

WISMO Quik Q2403

Application note for integration

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Overview

This document highlights important points from the Q2403 HW specification that need to be taken into account and helps you to design your application integrating a WISMO Quik Q2403 by reviewing:

- Power supply design
- SIM interface
- RF interface
- RS232 interface
- Layout restrictions and advices

These points are developed in appendices (1 to 3).

N.B. : This document doesn't target to replace the HW specification that has to be read anyway carefully.

The reference of the HW specification document is WM_PRJ_WM2D PTS_001.pdf.

1. Application field

When designing an application based on WISMO Quik Q2403, it is really important to consider the application field :

- Define what type of application: Automotive, Handset, M2M, ...
- Consider the associated mechanical constraints to define overall dimensions and to know if friction or vibration will apply.
- Consider the environmental constraints (specially temperature) for the application and check if they are compatible with Q2403 HW specification.

2. Hardware Specification analysis

Module specification gives all technical information for a good matching of WISMO in a customer application. Therefore it should be considered as a reference and read carefully.

This specification also contains some integration advices, PCB routing and components mapping to make application design easier.

3. Power supply design

Power supply design is the most difficult part in the design of a WISMO based application. The technical choice is highly dependant on the application field and the available overall dimensions. Several architectures are possible : linear regulators, switching regulator, DC-DC converter, or batteries.

Three major points are sensible, whatever the technical choice :

- Power supply voltage :

From HW specification we have: 3.3V min ; 3.6 V nominal and 4.5 V Max.

Our experience shows that it is better to take **3.4V min and 3.7V nominal** as you will have a better margin to respect GSM specification (burst emission).

- Voltage drop during Tx burst <300mV.
- Maximum authorized ripple @200kHz.

➔ **Appendix 1** develops all previous points and shows methods to help the designer to characterize its the power supply.

4. RF interface

Application designer can choose between 3 different types of RF connection :

- Spring contact : usually used in Handset design ; always a custom design.
- Soldered coaxial cable
- Board to board IMP connector, soldered on the application board and surface contact on WISMO (see Q2403 hardware specification for details).

Since there is no component soldering on Q2403, nor custom design required the IMP solution is recommended.

A particular attention has to be paid at the RF losses. We recommend that RF losses are to be less than 1 dB between the module output and application output.

➔ Appendix 2 gives some specific information for RF design rules and also in the Q2403 hardware specification .

5. General Purpose Connector

Q2403 hardware specification gives all necessary information for interfacing the 60 pins General Purpose Connector. Nevertheless, following points require specific care , as seen during many former designs of WISMO based applications :

- SIM interface : the 100 nF capacitor is mandatory and SIM_VPP signal must not be connected if not used in the application.

➔ Appendix 3 shows methods to help designer for measure of the SIM signals.

- RS232 interface : level shifter and related rising and falling times are critical ;caution to the hardware flow control if necessary .
- GPIO : maximum current must not be exceeded.
- ADC : check that the voltage level is within the acceptable range.

➔ Appendix 2 gives also specific information about GPC layout restrictions.

6. PCB recommendations

Following chart highlights the most sensible points to take into account when designing the PCB board (placement of component as well as PCB routing):

	RF POINTS TO CHECK
RF TRACK	- Short lines
	- 50 ohms until 2Ghz
VBATT TRACK	- Impedance line <10mOHM@217Hz
	- 2mm large width of the track
3 RF WAYS	- Spec antenna
	- Measures method and layout
Exclusive Zone	- Free space near RF connection
	- Not another RF functions
	- Not BF function with high current
	- Do not use antenna switching circuit between the module and the external antenna .
AUDIO ZONE	- Not filter or amp AUDIO near RF part

	GPC 60 POINTS TO CHECK
SIM ROUTE	- EMI routing
	- short line possible
	- SIM_CLK isolated
ESD ROUTE	- Avoid long track between diode and component to
AUDIO ROUTE	- EMI routing
	- Not GND AUDIO ONLY FOR SINGLE ENDED HEADSET
ADC ROUTE	- EMI routing
xxx ROUTE	

APPENDIX 1: Power Supply Characterization

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

This appendix develops the following points:

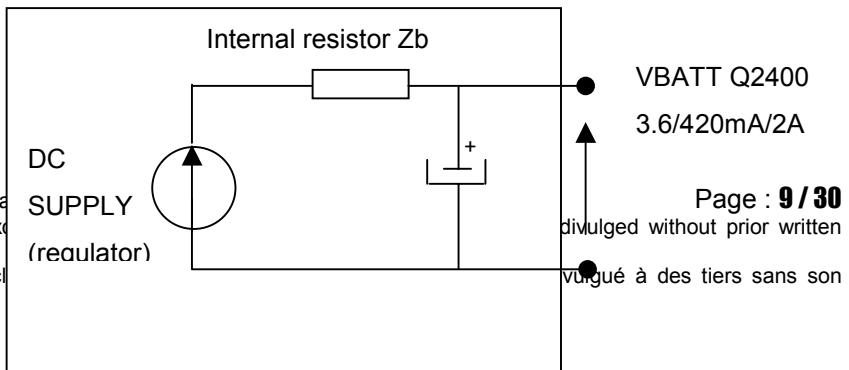
- Vdrop definition
- Ripple definition
- Vbatt measurement with and without GSM simulator
- Ibatt measurement

SPECIFICATION Q2403 POWER SUPPLY SUMMARY:

- Average current is 355 mA
- BUT during the burst (577µs), 3.3V / 2A is mandatory
- V drop max = 300 mV
- Ripple max = 2mV@200KHZ (to avoid if possible)

1. Vdrop definition

EQUIVALENT SCHEMATIC OF A POWER SUPPLY



INTERNAL RESISTANCE must be smallest possible, the drop voltage is directly concerned with this value.

$$V_{drop} = Z_b \times I_{max}$$

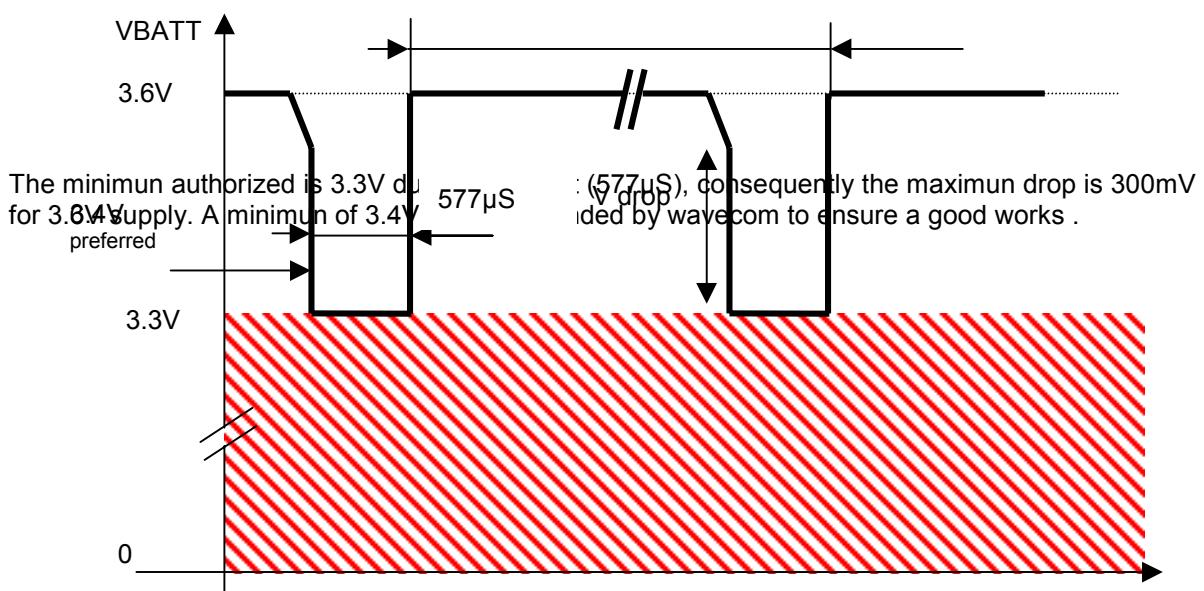
$I_{max} = 2A$

$V_{drop \ max} = 300 \text{ mV}$

- To provide the current missing some capacitors must be added.
- This capacitor can be adjusted to repair spurious problems .

WAVEFORM OF THE DROP VBATT DURING THE BURST (MAXIMUM POWER: PCL 5 in GSM)

4.6mS

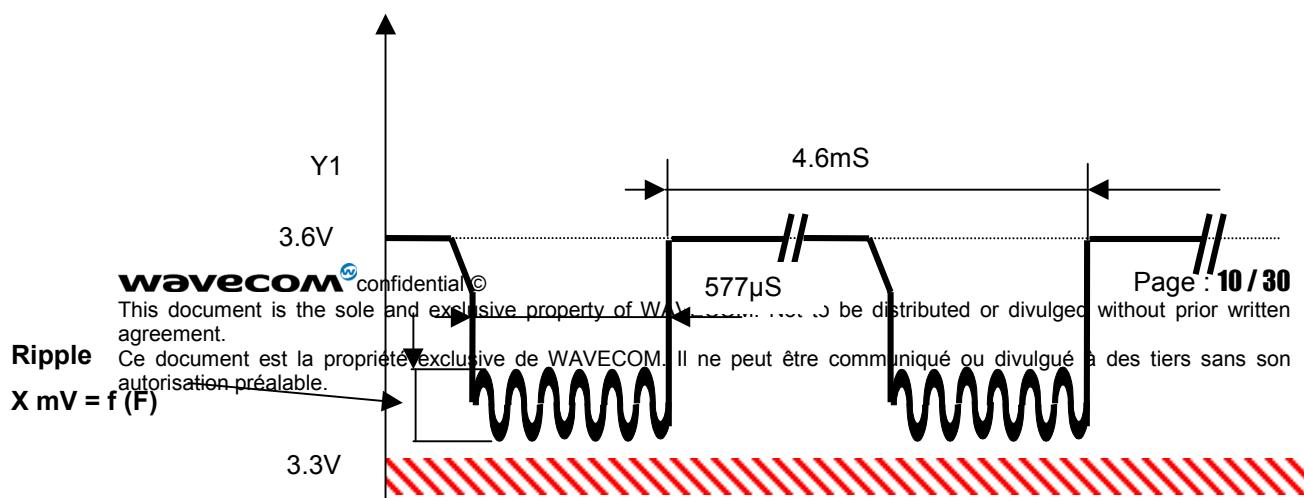


If V_{drop} is too significant the module can be disturbed.

Measurement methods are provided hereafter (§ 3, Vbatt measurement).

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2. Ripple definition



WAVEFORM OF THE MAX RIPPLE AUTHORIZED

F (Hz)	< 200KHz	200KHz
X maximun (mV)	50mV	2 mV

As shown by the table, 200 kHz is very critical as 2mV has to be respected.

Our experience shows that it is better to avoid this frequency and to choose another frequency to allow higher margin.

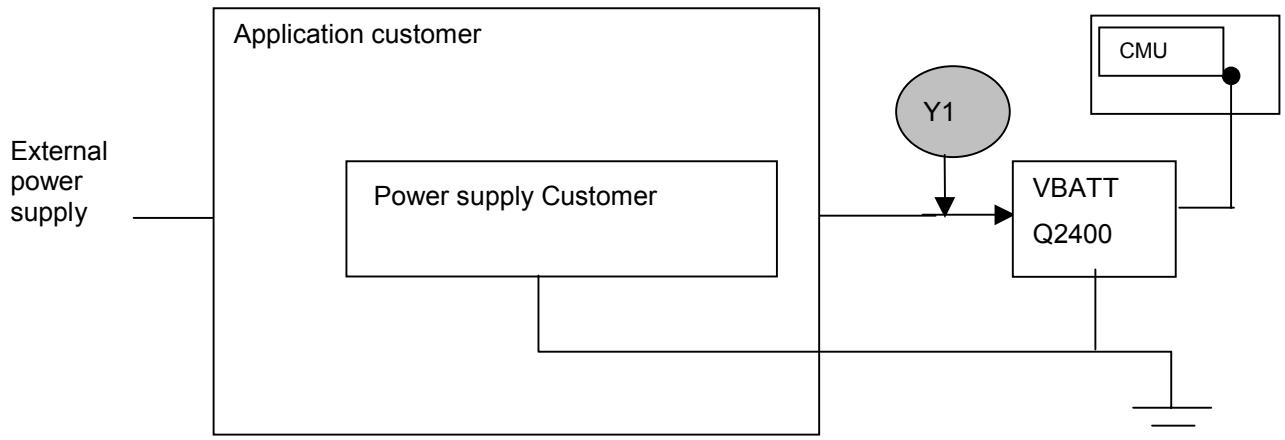
We provide later on the document methods to measure the ripple so that you respect specifications according to your settings (§ 3 Vbatt measurement).

3. Vbatt measurement

It enables you as well to measure Vdrop and the maximum ripple.

3.1 With a GSM network simulator (CMU) :

Just an oscilloscope (Y1) is necessary to check this point but you have to configure a GSM SIMULATOR .



The tests which will be carried out in COMMUNICATION mode will make using the CMU at PCL 5.

CMU configuration :

- RF level : -60 dBm

- control channel : GSM=31 ; DCS=735
- traffic channel : GSM=62 ; DCS=740
- RF connector / ext. attenuation :

(GSM): 0.6 dBm (cable 1m)

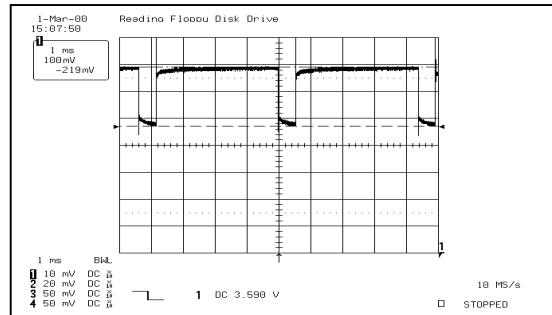
(DCS) : 1 dBm (cable 1m)

The test is carried out in communication using the CMU, and frequency error, phase error and modulation spectrum have to be checked.

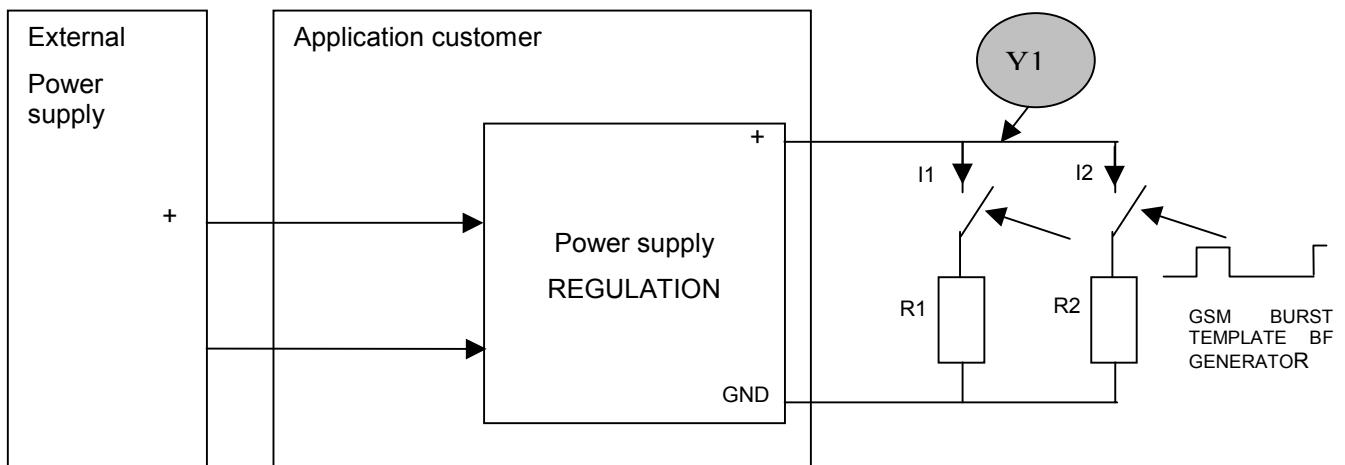
Measurements are done with an oscilloscope TEKTRONIX TDS 3034.

Example of Results on Y1 at PCL 5 in GSM mode:

DC Vbatt result = 3.598V
DROP VBATT result = 219mV
RIPPLE @1.8A = <10mV.



3.2 Without a GSM network simulator (CMU) :



R1 corresponds to a resistor according to the Vbatt average value (3.7V) and to the current value (0.1A).The ohmic value of this resistor is $3.7/0.1 = 37\text{Ohms}$ and the power is 0.5W minimum.

R2 corresponds to a resistor according to the Vbatt average value (3.7V) and to the current value (1.9A) when a GSM burst is set.The ohmic value of this resistor is $3.7/1.9 = 1.95 \text{ Ohms}$ and the power is 8 W minimum.

	Min Value	Typic value	Max value
R1	33Ohm/0.5W	37	40
R2	1.9 Ohm/8W	1.95	2

The waveform of Y1 will remain the same one that in the paragraph above.

3.1. AC parameter restriction to avoid any disturbances (phase, frequency error) :

Our module is sensitive to the oscillations coming from the application of the customer thus will check us that does not disturb operation in mode GSM.

- Just an oscilloscope is necessary to check this point but you have to amplify Y1 to see the ripple.
- to check on the CMD the 60 following parameters : phase error peak, phase error rms, frequency error.

4. Average consumption of Ivbatt

The measurement of Ivbatt is very important as you need to know usually the values of:

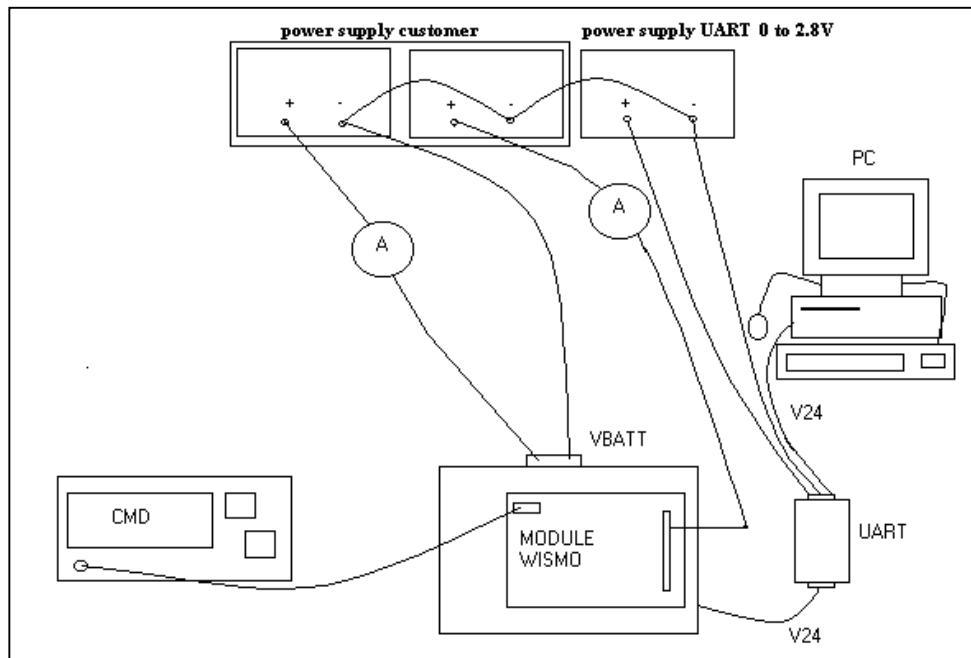
- Average consumption in mode COMMUNICATION (into the burst TX and RX)
- GSM : PCL5(2W) et PCL19(3mW)
- Consumption in IDLE mode
- Consumption in OFF mode

Please note as well the total consumption of your module is Ivbatt + Ivdd. It gives you the flexibility to supply only one of them if one part is not needed. It results in saving power.

4.1. Method of measurement :

- To put the module under tension
- Establish a communication with the CMD60 and adjust PCL.
- The multimeters are in ammeter mode: gauge mA (average mode)
- To raise average consumption on I_VBATT has a maximum level of power.
- To make the same thing for VDD using multimeter: (it does not matter the level of power).
- OFF method :
 - launch **AT+CPOF (OFF mode)**
 - remove serial link
 - to put in the gauge mA/ μ A (average mode)
 - read the result on VBATT and VDD.

4.2. Test configuration :



4.3. Specification values in GSM :

AVERAGE 1RX/1TX@PCL5	Minimun value	Maximun value
I VBATT	270mA	320mA
I VDD	85mA	100mA
I VBATT + I VDD	355mA	420mA

AVERAGE IDLE MODE	Minimun value	Maximun value
I VBATT	100µA	300µA
I VDD	3mA	6mA
I VBATT + I VDD	3.10mA	6.3mA

OFF MODE	Informative value

I VBATT	10µA
I VDD	0.5µA
I VBATT + I VDD	10.5µA

APPENDIX 2:

Layout rules explanations

This appendix gives an overview on the different restriction and recommendations that you have to respect when designing your layout. It is explained in two parts: RF and GPC connector.

1. RF Layout restrictions

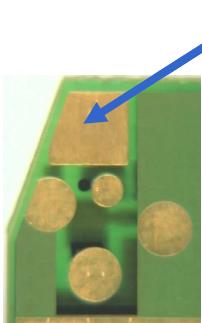
1.1. RF line :

RF line and cables shall be as short as possible to minimise losses and must have a characteristic impedance of 50 Ohms until F = 2GHz.

1.2. RF possibilities :

3 ways of connecting RF is possible, 50 Ohms coaxial connection, Spring contact area for handset or PDA and 50 Ohms BOARD TO BOARD connection.

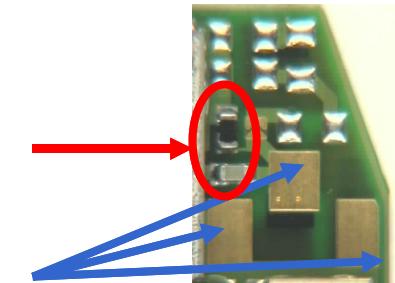
Spring contact



Module TOP

ESD Protection

PAD M P



Module BOTTOM

Following restrictions and recommendations have to be taken into account:

- **Co-axial connection (50 Ohms)** : this soldered solution is based on a RG178 coaxial cable and the losses are approximatively **2 dB /metre (max value)**

- **Spring contact** : as this solution is well suited for handset, the antenna shall be very close from the module so the RF impedance is not exactly 50 ohms.

An additional matching network placed on Q2403 module shall be required, this research of the value needed an experience in RF so WAVECOM recommends to work with an antenna manufacturer to develop and to adapt the antenna with the application.

- **IMP BOARD TO BOARD connection (50 Ohms)** : this solution improved the design of a RF line with a characteristic impedance equal to 50 Ohms, this design is tied to the PCB dielectric propriety and the geometric line design.

For help, a software for RF line impedance calculation can be downloaded from AGILENT web site (AppCAD : <http://www.agilent.com/view/rf>)

1.3. Vbatt :

- Since the maximum peak current can reach 2A Wavecom strongly recommends a large width for the layout of the power supply signal.
- The routing must be done in such a way that the total impedance line must be inferior or equal to 10 mOhms @ 217Hz.

1.4. Exclusive zone :

It is not recommended to place components around the module RF connection. The goal is to avoid the radio perturbations.

Here is a non exhaustive list to avoid to place in this zone:

- BF functions with high current like DC/DC converters
- AUDIO functions like amps or filters
- DIGITAL functions like microprocessor or RAM
- OTHER RF functions like FM receiver or GPS system
- Antenna switching circuit

2. GPC 60 pts layout restrictions

2.1. EMI definition :

EMI stands for ElectroMagnetic Interferences.

All the sensitive signals are listed to take EMI precautions.

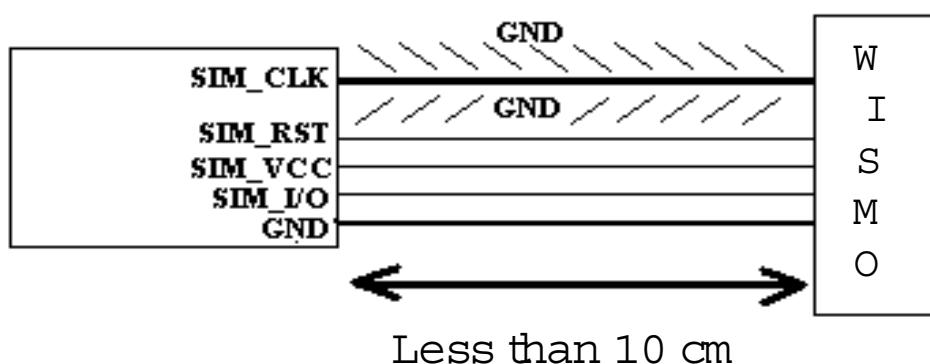
EMI LAYOUT :

- avoid current loop
- sensitive signals to isolate into ground

2.2. SIM :

For the SIM interface, length of the track between the WISMO module and the SIM connector should be as short as possible (10cm).

EMI layout is recommended for SIM_CLK signal .


2.3. ADC :

EMI layout is recommended.

2.4. Audio :

To have better acoustic performances, the SPKxx must be routed in parallel without any wire in between these lines. It is the same for MICxx.

All the filtering components must be placed as close as possible to MICxx and SPKxx pins.

Accordingly EMI layout is recommended.

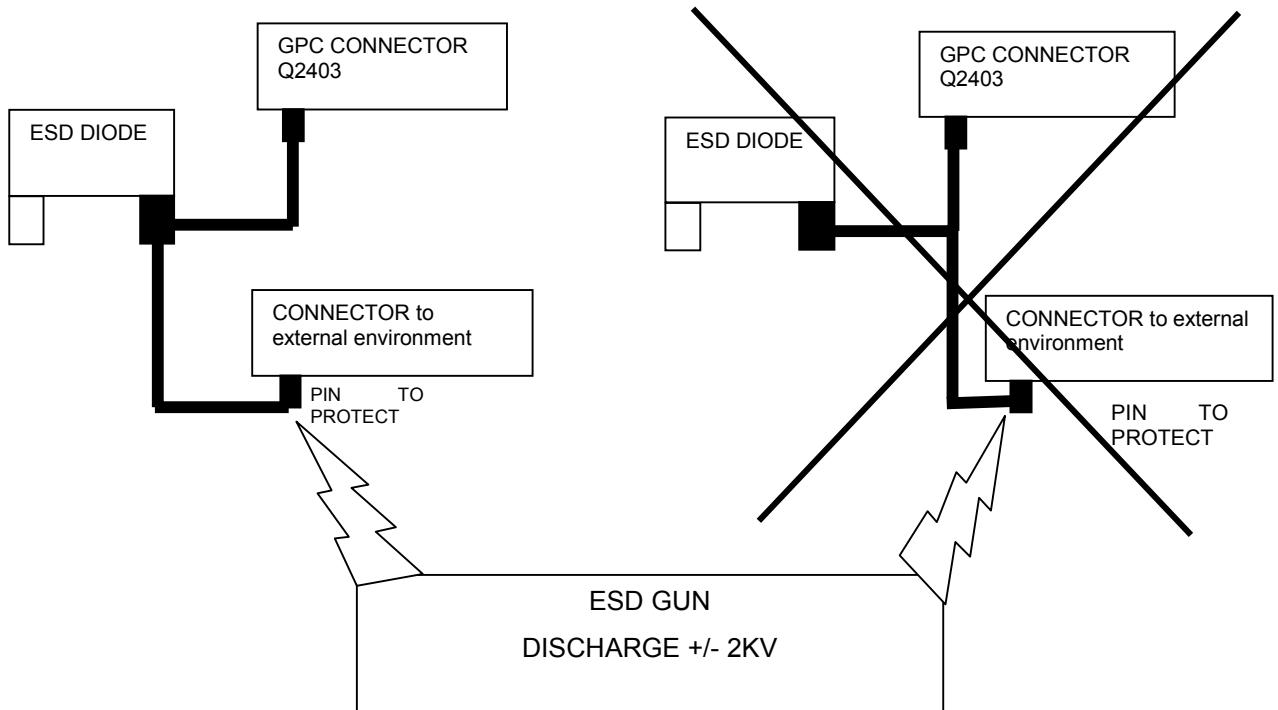
If single ended is used for headset anticipate ground audio to avoid disturbance due to length of cables .

It is possible to isolate a leg of the module to create a ground audio.

2.5. ESD protection :

ESD protection is recommended as soon as connection to external environment is used.

The track between diodes and the component to protect has to be short and like above :



2.6. DC volt:

A particular caution has to be taken to the width of the track and the line impedance.

APPENDIX 3 :

SIM Interface and measures

This appendix gives a summary about SIM interface, methods to measure SIM signals and an overview about SIM power ON / OFF sequences.

1. SIM interface :

The SIM interface controls a 3V SIM compliant with GSM 11.11 recommendations.

Before to begin measures on the SIM, it is very important to follow these requirements:

- Only 3V SIMs are supported.
- A level shifter has to be added to support 5V SIM.
- ESD protection has to be added on all the signals on CLK and DATA. The capacitor of the ESD diode itself has to be lower than 10pF.
- ESD Diodes have to be placed near the SIM socket.
- Capacitor needed on SIM_VCC has to be placed near the SIM socket.
- SIM_VPP must to be disconnected.
- SIM_PRES has to be connected to 2.8V max if not used.
- To avoid noise on SIM_VCC, SIM_CLK around GND plan could be isolated.

Pin description

Signal		I/O	I/O type	Description
SIMCLK	Y3	O	2X	SIM Clock
SIMRST	Y2	O	2X	SIM Reset
SIMDATA	Y4	I/O	CMOS / 3X	SIM Data
SIMVCC	Y1	O	Supply	SIM Power Supply
SIMPRES		I	CMOS	SIM Card Detect

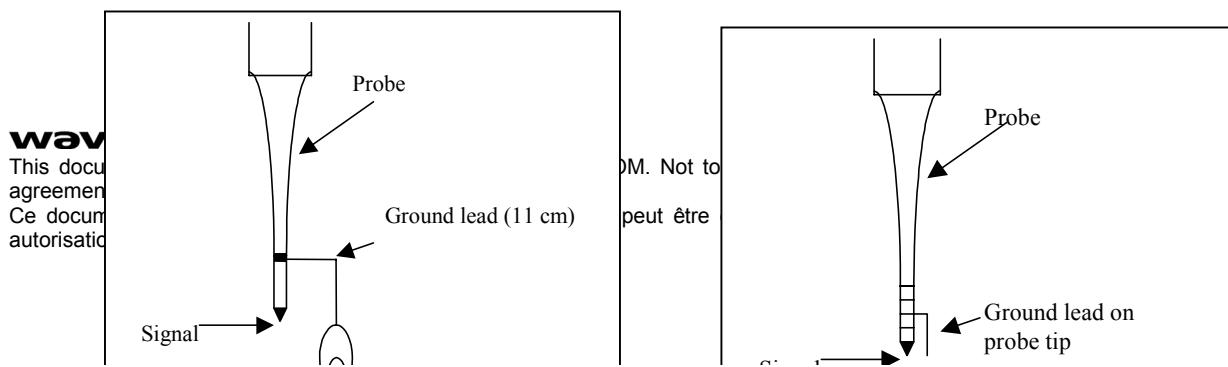
2. SIM Measures

2.1. Configuration and test methods :

In order to have a most unfavourable case of the measurement we add on signals SIM (SIMCLK, SIMDATA, SIMVCC, SIMRST) a capacity of 33pF [Worst Case].

Oscilloscope TEKTRONIX TDS 3034 is used at wavecom laboratory.

Probe is used like below to avoid NOISE on the signal , ground lead has to be close to the probe.



2.2. Requirements on the signals :

3GPP TS 11.11 version 8.6.0 release 1999

ETSI TS 100 977 version 8.6.0 (2001-12)

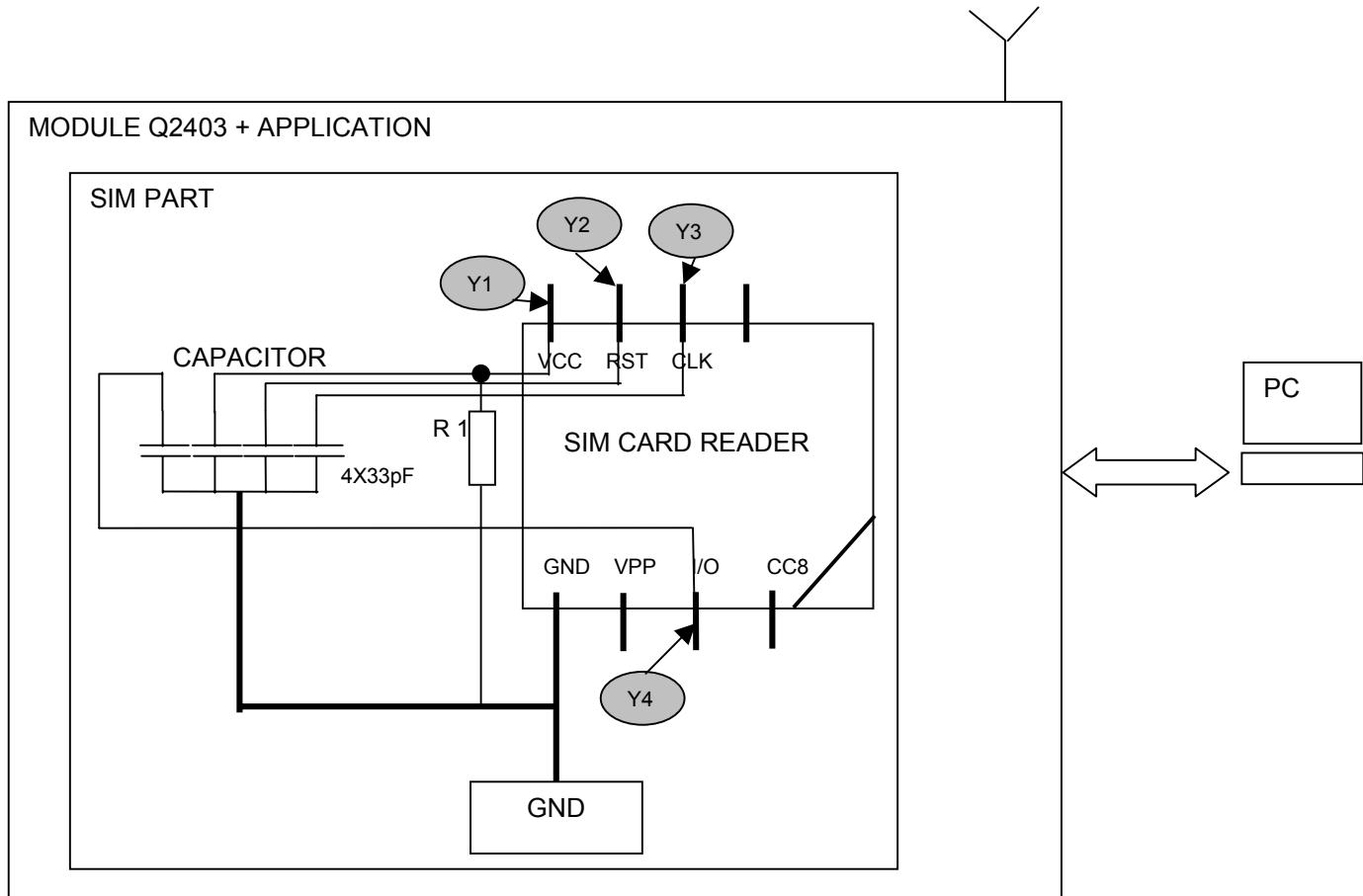
Following tables gives values taken from the later directives :

	LOW LEVEL		HIGH LEVEL	
SIM_VCC			2.7V	3.3V
SIM_RST	- 0.3V	+ 0.6V	SIM_VCC - 0.7	SIM_VCC + 0.3
SIM_CLK	- 0.3V	+ 0.5V	0.7 x SIM_VCC	SIM_VCC + 0.3
SIM_DATA	- 0.3V	+ 0.4V	0.7 x SIM_VCC	SIM_VCC + 0.3

	RISING TIME	FALLING TIME
SIM_VCC	400µs max/50ns in test	400µs max/50ns in test
SIM_RST	1µs max	1µs max
SIM_CLK	50ns max	50ns max
SIM_DATA	1µs max	1µs max

CAUTION: these values are measured when the SIM is charged (the worst case) if you do not want to charge SIM, you must measure the signals rather with 25nS for SIM _ RST and SIM_DATA.

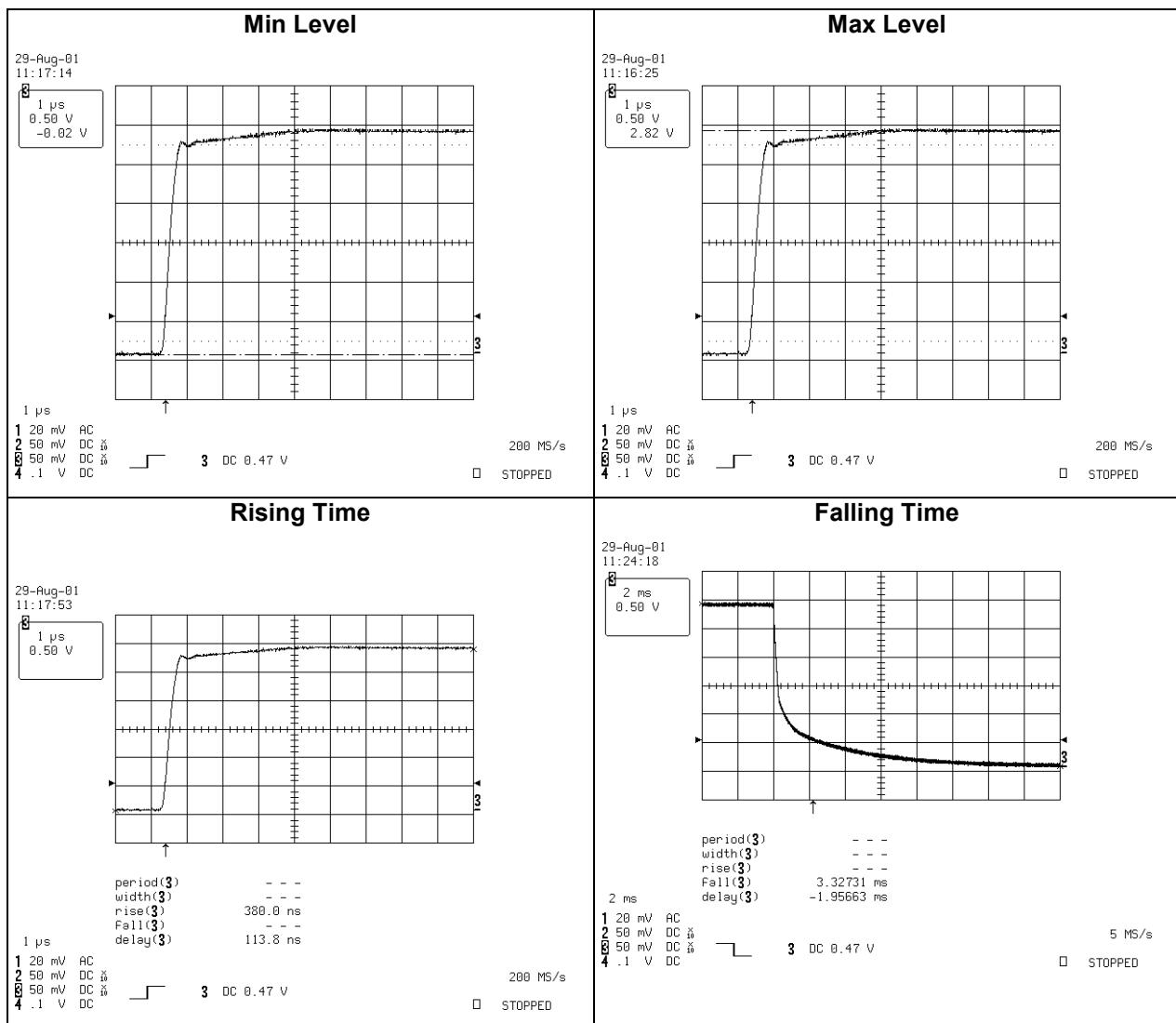
2.3. Schematic configuration :



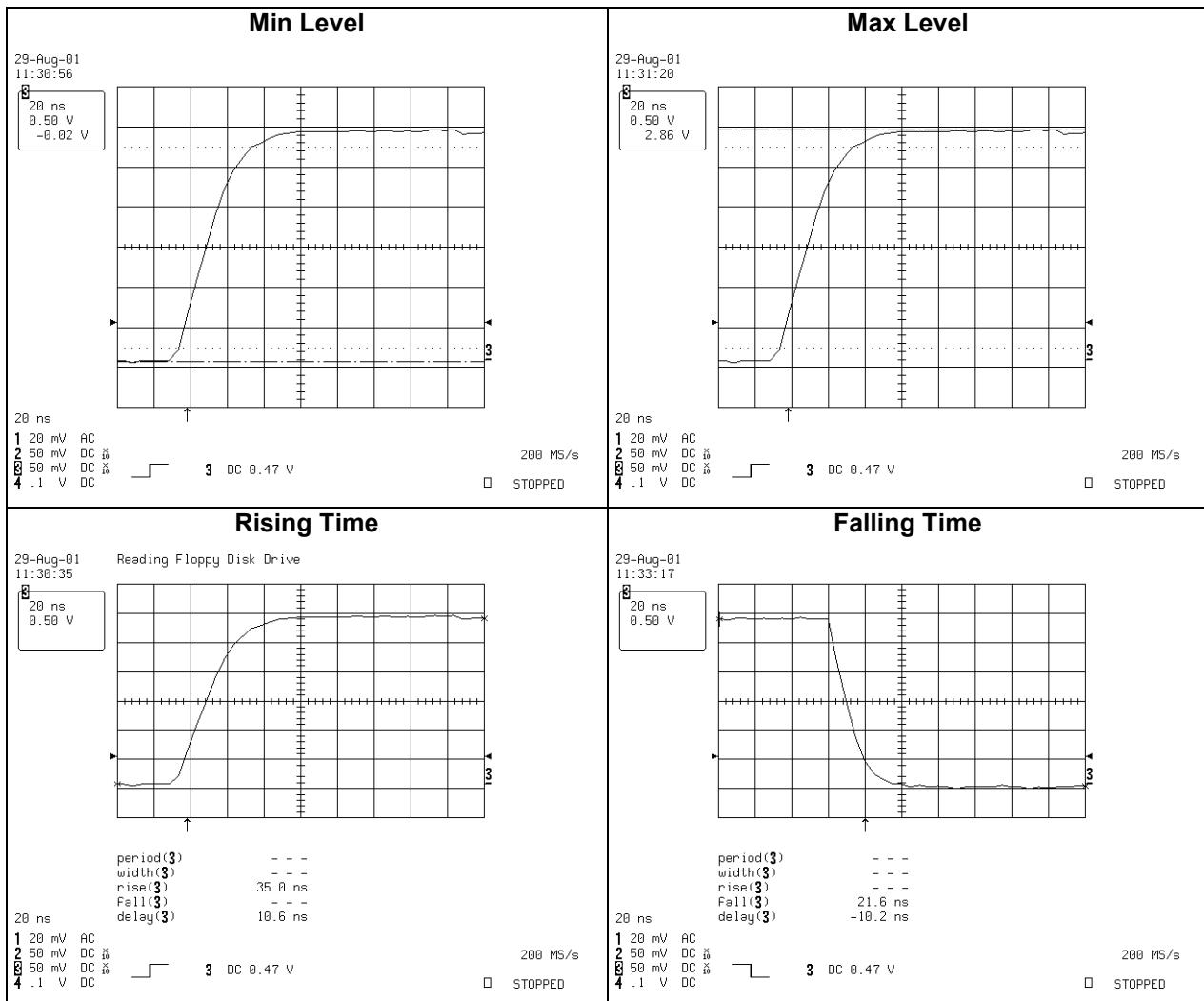
To be on the worst case, we had R1 to simulate a 6mA current to check SIM_VCC voltage and 4 capacitors on all the signals .

Following sheets gives examples of waveform observed on Y1, Y2, Y3, Y4.

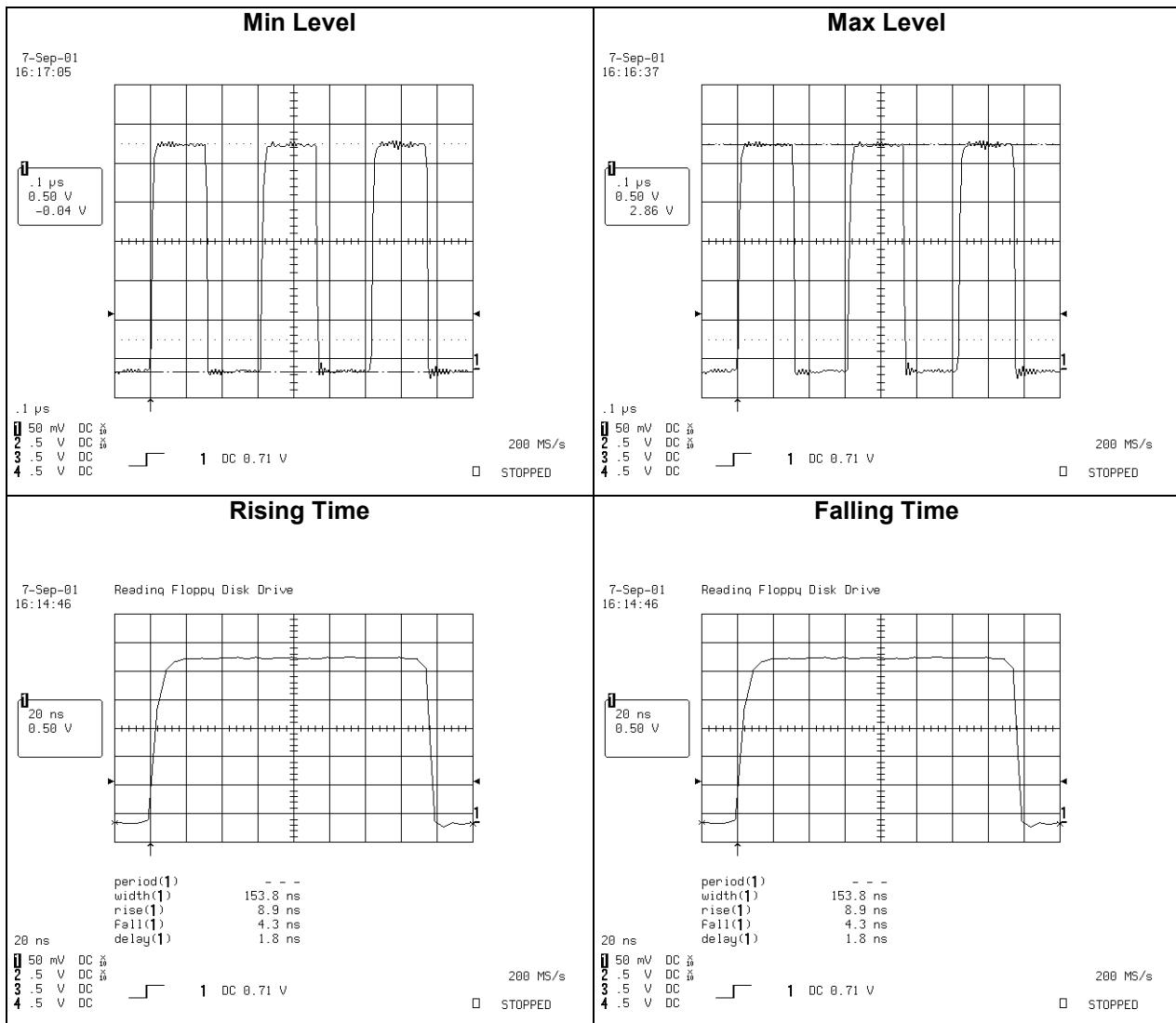
SIM VCC (Y1)

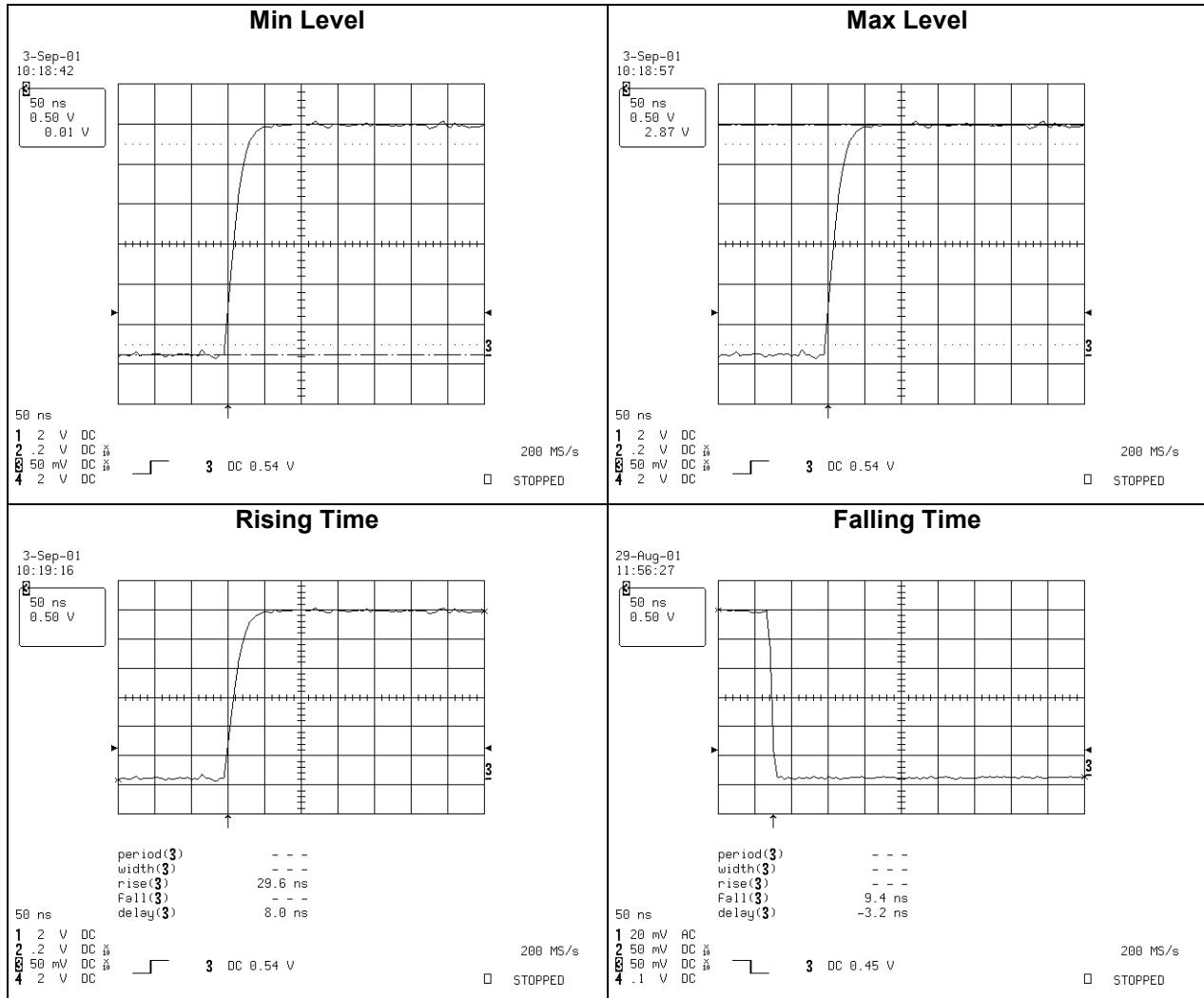


SIM RESET (Y2)



SIM CLK (Y3)



SIM I/O (DATA) (Y4)


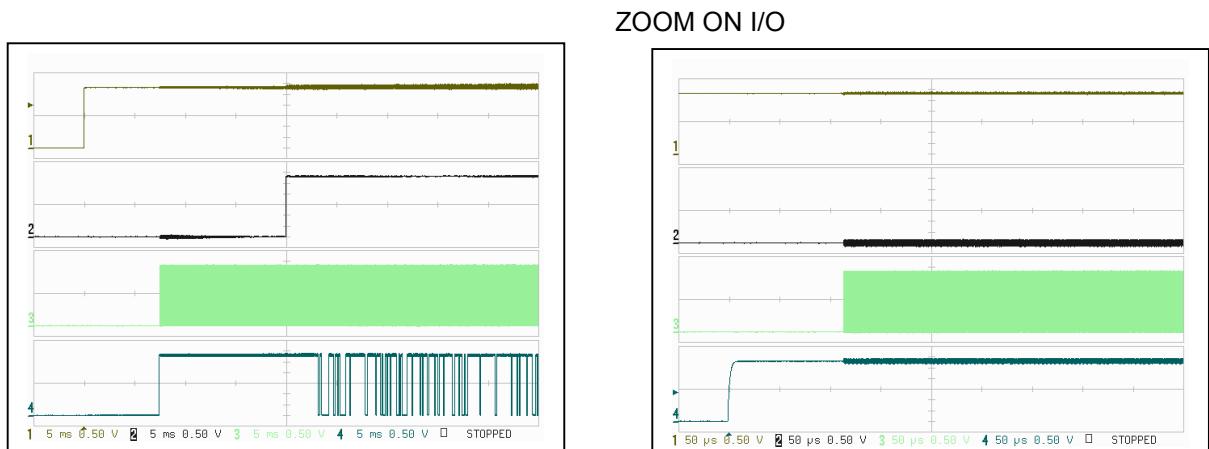
3. Power ON and Power OFF sequences

In addition the following test is performed to check SIM signals at POWER ON and POWER OFF of the application.

3.1. Power ON sequence :

When the MS is soft powered on, the contacts of the SIM/ME interface shall be activated in the following order:

- 1 - RST in state L
- 2 - Vcc powered
- 3 - I/O (ME) in reception mode
- 4 - Clock signal provided with a suitable and stable clock



Voie 1 : SIMVCC; Voie 2 : SIMRST; Voie 3 : SIMCLK; Voie 4 : SIMDATA

SIM POWER ON SEQUENCE : SIM_VCC, SIM_I/O, SIM_CLK, SIM_RST.

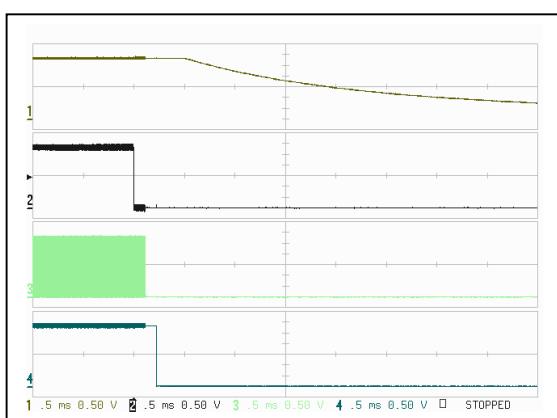
3.2. Power OFF sequence :

Depending on the state of the clock at the time of deactivation, the contacts of the SIM/ME shall be deactivated in one of two ways.

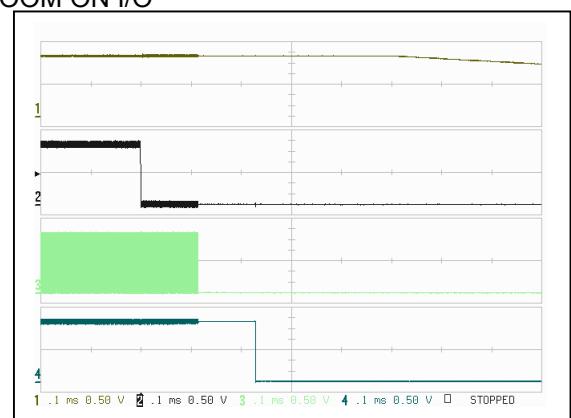
If the clock is running, the contacts of the SIM/ME interface shall be deactivated in the following order:

- 1 - RST at low level
- 2 - Clock stopped at low level
- 3 - I/O at status A
- 4 - Vcc inactive

If the clock is stopped and is not restarted, the ME is allowed to deactivate all the contacts in any order, provided that all signals reach low level before Vcc leaves high level.



ZOOM ON I/O



Voie 1 : SIMVCC; Voie 2 : SIMRST; Voie 3 : SIMCLK; Voie 4 : SIMDATA

SIM POWER OFF SEQUENCE : SIM_RST, SIM_CLK, SIM_I/O, SIM_VCC.