

GE864-AUTO Hardware User Guide

1v0300779 Rev.0 - 20/06/08



1 Overview

The aim of this document is the description of some hardware solutions useful for developing a product with the [Telit GE864-AUTO 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 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-AUTO module](#).

For further hardware details that may not be explained in this document refer to the Telit GE864-AUTO Product Description document where all the hardware information is reported.

NOTICE

(EN) The integration of the GSM/GPRS GE864-AUTO 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 GE864-AUTO all'interno dell'applicazione dell'utente dovrà rispettare le indicazioni progettuali descritte in questo manuale.

(DE) Die integration des GE864-AUTO GSM/GPRS Mobilfunk-Moduls in ein Gerät muß gemäß der in diesem Dokument beschriebenen Konstruktionsregeln erfolgen

(SL) Integracija GSM/GPRS GE864-AUTO modula v uporabniški aplikaciji bo morala upoštevati projektna navodila, opisana v tem piročniku.

(SP) La utilización del modulo GSM/GPRS GE864-AUTO debe ser conforme a los usos para los cuales ha sido diseñado descritos en este manual del usuario.

(FR) L'intégration du module cellulaire GSM/GPRS GE864-AUTO dans l'application de l'utilisateur sera faite selon les règles de conception décrites dans ce manuel.

(HE) האינטגרציה של המודול הסלולרי GE864-AUTO עם המוצר. את ההנחיות המפורטות במסמך זה בתהליך האינטגרציה של המודם הסלולרי.

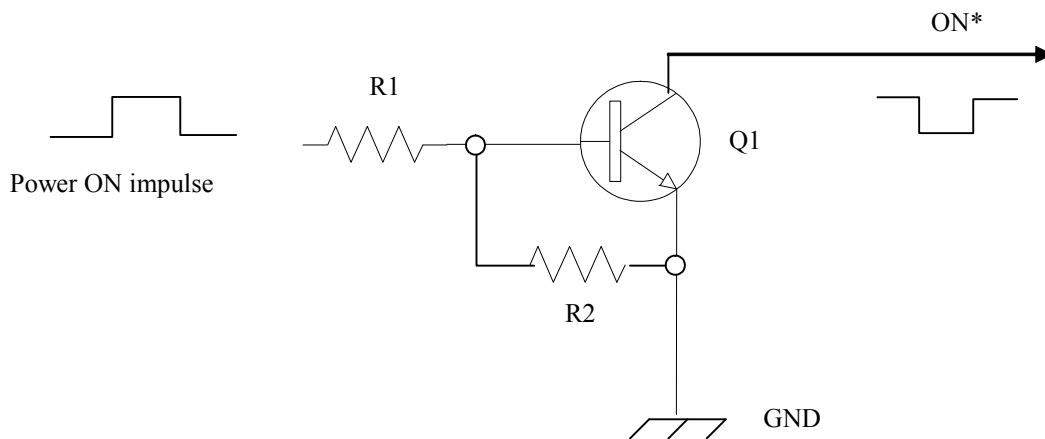
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4 Hardware Commands

4.1 Turning ON the GE864-AUTO module

To turn on the GE864-AUTO the pad ON* must be tied low for at least 1 seconds 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 GE864-AUTO 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 "*" .



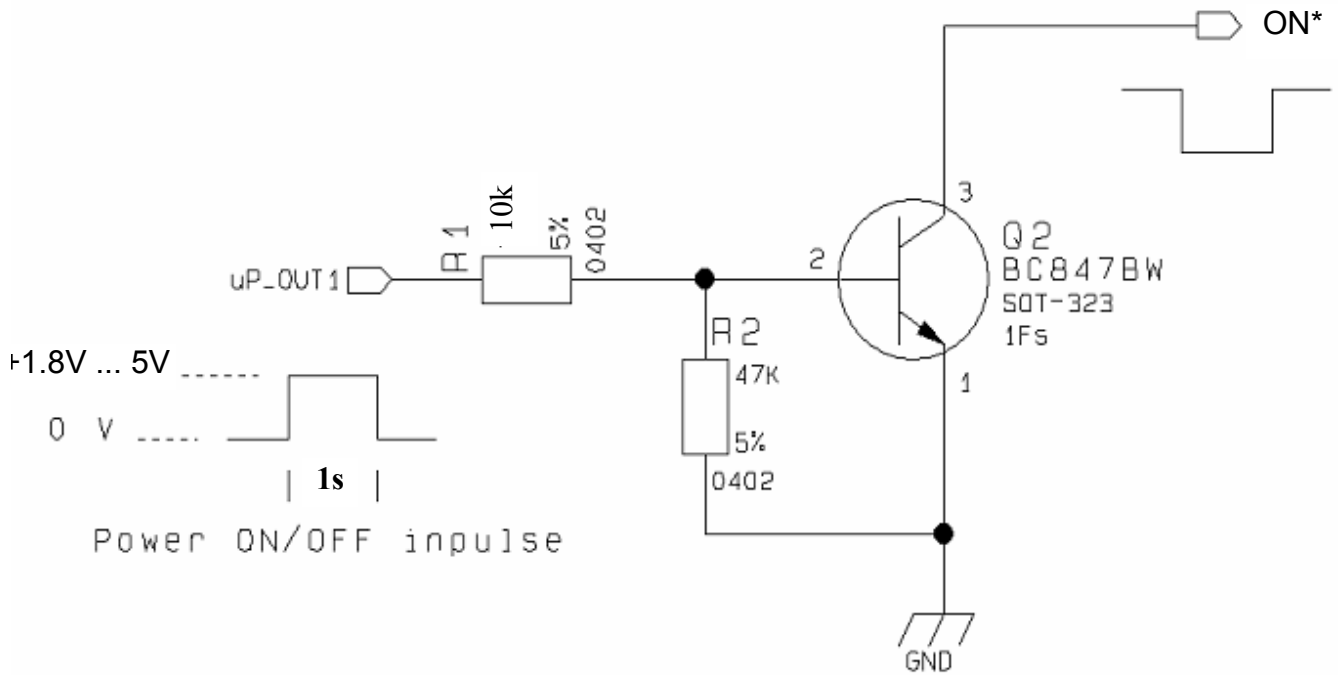
TIP: To check if the device has powered on, the hardware line PWRMON should be monitored. After 900ms the line raised up the device could be considered powered on.



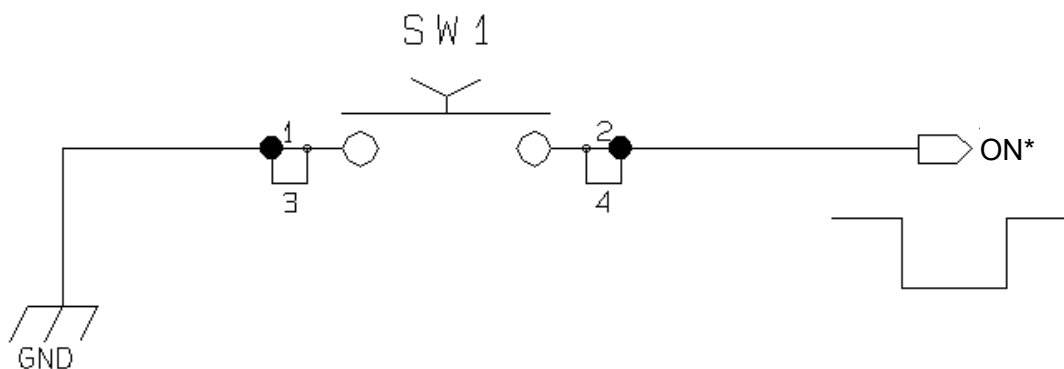
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For example:

1- Let's assume you need to drive the ON* pad with a totem pole output from +1.8V up to 5V microcontroller (uP_OUT1):



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



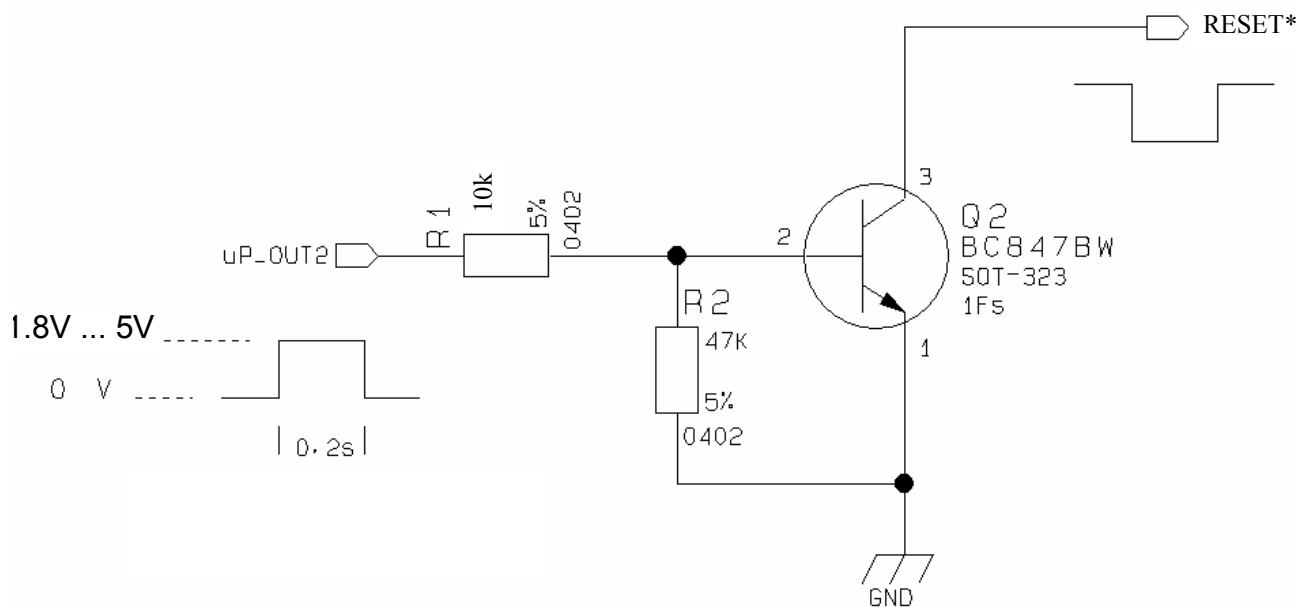
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NOTE: don't use any pull up resistor on the RESET* line nor any totem pole digital output. Using pull up resistor may bring to latch up problems on the GE864-AUTO power regulator and improper functioning of the module. The line RESET* must be connected only in open collector configuration.

TIP: The unconditional hardware Restart 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 from +1.8V up to +5V microcontroller (uP_OUT2):



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The GE864-AUTO power consumptions are:

GE864-AUTO		
Mode	Average (mA)	Mode description
IDLE mode		
		Stand by mode; no call in progress
AT+CFUN=1	23,9	Normal mode: full functionality of the module
AT+CFUN=4	22	Disabled TX and RX; module is not registered on the network
AT+CFUN=0 or AT+CFUN=5	7,20 / 3,56 ¹	Power saving: CFUN=0 module registered on the network and can receive voice call or an SMS; but it is not possible to send AT commands; module wakes up with an unsolicited code (call or SMS) or rising RTS line. CFUN=5 full functionality with power saving; module registered on the network can receive incoming calls and SMS
RX mode		
1 slot in downlink	52,3	GSM Receiving data mode
2 slot in downlink	65,2	
3 slot in downlink	78,6	
4 slot in downlink	88,4	
GSM TX and RX mode		
Min power level	78,1	GSM Sending data mode
Max power level	200,1	
GPRS (class 10) TX and RX mode		
Min power level	123,7	GPRS Sending data mode
Max power level	370,8	

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.

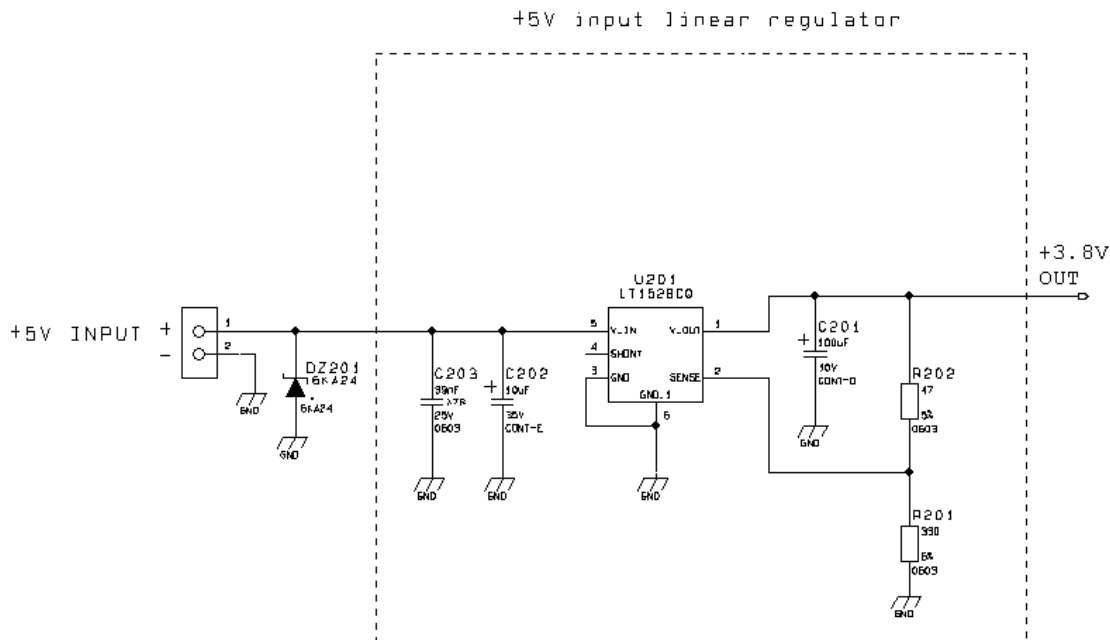


TIP: The electrical design for the Power supply should be made ensuring it will be capable of a peak current output of at least 2A.

¹ Worst/best case depends on network configuration and is not under module control



An example of linear regulator with 5V input is:



5.2.1.2 + 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 GE864-AUTO.
- 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 the switching frequency could also generate EMC interferences.
- 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 GE864-AUTO from power polarity inversion. This can be the same diode as for spike protection.



5.2.1.3 Battery Source Power Supply Design Guidelines

- The desired nominal output for the power supply is 3.8V and the maximum voltage allowed is 4.2V, hence a single 3.7V Li-Ion cell battery type is suited for supplying the power to the Telit GE864-AUTO 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-AUTO and damage it.



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



6.3 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.



8 Serial Ports

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

2 serial ports are available on the module:

- MODEM SERIAL PORT
- MODEM SERIAL PORT 2 (DEBUG)

8.1 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 doesn't need a level translation is the 2.8V UART.

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

Absolute Maximum Ratings -Not Functional

Parameter	Min	Max
Input level on any digital pad when on	-0.3V	+3.6V
Input voltage on analog pads when on	-0.3V	+3.0 V

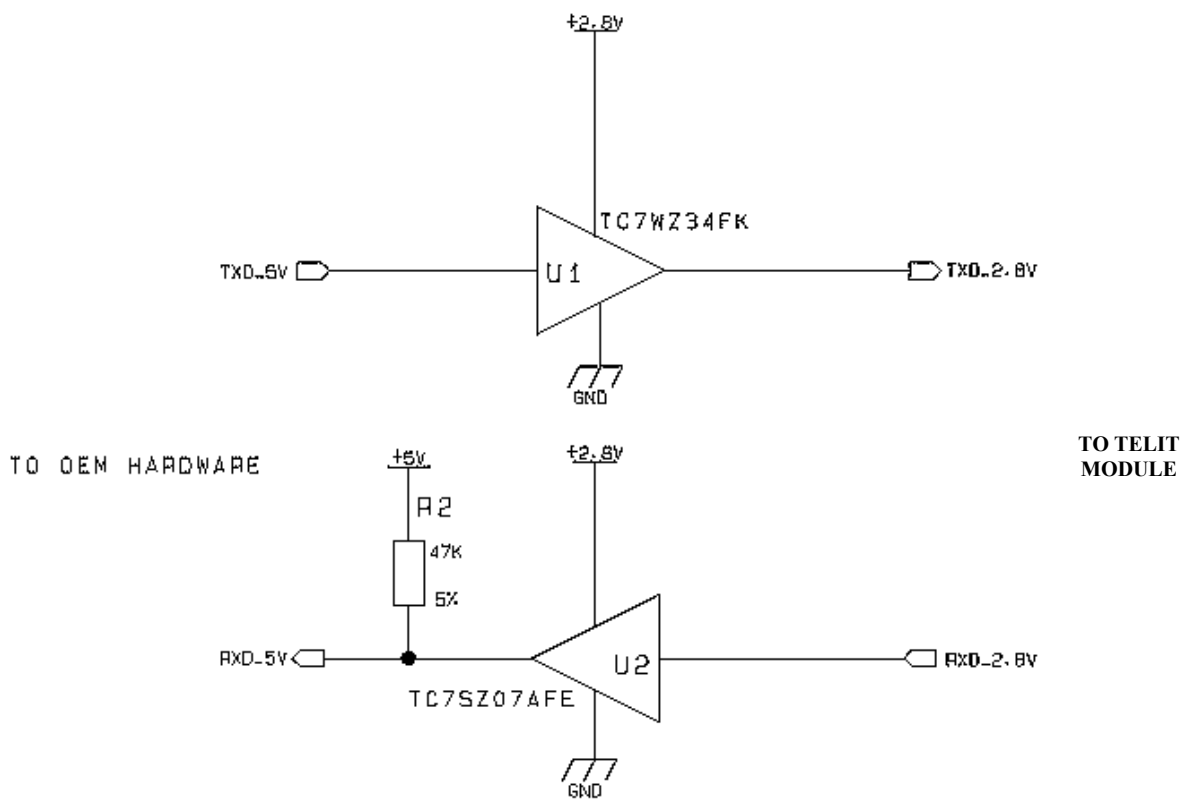
Operating Range - Interface levels (2.8V CMOS)

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



8.3 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: This logic IC for the level translator and 2.8V pull-ups (not the 5V one) can be powered directly from PWRMON line of the GE864-AUTO. Note that the TC7SZ07AE has open drain output, therefore the resistor R2 is mandatory.





NOTE: The UART input line TXD (*rx_uart*) of the GE864-AUTO is NOT internally pulled up with a resistor, so there may be the need to place an external 47K Ω 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 Ω may be required.

A power source of the internal interface voltage corresponding to the 2.8VCMOS high level is available at the PWRMON pin on the connector, whose absolute maximum output current is 1mA. A maximum of 9 resistors of 47 K Ω pull-up can be connected to the PWRMON pin, provided no other devices are connected to it and the pulled-up lines are GE864-AUTO input lines connected to open collector outputs in order to avoid latch-up problems on the GE864-AUTO.

Care must be taken to avoid latch-up on the GE864-AUTO 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-AUTO functionality.

NOTE: The input lines working at 2.8VCMOS can be pulled-up with 47K Ω resistors that can be connected directly to the PWRMON line provided they are connected as in this example.

NO OTHER devices than those suggested should be powered with the PWRMON line; otherwise the module functionality may be compromised.



It is important to consider that the added circuit must have consumption lower than 1mA.

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.



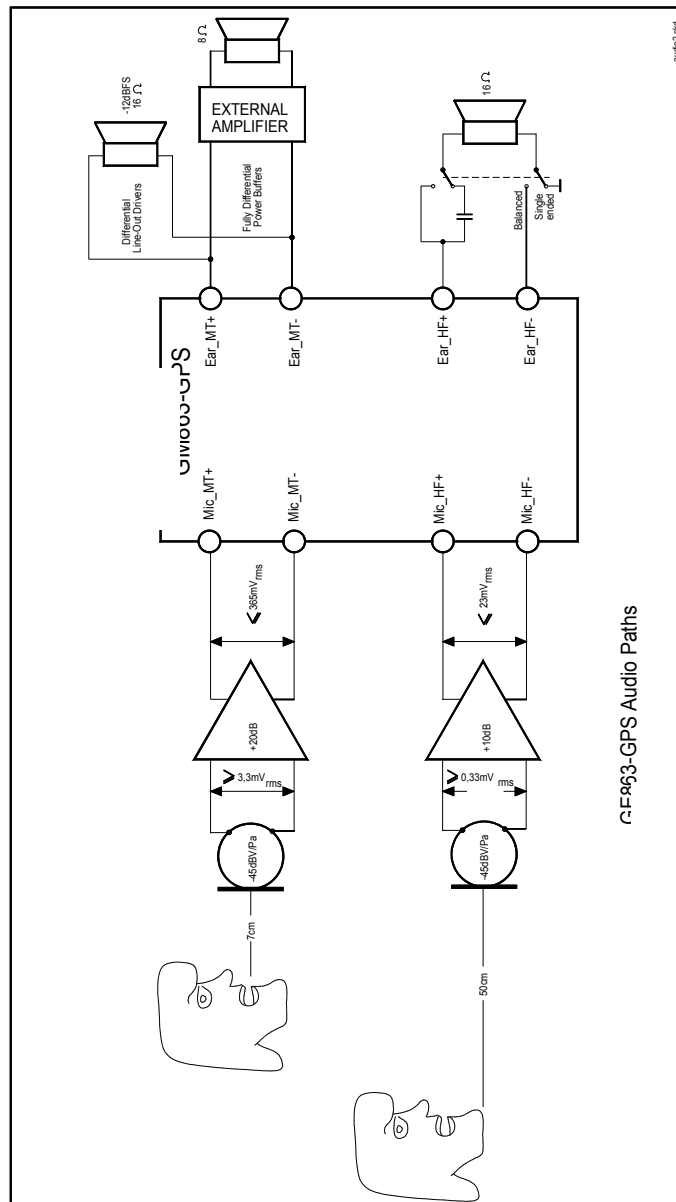
9 Audio Section Overview

The Base Band Chip of the GE864-AUTO 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.



9.1 INPUT LINES (Microphone)

9.1.1 Short description

The Telit GE864-AUTO provides two audio paths in transmit 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 transmit blocks when designing:

The “**MIC_MT**” audio path should be used for handset function, while the “**MIC_HF**” audio path is suited for hands-free function (car kit).



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.



9.1.2 Input Lines Characteristics

“MIC_MT” 1st differential microphone path	
Line Coupling	AC*
Line Type	Balanced
Coupling capacitor	$\geq 100\text{nF}$
Differential input resistance	$50\text{k}\Omega$
Differential input voltage	$\leq 1,03\text{V}_{\text{pp}}$ ($365\text{mV}_{\text{rms}}$)
Microphone nominal sensitivity	$-45\text{ dBV}_{\text{rms}}/\text{Pa}$
Analog gain suggested	+ 20dB
Echo canceller type	Handset

“MIC_HF” 2nd differential microphone path	
Line Coupling	AC*
Line Type	Balanced
Coupling capacitor	$\geq 100\text{nF}$
Differential input resistance	$50\text{k}\Omega$
Differential input voltage	$\leq 65\text{mV}_{\text{pp}}$ (23mV_{rms})
Microphone nominal sensitivity	$-45\text{ dBV}_{\text{rms}}/\text{Pa}$
Analog gain suggested	+10dB
Echo canceller type	Car kit hands-free



(*) WARNING: AC means that the signals from microphone has to be connected to input lines of the module by a CAPACITOR, which value must be $\geq 100\text{nF}$. Not respecting this constraint, the input stage will be damaged.



9.2 OUTPUT LINES (Speaker)

9.2.1 Short description

The Telit GE864-AUTO provides two audio paths in receive section. Only one of the two paths can be active at a time, selectable by *AXE* hardware line or by AT command.

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

→ the “*EAR_MT*” lines *EPN1* and *EPP1* are the *Differential Line-Out Drivers* ; they can drive an external amplifier or directly a **16 Ω earpiece** at -12dBFS (*) ;

→ the “*EAR_HF*” lines *EPPA1_2* and *EPPA2* are the *Fully Differential Power Buffers* ; they can directly drive a **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.



9.2.2 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 Ω (typical)
Signal bandwidth	150 – 4000 Hz @ -3 dB
Differential output voltage	328mVrms /16 Ω @ -12dBFS
SW volume level step	- 2 dB
Number of SW volume steps	10

“EAR_HF” Power Buffers Path	
Line Coupling	DC
Line Type	Bridged
Output load resistance	$\geq 14 \Omega$
Internal output resistance	4 Ω (>1,7 Ω)
Signal bandwidth	150 – 4000 Hz @ -3 dB
Max Differential output voltage	1310 mV _{rms} (typ, open circuit)
Max Single Ended output voltage	656 mV _{rms} (typ, open circuit)
SW volume level step	- 2 dB
Number of SW volume steps	10

For more detailed information about audio please refer to the Audio Settings Application Note 80000NT10007a.



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 GE864-AUTO firmware and acts depending on the function implemented. For Logic levels please refer to chapter 7.

The following GPIO are available on the GE864-AUTO:

Ball	Signal	I/O	Function	Type	Input / output current	Default State	State during Reset	Note
B3	TGPIO_04	I/O	GPIO04 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	x	Alternate function (RF Transmission Control)
B5	TGPIO_06	I/O	GPIO06 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	HIGH (see Fig.01)	Alternate function (ALARM)
E6	TGPIO_01	I/O	GPIO01 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	x	Alternate function (JDR)
H3	TGPIO_08	I/O	GPIO08 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	x	PCM_TX
H5	TGPIO_02	I/O	GPIO02 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	x	PCM_WAO
K7	TGPIO_03	I/O	GPIO03 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	x	PCM_RX
K8	TGPIO_05	I/O	GPIO05 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	x	Alternate function (RFTXMON)
L9	TGPIO_07	I/O	GPIO07 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	x	Alternate function (BUZZER)
D7	PCM_CLK	I/O	Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	x	PCM audio *

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)



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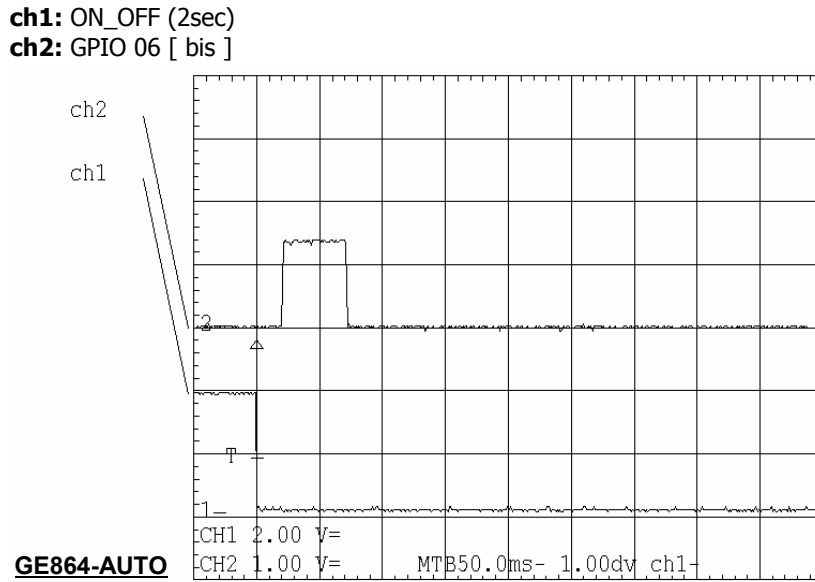


Fig.01



10.1 GPIO Logic levels

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 **GE864-AUTO** interface circuits:

Absolute Maximum Ratings -Not Functional

Parameter	Min	Max
Input level on any digital pin when on	-0.3V	+3.6V
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	3.3V
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



10.2 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.

10.3 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.

10.4 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 pull up resistor (47K to PWRMON);



10.5 Using the RFTXMON Output GPIO5

The GPIO5 pin, when configured as RFTXMON Output, is controlled by the GE864-AUTO module and will rise when the transmitter is active and fall after the transmitter activity is completed. The TXMON pin behaviour can be configured using the AT command

TXMONMODE

This command will be available only under AT#SELINT=2.

TXMONMODE – TTY-CTM DSP operating mode

# TXMONMODE – Set TXMON pin behaviour	
AT# TXMONMODE =<mode>	Set TXMON pin behaviour. Parameter: <mode> 0 – TXMON pin goes high when a call is started and it drops down when the call is ended. It also goes high when a location update starts, and it drops down when the location update procedure stops. Finally it goes high during SMS transmission and receiving. Even if the TXMON in this case is set as GPIO in output, the read command AT#GPIO=5,2 returns #GPIO:2,0 , as the GPIO is in alternate mode. 1 – TXMON is set in alternate mode and the Timer unit controls its state. TXMON goes high 200µs before TXEN goes high. Then power ramps start raising and there is the burst transmission. Finally TXMON drops down 47µs after power ramps stop falling down. This behaviour is repeated for every transmission burst. <i>Note 1: The parameter <mode> is saved in NVM.</i> <i>Note 2: if user sets GPIO 5 as input or output the TXMON does not follow the above behaviour.</i> <i>Note 3: if <mode> is change during a call from 1 to 0, TXMON goes down. If it is restored to 1, TXMON behaves as usual, following the bursts.</i> <i>Note 4: this command is not supported in GM862 product family.</i>
AT# TXMONMODE?	Read command reports the <mode> parameter set value, in the format: #TXMONMOD: <mode>
AT#TXMONMODE=?	Test command reports the supported values for <mode> parameter.

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 1sec after last TX burst.



10.6 Using the Alarm Output GPIO6

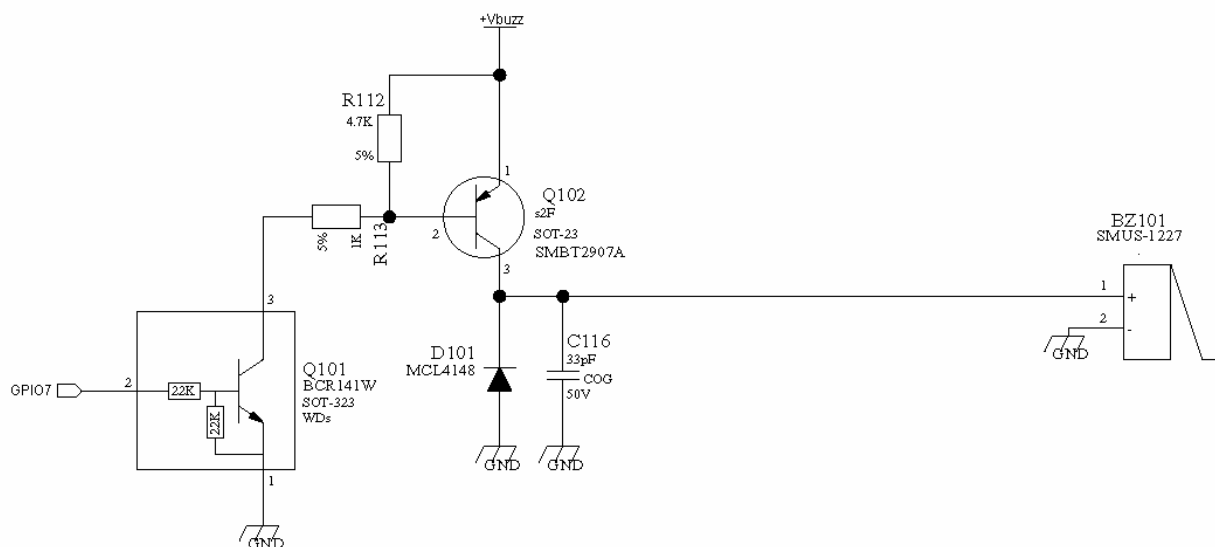
The GPIO6 pad, when configured as Alarm Output, is controlled by the GE864-AUTO module and will rise when the alarm starts and fall after the issue of a dedicated AT command. This output can be used to power up the GE864-AUTO controlling microcontroller or application at the alarm time, giving you the possibility to program a timely system wake-up to achieve some periodic actions and completely turn off either the application and the GE864-AUTO 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.

10.7 Using the Buzzer Output GPIO7

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





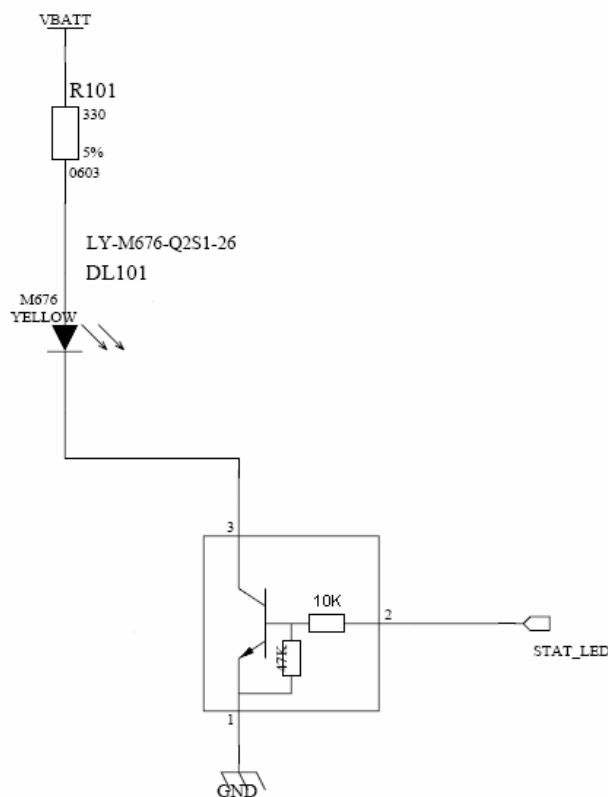
NOTE: To correctly drive a buzzer a driver must be provided, its characteristics depend on the Buzzer and for them refer to your buzzer vendor.

10.8 Indication of network service availability

The STAT_LED pin status shows information on the network service availability and Call status. In the GE864-AUTO 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



10.9 RTC Bypass out

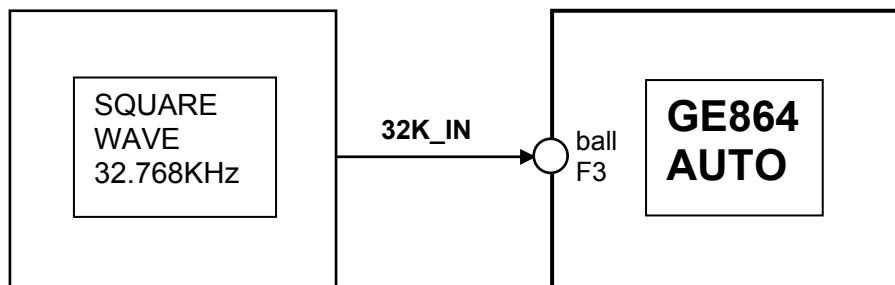
The VRTC pin brings out the Real Time Clock supply, which is separate from the rest of the digital part, allowing having only RTC going on when all the other parts of the device are off. To this power output a backup capacitor can be added in order to increase the RTC autonomy during power off of the battery. NO Devices must be powered from this pin.

10.10 External 32KHz oscillator

The GE864-AUTO has an internal 32.768 KHz oscillator for 'power saving' and 'Real Time Clock' features.

A common 32.768 KHz crystal is not reliable for 'automotive' applications.

For this reason, the **GE864 AUTO** will not have an internal oscillator, but the 32.768 KHz signal must be fed in externally (ball F3).



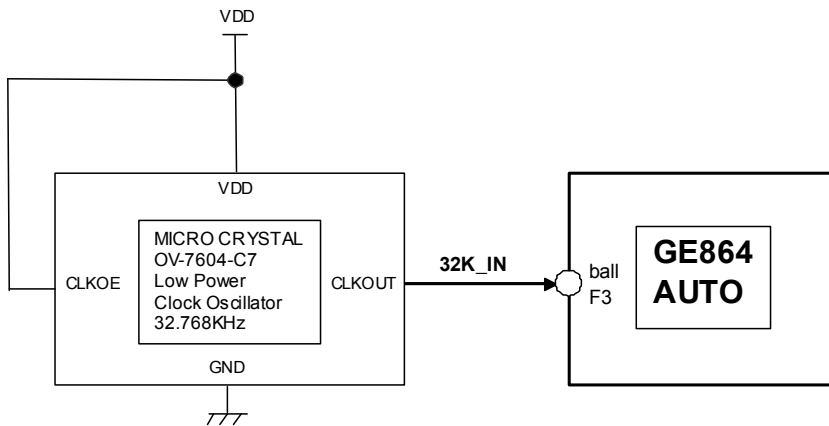
This signal must be a **square wave** with following specifications:

	Minimum	Maximum	Unit
L-input voltage	-0.25	+0.2	V
H-input voltage	1.8	2.2	V
Input impedance	> 10K		Ω

If 'power saving' and 'Real Time Clock' features are not required, the signal 32K_IN (ball F3) must be connected to ground.



A possible Clock Oscillator is shown in figure:



The Clock Oscillator should be placed close to GE864-AUTO.

The AT command used to test the presence and the status of an external 32KHz oscillator is **#OSC32KHZ**

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



11 ADC section

11.1 ADC Converter

11.1.1 Description

The on board A/D 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.

Input Voltage range	0 ÷ 2	Volt
AD conversion	11	bits
Resolution	1	mV

The GE864-AUTO module provides 3 Analog to Digital Converters. The input lines are:

ADC_IN1 available on Ball J11 and Pin 19 of PL102 on EVK2 Board (CS1302).

ADC_IN2 available on Ball H11 and Pin 20 of PL102 on EVK2 Board (CS1302).

ADC_IN3 available on Ball G11 and Pin 21 of PL102 on EVK2 Board (CS1302).

11.1.2 Using ADC Converter

An AT command is available to use the ADC function.

The command is **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.

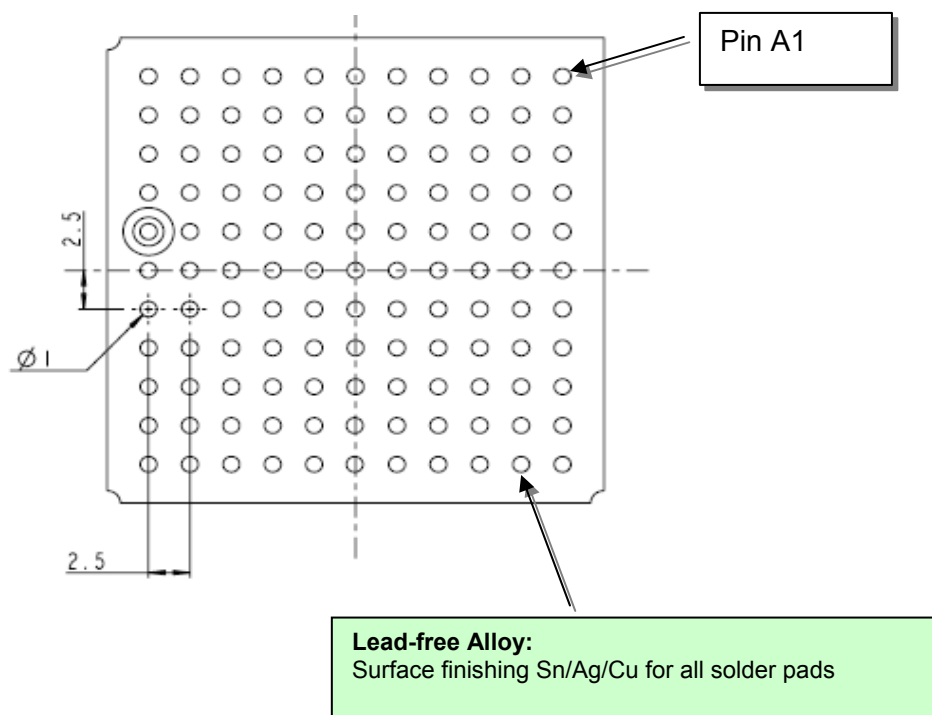


11.2 Mounting the GE864-AUTO on your Board

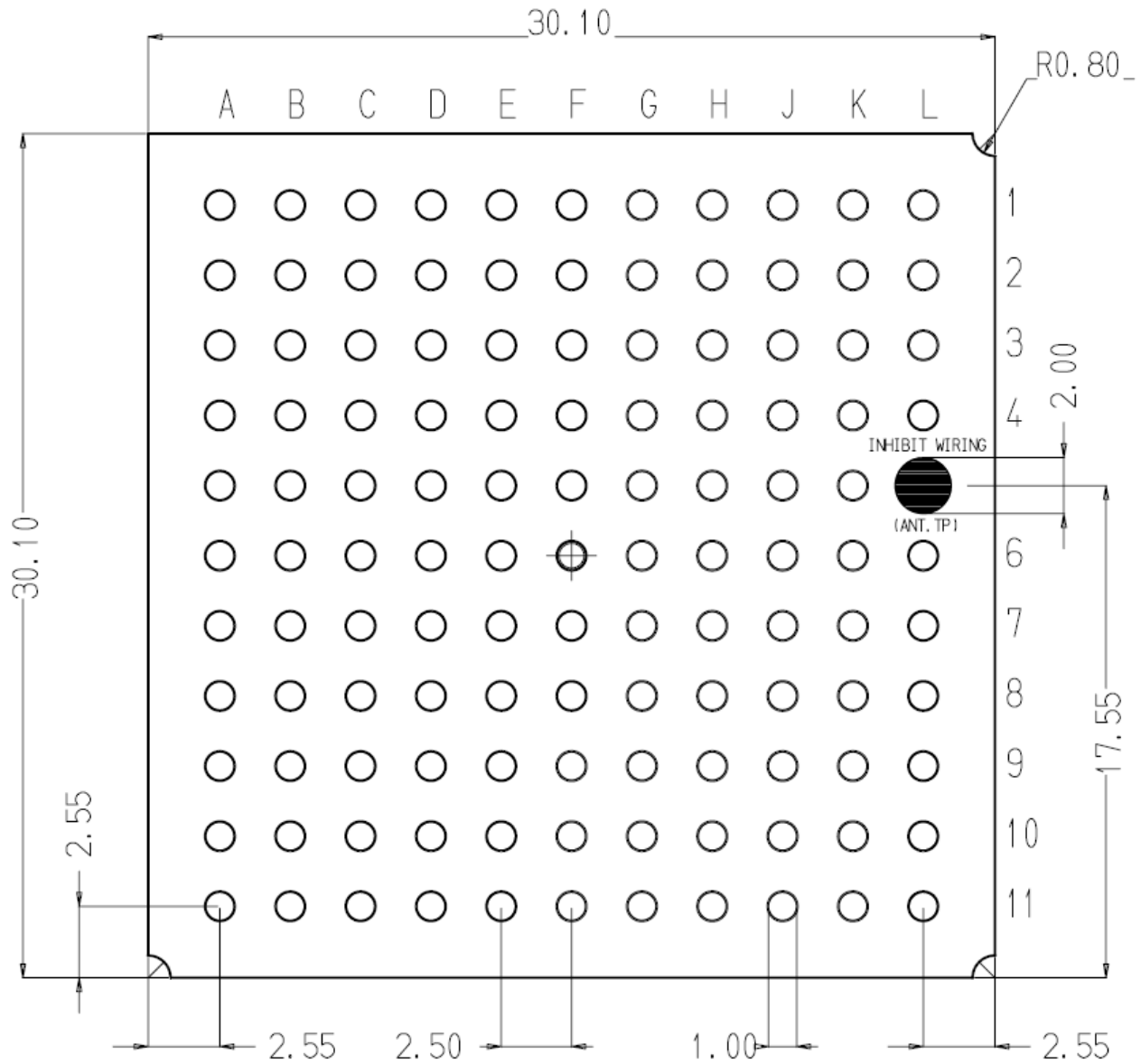
11.2.1 General

The **Telit GE864-AUTO modules** have been designed in order to be compliant with a standard lead-free SMT process.

11.2.2 Module finishing & dimensions



11.2.3 Recommended foot print for the application (GE864)



Top View



11.2.4 Debug of the GE864 in production

To test and debug the mounting of the GE864, we strongly recommend to foreseen test pads on the host PCB, in order to check the connection between the GE864 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:

- TXD
- RXD
- ON/OFF
- RESET
- GND
- VBATT
- TX_TRACE
- RX_TRACE
- PWRMON

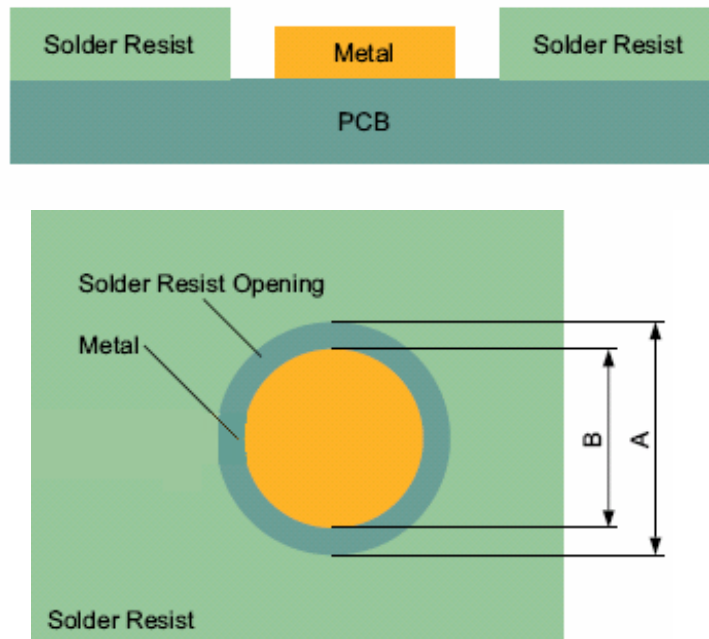
11.2.5 Stencil

Stencil's apertures layout can be the same of the recommended footprint (1:1), we suggest a thickness of stencil foil $\geq 120\mu\text{m}$.



11.2.6 PCB pad design

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

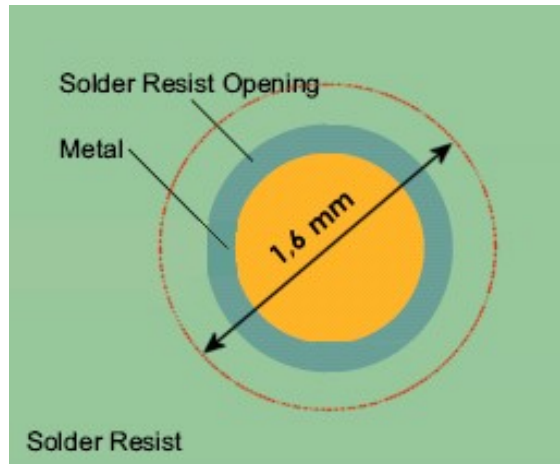


Recommendations for PCB pad dimensions

Ball pitch [mm]	2,5
Solder resist opening diameter A [mm]	1,150
Metal pad diameter B [mm]	1 ± 0.05

Placement of microvias not covered by solder resist is not recommended inside the “Solder resist opening”, unless the microvia carry the same signal of the pad itself.





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.

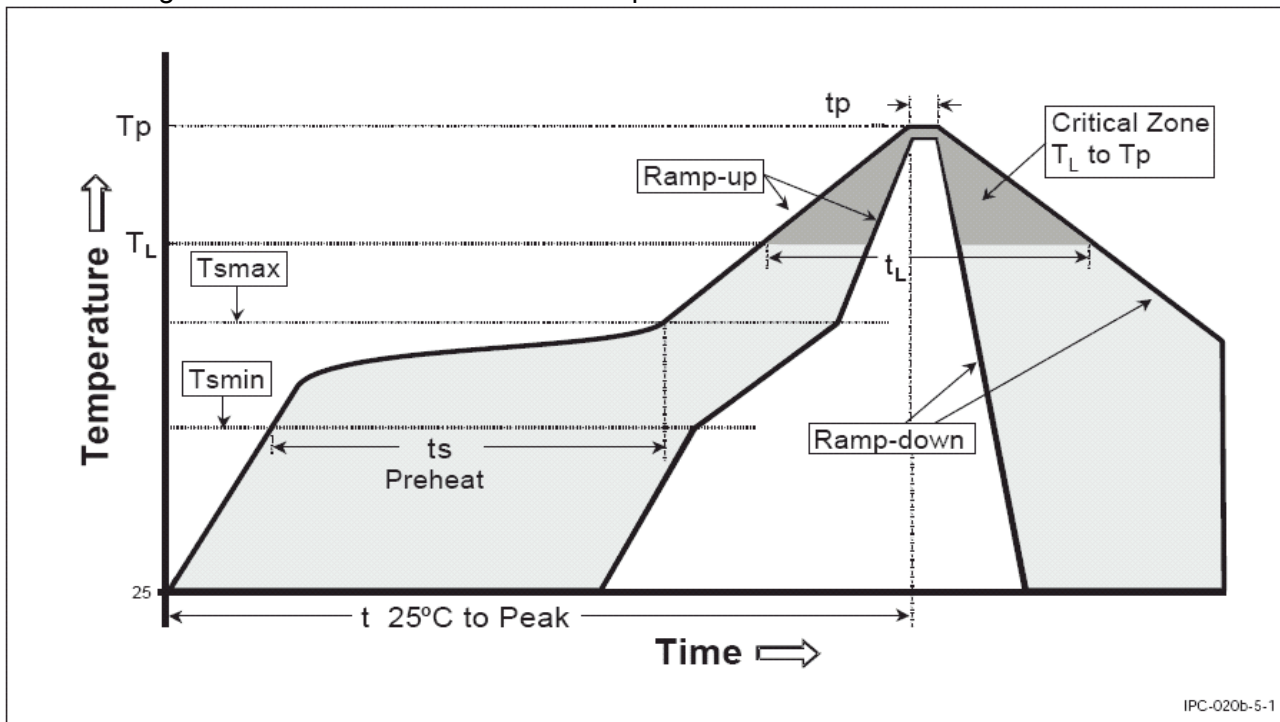
11.2.7 Solder paste

	Lead free
Solder paste	Sn/Ag/Cu



11.2.8 GE864 Solder reflow

The following is the recommended solder reflow profile



IPC-020b-5-1

Profile Feature	Pb-Free Assembly
Average ramp-up rate (T _L to T _p)	3°C/second max
Preheat	
– Temperature Min (T _{smin})	150°C
– Temperature Max (T _{smax})	200°C
– Time (min to max) (t _s)	60-180 seconds
T _{smax} to T _L	
– Ramp-up Rate	3°C/second max
Time maintained above:	
– Temperature (T _L)	217°C
– Time (t _L)	60-150 seconds
Peak Temperature (T _p)	245 +0/-5°C
Time within 5°C of actual Peak Temperature (t _p)	10-30 seconds
Ramp-down Rate	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

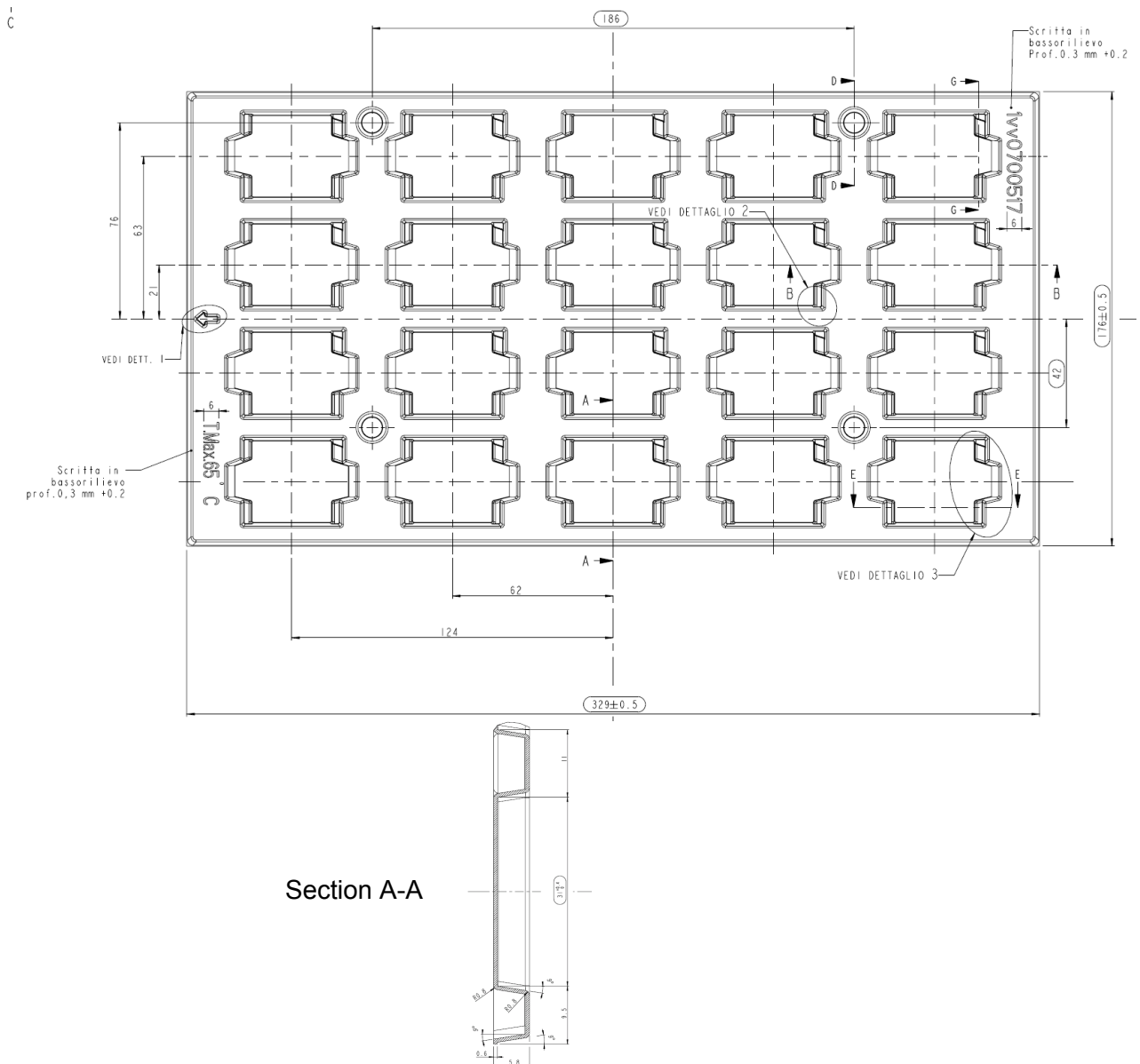
NOTE: All temperatures refer to topside of the package, measured on the package body surface.

NOTE: GE864 module can accept only one reflow process



11.3 Packing system

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

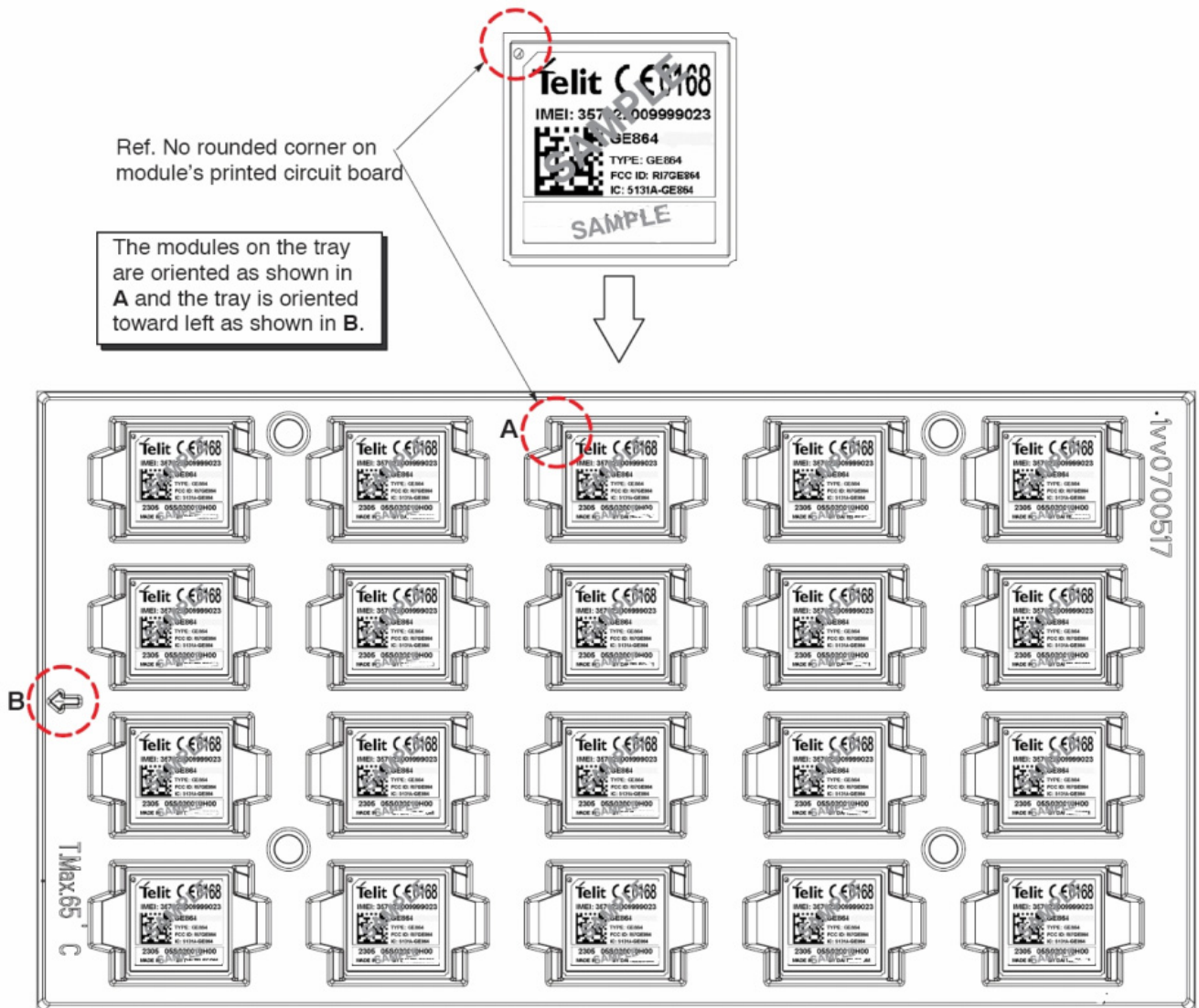


The size of the tray is: 329 x 176mm

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



11.3.1 GE864 orientation on the tray



11.3.2 Moisture sensibility

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



12 Conformity Assessment Issues

The GE864-AUTO 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-AUTO 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 GE864-AUTO 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 GE864-AUTO 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.



13 SAFETY RECOMMANDATIONS

READ CAREFULLY

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

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

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

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

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

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

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

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

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

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

The text of the Directive 99/05 regarding telecommunication equipments is available, while the applicable Directives (Low Voltage and EMC) are available at:

http://europa.eu.int/comm/enterprise/electr_equipment/index_en.htm



14 Document Change Log

Revision	Date	Changes
ISSUE#0	20/06/08	Release First ISSUE# 0

