GE864 QUAD ATEX
Hardware User Guide

1vv0300879 Rev.3 – 2011-04-06

Making machines talk.

APPLICABILITY TABLE

PRODUCT
GE864-QUAD ATEX

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1. Introduction

1.1. Scope

The aim of this document is the description of some hardware solutions useful for developing a product with the Telit GE864-QUAD ATEX module.

1.2. Audience

This document is intended for Telit customers, who are integrators, about to implement their applications using our GE864-QUAD ATEX module.

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

http://www.telit.com

To register for product news and announcements or for product questions contact Telit's Technical Support Center (TTSC).

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1.4. Document Organization

This document contains the following chapters:

Chapter 1: "Introduction" provides a scope for this document, target audience, contact and support information, and text conventions.

Chapter 2: "Overview" provides an overview of the document.

Chapter 3: "GE864 Mechanical Dimensions"

Chapter 4: "GE864 Module Connections" deals with the pin out configuration and layout.

Chapter 5: "Hardware Commands" How to operate on the module via hardware.

Chapter 6: "Power supply" Power supply requirements and general design rules.

Chapter 7: "Temperature range" ATEX temperature classification

Chapter 8: "Antenna" The antenna connection and board layout design are the most important parts in the full product design.

Chapter 8: "Logic Level specifications" Specific values adopted in the implementation of logic levels for this module.

Chapter 10: "Serial ports" The serial port on the Telit GE864- QUAD ATEX is the core of the interface between the module and OEM hardware

Chapter 11: "Audio Section overview" Refers to the audio blocks of the Base Band Chip of the GE864 Telit Modules.

Chapter 12: "General Purpose I/O" How the general purpose I/O pads can be configured.

Chapter 13 "DAC and ADC Section" Deals with these two kind of converters.

Chapter 16 "Conformity Assessment issues" Deals with the assessments of the module.

Chapter 17 "Safety Recommendations"

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1.5. Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.6. Related Documents

- GE864-QUAD ATEX Product description, 80336ST10052a
- Telit's GSM/GPRS Family Software User Guide, 1vv0300784
- Audio settings application note , 80000NT10007a
- Digital voice Interface Application Note, 80000NT10004a
- Product description, 80331ST10074a
- SIM Holder Design Guides, 80000NT10001a
- AT Commands Reference Guide, 80000ST10025a
- Telit EVK2 User Guide, 1vv0300704

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1.7. Document History

Revision	Date	Changes
Rev 0	2010-05-15	Release First Preliminary rev 0
Rev 1	2010-05-04	Second preliminary issue. New layout V2 compliant. §4: updated Pin-out table: ball F3 becomes RESERVED. External 32 KHz is not required. Added ball F9 (RTS) in table containing pins must be left connected if not used. Added note about RTS: must be connected to GND if flow control is not used. §6: Power Supply: updated electrical parameters for IIC,IIB,IIA gas classes Added § 6.1.1 " ATEX useful parameters"
Rev 2	2011-03-22	§6.1.1: Updated Ci and Li values added § 7: temperature range updated § 17: safety recommendations
Rev 3	2011-04-06	Updated ATEX temperature class

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2. Overview

In this document all the basic functions of a mobile phone are taken into account; for each one of them a proper hardware solution is suggested and eventually the wrong solutions and common errors to be avoided are evidenced. Obviously this document cannot 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 GE864-QUAD ATEX module.

NOTICE:

(EN) The integration of the GSM/GPRS GE864-QUAD ATEX cellular module within user application shall be done according to the design rules described in this manual.

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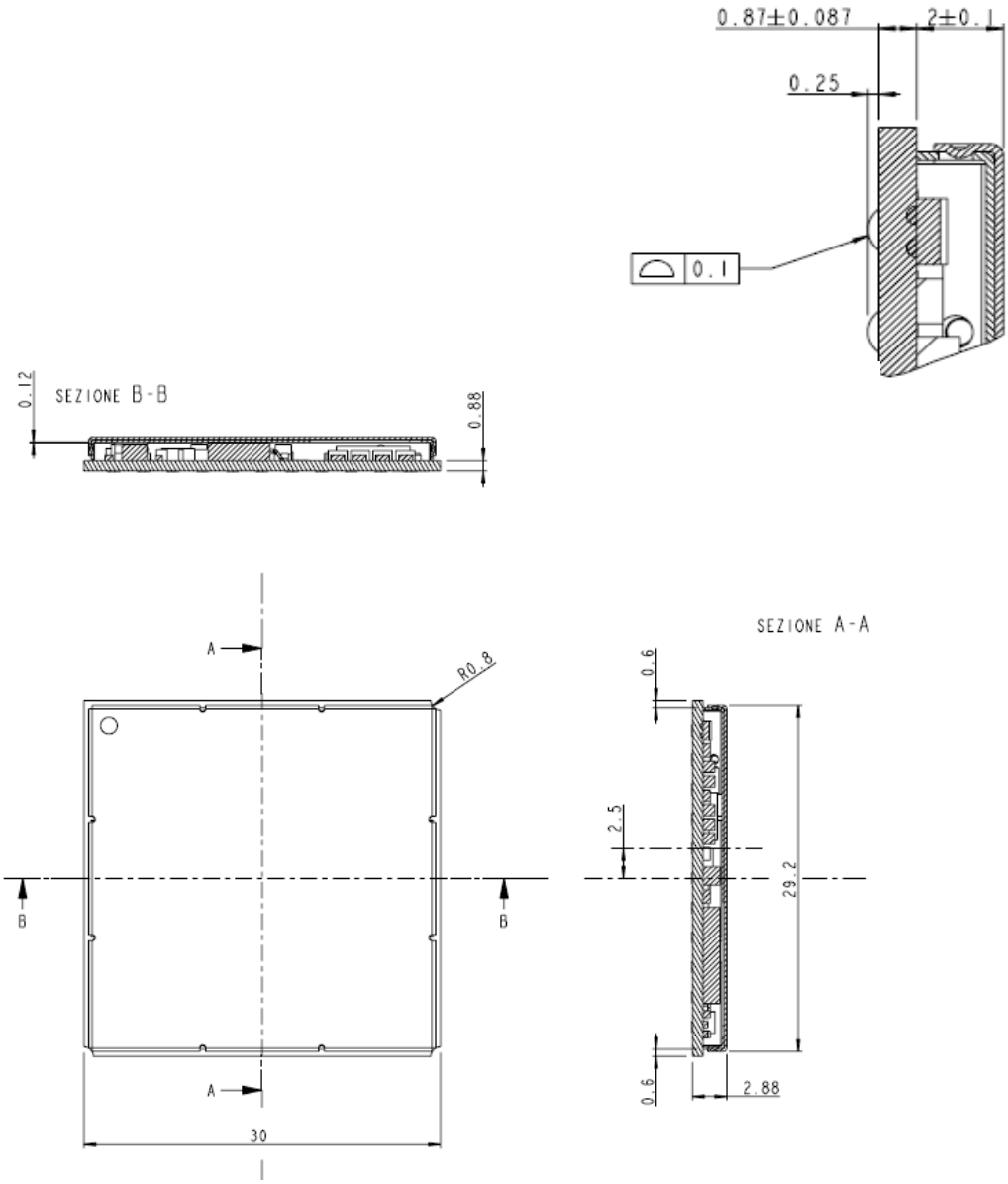
3. GE864-QUAD ATEX Mechanical Dimensions

The Telit GE864-QUAD ATEX module overall dimensions are:

- Length: 30 mm
- Width: 30 mm
- Thickness: 2,9 mm
- Weight: 4.2g



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4. GE864-QUAD ATEX Module Connections

4.1. PIN-OUT

The GE864-QUAD ATEX uses 11x11 array BGA technology connection

Ball	Signal	I/O	Function	Internal PULL UP	Type
Audio					
F9	AXE	I	Handsfree switching	100K	CMOS 2.8V
G8	MIC_HF+	AI	Handsfree mic. input; phase +, nom. level 3mVrms		Audio
G9	MIC_MT-	AI	Handset mic.signal input; phase-, nom. level 50mVrms		Audio
G10	EAR_MT+	AO	Handset earphone signal output, phase +		Audio
J8	MIC_MT+	AI	Handset mic.signal input; phase+, nom. level 50mVrms		Audio
J9	MIC_HF-	AI	Handsfree mic.input; phase -, nom. level 3mVrms		Audio
J10	EAR_HF-	AO	Handsfree ear output, phase -		Audio
H9	EAR_MT-	AO	Handset earphone signal output, phase -		Audio
H10	EAR_HF+	AO	Handsfree ear output, phase +		Audio
SIM card interface					
C10	SIMCLK	O	External SIM signal – Clock		1,8 / 3V
C11	SIMIN	I	External SIM signal - Presence (active low)	Pull up 47K	1,8 / 3V
D4	SIMVCC	-	External SIM signal – Power supply for the SIM		1,8 / 3V
D10	SIMIO	I/O	External SIM signal - Data I/O	Pull up 4.7K	1,8 / 3V
E9	SIMRST	O	External SIM signal – Reset		1,8 / 3V
Auxiliary UART/AUX					
D11	TX_AUX	O	Auxiliary UART (TX Data to DTE)		CMOS 2.8V
F10	RX_AUX	I	Auxiliary UART (RX Data from DTE)		CMOS 2.8V
H4	SERVICE	I	Service pin shall be used to upgrade the module from ASC1 (RX_AUX, TX_AUX). The pin shall be tied low to enable the feature only in case of a SW Update activity. It is required, for debug purpose, to be connected to a test pad on the final application.		CMOS 2.8V
Prog. / Data + HW Flow Control					
B6	C125/RING	O	Output for Ring indicator signal (RI) to DTE		CMOS 2.8V
B7	C108/DTR	I	Input for Data terminal ready signal (DTR) from DTE		CMOS 2.8V
D9	C109/DCD	O	Output for Data carrier detect signal (DCD) to DTE		CMOS 2.8V
E7	C103/TXD	I	Serial data input (TXD) from DTE		CMOS 2.8V
E11	C107/DSR	O	Output for Data set ready signal (DSR) to DTE		CMOS 2.8V
F7	C105/RTS	I	Input for Request to send signal (RTS) from DTE		CMOS 2.8V
F6	C106/CTS	O	Output for Clear to send signal (CTS) to DTE		CMOS 2.8V
H8	C104/RXD	O	Serial data output to DTE		CMOS 2.8V

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Ball	Signal	I/O	Function	Internal PULL UP	Type
DAC and ADC					
C7	DAC_OUT	AO	Digital/Analog converter output		D/A
J11	ADC_IN1	AI	Analog/Digital converter input		A/D
H11	ADC_IN2	AI	Analog/Digital converter input		A/D
Miscellaneous Functions					
A2	RESET#	I	Reset input		
D8	STAT_LED	O	Status indicator led		CMOS 1.8V
E2	VRTC	AO	VRTC		Power
J5	ON_OFF#	I	Input command for switching power ON or OFF (toggle command). The pulse to be sent to the GE864-QUAD ATEX must be equal or greater than 1 second.	Pull up 47K	Pull up to VBATT
L8	PWRMON	O	Power on Monitor		CMOS 2.8V
L4	GSM Antenna	O	Antenna output – 50 ohm		RF
Telit GPIO / DVI					
E6	GPIO_01 / JDR	I/O	Telit GPIO01 I/O pin / Jammer detect report		CMOS 2.8V
H5	GPIO_02/DVI_WAO	I/O	Telit GPIO02 Configurable GPIO / DVI audio *		CMOS 2.8V
K7	GPIO_03 / DVI_RX	I/O	Telit GPIO03 Configurable GPIO / DVI audio *		CMOS 2.8V
B3	GPIO_04	I/O	Telit GPIO04 Configurable GPIO / RF Transmission Control		CMOS 2.8V
K8	GPIO_05 / RFTXMON	I/O	Telit GPIO05 Configurable GPIO / Transmitter ON monitor		CMOS 2.8V
B5	GPIO_06 / ALARM	I/O	Telit GPIO06 Configurable GPIO / ALARM		CMOS 2.8V
L9	GPIO_07 / BUZZER	I/O	Telit GPIO07 Configurable GPIO / Buzzer		CMOS 2.8V
H3	GPIO_08 /DVI_TX	I/O	Telit GPIO08 Configurable GPIO / DVI audio *		CMOS 2.8V
D7	GPIO_09 / DVI_CLK	I/O	Telit GPIO09 Configurable GPIO / DVI audio *		CMOS 2.8V
Power Supply					
J1	VBATT	-	Main power supply		Power
K1	VBATT	-	Main power supply		Power
J2	VBATT	-	Main power supply		Power
K2	VBATT	-	Main power supply		Power
A1	GND	-	Ground		Power
A11	GND	-	Ground		Power
D6	GND	-	Ground		Power
F1	GND	-	Ground		Power
F11	GND	-	Ground		Power
H1	GND	-	Ground		Power
H2	GND	-	Ground		Power
J3	GND	-	Ground		Power
K3	GND	-	Ground		Power
K4	GND	-	Ground		Power
K5	GND	-	Ground		Power
K6	GND	-	Ground		Power
L1	GND	-	Ground		Power
L2	GND	-	Ground		Power

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Ball	Signal	I/O	Function	Internal PULL UP	Type
L3	GND	-	Ground		Power
L6	GND	-	Ground		Power
L11	GND	-	Ground		Power
RESERVED					
A3	-	-	Reserved		
A4	-	-	Reserved		
A5	-	-	Reserved		
A6	-	-	Reserved		
A7	-	-	Reserved		
A8	-	-	Reserved		
A9	-	-	Reserved		
A10	-	-	Reserved		
B1	-	-	Reserved		
B2	-	-	Reserved		
B4	-	-	Reserved		
B8	-	-	Reserved		
B9	-	-	Reserved		
B10	-	-	Reserved		
B11	-	-	Reserved		
C1	-	-	Reserved		
C2	-	-	Reserved		
C3	-	-	Reserved		
C4	-	-	Reserved		
C5	-	-	Reserved		
C6	-	-	Reserved		
C8	-	-	Reserved		
C9	-	-	Reserved		
D1	-	-	Reserved		
D2	-	-	Reserved		
D3	-	-	Reserved		
D5	-	-	Reserved		
E1	-	-	Reserved		
E3	-	-	Reserved		
E4	-	-	Reserved		
E5	-	-	Reserved		
E8	-	-	Reserved		
E10	-	-	Reserved		
F2	-	-	Reserved		
F3	-	-	Reserved		
F4	-	-	Reserved		
F5	-	-	Reserved		
F8	-	-	Reserved		
G1	-	-	Reserved		

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Ball	Signal	I/O	Function	Internal PULL UP	Type
G2	-	-	Reserved		
G3	-	-	Reserved		
G4	-	-	Reserved		
G5	-	-	Reserved		
G6	-	-	Reserved		
G7	-	-	Reserved		
G11	-	-	Reserved		
H6	-	-	Reserved		
H7	-	-	Reserved		
J4	-	-	Reserved		
J6	-	-	Reserved		
J7	-	-	Reserved		
K9	-	-	Reserved		
K10	-	-	Reserved		
K11	-	-	Reserved		
L5	-	-	Reserved		
L7	-	-	Reserved		
L10	-	-	Reserved		

* Ref. to Digital Voice Interface Application Note 80000NT10004a.

NOTE:

The GE864-QUAD ATEX Modules has one DVI port on the system.

NOTE:

Reserved pins must not be connected.

NOTE:

RTS must be connected to the GND (on the module side) if flow control is not used.

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NOTE:

If not used, almost all pins must be left disconnected. The only exceptions are the following pins:

Ball	Signal	Function
J1, J2, K1, K2	VBATT	Main power supply
A1, A11, D6, F1, F11, H1, H2, J3, K3, K4, K5, K6, L1, L2, L3, L6, L11	GND	Ground
E7	C103/TXD	Serial data input (TXD) from DTE
H8	C104/RXD	Serial data output to DTE
F7	C105/RTS	Input for Request to send signal (RTS) from DTE
J5	ON/OFF#	Input command for switching power ON or OFF (toggle command).
A2	RESET#	Reset input
F10	RX_AUX	RX Data for debug monitor
D11	TX_AUX	TX Data for debug monitor
H4	SERVICE	SERVICE connection
B7	DTR	Input for Data terminal ready signal (DTR) from DTE

NOTE: RTS (ball F7) should be connected to GND (on the module side) if flow control is not used

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4.1.1. BGA Balls Layout

TOP VIEW

	A	B	C	D	E	F	G	H	J	K	L
1	GND	-	-	-	-	GND	-	GND	VBATT	VBATT	GND
2	RESET#	-	-	-	VRTC	-	-	GND	VBATT	VBATT	GND
3	-	GPIO_04	-	-	-	-	-	GPIO_08 / DVI_TX	GND	GND	GND
4	-	-	-	SIMVCC	-	-	-	SERVICE	-	GND	Antenna
5	-	GPIO_06 / ALARM	-	-	-	-	-	GPIO_02 / DVI_WAO	ON_OFF#	GND	-
6	-	C125/RING	-	GND	GPIO_01 / JDR	C106 / CTS	-	-	-	GND	GND
7	-	C108 / DTR	DAC_OUT	GPIO_09 / DVI_CLK	C103 / TXD	C105 / RTS	-	-	-	GPIO_03/ DVI_RX	-
8	-	-	-	STAD_ LED	-	-	MIC_HF+	C104 / RXD	MIC_MT+	GPIO_05 / RFTXMON	PWRMON
9	-	-	-	C109 / DCD	SIMRST	AXE	MIC_MT-	EAR_MT-	MIC_HF-	-	GPIO_07 / BUZZER
10	-	-	SIMCLK	SIMIO	-	RX_AUX	EAR_MT+	EAR_HF+	EAR_HF-	-	-
11	GND	-	SIMIN	TX_AUX	C107 / DSR	GND	-	ADC_IN2	ADC_IN1	-	GND

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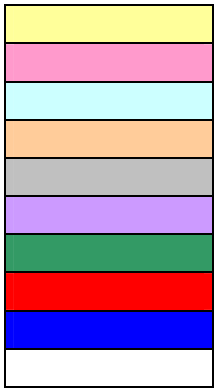

AUDIO Signals balls
SIM CARD interface balls
AUX UART&SERVICE Signals balls
Prog. / data + Hw Flow Control signals balls
ADC signals balls
MISCELLANEOUS functions signals balls
TELIT GPIO balls
POWER SUPPLY VBATT balls
POWER SUPPLY GND balls
RESERVED

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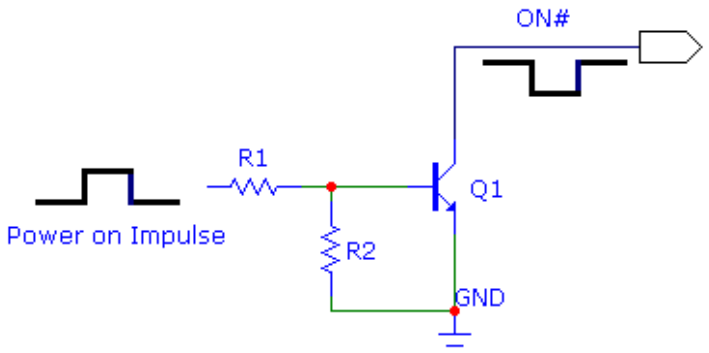
5. Hardware Commands

5.1. Turning ON the GE864-QUAD ATEX

To turn ON the GE864-QUAD ATEX the pad ON# must be tied low for at least 1 second and then released.

When the power supply voltage is lower than 3.4V the pad ON# must be tied low for at least 4 seconds.

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 module, 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 "#".

TIP:
To check if the device has powered on, the hardware line PWRMON should be monitored. After 1000ms the line raised up the device could be considered powered on

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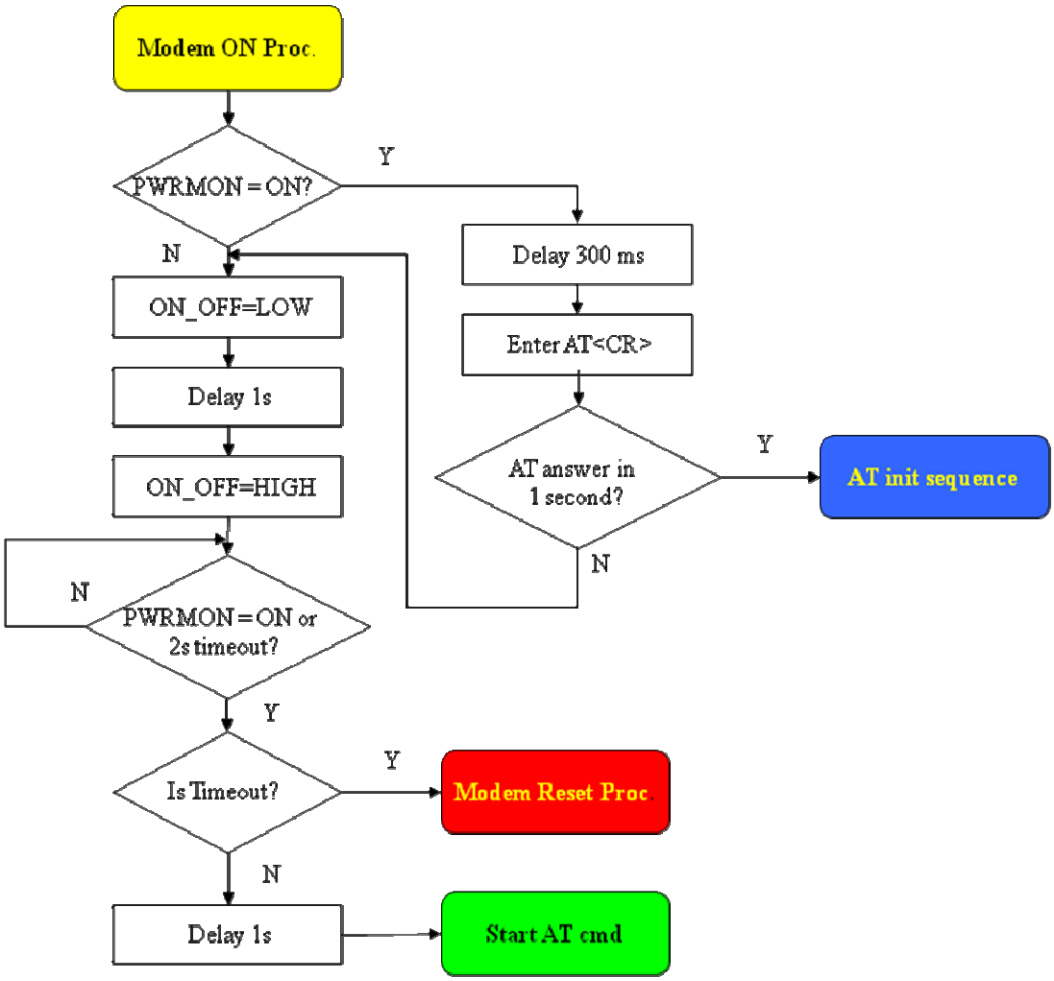
A flow chart showing the proper turn on procedure is displayed below:



NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the module when is powered OFF or during an ON/OFF transition.

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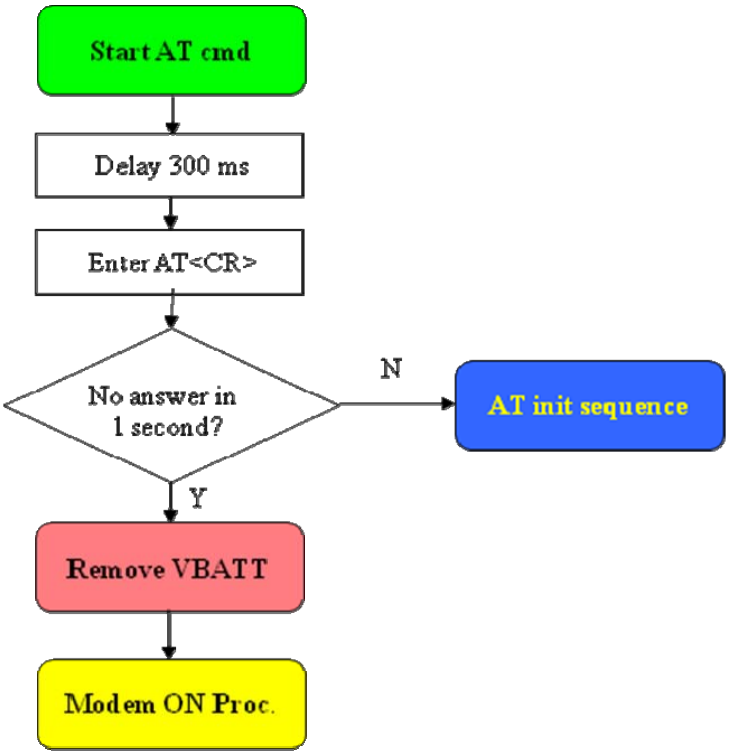
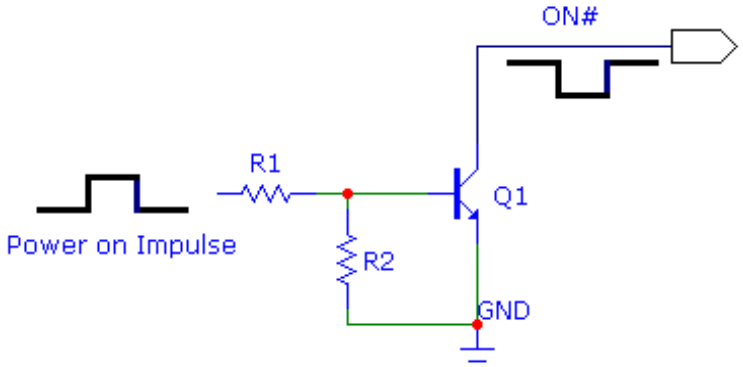
A flow chart showing the AT command managing procedure is displayed below:



For example:
1- Let's assume you need to drive the ON# pad with a totem pole output from +1.8V up to 5V microcontroller



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

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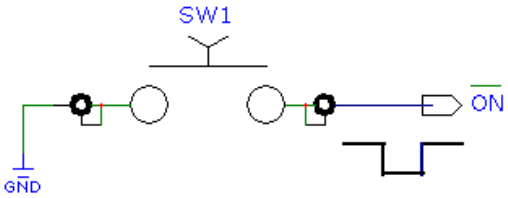

5.2. Turning OFF the GE864-QUAD ATEX

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

- via AT command (see Software User Guide AT#SHDN)
- by tying low pin ON#

Either ways, when the device issues a detach request to the network informing that the device will not be reachable any more.

To turn OFF the module the pad ON# must be tied low for at least 2 seconds 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.

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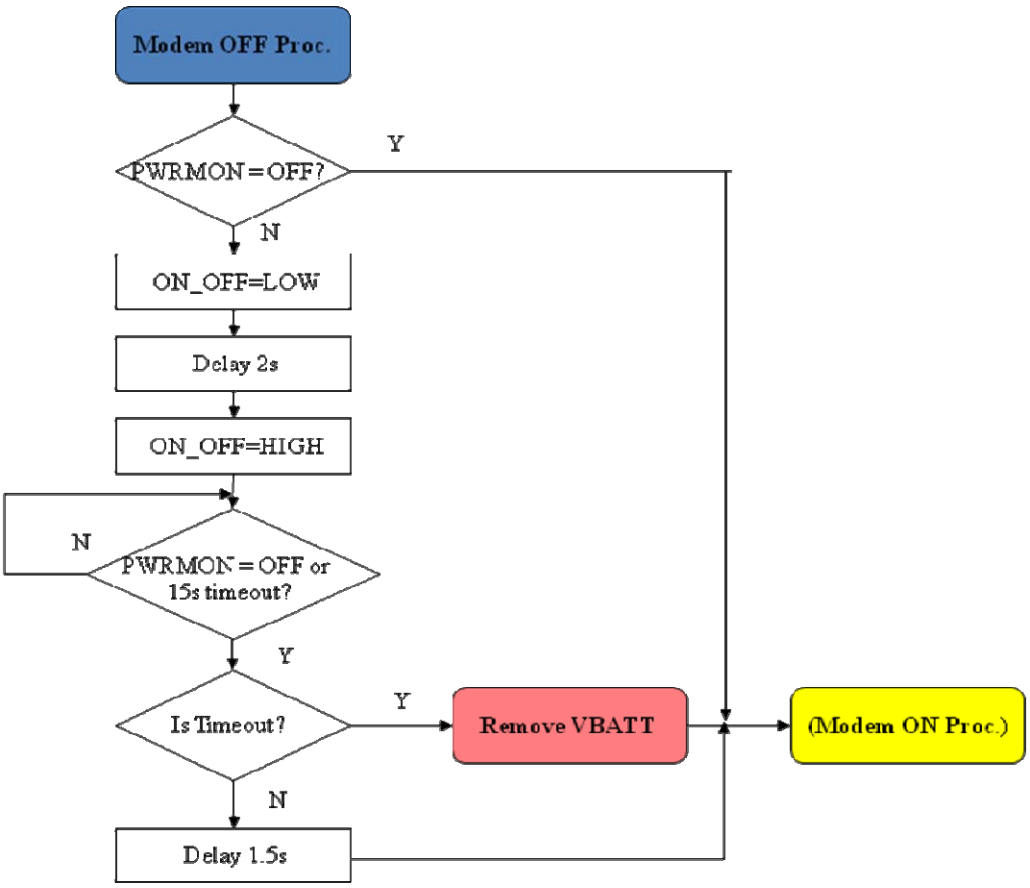
The following flow chart shows the proper turnoff procedure:



TIP:

To check if the device has been powered off, the hardware line PWRMON must be monitored. The device is powered off when PWRMON goes low.

NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the module when is powered OFF or during an ON/OFF transition.

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5.3. Hardware Unconditional Restart

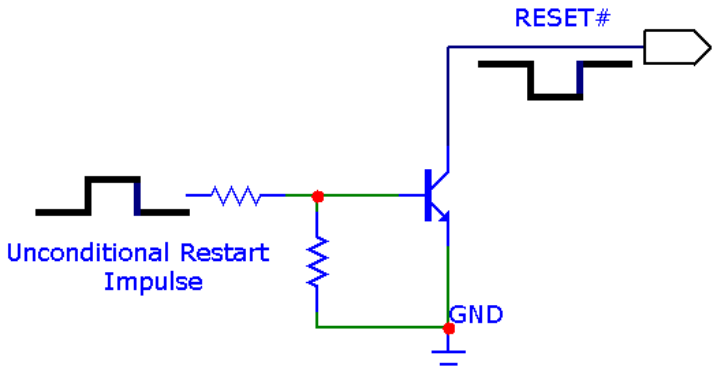
WARNING:

The hardware unconditional Restart must not be used during normal operation of the device since it does not detach the device from the network. It shall be kept as an emergency exit procedure to be done in the rare case that the device gets stacked waiting for some network or SIM responses.

To unconditionally restart the module, the pad RESET# must be tied low for at least 200 milliseconds and then released.

The maximum current that can be drained from the RESET# pad is 0.15 mA.

A simple circuit to do it is:



NOTE:

Do not use any pull up resistor on the RESET# line or any totem pole digital output. Using pull up resistor may bring to latch up problems on the module power regulator and improper functioning of the module. The line RESET# must be connected only in open collector configuration.

TIP:

The unconditional hardware Restart must always be implemented on the boards and must be used by the software as an emergency exit procedure.

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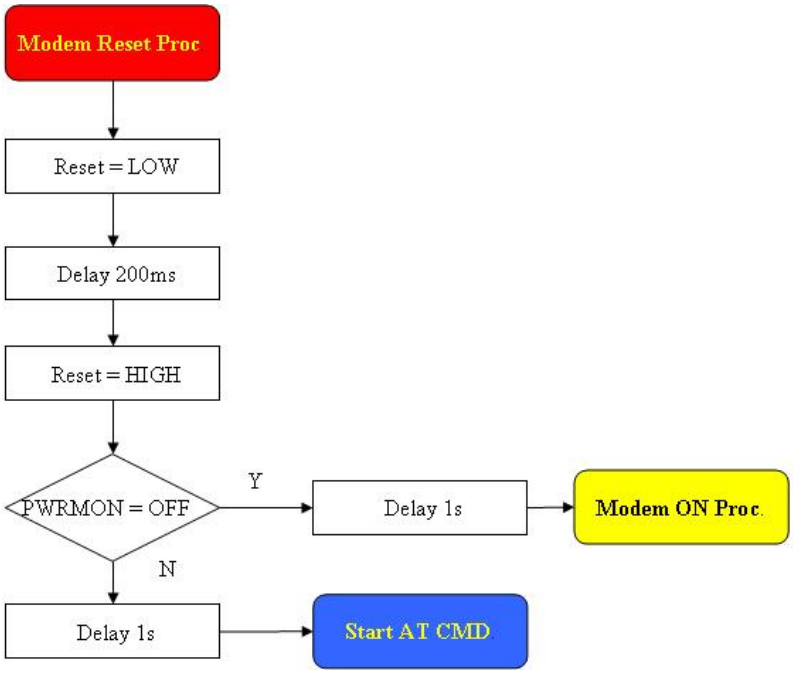
The following flow chart shows the proper RESET procedure:



NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the module when is powered OFF or during an ON/OFF transition.

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6. 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 following requirements and guidelines for a proper design.

6.1. Power Supply Requirements

Condition	Value
Nominal Supply Voltage	3.80 V
Normal operating Voltage Range	3.40 V - 4.20 V
Extended operating Voltage Range	3.22 V – 4.20 V

TIP:
The supply voltage is directly measured between VBATT and GND balls. It must stay within the Wide Supply Voltage tolerant range including any drop voltage and overshoot voltage (during the slot tx, for example).

NOTE:
The Operating Voltage Range MUST never be exceeded also in power off condition; care must be taken in order to fulfill min/max voltage requirement

NOTE:

When the power supply voltage is lower than 3.4V, to turn ON the module, the pad ON# must be tied low for at least 3 seconds.

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6.1.1. ATEX useful parameters

In order to integrate the Telit GE864-QUAD Atex module in ATEX applications, please refer to the appropriate ATEX reference standard. ATEX reference standard depends either by your ATEX application and either by the working hazardous area classification.
Below are listed parameters and useful information to integrate the module in your application:

- Total capacity: 27.5 µF
- Total inductance: 55.2 nH
- No voltage upper than the supply voltage is present into the module.
- All GPIOs are protected against short circuit.

6.1.2. Supply parameters for intrinsic safety

Mounting and wiring operations in classified areas for explosive gas atmospheres, must be executed accordingly to the current procedures and to the national and international standards (e.g. EN 60079-14) only by qualified personnel specifically and completely trained.

Supply power to the transmitter by means of an apparatus certified for the protection mode Ex ia IIC T4 according to the European standards EN 60079-0 and EN 60079-11 with the following limits:

- Rated max. voltage Ui = 4.2 V;
- Short circuit current Ii = 2.5 A;

Specific parameters for IIC Gas Group

Ui = 3.8 V
Ii = 1.4 A

Specific parameters for IIA/IIB Gas Group

Ui = 4.2 V
Ii = 2.5 A

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6.2. Power Consumption

The GE864-QUAD ATEX power consumptions are:

GE864-QUAD ATEX		
Mode	**Average (mA)**	**Mode description**
SWITCHED OFF		Module supplied but Switched Off
Switched Off	<62 uA	
IDLE mode		
AT+CFUN=1	16.0	Normal mode: full functionality of the module
AT+CFUN=4	16.0	Disabled TX and RX; module is not registered on the network
AT+CFUN=0 or =5	3.9	Paging Multiframe 2
	2.5	Paging Multiframe 3
	2.4	Paging Multiframe 4
	1.5	Paging Multiframe 9
CSD TX and RX mode		GSM VOICE CALL
GSM900 CSD PL5	270	
DCS1800 CSD PL0	195	
GPRS (class 8) 1TX		GPRS Sending data mode
GSM900 PL5	250	
DCS1800 PL0	170	
GPRS (class 10) 2TX		GPRS Sending data mode
GSM900 PL5	470	
DCS1800 PL0	290	

The GSM system is made de in a way that the RF transmission is not continuous, else it is packed into bursts at a base frequency of about 216 Hz, and 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.

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

6.3. 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.

6.3.1. 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

6.3.1.1. +5V input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence there is no big difference between the input source and the desired output. 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 GE864-QUAD ATEX, 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 can be inserted close to the power input, in order to save the GE864-QUAD ATEX from power polarity inversion.

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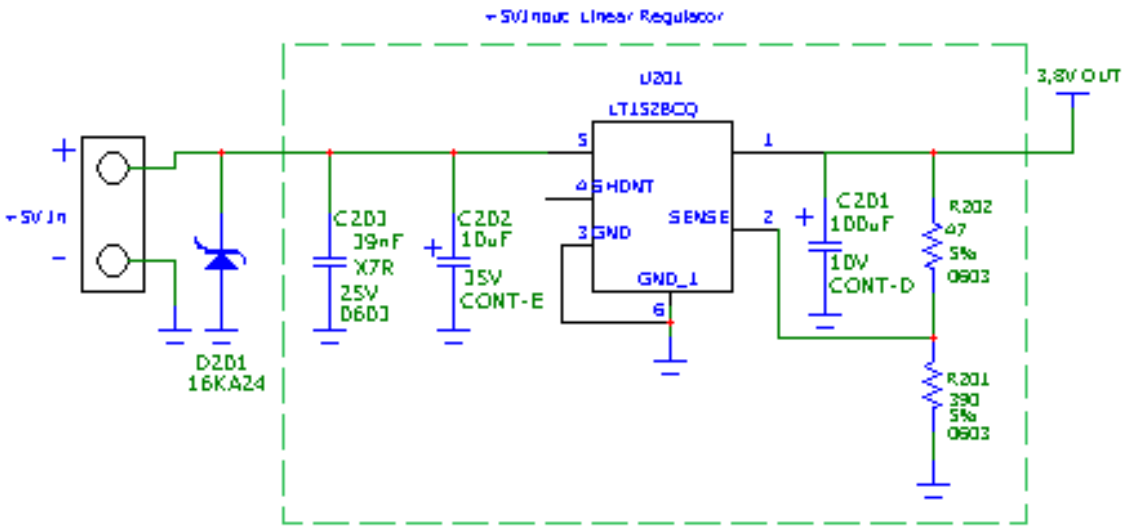
An example of linear regulator with 5V input is:



6.3.1.2. +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 GE864-QUAD ATEX.
- 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.
- In any case the frequency and switching design selection is related to the application to be developed, due to the fact that the switching frequency could also generate EMC interferences.
- As far as car PB battery, the input voltage can rise up to 15.8V. This must 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 typically used.
- Make sure the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.

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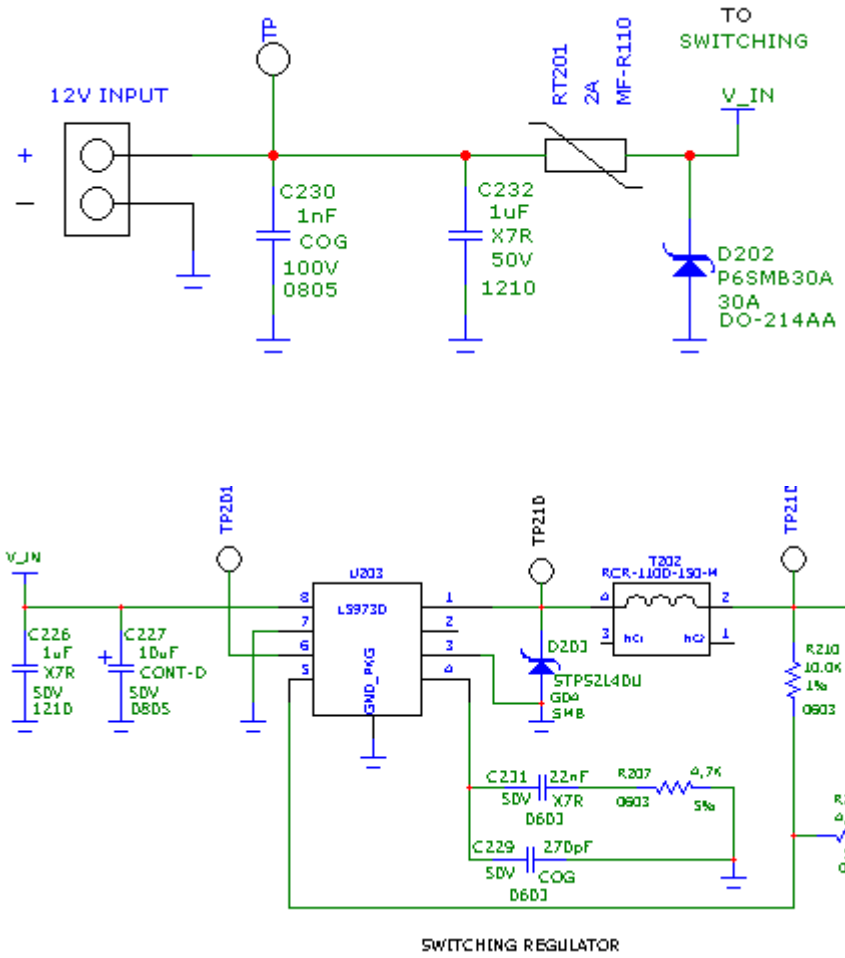
- As far as car applications, a spike protection diode must be inserted close to the power input, in order to clean the supply from spikes.
- A protection diode can be inserted close to the power input, in order to save the GE864-QUAD ATEX from power polarity inversion. This can be the same diode used for spike protection.

An example of switching regulator with 12V input is in the schematic below (split in 2 parts):



SWITCHING REGULATOR

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6.3.1.3. 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 GE864-QUAD ATEX 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 GE864-QUAD ATEX and damage it.

WARNING:
DON'T USE any Ni-Cd, Ni-MH, and Pb battery types directly connected with GE864-QUAD ATEX. Their use can lead to overvoltage on the GE864-QUAD ATEX 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 GE864-QUAD ATEX 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.

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6.3.2. Thermal Design Guidelines

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

- Average current consumption during transmission @PWR level max: 500mA
- Average current consumption during transmission @ PWR level min: 100mA
- Average current during Power Saving (CFUN=5): from 1.5 to 3.9mA
- Average current during idle (Power Saving disabled): 16mA

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.

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 us say few minutes) and then remains for a quite long time in idle (let us 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, hence the current consumption will be less than 500mA, 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 grants a good thermal condition to avoid overheating as well.

As far as the heat generated by the GE864-QUAD ATEX , you can consider it to be during transmissions of 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 GE864-QUAD ATEX ; you must ensure that your application can dissipate it.

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6.3.3. 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 GE864-QUAD ATEX 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 GE864-QUAD ATEX 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 does not have audio interface but only uses the data feature of the Telit GE864-QUAD ATEX then this noise is not so disturbing and power supply layout design can be more forgiving.
- The PCB traces to the GE864-QUAD ATEX 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 must 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.

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- The power supply input cables must be kept separate from noise sensitive lines such as microphone/earphone cables.

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7. Temperature Range

	GE864-QUAD Atex	Note
Operating Temperature Range	–20°C ÷ +55°C	The module is fully functional (*) in all the temperature range, and it fully meets the ETSI specifications.
	–40°C ÷ +80°C	The module is fully functional (*) in all the temperature range. Temperatures outside the range –20°C ÷ +55°C, might slightly deviate from ETSI specifications.
Storage and Non-Operating Temperature Range	–40°C ÷ +90°C	

(*) Functional: the module is able to make and receive voice calls, data calls, SMS and make GPRS traffic.

Note: GE864-QUAD ATEX is certified as T4 device for Tamb<40°C and T5 for Tamb>40°C.

7.1. ATEX temperature classification

With the supply power compliant to §6, the GE864-QUAD ATEX is classified as ATEX component in the following class:

Ambient Temperature	GE864 QUAD ATEX's Temperature Class
- 40°C ÷ + 40°C	T4
40°C ÷ + 80°C	T3

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8. 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.

8.1. GSM Antenna Requirements

As suggested on the Product Description the antenna for a Telit GE864-QUAD ATEX device shall fulfill the following requirements:

ANTENNA REQUIREMENTS	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth	70 MHz in GSM850, 80 MHz in GSM900, 170 MHz in DCS & 140 MHz PCS band
Gain	See safety recommendation chapter 17 and 8.1.1
Impedance	50 ohm
Input power	> 2 W peak power
VSWR absolute max	<= 10:1 (limit to avoid permanent damage)
VSWR recommended	<= 2:1 (limit to fulfil all regulatory requirements)

When using the Telit GE864-QUAD ATEX, since there's no antenna connector on the module, the antenna must be connected to the GE864-QUAD ATEX through the PCB with the antenna pad.

In the case that the antenna is not directly developed on the same PCB, hence directly connected at the antenna pad of the GE864-QUAD ATEX, then a PCB line is needed in order to connect with it or with its connector.

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This line of transmission shall fulfill the following requirements:

ANTENNA LINE ON PCB REQUIREMENTS	
Impedance	50 ohm
Max Attenuation	0,3 dB
No coupling with other signals allowed	
Cold End (Ground Plane) of antenna shall be equipotential to the GE864-QUAD ATEX ground pins	

Furthermore if the device is developed for the US market and/or Canada market, it shall comply with the FCC and/or IC approval requirements:

This device is to be used only for mobile and fixed application. The antenna(s) used for this transmitter 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. End-Users must be provided with transmitter operation conditions for satisfying RF exposure compliance. OEM integrators must ensure that the end user has no manual instructions to remove or install the GE864-QUAD ATEX module. Antennas used for this OEM module must not exceed 3dBi gain for mobile and fixed operating configurations.

8.1.1. Antenna limits in ATEX applications

For ATEX applications, the system antenna(s) used for this module must not exceed the limits reported in the following table, for mobile and fixed or mobile operating configurations:

Gas category	ATEX Power limit	Antenna gain @ 850/900 MHz	Antenna gain @ 1800/1900 MHz
IIA	6W	1.4 dBi	3 dBi
IIB	3.5W	1.4 dBi	3 dBi
IIC	2W	0 dBi	2 dBi

max Antenna gain allowed

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8.2. GSM Antenna - PCB line Guidelines

- Ensure that the antenna line impedance is 50 ohm;
- Keep the antenna line on the PCB as short as possible, since the antenna line loss shall be less than 0,3 dB;
- Antenna line must have uniform characteristics, constant cross section, avoid meanders and abrupt curves;
- Keep, if possible, one layer of the PCB used only for the Ground plane;
- Surround (on the sides, over and under) the antenna line on PCB with Ground, avoid having other signal tracks facing directly the antenna line track;
- The ground around the antenna line on PCB has to be strictly connected to the Ground Plane by placing vias once per 2mm at least;
- Place EM noisy devices as far as possible from GE864-QUAD ATEX antenna line;
- Keep the antenna line far away from the GE864-QUAD ATEX power supply lines;
- If you have EM noisy devices around the PCB hosting the GE864-QUAD ATEX, such as fast switching ICs, take care of the shielding of the antenna line by burying it inside the layers of PCB and surround it with Ground planes, or shield it with a metal frame cover.
- If you don't have EM noisy devices around the PCB of GE864-QUAD ATEX, by using a strip-line on the superficial copper layer for the antenna line, the line attenuation will be lower than a buried one;

8.3. GSM 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.

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9. Logic Level Specifications

Where not specifically stated, all the interface circuits work at 2.8V CMOS logic levels. The following table shows the logic level specifications used in the Telit GE864-QUAD ATEX interface circuits:

Absolute Maximum Ratings – Not Functional

Parameter	Min	Max
Input level on any digital pin when on	-0.3V	+3.1V
Input voltage on analog pins when on	-0.3V	+3.0 V

Operating Range – Interface Levels (2.8V CMOS)

Level	Min	Max
Input high level	2.1V	3.1V
Input low level	0V	0.5V
Output high level	2.2V	3.0V
Output low level	0V	0.35V

For 1,8V signals:

Operating Range – Interface Levels (1.8V CMOS)

Level	Min	Max
Input high level	1.6V	2.2V
Input low level	0V	0.4V
Output high level	1,65V	2.2V
Output low level	0V	0.35V

Current characteristics

Level	Typical
Output Current	1mA
Input Current	1uA

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9.1. Reset Signal

Signal	Function	I/O	Ball Number
RESET	Reset	I	A2

RESET is used to reset the GE864-QUAD ATEX modules. Whenever this signal is pulled low, the GE864-QUAD ATEX is reset. When the device is reset it stops any operation. After the release of the reset GE864-QUAD ATEX is unconditionally shut down, without doing any detach operation from the network where it is registered. This behavior is not a proper shut down because any GSM device is requested to issue a detach request on turn off. For this reason the Reset signal must not be used to normally shutting down the device, but only as an emergency exit in the rare case the device remains stuck waiting for some network response.

The RESET is internally controlled on start-up to achieve always a proper power-on reset sequence, so there is no need to control this pin on start-up. It may only be used to reset a device already on that is not responding to any command.

NOTE:

Do not use this signal to power off the GE864-QUAD ATEX . Use the ON/OFF signal to perform this function or the AT#SHDN command.

Reset Signal Operating Levels:

Signal	Min	Max
RESET Input high	2.0V*	2.2V
RESET Input low	0V	0.2V

* this signal is internally pulled up so the pin can be left floating if not used.

If unused, this signal may be left unconnected. If used, then it **must always be connected with an open collector transistor**, to permit to the internal circuitry the power on reset and under voltage lockout functions.

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10. Serial Ports

The serial port on the Telit GE864-QUAD ATEX is the core of the interface between the module and OEM hardware.

2 serial ports are available on the module:

- MODEM SERIAL PORT (Main, ASC0)
- MODEM SERIAL PORT 2 (Auxiliary, ASC1)

10.1. MODEM SERIAL PORT

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 does not need a level translation is the 2.8V UART.

The serial port on the GE864-QUAD ATEX 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 GE864-QUAD ATEX UART are the CMOS levels:

Absolute Maximum Ratings –Not Functional

Parameter	Min	Max
Input level on any digital pad when on	-0.3V	+3.1V
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	3.1V
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 table below shows the signals of the GE864-QUAD ATEX serial port:

RS232 Pin Number	Signal	GE864-QUAD ATEX Pad Number	Name	Usage
1	DCD – dcd_uart	D9	Data Carrier Detect	Output from the GE864-QUAD ATEX that indicates the carrier presence
2	RXD – tx_uart	H8	Transmit line *see Note	Output transmit line of GE864-QUAD ATEX UART
3	TXD – rx_uart	E7	Receive line *see Note	Input receive of the GE864-QUAD ATEX UART
4	DTR – dtr_uart	B7	Data Terminal Ready	Input to the GE864-QUAD ATEX that controls the DTE READY condition
5	GND	A1,F1, H1 L1, H2, L2, J3, K3….	Ground	ground
6	DSR – dsr_uart	E11	Data Set Ready	Output from the GE864-QUAD ATEX that indicates the module is ready
7	RTS –rts_uart	F7	Request to Send	Input to the GE864-QUAD ATEX that controls the Hardware flow control
8	CTS – cts_uart	F6	Clear to Send	Output from the GE864-QUAD ATEX that controls the Hardware flow control
9	RI – ri_uart	B6	Ring Indicator	Output from the GE864-QUAD ATEX that indicates the incoming call condition

NOTE:

According to V.24, RX/TX signal names are referred to the application side, therefore on the GE864-QUAD ATEX 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 GE864-QUAD ATEX 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.

NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the module when is powered OFF or during an ON/OFF transition.

10.2. RS232 Level Translation

In order to interface the Telit GE864-QUAD ATEX with a PC com port or a RS232 (EIA/TIA-232) application a level translator is required. This level translator must

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- 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 2.8V CMOS have an absolute maximum input voltage of 3.0V; therefore the level translator IC shall not be powered by the +3.8V supply of the module. Instead, it must be powered from a +2.7V / +2.9V (dedicated) power supply.

This is because in this way the level translator IC outputs on the module side (i.e. GE864 inputs) will work at +3.8V interface levels, damaging the module inputs.

NOTE:

In order to be able to do in circuit reprogramming of the GE864 firmware, the serial port on the Telit GE864 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 GE864.

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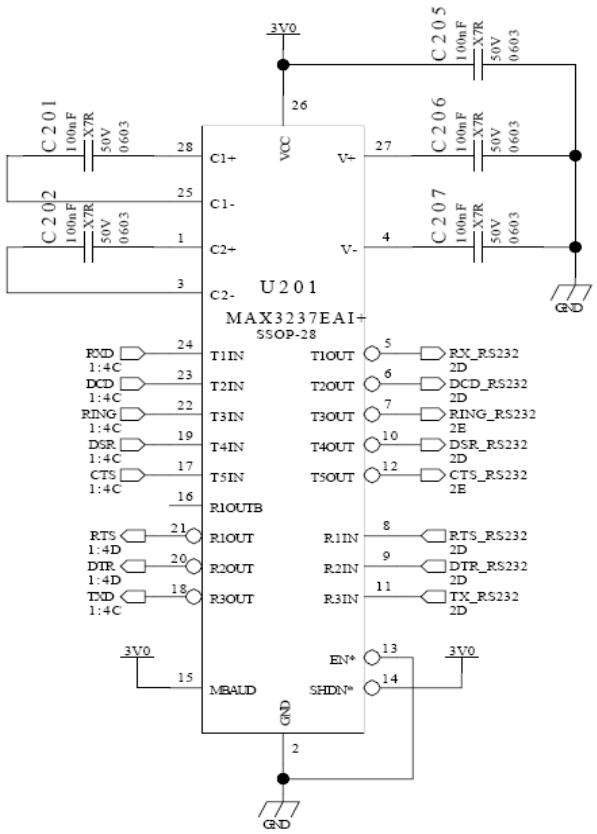
An example of level translation circuitry of this kind is:



RS232 LEVEL TRSANSLATOR

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

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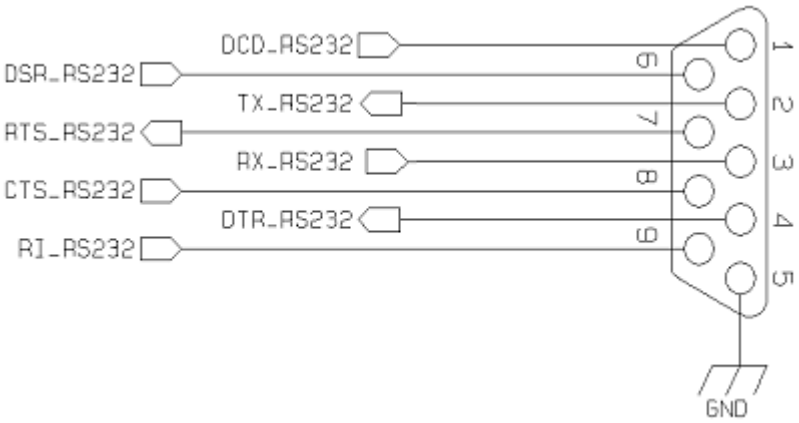

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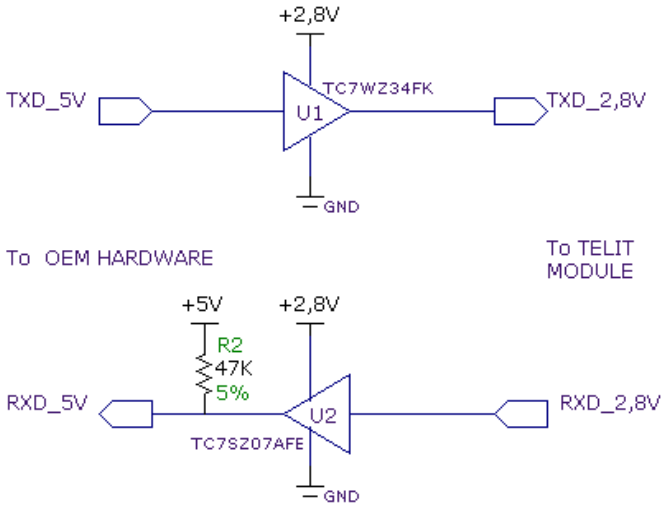
10.3. 5V UART Level Translation

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 set of signals. As for the RS232 translation there are a multitude of single chip translators. For example a possible translator circuit for a 5V TRANSMITTER/RECEIVER can be:



TIP:

Note that the TC7SZ07AE has open drain output; therefore the resistor R2 is mandatory.

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NOTE:

The UART input line TXD (rx_uart) of the GE864-QUAD ATEX 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.

Care must be taken to avoid latch-up on the GE864-QUAD ATEX and the use of this output line to power electronic devices shall be avoided, especially for devices that generate spikes and noise such as switching level translators, micro controllers, failure in any of these condition can severely compromise the GE864-QUAD ATEX functionality.

NOTE:

In case of reprogramming of the module has to be considered the use of the RESET line to start correctly the activity.

The preferable configuration is having an external supply for the buffer level translator.

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11. Audio Section Overview

The first Baseband chip was developed for the cellular phones, which needed two separated amplifiers both in RX and in TX section.

A couple of amplifiers had to be used with internal audio transducers while the other couple of amplifiers had to be used with external audio transducers.

To distinguish the schematic signals and the Software identifiers, two different definitions were introduced, with the following meaning:

- internal audio transducers → *HS/MT* (from *HandSet* or *MicroTelephone*)
- external audio transducers → *HF* (from HandsFree)

Actually the acronyms have not the original importance.

In other words this distinction is not necessary, being the performances between the two blocks like the same.

Only if the customer needs higher output power to drive the speaker, he needs to adopt the Aduio2 Section (*HF*) . Otherwise the choice could be done in order to overcome the PCB design difficulties.

For these reasons we have not changed the *HS* and *HF* acronyms, keeping them in the Software and on the schematics.

The Base Band Chip of the GE864-QUAD ATEX Telit Modules maintains the same architecture.

For more information and suggestions refer to Telit document:

- Audio settings application note , 80000NT10007a

11.1. Selection mode

Only one block can be active at a time, and the activation of the requested audio path is done via hardware, by *AXE* line, or via software ,by *AT#CAP* command .

Moreover the *Sidetone* functionality could be implemented by the amplifier fitted between the transmit path and the receive path, enabled at request in both modes.

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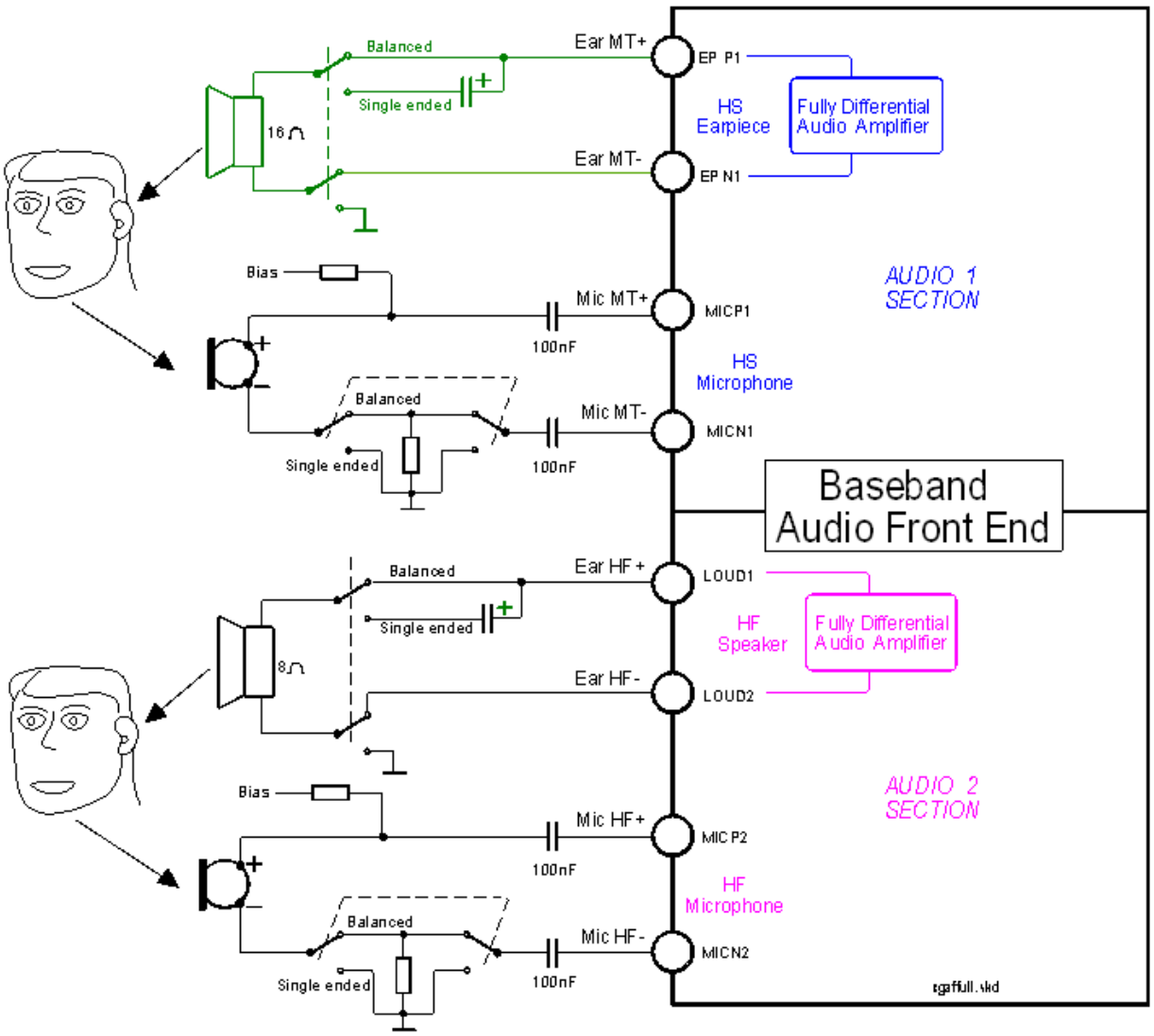

GE864 QUAD ATEX Audio front end

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11.2. Electrical Characteristics

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 must be balanced designed to reduce the common mode noise typically generated on the ground plane. However the customer can use the unbalanced circuitry for its particular application.

11.2.1. Input Lines Characteristics

"MIC_MT" and "MIC_HF" differential microphone paths	
Line Coupling	AC*
Line Type	Balanced
Differential input voltage	≤ 1,03V_{pp} @ *Mic G=0dB*
Gain steps	7
Gain increment	6dB per step
Coupling capacitor	≥ 100nF
Differential input resistance	50KΩ
Input capacitance	• 10pF

(*) WARNING : AC means that the signals from the microphone have to be connected to input lines of the module through capacitors which value has to be ≥ 100nF. Not respecting this constraint, the input stages will be damaged.

WARNING: when particular OEM application needs a *Single Ended Input* configuration, it is forbidden connecting the unused input directly to Ground, but only through a 100nF capacitor. Don't forget that the useful input signal will be halved in *Single Ended Input* configuration.

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11.2.2. Output Lines Characteristics

TIP:

We suggest driving the load differentially from both output drivers, thus the output swing will double and the need for the output coupling capacitor avoided. However if particular OEM application needs also a *Single Ended circuitry* can be implemented, but the output power will be reduced four times.

The OEM circuitry shall be designed to reduce the common mode noise typically generated on the ground plane and to get the maximum power output from the device (low resistance tracks).

WARNING:

The loads are directly connected to the amplifier outputs when in *Differential* configuration, through a capacitor when in *Single Ended* configuration.
Using a *Single Ended configuration*, the unused output line must be left open .
Not respecting this constraint, the output stage will be damaged.

TIP :
Remember that there are slightly different electrical performances between the two internal audio amplifiers:

- the *"Ear_MT"* lines can directly drive a ***16Ω load*** at –12dBFS **(**)** in *Differential* configuration
- the *"Ear_HF"* lines can directly drive a ***4Ω load*** in *Differential* configurations
- There is no difference if the amplifiers drive an external amplifier

(**) *0dBFS* is the normalized overall Analog Gain for each Output channel equal to $3,7V_{pp}$ differential

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"EAR_MT" Output Lines	
line coupling	AC single-ended DC differential
0dBFS normalized gain	3,7 V_{pp} differential
output load resistance	≥ 16 Ω *@ -12dBFS*
internal output resistance	4Ω (*typical*)
signal bandwidth	150 - 4000 Hz @ -3 dB
maximal full scale differential output voltage	3,7 V_{pp} *(typical)* Rload=*open circuit*
differential output voltage	925mV_{pp} / Rload=16Ω *@ -12dBFS*
volume increment	2 dB per step
volume steps	10

"EAR_HF" Output Lines	
line coupling	AC single-ended DC differential
output load resistance	≥ 8 Ω
signal bandwidth	150 - 4000 Hz @ -3 dB
maximal output power @ battery voltage ≥ 3,6V	0.35 W_{rms} /8 Ω
volume increment	2 dB per step
volume steps	10

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12. 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 GE864-QUAD ATEX firmware and acts depending on the function implemented.

The following GPIO are available on the GE864-QUAD ATEX :

Ball	Signal	I/O	Function	Type	Input / output current	Default State	ON_OFF state	During Reset state	Note
B3	GPIO_04	I/O	GPIO04 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (RF Transmission Control)
B5	GPIO_06	I/O	GPIO06 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (ALARM)
E6	GPIO_01	I/O	GPIO01 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (JDR)
H3	GPIO_08	I/O	GPIO08 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function DVI_TX
H5	GPIO_02	I/O	GPIO02 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function DVI_WAO
K7	GPIO_03	I/O	GPIO03 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function DVI_RX
K8	GPIO_05	I/O	GPIO05 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (RFTXMON)
L9	GPIO_07	I/O	GPIO07 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (BUZZER)
D7	GPIO_09	I/O	GPIO09 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (DVI_CLK)

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Not all GPIO pads support all these three modes:

- GPIO1 supports all three modes and can be input, output, Jamming Detect Output (Alternate function)
- GPIO4 supports all three modes and can be input, output, RF Transmission Control (Alternate function)
- GPIO5 supports all three modes and can be input, output, RFTX monitor output (Alternate function)
- GPIO6 supports all three modes and can be input, output, alarm output (Alternate function)
- GPIO7 supports all three modes and can be input, output, buzzer output (Alternate function)

12.1. GPIO Logic Levels

Where not specifically stated, all the interface circuits work at 2.8V CMOS logic levels.

The following tables show the logic level specifications used in the GE864-QUAD ATEX interface circuits:

Absolute Maximum Ratings –Not Functional

Parameter	Min	Max
Input level on any digital pin when on	-0.3V	+3.1V
Input voltage on analog pins when on	-0.3V	+3.0 V

Operating Range – Interface Levels (2.8V CMOS)

Level	Min	Max
Input high level	2.1V	3.1V
Input low level	0V	0.5V
Output high level	2.2V	3.0V
Output low level	0V	0.35V

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12.2. Using a GPIO Pad as INPUT

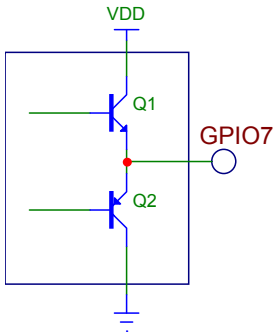
The GPIO pads, when used as inputs, can be connected to a digital output of another device and report its status, provided this device has interface levels compatible with the 2.8V CMOS levels of the GPIO.

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 buffered with an open collector transistor with a 47K pull up to 2.8V, this pull up must be switched off when the module is in off condition.

12.3. 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.

The illustration below shows the base circuit of a push-pull stage:



12.4. Using the RF Transmission Control GPIO4

The GPIO4 pin, when configured as RF Transmission Control Input, permits to disable the Transmitter when the GPIO is set to Low by the application.

In the design is necessary to add a resistor 47K pull up to 2.8V, this pull up must be switched off when the module is in off condition.

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12.5. Using the RFTXMON Output GPIO5

The GPIO5 pin, when configured as RFTXMON Output, is controlled by the GE864-QUAD ATEX module and will rise when the transmitter is active and fall after the transmitter activity is completed.

There are 2 different modes for this function:
1) Active during all the calls:
For example, if a call is started, the line will be HIGH during all the conversation and it will be again LOW after hanged up.
The line rises up 300ms before first TX burst and will became again LOW from 500ms to 1s after last TX burst.

2) Active during all the TX activity:
The GPIO is following the TX bursts

Please refer to the AT User interface manual for additional information on how to enable this function.

12.6. Using the Alarm Output GPIO6

The GPIO6 pad, when configured as Alarm Output, is controlled by the 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 module controlling micro controller 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 module during sleep periods, dramatically reducing the sleep consumption to few µA.

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

NOTE:

During RESET the line is set to HIGH logic level.

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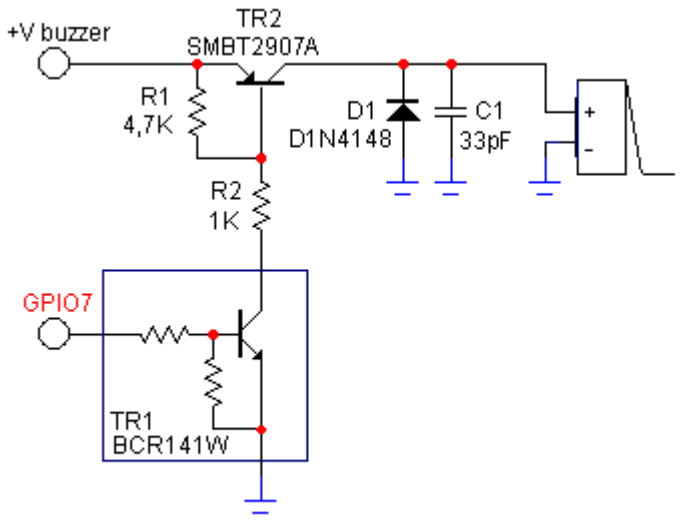
12.7. Using the Buzzer Output GPIO7

The GPIO7 pad, when configured as Buzzer Output, is controlled by the GE864-QUAD ATEX 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 GPIO7:



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.

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12.8. Using the Temperature Monitor Function

12.8.1. Short Description

The Temperature Monitor is a function of the module that permits to control its internal temperature and if properly set (see the #TEMPMON command on AT Interface guide) it raise to High Logic level a GPIO when the maximum temperature is reached.

12.8.2. Allowed GPIO

The AT#TEMPMON set command could be used with one of the following GPIO:

Ball	Signal	I/O	Function	Type	Input / output current	Default state	ON_OFF state	During Reset state	Note
C1	TGPIO_01	I/O	GPIO01 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	
E6	TGPIO_02 / JDR	I/O	GPIO02 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (JDR)
C2	TGPIO_03	I/O	GPIO03 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	
B3	TGPIO_04 / TXCNTRL	I/O	GPIO04 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (RF Transmission Control)
K8	TGPIO_05 / RFTXMON	I/O	GPIO05 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (RFTXMON)
B5	TGPIO_06 / ALARM	I/O	GPIO06 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (ALARM)
L9	TGPIO_07 / BUZZER	I/O	GPIO07 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (BUZZER)
K11	TGPIO_08	I/O	GPIO08 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	
C9	TGPIO_09	I/O	GPIO09 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	
H3	TGPIO_10 / DVI_TX	I/O	GPIO10 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	0	0	Alternate function (DVI_TX)

NOTE:
If the set command is enable the alternate function is not usable.

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12.9. Indication of Network Service Availability

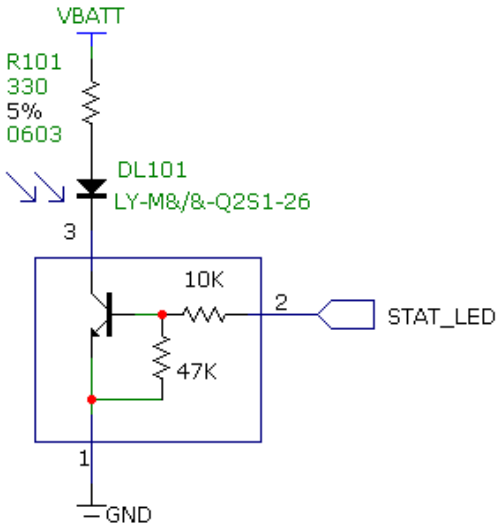
The STAT_LED pin status shows information on the network service availability and Call status.

In the GE864-QUAD ATEX modules, the STAT_LED usually needs an external transistor to drive an external LED.

Therefore, the status indicated in the following table is reversed with respect to the pin status.

LED status	Device Status
Permanently off	Device off
Fast blinking (Period 1s, Ton 0,5s)	Net search / Not registered / turning off
Slow blinking (Period 3s, Ton 0,3s)	Registered full service
Permanently on	a call is active

A schematic example could be:



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12.10. RTC Bypass Out

The VRTC pin brings out the Real Time Clock supply, which is separate from the rest of the digital part, allowing having only RTC going on when all the other parts of the device are off.

To this power output a backup capacitor can be added in order to increase the RTC autonomy during power off of the battery. NO Devices must be powered from this pin.

12.11. External SIM Holder Implementation

Please refer to the related User Guide (SIM Holder Design Guides, 80000NT10001a).

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13. DAC and ADC Converter

13.1. DAC Converter

13.1.1. Description

Ball	Signal	I/O	Function	Internal Pull up	Type
DAC Converter					
C7	DAC_OUT	AO	Digital/Analog converter output		D/A

The GE864-QUAD ATEX module provides one Digital to Analog Converter.

The on board DAC is a 10-bit converter, able to generate a analogue value based a specific input in the range from 0 up to 1023. However, an external low-pass filter is necessary.

	Min	Max	Units
Voltage range (filtered)	0	2,6	Volt
Range	0	1023	Steps

The precision is 10 bits, so if we consider that the maximum voltage is 2V, the integrated voltage could be calculated with the following formula:

Integrated output voltage = 2 * value / 1023

DAC_OUT line must be integrated (for example with a low band pass filter) in order to obtain an analog voltage.

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13.1.2. Enabling DAC

The AT command below is available to use the DAC function:

AT#DAC[=<enable>[,<value>]]

<value> – scale factor of the integrated output voltage (0–1023, with 10 bit precision), and it must be present if **<enable>=1**.

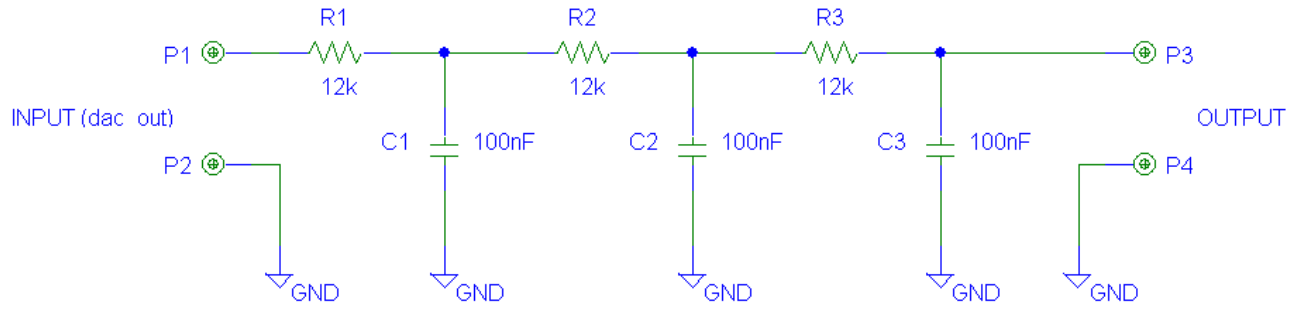
Refer to SW User Guide or AT Commands Reference Guide for the full description of this function.

Refer to SW User Guide or AT Commands Reference Guide for the full description of this function.

NOTE:

The DAC frequency is selected internally. D/A converter must not be used during POWERSAVING.

13.1.3. Low Pass Filter Example



13.2. ADC Converter

13.2.1. Description

Ball	Signal	I/O	Function	Internal Pull up	Type
ADC Converters					
J11	ADC_IN1	AI	Analog/Digital converter input		A/D
H11	ADC_IN2	AI	Analog/Digital converter input		A/D

The GE864-QUAD ATEX module provides three Analog to Digital Converter.

The on board A/Ds are 11-bit converter. They are able to read a voltage level in the range of 0÷2 volts applied on the ADC pin input, store and convert it into 11 bit word.

	Min	Max	Units
Input Voltage range	0	2	Volt
AD conversion	-	11	bits
Resolution	-	< 1	mV

13.2.2. Using ADC Converter

The AT command below is available to use the ADC function:

AT#ADC=1,2

The read value is expressed in mV.

Refer to SW User Guide or AT Commands Reference Guide for the full description of this function.

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13.3. Debug of the GE864-QUAD ATEX in Production

To test and debug the mounting of the GE864-QUAD ATEX, we strongly recommend to foreseen test pads on the host PCB, in order to check the connection between the GE864-QUAD ATEX itself and the application and to test the performance of the module connecting it with an external computer. Depending by the customer application, these pads include, but are not limited to the following signals:

Ball	Signal	Function
J1, J2, K1, K2	VBATT	Main power supply
A1, A11, D6, F1, F11, H1, H2, J3, K3, K4, K5, K6, L1, L2, L3, L6, L11	GND	Ground
E7	C103/TXD	Serial data input (TXD) from DTE
H8	C104/RXD	Serial data output (RXD) to DTE
L8	PRWMON	Power ON Monitor
J5	ON/OFF*	Input command for switching power ON or OFF (toggle command).
A2	RESET*	Reset input
F10	RX_AUX	Auxiliary UART (RX Data from DTE)
D11	TX_AUX	Auxiliary UART (TX Data to DTE)
H4	SERVICE	Service pin shall be used to upgrade the module from ASC1 (RX_AUX, TX_AUX). The pin shall be tied low to enable the feature only in case of a SW Update activity. It is required, for debug purpose, to be connected to a test pad on the final application.

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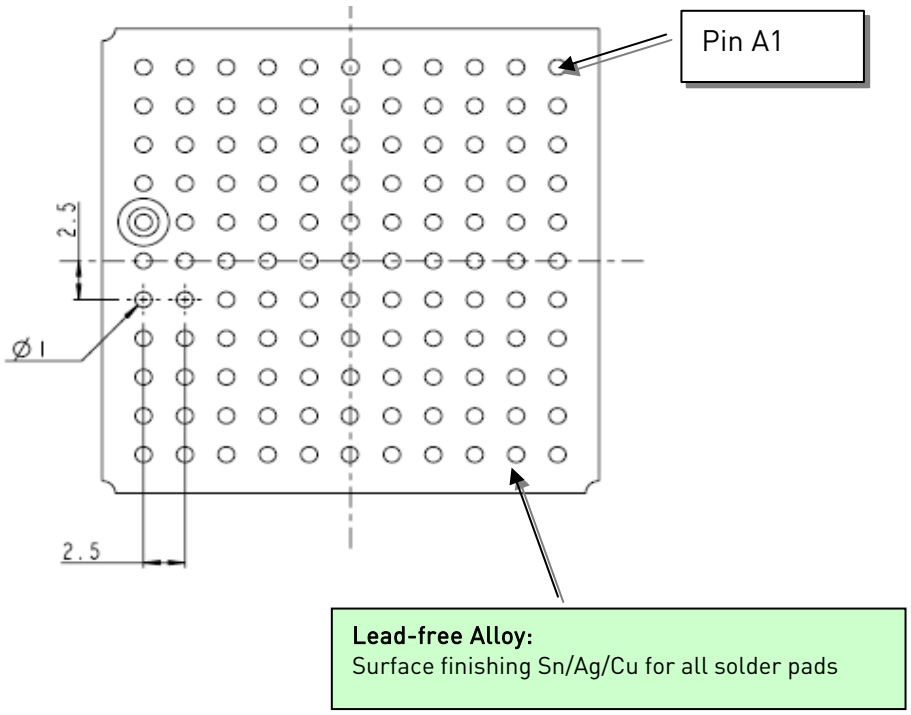
14. Assembly the GE864-QUAD ATEX on the Board

The Telit GE864-QUAD ATEX have been designed in order to be compliant with the standard lead-free SMT process.



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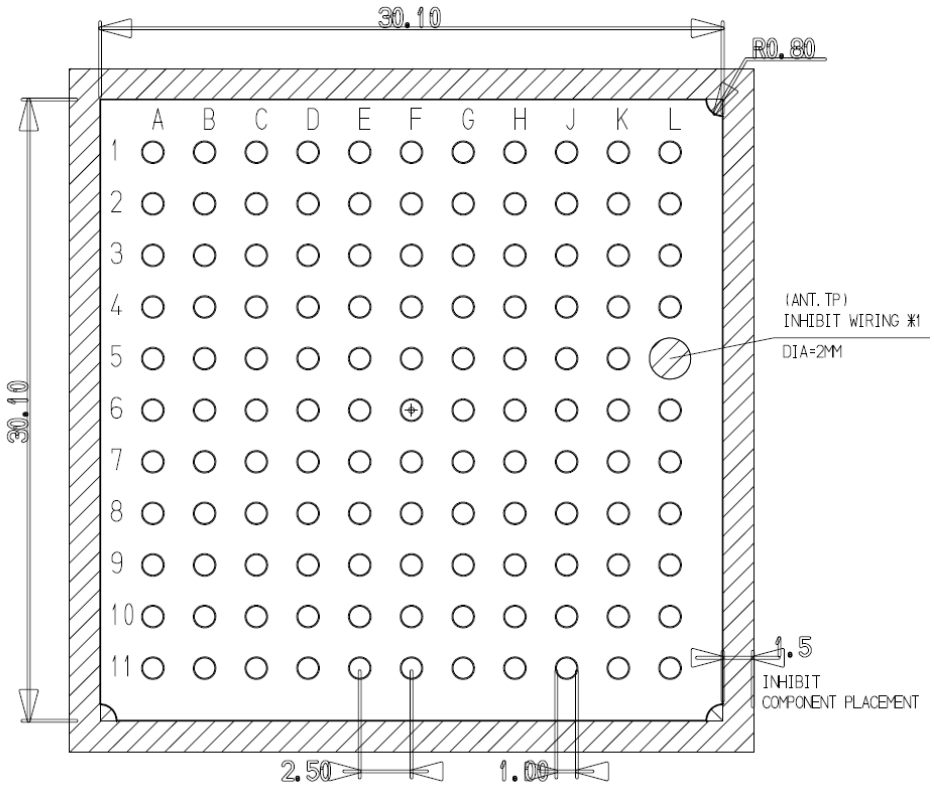
14.1. Recommended foot print for the application



In order to easily rework the GE864-QUAD ATEX module is suggested to consider on the application a 1.5mm inhibit area around the module.

It is also suggested, as common rule for a SMT component, to avoid having a mechanical part of the application in direct contact with the module.

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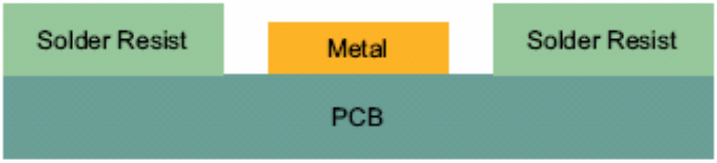
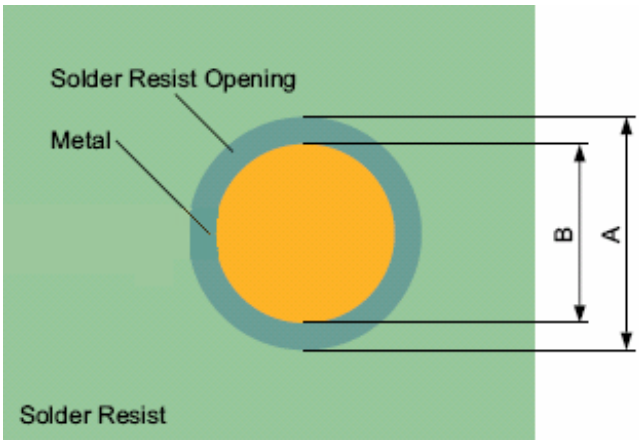
14.2. Stencil

Stencil apertures layout can be the same of the recommended footprint (1:1), we suggest a thickness of stencil foil >120µm.

14.3. PCB pad design

Non solder mask defined" (NSMD) type is recommended for the solder pads on the PCB.





Recommendations for PCB pad dimensions

Ball pitch [mm]	2,4
Solder resist opening diameter A [mm]	1,150
Metal pad diameter B [mm]	1 ± 0.05

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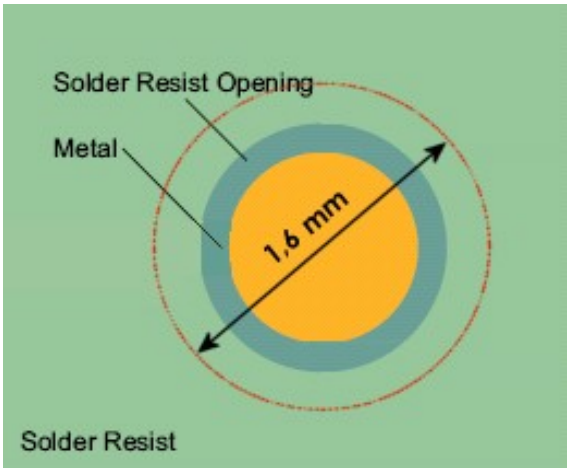
It is recommended no microvia without solder resist cover under the module and no microvia around the pads (see following figure).



Holes in pad are allowed only for blind holes and not for through holes.

Recommendations for PCB pad surfaces:

Finish	Layer thickness [µm]	Properties
Electro-less Ni / Immersion Au	3 –7 / 0.05 – 0.15	good solder ability protection, high shear force values

The PCB must be able to resist the higher temperatures which are occurring at the lead-free process. This issue should be discussed with the PCB-supplier. Generally, the wettability of tin-lead solder paste on the described surface plating is better compared to lead-free solder paste.

14.4. Solder paste

	Lead free
Solder paste	Sn/Ag/Cu

It is recommended to use only "no clean" solder paste in order to avoid the cleaning of the modules after assembly.

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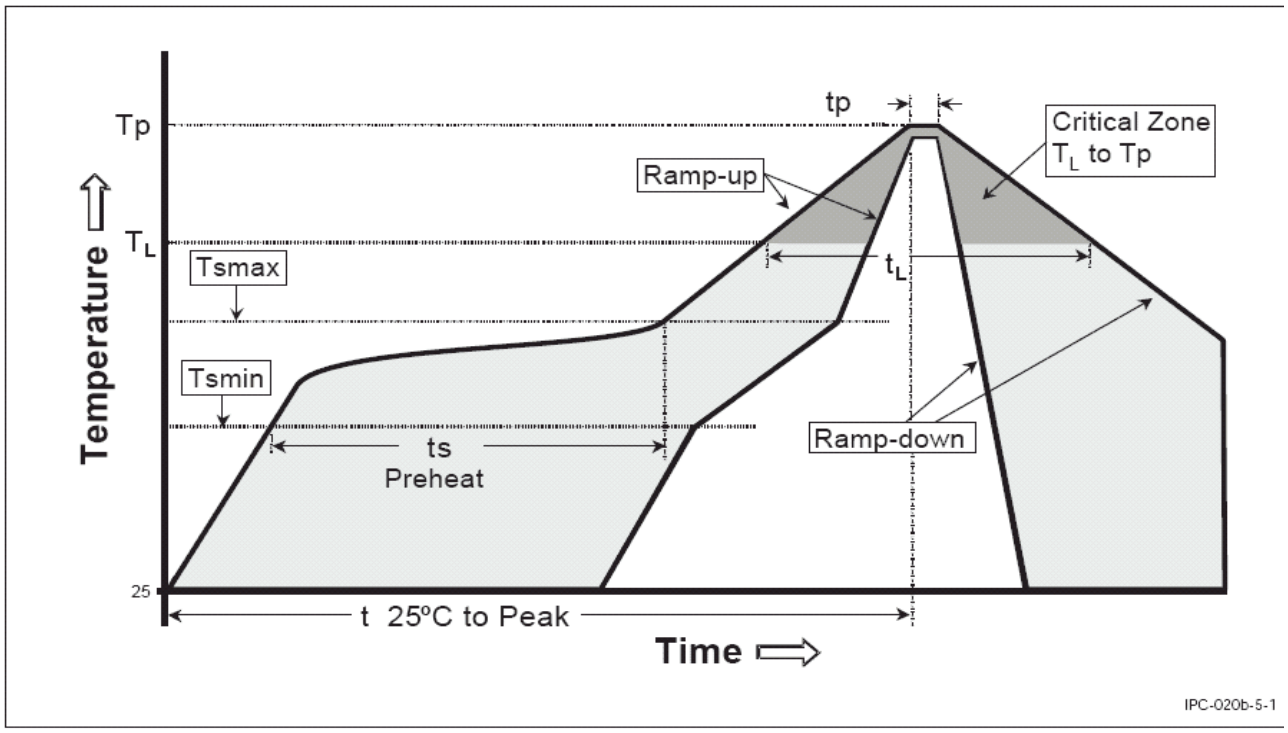
14.4.1. GE865 Solder reflow



The following is the recommended solder reflow profile

Profile Feature	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max
Preheat – Temperature Min (Tsmin) – Temperature Max (Tsmax) – Time (min to max) (ts)	 150°C 200°C 60-180 seconds
Tsmax to TL – Ramp-up Rate	 3°C/second max
Time maintained above: – Temperature (TL) – Time (tL)	 217°C 60-150 seconds
Peak Temperature (Tp)	245 +0/-5°C
Time within 5°C of actual Peak Temperature (tp)	10-30 seconds
Ramp-down Rate	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

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NOTE:

All temperatures refer to topside of the package, measured on the package body surface

WARNING:

The GE865 module withstands one reflow process only.

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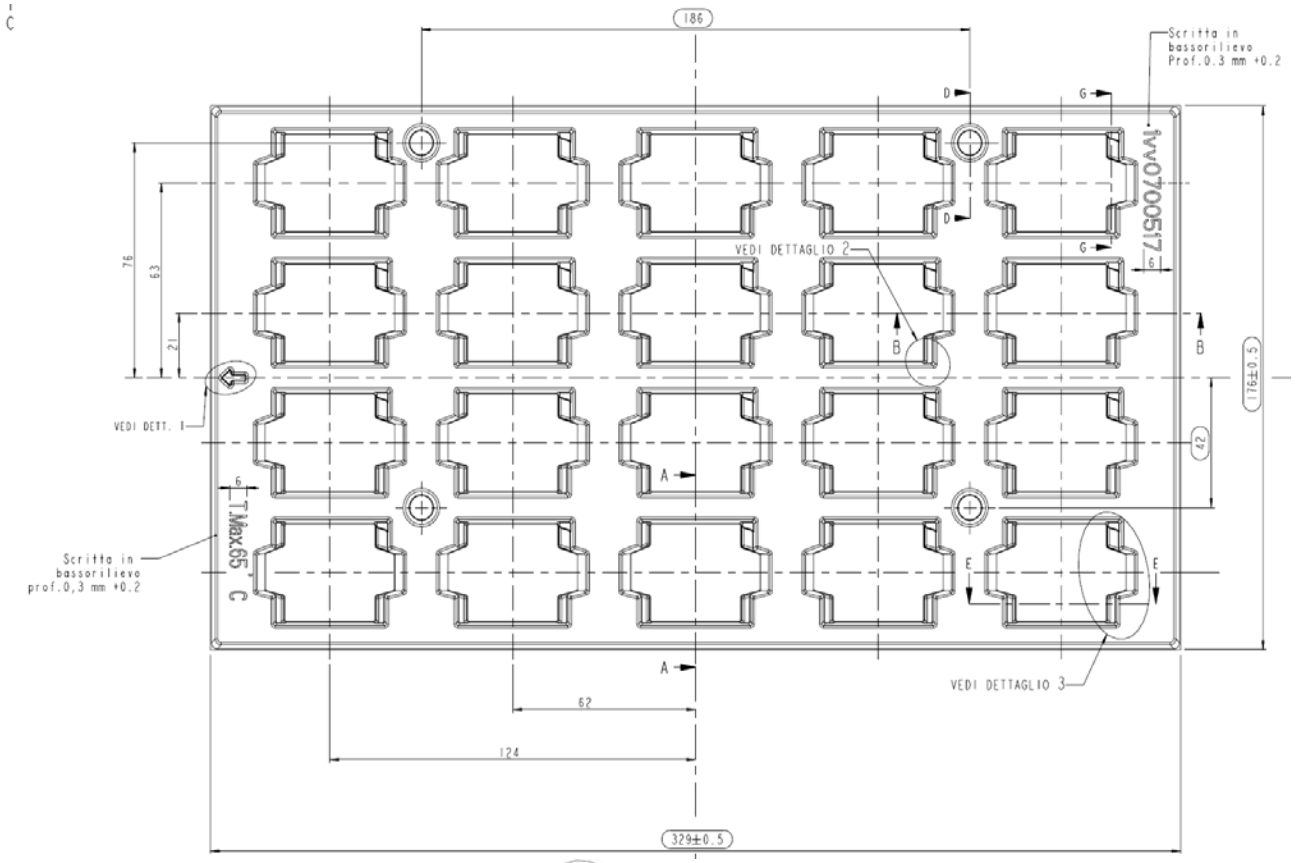
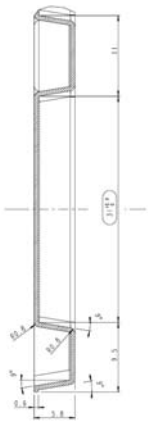
15. Packing system

The GE864-QUAD ATEX are packaged on trays of 20 pieces each. This is especially suitable for the GE864-QUAD ATEX according to SMT processes for pick & place movement requirements.



Section A-A



The size of the tray is: 329 x 176mm.

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WARNING:

These trays can withstand at the maximum temperature of 65° C.

NOTE:

All temperatures refer to topside of the package, measured on the package body surface

15.1. Moisture sensibility

The level of moisture sensibility of GE864-QUAD ATEX is "3", in according with standard IPC/JEDEC J-STD-020, take care all the relatives requirements for using this kind of components.

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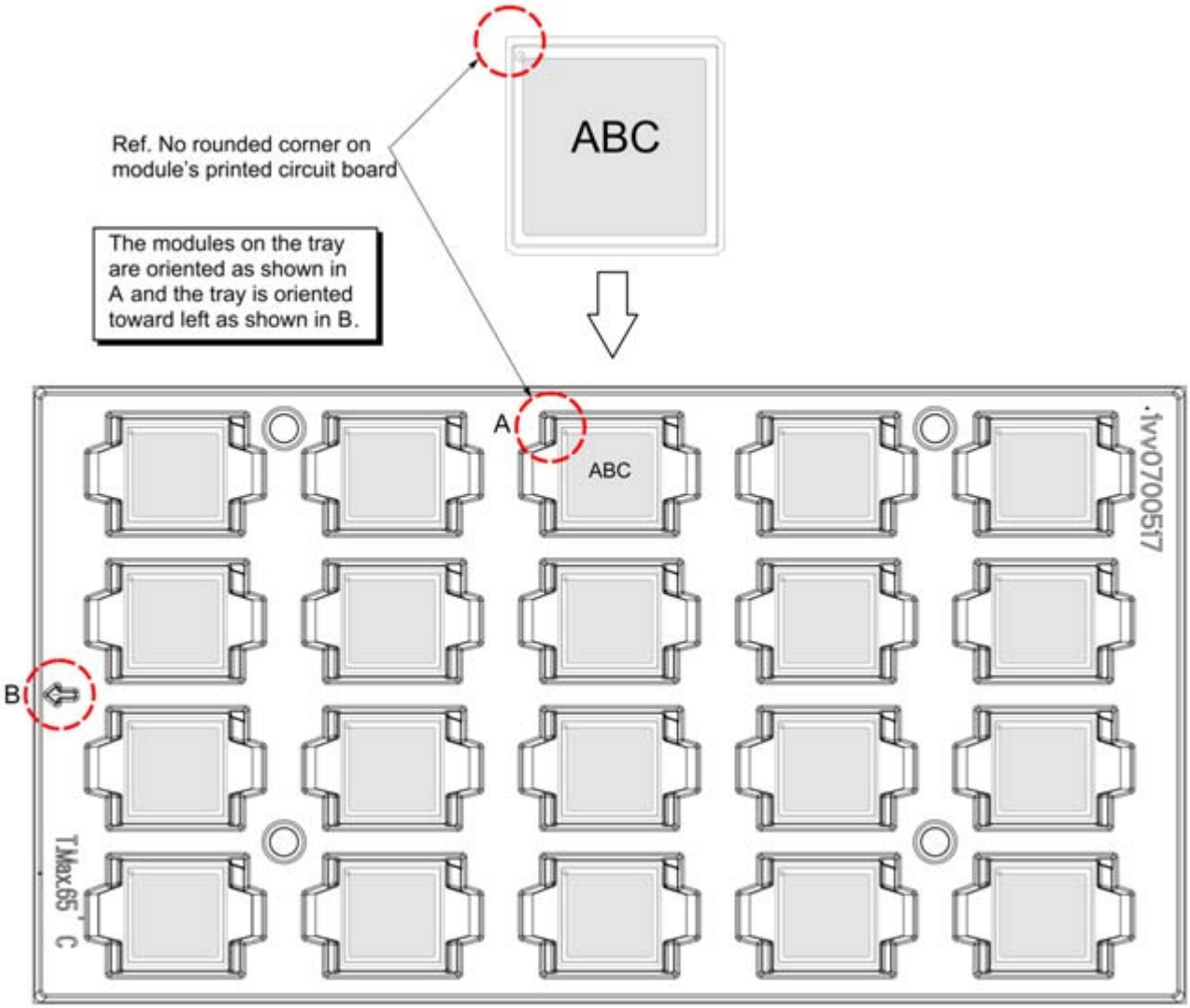
15.2. GE864 orientation on the tray



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16. Conformity Assessment Issues

The GE864-QUAD ATEX 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 GE864-QUAD ATEX module is conforming 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 GE864-QUAD ATEX 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.

. Furthermore The Telit GE864-QUAD Atex is assessed to be conform to the ATEX Directive

Telit GE864-QUAD Atex is conforming to the following European Union Directives:

- ATEX Directive 1994/9/EC (Explosive Atmospheres)

In order to satisfy the essential requisite of the ATEX 94/9/EC directive,

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the GE864-QUAD Atex module is compliant with the following standards:

-
- IEC EN 60079-0 (electrical apparatus for explosive gas atmospheres – general requirements)
- IEC EN 60079-11 (explosive atmospheres: Equipment protection by intrinsic safety "I")
- IEC EN 60079-26 (explosive atmospheres: Equipment with equipment protection level (EPL) Ga

All certifications are available in GE864-QUAD ATEX Product Description.

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17. SAFETY RECOMMENDATIONS

NOTE:

Read this section carefully to ensure the safe operation.

These safety instructions contain data and information related to the protection to be adopted for the installation of GE864-QUAD ATEX in hazardous areas classified according to the European standard EN 60079-10.

The essential safety requirements against the risk of explosion in classified areas are given in the European directives 94/9/CE dated 23 March 1994 (related to equipments) and 1999/92/CE dated 16 December 1999 (related to user plants).

ATTENTION !

Operations of assembling, installing, starting and servicing instruments in hazardous areas, can be executed only by qualified personnel specifically trained to perform these activities in areas with explosive gas atmospheres with reference to the safety standards

ATTENTION!

Deviation from installation procedures and conditions specified in this document and/or in the operator manual may invalidate the product's conformity with the 94/9/CE (ATEX) directive

Marking: the components GE864-QUAD ATEX have the following marking plates and have been certified to comply with Directive 94/9/EC.

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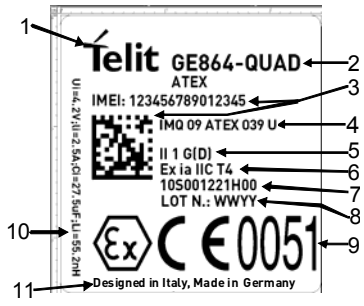
Following the type plates:



LAYOUT DESCRIPTION:
1) Telit Logo
2) Clear writing of device model name
3) Clear writing and Barcode type 2D datamatrix of IMEI number
4) Clear writing of indication IMQ 09 ATEX 39 U
5) Clear writing of indication II 1 G
6) Clear writing of indication Ex ia IIC T4
7) Clear writing of Software and Hardware release.
8) Clear writing of production lot WW=week YY=year.
9) Mark for protection from explosion, CE mark and Notify Body Number
10) Clear writing Ui=4.2V; Ii=2.5A;Ci=27.5uF;Li=55.2nH
11) Clear writing of Production Country

Limit conditions for safe use (U)

a) The component transmitters RF GE864-QUAD ATEX shall be mounted in other devices for the conformity of the product, which respect the intrinsically safe parameters shown in the label

b) The component transmitters RF GE864-QUAD ATEX, shall met to the instruments of communication with ATEX certification according the temperature class T4 minimum.

IMPORTANT NOTES !

The transmitters are certified for the use in areas with presence of gas or vapors group IIC (Hydrogen), therefore they are suitable also for the use in areas with presence of gas or vapors group IIB (Ethylene) and IIA (Propane).

The transmitters are certified for application with temperature class T4, therefore they are suitable also for higher temperature class T3, T4.

Mounting and Installation

Mounting and wiring operations in classified areas for explosive gas atmospheres, must be executed accordingly to the current procedures and to the national and international standards (e.g. EN 60079-14) only by qualified personnel specifically and completely trained.

For the handling, mounting and wiring refer to the operator manual instructions.

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Module power supply is depending on the Gas class of the final application

Max rates in IIC class

Supply power to the transmitter by means of an apparatus certified for the protection mode Ex ia IIC T4 according to the European standards EN 60079-0 and EN 60079-11 with the following limits:

Rated max. voltage Ui = 3.8 V;

Short circuit current Ii = 1.4 A;

Maximum RF output power = 2 W

Max rates in IIA and IIB class

Supply power to the transmitter by means of an apparatus certified for the protection mode Ex ia IIA/B T4 according to the European standards EN 60079-0 and EN 60079-11 with the following limits:

Max rates in IIA and IIB class

Rated max. voltage Ui = 4.2 V;

Short circuit current Ii = 2.5 A;

Maximum RF output power = 2 W

With the above Ui and Ii parameters, the component is suitable to be used in equipment with the following class:

Ambient Temperature	Temperature Class
- 40°C ÷ + 40°C	T4
40°C ÷ + 80°C	T3

Table 1

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Antenna

The system antenna 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 the limits reported in table 2 for mobile and fixed or mobile operating configurations.

Gas category	ATEX Power limit	850/900 MHz	1800/1900 MHz
IIA	6W	1.4 dBi	3 dBi
IIB	3.5W	1.4 dBi	3 dBi
IIC	2W	0 dBi	2 dBi

Table 2 – max Antenna gain allowed

- 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.

Repair, overhaul and reclaiming

Repairing of the intrinsic safety instruments have to be executed only by the manufacturer according EN 60079-19 standard and must be done complying all the safety parameters.

IMPORTANT NOTE !

In the event that, after the repairing, the safety parameters of the specific protection mode are not valid anymore, the identification label is removed and the transmitter can not be considered as a safety instrument.

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

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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 EN 50360.

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

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