Direction des Recherches et des Développements Etablissement de VELIZY
VELIZY R&D Center

NOTE D'ETUDE / *TECHNICAL DOCUMENT*

TITRE / *TITLE* :

MO300 series module Application Note

RESUME / *SUMMARY*

This document is the application note for the MO300 series modules.

NOTE D'ETUDE / *TECHNICAL DOCUMENT*

FICHE RECAPITULATIVE / *SUMMARY SHEET*

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4		
5		
6		

MO300 M2M MODULE APPLICATION NOTE

SAGEM

MO300

SOMMAIRE / *CONTENTS*

1 Overview

1.1 Object of the document

The aim of this document is to describe some examples of hardware solutions for developing some products around the SAGEM MO300 M2M Module. Most part of these solutions are not mandatory. Use them as suggestions of what should be done to have a working product and what should be avoided thanks to our experiences.
This document suggests how to integrate the MO300 M2M module in wireless communicating devices such as GSM Gateway, POS, EDGE/GPS Tracking system, Wireless modem : connection with external devices, layout advises, external components (decoupling capacitors…).

1.2 Reference documents

[1] URD1 – 5625.1 – 004 69772 - MO300 series modules specification
[2] URD1 - 5625.1 - 014 69979 - AT Command Set for SAGEM Modules

1.3 Modification of this document

The information presented in this document is supposed to be accurate and reliable.
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This document is subject to change without notice.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

1.4 FCC Compliance

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

2 Block diagram

MO300
EDGE QUAD-BANDS
GSM850 / GSM900 / DCS1800 / PCS1900

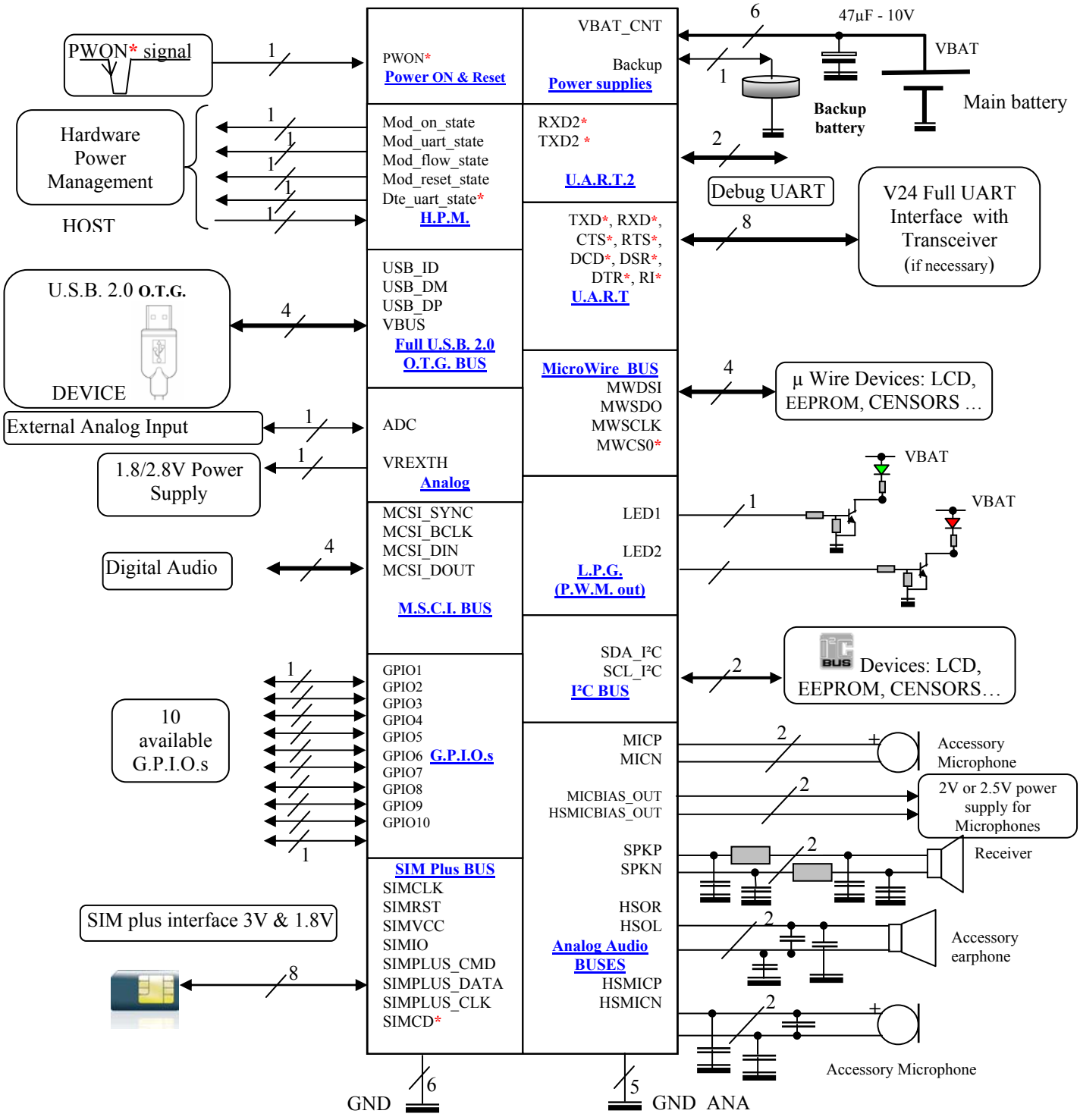


Figure 1
MO300 bloc diagram

** Low level active signal.*

3 Functional integration

The MO300 series modules target the M2M applications market.
Following the improvement of Silicon technologies includes functionality improvement, less power consumption, low voltage and higher working frequencies clock, the MO300 module meets all these requirement and uses last high end technology. All digital I/Os at the 80 pins connector are on 1.8V domain and 1.4 V for its core. Except VREXTH (1.8V or 2.8V) and VCCSIM (and the SIM I/Os at 1.8V or 2.8V) and obviously VBAT.
Thus, all chip used to communicate with the MO300 must be compatible with this voltage requirement.
Otherwise you will be simply required to use level shifters to adapt the voltage of the signals to meet the requirement of MO300 Module.
As example here is the validated chip on our design to shift I/Os voltage from 2.8V to 1.8V:

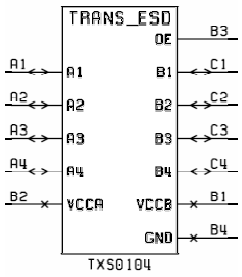
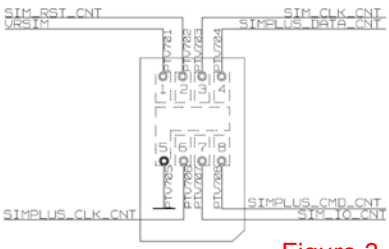


Figure 2
Example of Level Shifter

3.1 How to connect a SIM card ?:



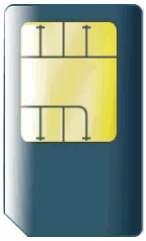


Figure 3
Sim plus card

Preliminary notes:

Regarding the Sim cards:
Some improvements and new features are supported by new generation of Sim cards.
The main features are the support for 1.8 power supply for USIM used in EDGE, HSDPA and UMTS applications.
The second one is the add-on, the flash memory included in Simplus card to mix and simplify the design of two Card holder in some applications. If necessary, with only one mechanical card holder it is possible to have access to Sim card features and at the same time to also have access to an external Flash memory module like MMC.

Regarding the card holders:
The Sim card holder can have 6 or 8 pins depending if it feature a mechanical card presence detector or not.
The Simplus card holder can have 8 or 10 pins depending if it feature a card presence detector or not.
There are two ways to connect a Sim card holder to the MO300 module.

- External Sim card holder uses 10 pins if Simplus compliant or 8 pins if normal Sim compliant from Pin 5 to pin 12 of the board to board (BtB)connector.
- Internal Sim card holder by soldering the card holder(and it's protective components) on the back side of the MO300 module.

Note: These two ways are exclusives, never use both solutions at the same time. This is mandatory.

3.1.1 SIM on the Board to Board Connector.

The SIM card connection could be done in two ways:

- Connector with 6 pins without SIM card detection.
- Connector with 8 pins with SIM card detection.

In both cases, decoupling capacitors of 10pF have to be added on SIMCLK, SIMRST, SIMVCC and SIMIO signals **as close as possible** to the SIM card connector to avoid EMC issues. Moreover, use ESD protection components to protect Sim card and module I/Os against Electro Static Discharges. The following schematic show how to protect the Sim access for 8 pins connector. Apply the same method for a 6 pins connector.

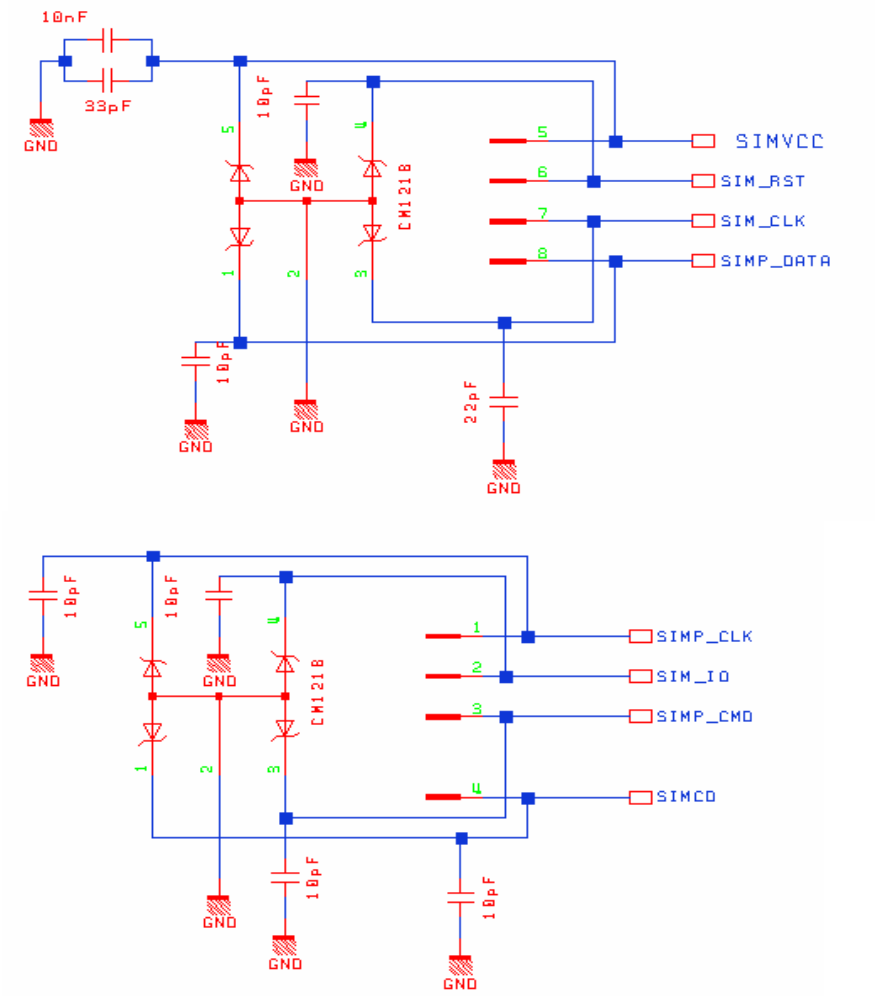


Figure 4
Protections : EMC and ESD components close to the Sim

3.1.1.1 Without SIM card detection

Normal SIM card case: 6 pins are used.

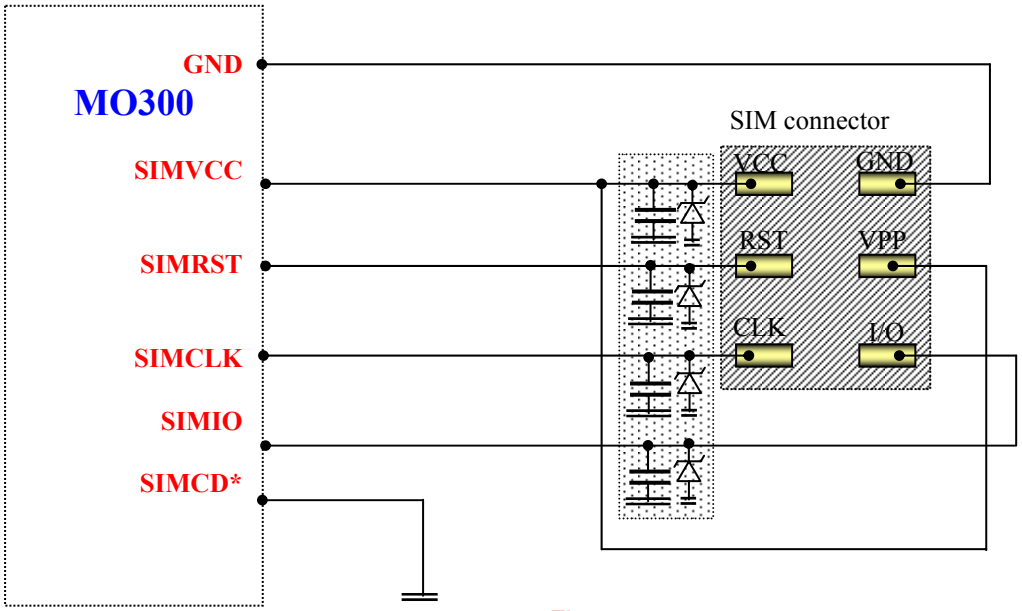


Figure 5
6 pins SIM card connection without presence detection

SIM Plus card case: 8 pins are used.

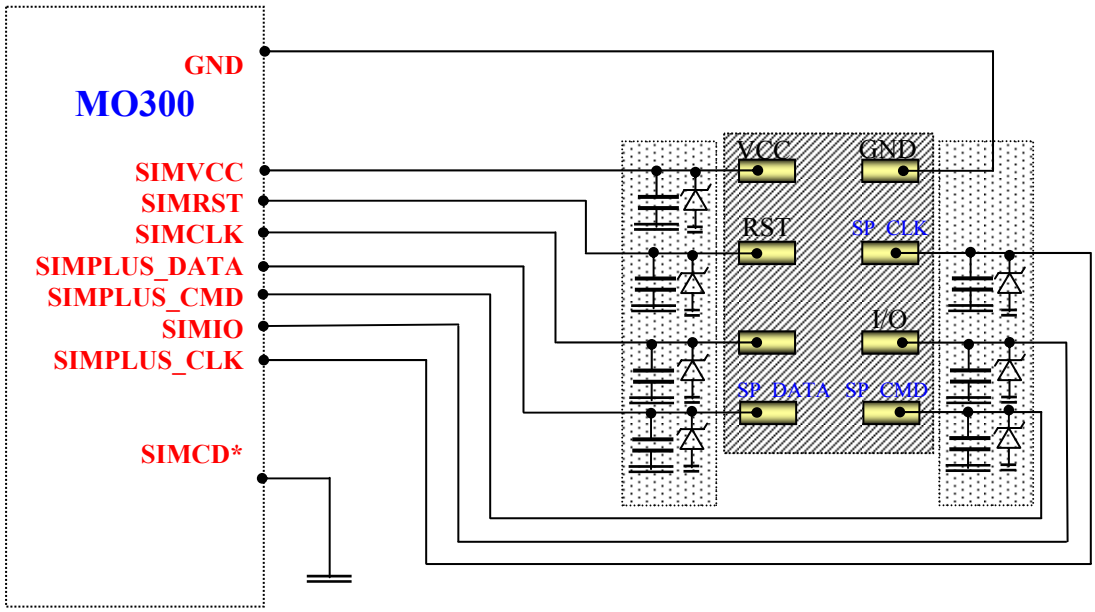


Figure 6
8 pins SIM plus card connection without presence detection

In these configurations, the SIMCD* signal is always Low.
There is no hardware SIM card detection, so the SIM card is considered as always present. (A software detection is always performed). For filtering, EMC and ESD values refer to schematics figure 4.

3.1.1.2 *With SIM card detection*

Normal SIM card case: 6 pins are used.

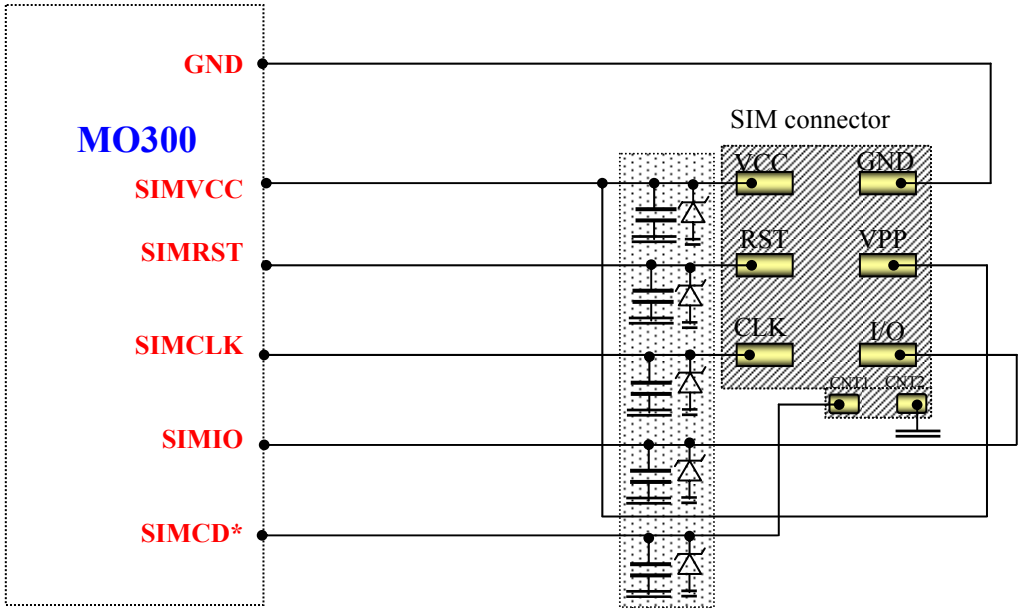


Figure 7
SIM card connection with presence detection

SIM Plus card case: 8 pins are used.

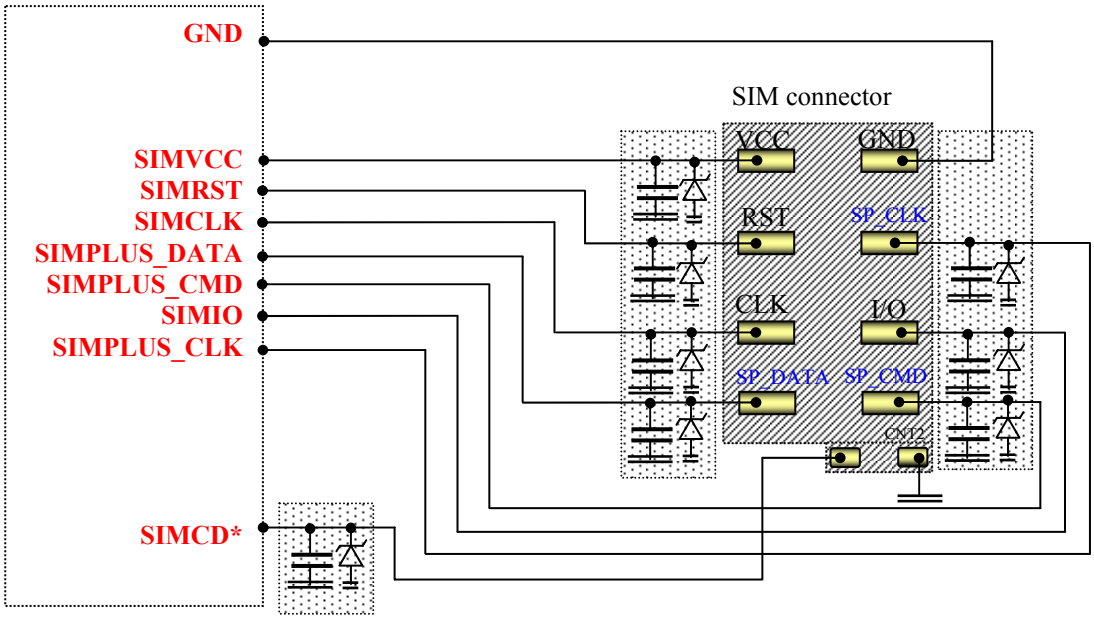


Figure 8
8 pins SIM plus card connection with presence detection

These configurations allows the module to detect if a SIM card is present in the connector or not. When present, the SIMCD signal is connected to GND signal through a mechanical switch integrated in the SIM connector (the type of switch depends of the SIM connector) thus a hardware interruption is generated. When the switch is opened, the internal MO300 pull up raise the signal to high level (1.8V)

3.1.2 SIM holder soldered on the back of the MO300.

The MO300 module feature a soldering area on its back to mount a Sim card holder with all necessary components to protect it from EMC and ESD.
For your design, if the Sim connection through the BtB connector is not required, use the following recommended schematic.
As already warned: Never use both SIM card connection solutions at the same time. This is mandatory.

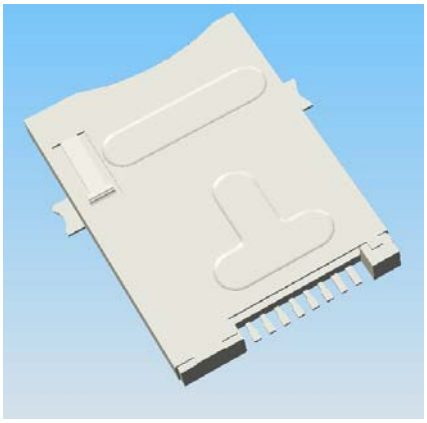


Figure 9 SIM holder

The behaviour is as described in the previous chapter.

3.1.2.1 Schematics

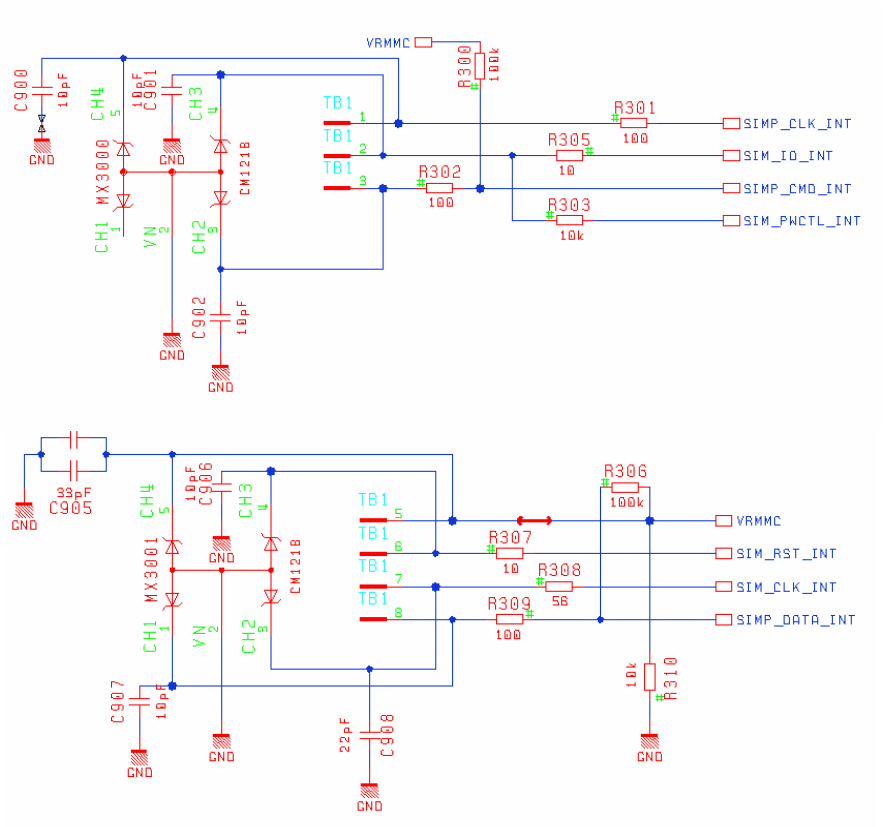


Figure 10
Components for backside Sim holder

Note: **SIM card presence detector cannot be used with the SIM holder on the back of the MO300. The SIMCD signal is therefore not used in that case.**

3.1.2.2 ***Placing***

All these components should be soldered at the following positions.

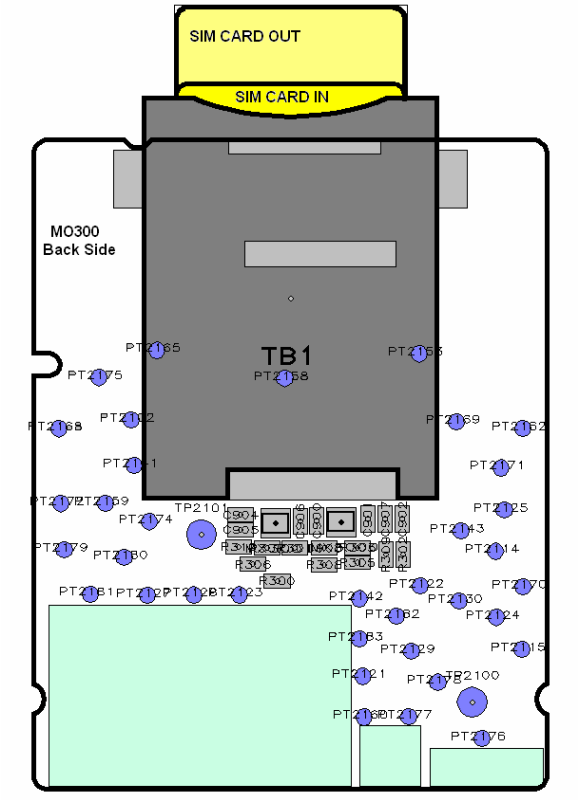


Figure 11
Components for backside SIM holder

Close view of the components area:

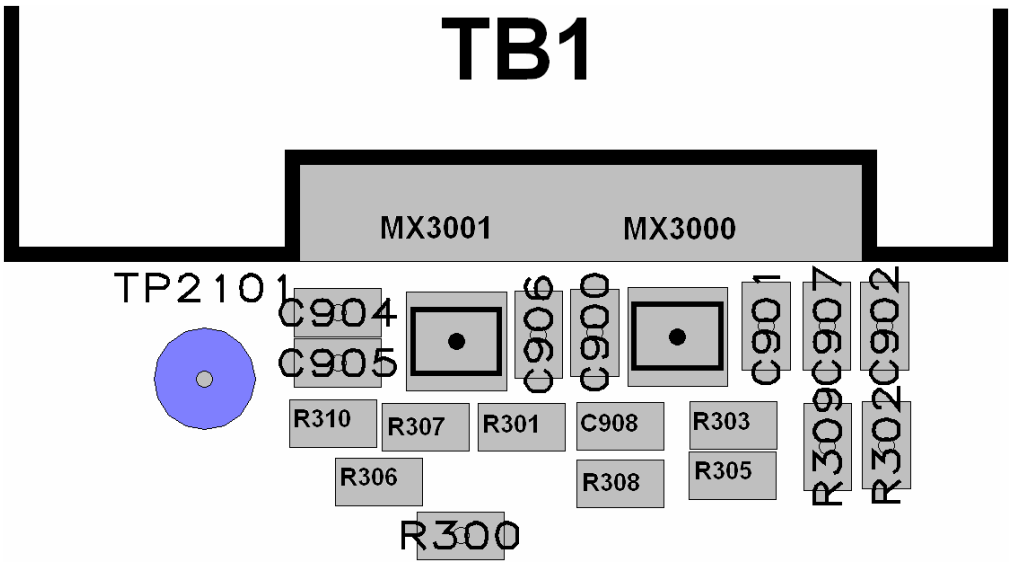


Figure 12
Zoom on components area

SAGEM can provide a suppliers component codes list on request

3.2 HOW to connect the AUDIOS?

The MO300 module feature 2 differential audio paths. A main audio path to connect a microphone and a speaker, and a second one to connect an auxiliary audio through a Jack (for example). In this following chapter examples of design will be given including protections against EMC and ESD and some notes about the routing rules to follow to avoid the TDMA noise usually present in this sensitive area of design. It will also give the way to use the hook function and the audio-jack presence detector.

3.2.1 Using a differential Handset mode on the main audio path

The MO300 can manage an external microphone (MICP/MICN) and external speaker (32 ohms SPKP/SPKN) in differential mode.
Thus, one receiver and one microphone can be connected to the module with the following characteristics (see SAGEM references):

- Receiver 32 ohms up to 120 ohms
- Microphone accepting the polarisation described below (FET Buffer + Open Drain).
- The microphone can be supplied using the internal MO300 bias supply (recommended but not mandatory) or any other external bias system compliant with selected microphone **within the MO300 inputs limits.**

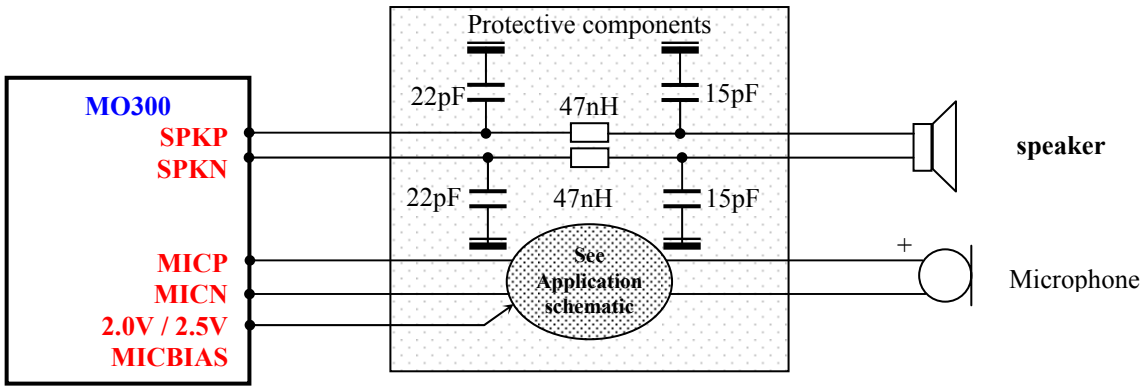


Figure 13
Differential audio handset mode

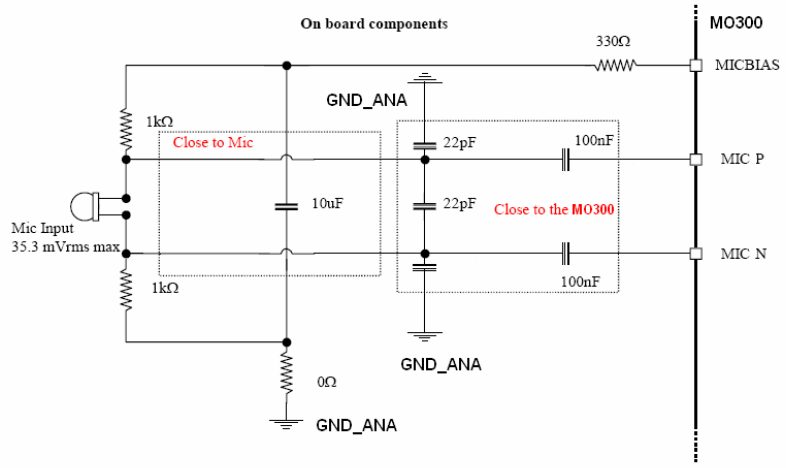


Figure 14
Microphone on board components

3.2.1.1 Notes for microphone

- Pay attention to the microphone device, It must not be sensitive to RF disturbances.
- *Some microphone includes two spatial microphones inside the same shell and allow to make an electrical difference between the environment noise (received by one of the two mic.) and the active signal (received by the other mic. + noise) resulting in a very high SNR.*
- Some resistors and capacitors should be connected as near as possible to the module as shown in the figure.
- If you Need to have deported microphone out of the board with long wires, you should pay attention to the EMC and ESD effect. It also the case when your design is ESD sensitive. In those cases, add the following protections to improve your design.
- To ensure proper operation of such sensitive signals, they have to be isolated from the others by analogue ground on mother board layout. (Refer to Layout design chapter)

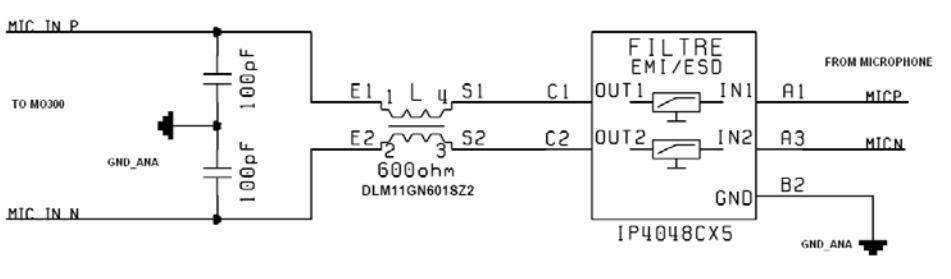


Figure 15
EMC& ESD protections for microphone in case of need

3.2.1.2 Notes for speaker

- For the speaker external π filters have to be added as near as possible to the speaker to suppress external disruption.
- Moreover, as explained for the microphone, if the speaker is deported out of the board or is sensitive to ESD, use the schematic here after to improve the audio.
- SPKP ,SPKN, and tracks must be larger than other tracks: 0.3mm .
- As described in the layout chapter, differential signals have to be routed in parallel: it is the case for SPKP, SPKN, MICP and MICN.

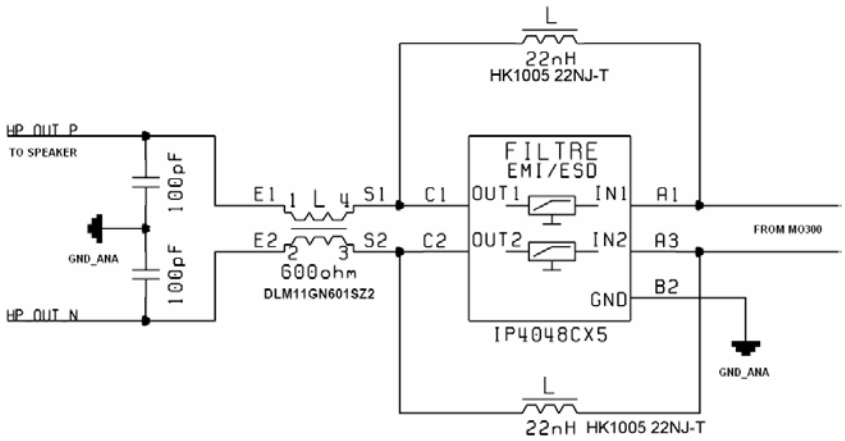


Figure 16
EMC& ESD protections for speaker in case of need

3.2.2 Non differential audio handset

For a better rejection of the common mode it is recommend to use differential audio lines.
In case, customer wants to implement a non differential solution, the figure below shows an example.
The microphone can be supplied using the internal MO300 bias supply (recommended but not mandatory) or any other external bias system compliant with selected microphone **within the MO300 inputs limits.**

Note:
SPKN and MICN must not be grounded
SPKN must not be connected to SPKP
MICN must not be connected to MICP

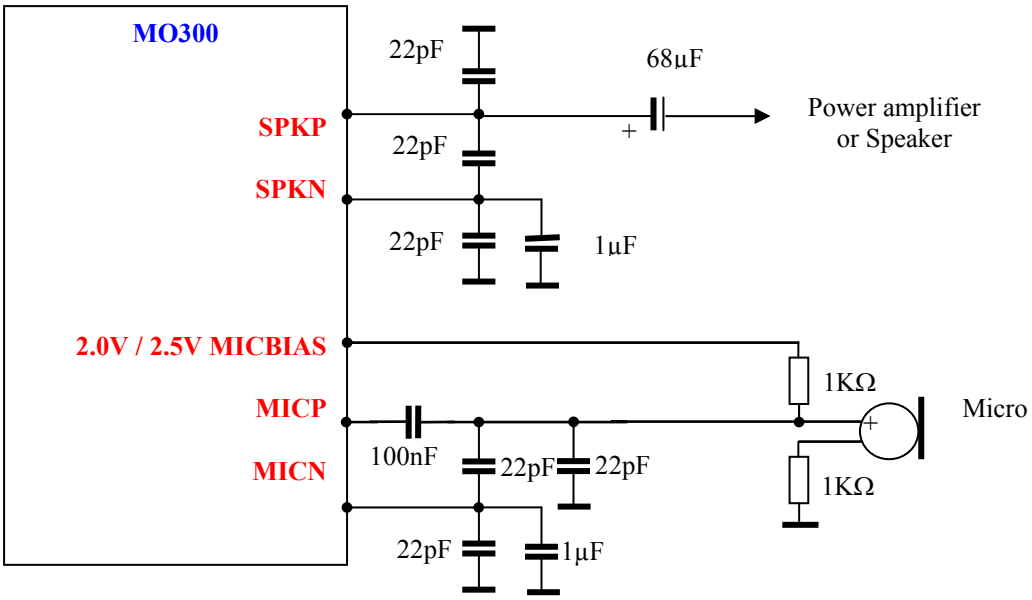


Figure 17
Non differential audio connections

Note:
If this design is ESD or EMC sensitive do not hesitate to improve it using the advises given in those chapters :

- **Notes for microphone**
- **Notes for speaker**

The weakness can either come from your PCB routing and placement or from the chosen components (or both).

- **This design is an example of single audio connection for both microphone and speaker. Only a part of it can be chosen depending on your project request (i.e. single microphone and differential speaker or vice-versa).**

3.2.3 Using a mono Headset mode on the secondary audio path

MO300 features a secondary audio path dedicated to be used with a Hands free kit accessory.
This audio path can also be used instead of the main depending on the required audio power.
An external microphone and earphone (32 ohms) can be connected to the MO300
Since the input unlink path is differential only mono headsets are supported, the speaker is connected between HSOR and HSOL.
The microphone can be supplied using the internal MO300 bias supply (recommended but not mandatory) or any other external bias system compliant with selected microphone **within the MO300 inputs limits.**

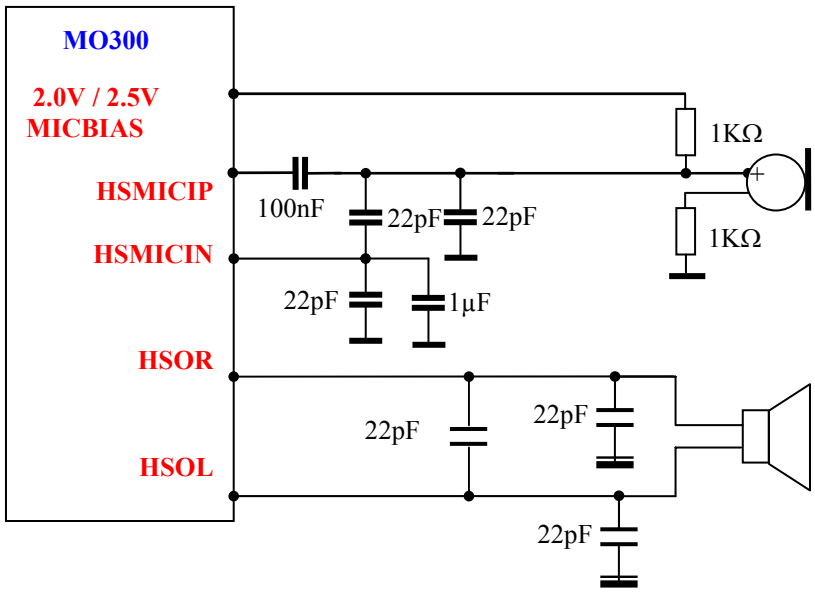


Figure 18
Mono audio headset

Note: The capacitors have to be close to the external connector.

3.2.4 Audio interface selection

In order to switch from one selection to the other, AT commands shall be used to configure the audio paths in case "SGV" file is used by default.

Refer to relevant paragraph of document [2] to implement AT commands.

3.2.5 Multi Channel Serial Interface

A MCSI bus is provided on the module MO300 for a digital interface application (i.e. Bluetooth).
Characteristics are the following :

- Voice samples : 16bits, 8kHz
- MCSI Clock : 520 kHz
- Voltage : 1.8V

More details can be given on request.

3.2.6 Characteristics of the microphone and speaker recommended by SAGEM

3.2.6.1 *Characteristics of the microphone recommended by SAGEM*

Item to be inspected	Acceptance criterion
Sensitivity	-32 dB SPL +/- 3 dB (0 dB = 1 V/Pa @ 1kHz) or -40 dB SPL +/- 3 dB (0 dB = 1 V/Pa @ 1kHz)
Frequency response	Limits (relatives values) Freq. (Hz) — Lower limit — Upper limit 100 — -1 — +1 200 — -1 — +1 300 — -1 — +1 1000 — 0 — 0 2000 — -1 — +1 3000 — -1.5 — +1.5 3400 — -2 — +2 4000 — -2 — +2
Current consumption	1 mA (maximum)
Operating voltage	DC 1 to 3 V (minimum)
S / N ratio	55 dB minimum (A-Curve at 1 kHz, 1 Pa)
Directivity	Omni-directional
Maximum input sound pressure level	100 dB SPL (1 kHz) Maximum distortion 1%
Radio frequency protection	Over 800 - 1200 MHz and 1700 - 2000 MHz, S/N ratio 50 dB minimum (signal 1 kHz, 1 Pa)

3.2.6.2 *Characteristics of the dual mode speaker recommended by SAGEM*

Inspection non operating

Item to be inspected	Acceptance criterion
Input power: rated / max	0.5 W / 1 W
DC Impedance	6 Ω +/- 10 %
Resonance frequency (Fo)	480 Hz +/- 10%
Magnetic field	< 50 Gauss at 5 mm on the back side of the speaker
Weight	< 3.0 g

Inspection operating

Test condition: Receiver is measured with IEC 318 coupler in sealed condition

Item to be inspected	Acceptance criterion			
Frequency response Input Voltage: 60mV$_{rms}$	Freq (Hz)	Lower limit (dBSPL)	Nom. value (dBSPL)	Upper Limit (dBSPL)
	200	119	121	123
	400	122	124	126
	700	125	127	129
	800	125	127	129
	1000	120	122	124
	1500	111	113	115
	2000	108	110	112
	3000	103	105	107
	4000	98	100	102
S / N ratio	50 dB minimum (A-Curve at 1 kHz, 1 Pa)			

3.3 Network LEDs

The MO300 module can manage two PWM outputs, for example to drive two network LED.
These LED could be used to interact with the network activity and the MO300 states.

If more than two LED are required, any GPIO can be used to drive a LED. A maximum of 10 GPIO are available on the MO300 Module.

3.3.1 Network LEDs connection.

Green LED shall be connected to LED1, Red LED shall be connected to LED2, serial resistor shall be connected to each LED.
These transistors can be found a in a single package referenced as UMDXX or PUMDXX Family.
Value of resistor depends on characteristic of chosen LED, it is used to limit the current through the diode,

Consider this formula to compute the resistor value in worst case: $$R_{max} = \frac{Vbat_{min} - (Vd_{min} + Vcesat_{max})}{Id_{min}}$$

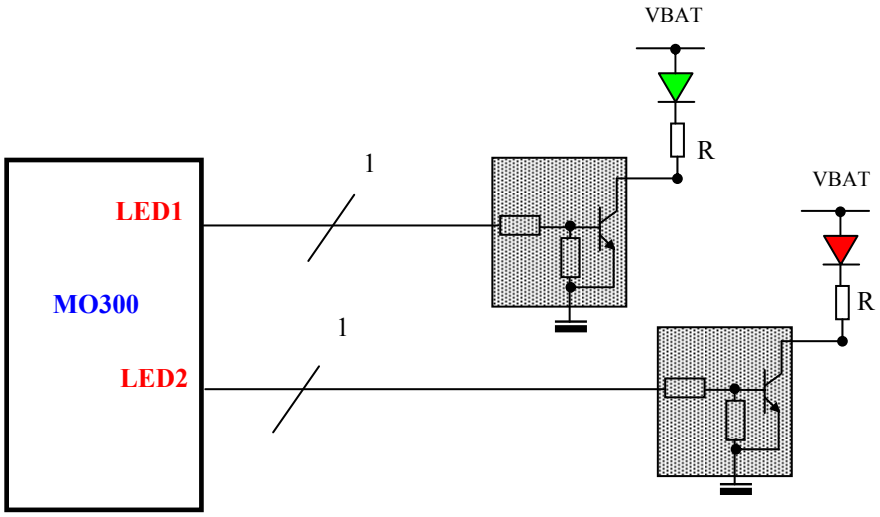


Figure 19
Network LED connection

3.3.2 Network LEDs behaviour.

As LEDs are driven through PWM outputs of the MO300, they can be configured with appropriate AT command.
User application can set for each output :

- Period between : 125ms and 3000ms
- Time on between : 3,889 and 93,59 ms

More details can be found in AT document referenced [2].

3.4 Power supply

The MO300 module can be supplied by battery or any DC/DC converter compliant with the module supply range 3.3Vmin and up to 5.5Vmax 2A.
The PCB tracks must be well dimensioned to support 2A maximum current.
Maximum serial resistance on VBAT = 170mΩ internal resistance of the battery plus tracks and contact resistance of the connectors for a new battery, or tracks & contact resistance of the connectors for a DC/DC converter.

Case of old batteries: If this value is overran, this can cause erratic reset of the module when the battery begins to be discharged.

The VBAT_CNT signal disturbs the other signal; it has to be isolated with ground from the other signals, especially radio and audio signals.
In case of batteries, it is mandatory to use Li-Ion or Li-Polymer batteries.

NOTE: The MO300 M2M module does not manage the charge of any kind of batteries.

3.5 V24 UART

The MO300 module feature a V24 UART interface plus a USB2 OTG interface to communicate with the Host through AT commands or for easy firmware upgrading purpose.

3.5.1 Complete V24 – connection MO300 - host

A V24 UART interface is provided on the main connector of the MO300 module with the following signals: RTS/CTS, RXD/TXD, DSR, DTR, DCD, RI.
It is recommended to manage an external access to the V24 interface, in order to allow easy software upgrade, especially when USB is not planed to be used.

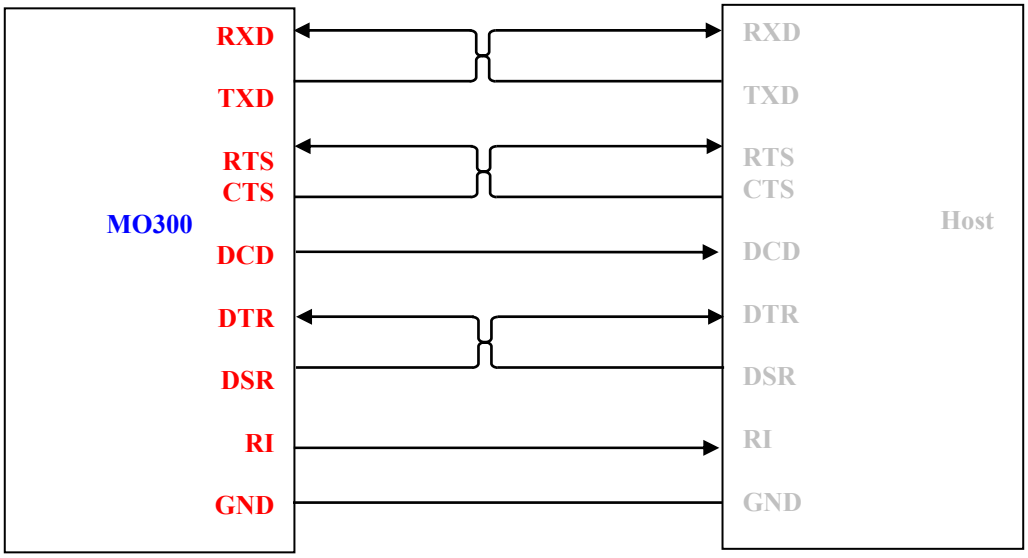


Figure 20
Complete V24 UART connection between MO300 and host

3.5.2 Complete V24 interface with PC

It supports speeds up to 115.2 KBPS and may be used in auto bauding mode as well.

To use the V24 interface, some adaptation components are necessary to convert the +1.8V signals from the MO300 to +5V signals compatible with a PC.

An example of connection between MO300 and a PC is given below.

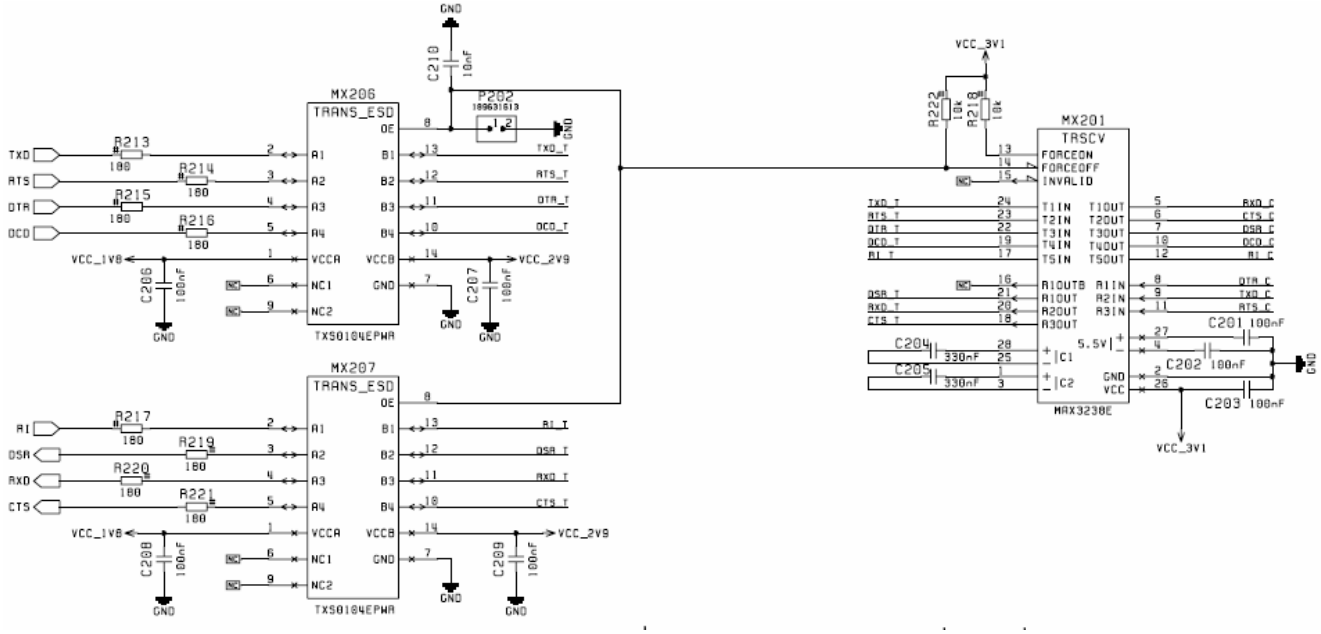


Figure 21
Signal adaptation using Level Shifters and RS232 Transceiver.

3.5.3 Partial V24 (RX-TX-RTS-CTS) – connection MO300 - host

When using only RX/TX/RTS/CTS instead of the complete V24 link, we recommend following schematic:

As we need DTR active (low electrical level), a loop DSR on DTR is sufficient because DSR is active (low electrical level) once the XS200 is switched on.

DCD and RI can stay not connected and floating.

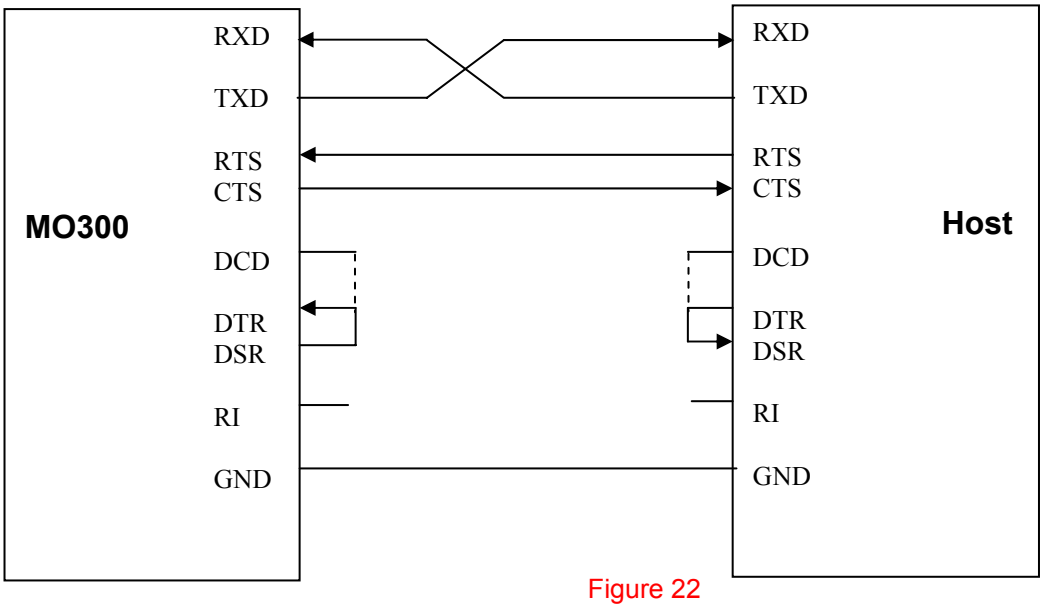


Figure 22
Partial V24 connection (4 wires) between MO300 and host

3.5.4 Partial V24 (RX-TX) – connection MO300 - host

When using only RX/TX instead of the complete V24 link, we recommend following schematic :

We need DTR active (low electrical level), a loop DSR on DTR is sufficient because DSR is active (low electrical level) once the MO300 is switched on.

We also need RTS active (low electrical level), a loop RTS on CTS is sufficient because CTS is active (low electrical level) once the MO300 is switched on.

DCD and RI can stay not connected and floating.

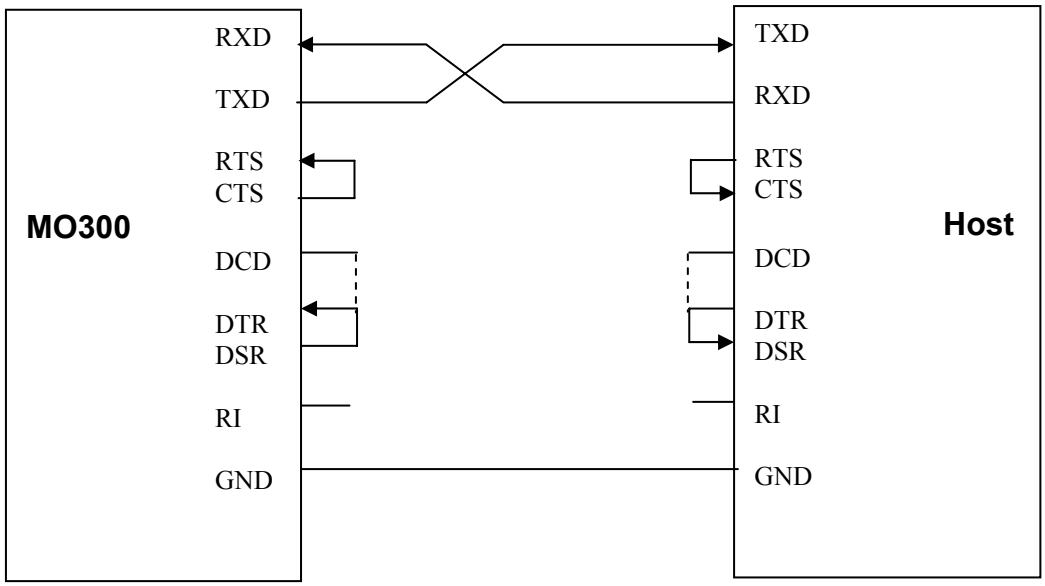


Figure 23
Partial V24 connection (2 wires) between MO300 and host

3.6 UART 2

It is strongly recommended to let this interface externally accessible for Debug (e.g. access by 2 tests pads). TXD2 and RXD2 can be used to get the software traces.

3.7 USB 2.0 OTG

The USB 2.0 interface is Full speed, then has a maximum rate of 12Mbit/s. It is On The Go capable then can be in slave or Master mode depending on the connected equipment and the MO300 Version.

MO300 can only be in slave mode. Master mode and capability to switch between the two modes is only available with the MO300E module.

In slave mode, the MO300 is answering to the customer application which is the Master of the communication.

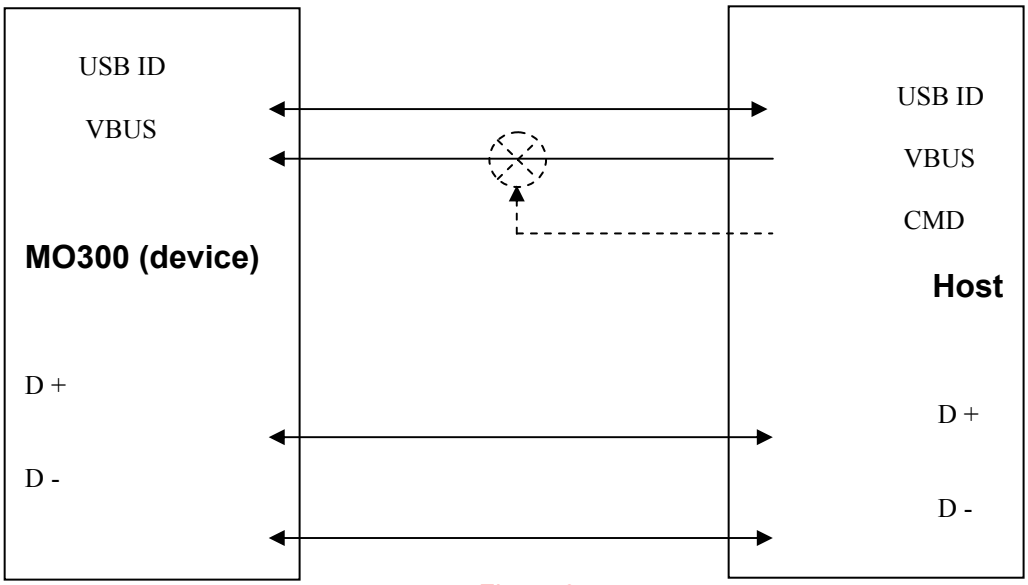


Figure 24
USB Connection between MO300 and host

To use USB link between Host and MO300, specific SAGEM USB drivers are needed and available on SAGEM www site and on request.

As soon as USB link is detected by the MO300 module, the AT command responses are sent on USB link and RS232 - UART1 interface is de-activated.

RS232 - UART2 interface for traces is still operational.

USB and RS232 - UART1 are then exclusive and priority is given to the USB interface.

CMD I/O command can be used if required, see "Stopping the module" chapter.

3.8 Backup battery

3.8.1 Backup battery function feature

A backup battery can be connected to the module in the aim to supply internal RTC (Real Time Clock) when the main battery is removed. Thus, when the main battery is removed, the RTC is still supplied. Otherwise, user will have to set the date and time after the next start.

With external BACKUP:
- if VBAT < VBACKUP, internal RTC is supplied by VBACKUP.
- if VBAT > VBACKUP, internal RTC is supplied by VBAT.

If there is no backup battery, VBACKUP input of the module has to be connected to VBAT signal.

Without external VBACKUP (VBACKUP input connected to VBAT)
- if VBAT > 2.2V, internal RTC is supplied by VBAT.
- if VBAT < 2.2V, internal RTC is not supplied.

Signal	Min	Max
VBACKUP	+1.8V	+3.2V

3.8.2 Current consumption on the backup battery

When the Main battery is removed, the current consumption which is supplied by the backup battery changes, depending on its voltage level.
The following table sum up the three different states:

VBACKUP (V)	Typical value of current Consumption (µA)
2.4 < VBACKUP	50
2.15 < VBACKUP < 2.4	Linear decrease from 250 (at 2.15V) to 50 (at 2.4V)
1 <VBACKUP < 2.15	Linear growth from 50 (at 1 V) to 250 (at 2.15V)

These values have to be taken into account for the choice of the Backup Battery technology and model.

3.8.2.1 Charge by internal MO300 charging function

The charging function is available on the MO300 without any additional external Power supply (the charging power supply is provided by the MO300).
The recommended schematic is given hereafter:

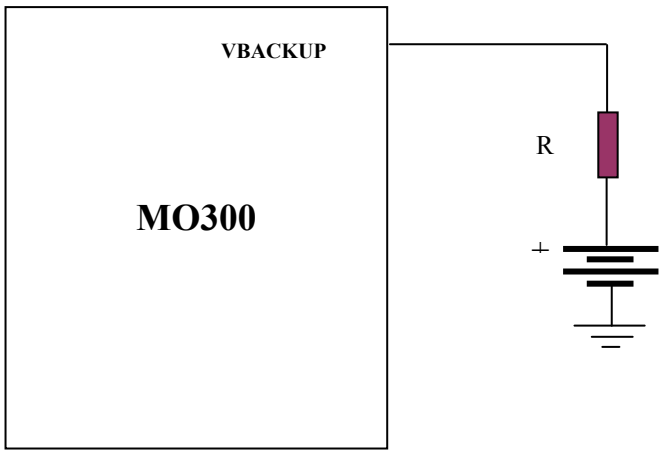


Figure 25
Backup battery internally charged

The resistor R depends on the charging current value provided by the battery manufacturer, R=100 Ohm has been tested with a capacitor battery.

The characteristics of the charging function done by the MO300 is given hereafter:

Conditions of test	Min (µA)	Typ(µA)	Max(µA)
V backup = 12 mV (deep discharge)	350	550	900
V backup = 2.8 V	350	550	900

If the recommended schematic is implemented by the customer, SAGEM will set a dedicated parameter in the software which will automatically manage the charging function.
The advantages of this management are:

- saving of component on the MAIN board,
- saving of available surface on the MAIN board,
- regulated charging current (independent of VBAT value) for the backup battery,
- improve overall power management.

3.8.3 Backup Battery technology recommended

3.8.3.1 Manganese Silicon Lithium-Ion rechargeable Battery

Sagem does not recommend to use this kind of technology because of the following drawbacks:

- the maximum discharge current is limited (Shall be compliant with the module characteristics)
- the over-discharge problem: most of the Lithium Ion rechargeable batteries are not able to recover their charge when their voltage reaches a low-level voltage. To avoid this, it is necessary to add a safety component to disconnect the backup battery in case of over–discharge condition. In such a case, this implementation is too complicated (too much components for that function).
- The charging current has to be regulated

SAGEM does not recommend to use this kind of backup battery technology at all.

3.8.3.2 Capacitor Battery

These kinds of backup battery have not the drawbacks of the Lithium Ion rechargeable battery.
As there are only capacitors:

- the maximum discharge current is generally bigger,
- there is no problem of over-discharge: the capacitor is able to recover its full charge even if its voltage has previously fallen to 0V.
- there is no need to regulate the charging current.

Moreover, this kind of battery is available in the same kind of package than the Lithium Ion cell and fully compatible on a mechanical point of view. The only disadvantage is that the capacity of this kind of battery is significantly smaller than Manganese Silicon Lithium Ion battery. But for this kind of use (supply internal RTC when the main battery is removed), the capacity is generally enough.
SAGEM strongly recommends to use this kind of backup battery technology.

3.9 General Purpose Input Output

Ten General Purpose Input Output (GPIO) are available on the board to board connector. The customer application can directly use them through the appropriate AT command as :

- output : pin is set to High or Low state
- input : pin is read on request and answer is given to the customer application.

As input, different cases are possible to cover the maximum possible of customer application :

- synchronous answer to the AT command (*)
- Asynchronous answer to the AT command. The customer application previously to the request has configured the GPIO to react on falling/rising edges. The customer application is notified asynchronously by AT command answer when the configured trigger occurs.

(*) : AT command process is not dedicated to real-time process. Then, driving the GPIO through this AT command is not aimed to emulated fast transient signals.

All details to drive GPIO are given in AT commands document [2].

3.10 Temperature sensor

One temperature sensor is available on the MO300 module. Its is located on the MO300 PCB (near the board to board connector) and not under the MO300 shield in order to give the ambient temperature of the customer application.
Due to the fast react and sensitivity of the temperature sensor, the result can be more or less accurate depending on possible draughts affecting the sensor. To give more precise results, the temperature sensor must be , as far as possible, isolated from draughts in the customer design.

The temperature sensor covers all the operational temperature range of the MO300 module.
The temperature can be read on request through appropriate AT commands as described in AT commands document [2].

3.11 ADC

The ADC value can be read by the specific AT command as defined in the document referenced [2]. The input limits are the following: **from 0V up to 1750mV**
The returned value is on 10 bits converted to decimal.

3.12 Micro-wire Bus

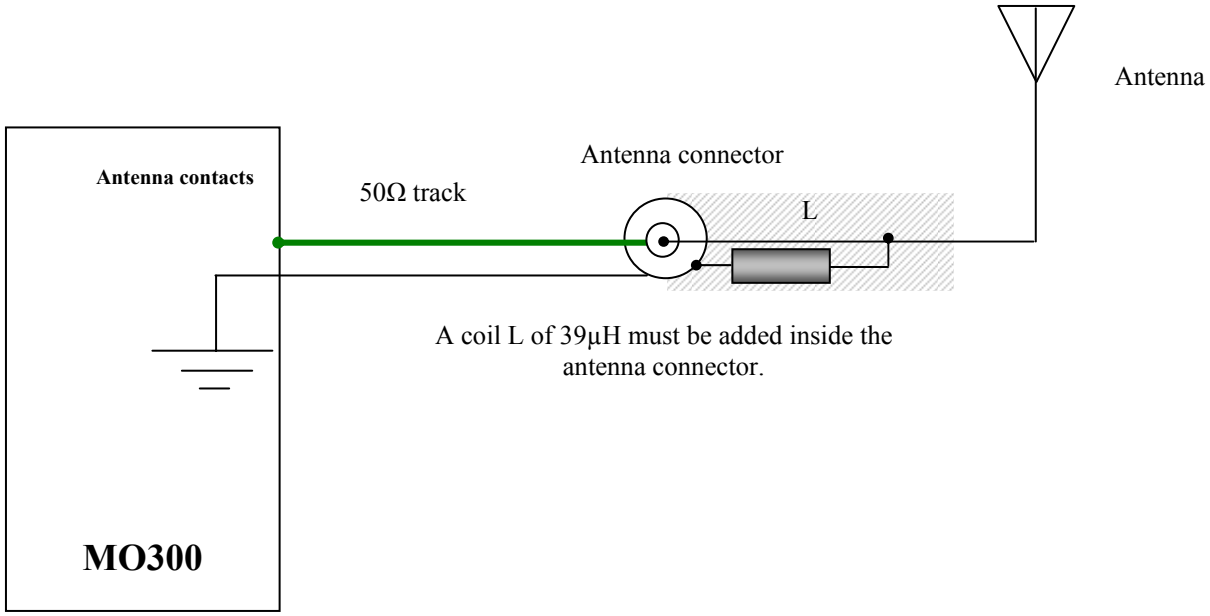
The microwire bus is available but the client has to ask SAGEM to develop the driver and the specific application related the connected device.

3.13 Antenna detection

Antenna detection can be provided if following criteria are met :

- Antenna design is performed according to design given below.
- Feature is activated through AT command.

AT command answer can be synchronous or asynchronous depending on customer request, as described in AT command document referenced [2].



3.14 Hardware Power management and multiplexing interfaces

In case hardware power management and multiplexing are used, it is necessary to isolate host and module MO300 in order to not generate current re-injection when MO300 is switched-off.

Typical schematics (only useful signals are represented):

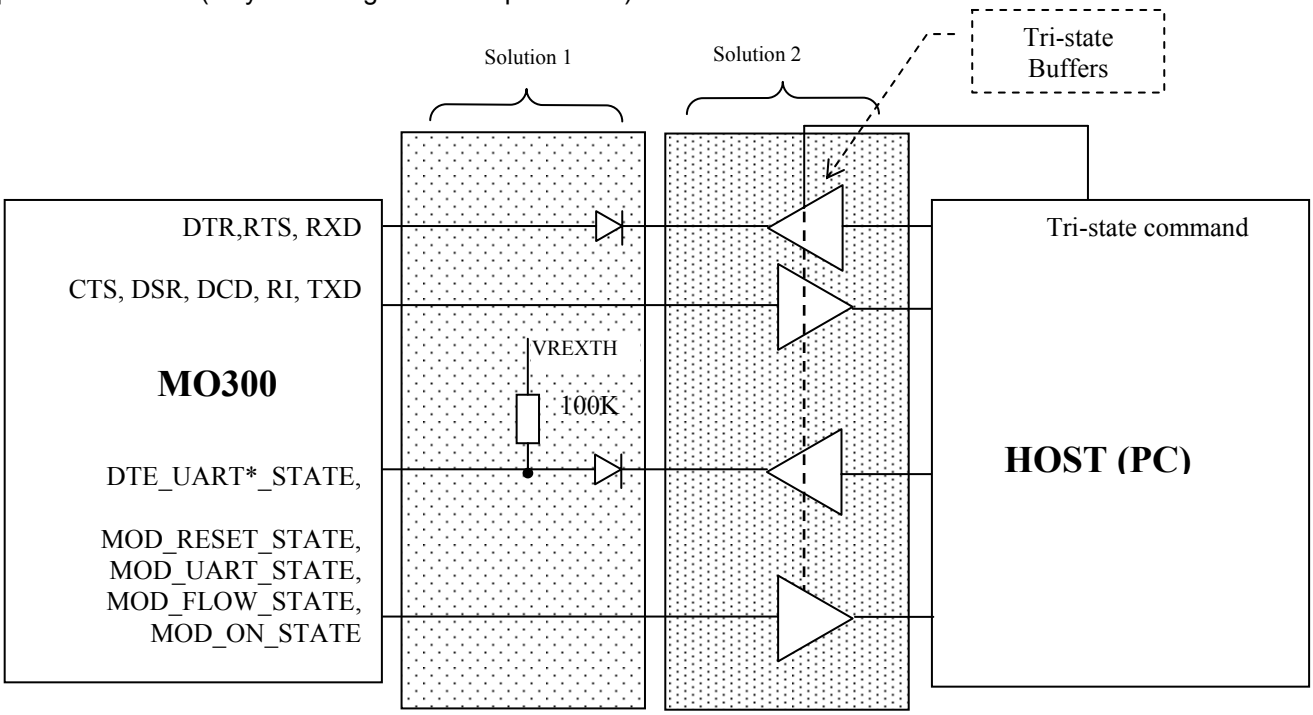


Figure 26
Hardware interface between MO300 and host

In a general case, solution 1 (cheaper) is enough to protect the module MO300.

3.15 Resetting the module

The MO300 module supports 2 kinds of reset:

- External software reset activated by the AT command as defined in the document referenced [2]
- External level 1 priority Hardware reset by pulling down the PWON* signal more than 8.2 seconds, on the next rise of PWON* the module is trigged. The reset is done 8.2 seconds later. This hardware reset, resets all the registers as well as the real time clock register, it is unconditional and have the highest priority. The module is in off mode after this hardware reset and need a new starting sequence to start again. At least 16.4 seconds are necessary to perform the hardware reset.

3.16 Starting the module

There are two ways to start the MO300 module.

3.16.1 Use of PWON*

First power up VBAT, which must be in the range 3.3V – 4.5V, and able to provide at least 2A during the TX bursts (refer to the module specification for more details).

To start the module, a low level pulse must be sent on PWON* during more than 31.25ms (at 25°C). This duration increases as the temperature decreases (up to ~ 1 second at –30°C).
After ~3 seconds CTS is active and so MOD_ON_STATE when it is ready to receive AT commands.

To be sure that the pulse duration is enough to start the module, independently from the temperature, MOD_ON_STATE can be used as feedback to stop the pulse:

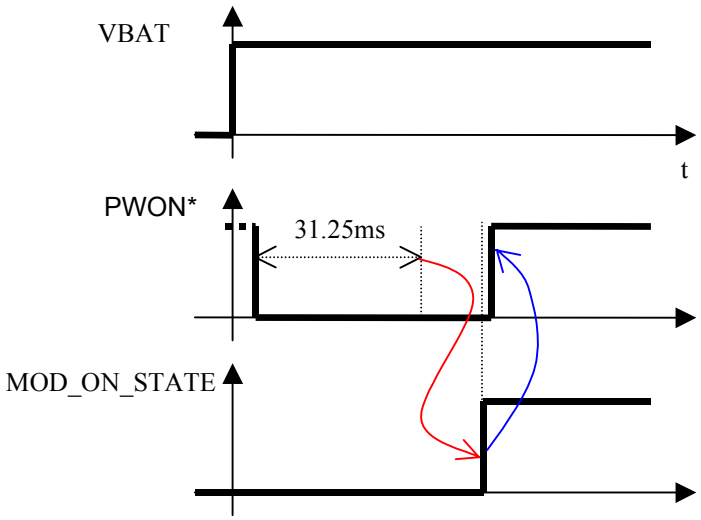


Figure 27
Suggested starting sequence

3.16.2 Case of USB Plugged

First power up VBAT, which must be in the range 3.3V – 4.5V, and able to provide at least 2A during the TX bursts (refer to the module specification for more details).

To start the module, plug an USB data cable to the PC then plug it to the module. The module detects the VBUS signal and start automatically.
MOD_ON_STATE can be used as feedback to know the module state.

3.17 Stopping the module

3.17.1 Case of UART Interface

To stop the module, use the AT command AT+CPOF, as defined in the document AT commands for MO300 series modules. If the Pwon* is not pulled down the module will turn in OFF mode after the AT command, otherwise the module restarts immediately (an OFF sequence is performed followed by a power ON sequence).

Note: The MO300 module stops automatically after few minutes when :

- **the sim card requests a pin code which is not entered**
- **no sim card is present.**

3.17.2 Case of USB Interface

As the module can also start when an USB cable is plugged, the sequence to stop the module needs the USB interface to be OFF or VBUS disconnected just after the command is sent and acknowledged by the module.
Thus, to stop the module when the USB interface is used, use the AT command AT+CPOF, as defined in the document AT commands for MO300 series modules, then disconnect VBUS (unplug the USB cable or use a commanded switch to switch of VBUS) signal when the module acknowledges (responds OK) the command, otherwise the module restarts immediately (an OFF sequence is be performed followed by a power ON sequence).

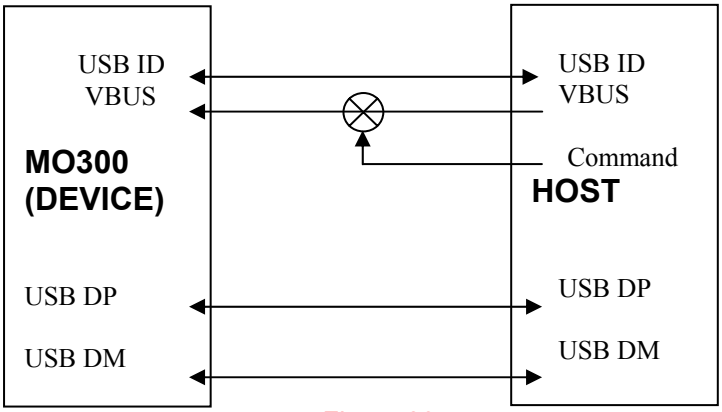


Figure 28
USB power command example

3.18 Sleep mode management

The module can save power consumption when it's in sleep mode. The module switchs off the unused I/Os and LDOs to reduce the power consumption. When the module is in sleep mode the power consumption is reduced to it's minimum, the module stays in sleep mode and only wakes up to listen to the paging blocks (still able to receive calls).
The module MO300 features 3 sleeps mode: The management is done using the AT command, as defined in the document AT referenced [2].

3.18.1 First mode

This mode allows the module to enter in sleep mode only when the DTE allows it. As long as the DTR signal is low, the module does not go into sleep mode.

3.18.2 Second mode

This mode allows the module to decide to go into sleep mode by itself.

3.18.3 Third mode

This mode allows the module to go into sleep mode according to the hardware power management specification using the 5 signals (DTE_UART*_STATE, MOD_RESET_STATE, MOD_UART_STATE, MOD_FLOW_STATE, MOD_ON_STATE).

3.18.4 USB connectivity impact on sleep mode

When the USB interface is used, the MO300 module can not reach it's best power saving performances. The MO300 module can not go into sleep mode as long as USB interface is active.
It is up to the Host responsibility to deactivate the USB connexion in order to allow sleep mode of the MO300 and then re-establish properly the USB connexion to communicate again with the MO300 module.

4 Mandatory points for the final tests and tuning

The design of the main board (which the module is connected to) ***must*** provide an access to following signals when the final product will be ***completely*** integrated.

The module's **firmware can be upgrade** over **serial or USB links**. To proceed, SAGEM recommends that products based on SAGEM modules provide a direct access to the module serial link or USB through an external connector or any mechanism allowing the upgrade of the module without opening the whole product.

Minimum necessary serial link I/Os

TXD	Output	UART transmit 1
RXD	Input	UART receive 1

For the USB: the 4 USB points are necessary.

5 ESD & EMC recommendations

5.1 Standard requirements for ESD

Test levels :

Contact discharge		Air discharge	
Test voltage (kV)	Level	Test voltage (kV)	Level
2	1	2	1
4	2	4	2
6	3	8	3
8	4	15	4
Special	X [1)]	Special	X [1)]

1) "X" is a level which has to be determined. This level is specified in the particular specification of the device. If higher voltages as specified are needed, special testers have to be used.

Standard indicates that tests have to be done when module is in call connected to the main supply (220V) trough any DC/DC converter. These tests consist to put some ESD impulses of 8 kV maximum everywhere on the device. It mustn't lose the call neither other functions and if one of them is lost, the device has to come back in its normal configuration without external action.

Classification of test results :

N°1 : normal behaviour in specification limits
N°2 : temporary degradation or function loss or auto-recoverable behaviour
N°3 : temporary degradation or function loss or behaviour lost needing help of operator or a system reset
N°4 : irreparable degradation or function loss due to failure of material (components), software or data loss

5.1.1 ESD Analysis

ESD current can penetrate inside the device via the typical following components:

- SIM connector
- Antenna
- USB Connector
- UART Connector
- Audio Connectors
- DC power connector
- Battery
- All pieces with conductive paint (Housing, etc...)

Therefore, in order to avoid ESD issues, efforts shall be done to decrease the level of ESD current on electronic components located inside the device (main board, input of the module MO300, etc…)

5.1.2 Recommendations to avoid ESD issues

They can be summarised as below:

- Insure good ground connections of the module MO300 to the MAIN board
- Flex (if any) shall be shielded and FPC connectors shall be correctly grounded at each extremities
- Put capacitor 100nF on battery (not on charger), or better put Varistors or ESD diode in parallel
- Uncouple microphone and speaker by capacitor or Varistors in parallel of each wire of these devices

5.2 ESD features

Using human body model from JEDEC JESD 22-A114 standard, the MO300 can hold 2kV on all MO300 pins and contact areas such as antenna pads and connector. Except for the following pins where 1kV is supported

- SIM RST
- SIM CLK
- SIM IO
- SIMPLUS DATA
- SIMPLUS CLK
- SIMPLUS CMD

External protection with ESD diode can be added to have a stronger ESD protection.

5.3 EMC recommendations

In case of EMC issue due to a headset audio device, the solution may consist in inserting a filter on the wires of the microphone and of the speaker.

6 Recommended components

On request, SAGEM can provide the reference part numbers for the following recommended components:

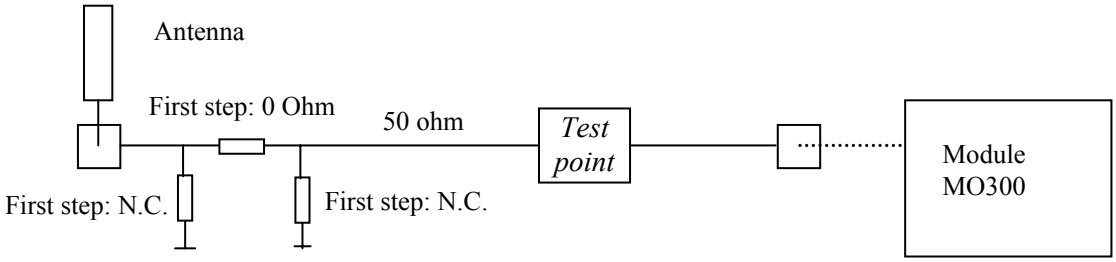
Component	SAGEM part
Handset microphone	MIC1
Handset speaker	HP1
Network Led	LED1
SIM connector (with detection)	SIM1
SIM connector (without detection)	SIM2

7 Radio integration

The module antenna connection has a characteristic impedance of 50 Ohms.
In order to get the best sensitivity and output power, it is recommended to implement a matching circuit between the module and the antenna:

In order to design the matching circuit :

- test with direct connection in the first step
- adjust inductors and capacitors in a second step if needed



7.1 Antenna connection

MO300 module feature two ways to connect it to the GSM antenna.

7.1.1 Mini Coaxial connector

A mini-coaxial connector is provided on the MO300 : Hirose U.FL-R-SMT-1 (10)

7.1.2 Spring contacts

- 50 Ω line matching (between module and MAIN board, and with RF test point)
- SAGEM strongly recommends to solder the spring contact on the whole surface instead of only 2 points

Keep matching circuit on MAIN board but with direct connection in the first step – it could be necessary to make some adjustment later, during RF qualification stage

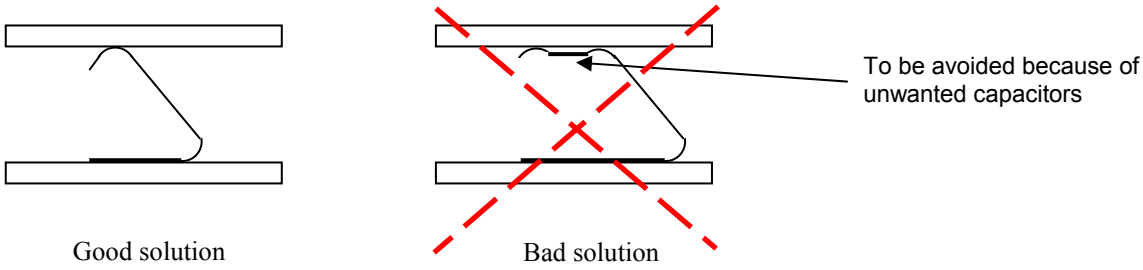


Figure 29
Spring contact mounting

7.2 Ground link area

The MO300 feature 3 ground Pads for the RF. The 3 pads must be in contact with the ground plan of the main board. Otherwise the RF performances will be degraded.

In case of need, if the 3 pads are not sufficient because of the client design, a metallic foam can be used as described here after.
To have the best radio performances (spurious, sensitivity…),good ground contact between the module shielding and the main board is needed using for example 0.5 / 0.7mm metallic foam or label. Do not solder the shielding of the module on ground pad of the main board.

Conductive foam:

minimum size = 1cm x 3 cm (located on the top of MO300 shielding – near antenna area)
minimal thickness = 0.5mm (take care of pressure % average) **[20% compression]**

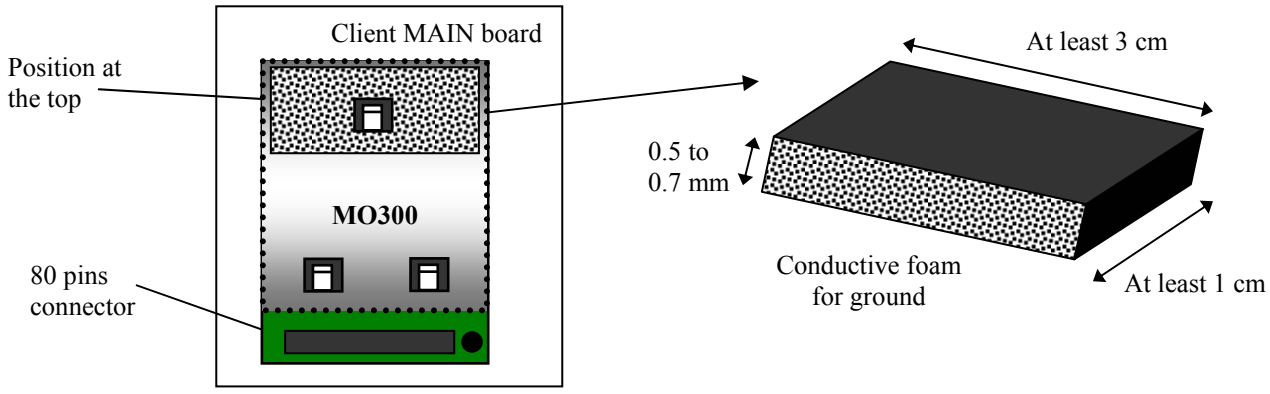


Figure 30
Metallic foam position

7.3 Layout

Warning: Isolate RF line and antenna from others bus or signals (audio, powers, digital I/O or buses ...).

- No signals on 50 ohms area and if that is not possible, add ground shielding using different layers.
- Do not add any ground layer under the antenna contact area.
- Be careful on the position of the network LED (sometimes situated in front of the antenna pad ...)

7.4 Mechanical surrounding

- Avoid any metallic part around the antenna area
- Keep jacks, FPCs and battery contact far from antenna area.
- FPC have to be a shielded one

7.5 Other recommendations – Tests for production/design

SAGEM guarantees the RF performances in conductive mode but strongly recommends to make RF measurements in an ***anechoide chamber*** in radiated mode (tests conditions for FTA) : the radiated performances strongly depend on radio integration (layout, antenna, matching circuit, ground area…..).

7.6 FCC RF compliance

The selected antenna must comply with FCC RF exposure limits in GSM850 and PCS1900 band :

- GSM850 : MPE < 0.55mW/cm^2 (Distance is 20 cm)
- PCS1900 : ERP < 3W

8 Audio integration

Audio mandatory tests for FTA are in **handset mode** only so a particular care must be brought to the design of audio (mechanical integration, gasket, electronic) in this mode.
The audio norms which describe the audio tests are 3GPP TS 26.131 & 3GPP TS 26.132.

8.1 Mechanical Integration and Acoustics

Particular care to Handset Mode : FTA

- Design of the microphone and speaker gasket.
- All receivers and speaker must be completely sealed on front side
- For the speaker mode, the back volume must be completely sealed
- The sealed volume must be as big as possible
- Microphone sensitivity depends on the shape of the device.
- Place the microphone and the speaker as far as possible from each other

8.2 Electronics and layout

Avoid Distortion & Burst noise

- Audio signals must be symmetric (same components on each path)
- Differential signals must be routed parallel
- Audio layer must be surrounded by 2 ground layers
- The link from one component to the ground must be as short as possible
- If possible separate the PCB of the microphone and the one of the speaker
- Reduce as much as possible the number of electronics components (loss of quality, more dispersion)
- Audio tracks must be larger than 0.5 mm

9 Recommendations on Layout of the main board

9.1 General recommendations on layout

There are many different types of signals in the module, that are disturbing each other. Particularly, Audio signals are very sensitive to external signals as VBAT.... Therefore it is very important to respect some rules to avoid disruptions or abnormal behaviour.

Main rules:

9.1.1 Ground

- A ground plan as complete as possible
- Ground of components has to be connected to the ground layer through many vias not regularly distributed.
- Top and bottom layer shall have as much as possible of ground plans.

9.1.2 Power supplies

- Plan for power supply signals (VBAT, VREXTH), no loop.
- Suitable power supply (VBAT, VREXTH) track width, thickness.

9.1.3 Clocks

- Clock signals must be shielded between two grounds plans and bordered with ground vias.

9.1.4 Data bus and other signals

- Data bus and commands have to be routed on the same plan, none of the lines of the bus shall be parallel to other lines
- Lines crossing shall be perpendicular
- Suitable other signals track width, thickness.
- Data bus must be protected by upper and lower ground plans

9.1.5 Radio

- Provide a 50 Ohm microstrip line for antenna connection

9.1.6 Audio

- Differential signals have to be routed together, parallel (for example HSMICP with HSMICN or SPKP with SPKN …).
- Audio signals have to be isolated, by pair, from all the other signals (ground all around each pair).
- Avoid any VBAT or GND loop near to the speaker to avoid the TDMA burst noise in the speaker during a communication.

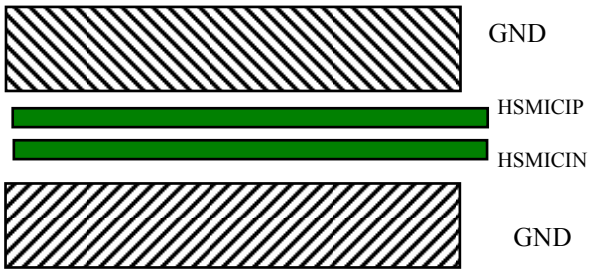


Figure 31
Layout of audio differential signals on a layer n

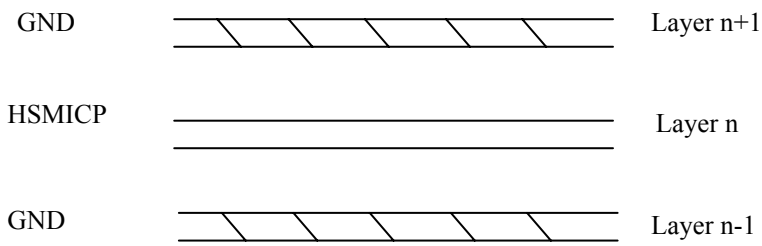


Figure 32
Adjacent layers of audio differential signals

***Warning:** Magnetic field generated by VBAT tracks may disturb the speaker, causing audio burst noise. In this case, one shall modify routing of the VBAT tracks to reduce the phenomena.

9.2 Example of layout for main board

The layout given hereafter is only for reference for a typical modem application, 6 layers are necessary.

Figure 33
6 layers Stack up example

For PDA application using processor, memories (RAM & flash), Audio codec, MO300, and other accessories, at least 8 layers may be necessary for a correct and safe layout.

10 Mechanical integration

The different points in this part deal with the mechanical specifications to ensure a correct integration of the module MO300. The constraints are about the connections (characteristics and layouts) and assembly of the module inside any housing.

10.1 External connections presentation

There are 2 connections on the MO300 :

- The connection to the 80 signals : through a Molex Board to Board connector
- The connection to the radio ! through a Hirose coaxial connection and a range connection

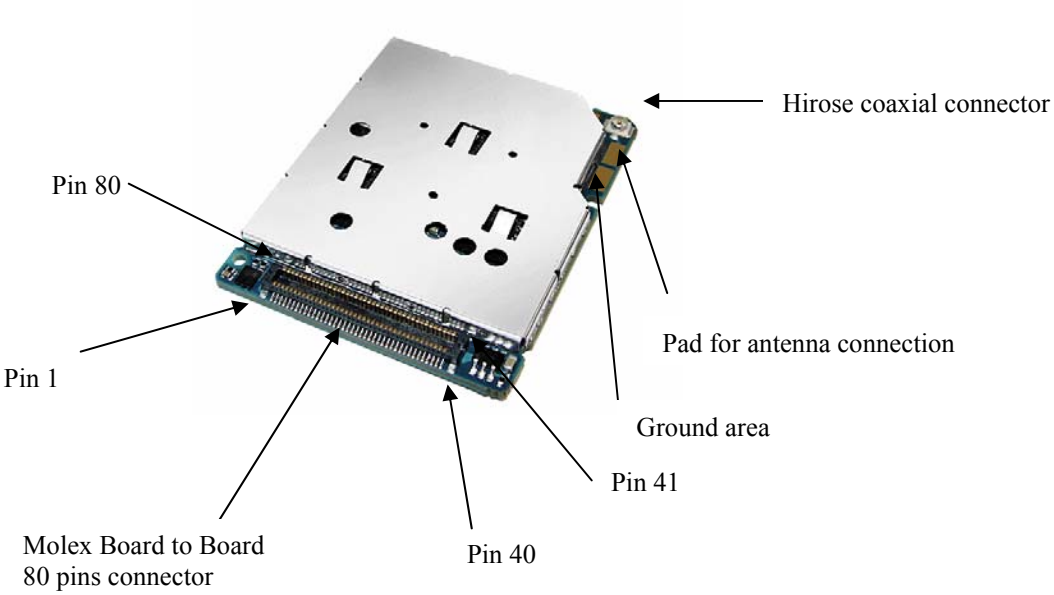


Figure 35
MO300 connections

10.2 Connection constraints

10.2.1 Board to board connection

The Molex board to board connector is a 80 signals connection.
The plug is mounted on the MO300 board and the receptacle should be mounted on the main board (which the module is connected to).

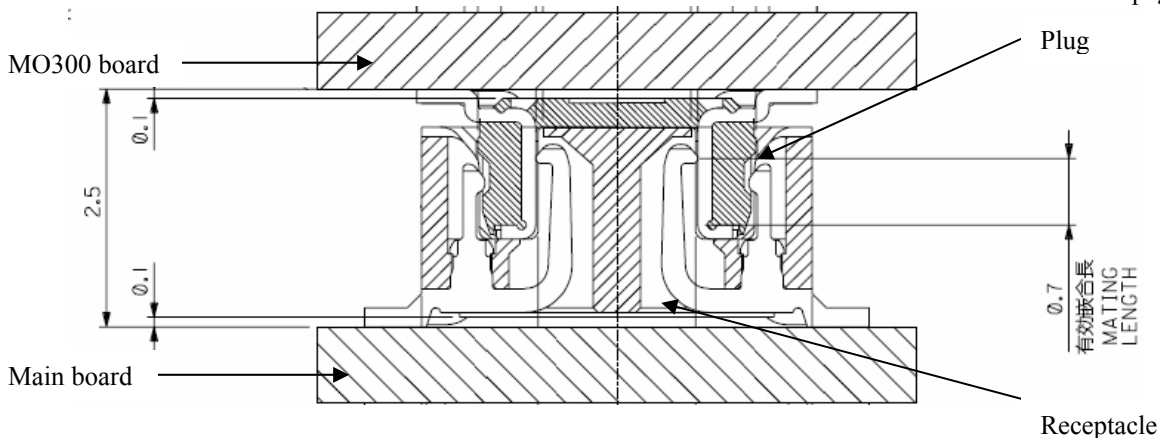


Figure 36
Board to board connection

To ensure a good soldering process for the receptacle on the main board, respect the layout specification following (dimension in mm).

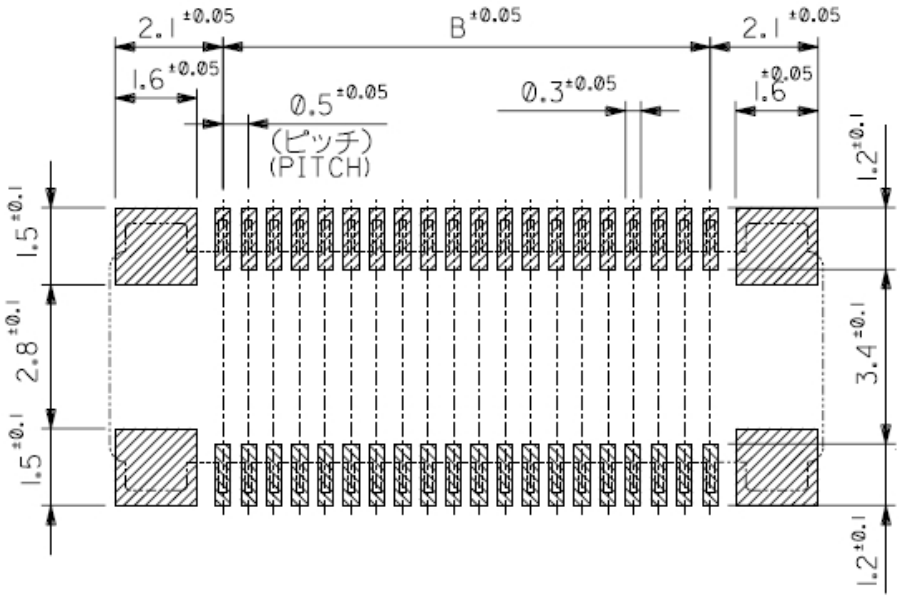


Figure 37
Recommended layout for board to board receptacle

10.2.2 Antenna connection

There are two possibilities to connect the antenna signal to the main board :

- The Hirose coaxial connection : a receptacle is mounted on the MO300, an other receptacle (the same Hirose reference) should be mounted on the main board. The connection should be realised by a plug/unplug cable.
- A contact plate connection

10.3 Warning related to the use of metallic housings

Metal particles presence in the mechanical disturbs strongly the radio performance of the module. For example, the minimum sensitivities levels are not guarantied in case of such use. Moreover, Sagem does not recommend to have metallic particles especially in the antenna area.

11 Summary of integration

On the following pages, you will find a sum-up of the different connectors which are assembled in the module MO300. Their references are mentioned and their specifications are available at the end of this document.

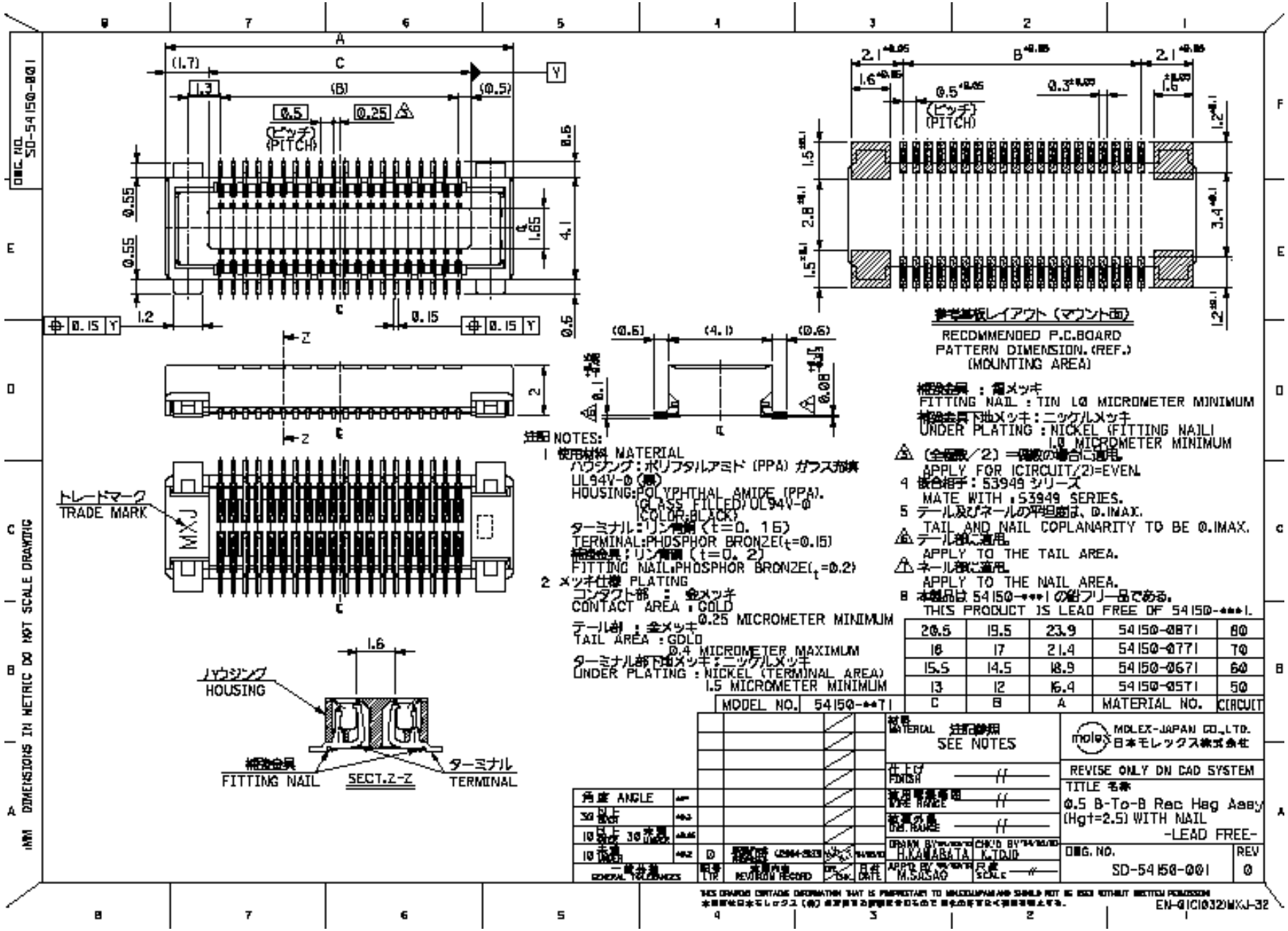
11.1 Annexe: Molex Board to Board connector

Dimensions and references:

Pin Number	References
80	MOLEX 54150-0878

Sagem reference : 189576119

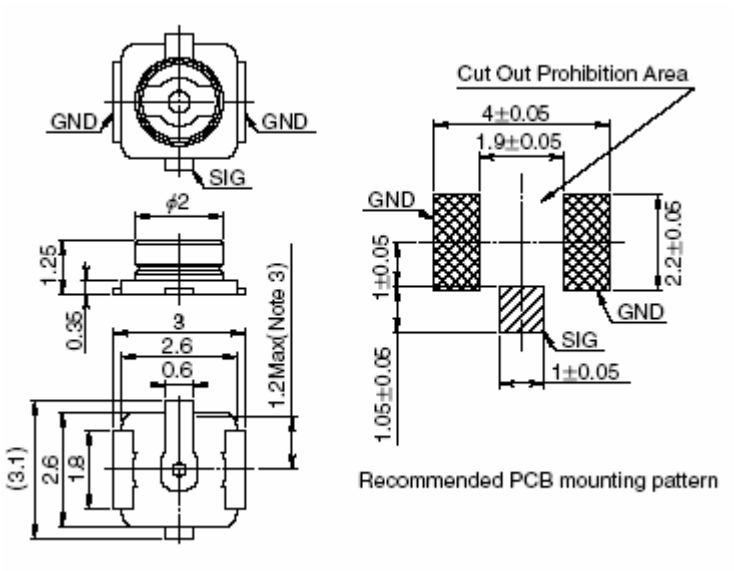
Dimension	A	B	C
mm	23.9	19.5	20.5



11.2 Annexe: Hirose coaxial connector

Reference
HIROSE U.FL-R-SMT-1 (10)

Sagem reference 189492503



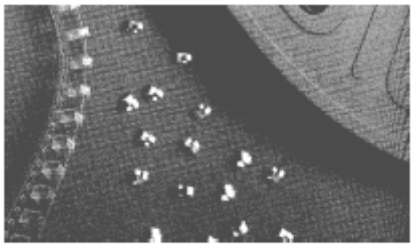
11.3 Annexe: Spring contact for antenna

AMIC Specification

SMD Finger(EXF-0023-02)

1. Introduction of SMD Finger

EX-SMD Finger is recently developed by AMIC SMD Finger Strip for the use of PCB featuring excellent resilience and electrical properties.
Its plating material is gold, so it provide very well-known for minimum contact resistance are eventually suitable for grounding of various PCBs.



2. Functions

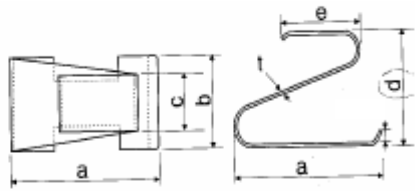
The package on a reel for EX-SMD Finger can also give productions such as SMD Line.

3. Applications

Grounding of PCB

4. Shape and Dimension

Part No.	a	b	c	d	e	f	Plating	Material
EXF-0023-02	3.94	2	1.6	3.1	2.4	0.1	Au	SUS



EXF-0023-02

5. Features

■ Standard Quantity for Packaging

Part No.	Tape & Reel 13" Reel(EA)	Bulk Vinyl
EXF-0023-02	2750	As wanted

Figure 38
layer allocation for a 6 layers circuit

12 LABEL

The MO300 module is labelled with its own FCC ID (VW3MO300QBM) on its bottom side.
When the module is installed in customer's product, the FCC ID label on the module will not be visible. To avoid this case, an exterior label must be stuck on the surface of customer's product signally to indicate the FCC ID of the enclosed module. This label can use wording such as the following: "Contains Transmitter module FCC ID: VW3MO300QBM" or "Contains FCC ID: VW3MO300QBM".

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END OF DOCUMENT
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