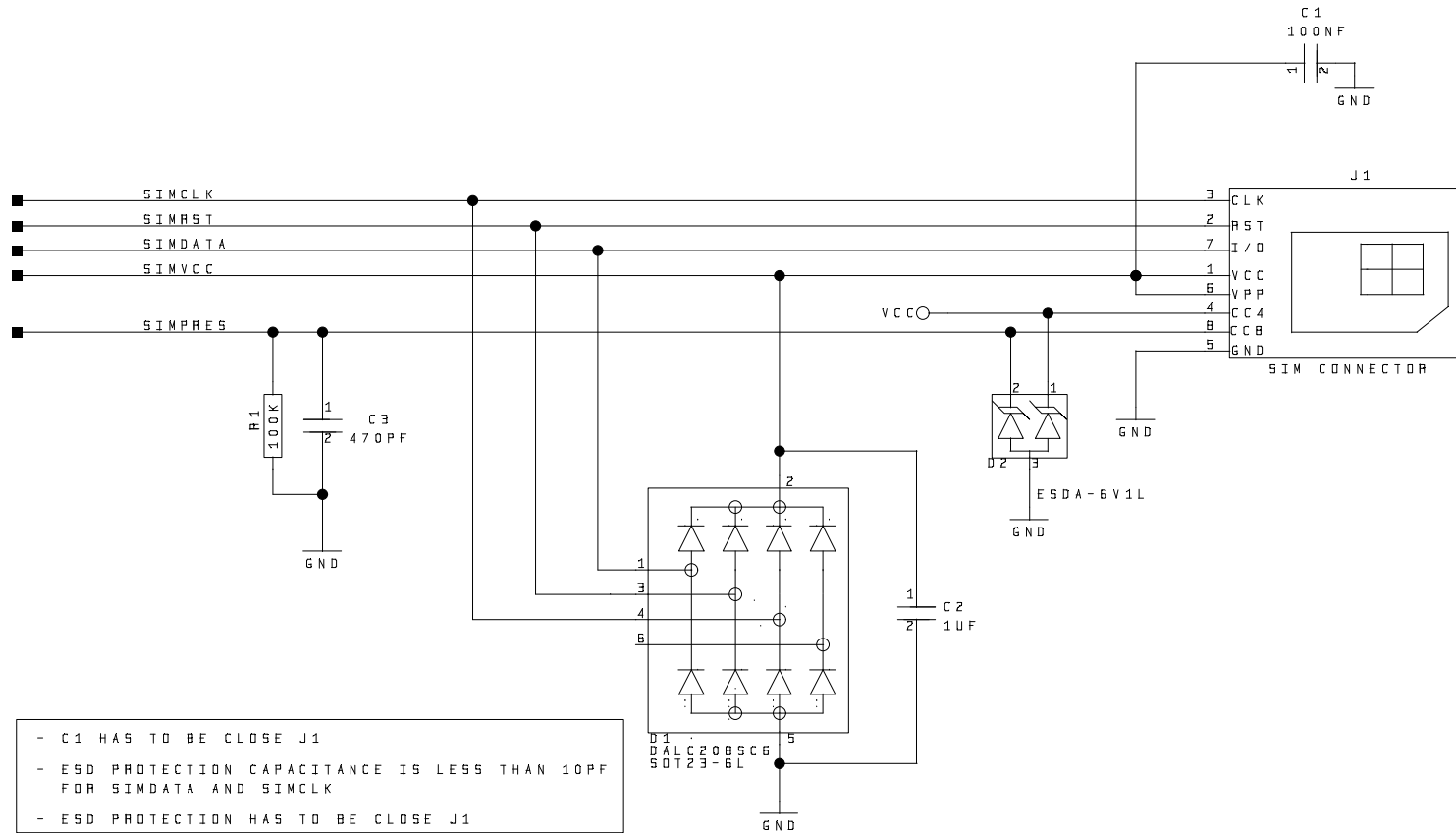
Do not transport or store flammable gas, liquid, or explosives, in the compartment of your vehicle which contains your terminal or accessories.


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.

7.4 Application notes for the SIM interface

The 2 next pages are application notes to interface the module with SIM cards:

- application note #1: interface with 3V SIMs
- application note #2: interface with 3V/5V SIMs

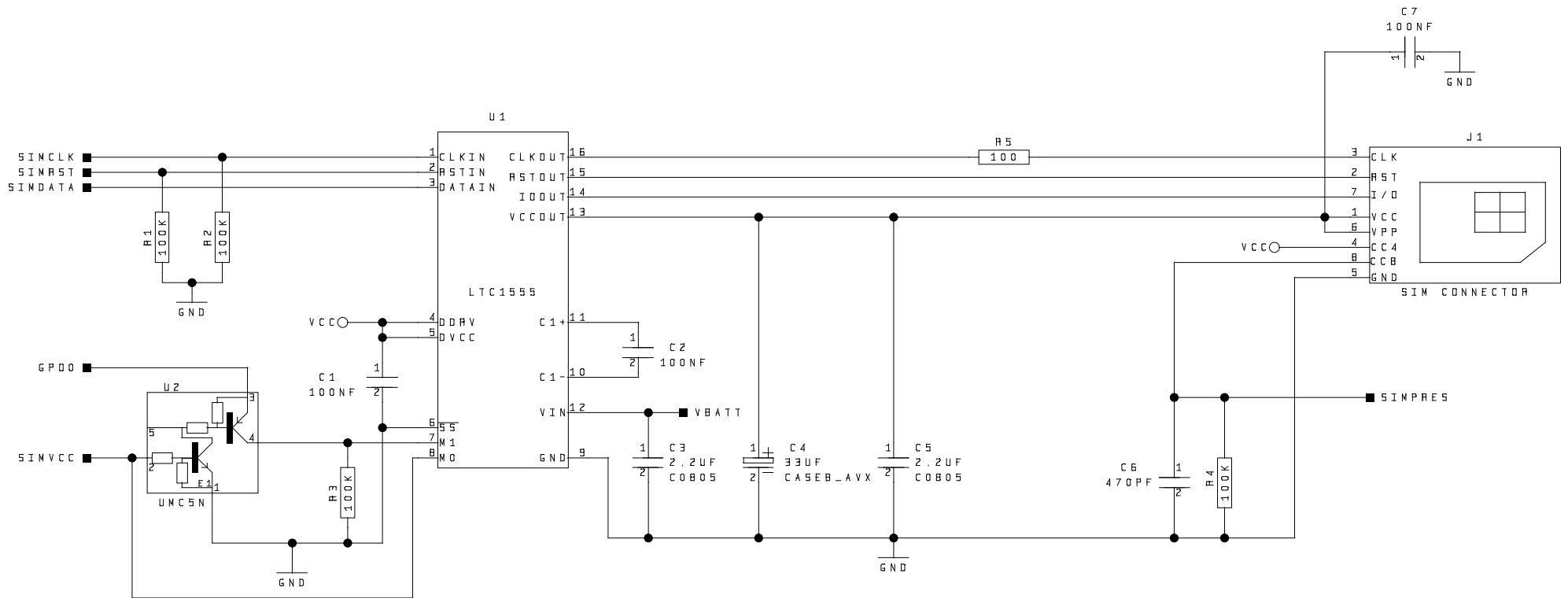





WAVECOM

The shock wave in the wireless world

PROJECT: APPLICATION NOTE	Sheet: 1/1
SCHEMATIC: SIM 3V ONLY (WISMD2C)	
WAVECOM 39 Rue du Gouverneur Ebaux 92130 ISSY LES MOULINEAUX FRANCE	Date: 12/07/2000 Version: 2.00 Eng: JMB



- C4 HAS TO BE CLOSE (13) & (9) OF U1
- C4 IS A LOW ESR TANTALUM CAPACITOR
- C7 HAS TO BE CLOSE J1



WAVECOM

The shock wave in the wireless world

PROJECT: APPLICATION NOTE	Sheet: 1/1
SCHEMATIC: SIM 3V-5V (WISMO2C)	
WAVECOM 39 Rue du Gouverneur Eboe 92130 ISSY LES MOULINEAUX FRANCE	Date: 06/01/2000 Version: 1.00 Eng: JMB

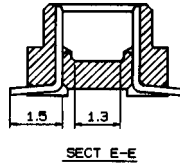
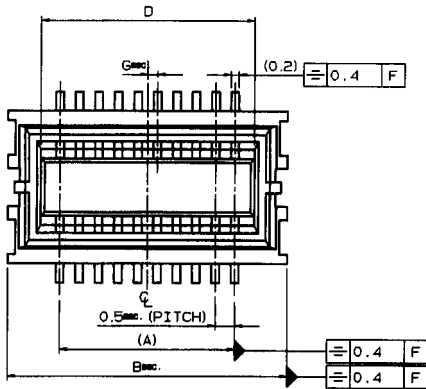
7.5 General Purpose Connector data sheet

The next pages are the KYOCERA/ELCO data sheets for the GPC (also available from <http://www.avxcorp.com> .

0,5 mm Spacing

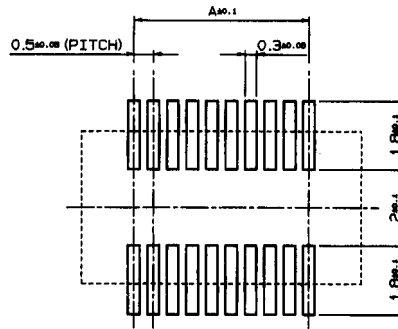
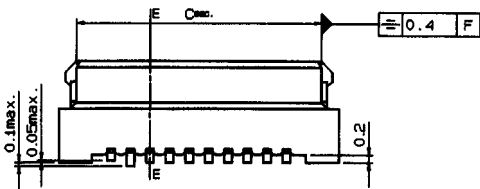
SERIES 5087

Surface Mount Vertical Plug

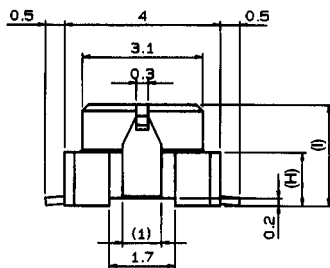


Specifications:

- 1000 per Tape and Reel
- Voltage - 50 V
- Current Rating - 0.4 A
- Dielectric Withstanding Voltage - 500 V
- Operating Temperature - (-25°C ~ +85°C)
- Contact Material - phosphor bronze
- Insulator Material - PPS (UL 94 V-0)



MOUNTING LAYOUT



No. of Pos.	P/N	A	B	C	D	G
20	10 5087 020 XX0 861	4.5/.177	7.2/.283	6.2/.244	5.5/.217	0.25/.0098
30	10 5087 030 XX0 861	7.0/.276	9.7/.382	8.7/.343	8.0/.315	0.50/.0196
36	10 5087 036 XX0 861	8.5/.335	11.2/.441	10.2/.402	9.5/.374	0.25/.0098
40	10 5087 040 XX0 861	9.5/.374	12.2/.480	11.2/.441	10.5/.414	0.25/.0098
50	10 5087 050 XX0 861	12.0/.472	14.7/.579	13.7/.539	13.0/.512	0.50/.0196
60	10 5087 060 XX0 861	14.5/.571	17.2/.677	16.2/.638	15.5/.610	0.25/.0098

Dimensions millimeters/inches

ORDERING CODE

Typical Example

14

5087

0XX

2XX

861

14: PLUG - Tape and Reel

NUMBER OF CONTACTS:

40, 60 : 3.0mm Stack

36, 40, 50 : 3.5mm Stack

20, 30, 36,

50, 60 : 4.0mm Stack

2: Without Adhesive Tape

9: Adhesive Cover Tape

VARIATION CODE:

30 H I .9 2.15

35 1.4 2.7

40 1.9 3.2

PLATING VARIATION:

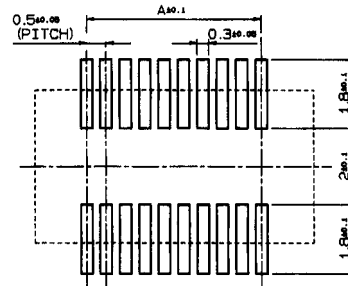
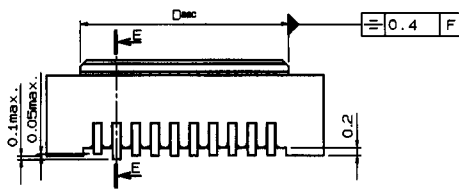
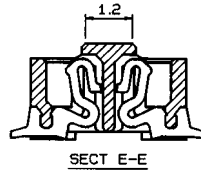
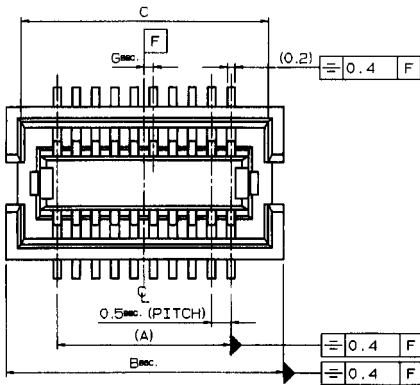
861: 15 microinches of gold with gold flash tails

Consult factory for other sizes

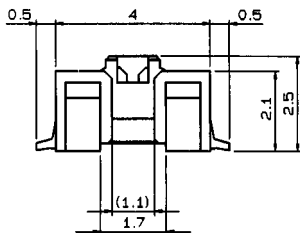
Surface Mount Vertical Receptacle

Specifications:

- 1000 per Tape and Reel
- Voltage - 50 V
- Current Rating - 0.4 A
- Dielectric Withstanding Voltage - 500 V
- Operating Temperature - (-25°C ~ +85°C)
- Contact Material - phosphor bronze
- Insulator Material - PPS (UL 94 V-0)



MOUNTING LAYOUT



No. of Pos.	P/N	A	B	C	D	G
20	20 5087 020 x00 861	4.5/.177	7.2/.283	6.4/.252	5.4/.213	0.25/.0098
30	20 5087 030 x00 861	7.0/.276	9.7/.382	8.9/.350	7.9/.311	0.50/.0196
36	20 5087 036 x00 861	8.5/.335	11.2/.441	10.4/.409	9.4/.370	0.25/.0098
40	20 5087 040 x00 861	9.5/.374	12.2/.480	11.4/.449	10.4/.409	0.25/.0098
50	20 5087 050 x00 861	12.0/.472	14.7/.579	13.9/.547	12.9/.508	0.50/.0196
60	20 5087 060 x00 861	14.5/.570	17.2/.677	16.4/.646	15.4/.606	0.25/.0098

Dimensions millimeters/inches

ORDERING CODE

Typical Example

24

5087

0XX

200

861

24: Receptacle - Tape and Reel

NUMBER OF CONTACTS:

20, 30, 36, 40, 50, 60

2: Without Adhesive Tape

9: Adhesive Cover Tape

PLATING VARIATION:

861: 15 microinches of gold with gold flash tails

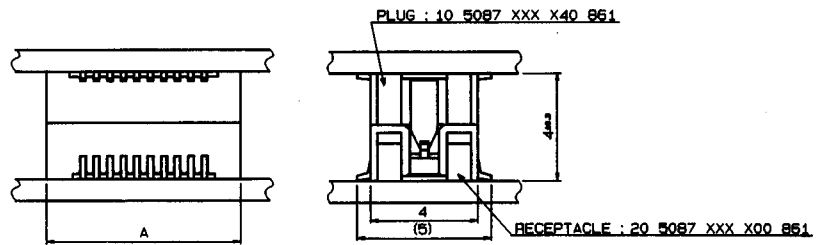
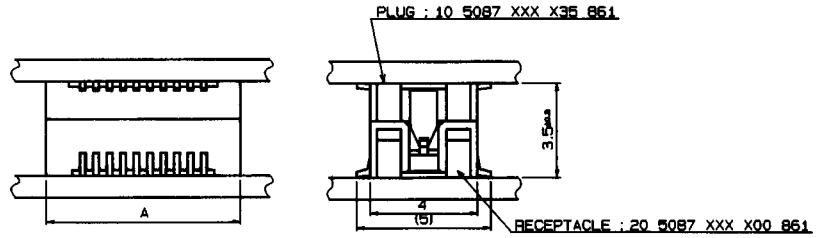
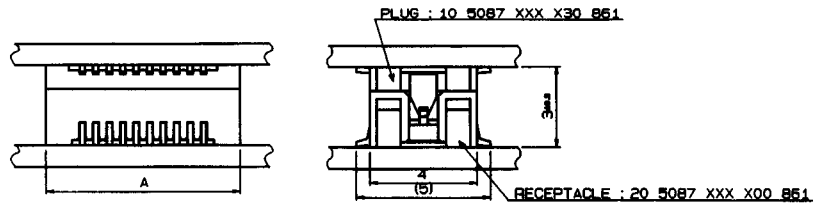
Consult factory for other sizes

0,5 mm Spacing

Applications

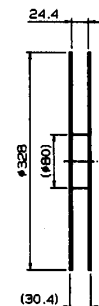
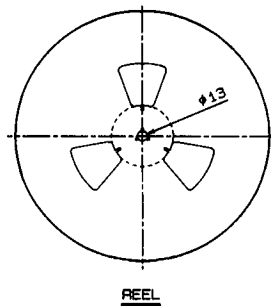
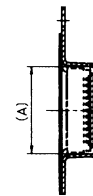
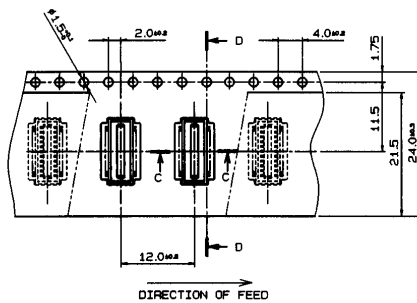
	P/N	Stacking Height
PLUG	10 5087 xxx x30 861	3.0
RECE.	20 5087 xxx x00 861	
PLUG	10 5087 xxx x35 861	3.5
RECE.	20 5087 xxx x00 861	
PLUG	10 5087 xxx x40 861	4.0
RECE.	20 5087 xxx x00 861	

No. of Pos.	A
20	7.2/283
30	9.7/382
36	11.2/441
40	12.2/480
50	14.7/579
60	17.2/677



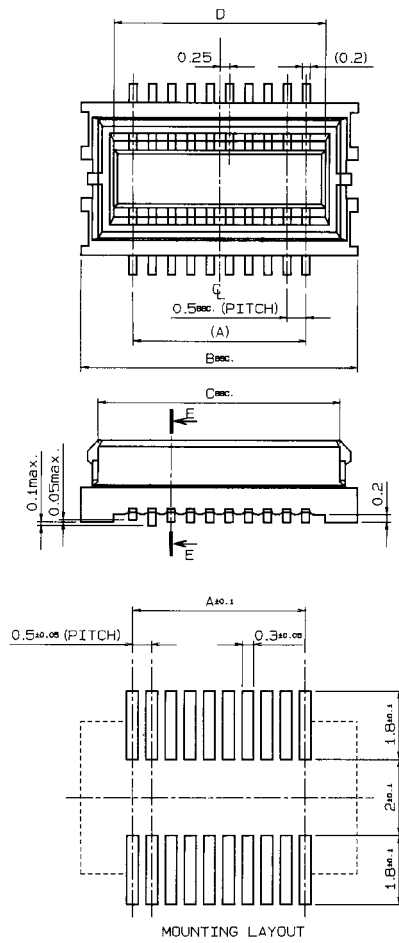
0,5 mm Spacing

Tape and Reel



Super Micro Connectors 0.5mm Pitch

Series 5087 Plug

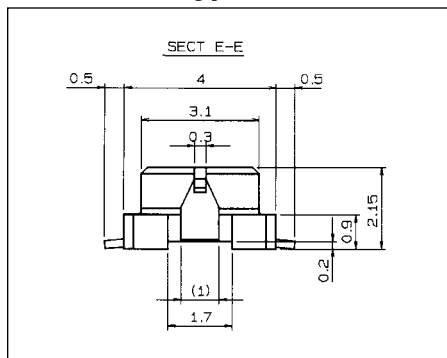


ORDERING CODE

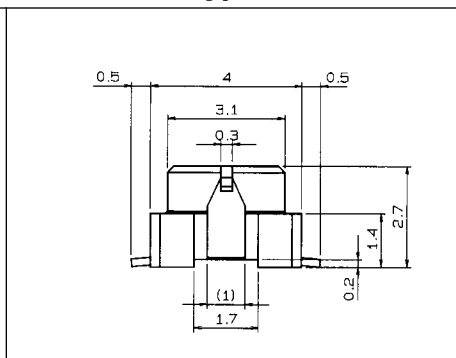
14 5087 0XX X XX 8XX

- FINISH
 - 861 = Ni Under Coated
1.25µm min.
Gold-Mating Area
Au 0.38µm min.
 - 829 = Ni Under Coated
1.25µm min.
Gold-Mating Area
Au 0.1µm min.
- VARIATION
 - 30 : H = 3.0mm
 - 35 : H = 3.5mm
 - 40 : H = 4.0mm
- TYPE
 - 0 = without Boss with Retention Clip
 - 2 = without Boss, Retention Clip
 - 9 = without Boss, Retention Clip, with Adhesive Tape
- NUMBER OF POSITIONS (20, 30, 32, 36, 40, 50, 60)
- SERIES
- TAPE AND REEL
14 = Plug

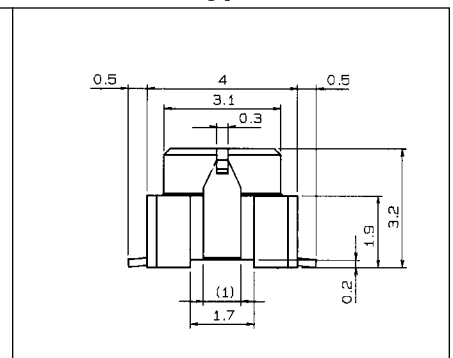
H = 3.0mm Type



H = 3.5mm Type



H = 4.0mm Type

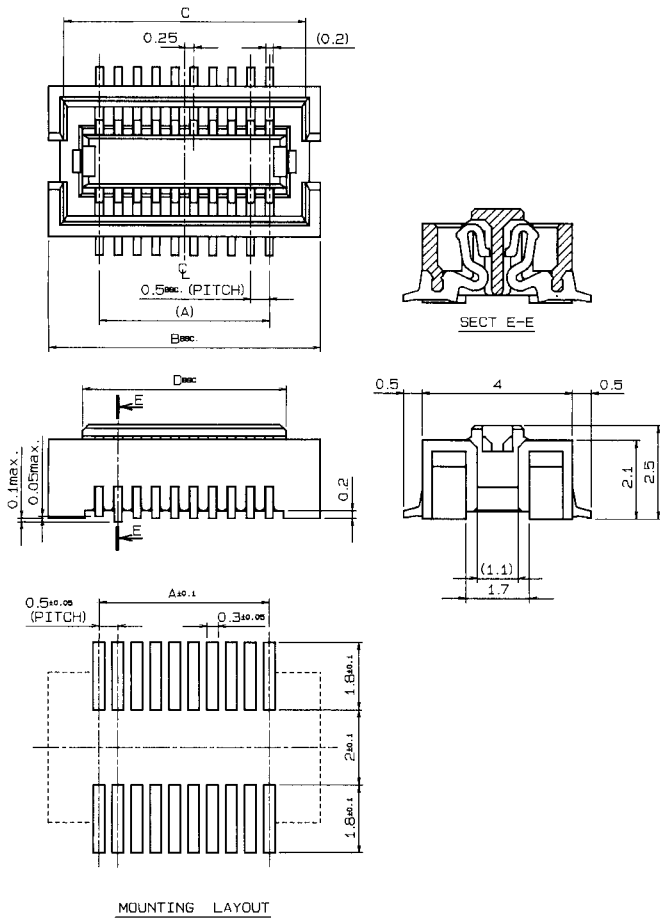


Additional information on this product is available from AVX's catalog or AVX's FAX Service. Call 1-800-879-1613 and request document #269. Visit our website <http://www.avxcorp.com>

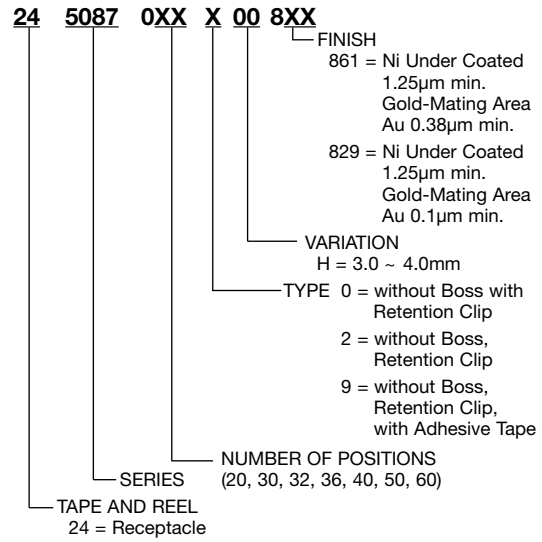
ELCO

Super Micro Connectors 0.5mm Pitch

Series 5087 Receptacle H = 3.0 ~ 4.0mm Type



ORDERING CODE

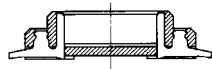
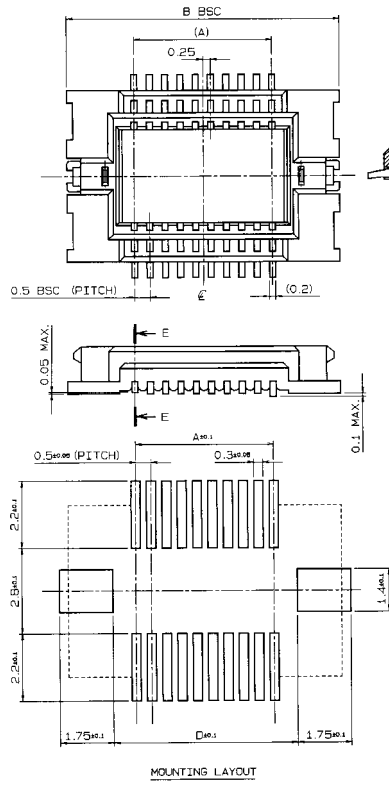


A = 0.5 (± -1)
B = A + 2.7
C = A + 1.9
D = A + 0.9

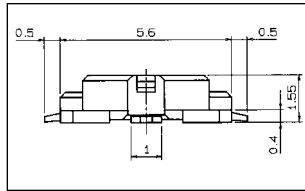
Additional information on this product is available from AVX's catalog or AVX's FAX Service. Call 1-800-879-1613 and request document #270. Visit our website <http://www.avxcorp.com>

Super Micro Connectors 0.5mm Pitch

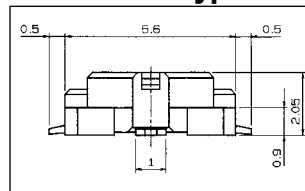
Series 5087 Plug



H = 2.0mm Type



H = 2.5mm Type



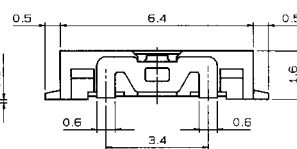
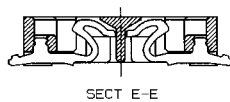
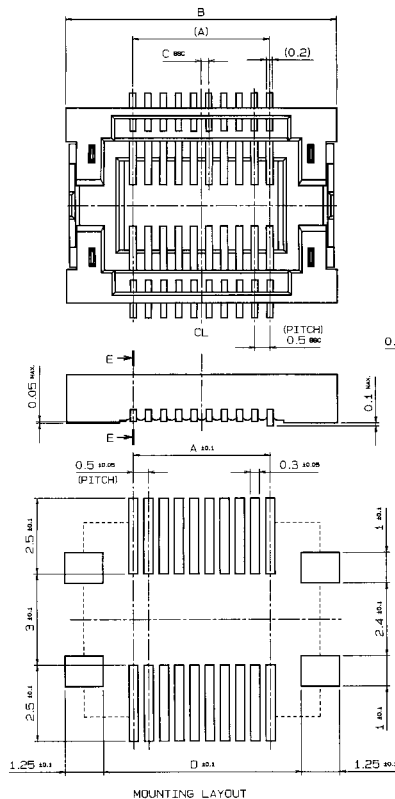
A = 0.5 (±1)
 B = 0.5 (±1)+4.4
 D = 0.5 (±1)+1.5

ORDERING CODE

14 5087 0XX X XX 8XX

- FINISH
 - 861 = Ni Under Coated 1.25µm min. Gold-Mating Area Au 0.38µm min.
 - 829 = Ni Under Coated 1.25µm min. Gold-Mating Area Au 0.1µm min.
- VARIATION
 - 20 : H = 2.0mm
 - 25 : H = 2.5mm
- TYPE
 - 0 = without Boss with Retention Clip
 - 2 = without Boss, Retention Clip
 - 9 = without Boss, Retention Clip, with Adhesive Tape
- NUMBER OF POSITIONS (10*, 20, 30, 40, 50, 60) *2.0mm H only
- SERIES
- TAPE AND REEL
 - 14 = Plug

Series 5087 Receptacle H = 2.0 ~ 2.5mm Type



ORDERING CODE

24 5087 0XX X 01 8XX

- FINISH
 - 861 = Ni Under Coated 1.25µm min. Gold-Mating Area Au 0.38µm min.
 - 829 = Ni Under Coated 1.25µm min. Gold-Mating Area Au 0.1µm min.
- VARIATION
 - H = 2.0 ~ 2.5mm
- TYPE
 - 0 = without Boss with Retention Clip
 - 2 = without Boss, Retention Clip
 - 9 = without Boss, Retention Clip, with Adhesive Tape
- NUMBER OF POSITIONS (10, 20, 30, 40, 50, 60)
- SERIES
- TAPE AND REEL
 - 24 = Receptacle

Additional information on this product is available from AVX's catalog or AVX's FAX Service. Call 1-800-879-1613 and request document #271. Visit our website <http://www.avxcorp.com>

ELCO