HC864-AUTO
Hardware User Guide

1vv0300946 Rev.4 – 2012-12-27

Making machines talk.

APPLICABILITY TABLE

PRODUCT
HC864-AUTO

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

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Contents

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 HC864-AUTO module.

1.2. Audience

This document is intended for Telit customers, who are integrators, about to implement their applications using our HC864-AUTO module.

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit's 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).

Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates feedback from the users of our information.

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: "General Product Description" gives an overview of the features of the product.

Chapter 3: "HC864-AUTO Module Connections" deals with the pin out configuration and layout.

Chapter 4: "Hardware Commands" How to control the module via hardware

Chapter 5: "Power Supply" deals on supply and consumption.

Chapter 6: "Antenna" The antenna connection and board layout design are the most important parts in the full product design

Chapter 7: "Logic Level specifications" Specific values adopted in the implementation of logic levels for this module.

Chapter 8: "Serial ports"

Chapter 9: "Audio Section"

Chapter 10: "USB Port"

Chapter 11: "General Purpose I/O" How the general purpose I/O pads can be configured.

Chapter 12 "DAC and ADC Section" Deals with these two kind of converters.

Chapter 13: "Accelerometer"

Chapter 14: "Mounting the module on your board"

Chapter 15: "Application Guides"

Chapter 16: "Packing System"

Chapter 17: "Conformity Assessments"

Chapter 18: "Safety Recommendations"

Chapter 19: "Document History"

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

- HC864-AUTO Product Description, TBD
- HC864-AUTO Software User guide, 1vv0300947
- HC864-AUTO AT command reference guide, 30387NT11076A
- HC864-AUTO Digital Voice Interface Application Note, TBD
- Telit EVK2 User Guide, 1vv0300704

2. General Product Description

2.1. Overview

The aim of this document is the description of some hardware solutions useful for developing a product with the Telit HC864-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 must be considered as mandatory, while the suggested hardware configurations must not be considered mandatory, instead the information given must be used as a guide and a starting point for properly developing your product with the Telit HC864-AUTO module.

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NOTICE:

The integration of the GSM/GPRS/EGPRS/WCDMA/HSPA+ HC864-AUTO cellular module within user application must be done according to the design rules described in this manual.

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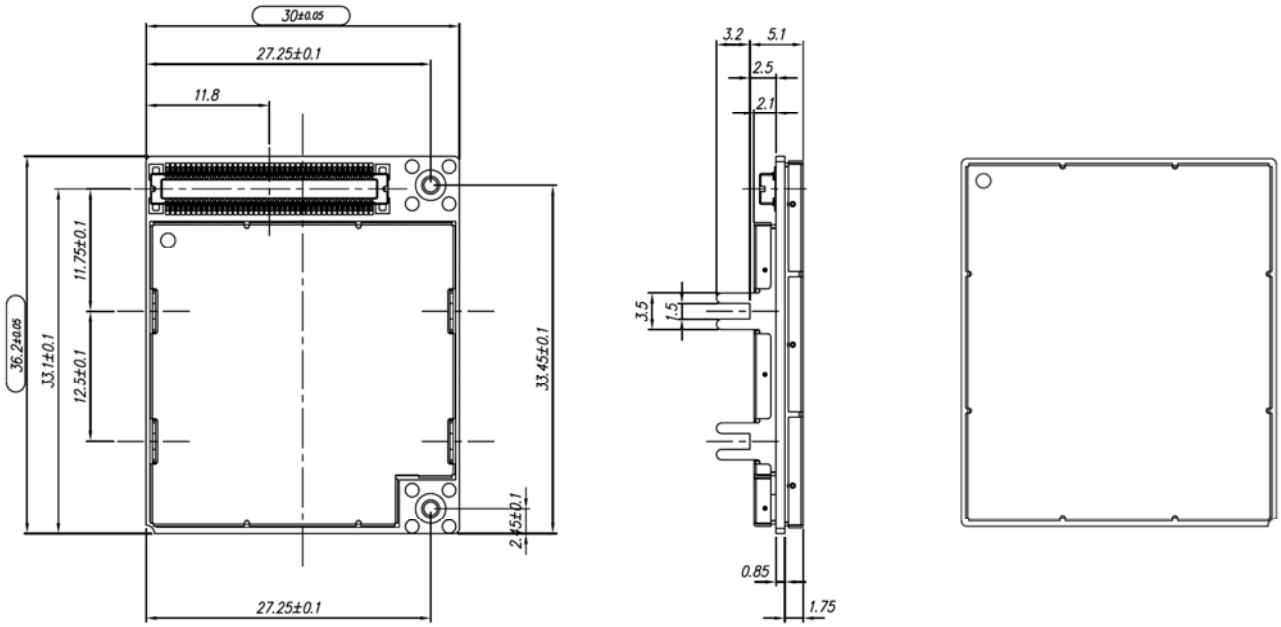
2.2. HC864-AUTO 2D Mechanical Dimensions

The Telit HC864-AUTO module overall dimensions are:

- Length: 36.2 mm
- Width: 30 mm
- Thickness: 5.1 mm



2.3. Weight

The module weight of HC864-AUTO is about 10.0 gram.

2.4. Environmental requirements

2.4.1. Temperature range

		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.
	–30°C ~ +85°C	The module is fully functional(*) in all the temperature range. Temperatures outside of the range –20°C ÷ +55°C might slightly deviate from ETSI specifications.
Storage and non-operating Temperature Range	–40°C ~ +85°C	

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

2.4.2. RoHS compliance

As a part of Telit corporate policy of environmental protection, the HC864-AUTO complies with the RoHS (Restriction of Hazardous Substances) directive of the European Union (EU directive 2002/95/EG).

2.5. Operating Frequency

The operating frequencies in GSM850, EGSM900, DCS1800, PCS1900, WCDMA modes are conformed to the 3GPP specifications.

Mode	Freq. TX (MHz)	Freq. RX (MHz)	Channels	TX - RX offset
GSM850	824.2 ~ 848.8	869.2 ~ 893.8	128 ~ 251	45 MHz
EGSM900	890.0 ~ 914.8	935.0 ~ 959.8	0 ~ 124	45 MHz
	880.2 ~ 889.8	925.2 ~ 934.8	975 ~ 1023	45 MHz
DCS1800	1710.2 ~ 1784.8	1805.2 ~ 1879.8	512 ~ 885	95MHz
PCS1900	1850.2 ~ 1909.8	1930.2 ~ 1989.8	512 ~ 810	80MHz
WCDMA850	826.4 ~ 846.6	871.4 ~ 891.6	Tx: 4132 ~ 4233 Rx: 4357 ~ 4458	45MHz
WCDMA900	882.4 ~ 912.6	927.4 ~ 957.6	Tx: 2712 ~ 2863 Rx: 2937 ~ 3088	45MHz
WCDMA1700 (AWS)	1712.4 ~ 1752.6	2112.4 ~ 2152.6	Tx: 1312 ~ 1513 Rx: 1537 ~ 1738	400MHz
WCDMA1900	1852.4 ~ 1907.6	1932.4 ~ 1987.6	Tx: 9262 ~ 9538 Rx: 9662 ~ 9938	80MHz
WCDMA2100	1922.4 ~ 1977.6	2112.4 ~ 2167.6	Tx: 9612 ~ 9888 Rx: 10562 ~ 10838	190MHz

3. HC864-AUTO Module Connections

3.1. PIN-OUT

HC864-AUTO uses an 80 pin Molex p.n. 53949-0878 male connector for the connections with the external applications. This connector matches the 54150-0878 models.

Pin	Signal	I/O	Function	Internal Pull up	Type HC864-AUTO
Power Supply					
1	VBATT	-	Main power supply		Power
2	VBATT	-	Main power supply		Power
3	VBATT	-	Main power supply		Power
4	VBATT	-	Main power supply		Power
5	GND	-	Ground		Power
6	GND	-	Ground		Power
7	GND	-	Ground		Power
SIM Card Interface					
18[1]	SIMVCC	-	External SIM signal – Power supply for the SIM		1.8 / 3V
19	SIMRST	O	External SIM signal – Reset		1.8 / 3V
20	SIMIO	I/O	External SIM signal - Data I/O		1.8 / 3V
21	SIMIN	I	External SIM signal - Presence (active low)		CMOS 1.8V
22	SIMCLK	O	External SIM signal – Clock		1.8 / 3V
Trace					
23	RX_TRACE	I	RX Data for debug monitor		CMOS 2.6V
24	TX_TRACE	O	TX Data for debug monitor		CMOS 2.6V
Prog. / Data + Hw Flow Control					
25	C103/TXD	I	Serial data input (TXD) from DTE		CMOS 2.6V
26	C104/RXD	O	Serial data output to DTE		CMOS 2.6V
27	C107/DSR	O	Output for Data set ready signal (DSR) to DTE		CMOS 2.6V
28	C106/CTS	O	Output for Clear to send signal (CTS) to DTE		CMOS 2.6V
29	C108/DTR	I	Input for Data terminal ready signal (DTR) from DTE		CMOS 2.6V
30	C125/RING	O	Output for Ring indicator signal (RI) to DTE		CMOS 2.6V
31	C105/RTS	I	Input for Request to send signal (RTS) from DTE		CMOS 2.6V
32	C109/DCD	O	Output for Data carrier detect signal (DCD) to DTE		CMOS 2.6V
Miscellaneous Functions					
35	USB_ID	AI	Analog input used to sense whether a peripheral device is connected, and determine the peripheral type, a host		Analog

[1] On this line a maximum of 10nF bypass capacitor is allowed

Pin	Signal	I/O	Function	Internal Pull up	Type HC864-AUTO
			or a peripheral		
36	PCM_CLOCK	I/O	PCM clock out		CMOS 2.6V
DAC and ADC					
37	ADC_IN1	AI	Analog/Digital converter input		A/D
38	ADC_IN2	AI	Analog/Digital converter input		A/D
40	DAC_OUT	AO	Digital/Analog converter output		D/A
			Miscellaneous Functions		
45	STAT_LED	O	Status indicator led		CMOS 1.8V
46	GND	-	Ground		Ground
48	USB_VBUS	AI	Power sense for the internal USB transceiver		4.4V ~5.25V
49	PWRMON	O	Power ON Monitor	1KΩ	CMOS 2.6V
50	VAUX1	-	Power output for external accessories		
53	ON/OFF	I	Input command for switching power ON or OFF (toggle command). The pulse to be sent to the HC864-AUTO must be equal or greater than 1 second.		Pulled up on chip
54	RESET	I	Reset input		
55	VRTC	AO	Power supply for RTC block		Power
			Telit GPIOs		
56	TGPIO_19	I/O	Telit GPIO19 Configurable GPIO		CMOS 1.8V
57	TGPIO_11	I/O	Telit GPIO11 Configurable GPIO		CMOS 1.8V
58	TGPIO_20	I/O	Telit GPIO20 Configurable GPIO		CMOS 1.8V
59	TGPIO_04	I/O	Telit GPIO4 Configurable GPIO		CMOS 1.8V
60	TGPIO_14	I/O	Telit GPIO14 Configurable GPIO		CMOS 1.8V
61	TGPIO_15	I/O	Telit GPIO15 Configurable GPIO		CMOS 1.8V
62	TGPIO_12	I/O	Telit GPIO12 Configurable GPIO		CMOS 1.8V
63	TGPIO_10/ PCM_TX	I/O	Telit GPIO10 Configurable GPIO / PCM Data Output	Pull Down	CMOS 2.6V
64	TGPIO_22	I/O	Telit GPIO22 Configurable GPIO		CMOS 1.8V
65	TGPIO_18/ PCM_RX	I/O	Telit GPIO18 Configurable GPIO / PCM Data input	Pull Down	CMOS 2.6V
66	TGPIO_03	I/O	Telit GPIO3 Configurable GPIO		CMOS 1.8V
67	TGPIO_08	I/O	Telit GPIO8 Configurable GPIO		CMOS 1.8V
68	TGPIO_06 / ALARM	I/O	Telit GPIO6 Configurable GPIO / ALARM		CMOS 1.8V
70	TGPIO_01	I/O	Telit GPIO1 Configurable GPIO		CMOS 1.8V
71	TGPIO_17/ PCM_SYNC	I/O	Telit GPIO17 Configurable GPIO / PCM Sync	Pull Down	CMOS 2.6V
72	TGPIO_21	I/O	Telit GPIO21 Configurable GPIO		CMOS 1.8V
73	TGPIO_07	I/O	Telit GPIO7 Configurable GPIO		CMOS 1.8V

Pin	Signal	I/O	Function	Internal Pull up	Type HC864-AUTO
74	TGPIO_02	I/O	Telit GPIO02 I/O pin		CMOS 1.8V
75	TGPIO_16	I/O	Telit GPIO16 Configurable GPIO		CMOS 1.8V
76	TGPIO_09	I/O	Telit GPIO9 Configurable GPIO		CMOS 1.8V
77	TGPIO_13	I/O	Telit GPIO13 Configurable		CMOS 1.8V
78	TGPIO_05	I/O	Telit GPIO05 Configurable GPIO		CMOS 2.6V
USB Interface					
79	USB_D+	I/O	USB differential Data (+)		3.0V ~3.6V
80	USB_D-	I/O	USB differential Data (-)		3.0V ~3.6V
RESERVED					
8		-			
9					
10					
11		-			
12		-			
13		-			
14		-			
15		-			
16		-			
17		-			
33					
34					
39		-			
41		-			
42		-			
43		-			
44		-			
47		-			
51					
52					
69					

NOTE:

DTR pin must be connected in order to enter HC864-AUTO's power saving mode.

NOTE:

RI pin must be connected in order to wake up the host when a call is coming in sleep mode of host.

NOTE:

RESERVED pins must not be connected

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

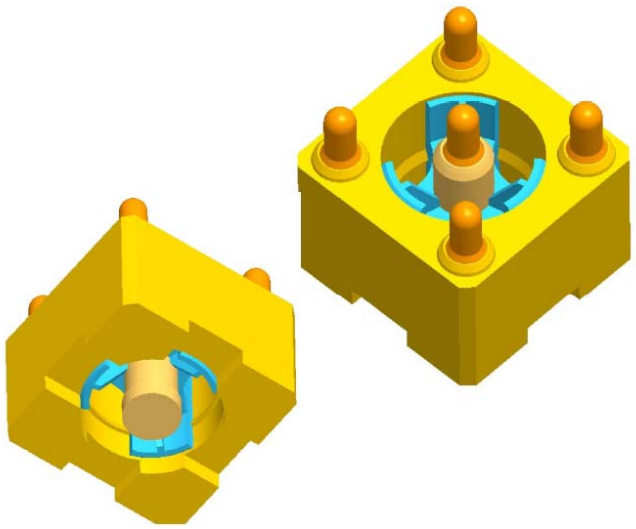
NOTE:

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

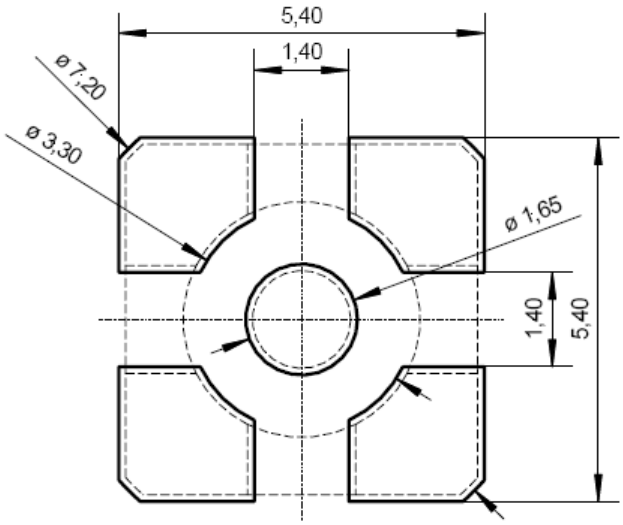
Pin	Signal	Function
1	VBATT	Main power supply
2	VBATT	Main power supply
3	VBATT	Main power supply
4	VBATT	Main power supply
5	GND	Ground
6	GND	Ground
7	GND	Ground
46	GND	Ground
25	C103/TXD	Serial data input (TXD) from DTE
26	C104/RXD	Serial data output to DTE
31	C105/RTS	Input for Request to send signal (RTS) from DTE
53	ON/OFF	Input command for switching power ON or OFF (toggle command).
54	RESET	Reset input

3.2. Antenna Connector(s)

The HC864-AUTO module is designed with a 50 Ohm RF PAD that permits to interface it with an application equipped by a Rosenberger coaxial Board to board connector. Furthermore the HC864-AUTO is designed with an additional RF PAD for GPS/Diversity antenna connection. The counterpart suitable is a Rosenberger 99CI106-030L5.



Suggested footprint on the application side:



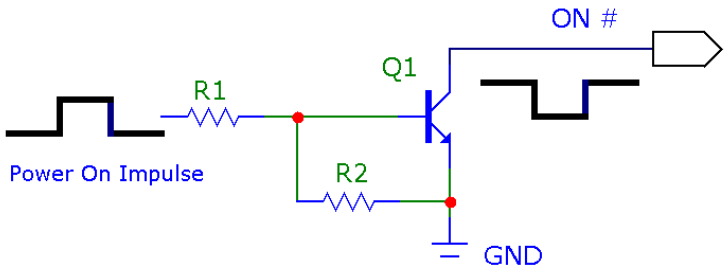
4. Hardware Commands

4.1. Turning ON the HC864-AUTO

To turn on HC864-AUTO, the pad ON# must be tied low for at least 1 second and then released.

The maximum current that can be drained from the ON# pad is 0.1 mA.

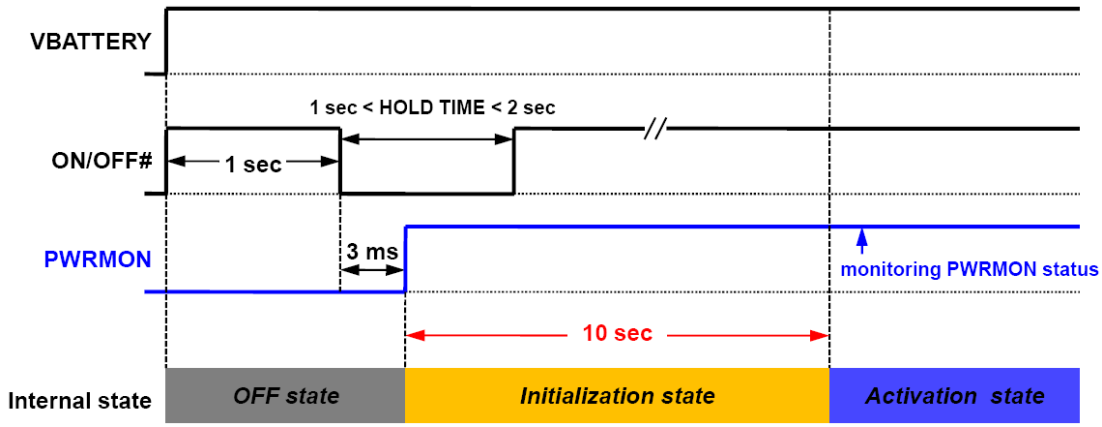
A simple circuit to do it is:



4.2. Initialization and Activation state

Upon turning on HC864-AUTO, HC864-AUTO is not activated yet because the boot sequence of HC864-AUTO is still going on internally. It takes about 10 seconds to complete the initializing the module internally.

For this reason, it would be useless to try to access HC864-AUTO during a Initialization state as below. To get the desirable stability, HC864-AUTO needs at least 10 seconds after the PWRMON goes High.



During the *Initialization state*, any kind of AT-command is not available. DTE must be waiting for the *Activation state* to communicate with HC864-AUTO.

NOTE:

To check if the HC864-AUTO has powered on, the hardware line PWRMON must be monitored. When PWRMON goes high, the module has powered on.

NOTE:

Do not 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 HC864-AUTO power regulator and improper power on/off of the module. The line ON# must be connected only in open collector configuration.

NOTE:

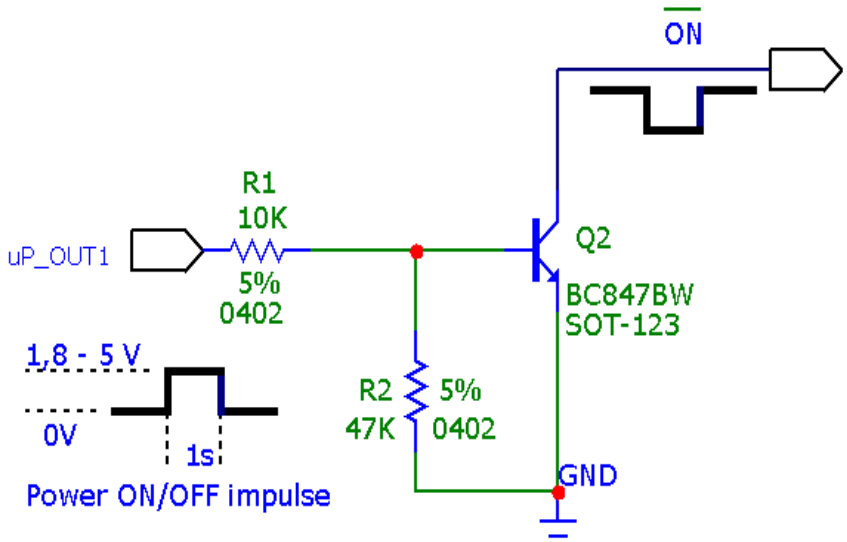
In this document all the lines are inverted. Active low signals are labeled with a name that ends with a "#" or with a bar over the name.

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.

For example:

1- Let us assume you need to drive the ON# pad with a totem pole output of a +1.8/5 V microcontroller (uP_OUT1):



4.3. Turning OFF the HC864-AUTO

Turning off the device can be done in three ways:

- by software command (see HC864-AUTO Software User Guide)
- by Hardware shutdown
- by Hardware Unconditional Restart

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

TIP:

To check if the device has powered off, hardware line PWRMON must be monitored. When PWRMON goes low it can be considered the device has powered off.

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.

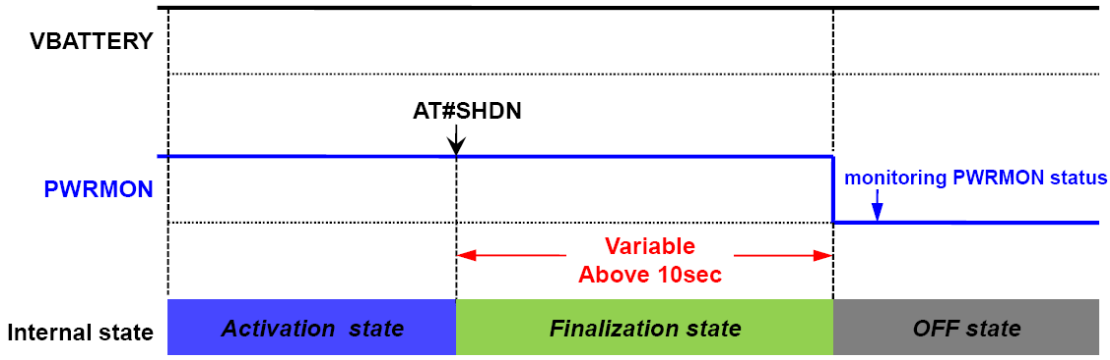
4.3.1. Shutdown by Software Command

HC864-AUTO can be shut down by a software command.

When a shut down command is sent, HC864-AUTO goes into the finalization state and finally will shut down PWRMON at the end of this state.

The period of the finalization state can differ according to the situation in which the HC864-AUTO is so it cannot be fixed definitely.

Normally it will be above 10 seconds later from sending a shut down command and DTE should monitor the status of PWRMON to see the actual power off.



TIP:

To check if the device has powered off, hardware line PWRMON must be monitored. When PWRMON goes low, the device has powered off.

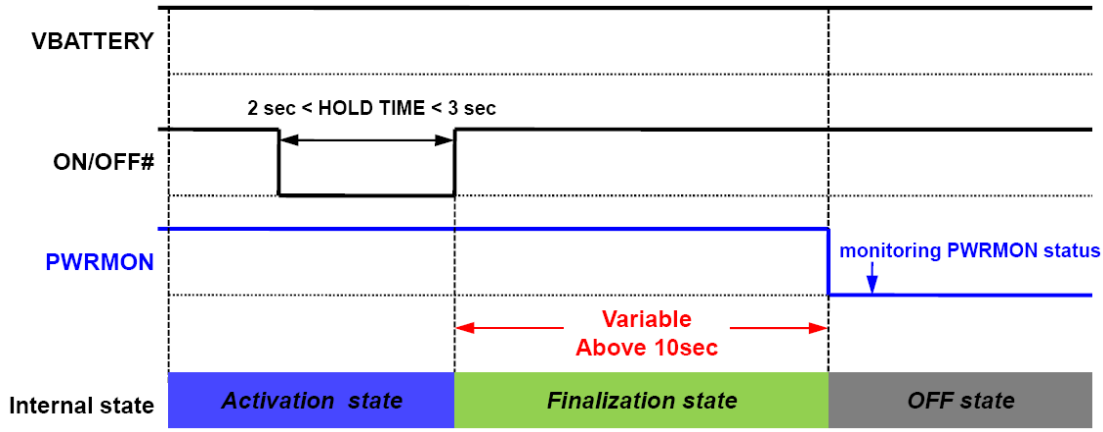
4.3.2. Hardware Shutdown

To turn OFF HC864-AUTO the pad ON/OFF# must be tied low for at least 2 seconds and then released. Same circuitry and timing for the power on must be used.

When the hold time of ON/OFF# is above 2 seconds, HC864-AUTO goes into the finalization state and finally will shut down PWRMON at the end of this state.

The period of the finalization state can differ according to the situation in which the HC864-AUTO is so it cannot be fixed definitely.

Normally it will be above 10 seconds later from releasing ON/OFF# and DTE should monitor the status of PWRMON to see the actual power off.



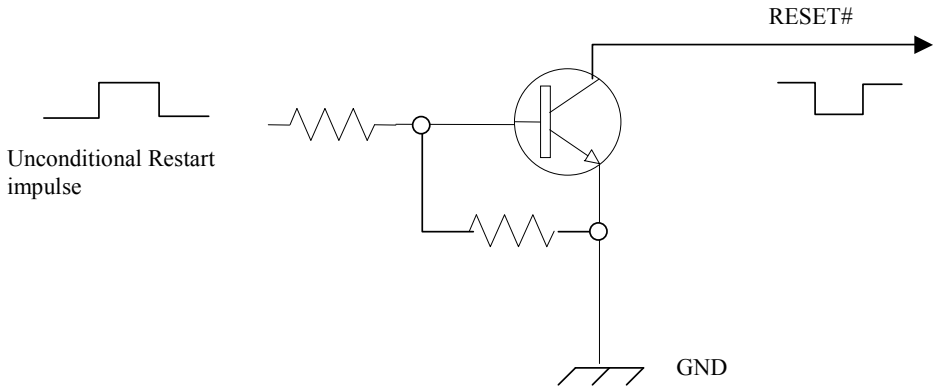
TIP:

To check if the device has powered off, hardware line PWRMON must be monitored. When PWRMON goes low, the device has powered off.

4.3.3. Hardware Unconditional Restart

To unconditionally restart HC864-AUTO, the pad RESET# must be tied low for at least 200 milliseconds and then released.

A simple circuit to do it is:



NOTE:

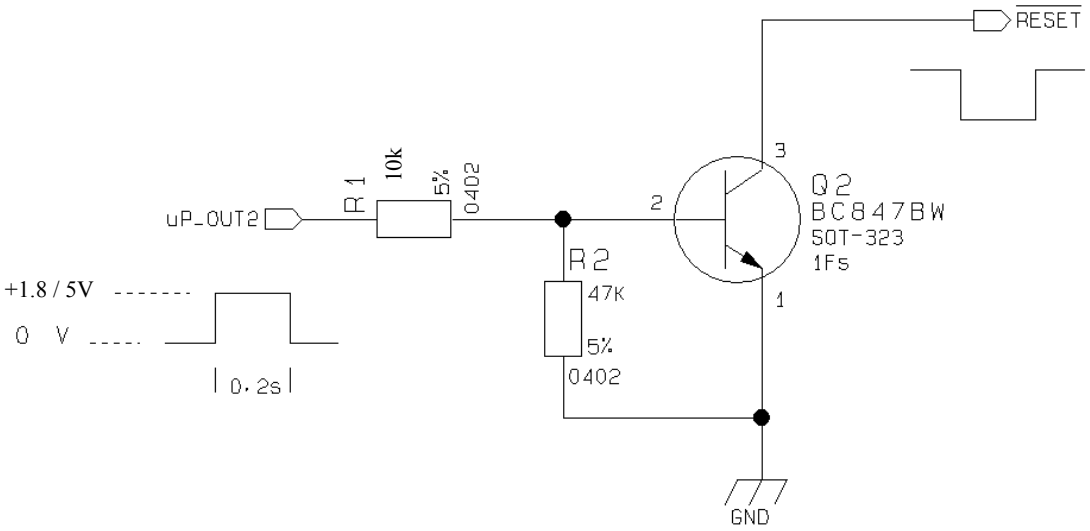
Do not use any pull up resistor on the RESET# line or any totem pole digital output. Using pull up resistor may bring to latch up problems on the HC864-AUTO power regulator and improper functioning of the module. The line RESET# must be connected only in open collector configuration.

TIP:

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

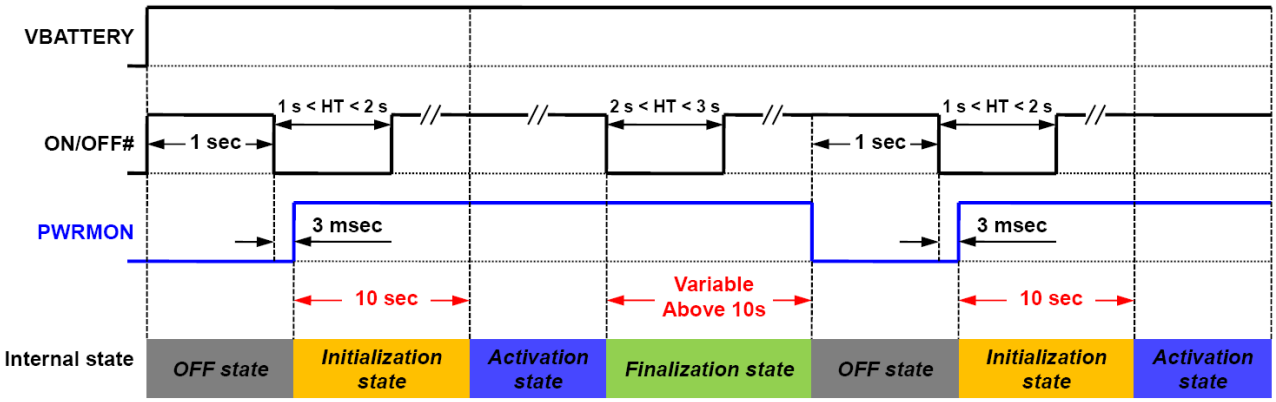
For example:

1- Let us assume you need to drive the RESET# pad with a totem pole output of a +1.8/5 V microcontroller (uP_OUT2):



4.4. Summary of Turning ON and OFF the module

Below chart describes the overall sequences for Turning ON and OFF.



5. 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. Read carefully the requirements and the guidelines that will follow for a proper design.

5.1. Power Supply Requirements

The HC864-AUTO power requirements are:

Power Supply	
Nominal Supply Voltage	3.8V
Max Supply Voltage	4.2V
Supply Voltage Range	3.4V – 4.2V

HC864-AUTO			
Mode		**Average(mA)**	**Mode Description**
IDLE mode			Standby mode; no call in progress
AT+CFUN=1	WCDMA	15.0	Normal mode; full functionality of the module
	GSM	15.0	
AT+CFUN=4	WCDMA	13.0	Disabled TX and RX; modules is not registered on the network
	GSM	13.0	
AT+CFUN=0 or AT+CFUN=5	WCDMA	2.7/1.0*	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. CFN=5 full functionality with power saving; Module registered on the network can receive incoming call sand SMS
	GSM	3.2/1.3*	
WCDMA TX and RX mode			
WCDMA Voice		630	WCDMA voice channel
HSPA		640	HSPA data channel
GSM TX and RX mode			
GSM Voice		260	GSM voice channel
GPRS Class33		680	GPRS data channel
EDGE Class33		380	EDGE data channel

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

TIP:

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

In GSM/GPRS mode, RF transmission is not continuous and 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 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; this will reflect on all the audio paths producing an audible annoying noise at 216 Hz; if the voltage drops during the peak, current absorption is too much. The device may even shut down as a consequence of the supply voltage drop.

5.2. General Design Rules

The principal guidelines for the Power Supply Design embrace three different design steps:

- the electrical design
- the thermal design
- the PCB layout

5.2.1. Electrical Design Guidelines

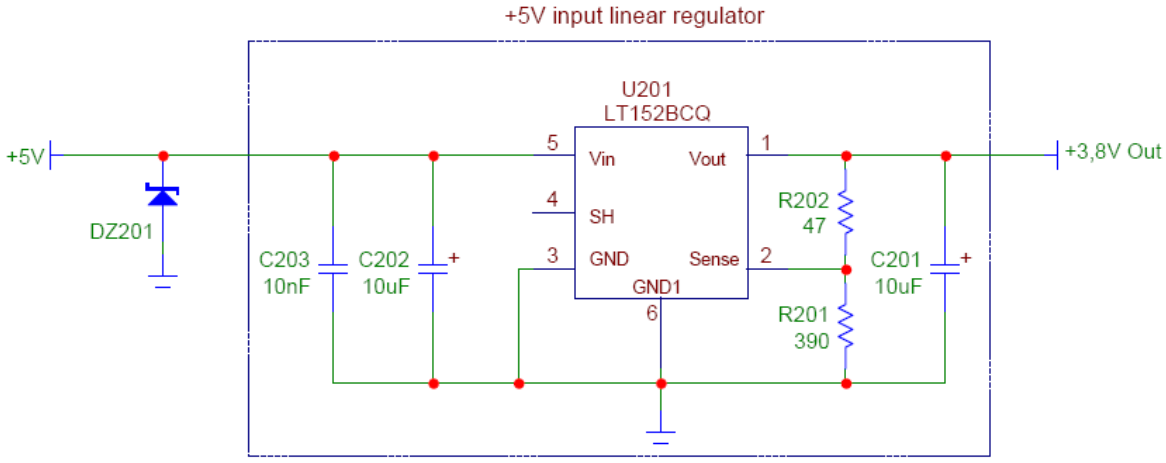
The electrical design of the power supply depends strongly on the power source where this power is drained. We will distinguish them into three categories:

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

5.2.1.1. + 5V Input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence there is not a big difference between the input source and the desired output and a linear regulator can be used. A switching power supply will not be suited because of the low drop-out requirements.
- When using a linear regulator, a proper heat sink must 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 HC864-AUTO, 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 must be inserted close to the power input, in order to save HC864-AUTO from power polarity inversion.

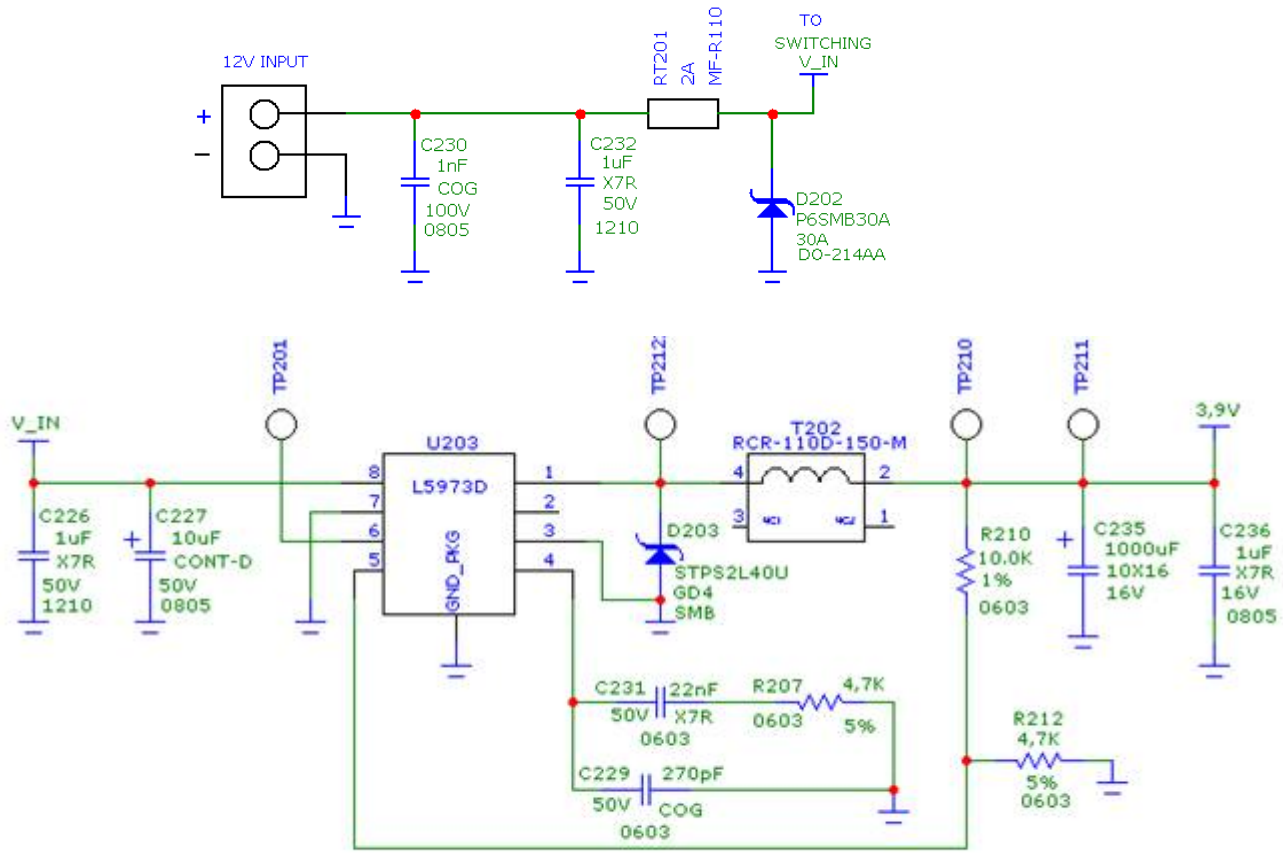
An example of linear regulator with 5V input is:



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 must not be used. A switching power supply will be preferable because of its better efficiency especially with the 2A peak current load represented by HC864-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 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 usually suited for this.
- 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 must be inserted close to the power input, in order to clean the supply from spikes.
- A protection diode must be inserted close to the power input, in order to save HC864-AUTO from power polarity inversion. This can be the same diode as for spike protection.

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



Switching regulator

5.2.1.3. Battery Source Power Supply Design Guidelines

- The desired nominal output for the power supply is 3.8V and the maximum allowed voltage is 4.2V, hence a single 3.7V Li-Ion cell battery type is suited for supplying the power to the Telit HC864-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 HC864-AUTO and damage it.

NOTE:

Do not use any Ni-Cd, Ni-MH, and Pb battery types directly connected with HC864-AUTO. Their use can lead to overvoltage on HC864-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 must be inserted close to the power input, in order to save HC864-AUTO from power polarity inversion. Otherwise the battery connector must 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.

5.2.2. Thermal Design Guidelines

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

- Average current consumption during HSPA transmission @PWR level max in HC864-AUTO : 640mA
- Average current consumption during class33 GPRS transmission @PWR level max: 680mA
- Average GPS current during GPS ON (Power Saving disabled) : 65mA

NOTE:

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

NOTE:

The thermal design for the Power supply must be made keeping an average consumption at the max transmitting level during calls of 640mA(HSPA)/680mA(GPRS) rms plus 65mA rms for GPS in tracking mode.

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 in transmission for short periods of time (let us say few minutes) and then remains for quite a 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 for 640mA (HSPA)/680mA (GPRS) maximum RMS current. There could even be a simple chip package (no heat sink).

Moreover in average network conditions the device is requested to transmit at a lower power level than the maximum and hence the current consumption will be less than 640mA (HSPA) /680mA (GPRS) (being usually around 250mA).

For these reasons the thermal design is rarely a concern and the simple ground plane where the power supply chip is placed can be enough to ensure a good thermal condition and avoid overheating.

For the heat generated by the HC864-AUTO, you can consider it to be during transmission 2W max during class33 GPRS upload. This generated heat will be mostly conducted to the ground plane under the HC864-AUTO; you must ensure that your application can dissipate heat.

In the WCDMA/HSPA mode, since HC864-AUTO emits RF signals continuously during transmission, you must pay special attention how to dissipate the heat generated.

The current consumption will be up to about 640mA in HSPA (630mA in WCDMA) continuously at the maximum TX output power (23dBm). Thus, you must arrange the PCB area as large as possible under HC864-AUTO which you will mount. You must mount

HC864-AUTO on the large ground area of your application board and make many ground vias to dissipate the heat.

The peak current consumption in the GSM mode is higher than that in WCDMA. However, considering the heat sink is more important in case of WCDMA.

As mentioned before, a GSM signal is bursty, thus, the temperature drift is more insensible than WCDMA. Consequently, if you prescribe the heat dissipation in the WCDMA mode, you don't need to think more about the GSM mode.

5.2.3. Power Supply PCB Layout Guidelines

As seen in the electrical design guidelines, the power supply must 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 HC864-AUTO 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 if the PCB trace from the capacitor to HC864-AUTO is wide enough to ensure a drop-less 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 to 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 (also 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 HC864-AUTO, then this noise is not so disturbing and power supply layout design can be more forgiving.
- The PCB traces to HC864-AUTO and the Bypass capacitor must be wide enough to ensure no significant voltage drops to occur when the 2A current peaks are absorbed. This is a must for the same above-mentioned reasons. 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 (usually 100-500 kHz).
- The use of a good common ground plane is suggested.
- The placement of the power supply on the board must be done in a way to guarantee that the high current return paths in the ground plane are not

overlapped to any noise sensitive circuitry as the microphone amplifier/buffer or earphone amplifier.

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

6. Antenna(s)

The antenna connection and board layout design are the most important parts in the full product design and they strongly reflect on the product's overall performances. Read carefully and follow the requirements and the guidelines for a proper design.

6.1. GSM/WCDMA Antenna Requirements

As suggested on the Product Description, the antenna for a Telit HC864-AUTO device must fulfill the following requirements:

GSM / WCDMA Antenna Requirements	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer must use the most suitable antenna for that/those band(s)
Bandwidth	GSM850 : 70 MHz GSM900 : 80 MHz GSM1800(DCS) : 170 MHz GSM1900(PCS) : 140 MHz WCDMA band I(2100) : 250 MHz WCDMA band II(1900) : 140 MHz WCDMA band IV(AWS) : 445 MHz WCDMA band V(850) : 70 MHz WCDMA band VIII(900) : 80 MHz
Impedance	50 Ohm
Input power	> 33dBm(2 W) peak power in GSM > 24dBm Average power in WCDMA
VSWR absolute max	<= 5:1(limit to avoid permanent damage)
VSWR recommended	<= 2:1(limit to fulfill all regulatory requirements)

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

This device is to be used only for mobile and fixed application. In order to re-use the Telit FCC/IC approvals 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. If antenna is installed with a separation distance of less than 20 cm from all persons or is co-located or operating in conjunction with any other antenna or transmitter then additional FCC/IC testing may be required. 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 HC864-AUTO module. Antennas used for this OEM module must not exceed 2dBi gain for mobile and fixed operating configurations.

6.2. GSM/WCDMA Antenna - Installation Guidelines

- Install the antenna in a place covered by the GSM/WCDMA signal.
- The Antenna shall 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;
- If the device antenna is located greater then 20cm from the human body and there are no co-located transmitter then the Telit FCC/IC approvals can be re-used by the end product.
- If the device antenna is located less then 20cm from the human body or there are no co-located transmitter then the additional FCC/IC testing may be required for the end product (Telit FCC/IC approvals cannot be reused)
- Antenna shall not be installed inside metal cases;
- Antenna shall be installed also according Antenna manufacturer instructions.

6.3. GPS/GNSS and RX diversity Antenna Requirements

The HC864-AUTO supports the GPS/GNSS and WCDMA RX diversity receiver.
The HC864-AUTO module provides one RF PAD for GPS/GNSS and RX diversity.
So the HC864-AUTO requires a combined GPS/RX diversity antenna for the simultaneous use of GPS/GNSS and WCDMA RX diversity.

6.3.1. GPS/GNSS Antenna Requirements

The customer shall use an external active antenna for the use of GNSS receiver.

The external active antenna for the Telit HC864-AUTO device must fulfill the following requirements:

ACTIVE GPS/GNSS Antenna Requirements	
Frequency range	1565 MHz ~ 1606 MHz
Gain	1.5 dBi < Gain < 4.5 dBi
Impedance	50 Ω
VSWR	<= 2:1
Noise figure	<= 1.0 dB
Amplification	14 dB ~ 17 dB

6.3.2. RX Diversity Antenna Requirements

The WCDMA RX diversity antenna for the Telit HC864-AUTO 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	WCDMA band I(2100) : 60 MHz ~ WCDMA band II(1900) : 60 MHz WCDMA band IV(AWS) : 45 MHz WCDMA band V(850) : 25 MHz WCDMA band VIII(900) : 35 MHz
Impedance	50Ω
VSWR recommended	≤ 2:1

The second Rx antenna should not be located in the close vicinity of main antenna. In order to improve Diversity Gain, Isolation and reduce mutual interaction, the two antennas should be located at the maximum reciprocal distance possible, taking into consideration the available space into the application.

6.4. GPS/GNSS Antenna Installation Guidelines

- The HC864-AUTO due to its characteristics of sensitivity is capable to perform a Fix inside the buildings. (In any case the sensitivity could be affected by the building characteristics i.e. shielding).
- The Antenna shall 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.

7. Logic Level Specifications

The following table shows the logic level specifications used in the Telit HC864-AUTO interface circuits:

NOTE:

Do not connect HC864-AUTO's digital logic signal directly to OEM's digital logic signal of with level higher than 3.0V for 2.6V CMOS signals.

Do not connect HC864-AUTO's digital logic signal directly to OEM's digital logic signal of with level higher than 2.7V for 1.8V CMOS signals.

For 2.6V CMOS signals:

Absolute Maximum Ratings -Not Functional

Parameter	HC864-AUTO	
	Min	Max
Input level on any digital pin when on	-0.3V	+3.0V
Input voltage on analog pins when on	-0.3V	+2.7 V

Operating Range - Interface levels

Level	HC864-AUTO	
	Min	Max
Input high level	2.0V	2.6 V
Input low level	-0.3V	0.6V
Output high level	2.2V	2.6V
Output low level	0V	0.4V

For 1,8V CMOS signals:

Absolute Maximum Ratings -Not Functional

Parameter	HC864-AUTO	
	Min	Max
Input level on any digital pin when on	-0.3V	+2.7V
Input voltage on analog pins when on	-0.3V	+2.7 V

Operating Range - Interface levels (1.8V CMOS)

Level	HC864-AUTO	
	Min	Max
Input high level	1.5V	2.1V
Input low level	-0.3V	0.5V
Output high level	1.35V	1.8V
Output low level	0V	0.45V

7.1. Reset Signal

Signal	Function	I/O	PIN Number
RESET	Phone reset	I	54

RESET is used to reset the HC864-AUTO module. Whenever this signal is pulled low HC864-AUTO is reset. When the device is reset it stops all operations. After the release of the reset HC864-AUTO is unconditionally shut down, without doing any detach operations from the network where it is registered. This behavior is not a proper shutdown because the device is requested to issue a detach request on turn off. For this reason, the Reset signal must not be used for 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. 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 HC864-AUTO. Use the ON/OFF signal to perform this function or the AT#SHDN command.

Reset Signal Operating levels:

Signal	Min	Max
RESET Input high	1.5V*	2.1V
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, it must always be connected with an open collector transistor to permit the internal circuitry the power on reset and under voltage lockout functions.

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.

8. Serial Ports

The serial port on the Telit HC864-AUTO is the interface between the module and OEM hardware.

2 serial ports are available on the module:

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

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.

8.1. Modem Serial Port

Several configurations can be designed for the serial port on the OEM hardware.

The most common are:

- RS232 PC com port;
- microcontroller UART @ 2.6V (Universal Asynchronous Receive Transmit) ;
- microcontroller UART @ 5V or other voltages different from 2.6V.

Depending on 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 2.6V UART.

The serial port on HC864-AUTO is a +2.6V UART with all the 7 RS232 signals. It differs from the PC-RS232 in signal polarity (RS232 is reversed) and levels.

The levels for HC864-AUTO UART are the CMOS levels:

Absolute Maximum Ratings -Not Functional

Parameter	HC864-AUTO	
	Min	Max
Input level on any digital pin when on	-0.3V	+3.0V
Input voltage on analog pins when on	-0.3V	+2.7 V

Operating Range - Interface levels

Level	HC864-AUTO	
	Min	Max
Input high level	2.0V	2.6 V
Input low level	-0.3V	0.6V
Output high level	2.2V	2.6V
Output low level	0V	0.4V

The signals of the HC864-AUTO serial port are:

RS232 Pin Number	Signal	HC864-AUTO Pad Number	Name	Usage
1	DCD - dcd_uart	32	Data Carrier Detect	Output from the HC864-AUTO that indicates the carrier presence
2	RXD - Tx_uart	26	Transmit line *see Note	Output transmit line of the HC864-AUTO UART
3	TXD - Rx_uart	25	Receive line *see Note	Input receive of the HC864-AUTO UART
4	DTR - dtr_uart	29	Data Terminal Ready	Input to the HC864-AUTO that controls the DTE READY condition
5	GND	5,6,7	Ground	ground
6	DSR - dsr_uart	27	Data Set Ready	Output from the HC864-AUTO that indicates the module is ready
7	RTS - rts_uart	31	Request to Send	Input to the HC864-AUTO that controls the Hardware flow control
8	CTS - cts_uart	28	Clear to Send	Output from the HC864-AUTO that controls the Hardware flow control
9	RI - ri_uart	30	Ring Indicator	Output from the HC864-AUTO that indicates the Incoming call condition

TIP:

For 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:

According to V.24, RX/TX signal names are referred to the application side, therefore on the HC864-AUTO 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 HC864-AUTO serial port and vice versa for RX.

8.2. RS232 Level Translation

In order to interface the Telit HC864-AUTO with a PC com port or a RS232 (EIA/TIA-232) application a level translator is required. This level translator must:

- invert the electrical signal in both directions;
- Change the level from 0/2.6V 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 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 drivers and receivers 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 0-2.6V UART to the RS232 level. The receiver is the translator from the RS232 level to 0-2.6V UART.

In order to translate the whole set of control lines of the UART you will need:

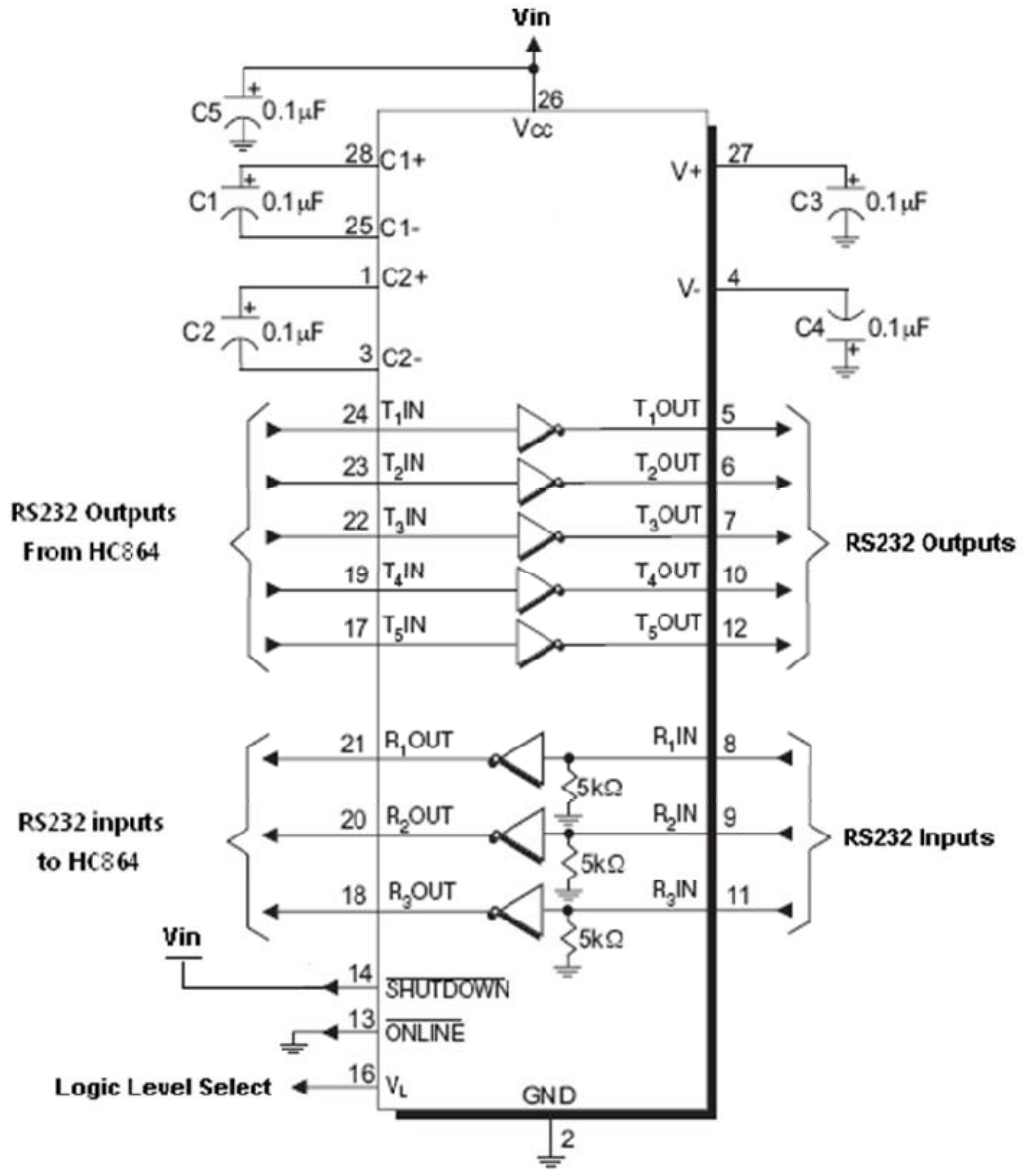
- 5 drivers
- 3 receivers

NOTE:

The digital input lines working at 2.6V 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 +2.6V (dedicated) power supply.

This is because in this way the level translator IC outputs on the module side (i.e. HC864-AUTO inputs) will work at +3.8V interface levels, damaging the module inputs.

An example of level translation circuitry of this kind is:

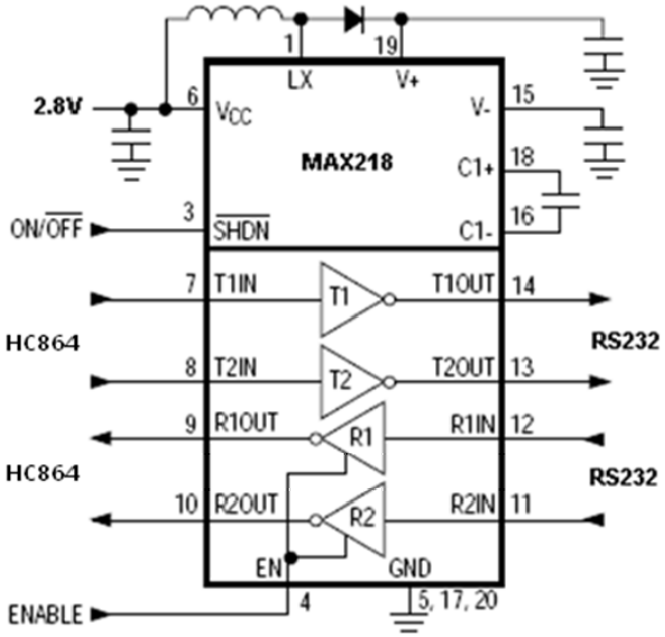


The example is done with a SIPEX SP3282EB RS232 Transceiver that could accept supply voltages lower than 3V DC.

NOTE:

In this case Vin has to be set with a value compatible with the logic levels of the module (Max 2.6V DC). In this configuration the SP3282EB will adhere to EIA/TIA-562 voltage levels instead of RS232 (-5 ~ +5V)

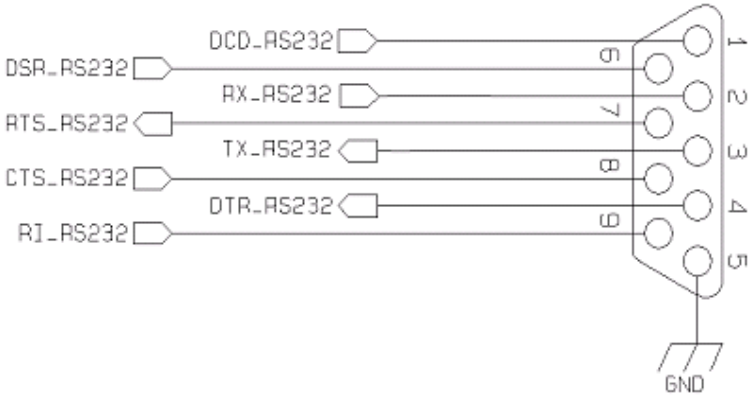
Second solution could be done using a MAXIM transceiver (MAX218) In this case the compliance with RS232 (+-5V) is possible.



Another level adapting method could be done using a standard RS232 Transceiver (MAX3237EAI) adding some resistors to adapt the levels on the HC864-AUTO Input lines.

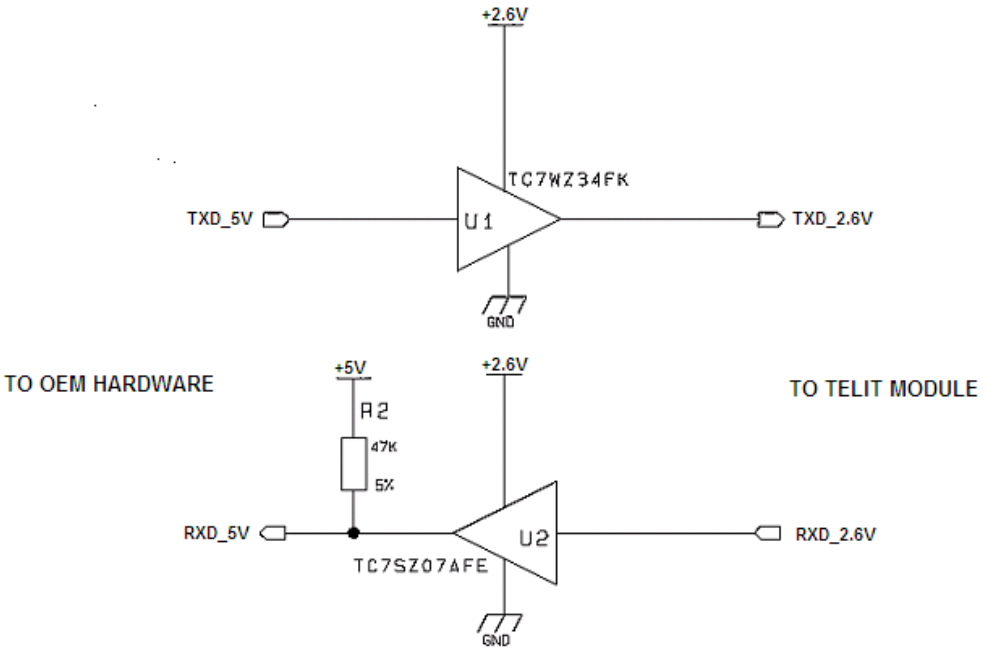
NOTE:
In this case has to be taken in account the length of the lines on the application to avoid problems in case of High-speed rates on RS232.

The RS232 serial port lines are usually connected to a DB9 connector with the following layout: signal names and directions are named and defined from the DTE point of view



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 2.6, then a circuitry has to adapt the different levels of the two signal sets. 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 2.6V pull-ups (not the 5V one) can be powered directly from VAUX1 line of HC864-AUTO. Note that the TC7SZ07AE has open drain output; therefore the resistor R2 is mandatory.

A power source of the internal interface voltage corresponding to the 2.6V CMOS high level is available at the VAUX1 pin on the connector.

A maximum of 9 resistors of 47 KΩ pull-up can be connected to the VAUX1 pin, provided no other devices are connected to it and the pulled-up lines are HC864-AUTO input lines connected to open collector outputs in order to avoid latch-up problems on HC864-AUTO.

Careful approach is needed to avoid latch-up on HC864-AUTO and the use of this output line to power electronic devices must 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 HC864-AUTO functionality .

TIP:

The input lines working at 2.6VCMOS can be pulled-up with 47KΩ resistors that can be connected directly to the VAUX1 line. It is a must that they are connected as in this example.

The preferable configuration is having external supply for the buffer.

9. Audio Section

HC864-AUTO module doesn't support an analog audio interface and supports only PCM interface. HC864-AUTO module can be connected to external codec through PCM interface.
For further information, please refer to the "HC864-AUTO_Digital_Voice_Interface_Application_Note".

10. USB Port

The HC864-AUTO module includes a Universal Serial Bus (USB) transceiver, which operates at USB low-speed (1.5Mbits/sec), USB full-speed (12Mbits/sec) and USB high-speed (480Mbits/sec).

It is compliant with the USB 2.0 specification and can be used for diagnostic monitoring, control and data transfers.

The USB_DPLUS and USB_DMINUS signals have a clock rate of 480MHz. The signal traces should be routed carefully. Trace lengths, number of vias and capacitive loading should be minimized. The impedance value should be as close as possible to 90 Ohms differential.

The table below describes the USB interface signals:

Signal	HC864-ATUO Pad No.	Usage
USB_VBUS	48	Power sense for the internal USB transceiver
USB_D-	80	Minus (-) line of the differential, bi-directional USB signal to/from the peripheral device
USB D+	79	Plus (+) line of the differential, bi-directional USB signal to/from the peripheral device
USB_ID (for future use)	35	Analog input used to sense whether a peripheral device is connected and if connected, to determine the peripheral type, host or slave

TIP:

HC864-AUTO does NOT support host device operation at the moment, that is, it works as a slave device. Consequently USB_ID must be opened (not connected).

11. 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 HC864-AUTO firmware and acts depending on the function implemented.

The following GPIOs are available on the HC864-AUTO.

PIN	Signal	I/O	Function	Type	Drive strength	Default State	ON_OFF State	Reset State	Note
70	TGPIO_01	I/O	GPIO01 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
74	TGPIO_02	I/O	GPIO02 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
66	TGPIO_03	I/O	GPIO03 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
59	TGPIO_04	I/O	GPIO04 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
78	TGPIO_05	I/O	GPIO05 Configurable GPIO	CMOS 2.6V	2mA	INPUT	LOW	LOW	
68	TGPIO_06	I/O	GPIO06 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	Alternate function (ALARM)
73	TGPIO_07	I/O	GPIO07 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
67	TGPIO_08	I/O	GPIO08 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
76	TGPIO_09	I/O	GPIO09 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
63	TGPIO_10	I/O	GPIO10 Configurable GPIO	CMOS 2.6V	2mA	INPUT	LOW	LOW	
57	TGPIO_11	I/O	GPIO11 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
62	TGPIO_12	I/O	GPIO12 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
77	TGPIO_13	I/O	GPIO13 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	

60	TGPIO_14	I/O	GPIO14 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
61	TGPIO_15	I/O	GPIO15 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
75	TGPIO_16	I/O	GPIO16 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
71	TGPIO_17	I/O	GPIO17 Configurable GPIO	CMOS 2.6V	2mA	INPUT	LOW	LOW	
65	TGPIO_18	I/O	GPIO18 Configurable GPIO	CMOS 2.6V	2mA	INPUT	LOW	LOW	
56	TGPIO_19	I/O	GPIO19 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
58	TGPIO_20	I/O	GPIO20 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	
72	TGPIO_21	I/O	GPIO21 Configurable GPIO	CMOS 1.8V	2mA	INPUT	HIGH	HIGH	
64	TGPIO_22	I/O	GPIO22 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	LOW	

Not all GPIO pads support all these three modes:

- GPIO6 supports all three modes and can be input, output, alarm output (Alternate function)

Some alternate functions for HC864-AUTO may be added if needed.

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.

11.1. Logic Level Specifications

The following table shows the logic level specifications used in the HC864-AUTO interface circuits:

For 2.6V CMOS signals:

Absolute Maximum Ratings -Not Functional

Parameter	HC864-AUTO	
	Min	Max
Input level on any digital pin when on	-0.3V	+3.0V
Input voltage on analog pins when on	-0.3V	+2.7 V

Operating Range - Interface levels

Level	HC864-AUTO	
	Min	Max
Input high level	2.0V	2.6 V
Input low level	-0.3V	0.6V
Output high level	2.2V	2.6V
Output low level	0V	0.4V

For 1,8V signals:

Absolute Maximum Ratings -Not Functional

Parameter	HC864-AUTO	
	Min	Max
Input level on any digital pin when on	-0.3V	+2.7V
Input voltage on analog pins when on	-0.3V	+2.7 V

Operating Range - Interface levels (1.8V CMOS)

Level	HC864-AUTO	
	Min	Max
Input high level	1.5V	2.1V
Input low level	-0.3V	0.5V
Output high level	1.35V	1.8V
Output low level	0V	0.45V

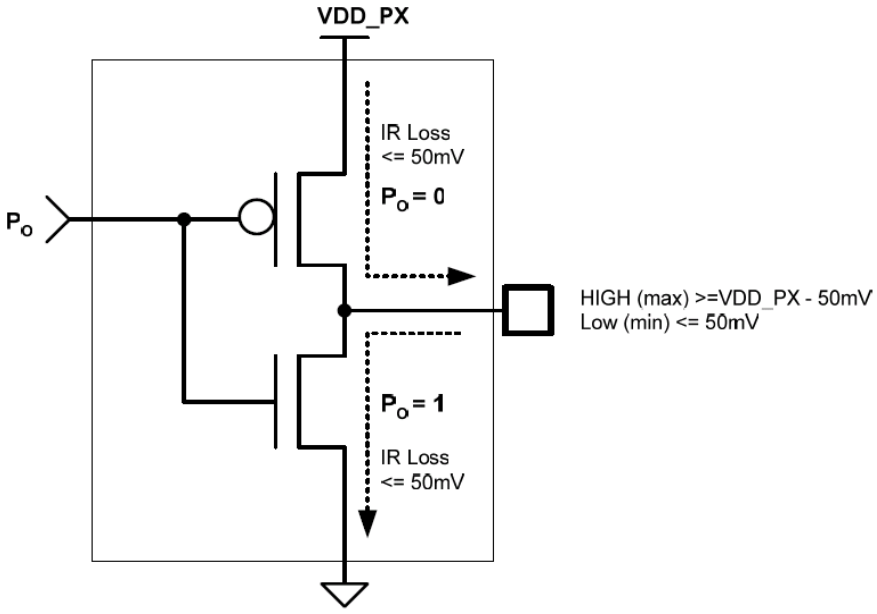
11.2. Using a GPIO Pad as Input

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 1.8V/2.6V CMOS levels of the GPIO.

If the digital output of the device is connected with the GPIO input, the pad has interface levels different from the 1.8V/2.6V CMOS. It can be buffered with an open collector transistor with a 47KΩ pull-up resistor to 1.8V/2.6V.

11.3. Using a GPIO Pad as Output

The GPIO pads, when used as outputs, can drive 1.8V/2.6V 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.



output PAD equivalent circuit

11.4. Using the Alarm Output GPIO6

The GPIO6 pad, when configured as Alarm Output, is controlled by the HC864-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 HC864-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 or the HC864-AUTO during sleep periods. This will dramatically reduce 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.

11.5. Using the Temperature Monitor Function

11.5.1. 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 raises to High Logic level a GPIO when the maximum temperature is reached.

11.5.2. Allowed GPIO

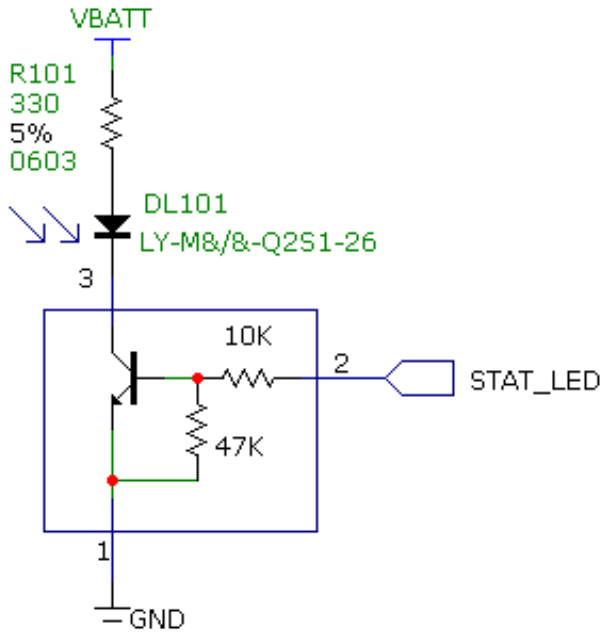
The AT#TEMPMON set command could be used with one of the following GPIO:

Signal	Function	Type	Drive strength	Note
GPIO_01	GPIO01 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_03	GPIO03 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_08	GPIO08 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_09	GPIO09 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_10	GPIO10 Configurable GPIO	CMOS 2.6V	2mA	
GPIO_11	GPIO11 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_12	GPIO12 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_13	GPIO13 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_14	GPIO14 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_15	GPIO15 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_16	GPIO16 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_17	GPIO17 Configurable GPIO	CMOS 2.6V	2mA	
GPIO_18	GPIO18 Configurable GPIO	CMOS 2.6V	2mA	
GPIO_19	GPIO19 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_20	GPIO20 Configurable GPIO	CMOS 1.8V	2mA	
GPIO_22	GPIO22 Configurable GPIO	CMOS 1.8V	2mA	

11.6. Indication of Network Service Availability

The STAT_LED pin status shows information on the network service availability and Call status. In the HC864-AUTO modules, the STAT_LED usually needs an external transistor to drive an external LED. Because of the above, 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



11.7. 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.

NOTE:

NO devices must be powered from this pin.

11.8. VAUX1 Power Output

A regulated power supply output is provided in order to supply small devices from the module. This output is active when the module is ON and goes OFF when the module is shut down. The operating range characteristics of the supply are:

Operating Range – VAUX1 power supply

	Min	Typical	Max
Output voltage	2.6V	2.65V	2.7V
Output current			100mA
Output bypass capacitor (Inside the module)			2.2µF

12. DAC and ADC section

12.1. DAC Converter

12.1.1. Description

The HC864-AUTO module provides a Digital to Analog Converter. The signal (named DAC_OUT) is available on pin 40 of the HC864-AUTO module and on pin 17 of PL102 on EVK2 Board (CS1203).

The on board DAC is in the range from 0 to 1023.

However, an external low-pass filter is necessary.

	Min	Max	Units
Voltage range (filtered)	0	1.8	Volt
Range	0	1023	Steps

The precision is 1023 steps, 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.

12.1.2. Enabling DAC

An AT command is available to use the DAC function.

The command is:AT#DAC[=<enable>[,<value>]]

<value> - scale factor of the integrated output voltage (0..1023 - 10 bit precision)

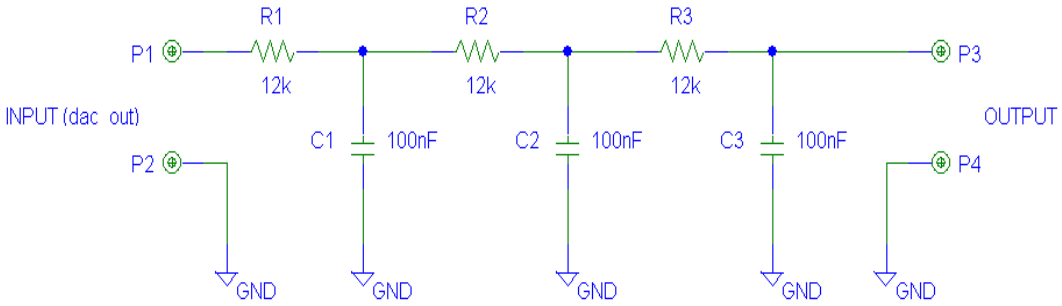
it must be present if <enable>=1

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.

12.1.3. Low Pass Filter Example



12.2. ADC Converter

12.2.1. Description

The on board ADCs are 8-bit converters. They are able to read a voltage level in the range of 0-2 volts applied on the ADC pin input and store and convert it into 8 bit word.

	Min	Max	Units
Input Voltage range	0	2.0	Volt
AD conversion	-	8	bits
Resolution	-	< 8.6	mV

The HC864-AUTO module provides 2 Analog to Digital Converters.

The input lines are:

ADC_IN1 available on Pin 37 and Pin 19 of PL102 on EVK2 Board (CS1203)

ADC_IN2 available on Pin 38 and Pin 20 of PL102 on EVK2 Board (CS1203)

12.2.2. 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.

13. Accelerometer

13.1. Description

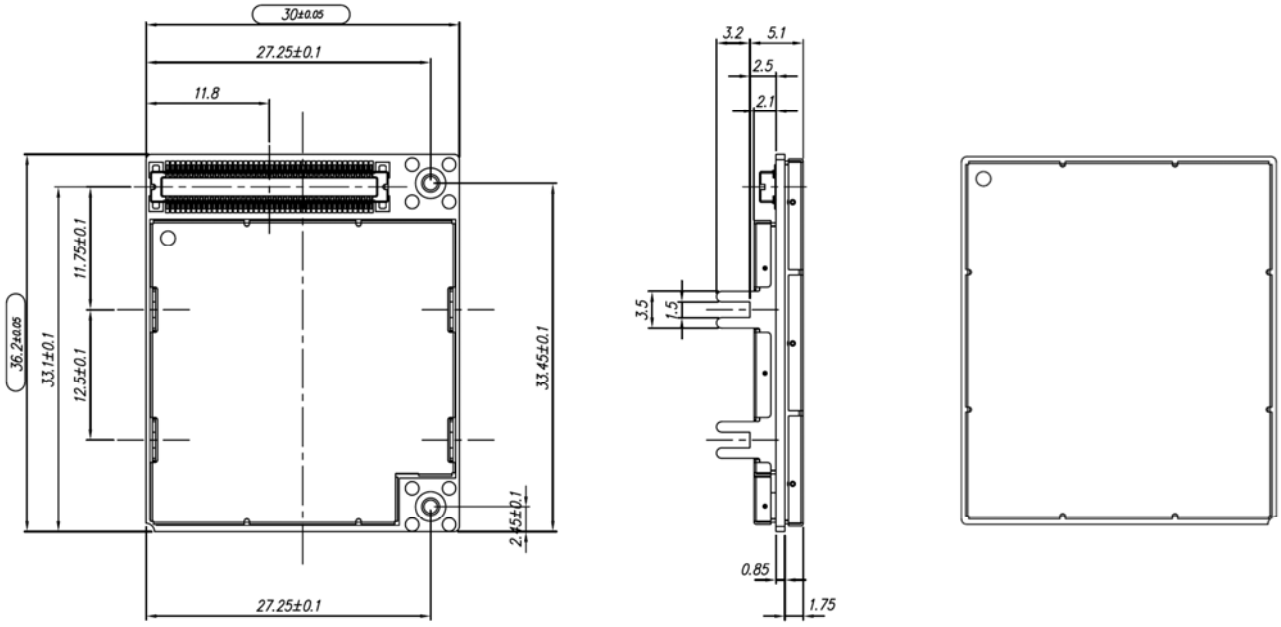
HC864-AUTO has a tri-axial, low-g acceleration sensor IC which is one of the BOSCH products.

It can sense the factors such as tilt, motion and shock vibration so on.

Please refer to the “HC864-AUTO AT Command Reference Guide” for the detailed use.

14. Mounting the module on your board

The position of the Molex board-to-board connector and pin 1 are shown in the following picture.



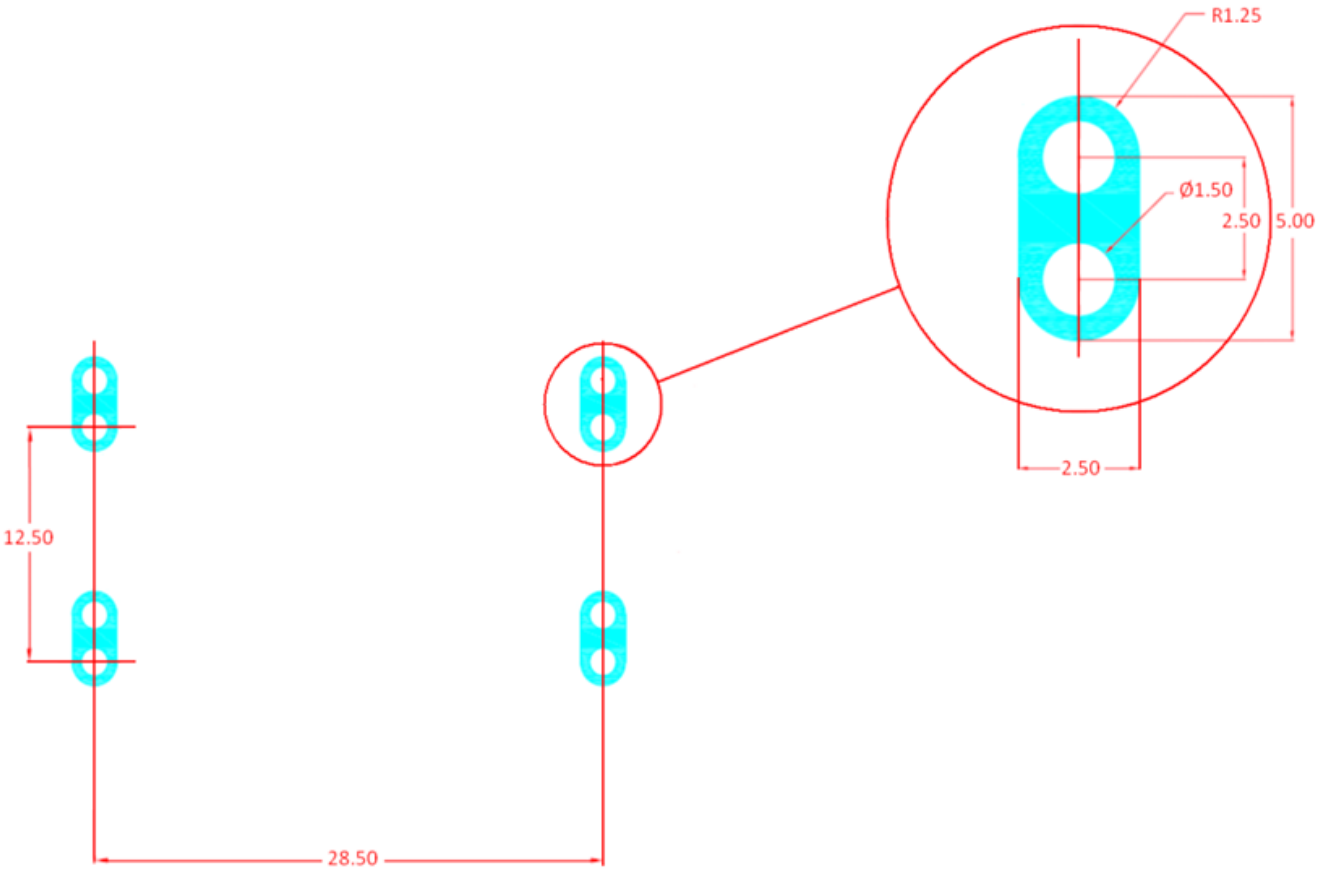
NOTE:

The Metal taps present on HC864-AUTO must be connected to GND.

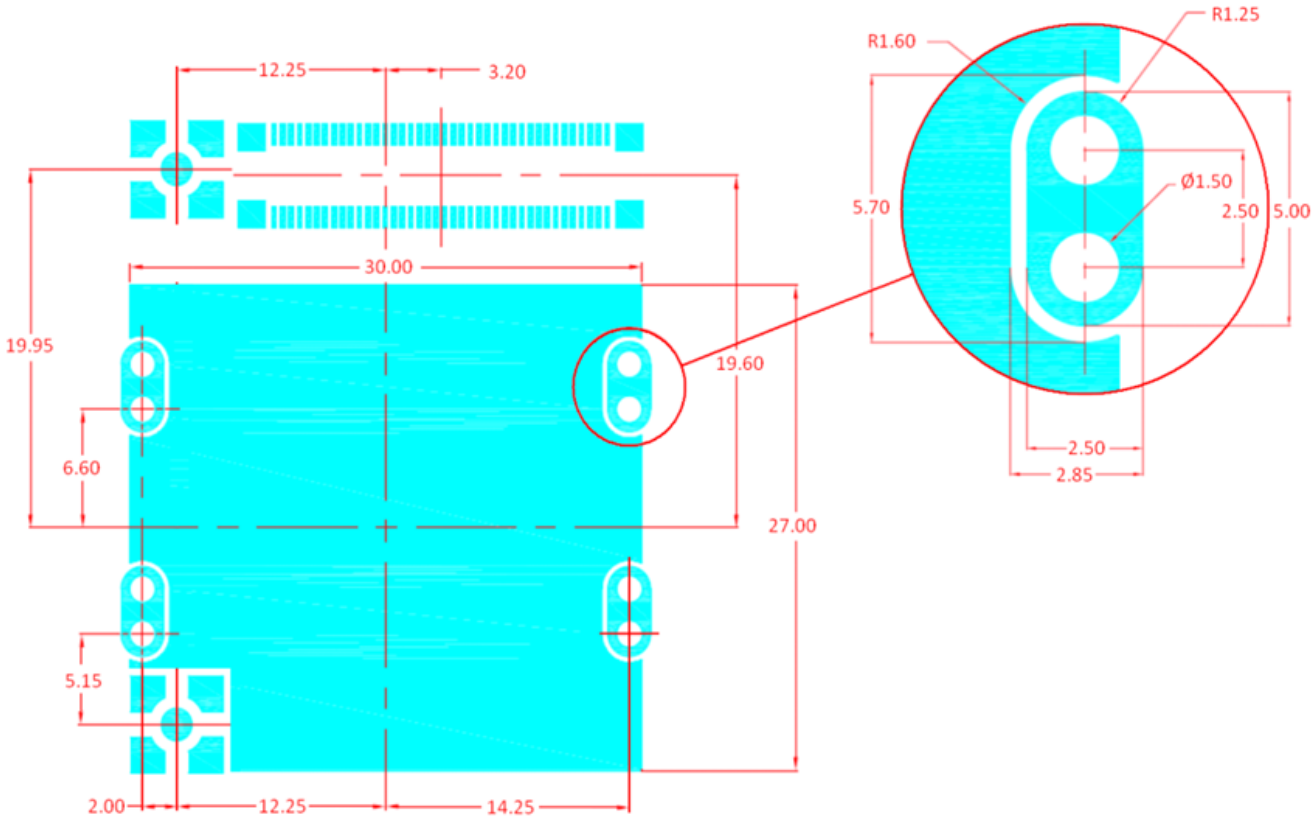
This module could not be processed with a reflow.

14.1. Application PCB layout

To obtain the best thermal dissipation it is suggested to design the host PCB as in the below image where a Ground area has been created below the module.

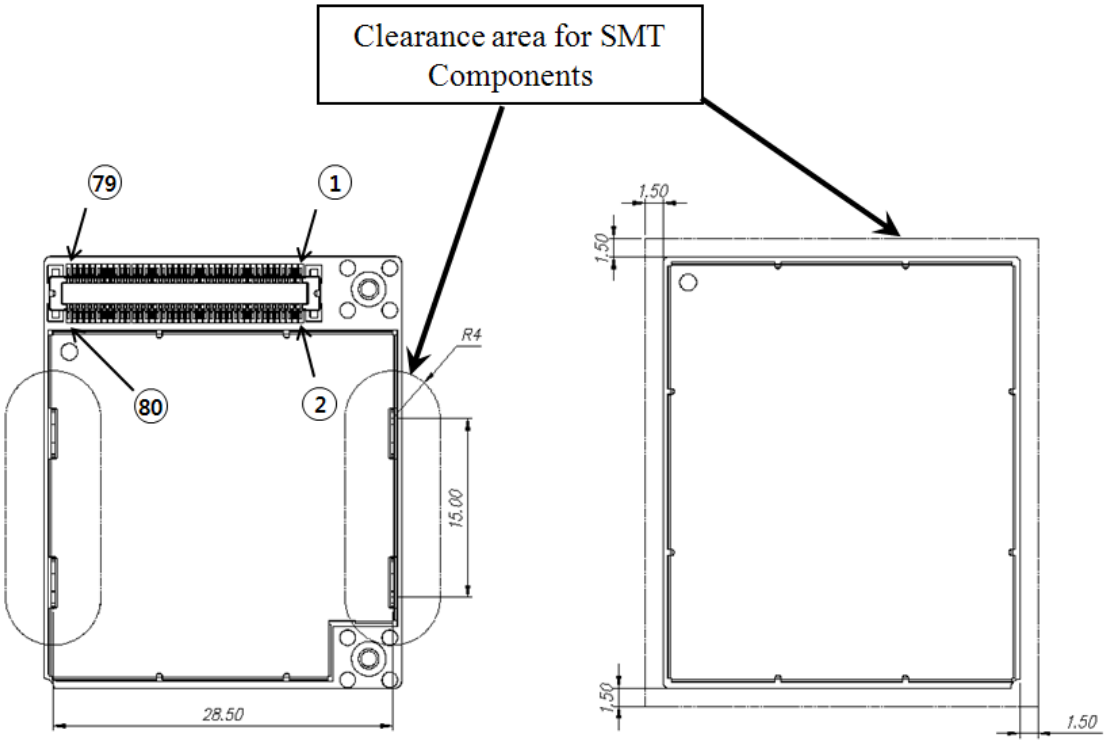


Bottom side
Top View



Top side
Top View

14.2. Clearance Area



BOTTOM SIDE

TOP SIDE

14.3. Thermal Dissipation

To permit a better thermal dissipation it is suggested to use a Thermal conductive material between the module and the application PCB.

Suggested types are Bergquist (Two parts) GAP filler 3500 or GAP Filler 1500

14.4. Module Soldering

The module could be soldered on the application in different kind of ways. Typical processes are follows:

- Manual Soldering
- Automatic Selective soldering
- Wave soldering

We suggest respecting necessary Clearance area in the design to permit a proper soldering process as shown in previous chapter.

15. Application guide

15.1. Debug of the HC864-AUTO in production

To test and debug the mounting of HC864-AUTO, we strongly recommend to foresee test pads on the host PCB, in order to check the connection between the HC864-AUTO itself and the application and to test the performance of the module connecting it with an external computer. Depending on 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
- USB_VBUS
- USB_D+
- USB_D-

15.2. Bypass capacitor on Power supplies

When a sudden voltage is asserted to or cut from the power supplies,
The steep transition makes some reactions such as the overshoot and undershoot.
This abrupt voltage transition can affect the device not to work or make it malfunction.
The bypass capacitors are needed to alleviate this behavior and it can be affected differently according to the various applications. The customers have to pay special attention to this when they design their application board..
The length and width of the power lines need to be considered carefully and the capacitance of the capacitors need to be selected accordingly.
The capacitor will also avoid the ripple of the power supplies and the switching noise caused in TDMA system like GSM.
Specially the suitable bypass capacitor must be mounted on the Vbatt (Pin 1,2,3,4) lines in the application board.

The recommended values can be presented as;

- 100uF for Vbatt

But the customers still have to consider that the capacitance mainly depends on the conditions of their application board.
Generally more capacitance is required as the power line is longer.

15.3. SIM interface

The resistor value on SIMIO pulled up to SIMVCC should be defined accordingly in order to be compliant to 3GPP specification.
6.8kohm can be recommended but it may depend on the application design.
Refer to the following document for the detail;

- Telit_SIM_interface_and ESD_protection_Application_note_r1

15.4. EMC recommendations

HC864-AUTO signals are provided by some EMC protections. In any case the accepted levels are different on the pins. The characteristics are described in the following Table:

Pin	Signal	I/O	Function	Contact	Air
Power Supply					
1,2,3,4	VBATT	-	Main power supply	± 8KV	± 15KV
SIM Card Interface					
18	SIMVCC	-	External SIM signal – Power supply for the SIM	± 8KV	± 15KV
19	SIMRST	O	External SIM signal – Reset	± 8KV	± 15KV
20	SIMIO	I/O	External SIM signal - Data I/O	± 8KV	± 15KV
22	SIMCLK	O	External SIM signal – Clock	± 8KV	± 15KV
Miscellaneous Functions					
35	USB_ID	AI	Analog input used to sense whether a peripheral device is connected	± 8KV	± 15KV
Miscellaneous Functions					
48	USB_VBUS	AI	Power sense for the internal USB transceiver	± 8KV	± 15KV
50	VAUX1	-	Power output for external accessories	± 8KV	± 15KV
53	ON/OFF	I	Input command for switching power ON or OFF (toggle command).	± 8KV	± 15KV
54	RESET	I	Reset input	± 8KV	± 15KV
55	VRTC	AO	Power supply for RTC block	± 8KV	± 15KV
Antenna					
PAD	Antenna Pad	AI	Antenna pad for Rosenberger connector	± 8KV	± 15KV

All other pins have the following characteristics:
HBM JESD22-A114-B ± 2000 V
CDM JESD22-C101-C ± 500 V

The Board to Board connector has to be considered as NO TOUCH area.

Appropriate series resistors have to be considered to protect the input lines from overvoltage.

15.5. Download and Debug Port

One of the following options should be chosen in the design of host system in order to download or upgrade the Telit's software and debug HC864-AUTO when HC864-AUTO is already mounted on a host system.

Users who use both of UART and USB interfaces to communicate HC864-AUTO

- Must implement a download method in a host system for upgrading HC864-AUTO when it's mounted.

Users who use USB interface only to communicate HC864-AUTO

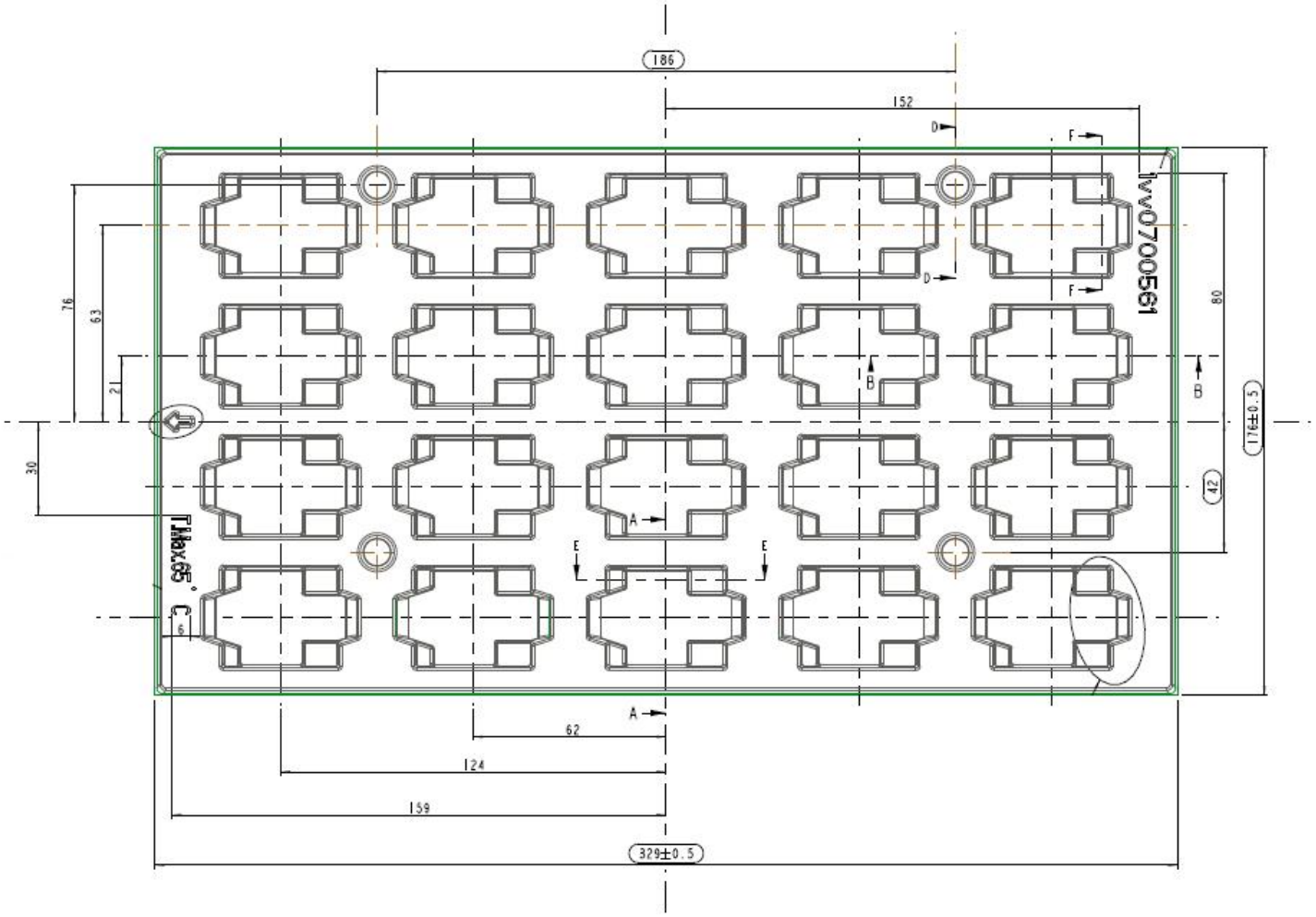
- Must arrange UART port in a host system for debugging or upgrading HC864-AUTO when it's mounted.

Users who use UART interface only to communicate HC864-AUTO

- Must arrange USB port in a host system for debugging or upgrading HC864-AUTO when it's mounted.

16. Packing system

The Telit HC864-AUTO is packaged on trays. Each tray contains 20 pieces with the following dimensions:



NOTE:

Trays can withstand the maximum temperature of 65° C.

17. Conformity Assessment Issues

17.1. 1999/5/EC Directive

The HC864-AUTO module has been assessed in order to satisfy the essential requirements of the R&TTE Directive 1999/05/EC (Radio Equipment & Telecommunications Terminal Equipments) to demonstrate the conformity against the harmonized standards with the final involvement of a Notified Body.

In order to satisfy the essential requirements of 1999/5/EC Directive, the HC864-AUTO is compliant with the following standards:

RF spectrum use (R&TTE art. 3.2)	EN 300 440-2 V1.4.1 EN 301 511 V9.0.2 EN 301 908-1 V5.2.1 EN 301 908-2 V5.2.1
EMC (R&TTE art. 3.1b)	EN 301 489-1 V1.9.2 EN 301 489-3 V1.4.1 EN 301 489-7 V1.3.1 EN 301 489-24 V1.5.1
Health & Safety (R&TTE art. 3.1a)	EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011+AC:2011

The conformity assessment procedure referred to in Article 10 and detailed in Annex IV of Directive 1999/5/EC has been followed with the involvement of the following Notified Body:

AT4 wireless, S.A.
Parque Tecnologico de Andalucía
C/ Severo Ochoa 2
29590 Campanillas – Málaga
SPAIN
Notified Body No: 1909

Thus, the following marking is included in the product:

CE 1909

The full declaration of conformity can be found on the following address:
http://www.telit.com

There is no restriction for the commercialization of the HC864-AUTO module in all the countries of the European Union.

Final product integrating this module must be assessed against essential requirements of the 1999/5/EC (R&TTE) Directive. It should be noted that assessment does not necessarily lead to testing. Telit Communications S.p.A. recommends carrying out the following assessments:

RF spectrum use (R&TTE art. 3.2)	It will depend on the antenna used on the final product.
EMC (R&TTE art. 3.1b)	Testing
Health & Safety (R&TTE art. 3.1a)	Testing

Alternately, assessment of the final product against EMC (Art. 3.1b) and Electrical safety (Art. 3.1a) essential requirements can be done against the essential requirements of the EMC and the LVD Directives:

- Low Voltage Directive 2006/95/EC and product safety
- Directive EMC 2004/108/EC for conformity for EMC

17.2. FCC/IC Regulatory notices

Modification statement

Telit has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

Telit n'approuve aucune modification apportée à l'appareil par l'utilisateur, quelle qu'en soit la nature. Tout changement ou modification peuvent annuler le droit d'utilisation de l'appareil par l'utilisateur.

Interference statement

This device complies with Part 15 of the FCC Rules and Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device. This Class B digital apparatus complies with Canadian ICES-0003.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Wireless notice

This equipment complies with FCC and IC radiation exposure limits set forth for an uncontrolled environment. The antenna should be installed and operated with minimum distance of 20 cm between the radiator and your body. Antenna gain must be below:

Frequency band	HC864-AUTO
GSM850 /FDD V	2.0 dBi
PCS1900 /FDD II	2.0 dBi
FDD IV	2.0 dBi

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Cet appareil est conforme aux limites d'exposition aux rayonnements de la IC pour un environnement non contrôlé. L'antenne doit être installé de façon à garder une distance minimale de 20 centimètres entre la source de rayonnements et votre corps. Gain de l'antenne doit être ci-dessous:

Bande de fréquence	*HC864-AUTO*
GSM850 /FDD V	*2.0 dBi*
PCS1900 /FDD II	*2.0 dBi*
FDD IV	*2.0 dBi*

L'émetteur ne doit pas être colocalisé ni fonctionner conjointement avec à autre antenne ou autre émetteur.

FCC Class B digital device notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Information To Be Supplied to the End User by the OEM or Integrator notice

Modular information form OEM Information to Be Supplied to the End User by the OEM or Integrator
The following regulatory and safety notices must be published in documentation supplied to the end user of the product or system incorporating an adapter in compliance with local regulations. Host system must be labeled with "Contains IC: 5131A-HC864AUTO" or "Contains FCCID:RI7HC864-AUTO", FCC ID/IC displayed on label.

18. Safety Recommendations

READ CAREFULLY!

Be sure about that the use of this product is allowed in your 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 be installed with the guarantee of a minimum 20 cm distance from the body. 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 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

19. Document History

Revision	Date	Changes
0	2011-05-18	First issue
1	2011-07-07	Renumbered chapters Added 2 General Product Description Updated 5.1 Power Supply Requirements Updated 5.2.2 Thermal Design Guidelines Added 9 Audio Section Added 13.1 Application PCB layout Added 13.2 Clearance Area
2	2012-01-25	Renumbered chapters Changed model name from HC864 to HC864-AUTO Updated 3 HC864-AUTO Module Connections Updated 3.2 Antenna Connector(s) Updated 5.1 Power Supply Requirements Updated 5.2.1.2 + 12V Input Source Power Supply Design Guidelines Updated 5.2.2 Thermal Design Guidelines Updated 6 Antenna(s) Updated 7 Logic Level Specifications Updated 10 USB Port Updated 11 General Purpose I/O Updated 11.1 Logic Level Specifications Updated 11.4 Using the Alarm Output GPIO6 Updated 11.5 Using the Temperature Monitor Function Updated 11.8 VAUX1 Power Output Updated 12 DAC and ADC Section Added 13 Accelerometer Updated 14.2 Clearance Area Updated 15.4 EMC recommendations Added 15.5 Download Debug Port
3	2012-10-31	Updated 3.1 PIN-OUT Updated 10 USB Port Updated 15.2 Bypass capacitor on Power supplies Updated 15.4 EMC recommendations
4	2012-12-27	Updated 6.1 GSM/WCDMA Antenna Requirements Updated 6.2.2 RX Diversity Antenna Requirements Updated 6.3 GSM/WCDMA Antenna - Installation Guidelines Updated 6.4 GPS/GNSS Antenna - Installation Guidelines Added 17.1 1999/5/EC Directive Added 17.2 FCC/IC Regulatory notices