







# 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: האינטגרציה של המודם הסלולרי GC864 עם המוצר. מתבקש ליישם את ההנחיות המפורטות במסמך זה בתהליך האינטגרציה של המודם הסלולרי.**

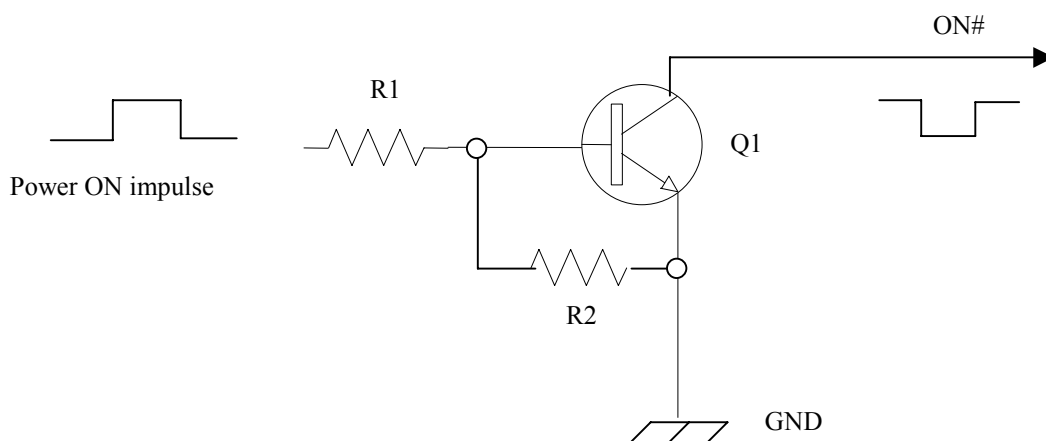
*The information presented in this document is believed to be accurate and reliable. However, Telit Communication assumes no responsibility for its use, nor any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under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



## 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.

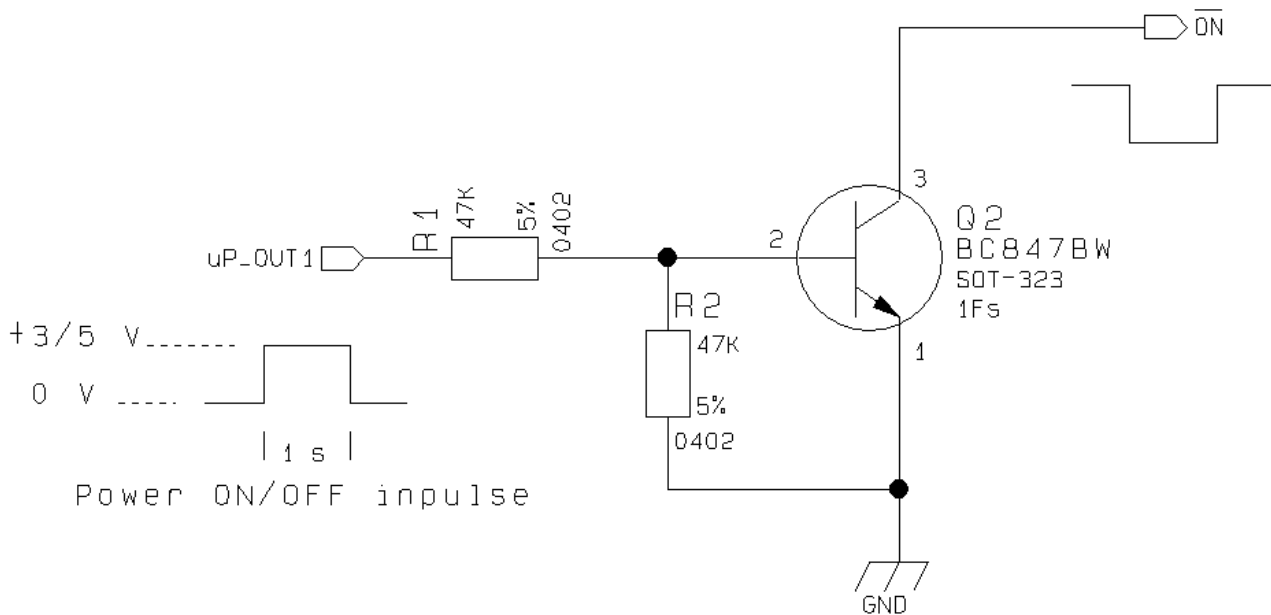
**NOTE:** In this document all the lines that are inverted, hence have active low signals are labeled with a name that ends with a "#" or with a bar over the name.

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

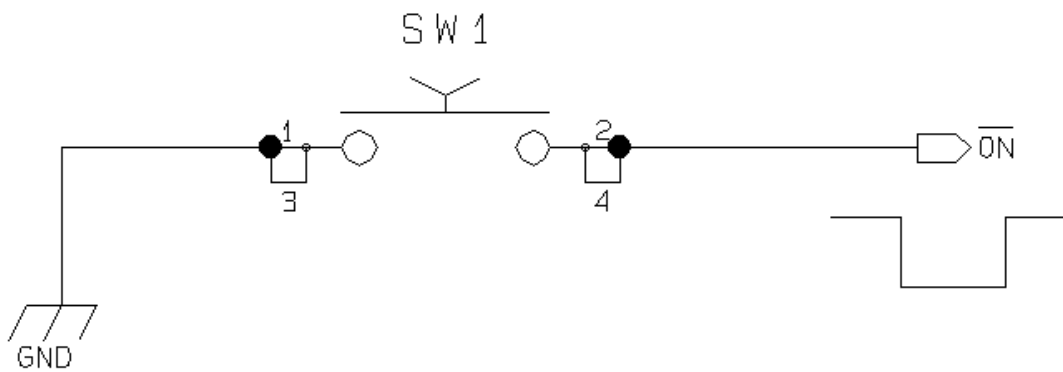


For example:

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.



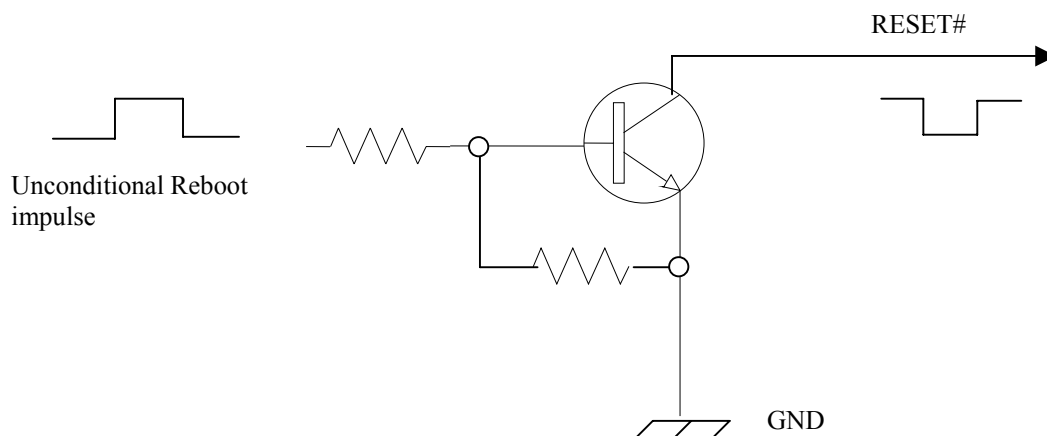
**TIP:** To check if the device has powered off, the hardware line PWRCTL should be monitored. When PWRCTL goes low, the device has powered off.

## 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.

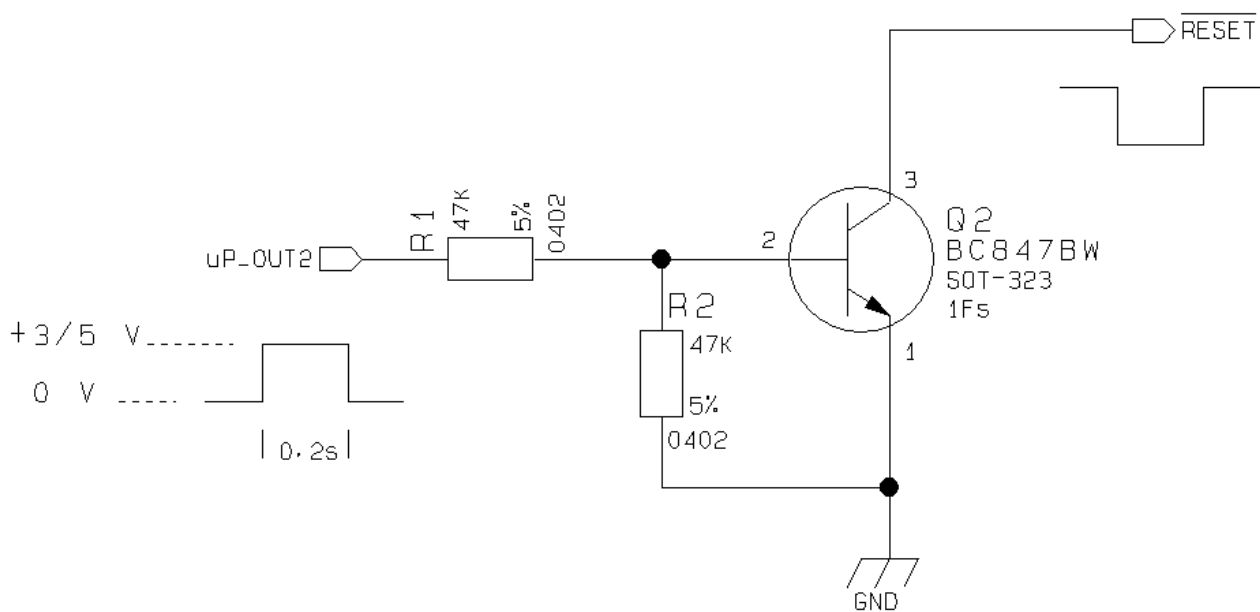




**TIP:** The unconditional hardware reboot should be always implemented on the boards and software should use it as an emergency exit procedure.

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:

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



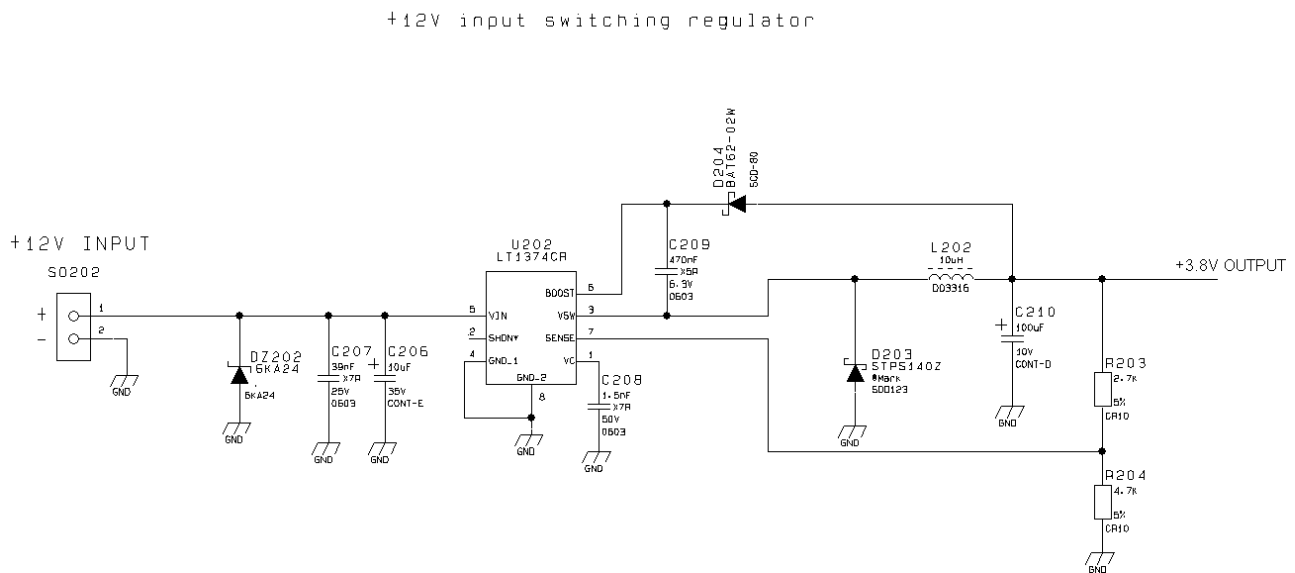




### 3.2.1.2 + 12V input Source Power Supply Design Guidelines

- 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:















## 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.



## 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
<b>Power Supply</b>					
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
<b>Audio</b>					
8	AXE	I	Handsfree switching	100K $\Omega$	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
<b>SIM Card Interface</b>					
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)	47K $\Omega$	1.8/3V
22	SIMCLK	O	External SIM signal – Clock		1.8/3V
<b>Trace</b>					
23	RX_TRACE	I	RX Data for debug monitor		CMOS 2.8V
24	TX_TRACE	O	TX Data for debug monitor		CMOS 2.8V
<b>Prog. / Data + Hw Flow Control</b>					
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





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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
<b>RESERVED</b>					
17		-			
33		-			
34		-			
41		-			
42		-			
43		-			
47		-			
48		-			
79		-			
80		-			

**NOTE: RESERVED pins must not be connected**



## 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



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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



## 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.***

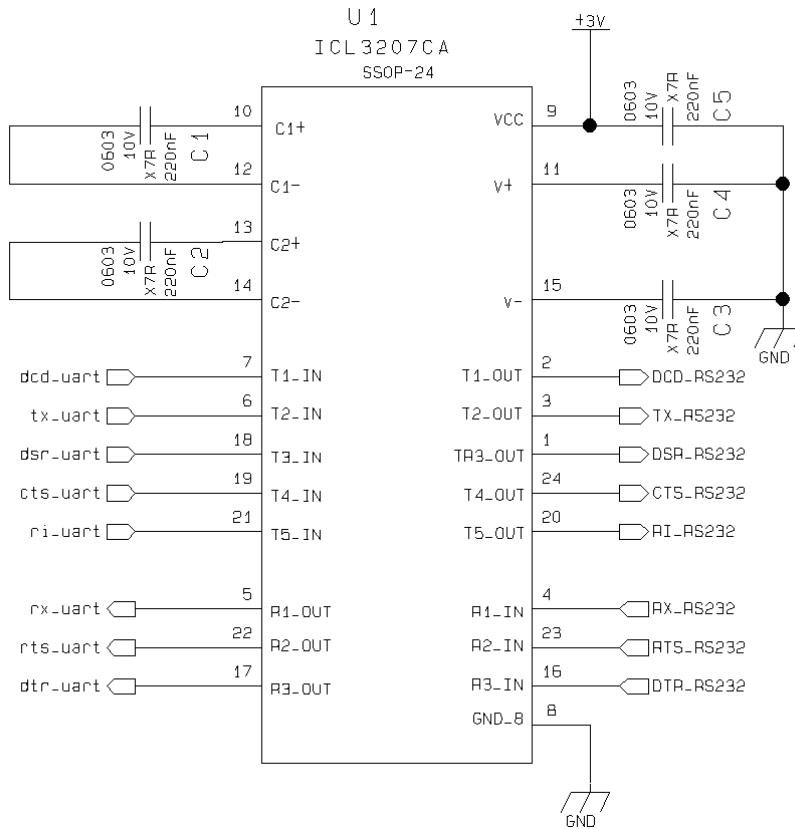
***Only RXD, TXD, GND and the On/off module turn on pad are required to the reprogramming of the module, the other lines are unused.***

***All applicator shall include in their design such a way of reprogramming the GC864.***

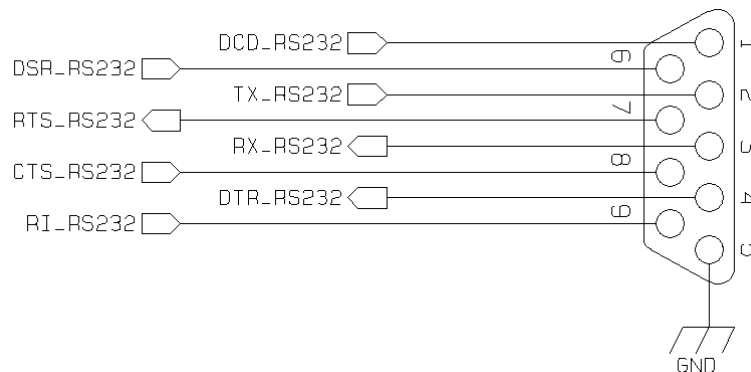




An example of level translation circuitry of this kind is:

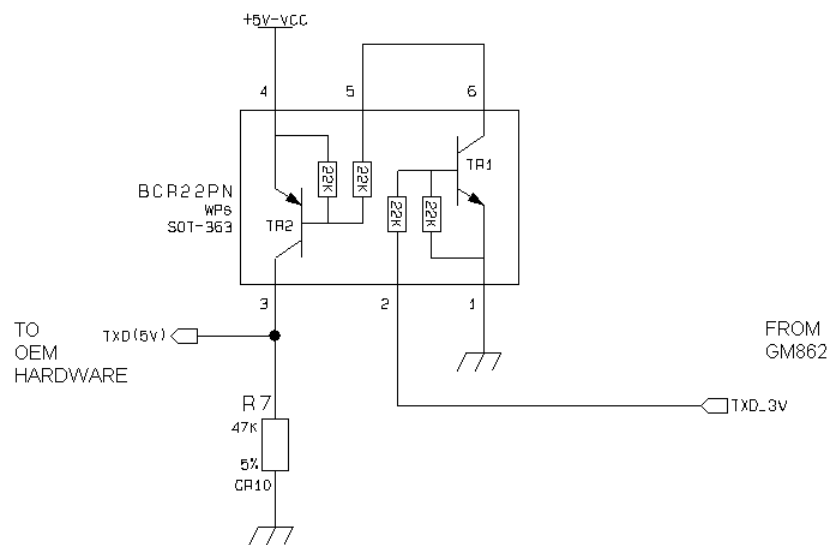


the RS232 serial port lines are usually connected to a DB9 connector with the following layout:

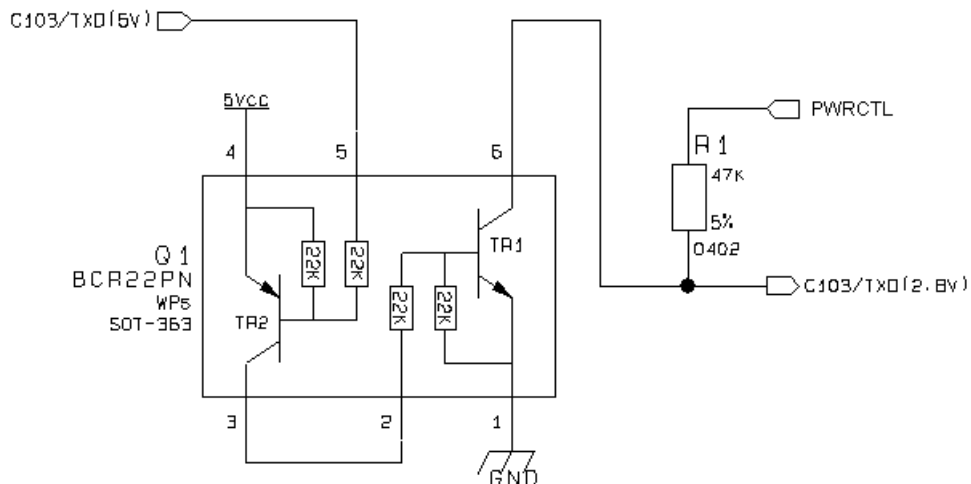


## 6.2 5V UART level translation

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:





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***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 47K $\Omega$  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 47K $\Omega$  may be required.***

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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.



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***NOTE: The input lines working at 2.8VCMOS can be pulled-up with 47K $\Omega$  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.***

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## 7 Audio Section Overview

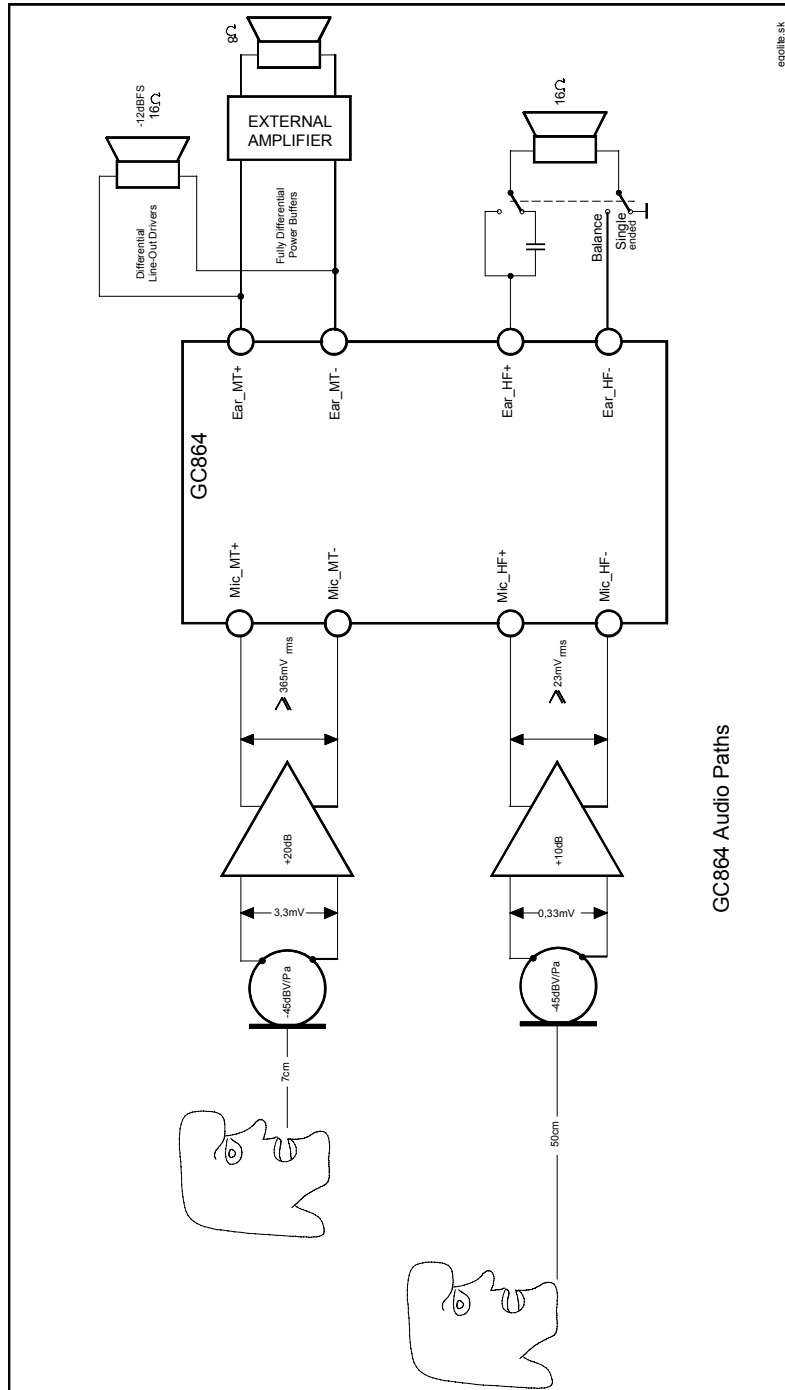
The Base Band Chip of the GC864 Telit Module provides two different audio blocks; both in transmit (*Uplink*) and in receive (*Downlink*) direction:

“*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.





## 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" 1<sup>st</sup> differential microphone path

<ul style="list-style-type: none"> <li>• line coupling</li> <li>• line type</li> <li>• coupling capacitor</li> <li>• differential input resistance</li> <li>• differential input voltage</li> <li>• microphone nominal sensitivity</li> <li>• analog gain suggested</li> <li>• echo canceller type</li> </ul>	<p>AC balanced ≥ 100nF 50kΩ ≤ 1,03V<sub>pp</sub> (365mV<sub>rms</sub>) -45 dBV<sub>rms</sub>/Pa + 20dB handset</p>
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### "Mic\_HF" 2<sup>nd</sup> differential microphone path

<ul style="list-style-type: none"> <li>• line coupling</li> <li>• line type</li> <li>• coupling capacitor</li> <li>• differential input resistance</li> <li>• differential input voltage</li> <li>• microphone nominal sensitivity</li> <li>• analog gain suggested</li> <li>• echo canceller type</li> </ul>	<p>AC balanced ≥ 100nF 50kΩ ≤ 65mV<sub>pp</sub> (23mV<sub>rms</sub>) -45 dBV<sub>rms</sub>/Pa  +10dB car kit hands-free</p>
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***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  $-45dB_{V_{rms}/Pa}$  , will produce

the electrical equivalent signal :

$$MicLevel = (-45) + (-4.7) = -49.7 dB_{V_{rms}}$$

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 *1<sup>st</sup> differential* 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 .





**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<sub>rms</sub>/Pa*, will produce a lower electrical

equivalent signal :

$$\text{MicLevel} = (-45) + (-4.7) - 20 = -69.7$$

that means :

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

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 :

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

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.







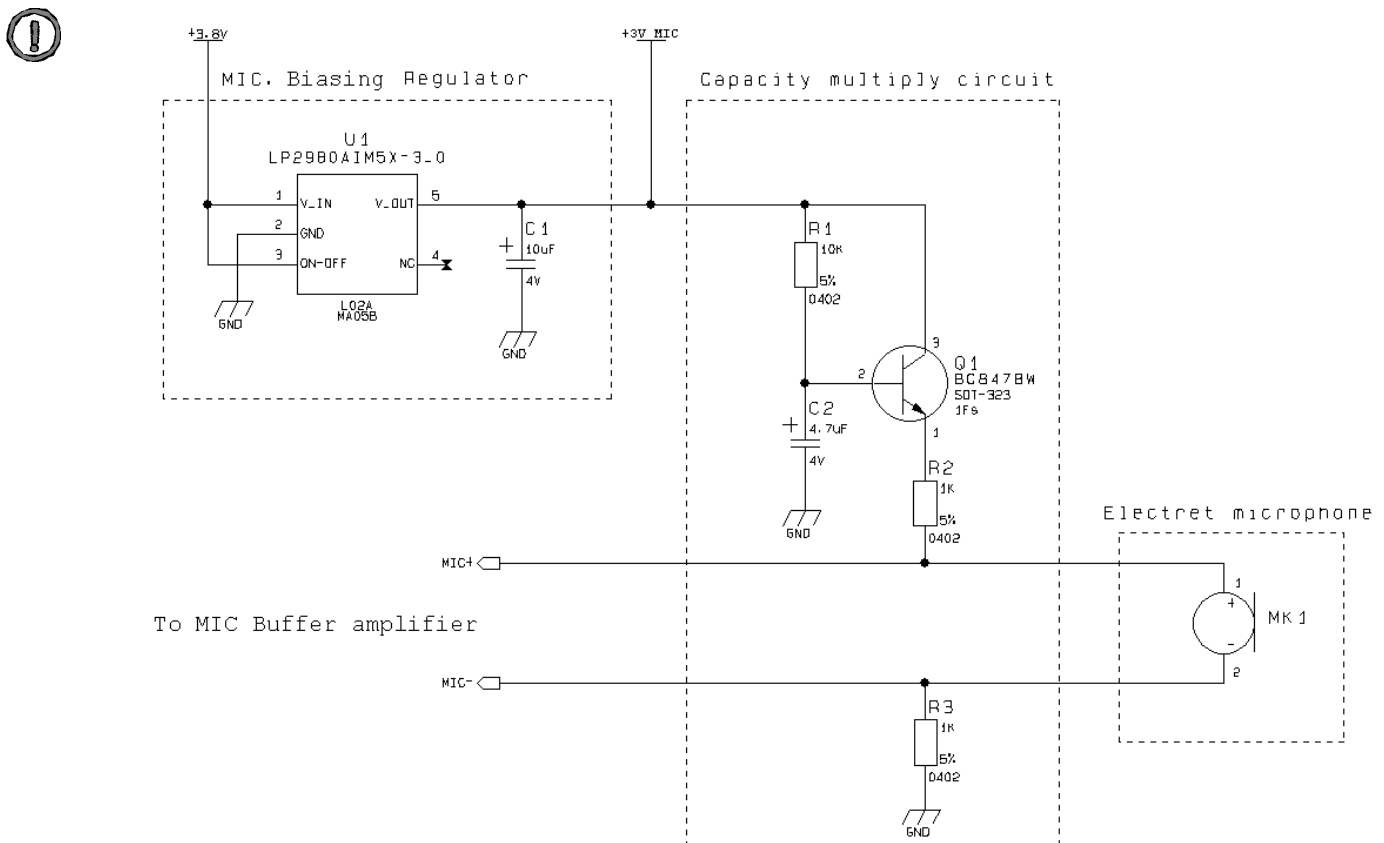
## 7.4 Microphone Biasing

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:



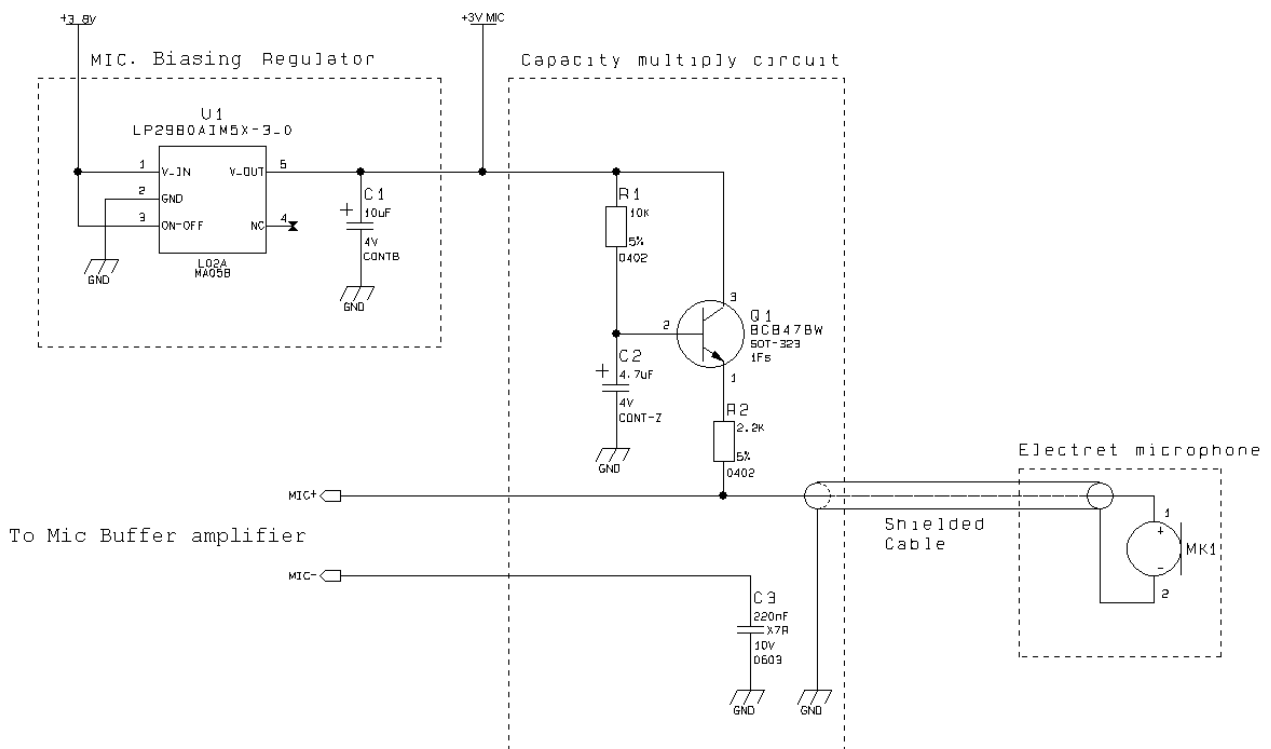
**NOTE:** *In the balanced application the resistors R2 and R3 must have the same value to keep the circuit balanced.*




-  **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 2k $\Omega$  biasing resistance, so try to keep the value of R2 around 2k $\Omega$ . For mic. characteristics refer to the manufacturer.

---



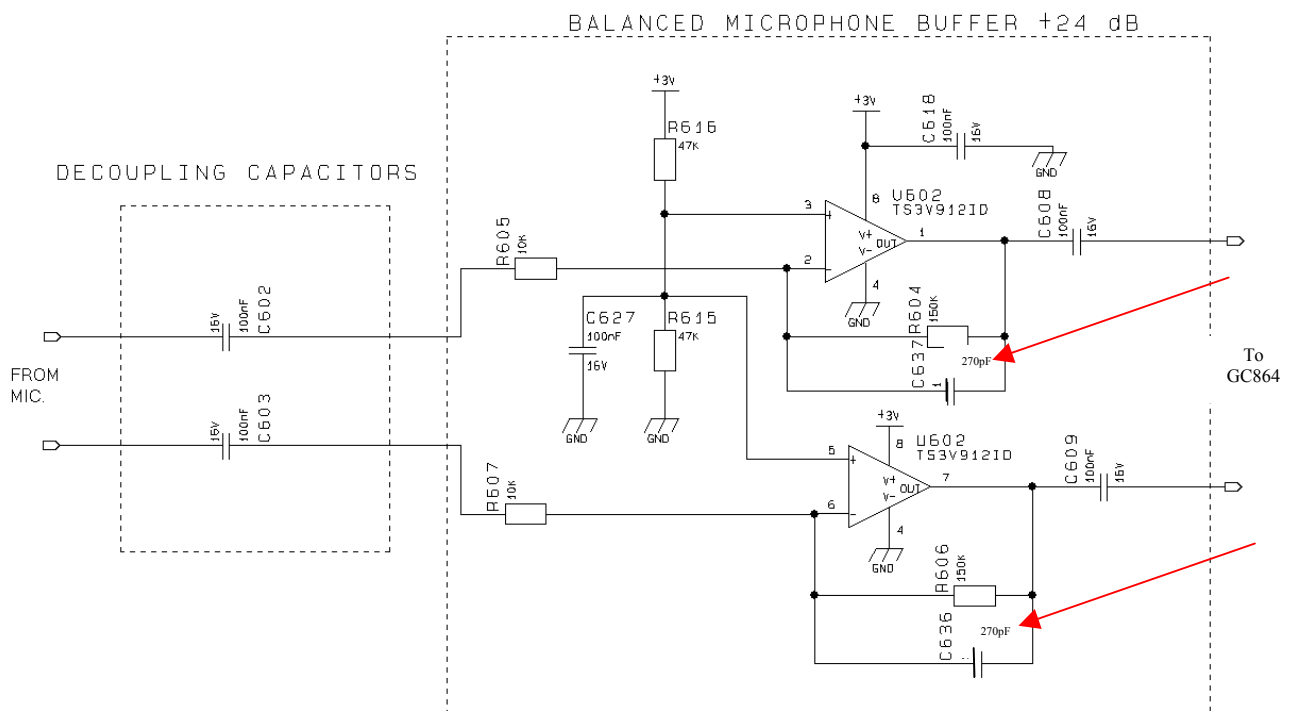
## 7.5 Microphone buffering

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 ( $-45 \text{ dBV}_{\text{rms}}/\text{Pa}$ ). 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 and R607) and as a consequence the capacitors C636 and C637 to maintain the bandwidth 150-4000Hz (at -3dB).



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  $-45 \text{ dBV}_{rms}/\text{Pa}$  and you want to use it in 1st differential microphone path ("Mic\_MT" inputs) in "normal spoken" conditions at acoustic pressure of  $-4.7\text{dBPa}$ .

As reported at page 33 , the electrical level output from the microphone will be :

$$MicLevel = (-45) + (-4.7) = -49.7 \text{ dBV}_{rms}$$

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

corresponding to:

When the talker is screaming ,we will have a signal of  $330 \text{ mV}_{rms}$  on the "Mic\_MT" inputs for a buffer gain  $G_A$  :

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

The corresponding values for the resistors on the buffer could be ( if we keep the input resistance  $10\text{k}\Omega$  )

$$R604 = R606 = gain * R603 = gain * R605 = 10 * 15 = 150 \text{ k}\Omega$$

The commercial values of  $150\text{k}\Omega$  &  $15\text{k}\Omega$  are then chosen.

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

$$C636=C637= 1/ (2\pi*4000*R606)= 265 *10^{-12} \text{ F}$$

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





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

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.**

Let's assume you have a microphone with a sensitivity of  $-45dB_{rms}/Pa$  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 gain  $G_A = "Mic\_HF / MicVoltage = (1 * 10^{-3}) / (0,33 * 10^{-3})$  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  $G_S = 1,5$ times (or +3,52dB).

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

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

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

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





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*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** ( $f_{c1}=4181\text{Hz}$ ) and **2,7nF** ( $f_{c2}=3931\text{Hz}$ ) because of commercial values .*



## 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  $-12\text{dBFS}$  (\*) ;
- the “**Ear\_HF**” lines *EPPA1\_2* and *EPPA2* are the *Fully Differential Power Buffers* ; they can directly drive a **16Ω 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.



## 8.2 Output lines characteristics .

### **“Ear\_MT” Differential Line-out Drivers Path**

- |                                    |   |
|------------------------------------|---|
| • line coupling:                   | DC  |
| • line type:                       | bridged                                     |
| • output load resistance :         | $\geq 14 \Omega$                            |
| • internal output resistance:      | 4 $\Omega$ (typical)                        |
| • signal bandwidth:                | 150 - 4000 Hz @ -3 dB                       |
| • max. differential output voltage | 1310 mV <sub>rms</sub> (typ, open circuit)  |
| • differential output voltage      | 328mV <sub>rms</sub> /16 $\Omega$ @ -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 :         | $\geq 14 \Omega$                           |
| • internal output resistance:      | 4 $\Omega$ ( >1,7 $\Omega$ )               |
| • signal bandwidth:                | 150 - 4000 Hz @ -3 dB                      |
| • max. differential output voltage | 1310 mV <sub>rms</sub> (typ, open circuit) |
| • max. single ended output voltage | 656 mV <sub>rms</sub> (typ, open circuit)  |
| • SW volume level step             | - 2 dB                                     |
| • number of SW volume steps        | 10   |





## 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.

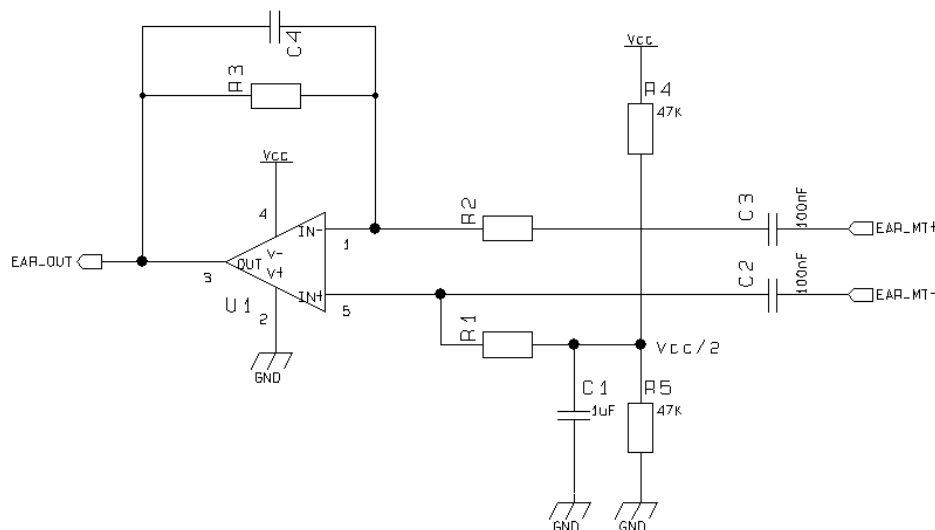
For these reasons, when the power output of the GC864 is not enough or if the speaker characteristics are different from the suggested, then it is preferable to use an amplifier to increase the power and current output capabilities.

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:

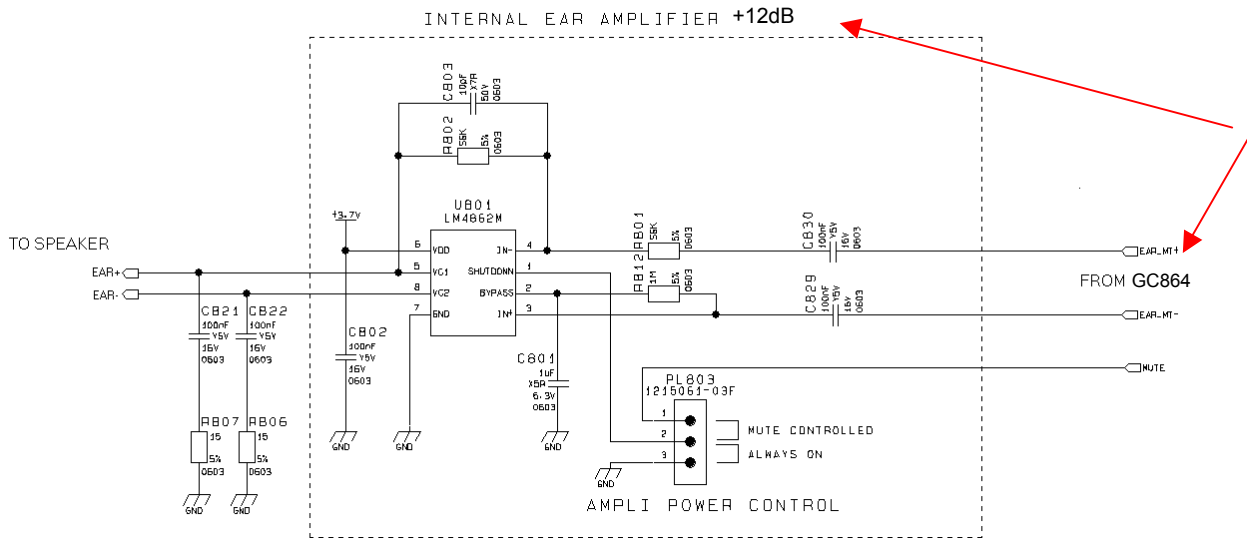


The resulting gain and high pass cut can be obtained with the formula:

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

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

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.





## 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:

<b>SIMVCC</b>	(SIM Power supply )
<b>SIMRST</b>	( SIM Reset )
<b>SIMIO</b>	( SIM Data )
<b>SIMIN</b>	( SIM Presence/Absence )
<b>SIMCLK</b>	( 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.





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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.

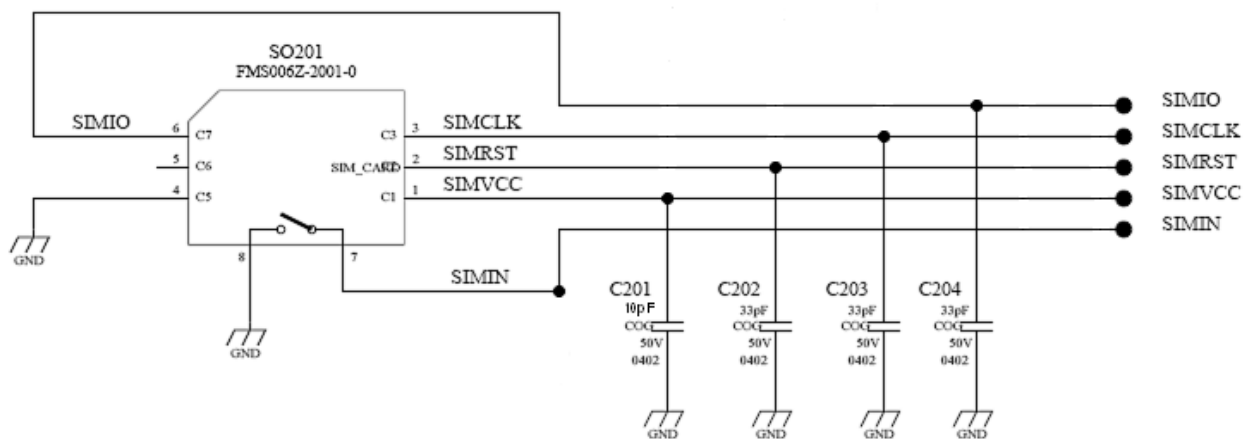
Do not insert resistor on SIMVCC, SIMRST and SIMIO lines, their use is not supported by SIM electrical interface.

- 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 47K $\Omega$  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.



## 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, dramatically reducing the sleep consumption to few  $\mu\text{A}$ .

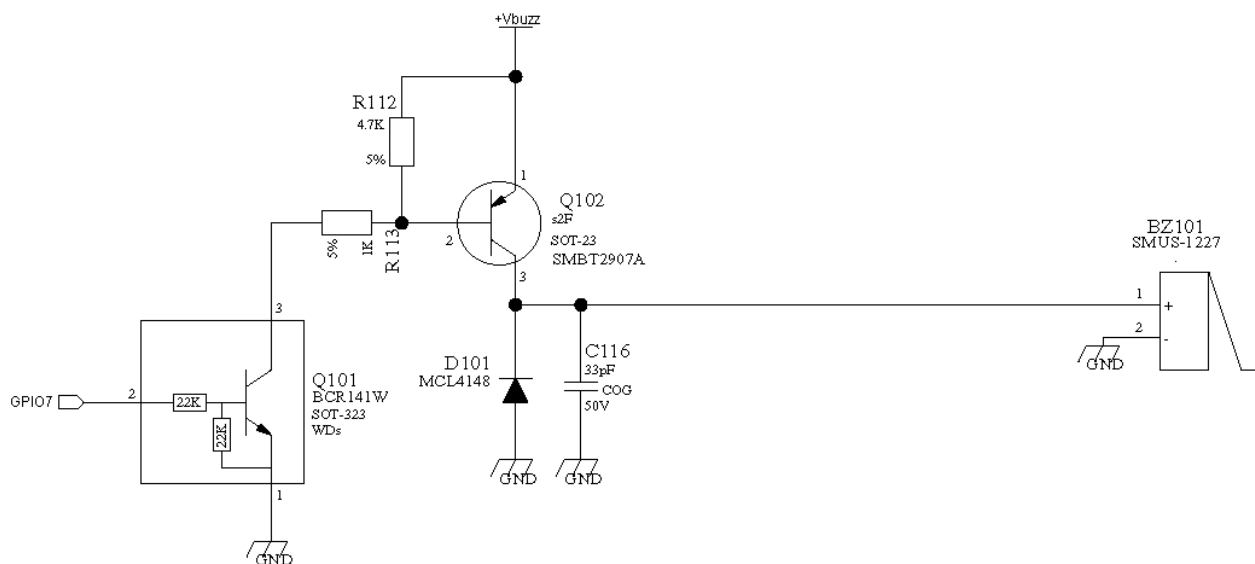
In battery powered devices this feature will greatly improve the autonomy of the device.

## 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:

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

### 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



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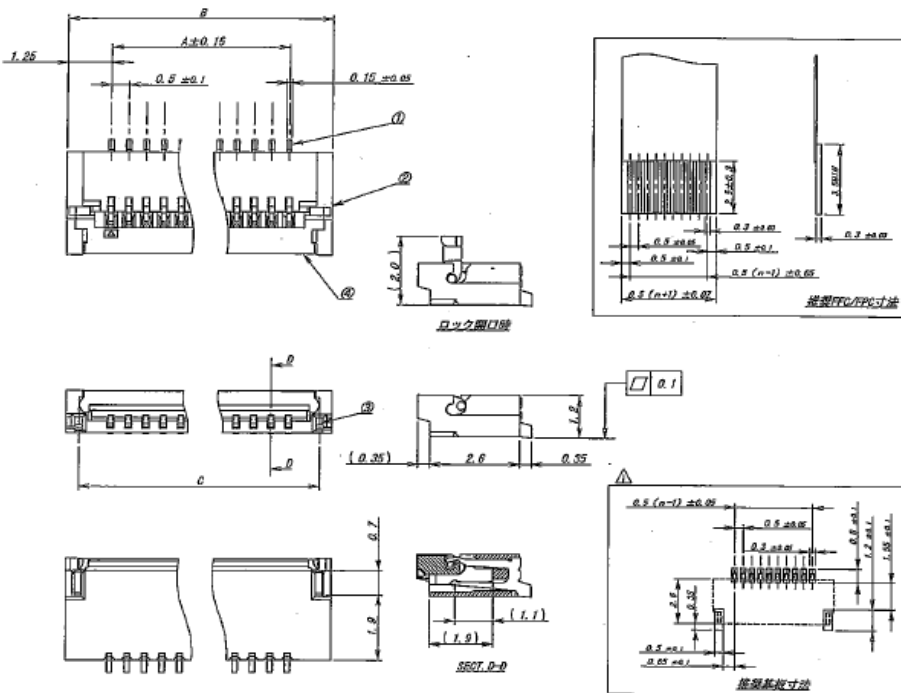
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-	n.c	-	-	14	DOUT_7	I/O
-	n.c	-	-	15	DOUT_8	I/O
-	n.c	-	-	16	VCLKOUT	O
-	n.c	-	-	17	VALIDH	O
-	n.c	-	-	18	VALIDV	O
-	VCC_MAIN_CAM	O	External 2.8V Regulator enable controlled by CAM_PWR_ON pin	19	DVDD28	I
D7	CAM_SDA/IIC_SDA	I/O	I2C bus serial data	20	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.



極数 (PCT)	部品番号 PART No.	A	B	C	EDP No.
5	9636S-05A-TC	2.0	4.8	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	10.2	
19	9636S-19A-TC	9.0	11.5	10.5	
20	9636S-20A-TC	9.5	12.0	11.1	
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	

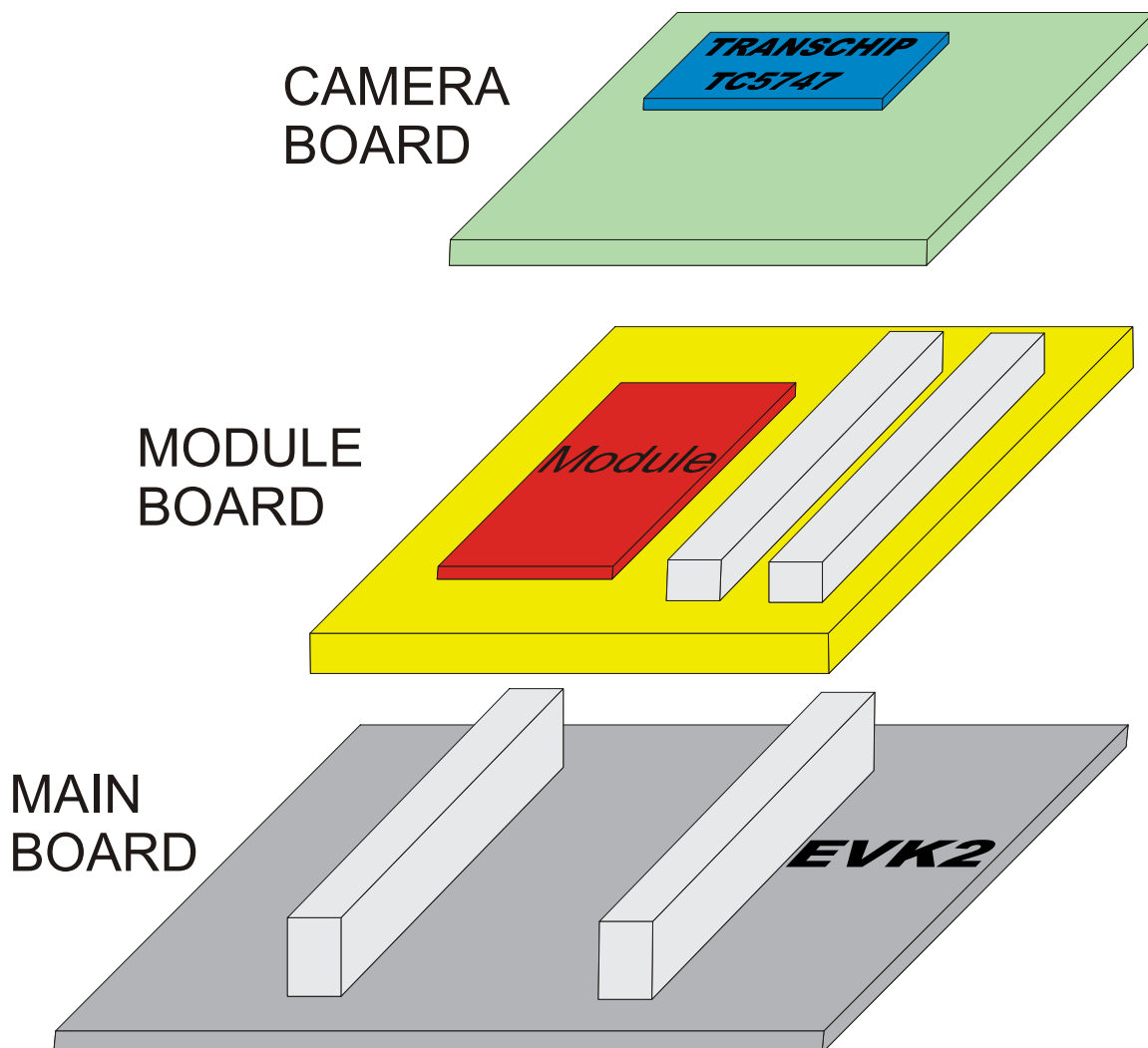
Camera Socket Connector



### 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
...data.....
OK
>AT#CAMEN=0    (camera OFF)
  
```

} Repeating photo capture and download n times



## 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.







# 14 Document Change Log

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



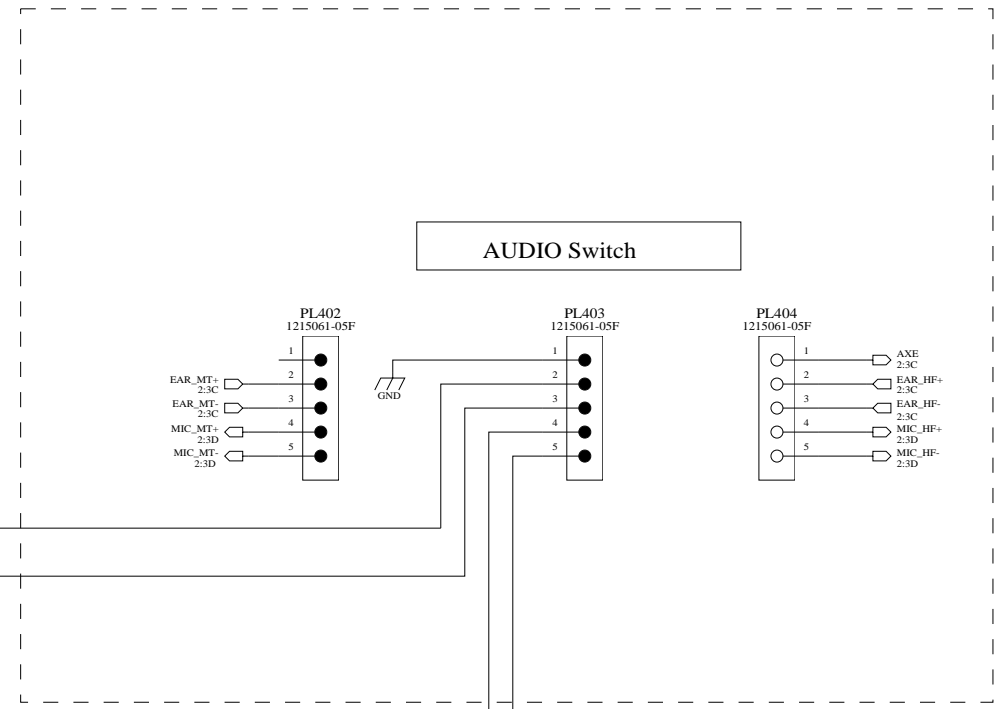
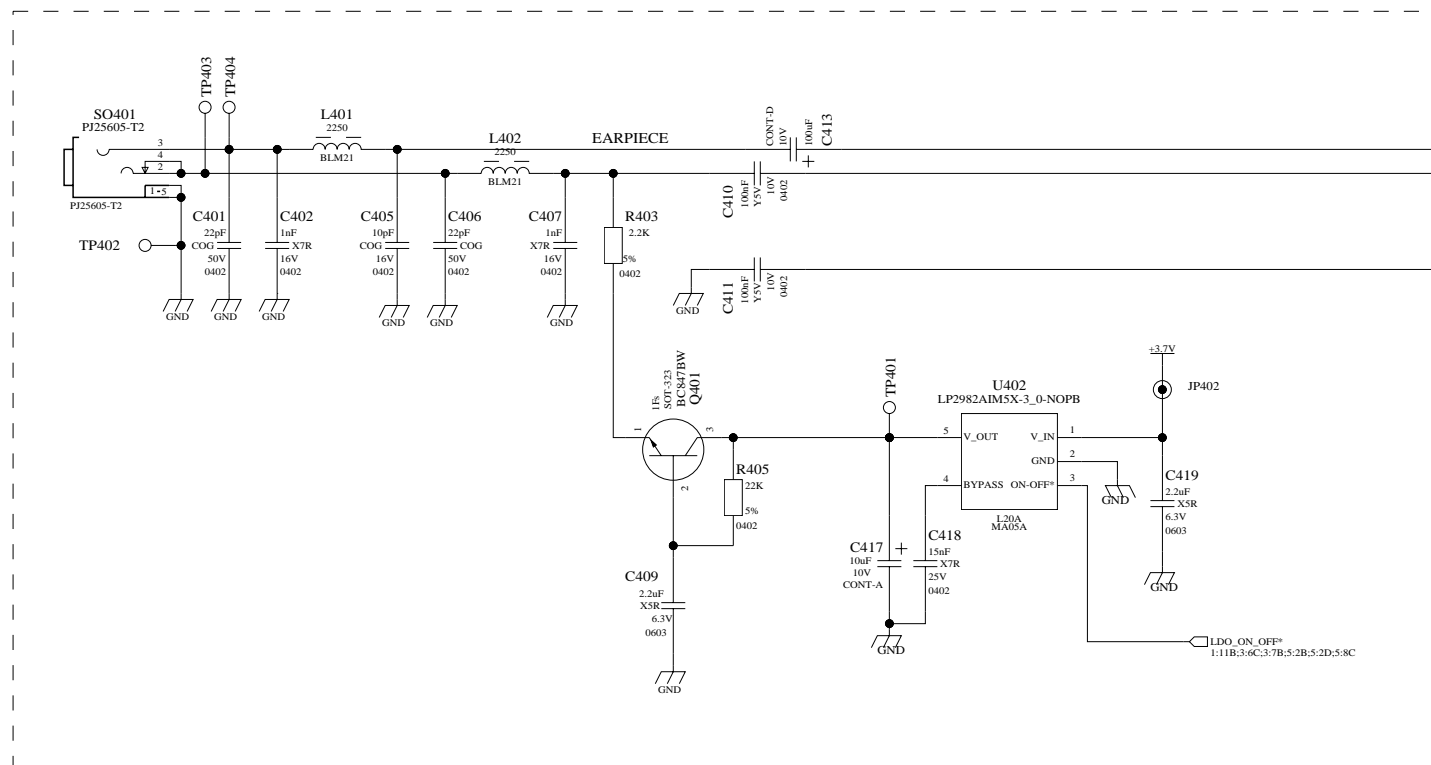
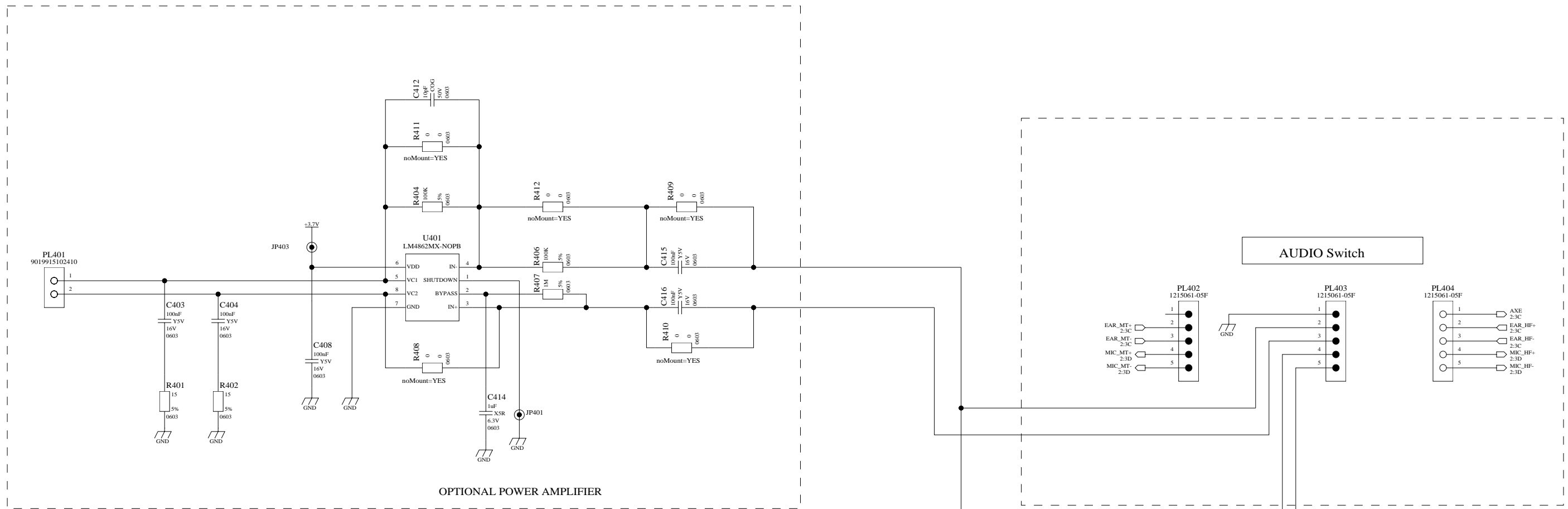
# Annex A – EVK2 schematics







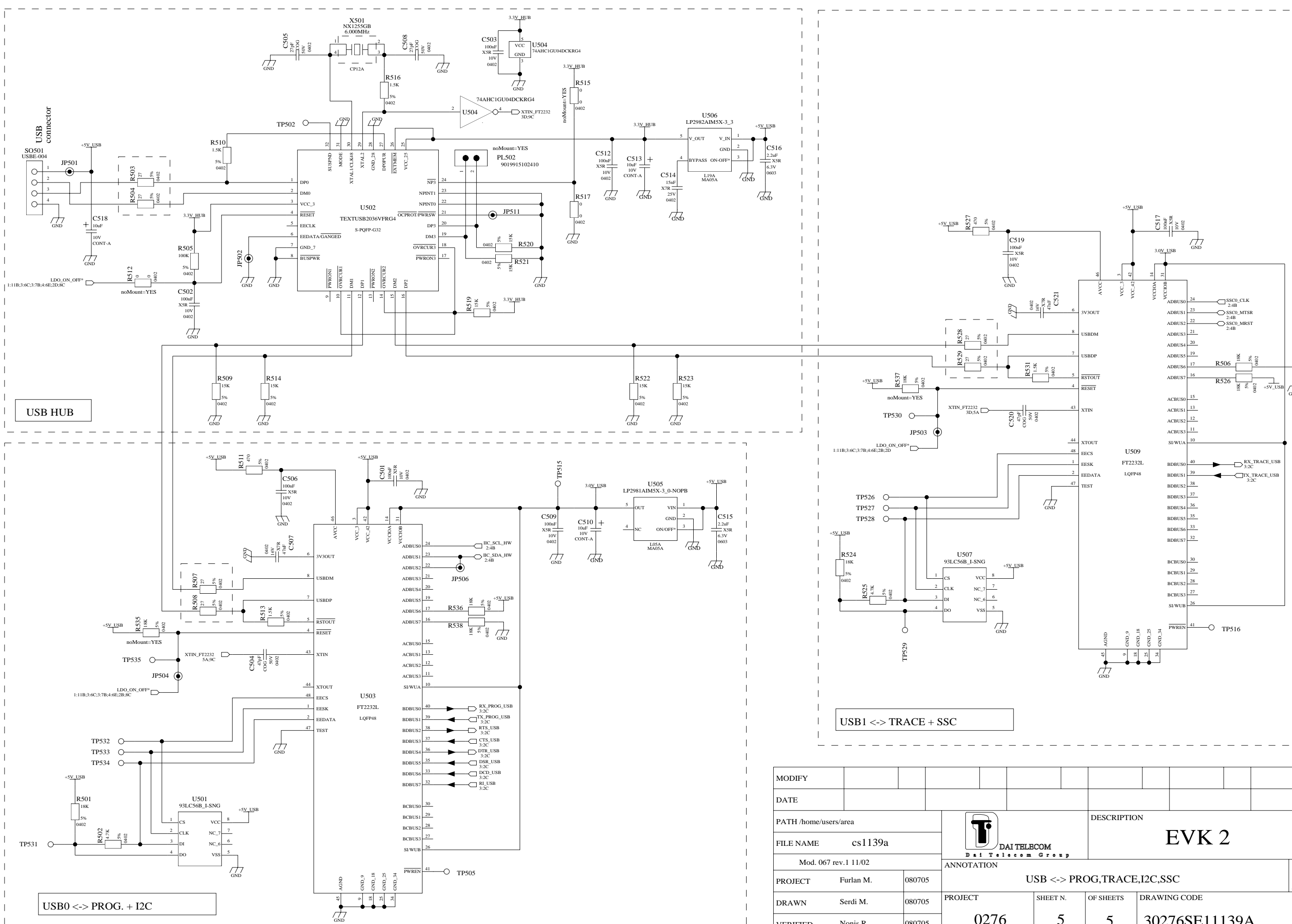





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Mod. 067 rev.1 11/02											ANNOTATION					
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DRAWN	Serdi M.	080705	PROJECT	0276	SHEET N.	4	OF SHEETS	5	DRAWING CODE							A3
VERIFIED	Nonis R.	080705														

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VERIFIED	Nonis R.	080705							FORM <b>A3</b>

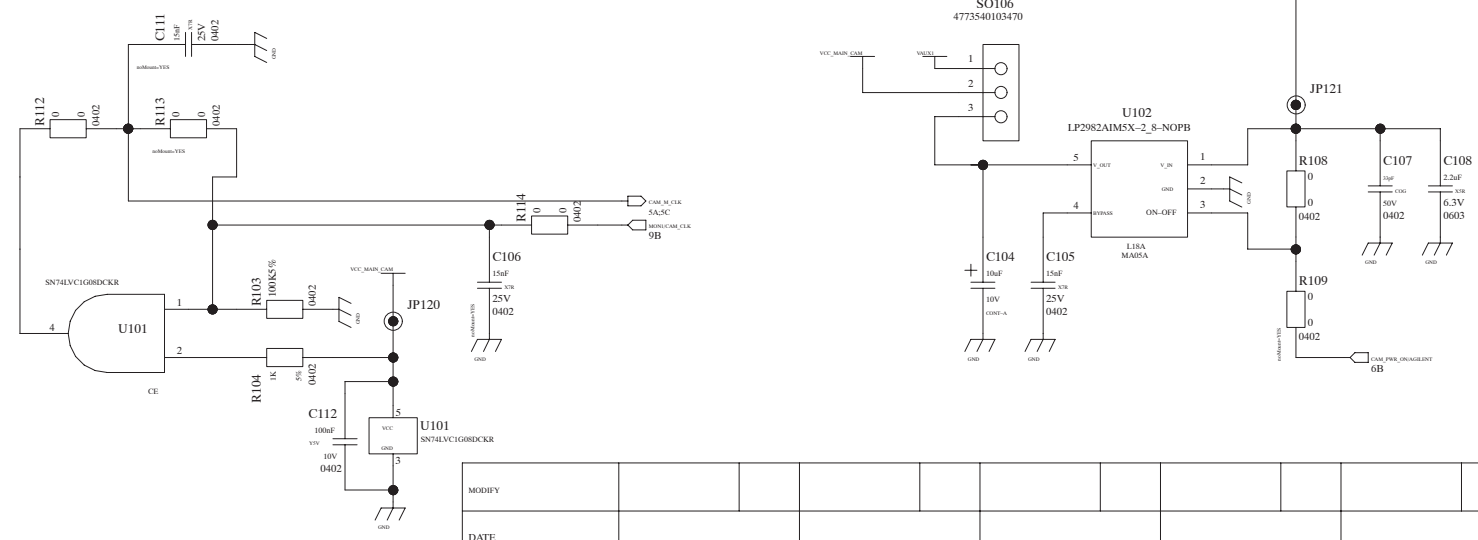
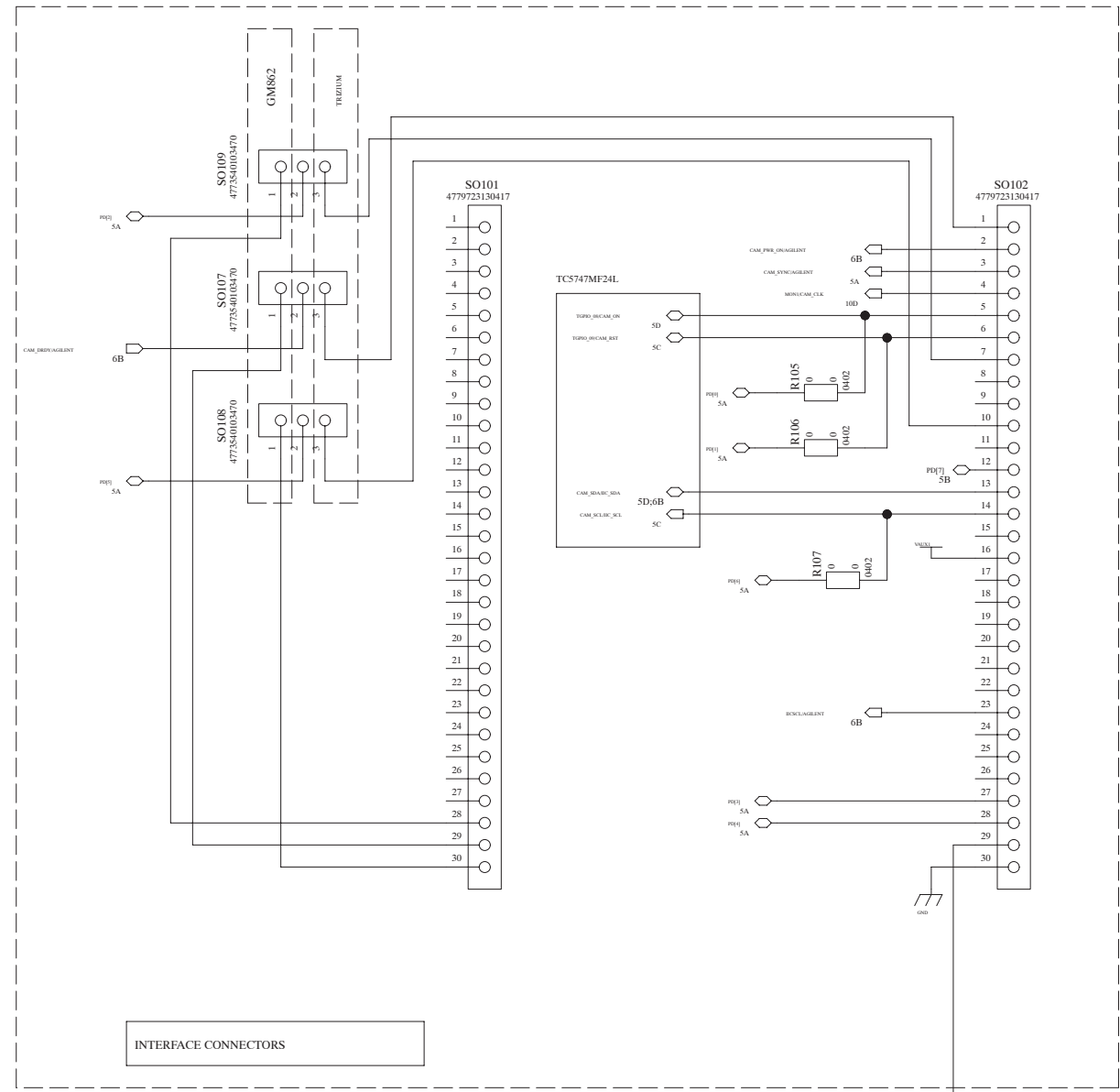
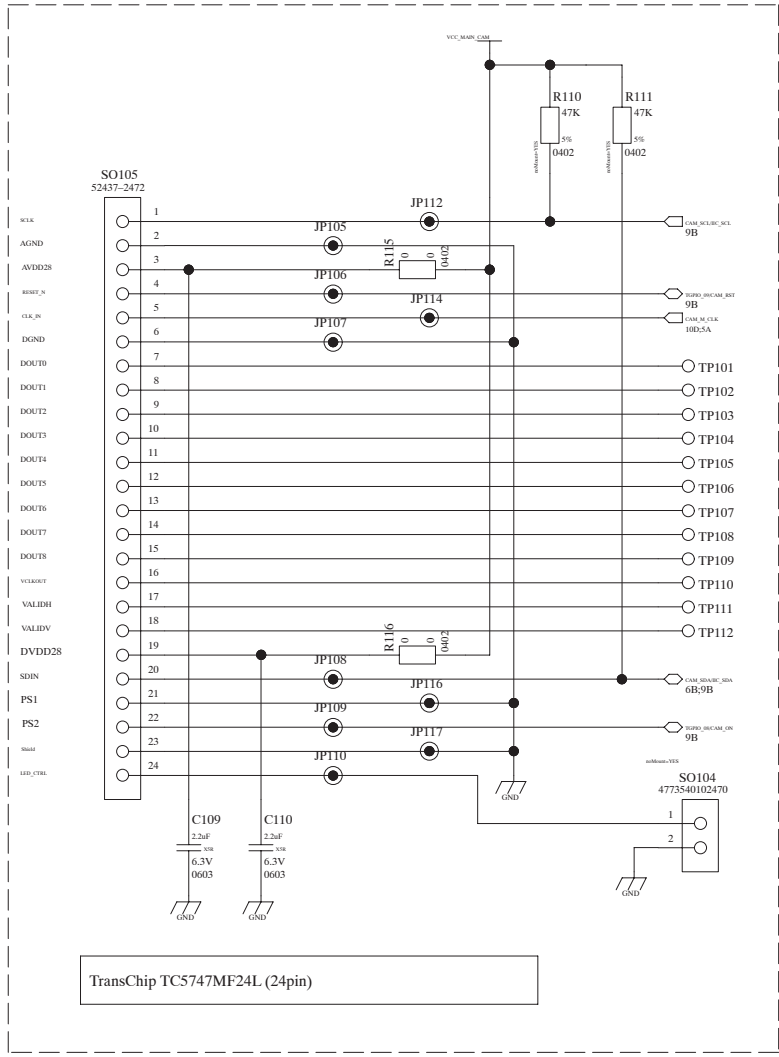


# Annex B - Camera EVB schematics



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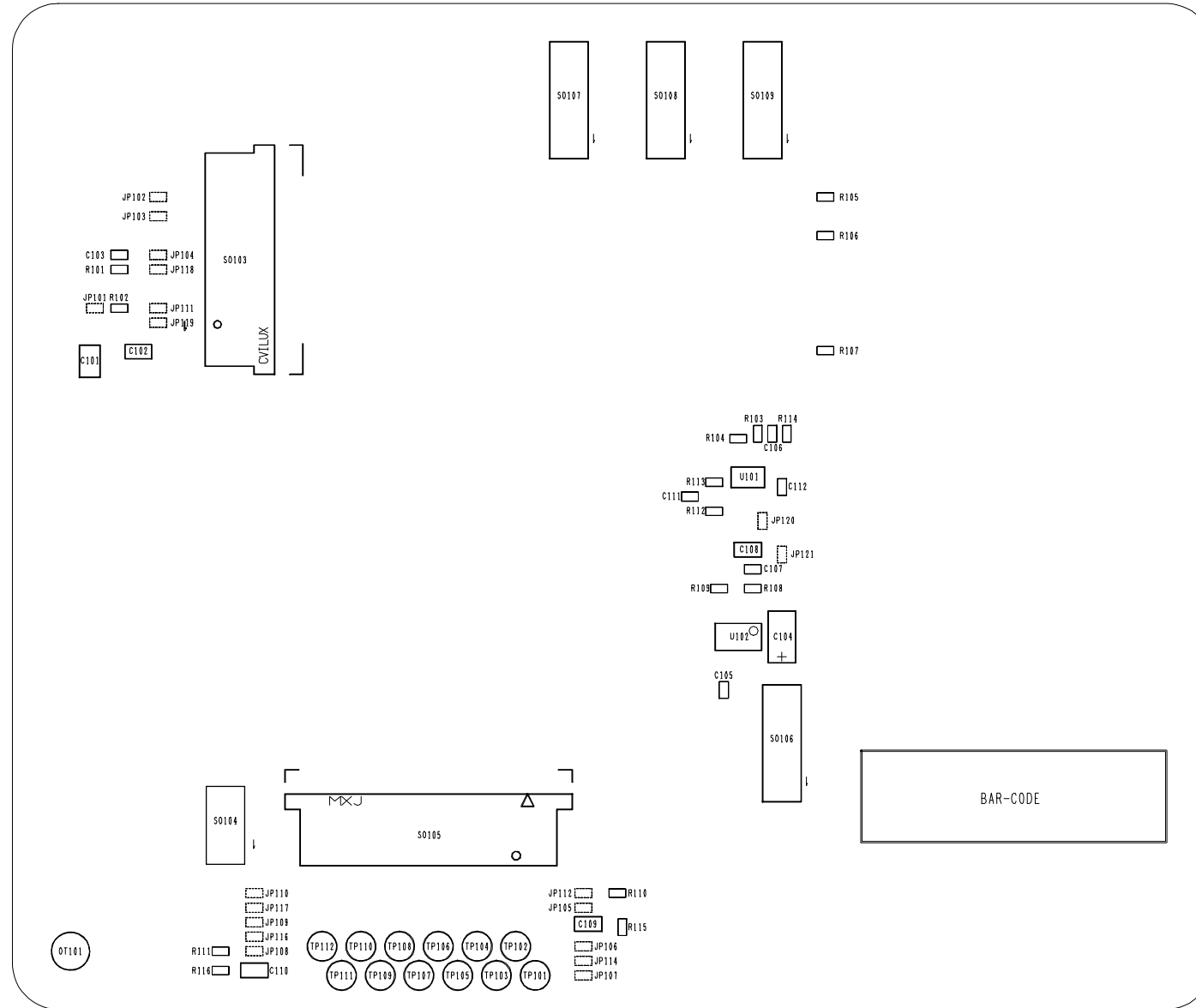
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DRAWN: Paganini	060905	PROJECT: 0276		SHEET N.: 1	OF SHEETS: 1	DRAWING CODE: 30276SE11170					
VERIFIED:		PROJECT: 0276		SHEET N.: 1	OF SHEETS: 1	DRAWING CODE: 30276SE11170					

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FILE GERBER											ANNOTATION									
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Project by											Silkscreen side A									
Drawn by:	Pasqualini Natascia		06/09/2005		Project		SHEET N.		OF SHEETS		DRAWING CODE									
Verif. by					0276		1		2		CS1170.SM									

