GC864 Hardware User Guide

GC864-PY, GC864-QUAD
1vv0300733 Rev. 0 - 12/06/06

Making machines talk.

Contents

1 Overview 4
2 Hardware Commands 5
2.1 Turning ON the GC864 5
2.2 Turning OFF the GC864 7
2.2.1 Hardware shutdown 7
2.3 Hardware Unconditional Reboot 7
3 Power Supply 9
3.1 Power Supply Requirements 9
3.2 General Design Rules 10
3.2.1 Electrical design Guidelines 10
3.2.1.1 + 5V input Source Power Supply Design Guidelines 10
3.2.1.2 + 12V input Source Power Supply Design Guidelines 12
3.2.1.3 Battery Source Power Supply Design Guidelines 13
3.2.1.4 Battery Charge control Circuitry Design Guidelines 13
3.2.2 Thermal Design Guidelines 15
3.2.3 Power Supply PCB layout Guidelines 16
4 Antenna 17
4.1 Antenna Requirements 17
4.2 GC864 Antenna Connector 17
4.3 Antenna installation Guidelines 18
5 GC864 pins allocation 19
NOTE: RESERVED pins must not be connected 21
6 Serial Port 22
6.1 RS232 level translation 24
6.2 5V UART level translation 26
7 Audio Section Overview 28
7.1 Microphone paths characteristic and requirements 30
7.2 General Design Rules 33
7.3 Other considerations. 33
7.4 Microphone Biasing 34
7.4.1 Balanced Microphone biasing 34
7.4.2 Unbalanced Microphone biasing 35

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

7.5 Microphone buffering 37
7.5.1 Buffered Balanced Mic 37
7.5.2 Buffered Unbalanced (Single Ended) Microphone 39
8 OUTPUT LINES (Speaker) 42
8.1 Short description. 42
8.2 Output lines characteristics 43
8.3 General Design rules 44
8.3.1 Noise Filtering 44
8.4 Handset earphone design 45
8.5 Hands-free earphone (low power) design 46
8.6 Car Kit speakerphone design 47
9 External SIM Holder 48
9.1 SIM DESIGN GUIDES 48
10 General Purpose I/O 50
10.1 Using a GPIO pad as INPUT 50
10.2 Using a GPIO pad as OUTPUT 50
10.3 Using the Alarm Output GPIO_06/ALARM 51
10.4 Using the Buzzer Output GPIO_07/BUZZER 51
11 Camera 52
11.1 Camera characteristics 52
11.1.1 Camera interface connectors 52
11.1.2 53
11.1.3 53
11.1.4 53
11.1.5 EVB for Transchip camera support 54
11.1.6 Example usage script for camera 55
12 Conformity Assessment Issues 56
13 SAFETY RECOMMANDATIONS 57
14 Document Change Log 58
Annex A – EVK2 schematics 59
Annex B - Camera EVB schematics 65

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

1 Overview

The aim of this document is the description of some hardware solutions useful for developing a product with the **Telit GC864 module**.
In this document all the basic functions of a mobile phone will be taken into account; for each one of them a proper hardware solution will be suggested and eventually the wrong solutions and common errors to be avoided will be evidenced. Obviously this document can not embrace the whole hardware solutions and products that may be designed. The wrong solutions to be avoided shall be considered as mandatory, while the suggested hardware configurations shall not be considered mandatory, instead the information given shall be used as a guide and a starting point for properly developing your product with the **Telit GC864 module**. For further hardware details that may not be explained in this document refer to the Telit GC864 Product Description document where all the hardware information is reported.

NOTICE

(EN) The integration of the GC864 GSM/GPRS cellular module within user application shall be done according to the design rules described in this manual.

(IT) L'integrazione del modulo cellulare GSM/GPRS GC864 all'interno dell'applicazione dell'utente dovrà rispettare le indicazioni progettuali descritte in questo manuale.

(DE) Die Integration des GC864 GSM/GPRS Mobilfunk-Moduls in ein Gerät muß gemäß der in diesem Dokument beschriebenen Konstruktionsregeln erfolgen

(SL) Integracija GSM/GPRS GC864 modula v uporabniški aplikaciji bo morala upoštevati projektna navodila, opisana v tem priročniku.

(SP) La utilización del modulo GSM/GPRS GC864 debe ser conforme a los usos para los cuales ha sido diseñado descritos en este manual del usuario

(FR) L'intégration du module cellulaire GC864 GSM/GPRS dans l'application de l'utilisateur sera faite selon les règles de conception décrites dans ce manuel

(HE)

הבהרה:
האינטגרטור מתבקש ליישם את ההנחיות המפורטות במסמך זה בתהליך האינטגרציה של המודם הסלולרי GE864 עם המוצר.

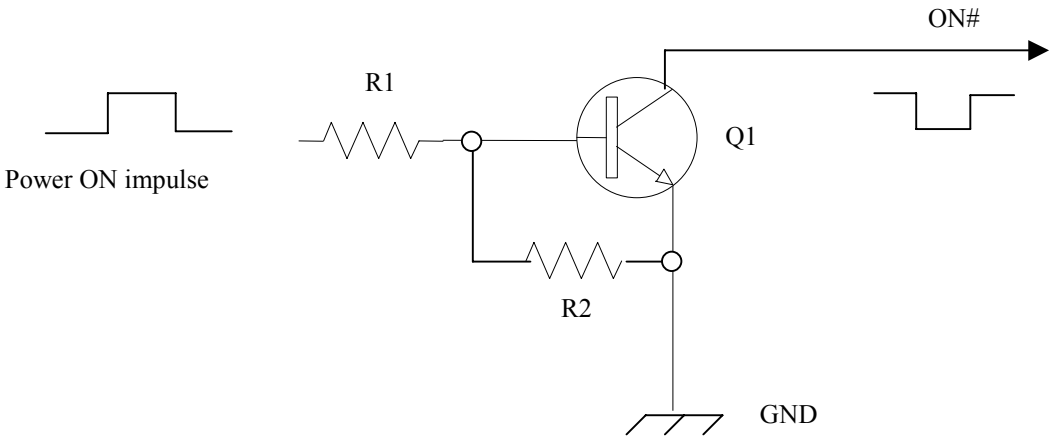
The information presented in this document is believed to be accurate and reliable. However, Telit Communication assumes no responsibility for its use, nor any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent rights of Telit Communication other than for circuitry embodied in Telit products. This document is subject to change without notice.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

2 Hardware Commands

2.1 Turning ON the GC864

To turn on the GC864 the pad ON# must be tied low for at least 1 second and then released.
The maximum current that can be drained from the ON# pad is 0,1 mA.
A simple circuit to do it is:



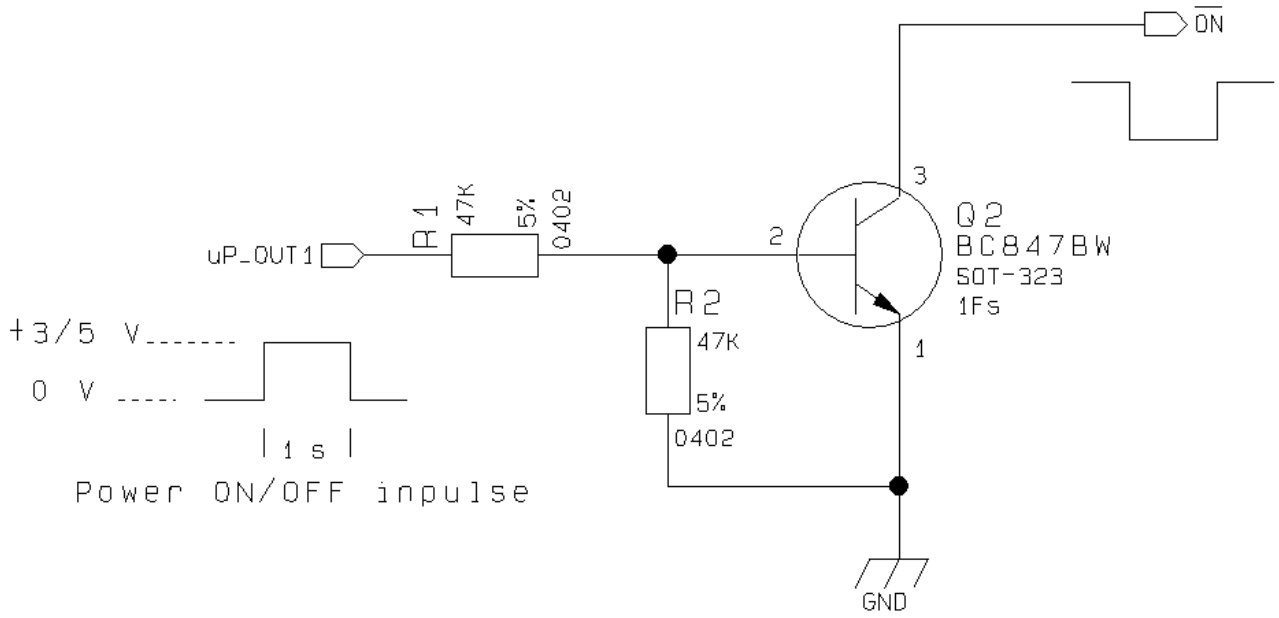
NOTE: don't use any pull up resistor on the ON# line, it is internally pulled up. Using pull up resistor may bring to latch up problems on the GC864 power regulator and improper power on/off of the module. The line ON# must be connected only in open collector configuration.

NOTE: In this document all the lines that are inverted, hence have active low signals are labeled with a name that ends with a "#" or with a bar over the name.

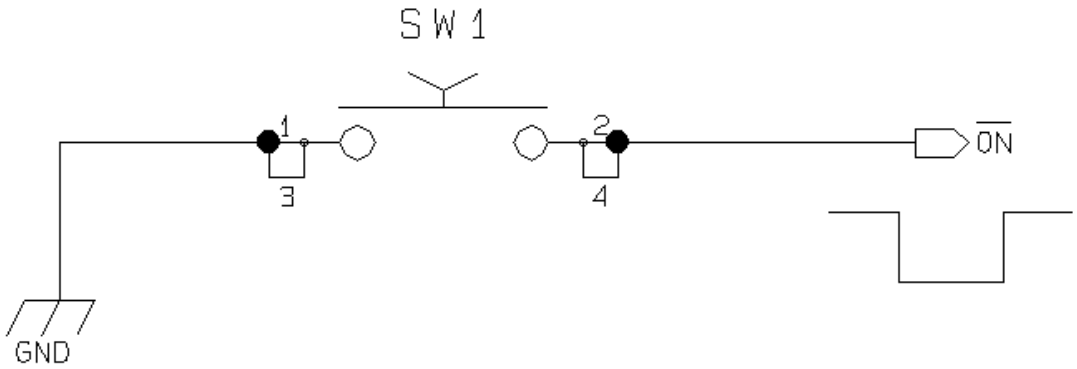
NOTE: The GC864 turns fully on also by supplying power to the Charge pad (provided there's a battery on the VBATT pads).

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

For example:
1- Let's assume you need to drive the ON# pad with a totem pole output of a +3/5 V microcontroller (uP_OUT1):



2- Let's assume you need to drive the ON# pad directly with an ON/OFF button:



2.2 Turning OFF the GC864

The turning off of the device can be done in three ways:

- by software command (see GC864 Software User Guide)
- by hardware shutdown

When the device is shut down by software command or by hardware shutdown, it issues to the network a detach request that informs the network that the device will not be reachable any more.

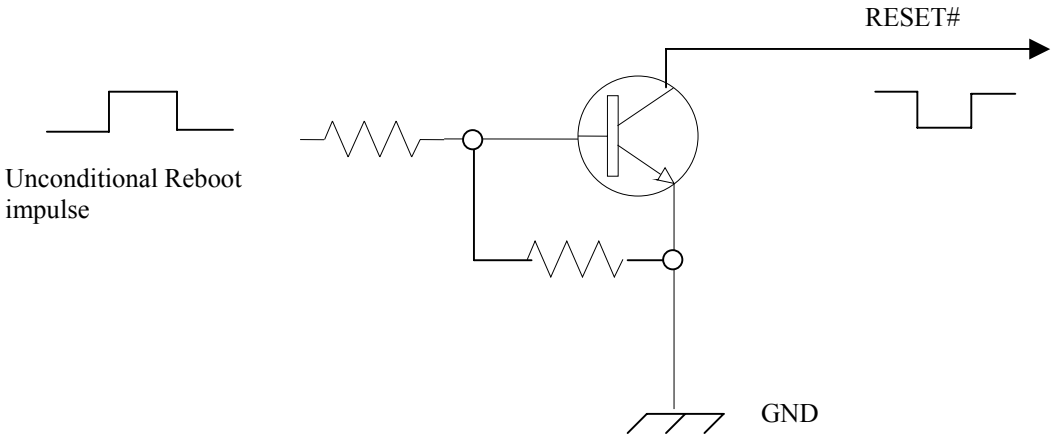
2.2.1 Hardware shutdown

To turn OFF the GC864 the pad ON# must be tied low for at least 1 second and then released.
The same circuitry and timing for the power on shall be used.
The device shuts down after the release of the ON# pad.

TIP: To check if the device has powered off, the hardware line PWRCTL should be monitored. When PWRCTL goes low, the device has powered off.

2.3 Hardware Unconditional Reboot

To unconditionally Reboot the GC864, the pad RESET# must be tied low for at least 200 milliseconds and then released.
The maximum current that can be drained from the ON# pad is 0,15 mA.
A simple circuit to do it is:

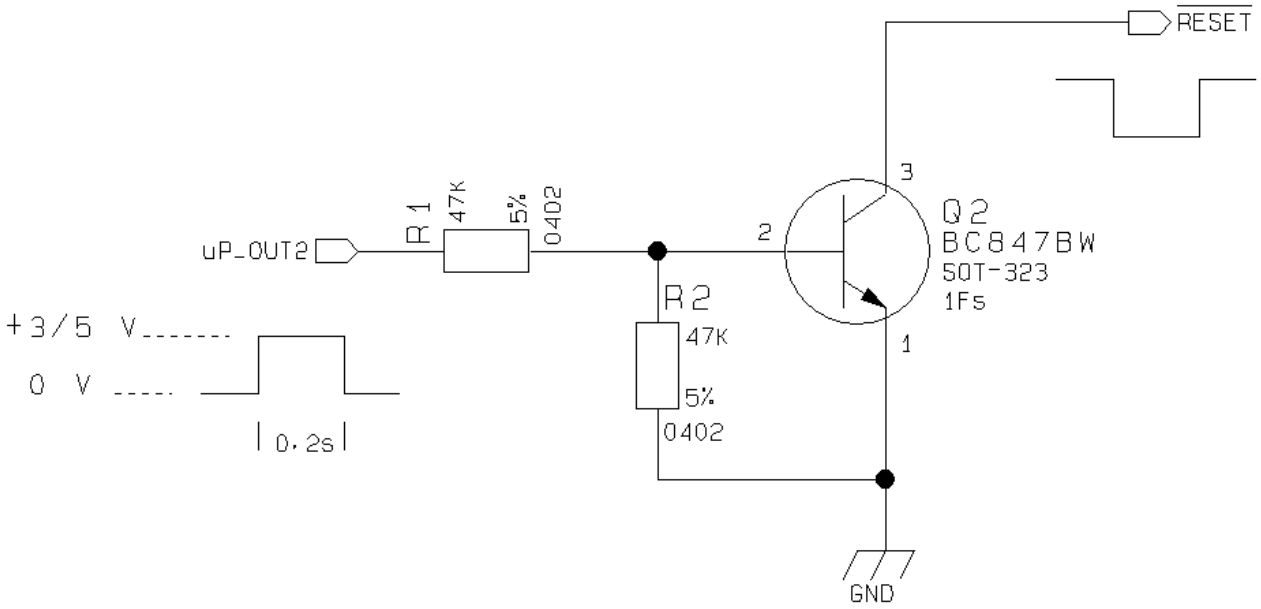


NOTE: don't use any pull up resistor on the RESET# line nor any totem pole digital output. Using pull up resistor may bring to latch up problems on the GC864 power regulator and improper functioning of the module. The line RESET# must be connected only in open collector configuration.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

TIP: The unconditional hardware reboot should be always implemented on the boards and software should use it as an emergency exit procedure.

For example:
1- Let's assume you need to drive the RESET# pad with a totem pole output of a +3/5 V microcontroller (uP_OUT2):



3 Power Supply

The power supply circuitry and board layout are a very important part in the full product design and they strongly reflect on the product overall performances, hence read carefully the requirements and the guidelines that will follow for a proper design.

3.1 Power Supply Requirements

The GC864 power requirements are:

- *Nominal Supply Voltage:* *3.8 V*
- *Max Supply Voltage:* *4.2 V*
- *Supply voltage range:* *3.4 V - 4.2 V*
- *Max Peak current consumption (impulsive):* *1.9 A*
- *Max Average current consumption during GPRS transmission (rms):* *500 mA*
- *Max Average current consumption during VOICE/CSD transmission (rms):* *270 mA*
- *Average current during Power Saving:* *≈ 4 mA*
- *Average current during idle (Power Saving disabled)* *≈ 19 mA*

The GSM system is made in a way that the RF transmission is not continuous, else it is packed into bursts at a base frequency of about 216 Hz, the relative current peaks can be as high as about 2A. Therefore the power supply has to be designed in order to withstand with these current peaks without big voltage drops; this means that both the electrical design and the board layout must be designed for this current flow.
If the layout of the PCB is not well designed a strong noise floor is generated on the ground and the supply; this will reflect on all the audio paths producing an audible annoying noise at 216 Hz; if the voltage drop during the peak current absorption is too much, then the device may even shutdown as a consequence of the supply voltage drop.

TIP: The electrical design for the Power supply should be made ensuring it will be capable of a peak current output of at least 2 A.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

3.2 General Design Rules

The principal guidelines for the Power Supply Design embrace three different design steps:
- the electrical design
- the thermal design.
- the PCB layout.

3.2.1 Electrical design Guidelines

The electrical design of the power supply depends strongly from the power source where this power is drained. We will distinguish them into three categories:

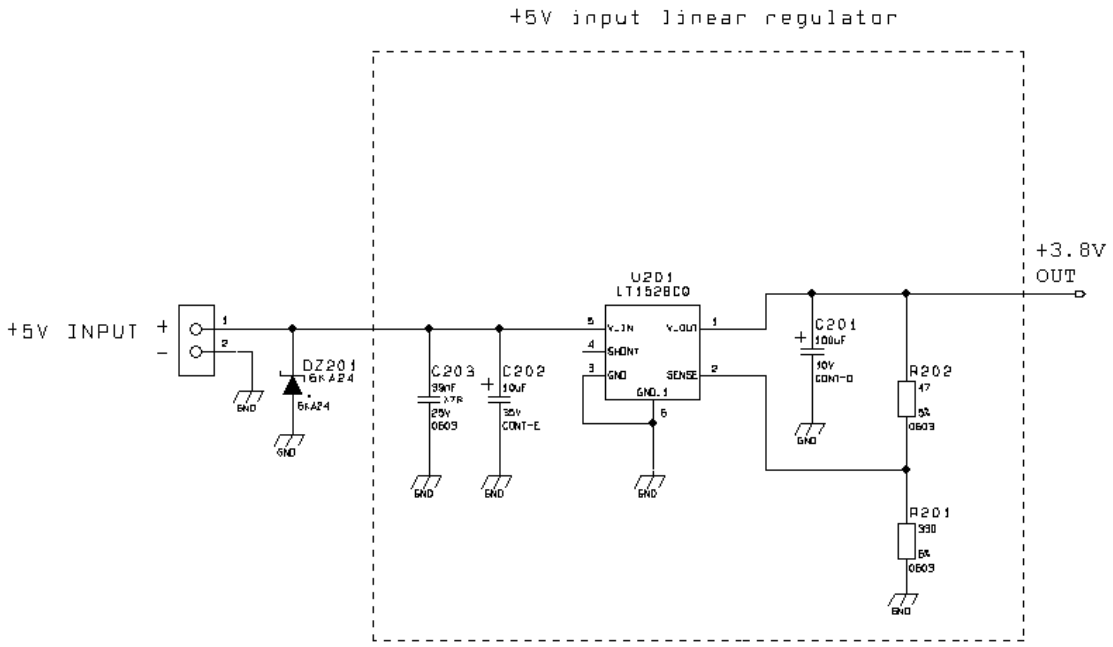
- +5V input (typically PC internal regulator output)
- +12V input (typically automotive)
- Battery

3.2.1.1 + 5V input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence there's not a big difference between the input source and the desired output and a linear regulator can be used. A switching power supply will not be suited because of the low drop out requirements.
- When using a linear regulator, a proper heat sink shall be provided in order to dissipate the power generated.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks close to the GC864, a 100µF tantalum capacitor is usually suited.
- Make sure the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.
- A protection diode should be inserted close to the power input, in order to save the GC864 from power polarity inversion.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

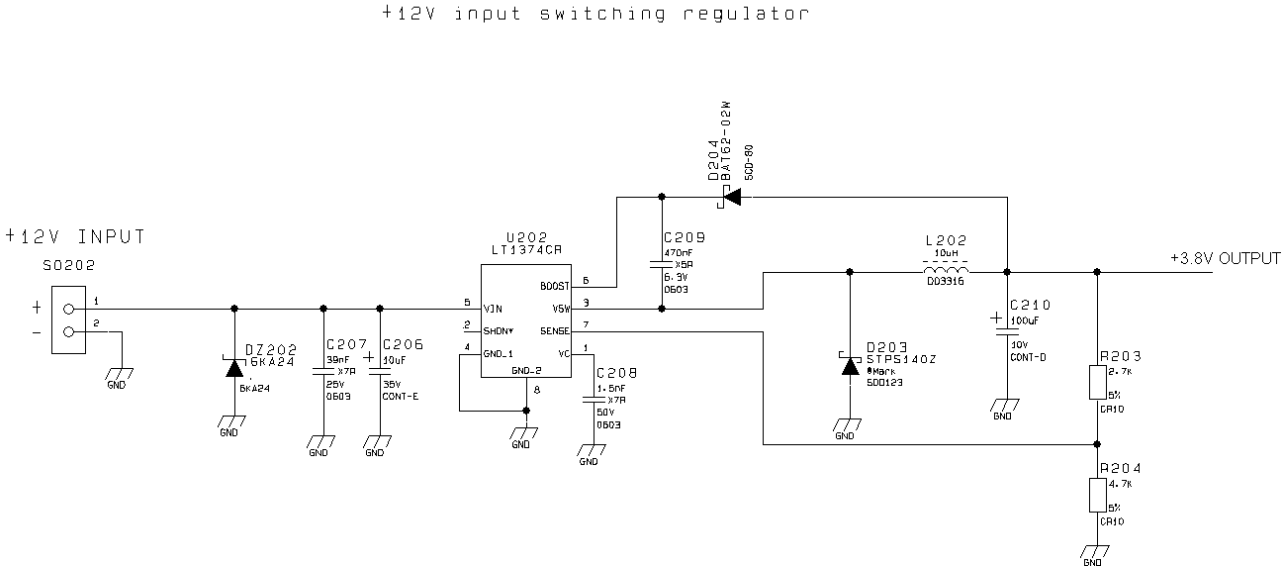
An example of linear regulator with 5V input is:



3.2.1.2 + 12V input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence due to the big difference between the input source and the desired output, a linear regulator is not suited and shall not be used. A switching power supply will be preferable because of its better efficiency especially with the 2A peak current load represented by the GC864.
- When using a switching regulator, a 500kHz or more switching frequency regulator is preferable because of its smaller inductor size and its faster transient response. This allows the regulator to respond quickly to the current peaks absorption.
- For car PB battery the input voltage can rise up to 15,8V and this should be kept in mind when choosing components: all components in the power supply must withstand this voltage.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks, a 100µF tantalum capacitor is usually suited.
- Make sure the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.
- For Car applications a spike protection diode should be inserted close to the power input, in order to clean the supply from spikes.
- A protection diode should be inserted close to the power input, in order to save the GC864 from power polarity inversion. This can be the same diode as for spike protection.

An example of switching regulator with 12V input is:



3.2.1.3 Battery Source Power Supply Design Guidelines

- The desired nominal output for the power supply is 3.8V and the maximum voltage allowed is 4.2V, hence a single 3.7V Li-Ion cell battery type is suited for supplying the power to the Telit GC864 module.
  The three cells Ni/Cd or Ni/MH 3,6 V Nom. battery types or 4V PB types ***MUST NOT BE USED DIRECTLY*** since their maximum voltage can rise over the absolute maximum voltage for the GC864 and damage it.

NOTE: DON'T USE any Ni-Cd, Ni-MH, and Pb battery types directly connected with GC864. Their use can lead to overvoltage on the GC864 and damage it. USE ONLY Li-Ion battery types.

- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks, a 100µF tantalum capacitor is usually suited.
- Make sure the low ESR capacitor (usually a tantalum one) is rated at least 10V.
- A protection diode should be inserted close to the power input, in order to save the GC864 from power polarity inversion. Otherwise the battery connector should be done in a way to avoid polarity inversions when connecting the battery.
- The battery capacity must be at least 500mAh in order to withstand the current peaks of 2A; the suggested capacity is from 500mAh to 1000mAh.

3.2.1.4 Battery Charge control Circuitry Design Guidelines

The charging process for Li-Ion Batteries can be divided into 4 phases:

- Qualification and trickle charging
- Fast charge 1 - constant current
- Final charge - constant voltage or pulsed charging
- Maintenance charge

The qualification process consists in a battery voltage measure, indicating roughly its charge status. If the battery is deeply discharged, that means its voltage is lower than the trickle charging threshold, then the charge must start slowly possibly with a current limited pre-charging process where the current is kept very low with respect to the fast charge value: the trickle charging.
During the trickle charging the voltage across the battery terminals rises; when it reaches the fast charge threshold level the charging process goes into fast charge phase.
During the fast charge phase the process proceeds with a current limited charging; this current limit depends on the required time for the complete charge and from the battery pack capacity. During this phase the voltage across the battery terminals still raises but at a lower rate.
Once the battery voltage reaches its maximum voltage then the process goes into its third state: Final charging. The voltage measure to change the process status into final charge is very important. It must be ensured that the maximum battery voltage is never exceeded, otherwise the battery may be damaged and even explode. Moreover for the constant voltage final chargers, the constant voltage phase (final charge) must not start before the battery voltage has reached its maximum value, otherwise the battery capacity will be highly reduced.
The final charge can be of two different types: constant voltage or pulsed. GC864 uses constant voltage.
The constant voltage charge proceeds with a fixed voltage regulator (very accurately set to the maximum battery voltage) and hence the current will decrease while the battery is becoming charged.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

When the charging current falls below a certain fraction of the fast charge current value, then the battery is considered fully charged, the final charge stops and eventually starts the maintenance.
The pulsed charge process has no voltage regulation, instead the charge continues with pulses. Usually the pulse charge works in the following manner: the charge is stopped for some time, let's say few hundreds of ms, then the battery voltage will be measured and when it drops below its maximum value a fixed time length charging pulse is issued. As the battery approaches its full charge the off time will become longer, hence the duty-cycle of the pulses will decrease. The battery is considered fully charged when the pulse duty-cycle is less than a threshold value, typically 10%, the pulse charge stops and eventually the maintenance starts.
The last phase is not properly a charging phase, since the battery at this point is fully charged and the process may stop after the final charge. The maintenance charge provides an additional charging process to compensate for the charge leak typical of a Li-Ion battery. It is done by issuing pulses with a fixed time length, again few hundreds of ms, and a duty-cycle around 5% or less.
This last phase is not implemented in the GC864 internal charging algorithm, so that the battery once charged is left discharging down to a certain threshold so that it is cycled from full charge to slight discharge even if the battery charger is always inserted. This guarantees that anyway the remaining charge in the battery is a good percentage and that the battery is not damaged by keeping it always fully charged (Li-Ion rechargeable battery usually deteriorate when kept fully charged).
Last but not least, in some applications it is highly desired that the charging process restarts when the battery is discharged and its voltage drops below a certain threshold, GC864 internal charger does it.
As you can see, the charging process is not a trivial task to be done; moreover all these operations should start only if battery temperature is inside a charging range, usually 5°C - 45°C.
The GC864 measures the temperature of its internal component, in order to satisfy this last requirement, it's not exactly the same as the battery temperature but in common application the two temperature should not differ too much and the charging temperature range should be guaranteed.

NOTE: For all the threshold voltages, inside the GC864 all threshold are fixed in order to maximize Li-Ion battery performances and do not need to be changed.

NOTE: In this application the battery charger input current must be limited to less than 400mA. This can be done by using a current limited wall adapter as the power source.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

3.2.2 Thermal Design Guidelines

The thermal design for the power supply heat sink should be done with the following specifications:

- *Average current consumption during transmission @PWR level max (rms):* *500mA*
- *Average current consumption during transmission @ PWR level min (rms):* *100mA*
- *Average current during Power Saving:* *4mA*
- *Average current during idle (Power Saving disabled)* *19mA*

NOTE: The average consumption during transmissions depends on the power level at which the device is requested to transmit by the network. The average current consumption hence varies significantly.

TIP: The thermal design for the Power supply should be made keeping a average consumption at the max transmitting level during calls of 500mA rms.

Considering the very low current during idle, especially if Power Saving function is enabled, it is possible to consider from the thermal point of view that the device absorbs current significantly only during calls.
If we assume that the device stays into transmission for short periods of time (let's say few minutes) and then remains for a quite long time in idle (let's say one hour), then the power supply has always the time to cool down between the calls and the heat sink could be smaller than the calculated one for 500mA maximum RMS current, or even could be the simple chip package (no heat sink).
Moreover in the average network conditions the device is requested to transmit at a lower power level than the maximum and hence the current consumption will be less than the 500mA, being usually around 150mA.
For these reasons the thermal design is rarely a concern and the simple ground plane where the power supply chip is placed can be enough to ensure a good thermal condition and avoid overheating.
For the heat generated by the GC864, you can consider it to be during transmission 1W max during CSD/VOICE calls and 2W max during class10 GPRS upload.
This generated heat will be mostly conducted to the ground plane under the GC864, you must ensure that your application can dissipate it.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

3.2.3 Power Supply PCB layout Guidelines

As seen on the electrical design guidelines the power supply shall have a low ESR capacitor on the output to cut the current peaks and a protection diode on the input to protect the supply from spikes and polarity inversion. The placement of these components is crucial for the correct working of the circuitry. A misplaced component can be useless or can even decrease the power supply performances.

- The Bypass low ESR capacitor must be placed close to the Telit GC864 power input pads or in the case the power supply is a switching type it can be placed close to the inductor to cut the ripple provided the PCB trace from the capacitor to the GC864 is wide enough to ensure a dropless connection even during the 2A current peaks.
- The protection diode must be placed close to the input connector where the power source is drained.
- The PCB traces from the input connector to the power regulator IC must be wide enough to ensure no voltage drops occur when the 2A current peaks are absorbed. Note that this is not made in order to save power loss but especially to avoid the voltage drops on the power line at the current peaks frequency of 216 Hz that will reflect on all the components connected to that supply, introducing the noise floor at the burst base frequency. For this reason while a voltage drop of 300-400 mV may be acceptable from the power loss point of view, the same voltage drop may not be acceptable from the noise point of view. If your application doesn't have audio interface but only uses the data feature of the Telit GC864, then this noise is not so disturbing and power supply layout design can be more forgiving.
- The PCB traces to the GC864 and the Bypass capacitor must be wide enough to ensure no significant voltage drops occur when the 2A current peaks are absorbed. This is for the same reason as previous point. Try to keep this trace as short as possible.
- The PCB traces connecting the Switching output to the inductor and the switching diode must be kept as short as possible by placing the inductor and the diode very close to the power switching IC (only for switching power supply). This is done in order to reduce the radiated field (noise) at the switching frequency (100-500 kHz usually).
- The use of a good common ground plane is suggested.
- The placement of the power supply on the board should be done in such a way to guarantee that the high current return paths in the ground plane are not overlapped to any noise sensitive circuitry as the microphone amplifier/buffer or earphone amplifier.
- The power supply input cables should be kept separate from noise sensitive lines such as microphone/earphone cables.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

4 Antenna

The antenna connection and board layout design are the most important part in the full product design and they strongly reflect on the product overall performances, hence read carefully and follow the requirements and the guidelines for a proper design.

4.1 Antenna Requirements

As suggested on the Product Description the antenna for a Telit GC864 device shall fulfill the following requirements:

ANTENNA REQUIREMENTS	
Frequency range	Standard Dual Band GSM/DCS frequency range or Standard Tri Band GSM/DCS/PCS frequency range if used for all three bands
Bandwidth	136 MHz in GSM 850 and 900 & 170 MHz in DCS & 140 MHz PCS band
Gain	Gain < 3dBi
Impedance	50 ohm
Input power	> 2 W peak power
VSWR absolute max	<= 10:1
VSWR recommended	<= 2:1

4.2 GC864 Antenna Connector

The **GC864** module is equipped with a 50 Ohm RF connector from Murata,
GSC type P/N **MM9329-2700B**.
The counterpart suitable is Murata **MXTK92** Type or **MXTK88** Type.
Moreover, the **GC864** has the antenna pads on the backside of the PCB. This allows the manual soldering of the coaxial cable directly on the back side of the PCB. However, the soldering is not an advisable solution for a reliable connection of the antenna.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

4.3 Antenna installation Guidelines

- Install the antenna in a place covered by the GSM signal.
- The Antenna must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter;
- Antenna shall not be installed inside metal cases
- Antenna shall be installed also according Antenna manufacturer instructions.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

5 GC864 pins allocation

The GC864 uses an 80 pin Molex p.n. 53949-0878 male connector for the connections with the external applications. This connector matches the 54150-0878 model.

Pin	Signal	I/O	Function	Internal Pull up	Type
Power Supply					
1	VBATT	-	Main power supply		Power
2	VBATT	-	Main power supply		Power
3	VBATT	-	Main power supply		Power
4	VBATT	-	Main power supply		Power
5	GND	-	Ground		Power
6	GND	-	Ground		Power
7	GND	-	Ground		Power
Audio					
8	AXE	I	Handsfree switching	100KΩ	CMOS 2.8V
9	EAR_HF+	AO	Handsfree ear output, phase +		Audio
10	EAR_HF-	AO	Handsfree ear output, phase -		Audio
11	EAR_MT+	AO	Handset earphone signal output, phase +		Audio
12	EAR_MT-	AO	Handset earphone signal output, phase -		Audio
13	MIC_HF+	AI	Handsfree microphone input; phase +, nominal level 3mVrms		Audio
14	MIC_HF-	AI	Handsfree microphone input; phase -, nominal level 3mVrms		Audio
15	MIC_MT+	AI	Handset microphone signal input; phase+, nominal level 50mVrms		Audio
16	MIC_MT-	AI	Handset microphone signal input; phase-, nominal level 50mVrms		Audio
SIM Card Interface					
18	SIMVCC	-	External SIM signal – Power supply for the SIM		1.8/3V
19	SIMRST	O	External SIM signal – Reset		1.8/3V
20	SIMIO	I/O	External SIM signal - Data I/O		1.8/3V
21	SIMIN	I	External SIM signal - Presence (active low)	47KΩ	1.8/3V
22	SIMCLK	O	External SIM signal – Clock		1.8/3V
Trace					
23	RX_TRACE	I	RX Data for debug monitor		CMOS 2.8V
24	TX_TRACE	O	TX Data for debug monitor		CMOS 2.8V
Prog. / Data + Hw Flow Control					
25	C103/TXD	I	Serial data input (TXD) from DTE		CMOS 2.8V
26	C104/RXD	O	Serial data output to DTE		CMOS 2.8V

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

Pin	Signal	I/O	Function	Internal Pull up	Type
27	C107/DSR	O	Output for Data set ready signal (DSR) to DTE		CMOS 2.8V
28	C106/CTS	O	Output for Clear to send signal (CTS) to DTE		CMOS 2.8V
29	C108/DTR	I	Input for Data terminal ready signal (DTR) from DTE		CMOS 2.8V
30	C125/RING	O	Output for Ring indicator signal (RI) to DTE		CMOS 2.8V
31	C105/RTS	I	Input for Request to send signal (RTS) from DTE		CMOS 2.8V
32	C109/DCD	O	Output for Data carrier detect signal (DCD) to DTE		CMOS 2.8V
IIC					
35	CAM_SCL / IIC_SCL	I/O	Camera IIC interface / Configurable GPIO		CMOS 2.8V
36	CAM_SDA / IIC_SDA	I/O	Camera IIC interface / Configurable GPIO		CMOS 2.8V
DAC and ADC					
37	ADC_IN1	AI	Analog/Digital converter input		A/D
38	ADC_IN2	AI	Analog/Digital converter input		A/D
39	ADC_IN3	AI	Analog/Digital converter input		A/D
40	DAC_OUT	AO	Digital/Analog converter output		D/A
Miscellaneous Functions					
44	MON1_CAM	I/O	MON1 / Camera interface		CMOS 2.8V
45	STAT_LED	O	Status indicator led		CMOS 1.8V
46	GND	-	Ground		Ground
49	PWRMON	I	Power ON Monitor		CMOS 2.8V
50	VAUX1	-	Power output for external accessories		-
51	CHARGE	AI	Charger input (*)		Power
52	CHARGE	AI	Charger input (*)		Power
53	ON/OFF*	I	Input command for switching power ON or OFF (toggle command). The pulse to be sent to the GC864 must be equal or greater than 1 second.	47KΩ	Pull up to VBATT
54	RESET*	I	Reset input		
55	VRTC	AO	VRTC Backup capacitor		Power
Telit GPIO					
56	TGPIO_19	I/O	Telit GPIO19 Configurable GPIO		CMOS 2.8V
57	TGPIO_11	I/O	Telit GPIO11 Configurable GPIO		CMOS 2.8V
58	TGPIO_20	I/O	Telit GPIO20 Configurable GPIO		CMOS 2.8V
59	TGPIO_04	I/O	Telit GPIO4 Configurable GPIO		CMOS 2.8V
60	TGPIO_14	I/O	Telit GPIO14 Configurable GPIO		CMOS 2.8V
61	TGPIO_15	I/O	Telit GPIO15 GPIO pin		CMOS 2.8V
62	TGPIO_12	I/O	Telit GPIO12 Configurable GPIO		CMOS 2.8V
63	TGPIO_10	I/O	Telit GPIO10 I/O pin		CMOS 2.8V
64	TGPIO_22	I/O	Telit GPIO22 Configurable GPIO		CMOS 1.8V
65	TGPIO_18	I/O	Telit GPIO18 I/O pin		CMOS 2.8V
66	TGPIO_03	I/O	Telit GPIO3 Configurable GPIO		CMOS 2.8V

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

Pin	Signal	I/O	Function	Internal Pull up	Type
67	TGPIO_08 / CAM_ON	I/O	Telit GPIO8 Configurable GPIO / Camera Interface		CMOS 2.8V
68	TGPIO_06 / ALARM	I/O	Telit GPIO6 Configurable GPIO / ALARM		CMOS 2.8V
69	TGPIO_23	I/O	Reserved to detect ON/OFF. It is physically connected to pin 49 (PWRMON)		CMOS 2.8V
70	TGPIO_01	I/O	Telit GPIO1 Configurable GPIO		CMOS 2.8V
71	TGPIO_17	I/O	Telit GPIO17 GPIO pin		CMOS 2.8V
72	TGPIO_21	I/O	Telit GPIO21 Configurable GPIO		CMOS 2.8V
73	TGPIO_07 / BUZZER	I/O	Telit GPIO7 Configurable GPIO / Buzzer		CMOS 2.8V
74	TGPIO_02 / JDR	I/O	Telit GPIO02 I/O pin / Jammer detect report		CMOS 2.8V
75	TGPIO_16	I/O	Telit GPIO16 Configurable GPIO		CMOS 2.8V
76	TGPIO_09 / CAM_RST	I/O	Telit GPIO9 GPIO I/O pin 7 Camera Interface		CMOS 2.8V
77	TGPIO_13	I/O	Telit GPIO13 Configurable GPIO		CMOS 2.8V
78	TGPIO_05 / RFTXMON	I/O	Telit GPIO05 Configurable GPIO / Transmitter ON monitor		CMOS 2.8V
RESERVED					
17		-			
33		-			
34		-			
41		-			
42		-			
43		-			
47		-			
48		-			
79		-			
80		-			

NOTE: RESERVED pins must not be connected

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

6 Serial Port

The serial port on the Telit GC864 is the core of the interface between the module and OEM hardware. Several configurations can be designed for the serial port on the OEM hardware, but the most common are:
- RS232 PC com port
- microcontroller UART @ 2.8V - 3V (Universal Asynchronous Receive Transmit)
- microcontroller UART@ 5V or other voltages different from 2.8V

Depending from the type of serial port on the OEM hardware a level translator circuit may be needed to make the system work. The only configuration that doesn't need a level translation is the 2.8V UART.
The serial port on the GC864 is a +2.8V UART with all the 7 RS232 signals. It differs from the PC-RS232 in the signal polarity (RS232 is reversed) and levels. The levels for the GC864 UART are the CMOS levels:

Absolute Maximum Ratings -Not Functional

Parameter	Min	Max
Input level on any digital pad when on	-0.3V	+3.75V
Input voltage on analog pads when on	-0.3V	+3.0 V

Operating Range - Interface levels (2.8V CMOS)

Level	Min	Max
Input high level V_{IH}	2.1V	3.3V
Input low level V_{IL}	0V	0.5V
Output high level V_{OH}	2.2V	3.0V
Output low level V_{OL}	0V	0.35V

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

The signals of the GC864 serial port are:

RS232 Pin Number	GC864 Pad Number	Signal	Type	Name	Usage
3	25	C103/TXD	I	Serial data input (TXD) from DTE	Input receive of the GC864 UART
2	26	C104/RXD	O	Serial data output to DTE	Output transmit line of GC864 UART
6	27	C107/DSR	O	Output for Data set ready signal (DSR) to DTE	Output from the GC864 that indicates the module is ready
8	28	C106/CTS	O	Output for Clear to send signal (CTS) to DTE	Output from the GC864 that controls the Hardware flow control
4	29	C108/DTR	I	Input for Data terminal ready signal (DTR) from DTE	Input to the GC864 that controls the DTE READY condition
9	30	C125/RING	O	Output for Ring indicator signal (RI) to DTE	Output from the GC864 that indicates the incoming call condition
7	31	C105/RTS	I	Input for Request to send signal (RTS) from DTE	Input to the GC864 that controls the Hardware flow control
1	32	C109/DCD	O	Output for Data carrier detect signal (DCD) to DTE	Output from the GC864 that indicates the carrier presence
5	5,6,7	GND	-	Ground	ground

NOTE: According to V.24, RX/TX signal names are referred to the application side, therefore on the GC864 side these signal are on the opposite direction: TXD on the application side will be connected to the receive line (here named TXD/ rx_uart) of the GC864 serial port and viceversa for RX.

TIP: For a minimum implementation, only the TXD and RXD lines can be connected, the other lines can be left open provided a software flow control is implemented.

The signals in the UART connector on the EVK2 are:

DCD	RXD
TXD	DTR
GND	DSR
RTS	CTS
RI	GND

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

6.1 RS232 level translation

In order to interface the Telit GC864 with a PC com port or a RS232 (EIA/TIA-232) application a level translator is required. This level translator must
- invert the electrical signal in both directions
- change the level from 0/3V to +15/-15V

Actually, the RS232 UART 16450, 16550, 16650 & 16750 chipsets accept signals with lower levels on the RS232 side (EIA/TIA-562) , allowing for a lower voltage-multiplying ratio on the level translator. Note that the negative signal voltage must be less than 0V and hence some sort of level translation is always required.
The simplest way to translate the levels and invert the signal is by using a single chip level translator. There are a multitude of them, differing in the number of driver and receiver and in the levels (be sure to get a true RS232 level translator not a RS485 or other standards).
By convention the driver is the level translator from the 0-3V UART level to the RS232 level, while the receiver is the translator from RS232 level to 0-3V UART.

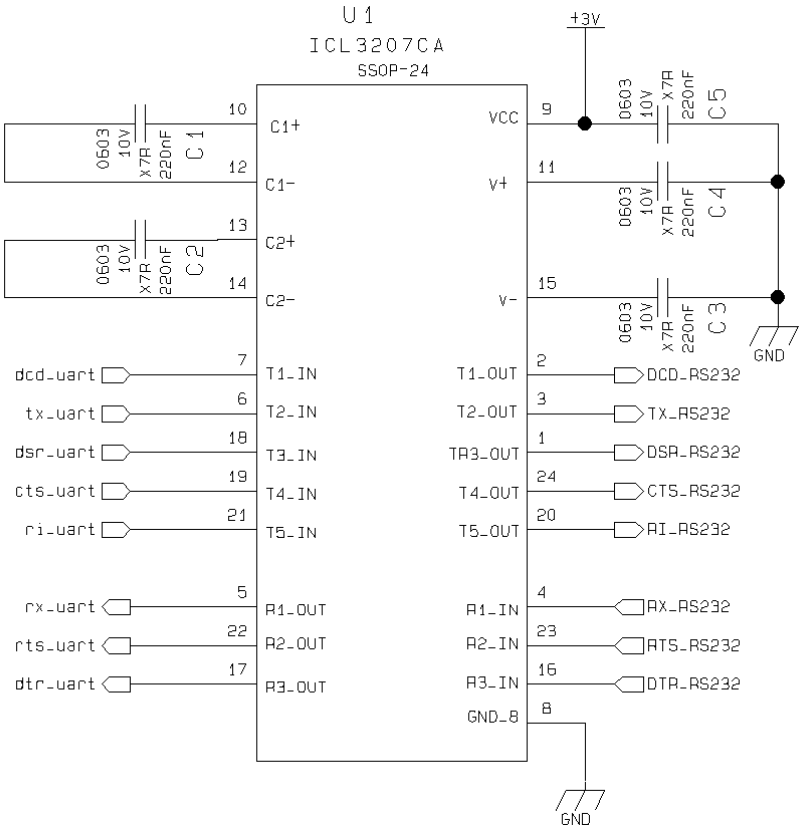
In order to translate the whole set of control lines of the UART you will need:
- 5 driver
- 3 receiver

NOTE: The digital input lines working at 2.8VCMOS have an absolute maximum input voltage of 3,75V; therefore the level translator IC shall not be powered by the +3.8V supply of the module. Instead it shall be powered from a +2.8V / +3.0V (dedicated) power supply.
This is because in this way the level translator IC outputs on the module side (i.e. GC864 inputs) will work at +3.8V interface levels, stressing the module inputs at its maximum input voltage.
This can be acceptable for evaluation purposes, but not on production devices.

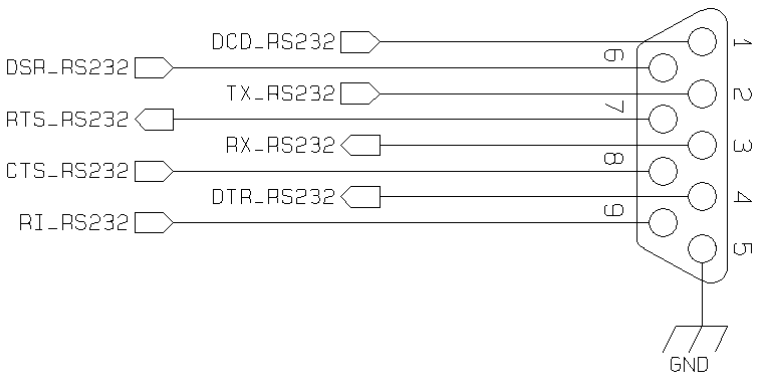
NOTE: In order to be able to do in circuit reprogramming of the GC864 firmware, the serial port on the Telit GC864 shall be available for translation into RS232 and either it's controlling device shall be placed into tristate, disconnected or as a gateway for the serial data when module reprogramming occurs.
Only RXD, TXD, GND and the On/off module turn on pad are required to the reprogramming of the module, the other lines are unused.
All applicator shall include in their design such a way of reprogramming the GC864.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

An example of level translation circuitry of this kind is:

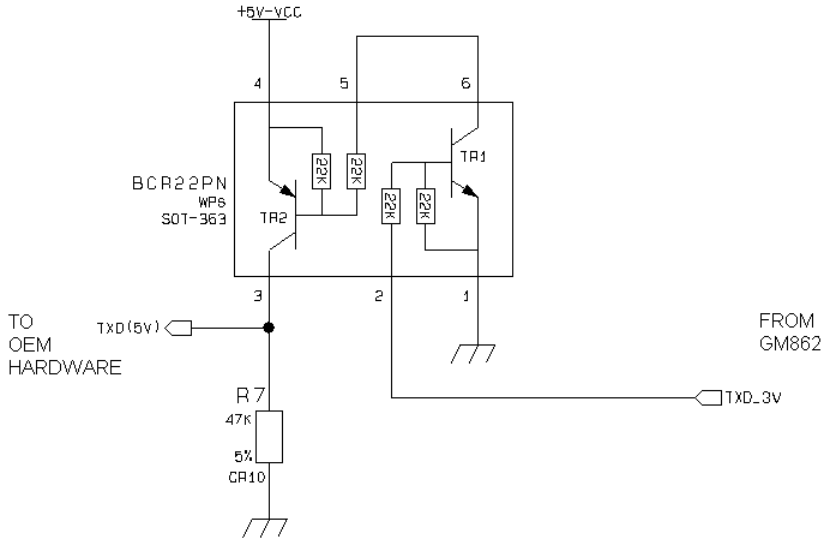


the RS232 serial port lines are usually connected to a DB9 connector with the following layout:

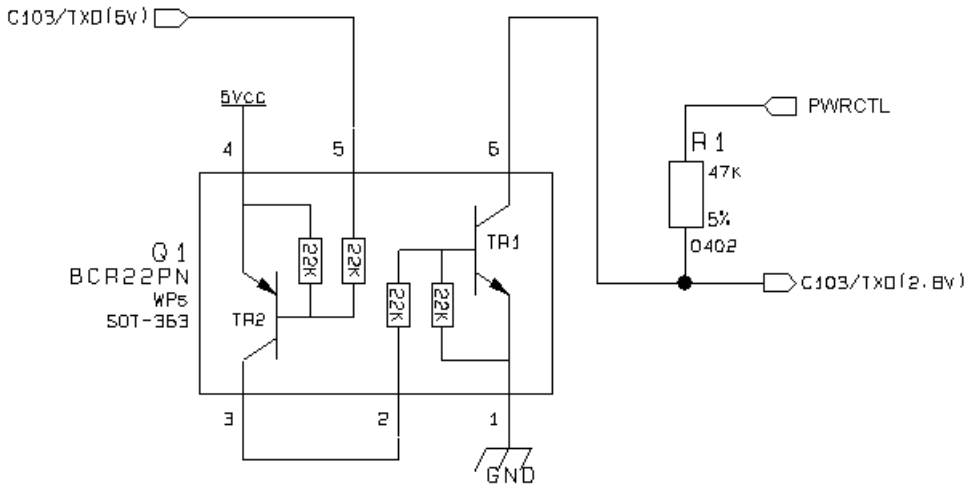


6.2 5V UART level translation

If the OEM application uses a microcontroller with a serial port (UART) that works at a voltage different from 2.8 - 3V, then a circuitry has to be provided to adapt the different levels of the two sets of signals. As for the RS232 translation there are a multitude of single chip translators, but since the translation requires very few components, then also a discrete design can be suited. For example a possible inexpensive translator circuit for a 5V driver can be:



and for a 5V receiver:



NOTE: The UART input line TXD (rx_uart) of the GC864 is NOT internally pulled up with a resistor, so there may be the need to place an external 47KΩ pull-up resistor, either the DTR (dtr_uart) and RTS (rts_uart) input lines are not pulled up internally, so an external pull-up resistor of 47KΩ may be required.

A power source of the internal interface voltage corresponding to the 2.8VCMOS high level is available at the VAUX pad, whose absolute maximum output current is 100mA.
Pull-up resistors can be connected to the VAUX pad provided that the pulled-up lines are GC864 input lines connected to open collector outputs in order to avoid latch-up problems on the GC864.
Care must be taken to avoid latch-up on the GC864 and the use of this output line to power electronic devices shall be considered with care, especially for devices that generate spikes and noise such as level translators, digital ICs or microcontroller, failure in any of these condition can severely compromise the GC864 functionality.

NOTE: The input lines working at 2.8VCMOS can be pulled-up with 47KΩ resistors that can be connected directly to the VAUX line.
NO disturbing devices should be powered with the VAUX line, otherwise the module functionality may be compromised.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

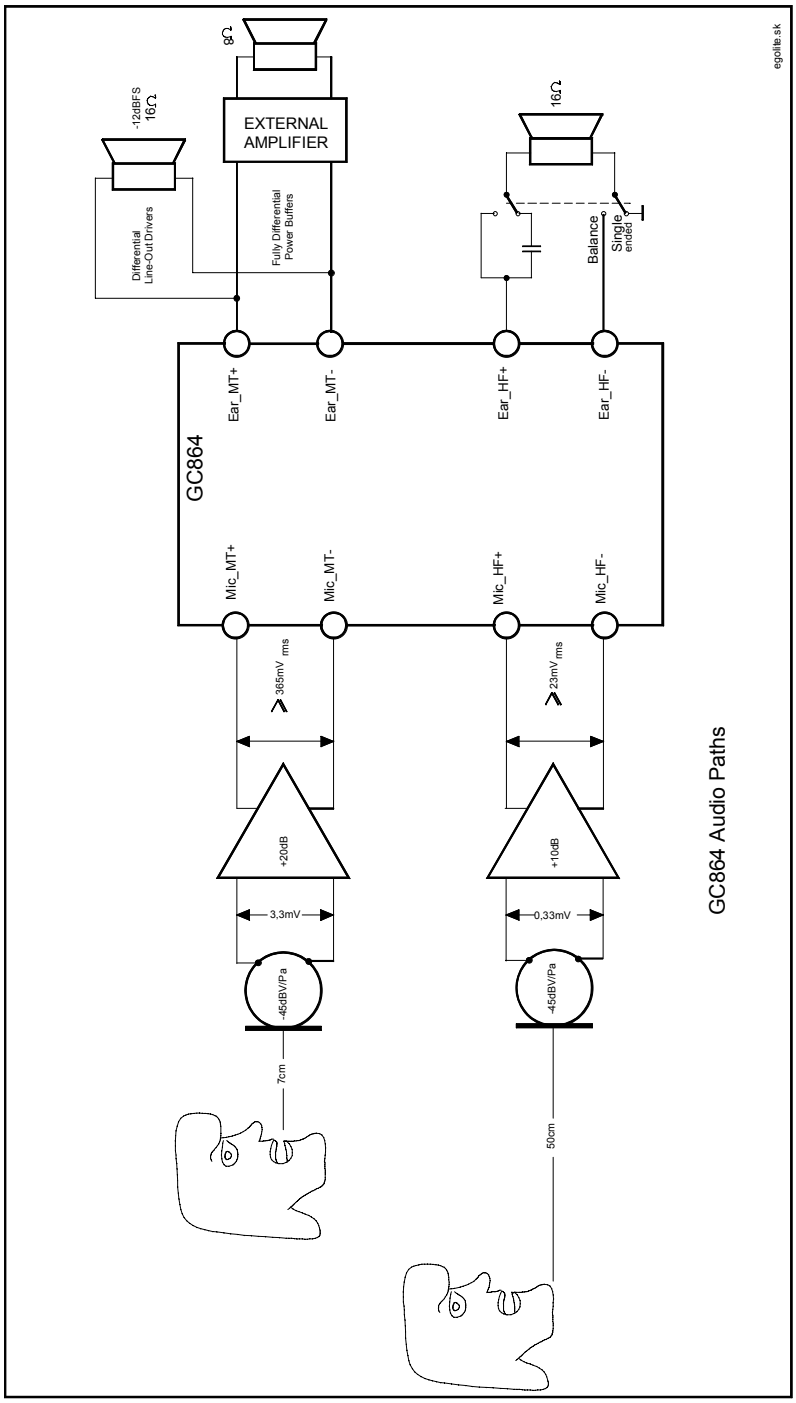
7 Audio Section Overview

The Base Band Chip of the GC864 Telit Module provides two different audio blocks; both in transmit (*Uplink*) and in receive (*Downlink*) direction:

"*MT lines*" should be used for handset function,
"*HF lines*" is suited for hands -free function (car kit).

These two blocks can be active only one at a time, selectable by *AXE* hardware line or by AT command.
The audio characteristics are equivalent in transmit blocks, but are different in the receive ones and this should be kept in mind when designing.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved


8Ω
EXTERNAL AMPLIFIER
-12dBFS 16Ω
16Ω
Differential Line-Out Drivers
Fully Differential Power Buffers
Balance
Single ended
Ear_MT+
Ear_MT-
Ear_HF+
Ear_HF-
GC864
Mic_MT+
Mic_MT-
Mic_HF+
Mic_HF-
365mV rms
23mV rms
+20dB
+10dB
3,3mV
0,33mV
-45dBV/Pa
-45dBV/Pa
7cm
50cm
GC864 Audio Paths
egolite.sk

7.1 Microphone paths characteristic and requirements

TIP: being the microphone circuitry the more noise sensitive , its design and layout must be done with particular care. Both microphone paths are balanced and the OEM circuitry should be balanced designed to reduce the common mode noise typically generated on the ground plane. However also an unbalanced circuitry can be used for particular OEM application needs .

TIP: due to the difference in the echo canceller type, the "Mic_MT" audio path is suited for Handset applications, while the "Mic_HF"audio path is suited for hands-free function (car kit). The Earphone applications should be made using the "Mic_HF" audio path but DISABLING the echo canceller by software AT command. If the echo canceller is left active with the Earphone, then some echo might be introduced by the echo cancel algorithm.

"Mic_MT" 1st differential microphone path

- **line coupling** — **AC**
- **line type** — **balanced**
- **coupling capacitor** — **≥ 100nF**
- **differential input resistance** — **50kΩ**
- **differential input voltage** — **≤ 1,03V_{pp} (365mV_{rms})**
- **microphone nominal sensitivity** — **-45 dBV_{rms}/Pa**
- **analog gain suggested** — **+ 20dB**
- **echo canceller type** — **handset**

"Mic_HF" 2nd differential microphone path

- **line coupling** — **AC**
- **line type** — **balanced**
- **coupling capacitor** — **≥ 100nF**
- **differential input resistance** — **50kΩ**
- **differential input voltage** — **≤ 65mV_{pp} (23mV_{rms})**
- **microphone nominal sensitivity** — **-45 dBV_{rms}/Pa**

- **analog gain suggested** — **+10dB**
- **echo canceller type** — **car kit hands-free**

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

TIP: definition of the nominal sensitivity of the microphone lines .

The nominal sensitivity of the microphone lines indicates the voltage level on the GC864 pins present during "*normal spoken*" conditions.
For a handset , the "*normal spoken"* conditions take place when the talker mouth is 7cm far from the microphone ; under these conditions the voice will produce an acoustic pressure of *-4,7dBPa @1kHz* on the microphone membrane .

TIP: electrical equivalent signal and operating voice levels .

At "*normal spoken*" conditions, a microphone having the suggested nominal sensitivity of -*45dBV$_{rms}$/Pa* , will produce

the electrical equivalent signal : $MicLevel = (-45) + (-4.7) = -49.7\ dB_{Vrms}$

that means : $MicVoltage = 10^{(-49.7/20)} = 3.3 * 10^{-3}\ V_{rms}$

During a call , this level varies according to the volume of the talker voice; usually the following rough thumb rule for the dynamic range may be used :

1) the talker is screaming . This is the *strongest voice level* condition : the signal increases by +20dB ;
2) the talker is whispering. This is the *lowest voice level* condition: the voice level decreases by –50dB .

These changes must be considered for designing the external microphone amplifier .

TIP: example of external microphone amplifier calculation .

Let's suppose to use the *1stdifferential* microphone path .In this case the maximum differential input voltage to "*Mic_MT*" lines is 365mV$_{rms}$(1,03V$_{pp}$) corresponding to –8,76dBV.
Now we can calculate the maximum voltage gain of an external microphone amplifier G_A :

$$[(MicLevel + 20dB) + G_A] = -8{,}76dBV$$

$$[-49{,}7 + 20 + G_A] = -8{,}76$$

$$-40{,}9 + 20 = -G_A$$

$$G_A = 20{,}94dB$$ ⟶ you can set G_A= **+20dB** to use standard resistor values .

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

TIP: environment consideration .

For *hands-free/car kit* microphone, you must take into account the voice attenuation, due to the distance between the microphone itself and the talker, when designing the external microphone amplifier.
Not only, you must consider that the microphone will pick up also ambient noise; to overcome this problem it is preferable to set the gain of the microphone *10dB* lower with respect to the calculated value for a nominal sensitivity. The corresponding reduction in signal level will be compensated by an increased voice volume of the talker which will speak louder because of the ambient noise.
For a car cabin usually the distance between the microphone itself and the talker is *40/50cm*; in these conditions the attenuation can be considered as a thumb rule around *20dB*.

For the earphone we shall distinguish two different types: the earphones having the microphone sustained close to the mouth and the ones having the microphone on the earpiece cable.
The same considerations for the additional voice attenuation due to the distance from the microphone and the noise pick up can be made for the earphone having the microphone on the earpiece cable, while the other kind of earphone shall be threaten as an handset.

TIP: how to compensate the losses in car cabin hands-free condition .

The voice signal , that in the "normal spoken" conditions produces on the microphone membrane an acoustic pressure of -4,7dBPa at 1kHz , will have a further attenuation of 20dB due the 50cm distance .

Therefore a microphone having the suggested nominal sensitivity of -45dBV$_{rms}$/Pa,will produce a lower electrical

equivalent signal : $MicLevel = (-45) + (-4.7) - 20 = -69.7$

that means : $MicVoltage = 10^{(-49.7/20)} = 0{,}33 * 10^{-3}$

Setting the "microphone gain" at +10dB (3 times), the signal in the nominal conditions on the "Mic_HF" inputs s of GC864 Telit Module will be :

"**Mic_HF**" $Level = 0{,}33 * 10^{-3} * 3 = 1 * 10^{-3}$

Hence in these conditions the signal level on the"***Mic_HF***" input pads of the GC864 is 10 dB (3 times) lower than the nominal, as suggested.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

7.2 General Design Rules

There are several configurations for the audio paths, but the most effective difference is between balanced and unbalanced microphone configuration.
It is highly recommended to keep the whole microphone path balanced even if this means having 2 wires connecting the microphone instead of one needed (plus ground) in the unbalanced case. The balanced circuitry is more suited because of its good common mode noise rejection, reducing the *216 Hz* burst noise produced during the GSM transmissions.

- Where possible use balanced microphone circuitry
- Keep the microphone traces on the PCB and wires as short as possible.
- If your application requires an unbalanced microphone, then keep the lines on the PCB balanced and "unbalance" the path close to the microphone wire connector if possible.
- For the microphone biasing voltage use a dedicated voltage regulator and a capacitor multiply circuit.
- Make sure that the microphone traces in the PCB don't cross or run parallel to noisy traces (especially the power line)
- If possible put all around to the microphone lines a ground trace connected to the ground plane by several vias. This is done in order to simulate a shielded trace on the PCB.
- The biasing circuit and eventually the buffer can be designed in the same manner for the internal and external microphones.

7.3 Other considerations.

If your application is a hands-free/car kit scenario, but you need to put microphone and speaker inside the same box:

- Try to have the maximum possible distance between them, at least 7cm;
- Because the microphone type is very important, if you use an omni-directional one (and this is the typical application) please seal it on the rear side (no back cavity) in order not to collect unwanted signals;
- Try to make divergent the main axes of the two devices.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

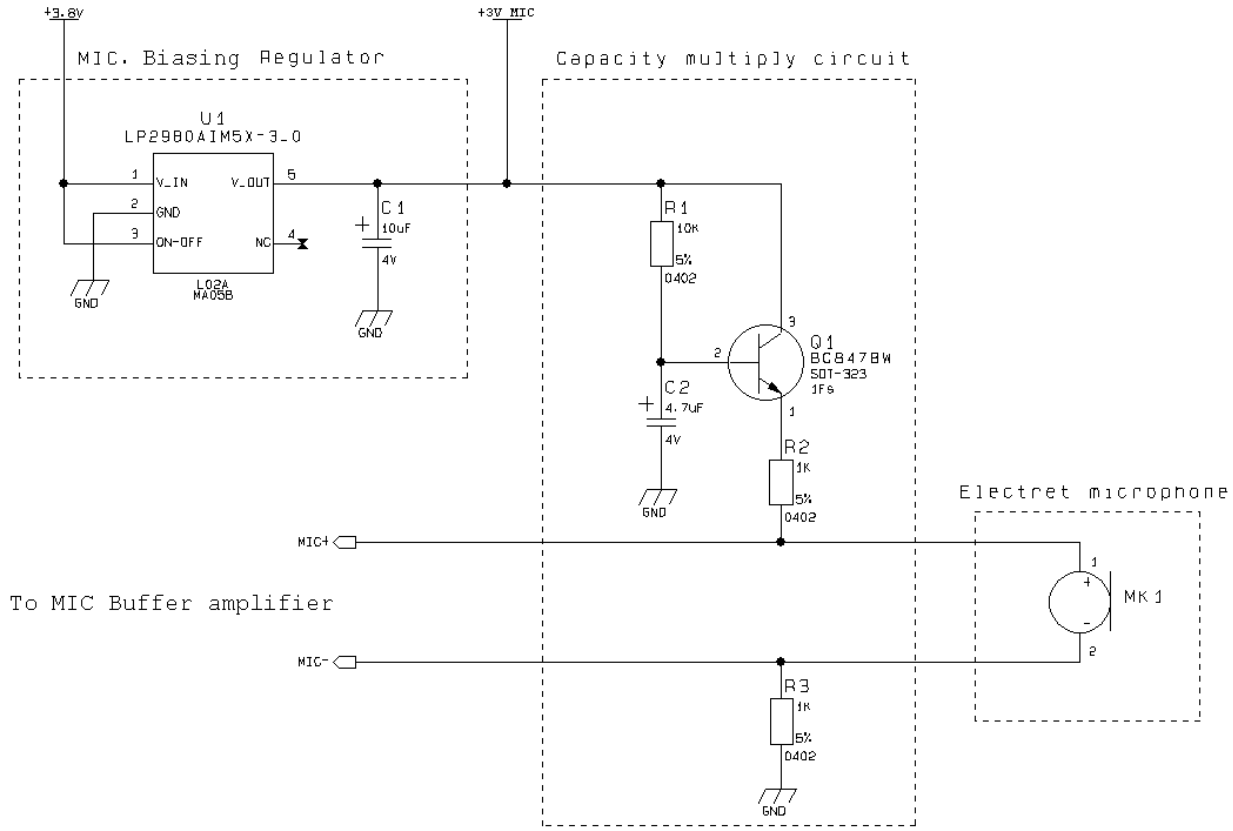
7.4 Microphone Biasing

The electret microphones usually need a biasing voltage to work properly. Refer to your microphone provider for the characteristics required.

NOTE: The microphones have a hot wire were the positive biasing must be connected. Usually it is indicated by a + symbol or a red point. If the polarity of the bias is reversed, then the microphone will not work properly. For this reason be sure to respect the mic. biasing polarity.

7.4.1 Balanced Microphone biasing

The balanced microphone bias voltage should be obtained from a dedicated voltage regulator, in order to eliminate the noise present on the power lines. This regulator can be the same for all the audio paths. The microphone should be supplied from a capacitor multiply circuit.
For example a circuit for the balanced microphone biasing can be:



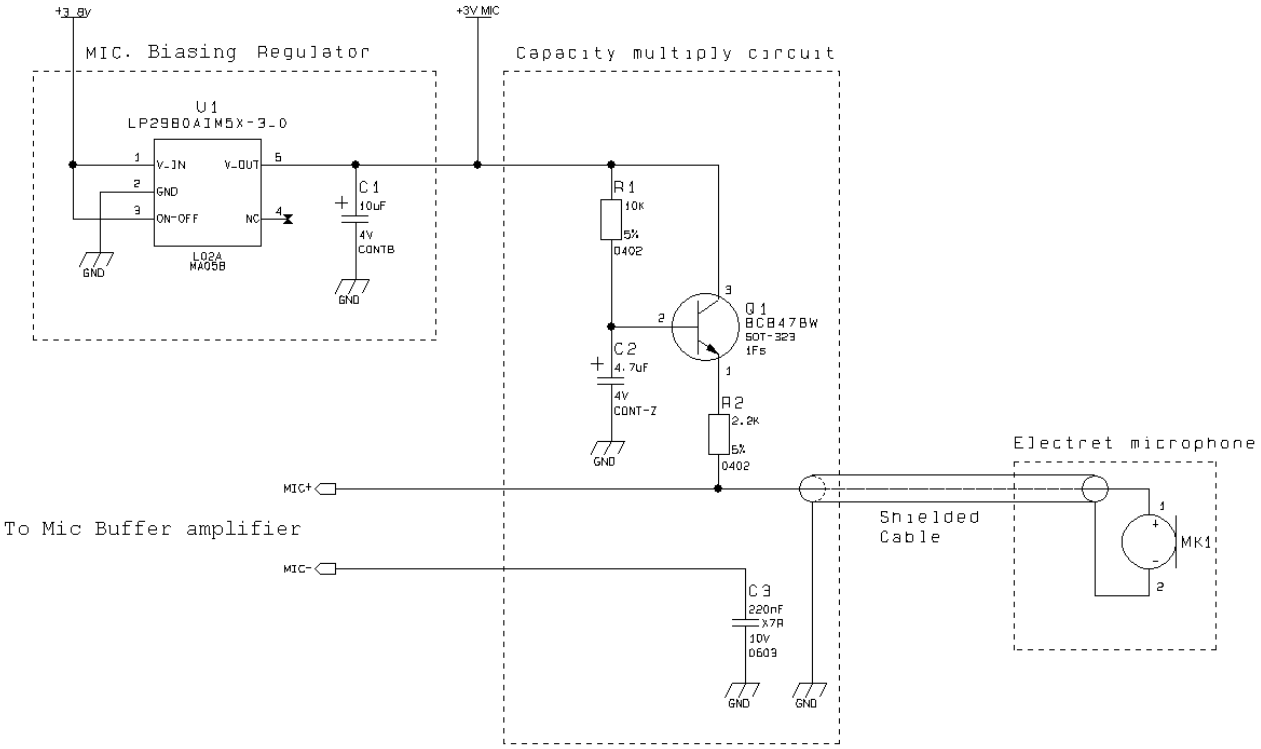
NOTE: In the balanced application the resistors R2 and R3 must have the same value to keep the circuit balanced.

NOTE: The cable to the microphone should not be shielded, instead a twisted pair cable shall be used.

NOTE: The microphone sensitivity changes with the value of R2 and R3. Usually the microphones are characterized with 2kΩ biasing resistance, so try to keep the sum of R2 and R3 around 2kΩ. Refer to your microphone manufacturer for the mic. characteristics.

7.4.2 Unbalanced Microphone biasing

The unbalanced microphone biasing voltage should be obtained from a dedicated voltage regulator, in order to eliminate the noise present on the power lines. This regulator can be the same for all the audio paths. The microphone should be supplied from a capacitor multiply circuit.
For example a circuit for the unbalanced microphone biasing can be:



NOTE: In the unbalanced application the capacitor C3 shall be > 200nF otherwise the frequency response will be cut at low band frequencies (down to 300Hz). This capacitor can be placed close to the MIC- pad (MIC_HF- or MIC_MT- depending on the audio path chosen) or if possible it should be placed close to the shielded cable connector. If the ground return path is well designed, then it is possible to eliminate the C3 capacitor, provided the buffer is close to the mic. input.

NOTE: The cable to the microphone should be shielded.

NOTE: The microphone changes with the value of R2. Usually the microphone sensitivity is characterized with 2kΩ biasing resistance, so try to keep the value of R2 around 2kΩ. For mic. characteristics refer to the manufacturer.

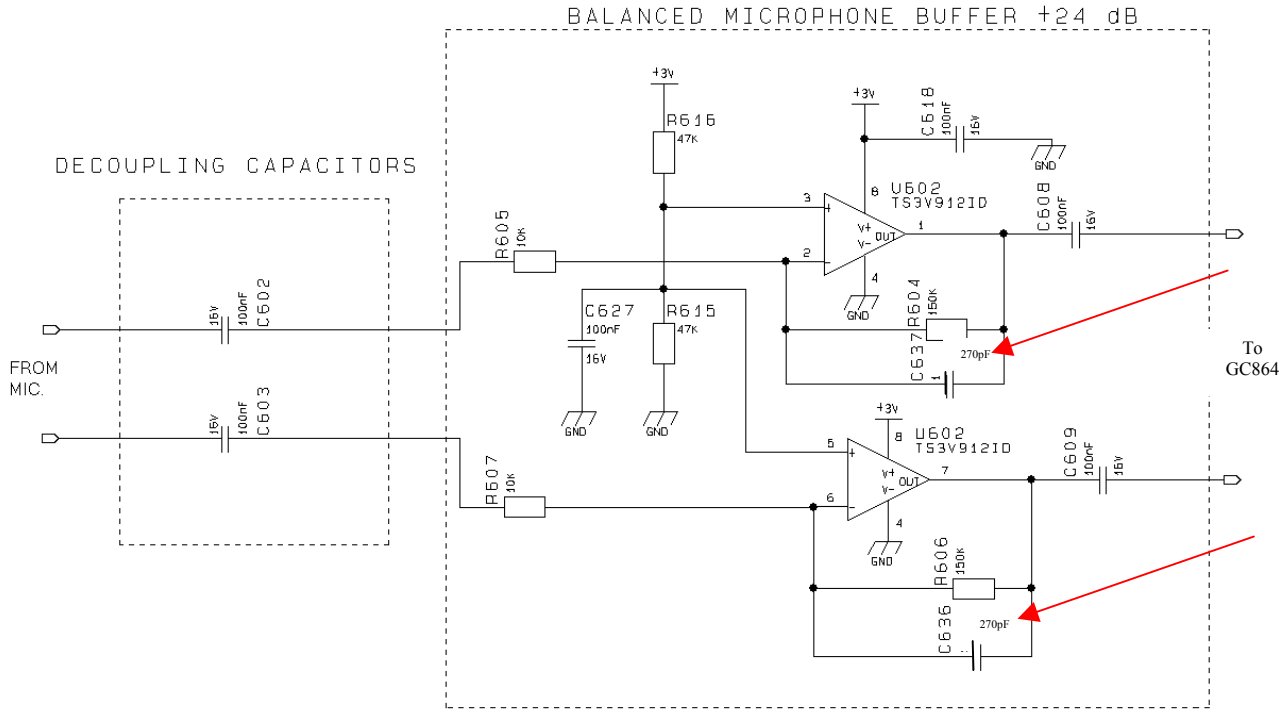
Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

7.5 Microphone buffering

As seen previously, a microphone shall be connected to the input pins of the GC864 through a buffer amplifier that boosts the signal level to the required value.
Again the buffered microphone circuitry can be balanced or unbalanced : where possible it is always preferable a balanced solution. The buffering circuit shall be placed close to the microphone or close to the microphone wire connector.

7.5.1 Buffered Balanced Mic.

A sample circuit can be:



This circuit has a gain of 10 times (+20 dB), and is therefore suited for the "***Mic_MT***" input if you have a microphone with a sensitivity close to the suggested one *(-45 dBV$_{rms}$/Pa)*. If your microphone has a different sensitivity or if the buffer is connected to the "***Mic_HF***" inputs , then a gain adjustment shall be done by changing resistors R604 and R606 (if the required value is not a standard one , you can change R605 e R607) and as a consequence the capacitors C636 and C637 to maintain the bandwidth 150-4000Hz (at -3dB).

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

The buffer gain is given by the formula:

$$Gain = \frac{R604}{R605} = \frac{R606}{R607}$$

The C636 and C637 capacitors are placed in order to cut off the gain at higher frequencies than the transmitted GSM band, the cutoff frequency (-3dB) should be 3500Hz in order to have -1dB at 3kHz. The cutoff frequency is given by the formula:

$$freq. = \frac{1}{2\pi * R604 * C637} = \frac{1}{2\pi * R606 * C636} \text{ [Hz]}$$

TIP: example of calculation .

*Let's assume you have a microphone with a sensitivity of -45 dBV_{rms}/Pa and you want to use it in 1st differential microphone path ("**Mic_MT**" inputs) in "normal spoken" conditions at acoustic pressure of -4.7dBPa.*
As reported at page 33 , the electrical level output from the microphone will be :

$MicLevel = (-45) + (-4.7) = -49.7\ dB_{Vrms}$

$MicVoltage = 10^{(-49.7/20)} = 3.3 * 10^{-3}\ V_{rms}$

corresponding to:
*When the talker is screaming ,we will have a signal of 330 mV_{rms} on the "**Mic_MT**" inputs for a buffer gain G_A :*

G_A** =20 log (AmplifierOutput / MicVoltage) =20 log (330 * 10^{-3})/(3.3 * 10^{-3}) = 20 log 10=**20dB

The corresponding values for the resistors on the buffer could be (if we keep the input resistance 10kΩ)

R604 = R606 = gain R603= gain* R605 = 10* 15 = 150 kΩ*

The commercial values of 150kΩ & 15kΩ are then chosen.

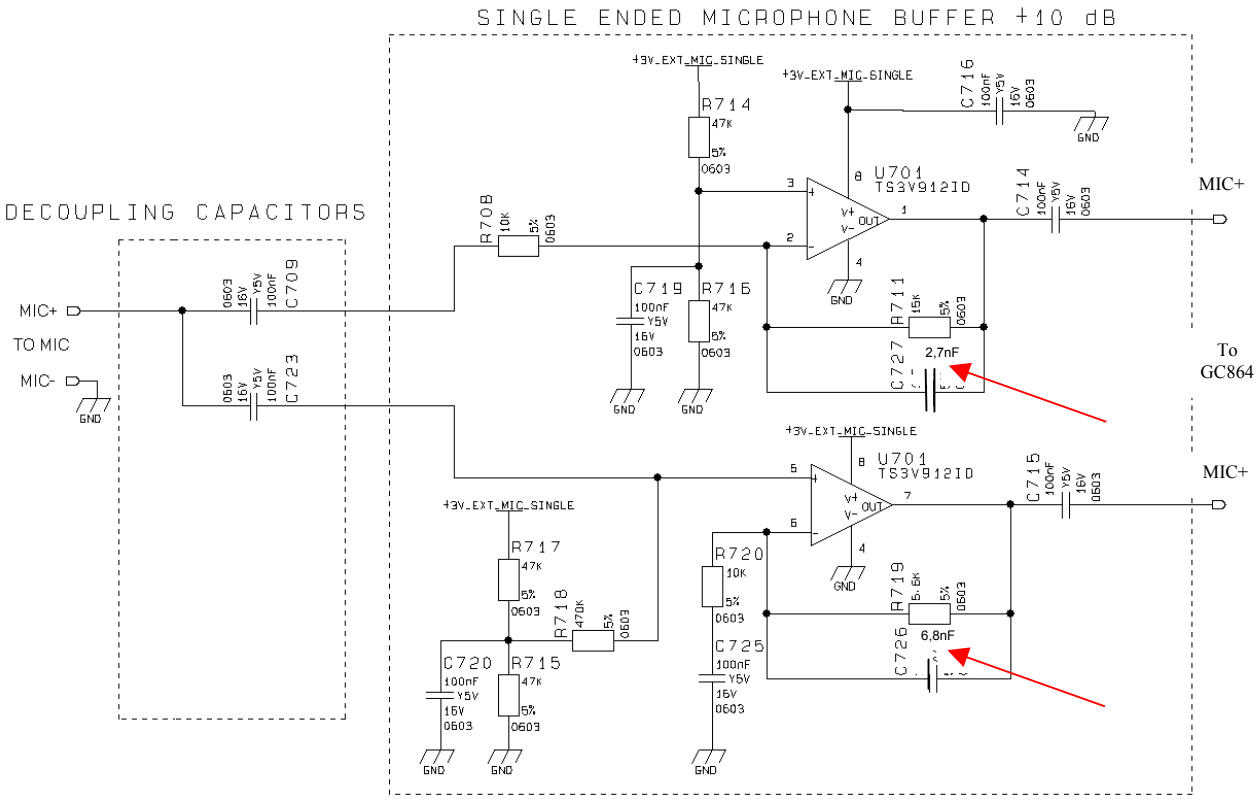
As a consequence the values of the capacitors C636 and C637 shall be:

*C636=C637= 1/ (2π*4000*R606)= 265 *10^{-12} F*

A commercial value of 270pF gives a cutoff frequency of 3931Hz with an errorless than 1,8% .

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

7.5.2 Buffered Unbalanced (Single Ended) Microphone .



The above schematic can be used for a single ended (*buffered unbalanced*) microphone; the required biasing circuitry is not included. Note also that the capacitor C3 is not needed .
The gains of the two amplifiers are given by the formulas :

$$Gain(\text{not inverting buffer}) = 1 + \frac{R719}{R720} \qquad Gain(\text{inverting buffer}) = \frac{R711}{R708}$$

Assigning half of overall gain to each amplifier, you will obtain the requested gain because of doubling the microphone signal path; in fact by the use of two amplifiers (the upper as “inverting” and the lower as “not inverting”configuration) we obtain an additional +6dB gain (2 times) .

Remember: the “not inverting “ amplifier section gain shall not be less than 1.
Like for the balanced buffered microphone, the amplifier overall gain can be modify changing the value of resistor R719/R720 and R711 and as a consequence the capacitors C726 and C727. It is advisable to change R708 only if you have difficulty to find a commercial value for R711; in this case change R708 as little as possible.

The -3dB bandwidth is given by the approximated formula (considering C725 >> C726):

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

$$freq. = \frac{1}{2\pi * R719 * C726} = \frac{1}{2\pi * R711 * C727} \text{ [Hz]}$$

The buffer bandwidth at -3dB shall be 4KHz.
Note that the biasing of the operational amplifier is given for the inverting amplifier by the series divider R714-R715. The 100nF capacitor C719 is needed to filter the noise that could be coupled to that divider. For the not inverting operational amplifier the biasing is given by a different divider R715-R717 with the capacitor C720 and through a series resistor R718 of 470KΩ.

TIP: example of calculation.

*Llet's assume you have a microphone with a sensitivity of -45dBV$_{rms}$/Pa and you want to use it in 2nd differential microphone path ("**Mic_HF**" inputs) in "normal spoken" conditions at acoustic pressure of -4.7dBPa.*
As reported at page XX , the electrical level output from the microphone will be :

$$MicLevel = (-45) + (-4.7) = -49.7\ dBV_{rms}$$

but we have to consider 20dB loss due to the higher distance from the mouth of the talker (50cm) .

$$MicLevel = (-49.7) + (-20) = -69.7\ dBV_{rms}$$

corresponding to

$$MicVoltage = 10^{(-69.7/20)} = 0{,}33 * 10^{-3}$$

*In order to have a signal of 1 mV$_{rms}$ at the **"Mic_HF"** inputs , as suggested at **TIP** "**environment consideration** ",*

the buffer must have a g

$$G_A = \text{"Mic_HF"} / MicVoltage = (1*10^{-3})/(0{,}33*10$$

or *+10 dB*

*Keeping in mind that " balancing the line will double the signal", to calculate the resistor values assign half of required gain **G$_A$** to each amplifier section . And therefore **G$_S$** =1,5times (or +3,52dB) .*

Choosing as 10kΩ as the input resistance , the corresponding values for the resistors on the buffer will be :

$$\mathbf{R711} = G_S * R708 = 1.5*10 = \mathbf{15\ k\Omega}$$

$$\mathbf{R719} = (G_S - 1) * R720 = (1.5 - 1)*10 = \mathbf{5\ k\Omega}$$

*The commercial values of **15kΩ** and **5.6kΩ** be accepted .*

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

As a consequence of the assigned values of the resistors, the nominal values of C726 and C727 are :

$$C726 = 1/(2\pi * 4000 * R719) = 7.10 * 10^{-9} F$$

$$C727 = 1/(2\pi * 4000 * R711) = 2,65 * 10^{-9} F$$

modified in ***6,8nF*** *(f_{c1}=4181Hz) and* ***2,7nF*** *(f_{c2}=3931Hz) because of commercial values .*

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

8 OUTPUT LINES (Speaker)

8.1 Short description.

The Telit GC864 provides two audio paths in receive section. Only one of the two paths can be active at a time, selectable by *AXE* hardware line or by AT command.

You must keep in mind the different audio characteristics of the receive blocks when designing:

→ the *"**Ear_MT**"* lines *EPN1* and *EPP1* are the *Differential Line-Out Drivers* ; they can drive an external amplifier or directly a ***16 Ω earpiece*** at –12dBFS (*) ;
→ the "***Ear_HF***" lines *EPPA1_2* and *EPPA2* are the *Fully Differential Power Buffers ;* they can directly drive a *16**Ω** speaker* in differential (*balanced*) or single ended (*unbalanced*) operation mode .

(*) *FS* : acronym of *Full Scale.* It is equal to 0dB, the maximum Hardware Analog Receive Gain of BaseBand Chip.

The *"**Ear_MT**"* audio path should be used for handset function, while the "***Ear_HF***" audio path is suited for hands-free function (car kit).

Both receiver outputs are B.T.L. type (Bridged Tie Load) and the OEM circuitry shall be designed bridged to reduce the common mode noise typically generated on the ground plane and to get the maximum power output from the device; however also a single ended circuitry can be designed for particular OEM application needs.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

8.2 Output lines characteristics .

"Ear_MT" Differential Line-out Drivers Path

- line coupling: DC
- line type: bridged
- output load resistance : ≥ 14 Ω
- internal output resistance: 4 Ω (typical)
- signal bandwidth: 150 - 4000 Hz @ -3 dB
- max. differential output voltage 1310 mV_{rms} (typ, open circuit)
- differential output voltage 328mVrms /16 Ω @ -12dBFS
- SW volume level step - 2 dB
- number of SW volume steps 10

"Ear_HF" Power Buffers path

- line coupling: DC
- line type: bridged
- output load resistance : ≥ 14 Ω
- internal output resistance: 4 Ω (>1,7 Ω)
- signal bandwidth: 150 - 4000 Hz @ -3 dB
- max. differential output voltage 1310 mV_{rms} (typ, open circuit)
- max. single ended output voltage 656 mV_{rms} (typ, open circuit)
- SW volume level step - 2 dB
- number of SW volume steps 10

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

8.3 General Design rules

There are several configurations for the audio output path, but the various design requirements can be grouped into three different categories:

- handset earphone (low power, typically a handset)
- hands-free earphone (low power, typically a earphone)
- car kit speakerphone (high power, typically a speaker)

The three groups have different power requirements, usually the first two applications need only few mW of power, which can be directly drained from the GC864 pads, provided a suited speaker is used. This direct connect design is the cheaper and simpler solution and will be suited for the most of the earphone design requirements. There's no need to decouple the output ear lines if a suited earpiece is connected. For the last group, the speakerphone, a power amplifier is required to raise the output power up to 5-10W required in a car cabin application.
All the designs shall comply with the following guidelines:

- Where possible use a bridged earphone circuitry, to achieve the maximum power output from the device.
- Keep the earphone traces on the PCB and wires as short as possible.
- If your application requires a single ended earpiece and you want a direct connection, then leave one of the two output lines open and use only the other referred to ground. Remember that in this case the power output is 4 times lower than the bridged circuit and may not be enough to ensure a good voice volume.
- Make sure that the earphone traces in the PCB don't cross or run parallel to noisy traces (especially the power line)
- The cable to the speaker shall be a twisted pair with both the lines floating for the bridged output type, shielded with the shield to ground for the single ended output type.

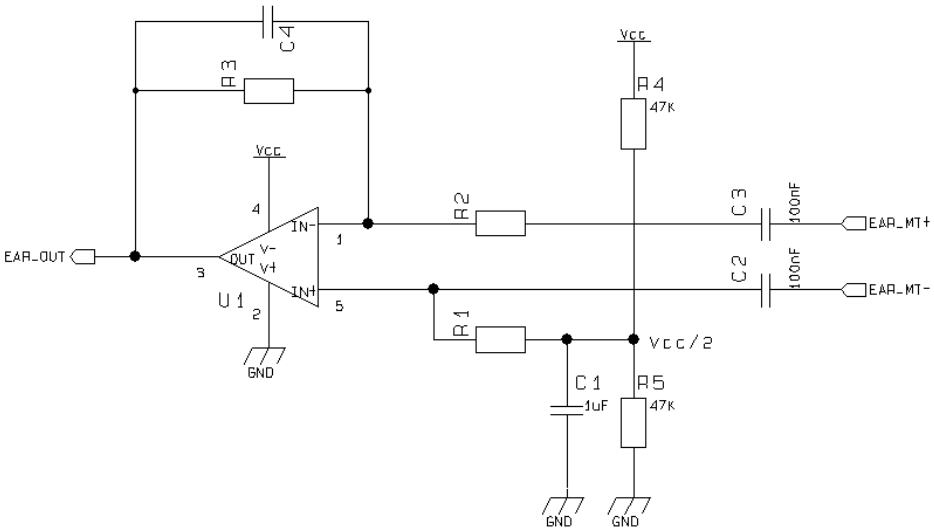
8.3.1 Noise Filtering

The I/O of the PCB should have a noise filter close to the connector, to filter the high frequency GSM noise. The filter can be a Π formed by 2 capacitor and a inductance, with the one capacitor of *39pF - 0603* case , and the other capacitor of *1nF - 0603*; the inductance shall have a value of *39µH* .

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

8.4 Handset earphone design

As seen previously, a 16Ω earpiece can be directly connected to the output pads EAR_MT+ and EAR_MT- of the *GC864*.
This solution is often the more cost effective, reducing the components count to a minimum. There are several limitations to the use of this solution: speaker direct connect imposes the speaker characteristics to be almost exactly the suggested ones, otherwise the power output may be reduced (if speaker impedance is bigger than 16Ω) or the *GC864* ear port may be damaged (if speaker impedance is less than 15Ω).
The other limitation of the speaker direct connection is the power output capability of the *GC864*, which is limited, and for some particular applications may not be enough.
For these reasons, when the power output of the *GC864* is not enough or if the speaker characteristics are different from the suggested, then it is preferable to use an amplifier to increase the power and current output capabilities.
Again the output from the *GC864* is bridged and both lines should be used, where possible, as inputs to the power amplifier. This ensures a higher common mode rejection ratio; reducing the GSM current busts noise on the speaker output.
In this case the "***EAR_MT***" lines from the *GC864* should be AC coupled with a ceramic capacitor of 100nF (or bigger).
It is always desirable to have a mute control on the amplifier, in order to turn it off while the device is not sending signal to the output, in this manner the amplifier background noise that may be audible during idle conditions is cut off.
A principle schematic may be:

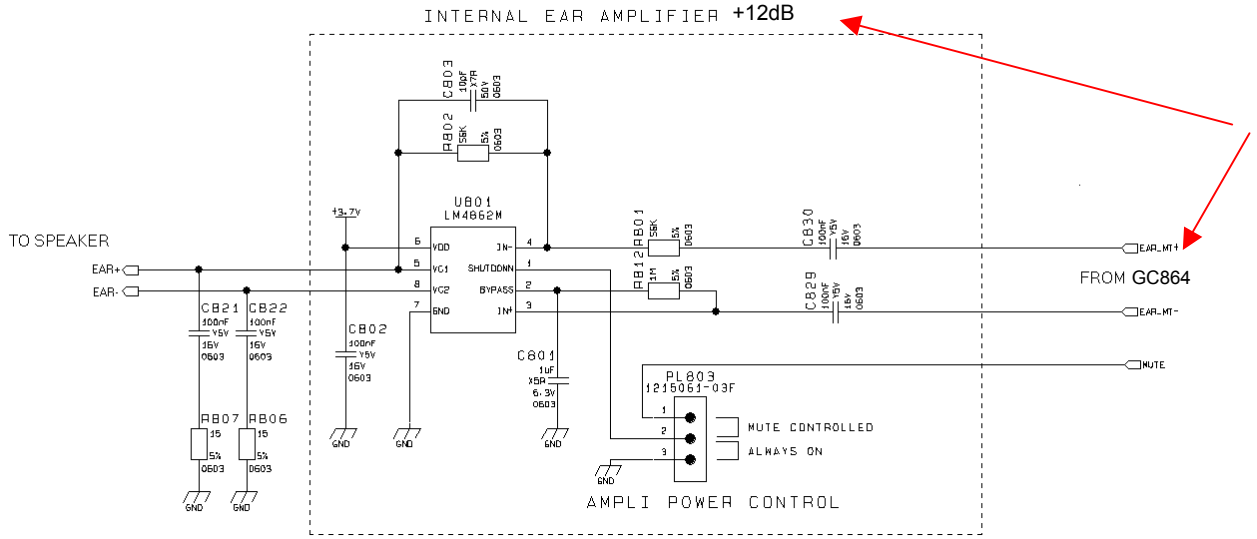


The resulting gain and high pass cut can be obtained with the formula:

$$Gain = \frac{R3}{R2}$$

$$freq. = \frac{1}{2\pi * R3 * C4} \text{ [Hz]}$$

And an example of internal Ear amplifier could be:



Some amplifier require a low impedance load at high frequency in order to avoid auto oscillation, this can be made with a capacitor (*100nF*) in series with a resistor (*15Ω*).

When designing your application, remember to provide an adequate bypass capacitor to the amplifier and place it close to the power input pin of the IC, keeping the traces as short as possible.

8.5 Hands-free earphone (low power) design

The same design considerations made for the handset are valid for the hands-free earphone.

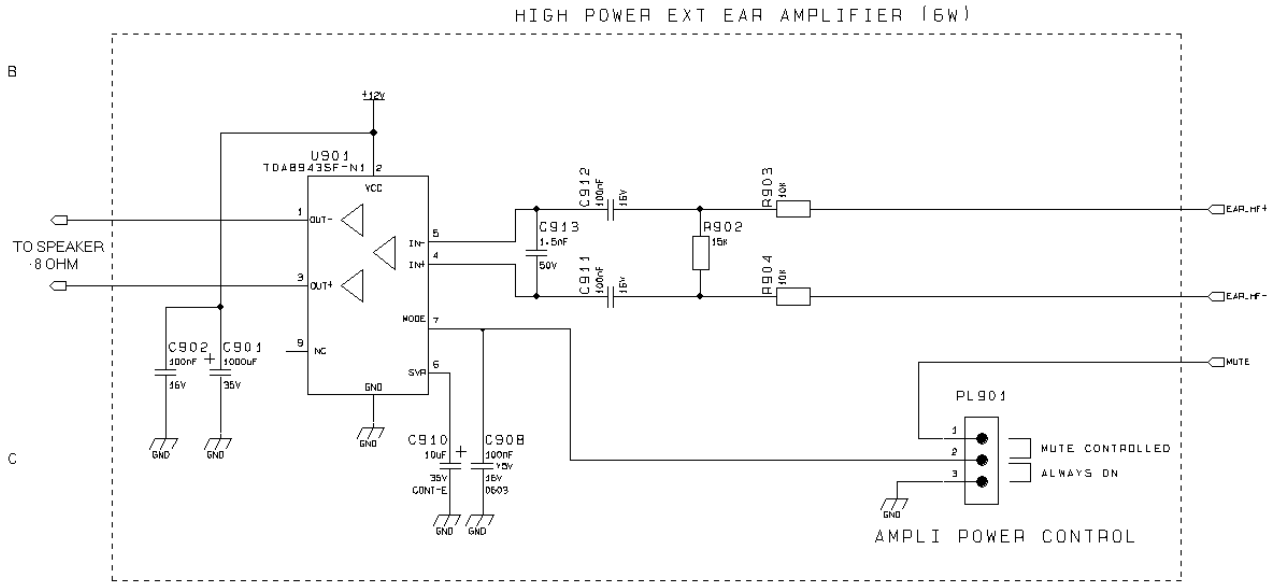
8.6 Car Kit speakerphone design

For the car kit speaker phone function the power output requirement is usually at least 4W, therefore an amplifier is needed to boost the *GC864* output.
The design of the amplifier shall comply with the following guidelines:

- The input to the amplifier MUST be taken from the "***Ear_HF***" audio path of the *GC864*, because of its echo canceller parameters suited to a car cabin use.
- The amplifier shall have a gain of 30-40 times (29-32 dB) to provide the desired output power of 5-10W with the signal from the *GC864* "***Ear_HF***" audio output lines.
- If the amplifier has a fixed gain then it can be adjusted to the desired value by reducing the input signal with a resistor divider network.
- The amplifier shall have a mute control to be used while not in conversation. This results in two benefits: eliminating the background noise when not in conversation and saving power.
- The power to the amplifier should be decoupled as much as possible from the *GC864* power supply, by either keeping separate wires and placing bypass capacitors of adequate value close to the amplifier power input pads.
- The biasing voltage of the amplifier shall be stabilized with a low ESR (e.g. a tantalum) capacitor of adequate value.

NOTE: The GC864 audio path connected to the car kit hands-free amplifier MUST be "Ear_HF" one, otherwise the echo cancellation will not be done due to the difference in the echo canceller characteristics of the GC864 internal audio path from the external audio path.

Example of car kit amplifier schematic.



9 External SIM Holder

Aim of this section is to give basic design guide lines to integrate a SIM holder in applications that uses Telit modules

9.1 SIM DESIGN GUIDES

In all Telit modules there are five pins for SIM card holder connection
These lines are:

SIMVCC	(SIM Power supply)
SIMRST	(SIM Reset)
SIMIO	(SIM Data)
SIMIN	(SIM Presence/Absence)
SIMCLK	(SIM Clock)

SIM connection must take in account of **four** key issues:

1) **Data Integrity:** standard rules for digital layout and routing must be followed taking in consideration that SIMCLK has frequency of 3.57Mhz and SIMIO has 9600Bps baud rate.

2) **EMI/EMC:** this is a key aspect to consider designing an application based on TELIT module with internal antenna and/or without a proper-shielded box. Some of these conditions may occur:
   - Antenna picks-up digital noise coming from SIM card lines.
   - Antenna radiated field may interfere digital lines.
   - Digital lines (in particular clock) may radiate spurious in the surrounding space.

To overcome all these potential problems, connection lines must be kept as short as possible and shielded.

SIM-holder position has to be as far as possible from antenna.

RF bypass capacitors (10pF...33pF) closed to SIM card SIM-holder are another good care.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

When connection is not short, insertion of 10..100ohm resistor with 10..33pF capacitor (RC filter) is a good caution to improve EMI from SIMCLK line.
Do not insert resistor on SIMVCC, SIMRST and SIMIO lines, their use is not supported by SIM electrical interface.

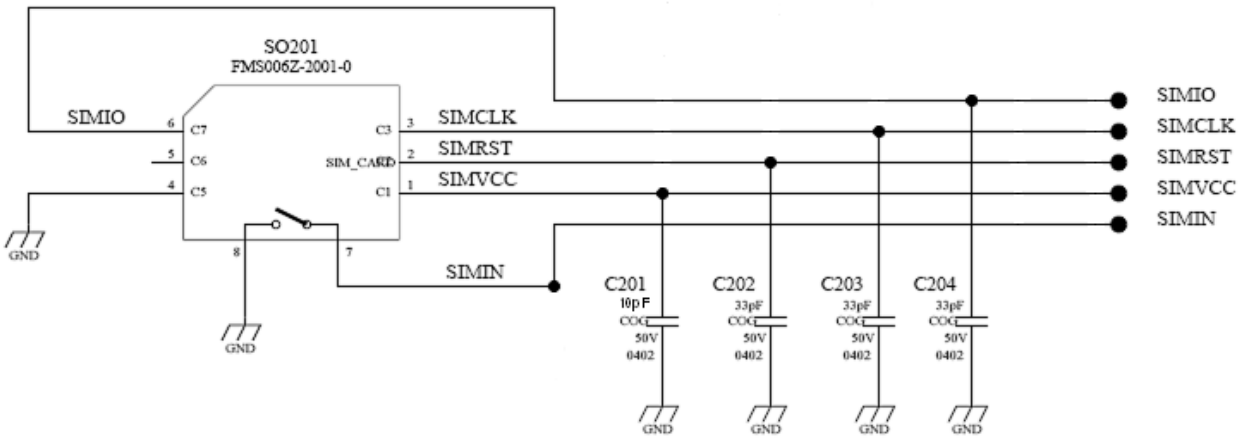
3) **ESD:** take standard ESD caution if application based on TELIT module has SIM holder with contacts reachable from human body.

4) **SIM supply:** do not connect capacitance greater than 10nF to SIMVCC line.

Other notes:

- SIMIN doesn't require any pull-up resistor. It is built in.
- SIM card is detected inserted when this line is short to ground.

Schematic Example:



10 General Purpose I/O

The general purpose I/O pads can be configured to act in three different ways:
- input
- output
- alternate function (internally controlled)

Input pads can only be read and report the digital value (high or low) present on the pad at the read time; output pads can only be written or queried and set the value of the pad output; an alternate function pad is internally controlled by the GC864 firmware and acts depending on the function implemented.

Not all GPIO pads support all these three modes:
- GPIO_06/ALARM supports all three modes and can be input, output, alarm output (Alternate function)
- GPIO_07/BUZZER supports all three modes and can be input, output, buzzer output (Alternate function)

10.1 Using a GPIO pad as INPUT

The GPIO pads, when used as inputs, can be connected to a digital output of another device and report its status, provided this device has interface levels compatible with the 2.8V CMOS levels of the GPIO.
If the digital output of the device to be connected with the GPIO input pad has interface levels different from the 2.8V CMOS, then it can be connected to GPIO1 or can be buffered with an open collector transistor, provided a 47KΩ pull-up resistor is connected as seen in the paragraph 6.2
5V UART Level translation.

10.2 Using a GPIO pad as OUTPUT

The GPIO pads, when used as outputs, can drive 2.8V CMOS digital devices or compatible hardware. When set as outputs, the pads have a push-pull output and therefore the pull-up resistor may be omitted.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

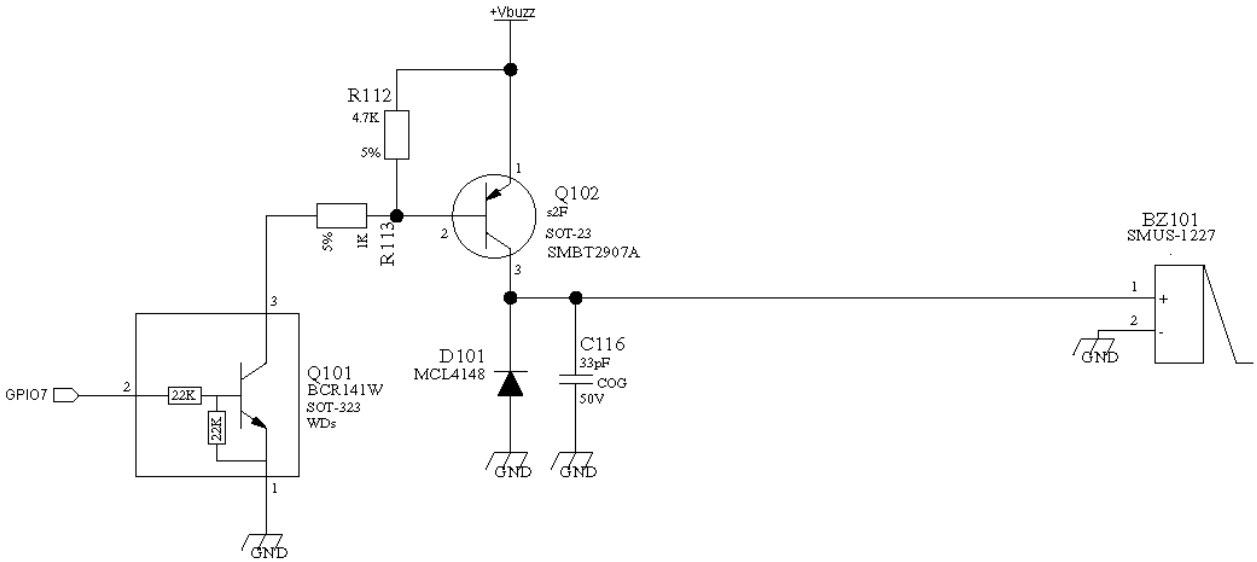
10.3 Using the Alarm Output GPIO_06/ALARM

The **GPIO_06/ALARM** pad, when configured as Alarm Output, is controlled by the GC864 module and will rise when the alarm starts and fall after the issue of a dedicated AT command.
This output can be used to power up the GC864 controlling microcontroller or application at the alarm time, giving you the possibility to program a timely system wake-up to achieve some periodic actions and completely turn off either the application and the GC864 during sleep periods, drammatically reducing the sleep comsumption to few µA.
In battery powered devices this feature will greatly improve the autonomy of the device.

10.4 Using the Buzzer Output GPIO_07/BUZZER

The **GPIO_07/BUZZER** pad, when configured as Buzzer Output, is controlled by the GC864 module and will drive with appropriate square waves a Buzzer driver.
This permits to your application to easily implement Buzzer feature with ringing tones or melody played at the call incoming, tone playing on SMS incoming or simply playing a tone or melody when needed by your application.

A sample interface scheme is included below to give you an idea of how to interface a Buzzer to the GPIO_07/BUZZER.



NOTE: To correctly drive a buzzer a driver must be provided, its characteristics depend on the Buzzer and for them refer to your buzzer vendor.

11 Camera

11.1 Camera characteristics

The GC864 module provides a direct support for digital cameras with the following characteristics:

Type:	**TRANSCHIP TC5747**
Technology:	**CMOS COLOR camera**
Max picture size:	**VGA 480x640 pixels landscape**
Output format:	**JPEG**
Sensitivity:	**4 Lux**

11.1.1 Camera interface connectors

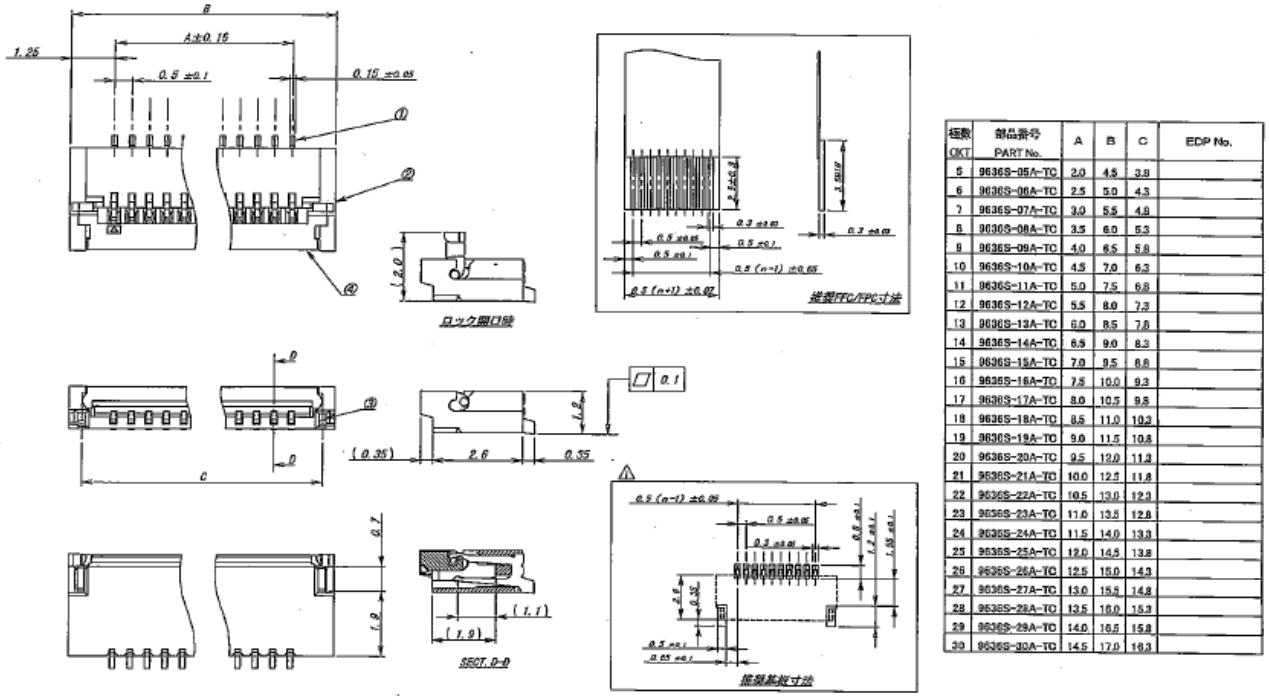
The 24-pads ZIF connector provides the interface connection between GC864 and camera.

GC864				ZIF 52437-2472		
Ball	**Signal**	**I/O**	**Function**	**Pin**	**Signal**	**I/O**
C6	CAM_SCL/IIC_SCL	O	I2C bus serial clock	1	SCLK	I
-	GND	-	Ground	2	AGND	I
-	VCC_MAIN_CAM	O	External 2.8V Regulator enable controlled by CAM_PWR_ON pin	3	AVDD28*	I
C9	TGPIO_09/CAM_RST	O	Camera Reset	4	RESET_N	I
F8	MON1/CAM_CLK	O	Clock	5	CLK_IN**	I
-	GND	-	Ground	6	DGND	I
-	n.c	-	-	7	DOUT_0	I/O
-	n.c	-	-	8	DOUT_1	I/O
-	n.c	-	-	9	DOUT_2	I/O
-	n.c	-	-	10	DOUT_3	I/O
-	n.c	-	-	11	DOUT_4	I/O
-	n.c	-	-	12	DOUT_5	I/O
-	n.c	-	-	13	DOUT_6	I/O

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

-	n.c	-	-	14	DOUT_7	I/O
-	n.c	-	-	15	DOUT_8	I/O
-	n.c	-	-	16	VCLKOUT	O
-	n.c	-	-	17	VALIDH	O
-	n.c	-	-	18	VALIDV	O
-	VCC_MAIN_CAM	O	External 2.8V Regulator enable controlled by CAM_PWR_ON pin	19	DVDD28	I
D7	CAM_SDA/IIC_SDA	I/O	I2C bus serial data	20	SDIN	I/O
-	GND	-	Ground	21	PS1	I
K11	TGPIO_08/CAM_ON	O	Camera power type selector	22	PS2	I
-	GND	-	Ground	23	SHIELD	-
-	-	-	Flash Enable	24	LED_CTRL	O

* Filter the AVDD28.
** Use a Buffer between module clk out, MON1_CAM and camera clk in, CLK_IN.
n.c = Not-connected.



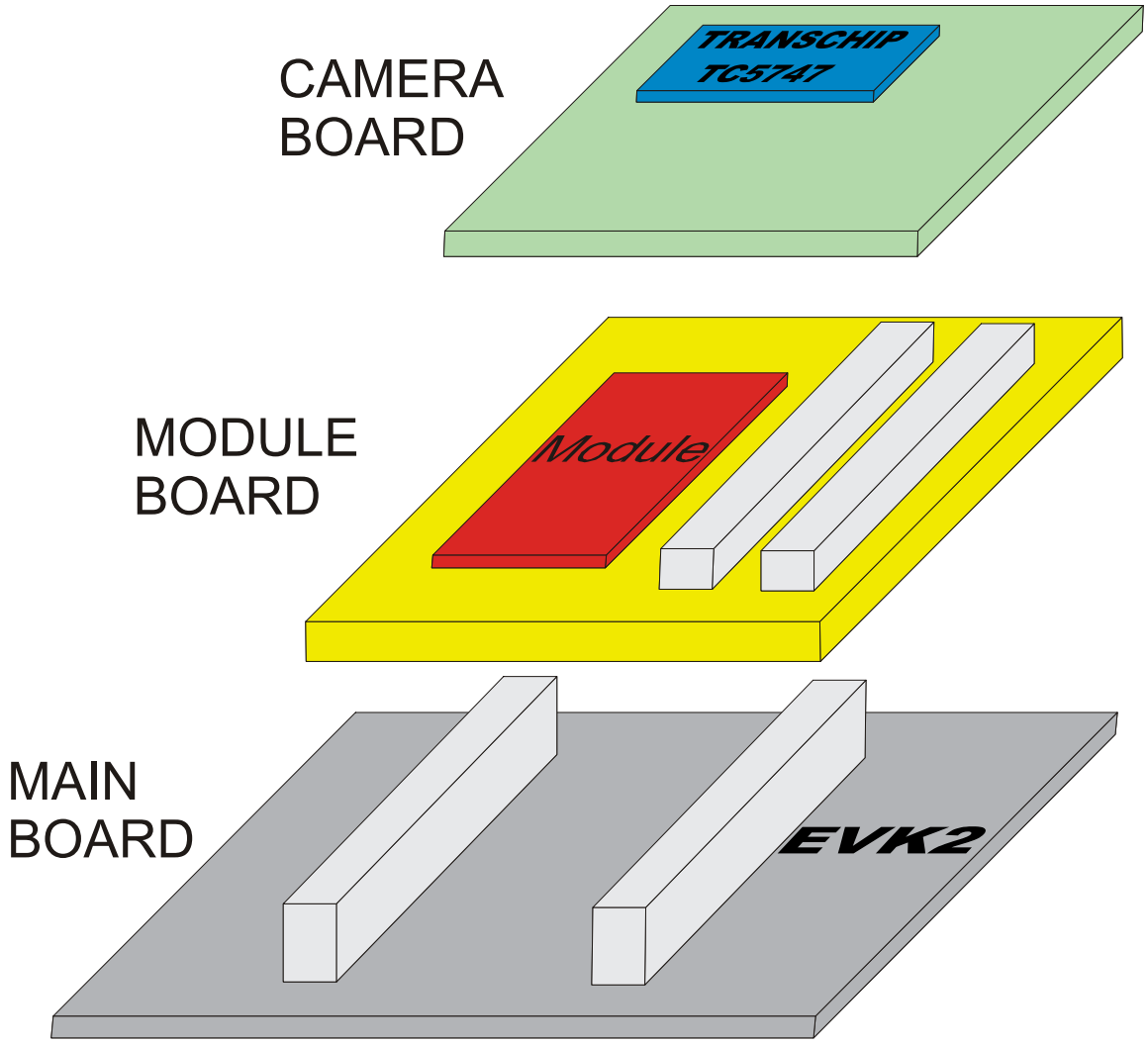
CKT	PART No.	A	B	C	EDP No.
5	9636S-05A-TC	2.0	4.5	3.8	
6	9636S-06A-TC	2.5	5.0	4.3	
7	9636S-07A-TC	3.0	5.5	4.8	
8	9636S-08A-TC	3.5	6.0	5.3	
9	9636S-09A-TC	4.0	6.5	5.8	
10	9636S-10A-TC	4.5	7.0	6.3	
11	9636S-11A-TC	5.0	7.5	6.8	
12	9636S-12A-TC	5.5	8.0	7.3	
13	9636S-13A-TC	6.0	8.5	7.8	
14	9636S-14A-TC	6.5	9.0	8.3	
15	9636S-15A-TC	7.0	9.5	8.8	
16	9636S-16A-TC	7.5	10.0	9.3	
17	9636S-17A-TC	8.0	10.5	9.8	
18	9636S-18A-TC	8.5	11.0	10.3	
19	9636S-19A-TC	9.0	11.5	10.8	
20	9636S-20A-TC	9.5	12.0	11.3	
21	9636S-21A-TC	10.0	12.5	11.8	
22	9636S-22A-TC	10.5	13.0	12.3	
23	9636S-23A-TC	11.0	13.5	12.8	
24	9636S-24A-TC	11.5	14.0	13.3	
25	9636S-25A-TC	12.0	14.5	13.8	
26	9636S-26A-TC	12.5	15.0	14.3	
27	9636S-27A-TC	13.0	15.5	14.8	
28	9636S-28A-TC	13.5	16.0	15.3	
29	9636S-29A-TC	14.0	16.5	15.8	
30	9636S-30A-TC	14.5	17.0	16.3	

Camera Socket Connector

11.1.5 EVB for Transchip camera support

In order to interface the Telit GC864 module with a CMOS camera, Telit has developed an evaluation board (see Annex B). The EVK2 (see Annex A) allow connecting all Telit modules through 2 connectors of 40 pins each.

The I2CBUS CAMERA board is plugged in the 2 connectors of 30 pins each on the module board.



11.1.6 Example usage script for camera

Camera setting: (shown here are the defaults ones)

```
>AT#CAMSEL=0          (camera selection: 0-auto, 2-transchip)
OK
>AT#CMODE=0           (camera mode: 0-day, 1-night)
OK
>AT#CAMQUA=0                (camera quality: 0-low, 1-medieum, 2-high)
OK
>AT#CAMRES=0                (camera resolution: 0-VGA, 1-QVGA, 2-QQVGA)
OK
>AT#CAMCOL=0                (camera color: 0-color, 1-grayscale)
OK
>AT#CAMZOOM=0               (camera zoom: 0-x1, 1-x2, 2-x4)
OK
>AT#CAMTXT=0          (camera timestamp: 0-no, 1-time only, 2-data only, 3-time&data)
OK
```

Taking an reading a photo:

```
>AT#CAMEN=1           (camera ON)
OK
>AT#TPHOTO            (take photo)
OK
>AT+OBJL?                   (see photo dimension)
#OBJL: Snapshot,38900       (where 38900 is the file dimension in bytes of the photo taken)
OK
>AT#RPHOTO            (download the photo)
…data…..                    (where …data…  Correspond to the photo data in binary)
OK
>AT#TPHOTO
OK
>AT#RPHOTO            Repeating photo capture and download n times
…data…..
OK
>AT#CAMEN=O           (camera OFF)
```

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

12 Conformity Assessment Issues

The GC864 module is assessed to be conform to the R&TTE Directive as stand-alone products, so If the module is installed in conformance with Dai Telecom installation instructions require no further evaluation under Article 3.2 of the R&TTE Directive and do not require further involvement of a R&TTE Directive Notified Body for the final product.

In all other cases, or if the manufacturer of the final product is in doubt then the equipment integrating the radio module must be assessed against Article 3.2 of the R&TTE Directive**.**
In all cases assessment of the final product must be made against the Essential requirements of the R&TTE Directive Articles 3.1(a) and (b), safety and EMC respectively, and any relevant Article 3.3 requirements.
The GC864 module is conform with the following European Union Directives:

- R&TTE Directive 1999/5/EC (Radio Equipment & Telecommunications Terminal Equipments)
- Low Voltage Directive 73/23/EEC and product safety
- Directive 89/336/EEC for conformity for EMC

In order to satisfy the essential requisite of the R&TTE 99/5/EC directive, the GC864 module is compliant with the following standards:

- GSM (Radio Spectrum). Standard: EN 301 511 and 3GPP 51.010-1
- EMC (Electromagnetic Compatibility). Standards: EN 301 489-1 and EN 301 489-7
- LVD (Low Voltage Directive) Standards: EN 60 950

In this document and the Hardware User Guide, Software User Guide all the information you may need for developing a product meeting the R&TTE Directive is included.
The GC864 module is conform with the following US Directives:

- Use of RF Spectrum. Standards: FCC 47 Part 24 (GSM 1900)
- EMC (Electromagnetic Compatibility). Standards: FCC47 Part 15

To meet the FCC's RF exposure rules and regulations:

- The system antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all the persons and must not be co-located or operating in conjunction with any other antenna or transmitter.
- The system antenna(s) used for this module must not exceed 3 dBi for mobile and fixed or mobile operating configurations.
- Users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

Manufacturers of mobile, fixed or portable devices incorporating this module are advised to clarify any regulatory questions and to have their complete product tested and approved for FCC compliance.

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

13 SAFETY RECOMMANDATIONS

READ CAREFULLY

Be sure the use of this product is allowed in the country and in the environment required. The use of this product may be dangerous and has to be avoided in the following areas:

- Where it can interfere with other electronic devices in environments such as hospitals, airports, aircrafts, etc
- Where there is risk of explosion such as gasoline stations, oil refineries, etc

It is responsibility of the user to enforce the country regulation and the specific environment regulation.

Do not disassemble the product; any mark of tampering will compromise the warranty validity.

We recommend following the instructions of the hardware user guides for a correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conforming to the security and fire prevention regulations.

The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. Same cautions have to be taken for the SIM, checking carefully the instruction for its use. Do not insert or remove the SIM when the product is in power saving mode.

The system integrator is responsible of the functioning of the final product; therefore, care has to be taken to the external components of the module, as well as of any project or installation issue, because the risk of disturbing the GSM network or external devices or having impact on the security. Should there be any doubt, please refer to the technical documentation and the regulations in force.

Every module has to be equipped with a proper antenna with specific characteristics. The antenna has to be installed with care in order to avoid any interference with other electronic devices and has to guarantee a minimum distance from the body (20 cm). In case of this requirement cannot be satisfied, the system integrator has to assess the final product against the SAR regulation.

The European Community provides some Directives for the electronic equipments introduced on the market. All the relevant information's are available on the European Community website:

http://europa.eu.int/comm/enterprise/rtte/dir99-5.htm

The text of the Directive 99/05 regarding telecommunication equipments is available, while the applicable Directives (Low Voltage and EMC) are available at:
http://europa.eu.int/comm/enterprise/electr_equipment/index_en.htm

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

14 Document Change Log

Revision	Date	Changes
ISSUE#0	12/06/06	Release First ISSUE# 0

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

Annex A – EVK2 schematics

Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

ALL RIGHTS RESERVED
REPRODUCTION AND DISCLOSURE
FORBIDDEN

TUTTI I DIRITTI RISERVATI
RIPRODUZIONE E DIVULGAZIONE
VIETATE

CURRENT UNLIMITED
BATTERY CHARGER INPUT
6 Vcc

PL103
1984617PT1.5_2-3.5-H

R104 0 0603

WARNING!!!!
Care must be taken to ensure
that the right polarity in the
power input is respected!
DO NOT Supply power when the
Battery is not connected

R105 680 5% 0603

C105 4.7nF X7R 50V 0603

R108 680 5% 0603

R109 5.6K 5% 0603

R110 4.7 5% 1206
R111 4.7 5% 1206
R112 4.7 5% 1206
R113 4.7 5% 1206

TO-263AB IRL5602SPBF Q103

SMB U34 STPS340U D104

PL106
9019915102410

CHARGE 2:9B

CHARGER ON

M676 YELLOW
LY-M676-Q2S1-26
DL101

3Fs SOT-23 BC857B Q102

R106 8.2K 5% 0402

Q101 BC847BW SOT-323 1Fs

R107 2.2K 5% 0402

GND

+3.7V

ON_OFF* 2:5E;2:9B

WNs SOT-323 BCR185W Q105

R116 47K 5% 0402

Q104 BCR48PN WTs SOT-363
TR1 47K 47K
TR2 2K2 47K

R118 0 0402 noMount=YES

RESET* 2:4E;2:9C

LDO_ON_OFF* 3:6C;3:7B;4:6E;5:2B;5:2D;5:8C

R117 47K 5% 0402

PL101
1984617PT1.5_2-3.5-H

3.8V IN

R103 0 0603

WARNING!!!!
Care must be taken to ensure
that the right polarity in the
power input is respected!

1-2 : 5-40V IN
2-3 : 3.8V IN

PL104
1215061-03F

PL105
1215061-03F

1-2 : Regulator
2-3 : Battery

D103 STPS140Z SOD123

PL102
1984617PT1.5_2-3.5-H

MIN 5V
MAX 40V
INPUT

R101 0 0603

D101 STPS3L60U G36 SMB

C101 10nF X7R 50V 0603
C102 10nF X7R 50V 0603
C103 10nF X7R 50V 0603
C104 470uF 50V 16X16.5 NR

U101 LM2596S-ADJ-NOPB
+VIN VOUT ON/OFF FBACK GND TAB

L101 SLF12575

D102 STPS3L60U G36 SMB

C106 330uF 6.3V CONT-E
C107 330uF 6.3V CONT-E

R114 2.0K 1% 0603

C108 10nF X7R 16V 0402

R115 1.0K 1% 0603

SO101 RAPC712X
RAPC

TP101 TP102

R102 0 0603

POWER JACK

FUSE 1206

PL107
1984617PT1.5_2-3.5-H

D105 STPS140Z SOD123

BATTERY LI-ION
3,7V(Li-Ion) Nominal
max voltage 4,2V (Li-Ion)
suggested capacity: 1000mAh

WARNING!!!!
When using battery care must be
taken to ensure that the right
polarity is respected!

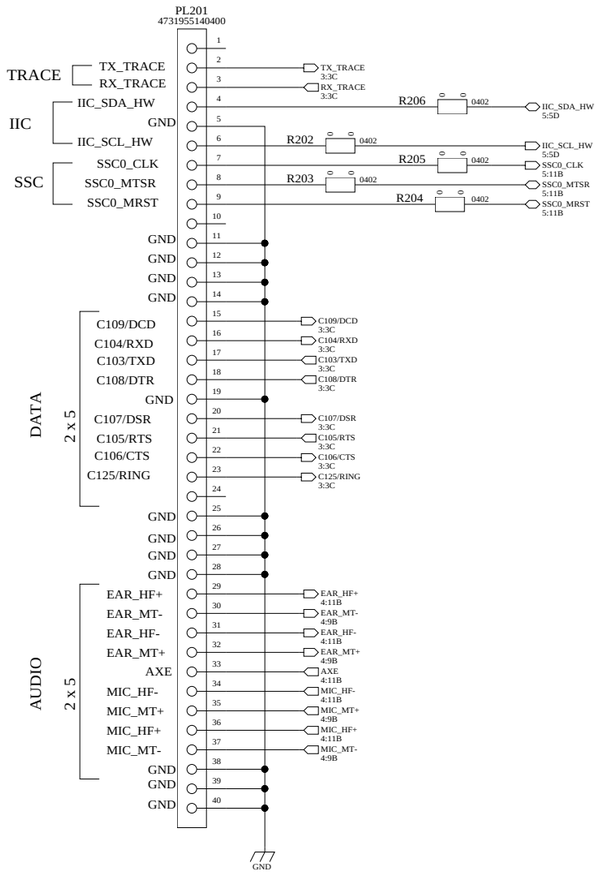
OT101 OT102 OT103

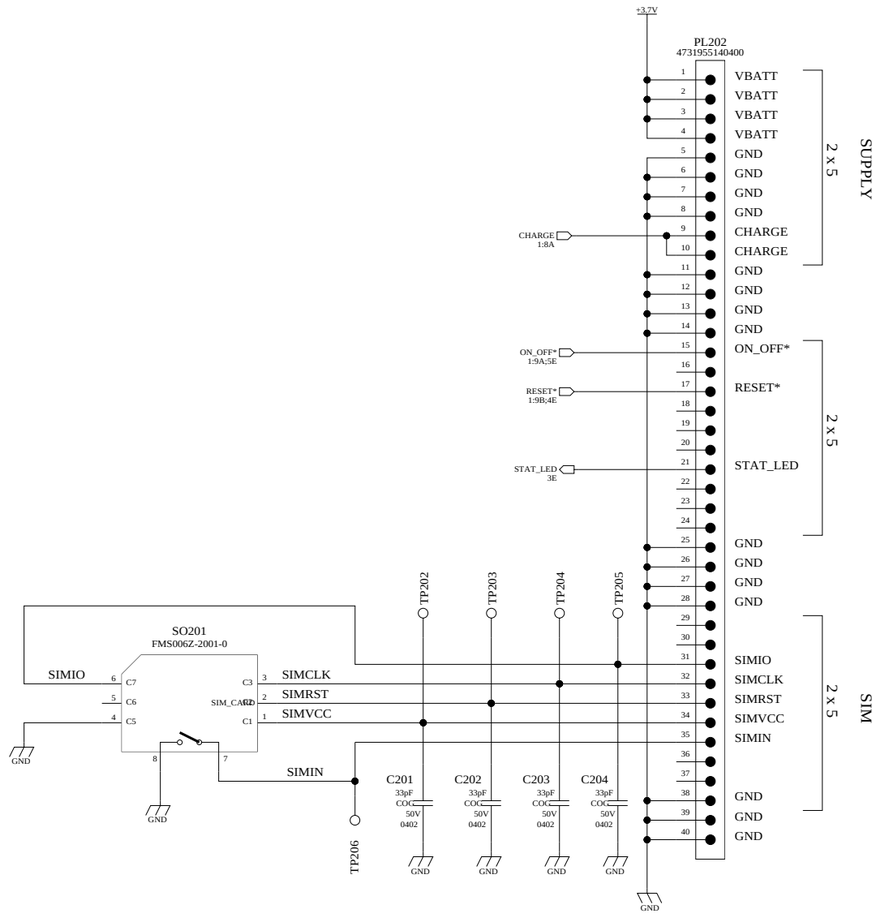
MODIFY												
DATE												

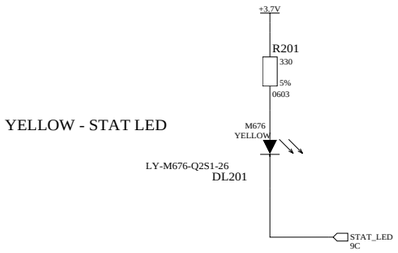
PATH /home/users/area		DAI TELECOM Dai Telecom Group	DESCRIPTION: EVK 2
FILE NAME cs1139a.cir			
Mod. 067 rev.1 11/02		ANNOTATION: POWER REGULATOR / BATTERY CHARGE	FORM: A3
PROJECT Furlan M.	080705		
DRAWN Serdi M.	080705	PROJECT: 0276 / SHEET N.: 1 / OF SHEETS: 5	DRAWING CODE: 30276SE11139A
VERIFIED Nonis R.	080705		

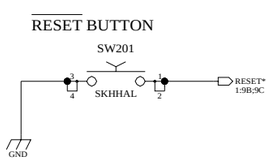
ALL RIGHTS RESERVED
REPRODUCTION AND DISCLOSURE
FORBIDDEN

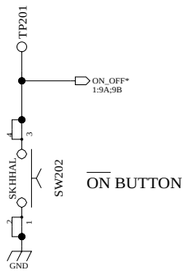
TUTTI I DIRITTI RISERVATI
RIPRODUZIONE E DIVULGAZIONE
VIETATE







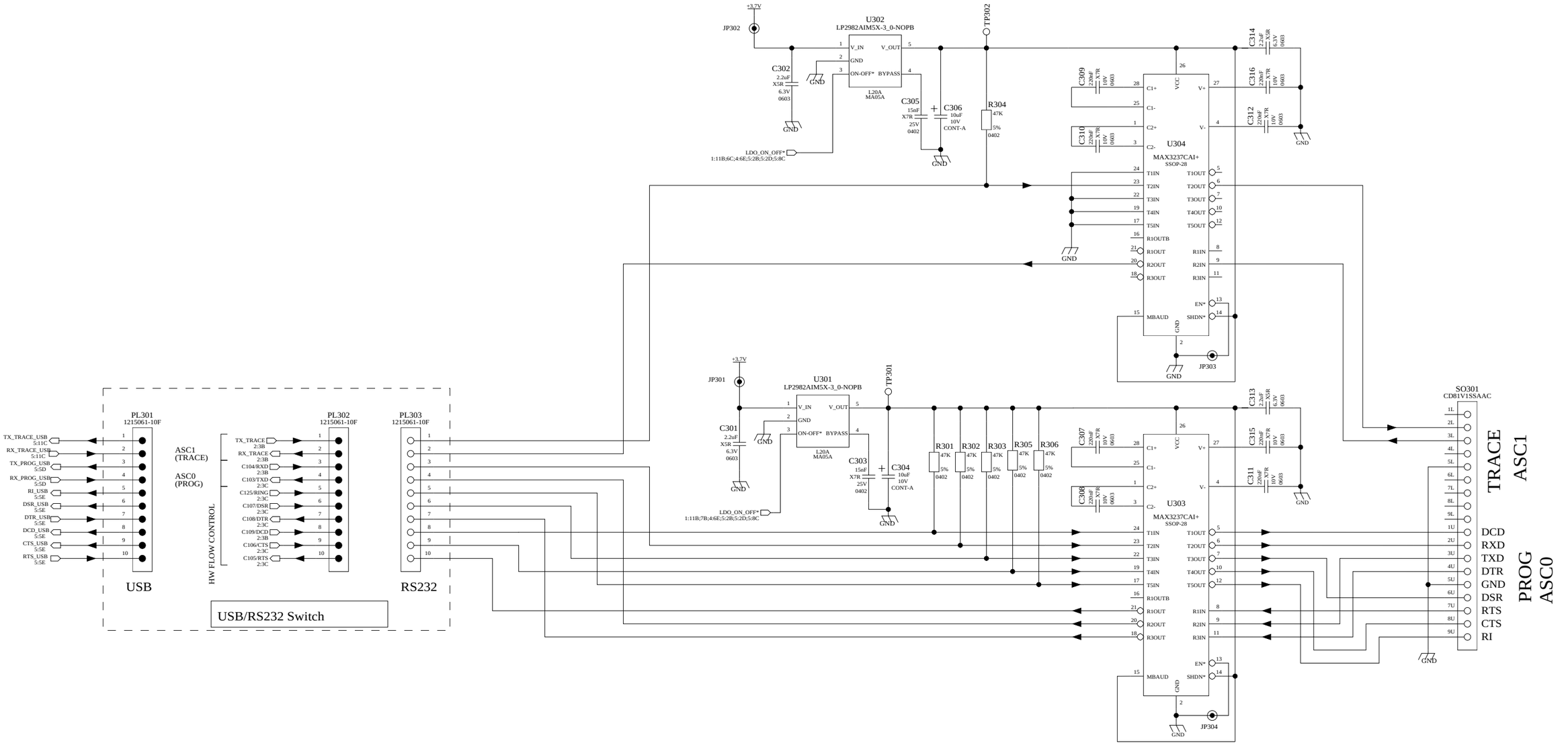




MODIFY													
DATE													
PATH /home/users/area							DAI TELECOM Dai Telecom Group		DESCRIPTION				
FILE NAME	cs1139a.cir								EVK 2				
Mod. 067 rev.1 11/02									ANNOTATION				FORM
PROJECT	Furlan M.	080705							INTERFACE CONNECTORS				A3
DRAWN	Serdi M.	080705							PROJECT	SHEET N.	OF SHEETS	DRAWING CODE	
VERIFIED	Nonis R.	080705							0276	2	5	30276SE11139A	

ALL RIGHTS RESERVED
REPRODUCTION AND DISCLOSURE
FORBIDDEN

TUTTI I DIRITTI RISERVATI
RIPRODUZIONE E DIVULGAZIONE
VIETATE



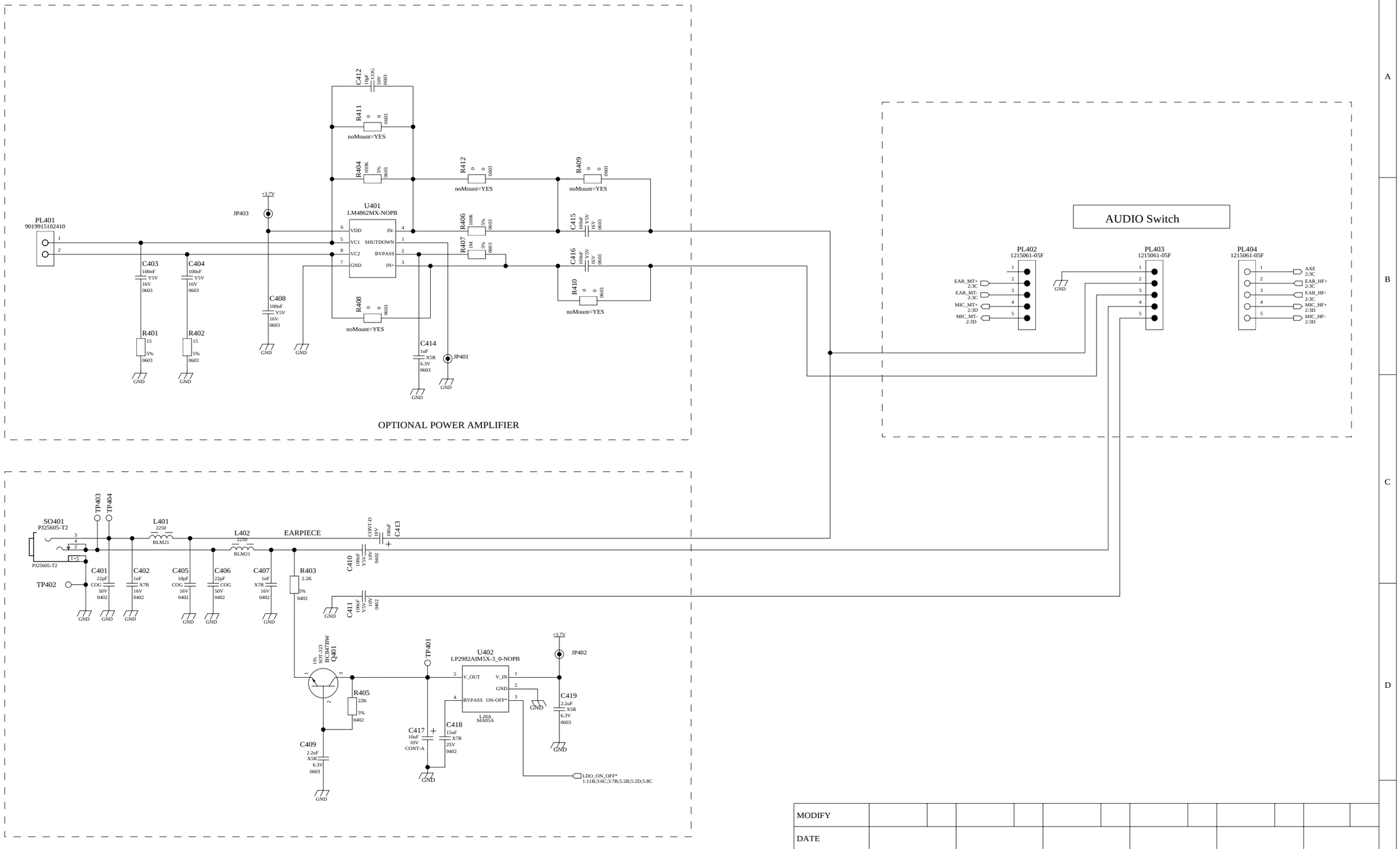
MODIFY													
DATE													

PATH /home/users/area			DESCRIPTION	
FILE NAME cs1139a.cir			EVK 2	
Mod. 067 rev.1 11/02			ANNOTATION	FORM
PROJECT Furlan M.	080705		UART	A3
DRAWN Serdi M.	080705		PROJECT 0276 / SHEET N. 3 / OF SHEETS 5 / DRAWING CODE 30276SE11139A	
VERIFIED Nonis R.	080705			

DAI TELECOM
Dai Telecom Group

ALL RIGHTS RESERVED
REPRODUCTION AND DISCLOSURE
FORBIDDEN

TUTTI I DIRITTI RISERVATI
RIPRODUZIONE E DIVULGAZIONE
VIETATE

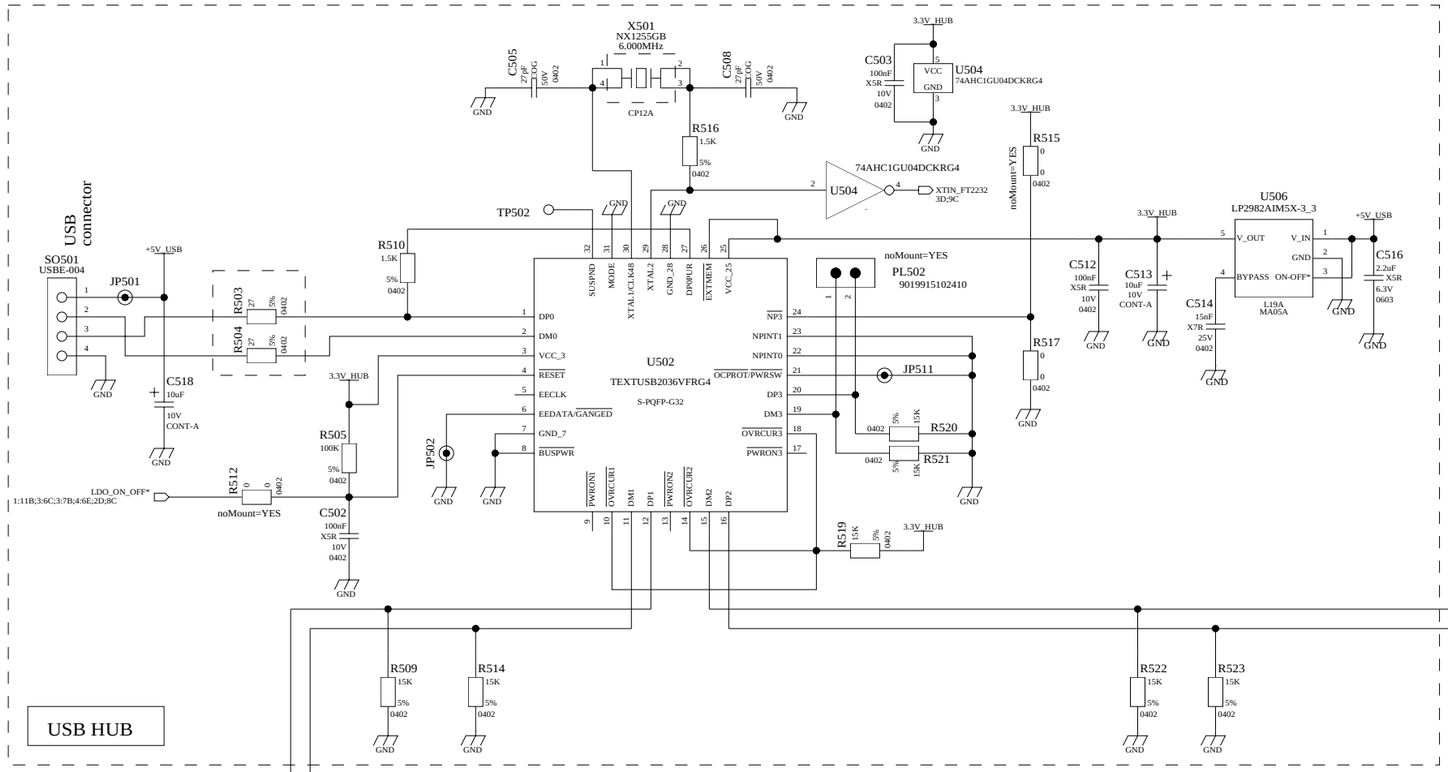


MODIFY												
DATE												

PATH /home/users/area		DAI TELECOM Dai Telecom Group	DESCRIPTION: EVK 2
FILE NAME cs1139a.cir			
Mod. 067 rev.1 11/02			
PROJECT Furlan M.	080705	ANNOTATION: AUDIO	FORM: A3
DRAWN Serdi M.	080705	PROJECT: 0276 / SHEET N.: 4 / OF SHEETS: 5	DRAWING CODE: 30276SE11139A
VERIFIED Nonis R.	080705		

ALL RIGHTS RESERVED
REPRODUCTION AND DISCLOSURE
FORBIDDEN

TUTTI I DIRITTI RISERVATI
RIPRODUZIONE E DIVULGAZIONE
VIETATE



MODIFY													
DATE													

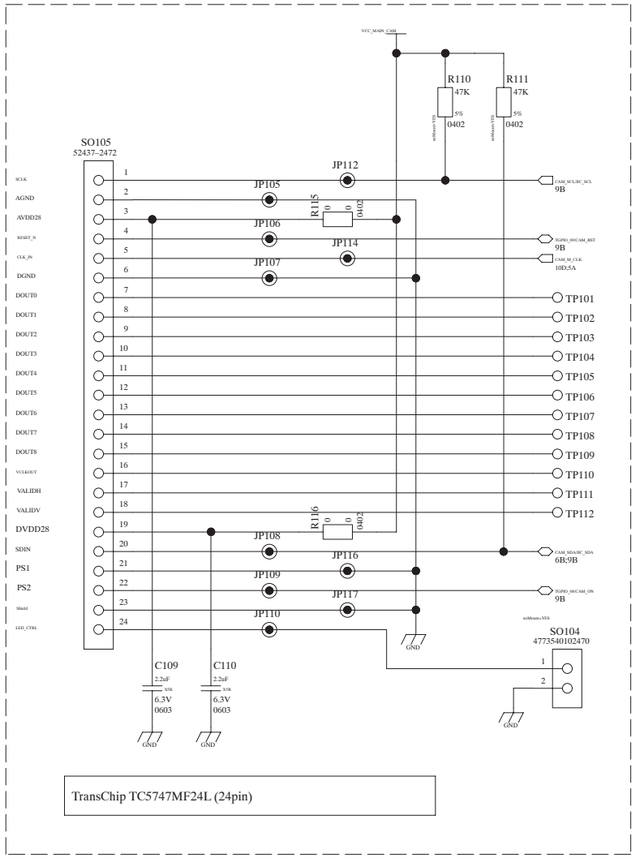
PATH /home/users/area			DESCRIPTION	
FILE NAME cs1139a			DAI TELECOM Dai Telecom Group	EVK 2
Mod. 067 rev.1 11/02			ANNOTATION	FORM
PROJECT	Furlan M.	080705	USB <-> PROG,TRACE,I2C,SSC	A3
DRAWN	Serdi M.	080705	PROJECT / SHEET N. / OF SHEETS / DRAWING CODE	
VERIFIED	Nonis R.	080705	0276 / 5 / 5 / 30276SE11139A	

Annex B - Camera EVB schematics

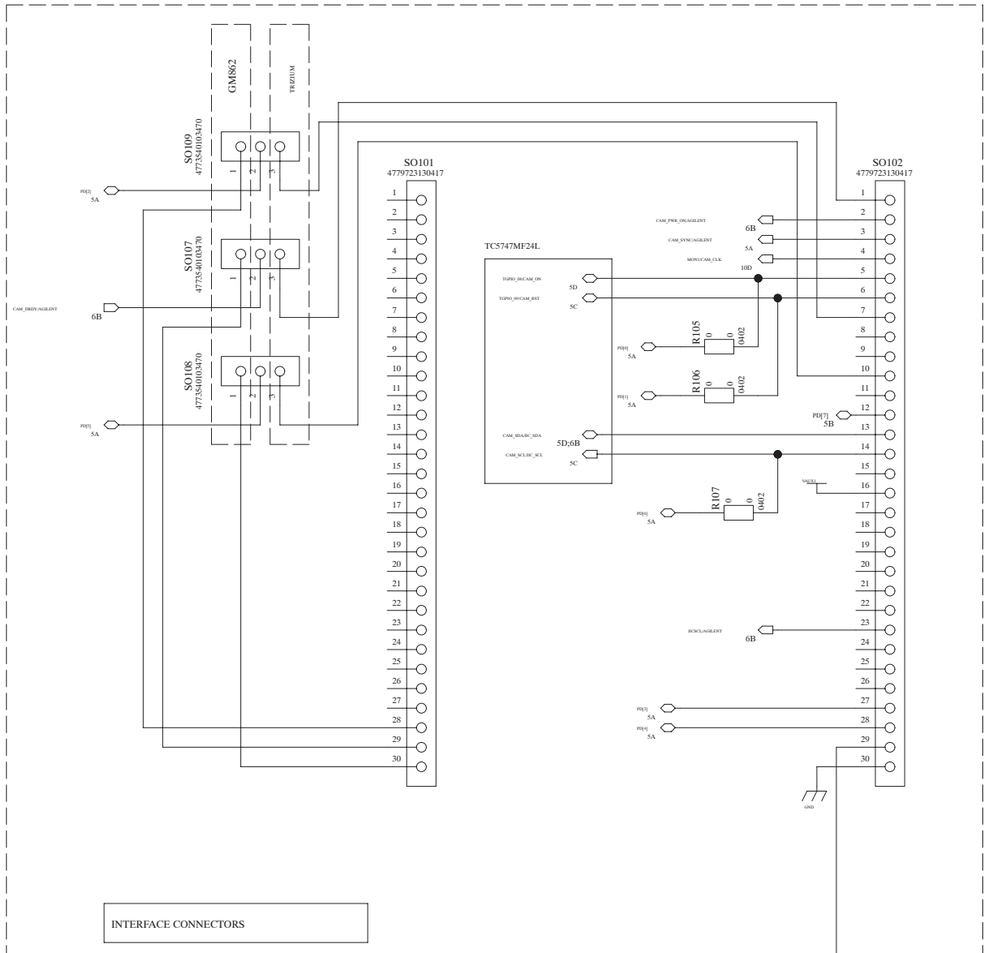
Reproduction forbidden without Telit Communications S.p.A. written authorization - All Right reserved

ALL RIGHTS RESERVED
REPRODUCTION AND DISCLOSURE FORBIDDEN

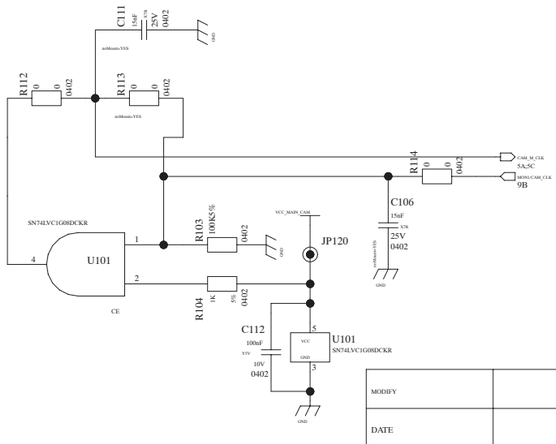
TUTTI I DIRITTI RISERVATI
RIPRODUZIONE E DIVULGAZIONE VIETATE

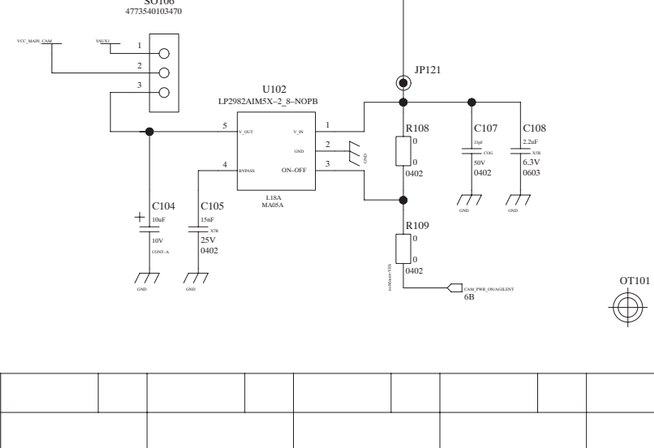


TransChip TC5747MF24L (24pin)



INTERFACE CONNECTORS





MODIFY													
DATE													

PATH /home/users/area

FILE NAME cs1170.cir

Mod. 067 rev.1 11/02

PROJECT	Furlan M.	060905
DRAWN	Pesqualini N.	060905
VERIFIED		

DAI TELECOM
Dai Telecom Group

DESCRIPTION: I2CBUS DUAL CAMERA

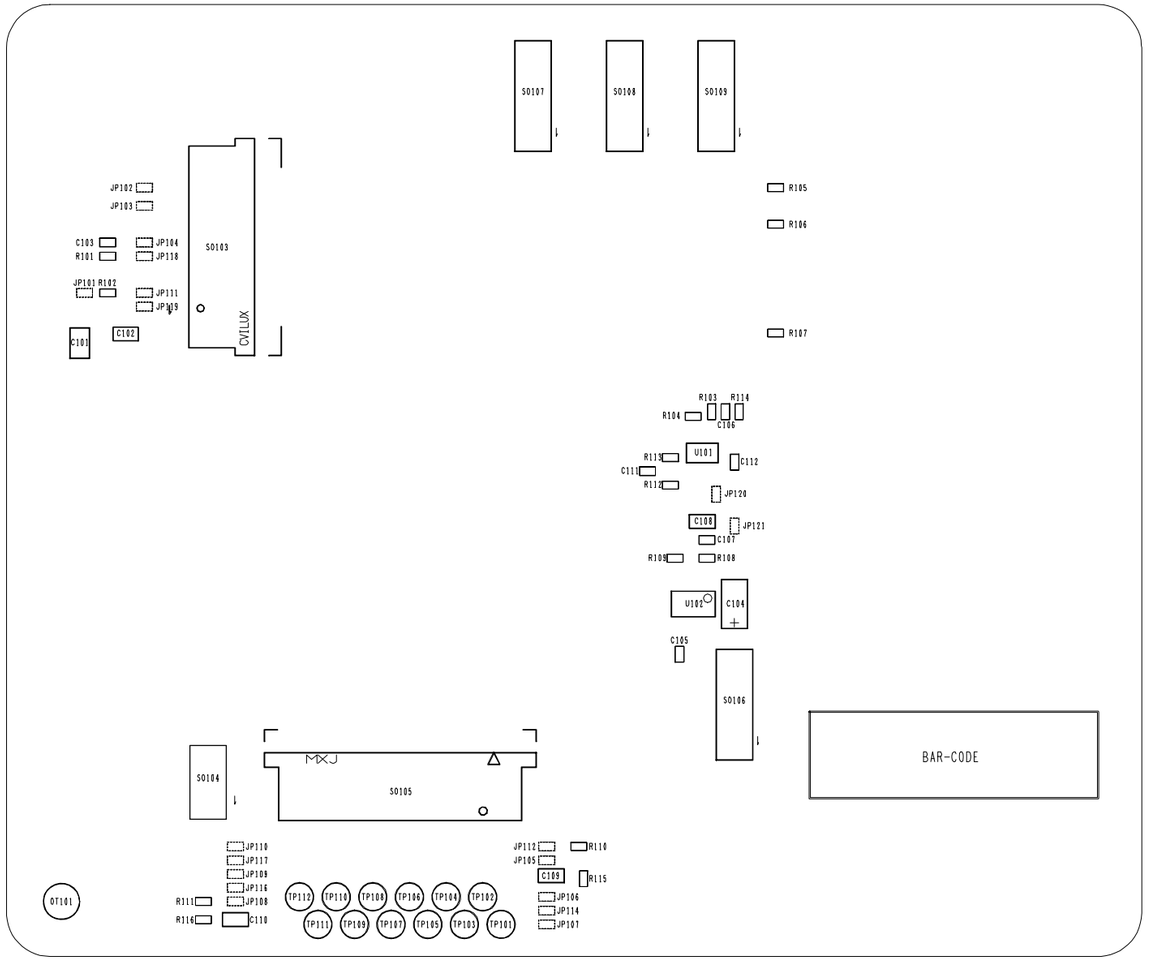
ANNOTATION

FORM: A3

PROJECT	SHEET N.	OF SHEETS	DRAWING CODE
0276	1	1	30276SE11170

TUTTI I DIRITTI RISERVATI
RIPRODUZIONE E DIVULGAZIONE
VIETATE

ALL RIGHTS RESERVED
REPRODUCTION AND DISCLOSURE
FORBIDDEN

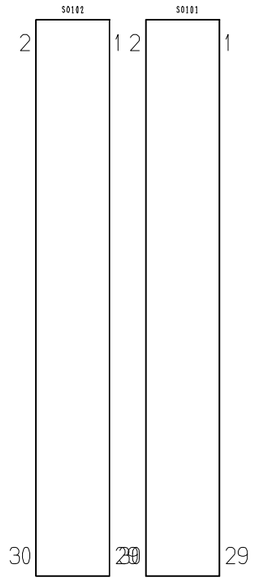


MODIFY												
DATE												

PATH	/Archivio_PCB/cs1170	DESCRIPTION	cs1170
FILE NAME	cs1170	DAI TELECOM Dai Telecom Group	I2CBUS DUAL CAMERA
FILE GERBER			
Mod. 048 Rev.0 6/99		ANNOTATION	FORM
Project by		Silkscreen side A	A3
Drawn by: Pasqualini Natascia	06/09/2005	Project	SHEET N. / OF SHEETS / DRAWING CODE
Verif. by		0276	1 / 2 / CS1170.SM

TUTTI I DIRITTI RISERVATI
RIPRODUZIONE E DIVULGAZIONE
VIETATE

ALL RIGHTS RESERVED
REPRODUCTION AND DISCLOSURE
FORBIDDEN



MODIFY												
DATE												

PATH	/Archivio_PCB/cs1170	DESCRIPTION	cs1170
FILE NAME	cs1170	DAI TELECOM Dai Telecom Group	I2CBUS DUAL CAMERA
FILE GERBER			
Mod. 048 Rev.0 6/99		ANNOTATION	FORM
Project by		Silkscreen side B	A3
Drawn by: Pasqualini Natascia	06/09/2005	Project	SHEET N. / OF SHEETS / DRAWING CODE
Verif. by		0276	2 / 2 / CS1170.SM