GE863 Family Hardware User Guide

For GE863-PY, GE863-QUAD, GE863-SIM and GE863-GPS
1vv0300783 Rev.4 – 2009-12-16

Making machines talk.

APPLICABILITY TABLE

PRODUCT
GE863-PY
GE863-QUAD
GE863-SIM
GE863-GPS

NOTE:

This document substitutes the following specifications:

1vv0300715 GE863-QUAD/PY Hardware User Guide
1vv0300714 GE863-GPS Hardware User Guide

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1. Introduction

1.1. Scope

The aim of this document is the description of some hardware solutions useful for developing a product with the Telit GE863-GPS / QUAD / PY / SIM modules.

1.2. Audience

This document is intended for Telit customers, who are integrators, about to implement their applications using our modules of the GE863 Family.

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: “Overview” provides an overview of the document.

Chapter 3: “GE863 Mechanical Dimensions”

Chapter 4: “GE863 Module Connections” deals with the pin out configuration and layout.

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

Chapter 6: “Power supply” Power supply requirements and general design rules.

Chapter 7: “Antenna” The antenna connection and board layout design are the most important parts in the full product design

Chapter 8: “Serial ports” The serial port on the Telit GE863 is the core of the interface between the module and OEM hardware

Chapter 9: “Audio Section overview” Refers to the audio blocks of the Base Band Chip of the GE863 Telit Modules

Chapter 10: “General Purpose I/O” How the general purpose I/O pads can be configured.

Chapter 11: “RTC and Auxiliary Supply”

Chapter 12: “PPS GPS Output (GE863-GPS only)”

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

Chapter 14: “Mounting the GE863 on the application board” Recommendations and specifics on how to mount the module on the user’s board.

1.5. Text Conventions

STOP *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.*

ℹ 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

- Telit GSM/GPRS Family Software User Guide, 1vv0300784
- GE863 Product Description, 80278ST10016a
- Audio Settings Application Note , 80000NT10007a
- Digital voice Interface Application Note, 80000NT10004a
- AT Commands Reference Guide, 80000ST10025a
- Telit EVK2 User Guide, 1vv0300704

1.7. Document History

Revision	Date	Changes
ISSUE #0	2008-06-10	First release
ISSUE #1	2009-02-03	updated P/N List §4: Updated turn on, turn off and reset procedure Added OFF current Updated operating voltage Added ATEX parameters §8 : Updated IO Levels Table
ISSUE#2	2009-03-25	Added new disclaimer Updated § 12.2 Modules with single label, orientation on the tray §4 Added clarification on Turn ON / Turn OFF pulse duration
ISSUE#3	2009-08-31	Applied new layout + minor editing Added DVI info in the pin-out section + notice Added DVI App note in the related documents list Added embodied battery charger description Noted in the pin-out section about RTS in need of being connected to ground and DTR should be pulled up if not used. Updated chapter 9 Audio Section Updated schematic drawings
ISSUE #4	2009-12-16	Updated hardware command section Updated power consumption section

2. Overview

NOTICE:

The integration of the GSM/GPRS GE863-GPS/QUAD/PY/SIM cellular module within user application must be done according to the design rules described in this manual.

In this document all the basic functions of a mobile phone are taken into account; for each one of them a proper hardware solution is suggested and eventually the wrong solutions and common errors to be avoided will be evidenced. This document is not intended to embrace the whole hardware solutions and products that may be designed. Wrong solutions to be avoided must be considered as mandatory, while hardware configurations are only suggested. This document can be regarded as a guide and a starting point to properly develop your product with the Telit GE863-GPS / QUAD / PY / SIM modules. For further hardware details that may not be explained in this document refer to the Telit GE863 Product Description document where all the hardware information is reported.

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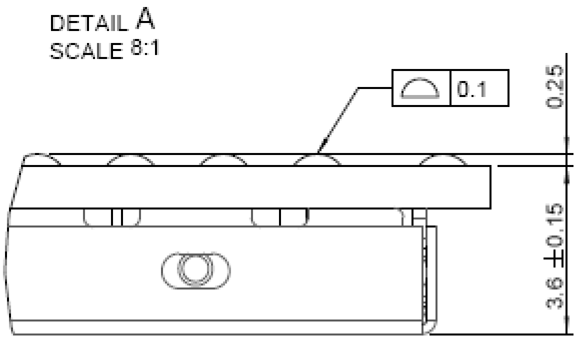
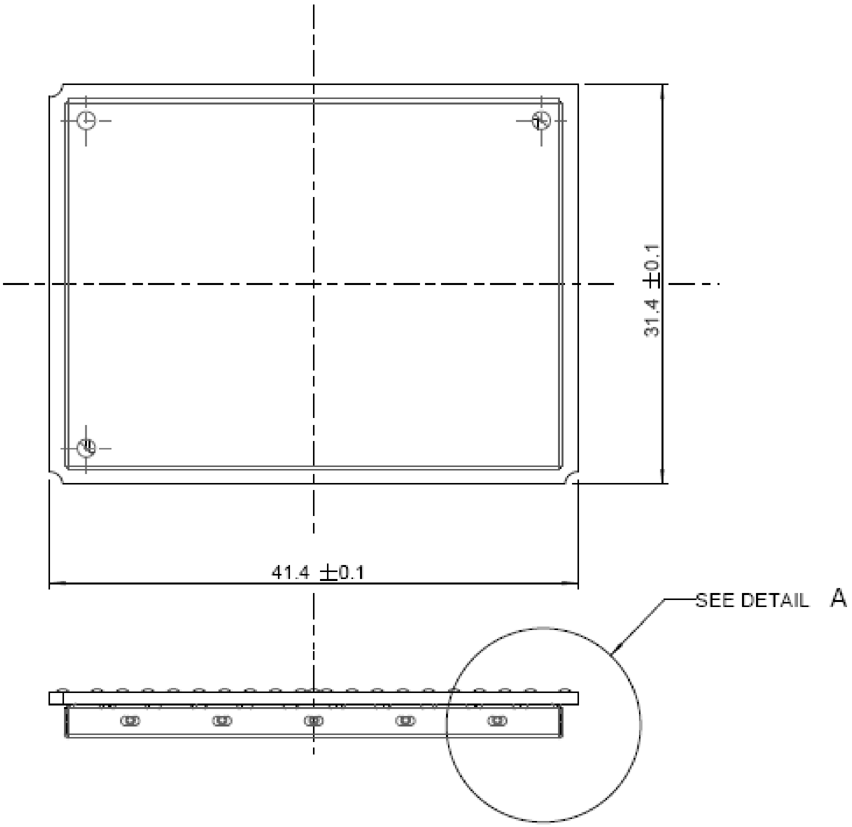
3. GE863 Mechanical Dimensions

The Telit GE863 module’s overall dimensions are:

- Length: 41,4 mm
- Width: 31,4 mm
- Thickness: 3,6 Mm


DETAIL A
SCALE 8:1
0.1
0.25
3.6 ±0.15


31.4 ±0.1
41.4 ±0.1
SEE DETAIL A

4. GE863 Module Connections

4.1. PIN-OUT

BGA Ball	Signal	I/O	Function	Internal Pull up	Type
1	GPIO13	I/O	GPIO13		CMOS 2.8V
2	GPIO12	I/O	GPIO12	47KΩ	CMOS 2.8V
3	GPIO11	I/O	GPIO11	4.7KΩ	CMOS 2.8V
4	GPIO10	I/O	GPIO10		CMOS 2.8V
5	GPIO9	I/O	GPIO9		CMOS 2.8V
6	GPIO8	I/O	GPIO8		CMOS 2.8V
7	RESERVED	-	RESERVED		-
8	GND	-	Ground		Power
9	EAR_MT-	AO	Handset earphone signal output, phase -		Audio
10	EAR_MT+	AO	Handset earphone signal output, phase +		Audio
11	EAR_HF+	AO	Handsfree ear output, phase +		Audio
12	EAR_HF-	AO	Handsfree ear output, phase -		Audio
13	MIC_MT+	AI	Handset microphone signal input; phase+		Audio
14	MIC_MT-	AI	Handset microphone signal input; phase-		Audio
15	MIC_HF+	AI	Handsfree microphone input; phase +		Audio
16	MIC_HF-	AI	Handsfree microphone input; phase -		Audio
17	GND	-	Ground		Power
18	SIMCLK	O	External SIM signal - Clock		1.8/3V ONLY
19	SIMRST	O	External SIM signal - Reset		1.8/3V ONLY
20	SIMIO	I/O	External SIM signal - Data I/O		1.8/3V ONLY
21	SIMIN	I/O	External SIM signal - Presence (active low)	47KΩ	CMOS 2.8V
22	SIMVCC	-	External SIM signal - Power		1.8/3V ONLY
23	ADC_IN1	AI	Analog /Digital converter input		A/D
24	VRTC	AO	VRTC Backup capacitor		Power
25	TX_TRACE		TX data for GPS control (TX data for Debug in case of GE863-QUAD/PY/SIM)		CMOS 2.8V
26	RX_TRACE		RX data for GPS control (RX data for Debug in case of GE863-QUAD/PY/SIM)		CMOS 2.8V
27	VBATT	-	Main power supply		Power
28	GND	-	Ground		Power
29	STAT_LED	O	Status indicator led		CMOS 1.8V
30	AXE	I	Handsfree switching	100KΩ	CMOS 2.8V
31	VAUX1	-	Power output for external accessories		-
32	GPIO4	I/O	GPIO4 Configurable general purpose I/O pin/	4.7KΩ	CMOS 2.8V

BGA Ball	Signal	I/O	Function	Internal Pull up	Type
			DVI2_CLK (Digital Voice Interface)		
33	GPIO2 / JDR	I/O	GPIO2 Configurable general purpose I/O pin / Jammer Detect Output	47KΩ	CMOS 2.8V
34	GPIO1	I/O	GPIO1 Configurable general purpose I/O pin		CMOS 2.8V
35	CHARGE	AI	Charger input		Power
36	GND	-	Ground		Power
37	C103/TXD	I	Serial data input (TXD) from DTE		CMOS 2.8V
38	C104/RXD	O	Serial data output to DTE		CMOS 2.8V
39	C108/DTR[1]	I	Input for Data terminal ready signal (DTR) from DTE		CMOS 2.8V
40	C105/RTS[2]	I	Input for Request to send signal (RTS) from DTE		CMOS 2.8V
41	C106/CTS	O	Output for Clear to send signal (CTS) to DTE		CMOS 2.8V
42	C109/DCD	O	Output for Data carrier detect signal (DCD) to DTE		CMOS 2.8V
43	C107/DSR	O	Output for Data set ready signal (DSR) to DTE		CMOS 2.8V
44	C125/RING	O	Output for Ring indicator signal (RI) to DTE		CMOS 2.8V
45	GND	-	Ground		Power
46	ON_OFF*	I	Input command for switching power ON or OFF (toggle command).	47KΩ	Pull up to VBATT
47	RESET*	I	Reset input		
48	GND	-	Ground		Power
49	ANTENNA	O	GSM Antenna output - 50 Ω		RF
50	GND	-	Ground		Power
51	GPIO7 / BUZZER	I/O	GPIO7 / BUZZER output		CMOS 2.8V
52	PWRMON	O	Power ON Monitor		CMOS 2.8V
53	GPIO5 RFTXMON	I/O	GPIO5 / RF TX_ON signalling output		CMOS 2.8V
54	GPIO6 ALARM	I/O	GPIO6 / ALARM output		CMOS 2.8V
55	GPIO3	I/O	GPIO3	47KΩ	CMOS 2.8V
56	GND	-	Ground		Power

---

[1] DTR Lines should be set correctly (pull-up), since a transition of the DTR causes closing of multiplexer

[2] RTS should be connected to the GND (on the module side) if flow control is not used.

BGA Ball	Signal	I/O	Function	Internal Pull up	Type
57	RESERVED	-	RESERVED		-
58	**CLK**	I/O	Python Debug (CLK) [3]		CMOS 2.8V
59	GPIO17	I/O	GPIO17 Configurable general purpose I/O pin/ DVI2_WA (Digital Voice Interface)		CMOS 2.8V
60	**GPIO14**	I/O	GPIO		-
61	MRST	I/O	Python Debug (MRST) [3]		-
62	RESERVED	-	RESERVED		-
63	DAC_OUT	O	DAC out		
64	GPIO16	I/O	GPIO		CMOS 2.8V
65	RESERVED	-	RESERVED		-
66	MTSR	I/O	Python Debug (MTSR) [3]		-
67	GND	-	Ground		Power
68	TX_GPS	-	GPS serial Port (TX) [3]		-
69	GND	-	Ground		Power
70	RESERVED	-	RESERVED		-
71	GPIO15	I/O	GPIO		-
72	GND	-	Ground		Power
73	RX_GPS	-	GPS serial Port (RX) [3]		-
74	RESERVED	-	RESERVED		-
75	PPS	O	1 Pulse per Second signal [3]	100KΩ pull down	CMOS 2.8V
76	GPIO18	I/O	GPIO18 Configurable general purpose I/O pin/ DVI2_RX (Digital Voice Interface)		CMOS 2.8V
77	GND	-	Ground		Power
78	RX_GPS_BIN	-	GPS serial Port (RX) - SIRF BINARY [3]		CMOS 2.8V
79	GND	-	Ground		Power
80	TX_GPS_BIN	-	GPS serial Port (TX) - SIRF BINARY [3]		CMOS 2.8V
81	RESERVED	-	RESERVED		-
82	GND	-	Ground		Power
83	GPS_ANT	-	GPS ANTENNA [3]		
84	GND_GPS	-	GPS_ANTENNA GND [3]		Power

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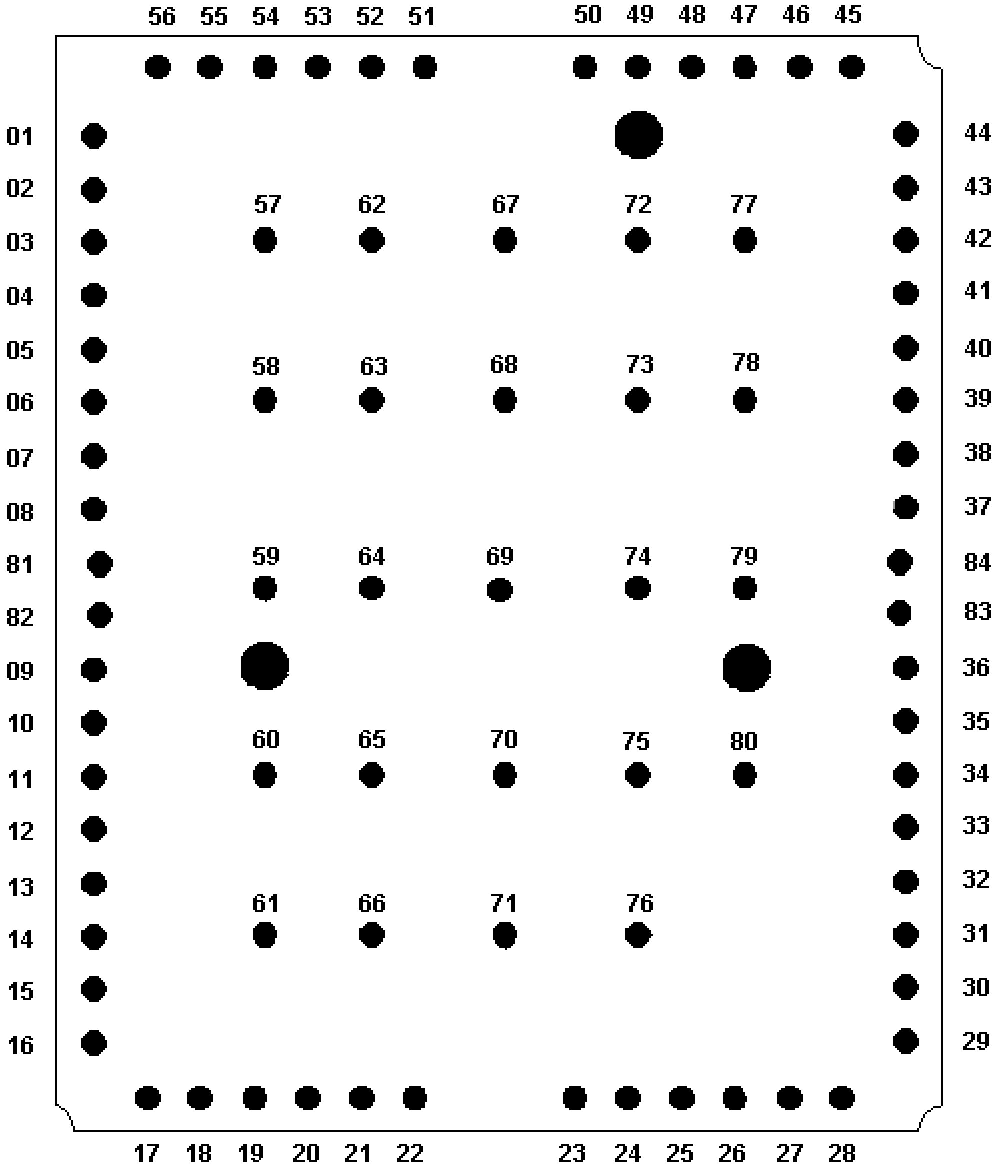
[3] Available only on GE863-GPS (in case of GE863-QUAD/PY/SIM it has to be considered RESERVED)

NOTE:

The GE863 family Wireless Modules (GE863-GPS, GE863-PY, GE863-SIM and GE863-QUAD) has one DVI port present on the system interface. For the GE863 Wireless Modules, the DVI port can only be set to 2 if the digital audio functionality is to be used. This is due to physical interface restrictions.

4.2. PINS Layout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TOP VIEW

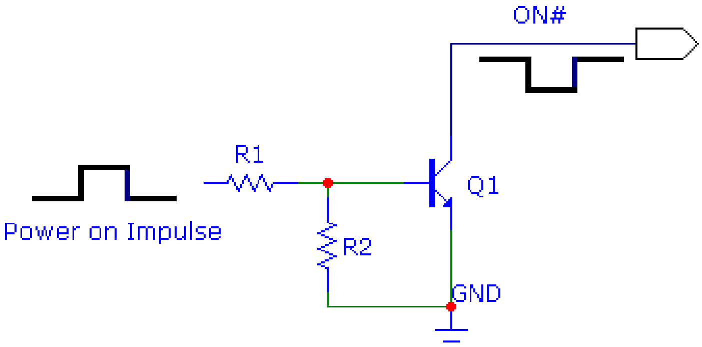
5. Hardware Commands

5.1. Turning ON the GE863

To turn the GE863 on, the pad ON# must be tied low for at least 1 second and then released. A pulse duration less than 1 second should also start the power on procedure, but this is not guaranteed.

The maximum current that can be drained from the ON# pad is 0,1 mA.

A simple circuit to do it is:



NOTE:

Do not use any pull up resistor on the ON# line, since it is internally pulled up. Using pull up resistor may cause latch up problems on the GE863 power regulator and improper power on/off of the module. The line ON# must be connected only in open collector configuration.

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

The GE863 turns fully on by supplying power to the Charge pad as well (as in a module equipped with a battery on the VBATT pads).

TIP:

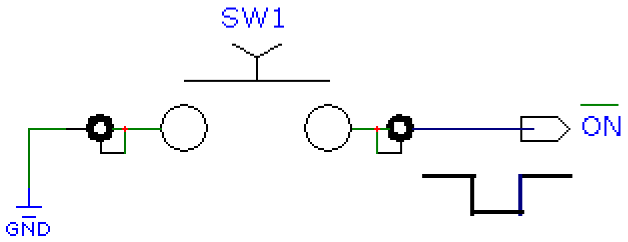
Monitor the hardware line PWRMON to check if the device has been powered on. The device should be considered powered on 900ms after the line raised up.

PWRMON line rises up also when supplying power to the Charge pad.

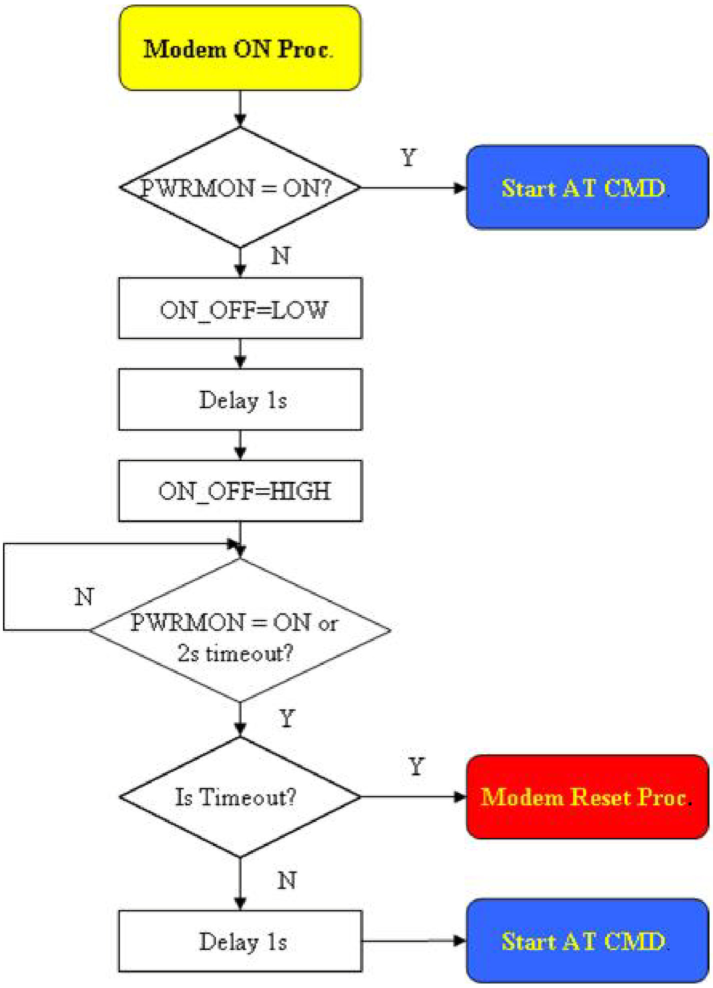
For example:

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

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



A flow chart with proper turn on procedure is detailed below:


Modem ON Proc.
PWRMON = ON?
Y
Start AT CMD.
N
ON_OFF=LOW
Delay 1s
ON_OFF=HIGH
N
PWRMON = ON or 2s timeout?
Y
Is Timeout?
Y
Modem Reset Proc.
N
Delay 1s
Start AT CMD.

5.2. Turning OFF the GE863

Turning off of the device can be done in two ways:

- via AT command (see GE863 Software User Guide, AT#SHDN)
- by tying low pin ON#

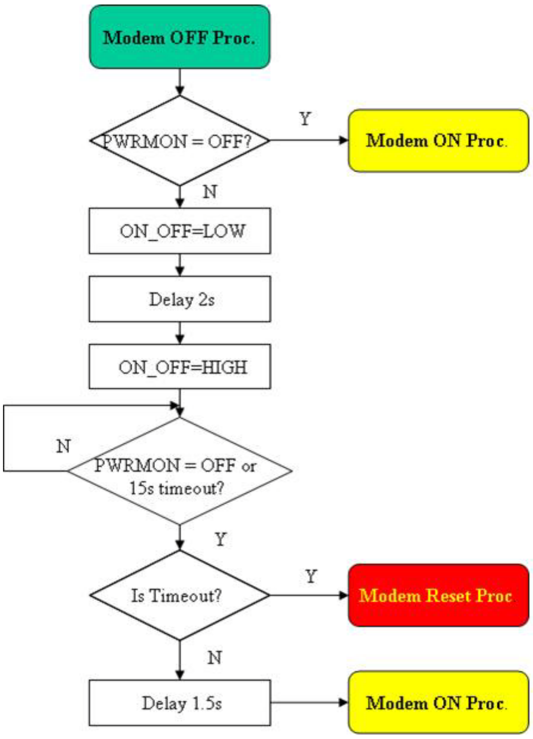
Either ways, the device issues a detach request to network informing that the device will not be reachable any more.

To turn OFF the GE863 the pad ON# must be tied low for at least 2 seconds and then released.

The same circuitry and timing for the power on must be used.

The device shuts down after the release of the ON# pad.

The following flow chart shows the proper turnoff procedure:


Modem OFF Proc.
PWRMON = OFF?
Y
Modem ON Proc.
N
ON_OFF=LOW
Delay 2s
ON_OFF=HIGH
N
PWRMON = OFF or 15s timeout?
Y
Is Timeout?
Y
Modem Reset Proc
N
Delay 1.5s
Modem ON Proc.

TIP:

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

5.3. Resetting the GE863

NOTE:

The concept of resetting the module differs from versions of the GE863. On GE863-QUAD/PY/SIM modules, operating on the RESET# pin as described next will actually reboot the module, giving place to what we'll call an Hardware Unconditional Restart(par 5.3.2), while on GE863-GPS it will shut the module down generating an Hardware Unconditional Shutdown (par 5.3.1).

5.3.1. Hardware Unconditional Shutdown (for GE863-GPS only)

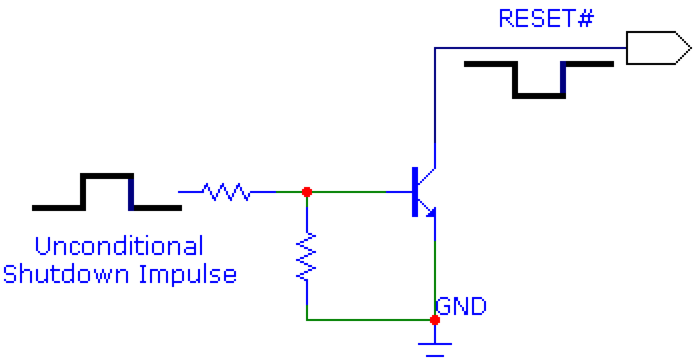
WARNING:

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

To unconditionally shut down the GE863-GPS, the pad RESET# must be tied low for at least 200 milliseconds and then released.

The maximum current that can be drained from the RESET# pad is 0,15 mA.

A simple circuit to do it is:



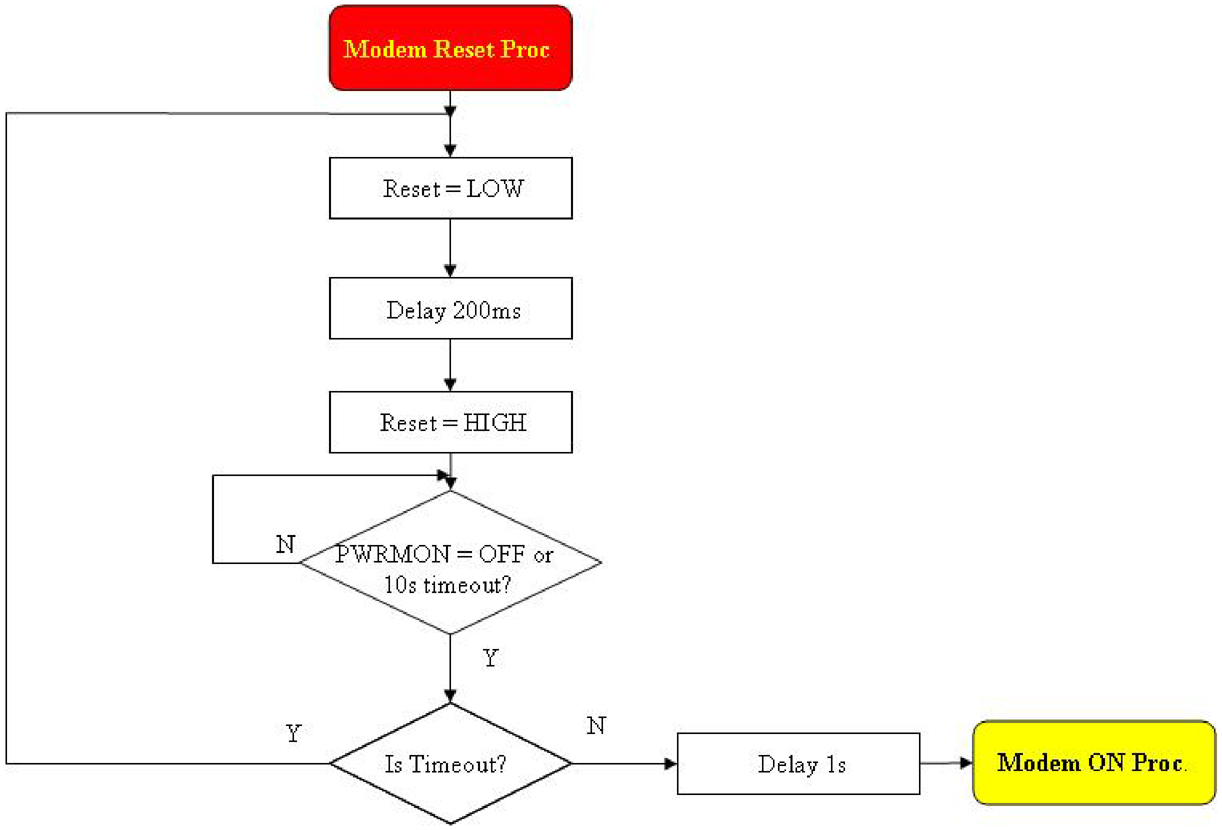
NOTE:

Do not use any pull up resistor on the RESET* line nor any totem pole digital output. Using pull up resistor may cause latch up problems on the GE863-GPS power regulator and improper functioning of the module. The RESET* line must be connected in open collector configuration only.

TIP:

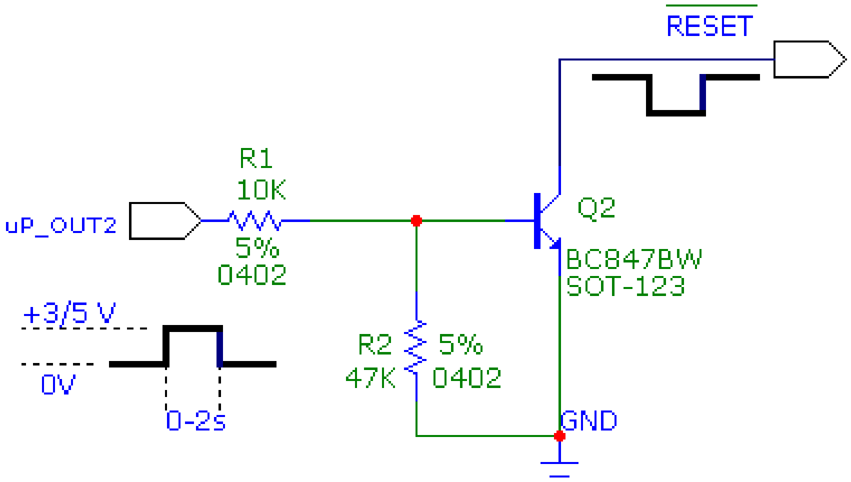
The unconditional hardware shutdown must be always implemented on the boards and the software must use it as an emergency exit procedure.

A flow chart for this is detailed below:


Modem Reset Proc
Reset = LOW
Delay 200ms
Reset = HIGH
N
PWRMON = OFF or 10s timeout?
Y
Y
N
Is Timeout?
Delay 1s
Modem ON Proc.

For example:

Let us assume you need to drive the RESET# pad with a totem pole output of a +3/5 V microcontroller (uP_OUT2):


RESET
R1
10K
5%
0402
uP_OUT2
Q2
BC847BW
SOT-123
+3/5 V
0V
0-2s
R2
47K
5%
0402
GND

5.3.2. Hardware Unconditional restart (GE863-QUAD/PY/SIM only)

WARNING:

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

To unconditionally reboot the GE863-QUAD/PY/SIM, the pad RESET# must be tied low for at least 200 milliseconds and then released.

The maximum current that can be drained from the RESET# pad is 0,15 mA.

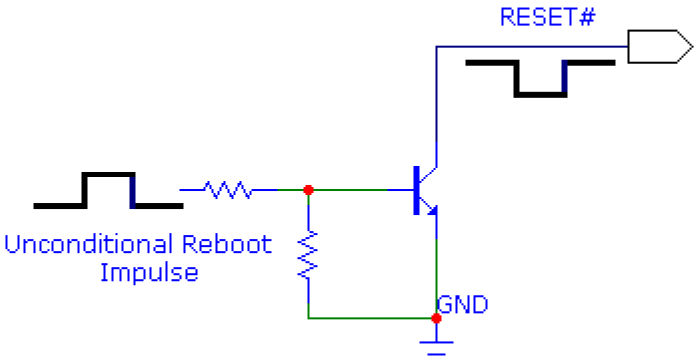
NOTE:

Do not 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 GE863-QUAD/PY/SIM power regulator and improper functioning of the module. The line RESET* must be connected only in open collector configuration.

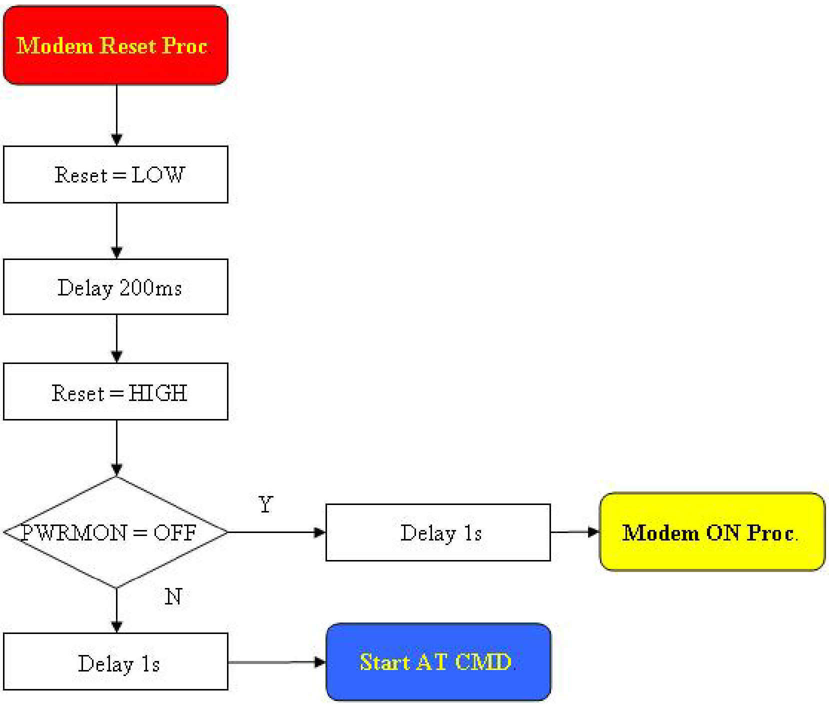
TIP:

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

A simple circuit to do it is:

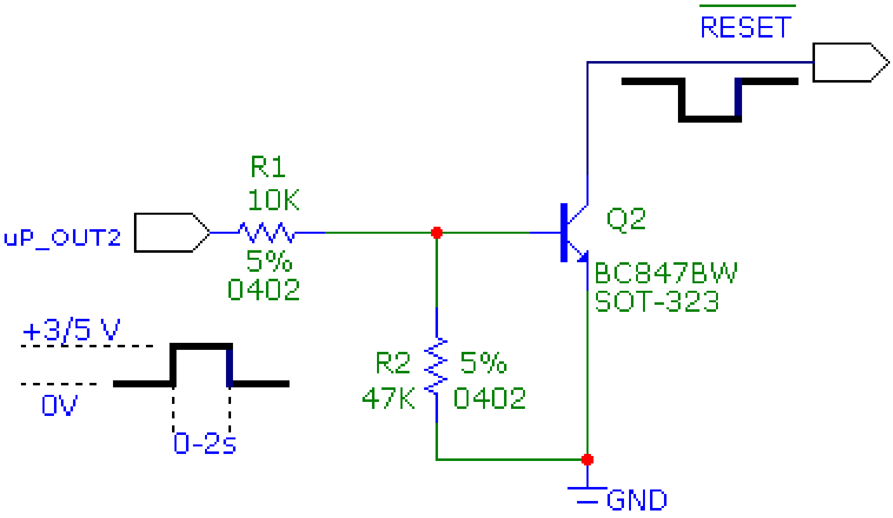


In the following flow chart is detailed the proper restart procedure:


Modem Reset Proc
Reset = LOW
Delay 200ms
Reset = HIGH
PWRMON = OFF
Y
Delay 1s
Modem ON Proc.
N
Delay 1s
Start AT CMD

For example:

Let us assume you need to drive the RESET# pad with a totem pole output of a +3/5 V microcontroller (uP_OUT2):


RESET
R1
10K
5%
0402
uP_OUT2
Q2
BC847BW
SOT-323
+3/5 V
0V
0-2s
R2
47K
5%
0402
GND

6. Power Supply

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

6.1. Power Supply Requirements

POWER SUPPLY (SW release 7.02.xx4 or older)	
Nominal Supply Voltage	3.8 V
Normal Operating Voltage Range	3.4 V÷ 4.20 V

POWER SUPPLY (SW release 7.03.x00 or newer)	
Nominal Supply Voltage	3.8 V
Normal Operating Voltage Range	3.4 V÷ 4.20 V
Extended Operating Voltage Range	3.22 V÷ 4.50 V

NOTE:

The Operating Voltage Range MUST never be exceeded; care must be taken in order to fulfil min/max voltage requirement.

NOTE:

Overshoot voltage (regarding MAX Extended Operating Voltage) and drop in voltage (regarding MIN Extended Operating Voltage) MUST never be exceeded;

The “Extended Operating Voltage Range” can be used only with completely assumption and application of the HW User guide suggestions.

The following table is describing the power consumptions of the module:

GE863-QUAD/PY		
Mode	**Average (mA)**	**Mode description**
SWITCHED OFF		Module supplied but Switched Off
Switched Off	<26 uA	
IDLE mode		
AT+CFUN=1	19.0	Normal mode: full functionality of the module
AT+CFUN=4	18.2	Disabled TX and RX; module is not registered on the network
AT+CFUN=0 or =5	6.6	Paging Multiframe 2
	4.5	Paging Multiframe 4
	3.3	Paging Multiframe 6
	3.2	Paging Multiframe 8
	2.5	Paging Multiframe 9
CSD TX and RX mode		GSM VOICE CALL
GSM900 CSD PL5	237.3	
DCS1800 CSD PL0	223.8	
GPRS (class 10) 1TX		GPRS Sending data mode
GSM900 PL5	264,0	
DCS1800 PL0	176,0	
GPRS (class 10) 2TX		GPRS Sending data mode
GSM900 PL5	473,8	
DCS1800 PL0	307,8	

The following table is describing the power consumptions of the module in case of the GE863-GPS:

GE863-GPS		
Mode	**Average (mA)**	**Mode description**
SWITCHED OFF		Module supplied but Switched Off
Switched Off	<30 uA	
IDLE mode (GPSP=0)		
AT+CFUN=1	19.0	Normal mode: full functionality of the module
AT+CFUN=4	18.2	Disabled TX and RX; module is not registered on the network
AT+CFUN=0 or =5	6.6	Paging Multiframe 2
	4.5	Paging Multiframe 4
	3.3	Paging Multiframe 6
	3.2	Paging Multiframe 8
	3.3	Paging Multiframe 9
IDLE mode (GPSP=1)		
AT+CFUN=1	79.4	Normal mode: full functionality of the module
AT+CFUN=4	79.0	Disabled TX and RX; module is not registered on the network
AT+CFUN=0 or =5	70.3	Paging Multiframe 2
	68.6	Paging Multiframe 4
	67.8	Paging Multiframe 6
	63.4	Paging Multiframe 8
	63.0	Paging Multiframe 9
IDLE mode (GPSPS=2,1800)		
AT+CFUN=0 or =5	11.5	Paging Multiframe 2
	10.0	Paging Multiframe 9
CSD TX and RX mode		GSM VOICE CALL + GPS receiver active
GSM900 CSD PL5	325.0	
DCS1800 CSD PL0	302.2	
GPRS (class 10) 1TX		GPRS Sending data mode
GSM900 PL5	264,0	
DCS1800 PL0	176,0	
GPRS (class 10) 2TX		GPRS Sending data mode
GSM900 PL5	473,8	
DCS1800 PL0	307,8	

RF transmission in GSM systems is not continuous, being packed into bursts at a base frequency of about 216 Hz. The relative current peaks can be as high as about 2A. 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.

TIP:

The power supply electrical design must forecast a peak current output of at least 2A.

If the layout of the PCB is not properly designed, then a strong noise floor is generated on the ground and the supply; this reflects on all the audio paths producing an audible and annoying noise at 216 Hz; if the voltage drops, the overwhelming peak current absorption might cause the device to even shutdown, as a consequence of the supply voltage drop.

6.2. Embodied Battery Charger

The battery charger is suited for 3.7V Li-Ion rechargeable battery (suggested capacity 500-1000mAH). The Charger needs only a CURRENT LIMITED power source input and charges the battery directly through VBATT connector pins.

Battery charger input pin	CHARGE
Battery pins	VBATT, GND
Battery charger input voltage min	5.0 V
Battery charger input voltage typ	5.5 V
Battery charger input voltage max	7.0 V
Battery charger input current max	400mA
Battery type	Li-Ion rechargeable

NOTE:

If embodied battery charger is used, then a LOW ESR capacitor of at least 100μF must be mounted in parallel to VBATT pin.

NOTE:

When power is supplied to the CHARGE pin, a battery must always be connected to the VBATT pin of the GE863.

6.3. General Design Rules

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

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

6.3.1. Electrical Design Guidelines

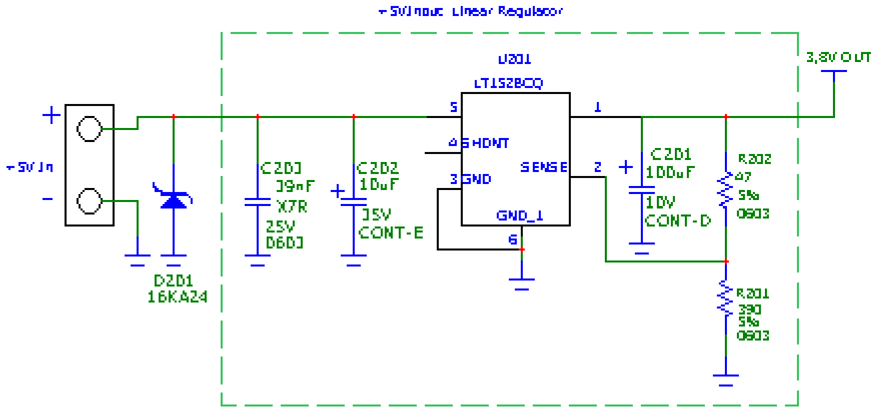
The electrical design of the power supply depends strongly on the power sources where this power is drained. We distinguish them into three categories:

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

6.3.1.1. + 5V Input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence there is not a big difference between the input source and the desired output, and a linear regulator can be used. A switching power supply is not suited because of the low drop out requirements.
- 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 the GE863. 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 the GE863 from power polarity inversion.

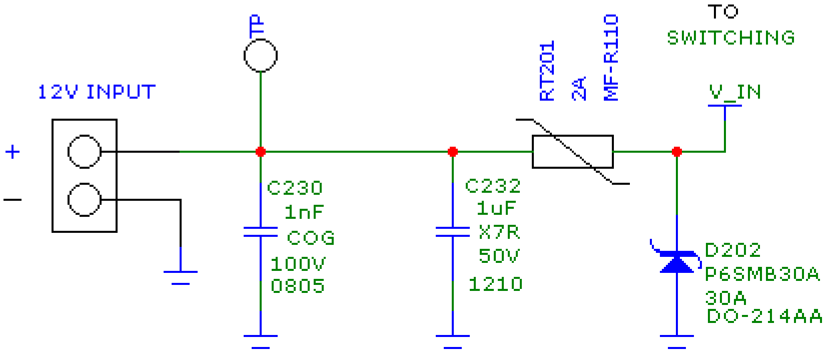
An example of linear regulator with 5V input is:

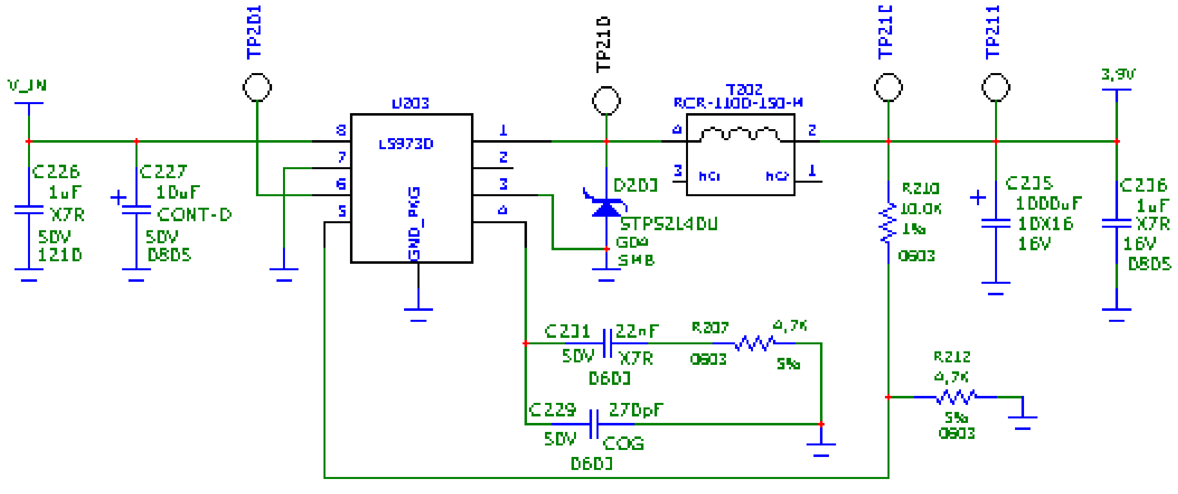


6.3.1.2. + 12V Input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, 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 is preferable because of better efficiency especially with the 2A peak current load represented by the GE863.
- When using a switching regulator, a 500 kHz (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, cause the switching frequency could also generate EMC interferences.
- As far as PB batteries (as inside cars), 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.
- 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 the GE863 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):


TP
12V INPUT
+
–
C230
1nF
COG
100V
0805
C232
1uF
X7R
50V
1210
RT201
2A
MF-R110
TO
SWITCHING
V_IN
D202
P6SMB30A
30A
DO-214AA


V_IN
TP201
C226
1uF
X7R
50V
1210
C227
10uF
CONT-D
50V
0805
U203
L5973D
GND_PKG
8
7
6
5
1
2
3
4
TP210
D203
STPS2L40U
GD4
SMB
T202
RCR-1100-150-M
4
2
3
1
nC1
nC2
TP21C
TP211
3,3V
R210
10.0K
1%
0603
C235
1000uF
10X16
16V
C236
1uF
X7R
16V
0805
C231
22nF
50V
X7R
0603
R207
4,7K
0603
5%
C229
270pF
50V
COG
0603
R212
4,7K
5%
0603

SWITCHING REGULATOR

6.3.1.3. Battery Source Power Supply Design Guidelines

The desired nominal output for the power supply is 3.8V and the maximum voltage allowed is 4.2V (4.5 V if using SW release 7.03.x00 or newer), hence a single 3.7V Li-Ion cell battery type is suited for supplying the power to the Telit GE863 module.

⚠ **WARNING:**

Do not use any Ni-Cd, Ni-MH, and Pb battery types directly connected with GE863. Their use can lead to overvoltage on the GE863 and damage it. USE ONLY Li-Ion battery types.

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 GE863-GPS and damage it.

- 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 the GE863 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.

6.3.1.4. Battery Charge Control Circuitry Design Guidelines

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

- qualification and trickle charging
- fast charge 1 - constant current
- final charge - constant voltage or pulsed charging
- maintenance charge

The qualification process consists of a battery voltage measure, indicating roughly its charge status. If the battery is deeply discharged, meaning its voltage is lower than the trickle charging threshold, then charging must start slowly, possibly with a current limited to the pre-charging process. The current must be kept very low with respect to the fast charge value.

During trickle charging the voltage across the battery terminals rises; when it reaches the fast charge threshold level the charging process goes into a fast charge phase.

During the fast charge phase the process proceeds with a current limited for charging; this current limit depends on the required time for completing the charge and on battery pack capacity. During this phase the voltage across the battery terminals still raises but at a lower rate. Once the battery voltage reaches its maximum voltage the process goes into its third state: Final charging. The voltage measure to change the process status into final charge is very important. It must be ensured that the maximum battery voltage is never exceeded, otherwise the battery may be damaged and even explode.

Moreover, for constant final chargers, the voltage phase (final charge) must not start before the battery voltage has reached its maximum value, otherwise the battery capacity will be slightly reduced.

The final charge can be of two different types: constant voltage or pulsed. GE863 uses constant voltage.

The constant voltage charge proceeds with a fixed voltage regulator (very accurately set to the maximum battery voltage) and the current decreases while the battery is becoming charged. When the charging current falls below a certain fraction of the fast charge current value, then the battery is considered fully charged, the final charge stops and eventually starts the maintenance.

The pulsed charge process has no voltage regulation, instead charge continues with pulses. Usually the pulse charge works in the following manner: the charge is stopped for some time, let us say few hundreds of ms, then the battery voltage will be measured and when it drops below its maximum value a fixed time length charging pulse is issued. As the battery approaches its full charge, the off time becomes longer and the duty-cycle of the pulses decreases. The battery is considered fully charged when the pulse duty-cycle is less than a threshold value, typically 10%, the pulse charge stops and eventually the maintenance starts.

The last phase is not properly a charging phase, since the battery at this point is fully charged and the process may stop after the final charge. The maintenance charge provides an additional charging process to compensate the charge leak typical of a Li-Ion battery. It is done by issuing pulses with a fixed time length, again few hundreds of ms, and a duty-cycle around 5% or less.

This last phase is not implemented in the GE863 internal charging algorithm so once-charged battery is left discharging down to a certain threshold. It is cycled from full charge to slight discharge even if the battery charger is inserted. This guarantees that the remaining charge in the battery is a good percentage and that the battery is not damaged by keeping it always fully charged (Li-Ion rechargeable batteries usually deteriorate when kept fully charged).

Last but not least, in some applications, it is highly desired that the charging process restarts when the battery is discharged and its voltage drops below a certain threshold. This is typical for the GE863 internal charger.

As you can see, the charging process is not a trivial task to do; moreover all these operations must start only if battery temperature is inside charging range, usually 5°C - 45°C.

NOTE:

For all the threshold voltages, inside the GE863 all thresholds are fixed in order to maximize Li-Ion battery performances and do not need to be changed.

NOTE:

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

NOTE:

When starting the charger from Module powered off the startup is in CFUN4; to activate the normal mode a command AT+CFUN=1 has to be provided. There is also the possibility to activate the normal mode using the ON_OFF* signal.

In this case, when HW powering off the module with the same line (ON_OFF*) and having the charger still connected, the module goes back to CFUN4.

NOTE:

It is important having a 100ɥF Capacitor to VBAT in order to avoid instability of the charger circuit if the battery is accidentally disconnected during the charging activity.

The GE863-GPS measures the temperature of its internal component in order to satisfy this last requirement. This not exactly the same as the battery temperature but in common use, the two temperatures must not differ too much and the charging temperature range must be guaranteed.

6.3.2. Thermal Design Guidelines

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

- average current consumption during transmission @ max PWR level: 500mA
- average current consumption during transmission @ min PWR level: 100mA
- average current during Power Saving(AT+CFUN=5) 4mA
- average current during idle (Power Saving disabled) 24mA

For GE863-GPS only:

- average GPS section consumption during Power Saving: 1mA
- average GPS section consumption during Tracking (Power Saving disabled) 60mA

TIP:

The thermal design for the Power supply must be made keeping an average consumption at the max transmitting level during calls of 500mA rms plus 60mA rms for GPS in tracking mode.

NOTE:

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

Considering the very low current during idle, especially if the 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. The heat sink could be smaller than calculated for 500mA 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, hence the current consumption will be less than 500mA (being usually around 150mA).

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

Let's consider the heat of the module during the transmission of 1W max during CSD/VOICE calls and 2W max during class10 GPRS upload.

This generated heat will be mostly conducted to the ground plane under the GE863; you must ensure that your application can dissipate it.

6.3.3. Power Supply PCB Layout Guidelines

As seen on 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 power supply performances.

- The Bypass low ESR capacitor must be placed close to the Telit GE863 power input pads or in the case the power supply is a switching. It can be placed close to the inductor to cut the ripple provided by the PCB trace from the capacitor. The GE863 is wide enough to ensure a dropless connection even during 2A current peaks.
- The protection diode must be placed close to the input connector where the power source is drained.
- The PCB traces from the input connector to the power regulator IC must be wide enough to ensure no voltage drops occur when the 2A current peaks are absorbed. Note that this is not made especially in order to save power, but to avoid the voltage drops on the power line at the current peaks frequency of 216 Hz. that the 216 Hz reflects on all the components connected to that supply, introducing the noise floor at the burst base frequency. For this reason, while a voltage drop of 300-400 mV may be acceptable from the power loss point of view, the same voltage drop may not be acceptable from the noise point of view. If your application does not have audio interface but only uses the data feature of the Telit GE863, then this noise is not so disturbing and the power supply layout design can be more forgiving.
- The PCB traces to the GE863 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 for the same reason as previous point. Try to keep this trace as short as possible.
- The PCB traces connecting the Switching output to the inductor and the switching diode must be kept as short as possible by placing the inductor and the diode very close to the power switching IC (only for switching

power supply). This is done in order to reduce the radiated field (noise) at the switching frequency (100-500 kHz usually).

- The use of a good common ground plane is suggested.
- The placement of the power supply on the board must be done in such a way to guarantee that the high current return paths in the ground plane are not overlapped to any noise sensitive circuitry as the microphone amplifier/buffer or earphone amplifier.

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

6.3.4. Parameters for ATEX Application

In order to integrate the Telit's GE863 module into an ATEX application, the appropriate reference standard IEC EN xx and integrations must be followed.

Below are listed parameters and useful information to integrate the module in your application:

- GE863-QUAD & GE 863-PY
    - Total capacity: 78.394 ųF
    - Total inductance: 10.163 ųH
- GE863-GPS
    - Total capacity: 83.167 ųF
    - Total inductance: 10.264 ųH
- No voltage upper than supply voltage is present in the module.
- No step-up converters are present in the module.
- In abnormal conditions, the maximum RF output power is up 34 dBm max for few seconds.

For this particular application, we recommend the customer to involve TTSC (Telit Technical Support Center) in the design phase of the application.

7. Antenna

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

7.1. GSM Antenna Requirements

As suggested on the Product Description the antenna and antenna line on PCB for a Telit GE863 device must fulfill the following requirements:

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	70 MHz in GSM850, 80 MHz in GSM900, 170 MHz in DCS & 140 MHz PCS band
Gain	Gain < 3dBi
Impedance	50 Ω
Input power	> 2 W peak power
VSWR absolute max	≤ 10:1
VSWR recommended	≥ 2:1

When using the Telit GE863, since there is no antenna connector on the module, the antenna must be connected to the GE863 through the PCB with the antenna pad.

In the case the antenna is not directly developed on the same PCB or directly connected at the antenna pad of the GE863, a PCB line is needed in order to connect with it or with its connector.

This line of transmission must fulfill the following requirements:

Antenna Line on PCB Requirements	
Impedance	50 Ω
Max Attenuation	0,3 dB
No coupling with other signals allowed	
Cold End (Ground Plane) of antenna must be equipotential to the GE863 ground pins	

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

This device is to be used only for mobile and fixed application. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any

other antenna or transmitter. End-Users must be provided with transmitter operation conditions for satisfying RF exposure compliance. OEM integrators must ensure that the end user has no manual instructions to remove or install the GE863 module.

Antennas used for this OEM module must not exceed 3dBi gain for mobile and fixed operating configurations.

7.2. GSM Antenna - PCB Line Guidelines

- Ensure that the antenna line impedance is 50 Ω.
- Keep the antenna line on the PCB as short as possible, since the antenna line loss must be less than 0,3 dB.
- Antenna line must have uniform characteristics, constant cross section, avoid meanders and abrupt curves.
- Keep, if possible, one layer of the PCB used only for the Ground plane;
- Surround (on the sides, over and under) the antenna line on PCB with Ground, avoid having other signal tracks facing directly the antenna line track.
- The ground around the antenna line on PCB has to be strictly connected to the Ground Plane by placing vias once per 2mm at least.
- Place EM noisy devices as far as possible from GE863 antenna line.
- Keep the antenna line far away from the GE863 power supply lines.
- If you have EM noisy devices around the PCB hosting the GE863, such as fast switching ICs, take care of the shielding of the antenna line by burying it inside the layers of PCB and surround it with Ground planes, or shield it with a metal frame cover.
- If you do not have EM noisy devices around the PCB of GE863, by using a strip-line on the superficial copper layer for the antenna line, the line attenuation will be lower than a buried one.

7.3. 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 must not be installed inside metal cases.

- Antenna must be installed also according Antenna manufacturer instructions.

7.4. GPS Antenna Requirements

The GE863-GPS module is not provided with an internal LNA amplifier. The use of an active antenna is important to achieve a good performance.

The module is provided of an Antenna supply circuit with the following characteristics:

- supply voltage referred to VBATT (Must accept values from 3.4 to 4.2 V DC)
- supply enable controlled internally by the BB
- current measurement circuit (readable also with AT commands)
- voltage measurement circuit (readable also with AT commands)
- HW Protection for antenna short circuit (if consumption exceeds 40mA)

7.4.1. Combined GPS Antenna

The use of combined GPS antennas is NOT recommended; this solution could generate an extremely poor GPS reception and also the combination antenna requires additional diplexer and adds a loss in the RF route.

7.4.2. Linear and Patch GPS Antenna

Using this type of antenna introduces at least 3 dB of loss if compared to a circularly polarized (CP) antenna. Having a spherical gain response instead of a hemispherical gain response could aggravate the multipath behaviour & create poor position accuracy.

7.4.3. LNA and Front End Design Considerations

LNA gain must be between 12 dB and 26 dB (assumes a patch antenna). - This assumes the patch used has >3 dBic of gain.

Linear antenna implementation must consider a minimum of ~14.5 dB of LNA gain.

Excessive LNA gain (>27 dB) can introduce jamming spurs, degrade 3IP, and saturate the receiver.

The supply voltage most accept the range between 3.4 to 4.2 V DC

In highly integrated environments rich with potential interference, SiRF suggests design implementations with PRE filters.

The module’s GPS input is already provided of a SAW filter.

As suggested on the Product Description the external active antenna for a Telit GE863-GPS device must fulfill the following requirements:

Antenna Requirements	
Frequency range	1575.42 MHz (GPS L1)
Bandwidth	± 1.023 MHz
Gain	1.5 dBi < Gain < 4.5 dBi
Impedance	50Ω
Amplification	Typical 25dB (max 27dB)
Supply voltage	Must accept from 3 to 5 V DC
Current consumption	Typical 20mA (40 mA max)

When using the Telit GE863-GPS, since there is no antenna connector on the module, the antenna must be connected to the GE863-GPS through the PCB with the antenna pad.

In the case that the antenna is not directly developed on the same PCB, hence directly connected at the antenna pad of the GE863-GPS, then a PCB line is needed in order to connect with it or with its connector.

This line of transmission must fulfill the following requirements:

Antenna Line on PCB Requirements	
Impedance	50Ω
No coupling with other signals allowed	
Cold End (Ground Plane) of antenna must be equipotential to the GE863-GPS ground pins	

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.

7.5. GPS Antenna - PCB Line Guidelines

- Ensure that the antenna line impedance is 50Ω.
- Keep the antenna line on the PCB as short as possible to reduce the loss.
- Antenna line must have uniform characteristics, constant cross section, avoid meanders and abrupt curves.
- Keep one layer of the PCB used only for the Ground plane, if possible.
- Surround (on the sides, over and under) the antenna line on PCB with Ground, avoid having other signal tracks facing directly the antenna line of track.

- The ground around the antenna line on PCB has to be strictly connected to the Ground Plane by placing vias once per 2mm at least.
- Place EM noisy devices as far as possible from GE863-GPS antenna line.
- Keep the antenna line far away from the GE863-GPS power supply lines.
- Keep the antenna line far away from the GE863-GPS GSM RF lines.
- If you have EM noisy devices around the PCB hosting the GE863-GPS, such as fast switching ICs, take care of the shielding of the antenna line by burying it inside the layers of PCB and surround it with Ground planes, or shield it with a metal frame cover.
- If you do not have EM noisy devices around the PCB of GE863-GPS, use a strip-line on the superficial copper layer for the antenna line. The line attenuation will be lower than a buried one.

7.6. GPS Antenna - Installation Guidelines

- The GE863-GPS 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 must not be co-located or operating in conjunction with any other antenna or transmitter.
- Antenna must not be installed inside metal cases.
- Antenna must be installed also according Antenna manufacturer instructions.

7.7. Logic Level Specifications

Where not specifically stated, all the interface circuits work at 2.8V CMOS logic levels. The following table shows the logic level specifications used in the Telit GE863 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

Current Characteristics

Level	Typical
Output Current	1mA
Input Current	1ųA

7.7.1. Reset Signal

Signal	Function	I/O	BGA Ball
RESET	Phone reset	I	47

RESET is used to reset the GE863 modules. Whenever this signal is pulled low, the GE863 is reset. When the device is reset it stops any operation in progress. After the release of the reset, GE863-GPS is unconditionally shut down (in case of GE863-QUAD/PY/SIM the reset line perform an unconditional restart), without doing any detach operation from the network where it is registered. This behavior is not a proper shut down because GSM devices are requested to issue a detach request on turn off. For this reason the Reset signal must not be used to normally, shutting down the device, but only as an emergency exit in the rare case the device remains stuck waiting for some network response.

NOTE:

Do not use this signal to power off the GE863. Use the ON/OFF signal to perform this function or the AT#SHDN command.

The RESET is internally controlled at start-up to achieve always a proper power-on reset sequence. There is no need to control this pin at start-up; it may only be used to reset a device if it is not responding to any command.

Reset Signal Operating Levels:

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

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

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

8. Serial Ports

8.1. GE863-GPS Serial Ports

The serial port on the Telit GE863-GPS is the core of the interface between the module and OEM hardware. 4 serial ports are available on the module:

- MODEM SERIAL PORT
- MODEM SERIAL PORT 2 (GPS CONTROL PORT)
- GPS SERIAL PORT A (SIRF BINARY)
- GPS SERIAL PORT B (NMEA)

8.2. GE863-QUAD/PY/SIM Serial Ports

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

8.3. Modem Serial Port

Several configurations can be designed for the serial port on the OEM hardware, but the most common are:

- RS232 PC com port
- microcontroller UART @ 2.8V - 3V (Universal Asynchronous Receive Transmit)
- microcontroller UART@ 5V or other voltages different from 2.8V

Depending from the type of serial port on the OEM hardware a level translator circuit may be needed to make the system work. The only configuration that does not need a level translation is the 2.8V UART.

The serial port on the GE863 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 GE863 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

The signals of the GE863 serial port are:

RS232 Pin Number	Signal	GE863 Pad Number	Name	Usage
1	DCD - dcd_uart	42	Data Carrier Detect	Output from the GE863 that indicates the carrier presence
2	RXD - tx_uart	38	Transmit line *see Note	Output transmit line of GE863 UART
3	TXD - rx_uart	37	Receive line *see Note	Input receive of the GE863 UART
4	DTR - dtr_uart	39	Data Terminal Ready	Input to the GE863 that controls the DTE READY condition
5	GND	8-17-28-36-45-48-50-56	Ground	ground
6	DSR - dsr_uart	43	Data Set Ready	Output from the GE863 that indicates the module is ready
7	RTS - rts_uart	40	Request to Send	Input to the GE863 that controls the Hardware flow control
8	CTS - cts_uart	41	Clear to Send	Output from the GE863 that controls the Hardware flow control
9	RI - ri_uart	44	Ring Indicator	Output from the GE863 that indicates the incoming call condition

NOTE:

According to V.24, RX/TX signal names are referred to the application side, therefore on the GE863 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 GE863 serial port and vice versa for RX.

TIP:

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

TIP:

In order to avoid noise or interferences on the RXD lines it is suggested to add a pull up resistor (100KΩ to 2.8V)

8.4. GE863-GPS Secondary Ports

8.4.1. Modem Serial Port 2 (GPS Control)

This port is used to control the GPS part by the GSM part.

It is available on the following pins:

PIN #	NAME	DESCRIPTION	TYPE
25	TX_TRACE	TX Data for GPS control	CMOS 2.8V
26	RX_TRACE	RX Data for GPS control	CMOS 2.8V

The typical integration requires connecting these pins to GPS serial port A:

PIN #	NAME		NAME	PIN#
25	TX_TRACE	↔	RX_GPS_BIN	**78**
26	RX_TRACE	↔	TX_GPS_BIN	**80**

8.4.2. GPS Serial Port A (SIRF Binary)

This port is carrying out the GPS navigation data in SIRF BINARY format. The default configuration is 57600 bps, 8, n, 1

It is available on the following pins:

PIN #	NAME	DESCRIPTION	TYPE
78	RX_GPS_BIN	GPS RX Data (Sirf Binary)	CMOS 2.8V
80	TX_GPS_BIN	GPS TX Data (Sirf Binary)	CMOS 2.8V

The typical integration requires connecting these pins to MODEM serial port 2.

8.4.3. GPS Serial Port B (NMEA)

This port is carrying out the GPS navigation data in NMEA 0183 format. The default configuration is 4800 bps, 8, n, 1

It is available on the following pins:

PIN #	NAME	DESCRIPTION	TYPE
68	TX_GPS	GPS TX Data (NMEA)	CMOS 2.8V
73	RX_GPS	GPS RX Data (NMEA)	CMOS 2.8V

GPS RX Lines and TX lines may need a dual supply isolation buffer like an FXLP34 to avoid CMOS high states while in POWER SAVING.

8.5. GE863-QUAD/PY/SIM Secondary Port

8.5.1. Modem Serial Port 2 (Python Debug)

It is available on the following pins:

PIN #	NAME	DESCRIPTION	TYPE
25	TX_TRACE	TX Data	CMOS 2.8V
26	RX_TRACE	RX Data	CMOS 2.8V

8.6. RS232 Level Translation

In order to interface the Telit GE863 with a PC COM port or a RS232 (EIA/TIA-232) application a level translator is required. This level translator must

- invert the electrical signal in both directions
- change the level from 0/3V to +15/-15V

Actually, the RS232 UART 16450, 16550, 16650 & 16750 chipsets accept signals with lower levels on the RS232 side (EIA/TIA-562), allowing for a lower voltage-multiplying ratio on the level translator. Note that the negative signal voltage must be less than 0V and hence some sort of level translation is always required.

The simplest way to translate the levels and invert the signal is by using a single chip level translator. There are a multitude of them, differing in the number of drivers and receivers and the levels (be sure to get a true RS232 level translator not a RS485 or other standards).

By convention the driver is the level translator from the 0-3V UART level to the RS232 level, while the receiver is the translator from RS232 level to 0-3V UART.

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

- 5 driver
- 3 receiver

NOTE:

The digital input lines working at 2.8VCMOS have an absolute maximum input voltage of 3,75V; therefore the level translator IC must not be powered by the +3.8V supply of the module. Instead it must be powered from a +2.8V / +3.0V (dedicated) power supply.

This is because this way the level translator IC outputs on the module side (i.e. GE863 inputs) will work at +3.8V interface levels, stressing the module inputs at its maximum input voltage.

This can be acceptable for evaluation purposes, but not on production devices.

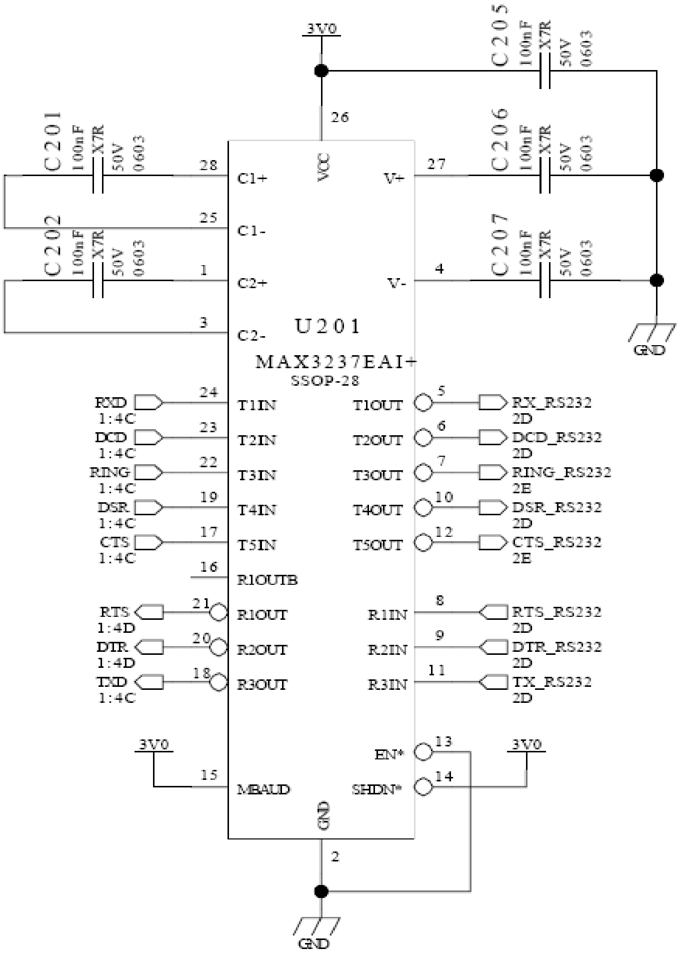
NOTE:

In order to be able to do in circuit reprogramming of the GE863 firmware, the serial port on the Telit GE863 must be available for translation into RS232 and either it is controlling device must be placed into tristate, disconnected or as a gateway for the serial data when module reprogramming occurs.

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

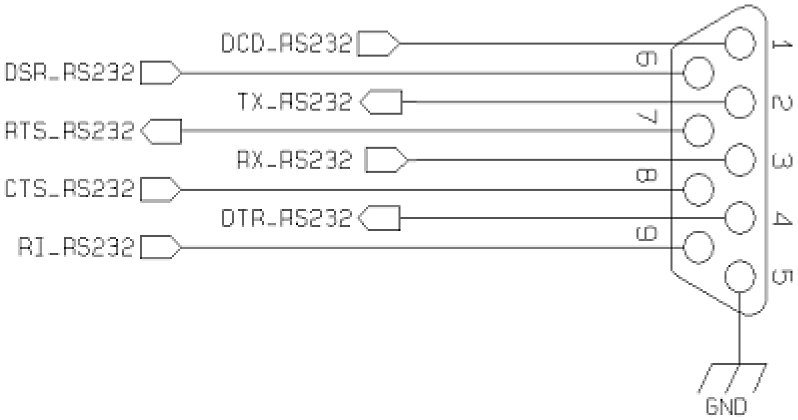
All applicators must include in their design a way reprogramming the GE863.

An example of level translation circuitry of this kind is:


3V0
C205
100nF
X7R
50V
0603
26
C201
100nF
X7R
50V
0603
28
C1+
VCC
V+
27
C206
100nF
X7R
50V
0603
25
C1-
C202
100nF
X7R
50V
0603
1
C2+
V-
4
C207
100nF
X7R
50V
0603
3
C2-
U201
MAX3237EAI+
SSOP-28
GND
RXD
1:4C
24
T1IN
T1OUT
5
RX_RS232
2D
DCD
1:4C
23
T2IN
T2OUT
6
DCD_RS232
2D
RING
1:4C
22
T3IN
T3OUT
7
RING_RS232
2E
DSR
1:4C
19
T4IN
T4OUT
10
DSR_RS232
2D
CTS
1:4C
17
T5IN
T5OUT
12
CTS_RS232
2E
16
R1OUTB
RTS
1:4D
21
R1OUT
R1IN
8
RTS_RS232
2D
DTR
1:4D
20
R2OUT
R2IN
9
DTR_RS232
2D
TXD
1:4C
18
R3OUT
R3IN
11
TX_RS232
2D
3V0
15
MBAUD
EN*
13
SHDN*
14
3V0
GND
2
GND

RS232 LEVEL TRSANSLATOR

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


DCD_RS232
DSR_RS232
TX_RS232
RTS_RS232
RX_RS232
CTS_RS232
DTR_RS232
RI_RS232
1
2
3
4
5
6
7
8
9
GND

8.7. 5V UART Level Translation

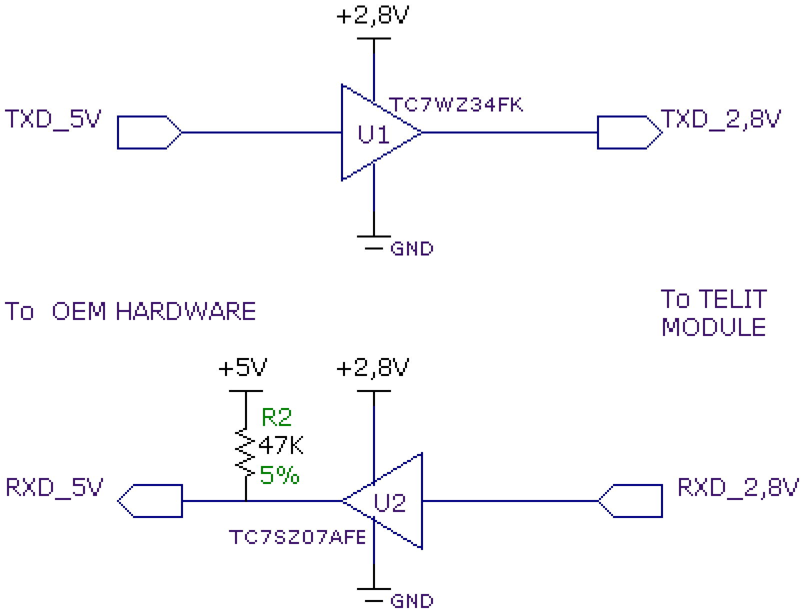
If the OEM application uses a microcontroller with a serial port (UART) that works at a voltage different from 2.8 - 3V, then a circuitry has to be provided to adapt the different levels of the two set of signals. As for the RS232 translation, there are a multitude of single chip translators. For example 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 VAUX line of the GE863. Note that the TC7SZ07AE has open drain output, therefore the resistor R2 is mandatory.

NOTE:

The UART input line TXD (rx_uart) of the GE863 is NOT internally pulled up with a resistor, so there may be the need to place an external 47KΩ pull-up resistor. Either the DTR (dtr_uart) or RTS (rts_uart) input lines are not pulled up internally, so an external pull-up resistor of 47KΩ may be required.



A power source of the internal interface voltage corresponding to the 2.8VCMOS high level is available at the VAUX pin.

A maximum of 9 resistors of 47KΩ pull-up can be connected to the VAUX pin, provided no other devices are connected to it and the pulled-up lines are GE863 input lines connected to open collector outputs in order to avoid latch-up problems on the GE863.

NOTE:

The input lines working at 2.8VCMOS can be pulled-up with 47KΩ resistors that can be connected directly to the VAUX line provided (they are connected as in this example).

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

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

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

Care must be taken to avoid latch-up on the GE863 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 conditions can severely compromise the GE863 functionality.

9. Audio Section Overview

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

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

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

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

Actually the acronyms have not the original importance.

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

Only if the customer needs higher output power to the speaker , he has a constraint. Otherwise the choice could be done in order to overcome the PCB design difficulties.

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

The Base Band Chip of the GE863 Telit Module maintains the same architecture.

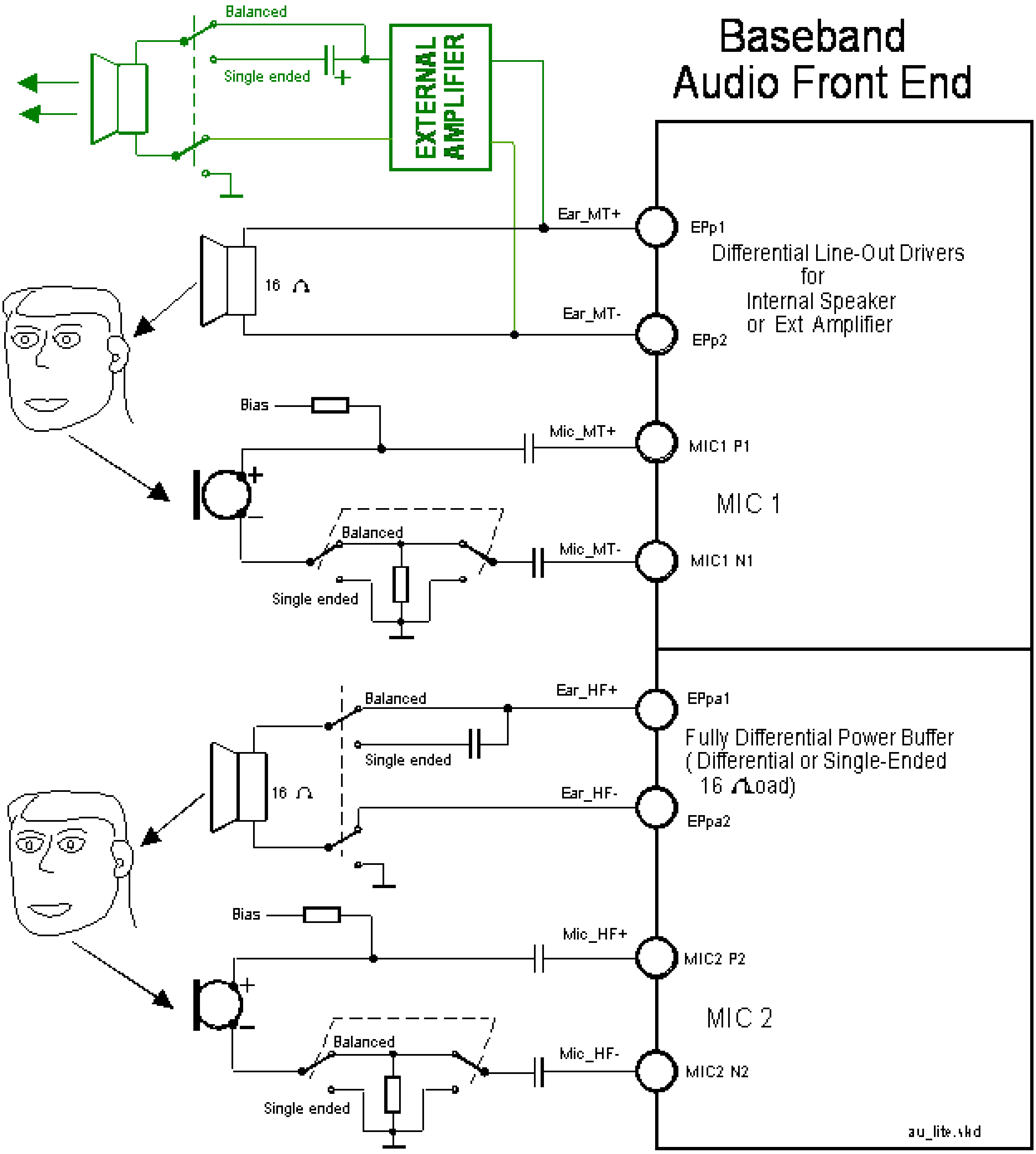
For more information refer to Telit document :

"*80000NT10007a Audio Settings Application Note*".

9.1. Selection mode

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

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


Baseband
Audio Front End
Balanced
Single ended
EXTERNAL AMPLIFIER
Ear_MT+
EPp1
Differential Line-Out Drivers
for
Internal Speaker
or Ext Amplifier
16 Ω
Ear_MT-
EPp2
Bias
Mic_MT+
MIC1 P1
MIC 1
Balanced
Mic_MT-
MIC1 N1
Single ended
Balanced
Ear_HF+
EPpa1
Fully Differential Power Buffer
(Differential or Single-Ended
16 Ω Load)
Single ended
16 Ω
Ear_HF-
EPpa2
Bias
Mic_HF+
MIC2 P2
MIC 2
Balanced
Mic_HF-
MIC2 N2
Single ended
au_lite.skd

Audio Section Block Diagram

9.2. Electrical Characteristics

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

9.2.1. Input Lines Characteristics

“MIC_MT” and “MIC_HF” differential microphone paths	
Line Coupling	AC*
Line Type	Balanced
Coupling capacitor	≥ 100nF
Differential input resistance	50KΩ
Differential input voltage	≤ 1,03V_{pp} @ *MicG=0dB*

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

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

9.2.2. Output Lines Characteristics

TIP:

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

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

WARNING:

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

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

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

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

“EAR_MT” Output Lines	
line coupling	AC single-ended DC differential
output load resistance	≥ 14 Ω
internal output resistance	4 Ω (*typical*)
signal bandwidth	150 - 4000 Hz @ -3 dB
max. differential output voltage	1.31 V_{rms} (*typical, open circuit*)
differential output voltage	328mV_{rms} /16 Ω /*@ -12dBFS*
volume increment	2 dB per step
volume steps	10

“EAR_HF” Output Lines	
line coupling:	AC single-ended DC differential
output load resistance :	≥ 14 Ω
internal output resistance:	4 Ω (>1,7 Ω)
signal bandwidth:	150 - 4000 Hz @ -3 dB
max. differential output voltage	1.31 V_{rms} (*typical, open circuit*)
max. S.E. output voltage	656 mV_{rms} (*typical, open circuit*)
volume increment	2 dB per step
volume steps	10

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)

The following GPIO are available on the GE863:

Ball	Signal	I/O	Function	Type	Input / Output Current	Default State	ON_OFF state	State During Reset	Note
34	GPIO1	I/O	GPIO01 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		
33	GPIO2	I/O	GPIO02 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		Alternate function (JDR)
55	GPIO3	I/O	GPIO03 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	1	1	47K Pull Up
32	GPIO4	I/O	GPIO04 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	1	1	4.7K Pull Up Alternate function (RF Transmission Control)
53	GPIO5	I/O	GPIO05 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		Alternate function (RFTXMON)
54	GPIO6	I/O	GPIO06 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	fig. 01	HIGH	Alternate function (ALARM)
51	GPIO7	I/O	GPIO07 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		Alternate function (BUZZER)
6	GPIO8	I/O	GPIO08 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		
5	GPIO9	I/O	GPIO09 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		
4	GPIO10	I/O	GPIO10 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		
3	GPIO11	I/O	GPIO11 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	1	1	4.7K Pull Up
2	GPIO12	I/O	GPIO12 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	1	1	47K Pull Up
1	GPIO13	I/O	GPIO13 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		
60	GPIO14	I/O	GPIO14 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		
71	GPIO15	I/O	GPIO15 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	INPUT	0		

Ball	Signal	I/O	Function	Type	Input / Output Current	Default State	ON_OFF state	State During Reset	Note
64	GPIO16	I/O	GPIO16 Configurable GPIO	CMOS 2.8V	1μA / 1mA	INPUT	0		
59	GPIO17	I/O	GPIO17 Configurable GPIO	CMOS 2.8V	1μA / 1mA	INPUT	0		
76	GPIO18	I/O	GPIO18 Configurable GPIO	CMOS 2.8V	1μA / 1mA	INPUT	0		

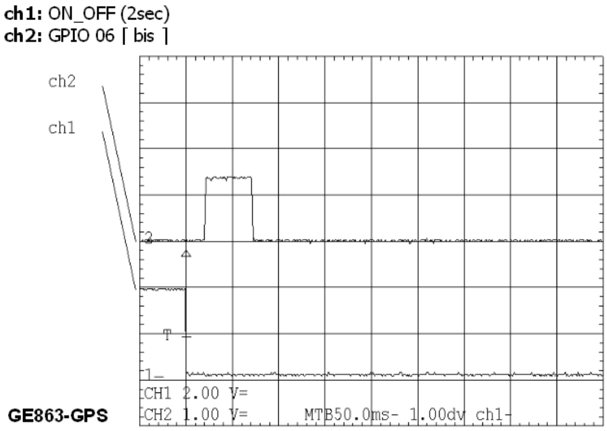
Input pads can only be read and report the digital value (high or low) present on the pad at the read time; output pads can only be written or queried and set the value of the pad output; an alternate function pad is internally controlled by the GE863 firmware and acts depending on the function implemented.

Not all GPIO pads support all these three modes:

- GPIO1, GPIO3, GPIO8 to GPIO18 support both input and output mode but not Alternate function.
- GPIO2 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)

All GPIO pads are 2.8V CMOS signals and their interface levels are the same specified in the paragraph 6.

Figure 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 GE863 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

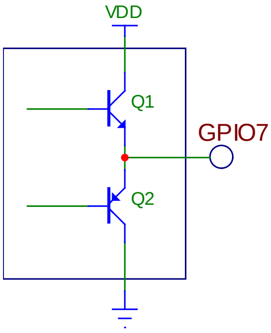
The GPIO pads, when used as inputs, can be connected to a digital output of another device and report its status, provided this device has interface levels compatible with the 2.8V CMOS levels of the GPIO.

If the digital output of the device were to be connected with the GPIO input pad had interface levels different from the 2.8V CMOS, then it could 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.

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



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.

10.5. Using the RFTXMON Output GPIO5

The GPIO5 pin, when configured as RFTXMON Output, is controlled by the GE863 module and rises when the transmitter is active and fall after the transmitter activity is completed.

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 becomes LOW again 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 GE863 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 GE863 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 GE863 during sleep periods, dramatically reducing the sleep consumption to few µA.

NOTE:

During RESET the line is set to HIGH logic level.

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

10.7. Using the Buzzer Output GPIO7

As Alternate Function, the GPIO7 is controlled by the firmware that depends on the function implemented internally.

This setup always places the GPIO7 pin in OUTPUT direction and the corresponding function must be activated properly by AT#SRP command (refer to AT commands specification).

In this case, the dummy value for the pin state can also be both “0” or “1”.

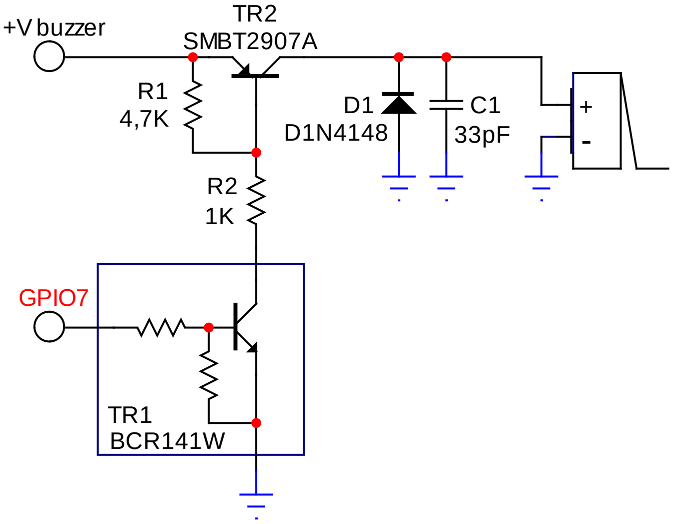
- send the command AT#GPIO=7, 1, 2<cr>:
- wait for response OK
- send the command AT#SRP=3

The GPIO7 pin will be set as Alternate Function pin with its dummy logic status set to HIGH value.

The "Alternate function” permits your application to easily implement Buzzer feature with some small hardware extension of your application as shown in the next sample figure.

NOTE:

To correctly drive a buzzer, a driver must be provided; its characteristics depend on the Buzzer and to get these pieces of info, contact your buzzer vendor.

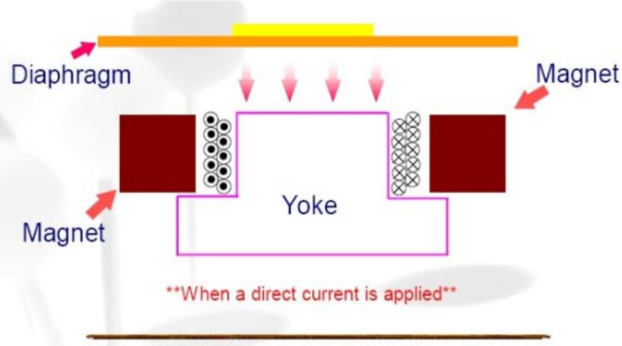


Example of Buzzer’s driving circuit.

10.8. Magnetic Buzzer Concepts

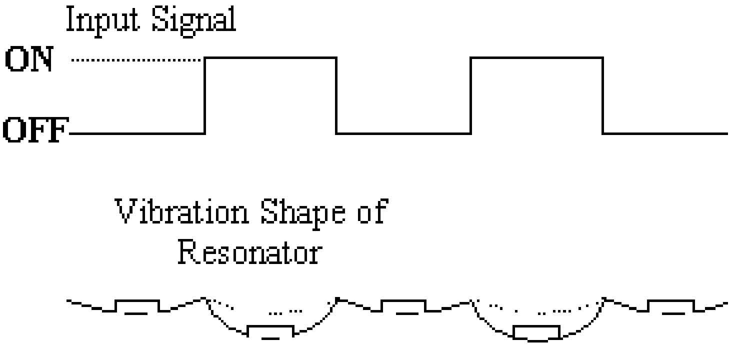
10.8.1. Short Description

A magnetic Buzzer is a sound-generating device with a coil located in the magnetic circuit consisting of a permanent magnet, an iron core, a high permeable metal disk and a vibrating diaphragm.


Diaphragm
Magnet
Yoke
Magnet
When a direct current is applied

Drawing of the Magnetic Buzzer.

The disk and diaphragm are attracted to the core by the magnetic field. When an oscillating signal is moved through the coil, it produces a fluctuating magnetic field which vibrates the diaphragm at a frequency of the drive signal. Thus the sound is produced relative to the frequency applied.


Input Signal
ON
OFF
Vibration Shape of Resonator

Diaphragm movement.

10.8.2. Frequency Behavior

The frequency behavior represents the effectiveness of the reproduction of the applied signals. Because performance is related to a square driving waveform (whose amplitude varies from 0V to Vpp), if you modify the waveform (e.g. from square to sinus) the frequency response will change.

10.8.3. Power Supply Influence

Applying a signal whose amplitude is different from that suggested by the manufacturer, the performance change following the rule "*if resonance frequency* f_o *increases, amplitude decreases*".

Because resonance frequency depends on acoustic design, by lowering the amplitude of the driving signal the response bandwidth tends to become narrow, and vice versa.

Summarizing: Vpp ↑ → f_o ↓ Vpp ↓ → f_o ↑

WARNING:

It is very important to respect the sense of the applied voltage: never apply to the "-" pin a voltage more positive than the "+" pin: if this happens, the diaphragm vibrates in the opposite direction with a high probability to be expelled from its physical position. This damages the device permanently.

The risk is that the f_o could easily fall outside of new bandwidth; consequently the SPL could be much lower than the expected.

10.8.4. Working Current Influence

In the component data sheet you will find the value of MAX CURRENT: this represents the maximum average current that can flow at nominal voltage without current limitation. In other words it is not the peak current, which could be twice or three times higher. If driving circuitry does not support these peak values, the SPL will never reach the declared level or the oscillations will stop.

10.9. Using the Temperature Monitor Function

10.9.1. 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.

10.9.2. Allowed GPIO

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

Ball	Signal	Function	Type	Input / Output Current	Note
34	GPIO 01	GPIO01 Configurable GPIO	CMOS 2.8V	1µA / 1mA	
6	GPIO 08	GPIO08 Configurable GPIO	CMOS 2.8V	1µA / 1mA	
5	GPIO 09	GPIO09 Configurable GPIO	CMOS 2.8V	1µA / 1mA	
4	GPIO 10	GPIO10 Configurable GPIO	CMOS 2.8V	1µA / 1mA	
1	GPIO 13	GPIO13 Configurable GPIO	CMOS 2.8V	1µA / 1mA	
60	GPIO 14	GPIO14 Configurable GPIO	CMOS 2.8V	1µA / 1mA	
71	GPIO 15	GPIO15 Configurable GPIO	CMOS 2.8V	1µA / 1mA	
64	GPIO 16	GPIO16 Configurable GPIO	CMOS 2.8V	1µA / 1mA	
59	GPIO 17	GPIO17 Configurable GPIO	CMOS 2.8V	1µA / 1mA	
76	GPIO 18	GPIO18 Configurable GPIO	CMOS 2.8V	1µA / 1mA	

The set command could be used also with one of the following GPIO but in that case the alternate function is not usable:

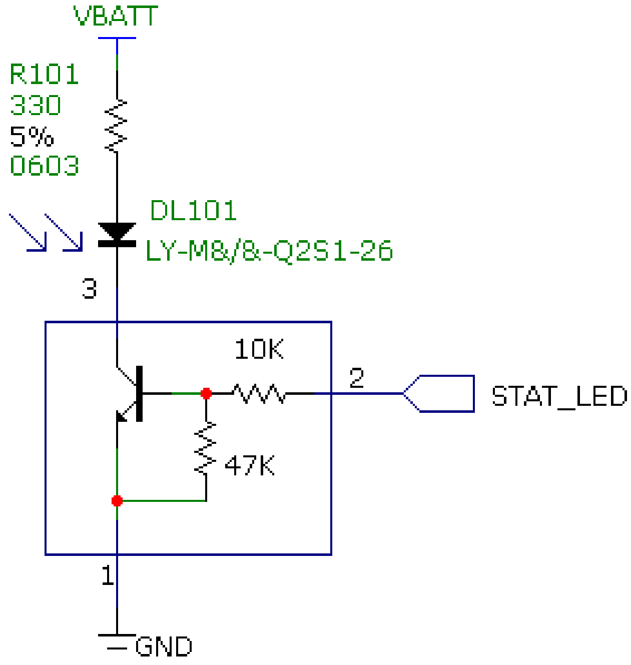
Ball	Signal	Function	Type	Input / Output Current	Note
33	GPIO 02	GPIO02 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	Alternate function (JDR)
53	GPIO 05	GPIO05 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	Alternate function (RFTXMON)
51	GPIO 07	GPIO07 Configurable GPIO	CMOS 2.8V	1ųA / 1mA	Alternate function (BUZZER)

10.10. Indication of Network Service Availability

The STAT_LED pin status shows information on the network service availability and Call status. In the GE863 modules, the STAT_LED 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

A schematic example could be:



11. RTC and Auxiliary Supply

11.1. RTC Bypass Out

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

11.2. 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 - GE863-GPS

	Min	Typical	Max
Output voltage	2.75V	2.85V	2.95V
Output current			50mA
Output bypass capacitor (inside the module)			2.2µF

Operating Range - VAUX1 power supply - GE863-QUAD/PY/SIM

	Min	Typical	Max
Output voltage	2.75V	2.85V	2.95V
Output current			100mA
Output bypass capacitor (inside the module)			2.2µF

12. PPS GPS Output (GE863-GPS only)

12.1. Description

The Time Mark output 1PPS provides a one pulse-per-second signal to the user specific application. The 1PPS pulse is available at any time as soon as a fix is done. This signal is a positive logic, CMOS level output pulse that transitions from logic 'low' condition to logic 'high' at a 1 Hz rate.

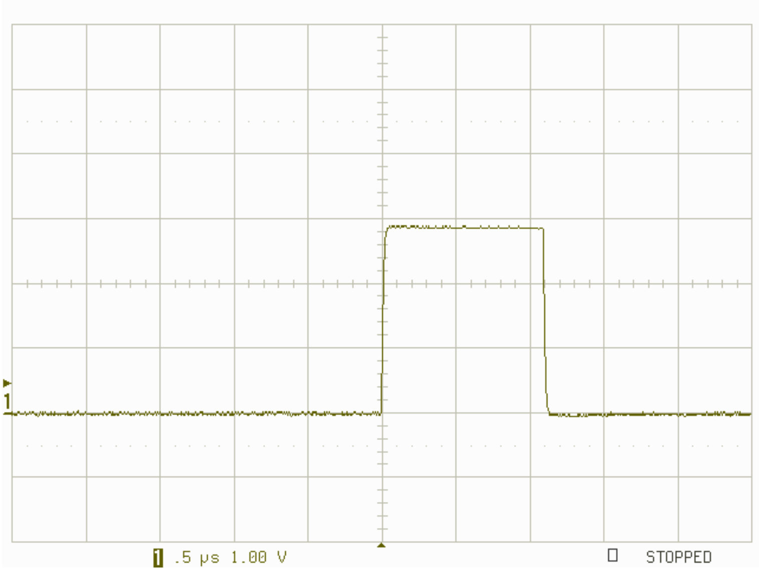
12.2. Pulse Characteristics

The signal is available on BGA Ball # 75 on GE863-GPS and on pin 26 of PL104 on EVK2 Adapter board (CS1151).

Type:	Output CMOS 2.8V
Duration:	Typically 1us
Pull up/ down:	Internal 100KΩ Pull down

NOTE:

The signal is available only when the receiver provides a valid Navigation solution.



13. DAC and ADC section

13.1. DAC Converter

13.1.1. Description

The GE863 module provides a Digital to Analog Converter. The signal (named DAC_OUT) is available on BGA Ball #63 of the GE863 module and on pin 17 of PL104 on EVK2 Board (CS1151).

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

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

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

Integrated output voltage = 2 * value / 1023

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

13.1.2. 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)

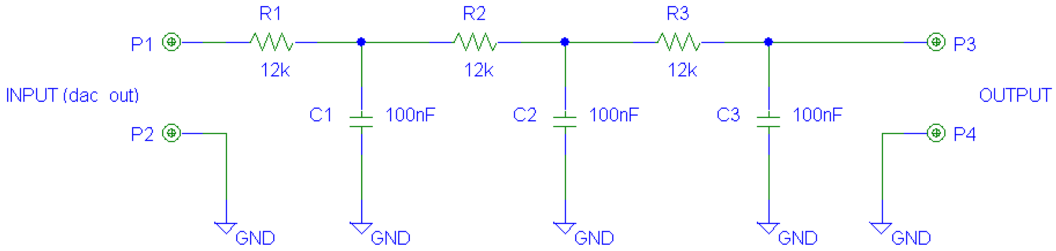
it must be present if <enable>=1

NOTE:

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

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

13.1.3. Low Pass Filter Example



13.2. ADC Converter

13.2.1. Description

The GE863-GPS module provides one Analog to Digital Converter. The input line (named ADC_IN1) is available on BGA Ball #23 of the GE863-GPS module and on pin 19 of PL104 on EVK2 Board (CS1151).

The GE863-QUAD / PY / SIM modules provide 3 Analog to Digital Converters.

The input lines are available on:

ADC_IN1 on BGA Ball #23 of the module and on pin 19 of PL104 on EVK Interface board.

ADC_IN2 on BGA Ball #74 of the module and on pin 20 of PL104 on EVK Interface board.

ADC_IN3 on BGA Ball #70 of the module and on pin 21 of PL104 on EVK Interface board.

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

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

13.2.2. Using ADC Converter

An AT command is available to use the ADC function.

The command is AT#ADC=1,2 and the read value is expressed in mV

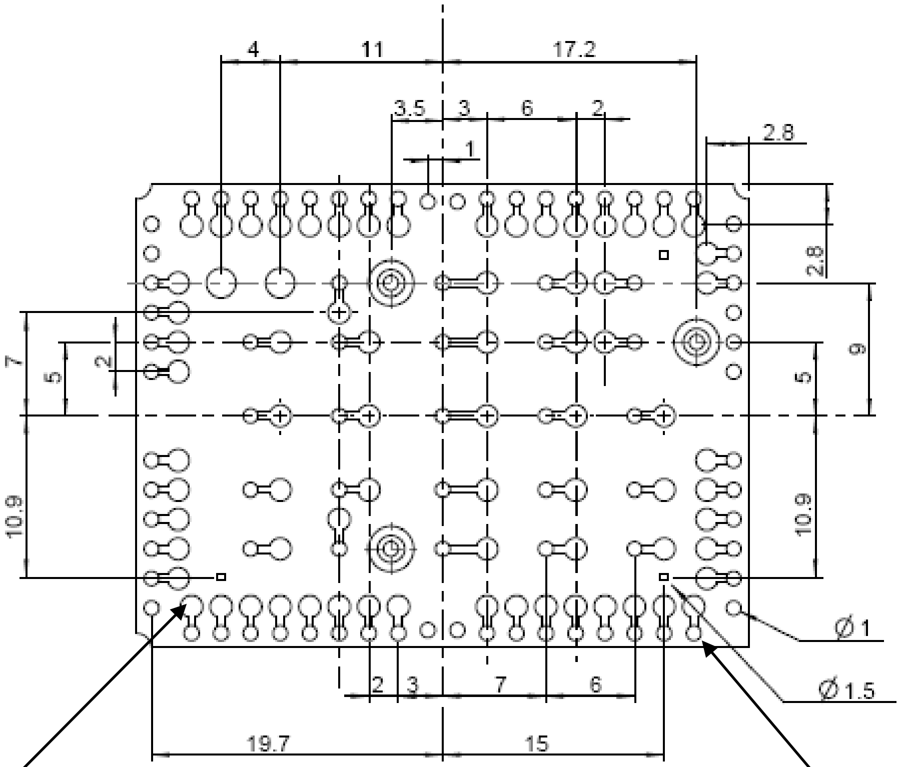
Refer to SW User Guide or to AT Commands Reference Guide for the full description of this function.

14. Mounting the GE863 on the Application Board

14.1. General

The Telit GE863 modules have been designed in order to be compliant with a standard lead-free SMT process.

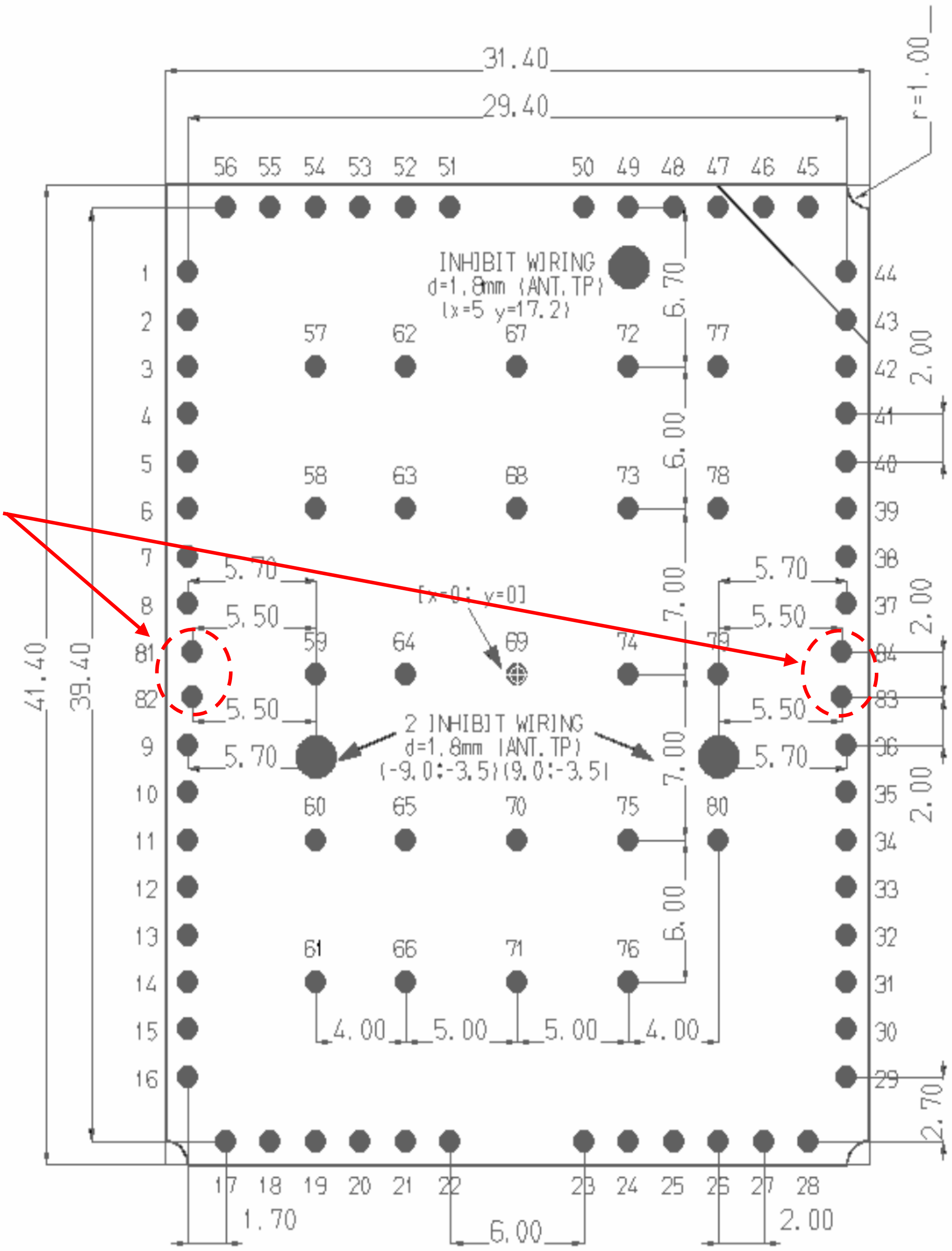
14.1.1. Module Finishing & Dimensions



Surface finishing Ni/Au for all test pads

Lead-free Alloy:
Surface finishing Sn/Ag/Cu for all solder pads

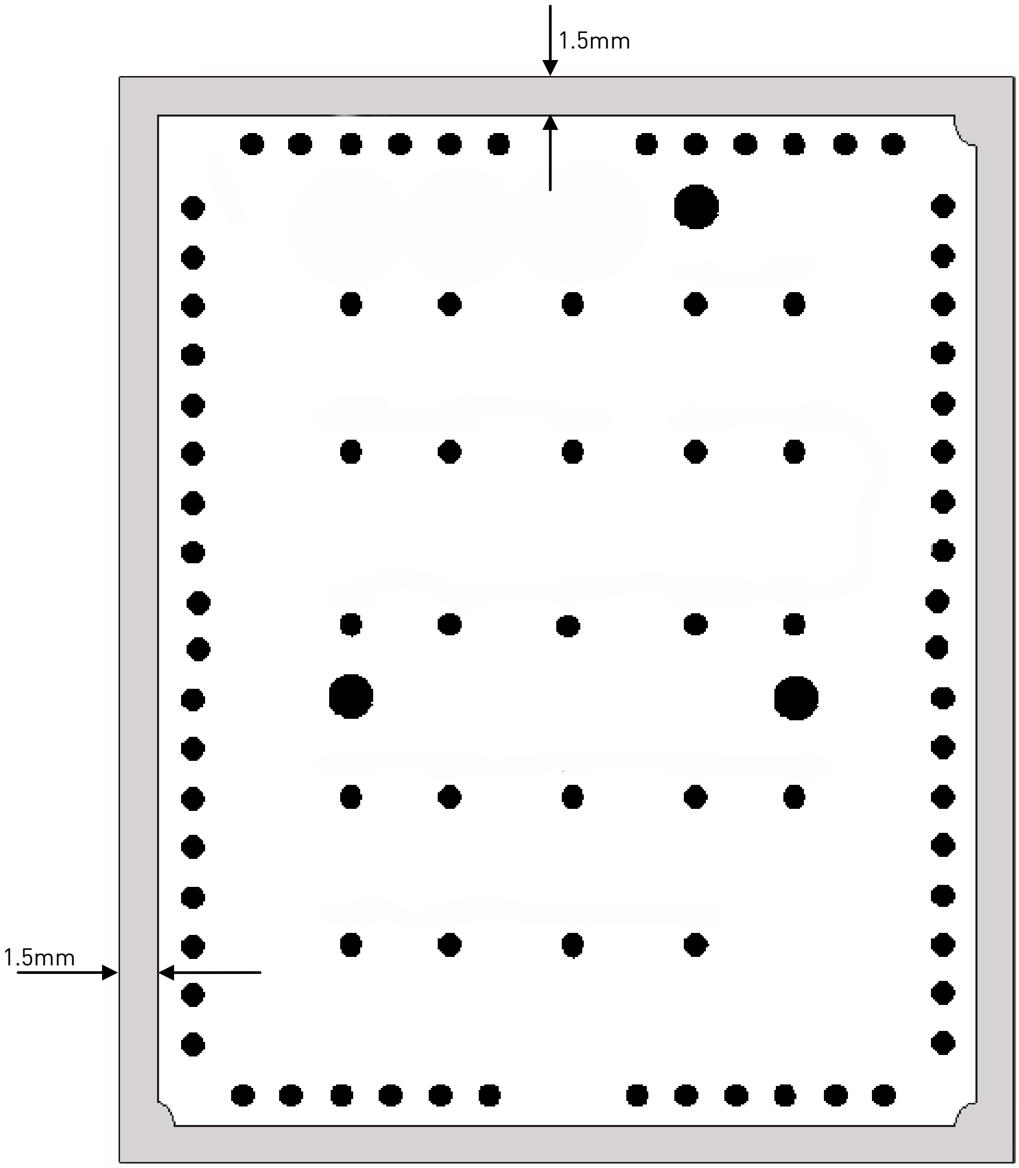
14.1.2. Recommended Foot Print for the Application


31.40
29.40
r=1.00
56 55 54 53 52 51 50 49 48 47 46 45
INHIBIT WIRING
d=1.8mm (ANT.TP)
(x=5 y=17.2)
1 2 3 4 5 6 7 8 81 82 9 10 11 12 13 14 15 16
44 43 42 41 40 39 38 37 84 83 36 35 34 33 32 31 30 29
57 62 67 72 77
58 63 68 73 78
59 64 69 74 79
60 65 70 75 80
61 66 71 76
6.70
6.00
7.00
7.00
6.00
2.00
2.00
2.00
2.70
5.70
5.50
5.50
5.70
[x=0; y=0]
2 INHIBIT WIRING
d=1.8mm (ANT.TP)
(-9.0;-3.5)(9.0;-3.5)
41.40
39.40
4.00 5.00 5.00 4.00
17 18 19 20 21 22 23 24 25 26 27 28
1.70
6.00
2.00

NOTE:
Pads 81, 82, 83 and 84 are not in line with the others. Please check the quotes.

14.1.3. Suggested Inhibit Area

In order to easily rework the GE863 it is suggested to consider on the application of a 1.5mm Inhibit area around the
module.



Top View

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

14.1.4. Debug of the GE863 in Production

To test and debug mounting of the GE863, we strongly recommend to foresee test pads on the host PCB, in order to check the connection between the GE863 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:

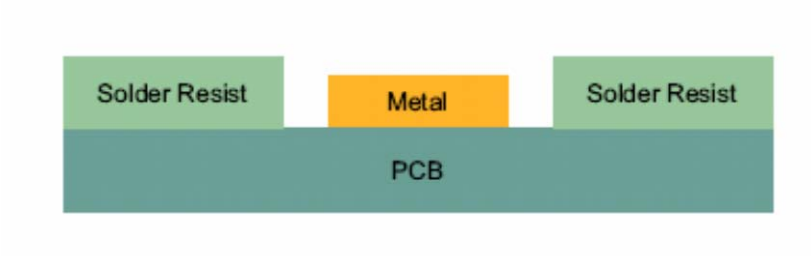
- TXD
- RXD
- ON/OFF
- RESET
- GND
- VBATT
- TX_TRACE
- RX_TRACE
- PWRMON

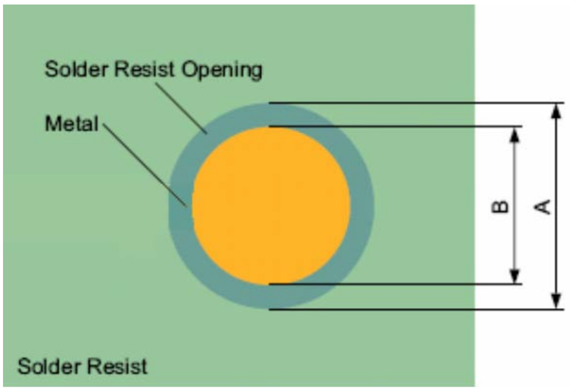
14.1.5. Stencil

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

14.1.6. PCB Pad Design

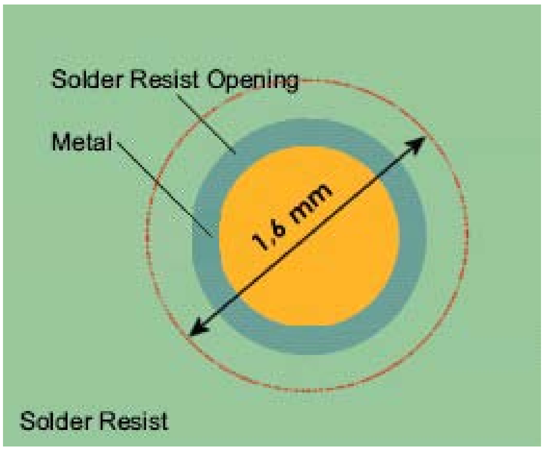
“Non solder mask defined” (NSMD) type is recommended for the solder pads on the PCB.


Solder Resist
Metal
Solder Resist
PCB


Solder Resist Opening
Metal
B
A
Solder Resist

Recommendations for PCB Pad Dimensions	
Ball pitch [mm]	2
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, unless the microvia carries 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:

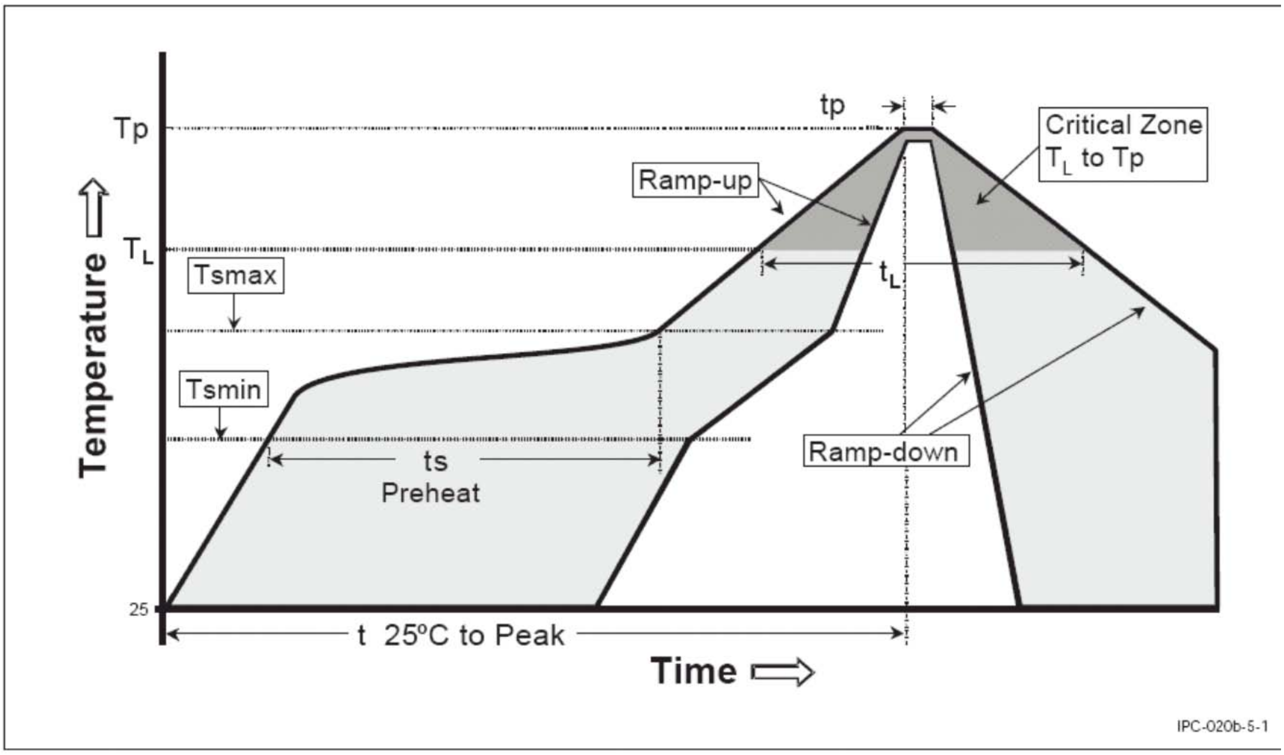
Finish	Layer thickness [µm]	Properties
Electro-less Ni / Immersion Au	3 -7 / 0.05 - 0.15	Good solder ability protection, high shear force values

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

14.1.7. Solder Paste

	Lead free
Solder paste	Sn/Ag/Cu

14.1.8. GE863 Solder Reflow



Profile Feature	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max
Preheat: - Temperature Min (Tsmin) - Temperature Max (Tsmax) - Time (min to max) (ts)	 150°C 200°C 60-180 seconds
Tsmax to TL: - Ramp-up Rate	 3°C/second max
Time maintained above: - Temperature (TL) - Time (tL)	 217°C 60-150 seconds
Peak Temperature (Tp):	245 +0/-5°C

Time within 5°C of actual Peak Temperature (tp)	10-30 seconds
Ramp-down Rate	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

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

⚠ **WARNING:**

The GE863 module can accept only one reflow process.

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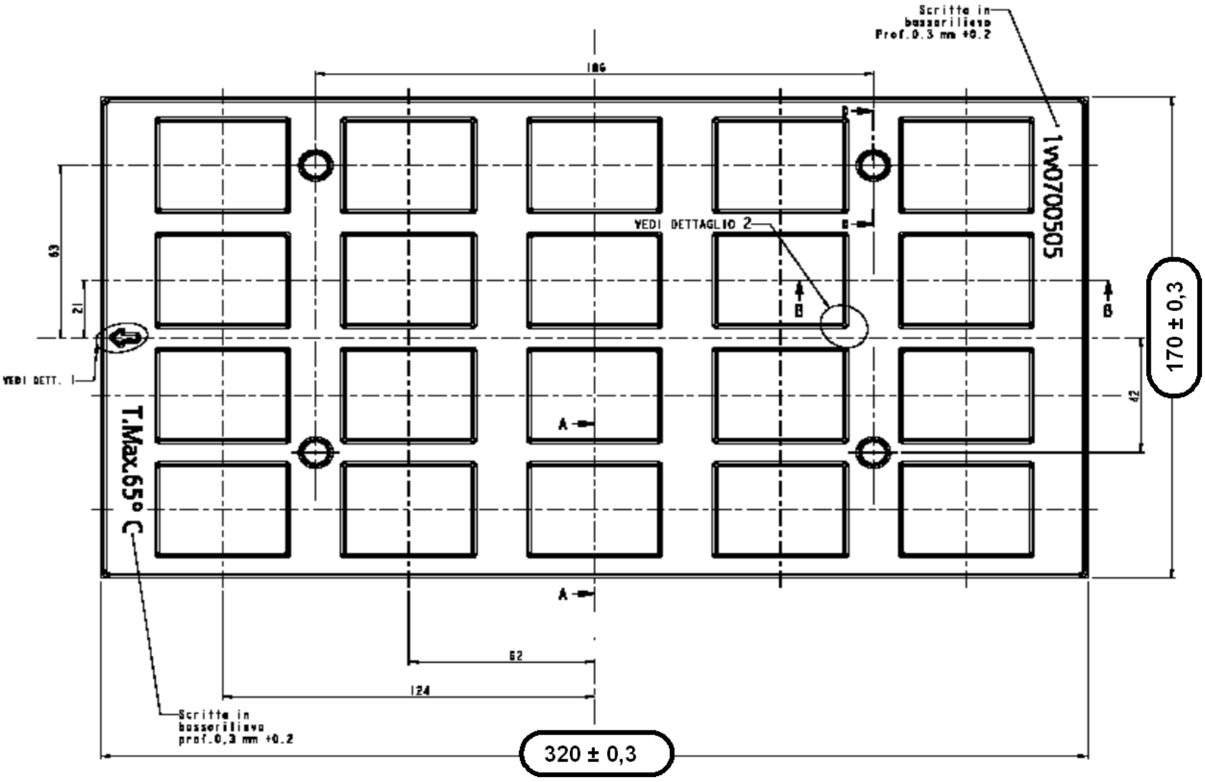
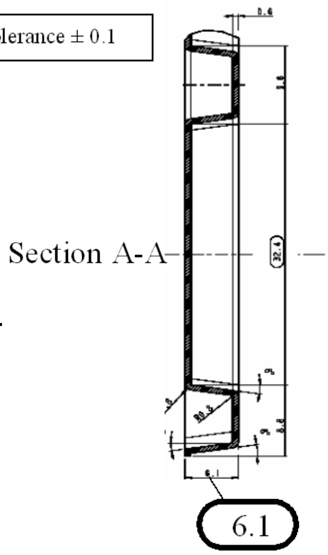
15. Packing System

According to SMT processes, for picking & placing movement requirements, Telit GE863 modules are packaged on trays. Each tray contains 20 pieces with the following dimensions:

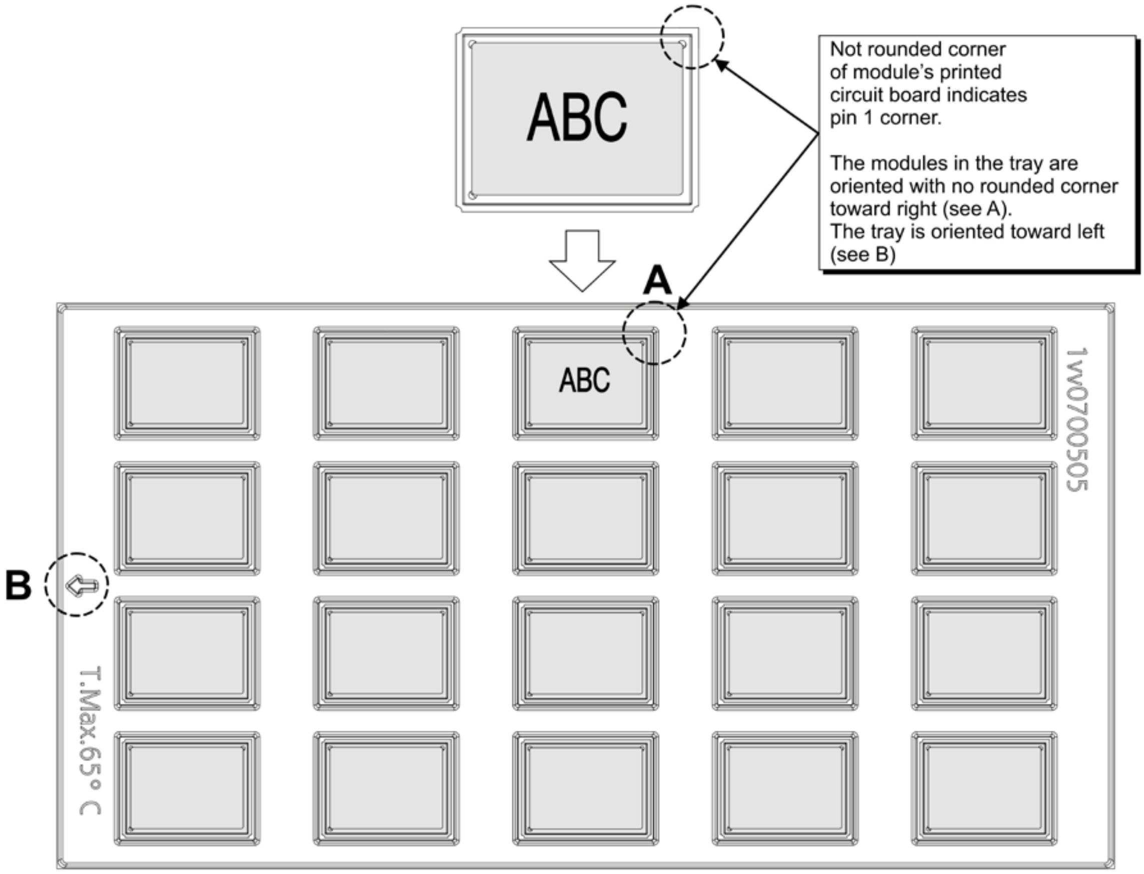

Scritte in bassorilievo Prof.0.3 mm +0.2
186
1vv0700505
VEDI DETTAGLIO 2
63
21
VEDI DETT. 1
T.Max.65° C
170 ± 0,3
42
A
B
62
124
Scritte in bassorilievo prof.0,3 mm +0.2
320 ± 0,3

All quotes are in mm, general tolerance ± 0.1


Section A-A
6.1

Note that trays can withstand a maximum temperature of 65° C.

Modules orientation on tray:



Not rounded corner of module's printed circuit board indicates pin 1 corner.

The modules in the tray are oriented with no rounded corner toward right (see A).
The tray is oriented toward left (see B)

15.1.1. Moisture Sensibility

The level of moisture sensibility of Telit GE863 modules is “3”, according with standard IPC/JEDEC J-STD-020, take care of all the relative requirements for using this kind of components.

Moreover, the customer has to take care of the following conditions:

a) The shelf life of GE863 inside of the dry bag must be 12 months from the bag seal date, when stored in a non-condensing atmospheric environment of <40°C / 90% RH

b) Environmental condition during the production: ≤ 30°C / 60% RH according to IPC/JEDEC J-STD-033A paragraph 5

c) The maximum time between the opening of the sealed bag and the reflow process must be 168 hours if condition b) “IPC/JEDEC J-STD-033A paragraph 5.2” is respected

d) Baking is required if conditions b) or c) are not respected

e) Baking is required if the humidity indicator inside the bag indicates 10% RH or more

16. Conformity Assessment Issues

The Telit GE863-GPS/PY/QUAD/SIM 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.

CE 0168

If the module is installed in conformance to the Telit installation manuals, 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 the 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.

This Product Description, the Hardware User Guide and Software User Guide contain all the information you may need for developing a product meeting the R&TTE Directive.

Furthermore the GE863-GPS/PY/QUAD/SIM module is FCC Approved as module to be installed in other devices. This device is to be used only for fixed and mobile applications. If the final product after integration is intended for portable use, a new application and FCC is required.

The GE863-GPS/PY/QUAD/SIM is conforming to the following US Directives:

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

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

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 1.4dBi (850MHz) and 3.0dBi (1900MHz) 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.

17. Safety Recommendations

Read Carefully!

Be sure about that 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, aircraft, etc
- Where there is a risk of explosion such as gasoline stations, oil refineries, etc

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

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

We recommend to follow 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 for the functioning of the final product; therefore, care has to be taken to the external components of the module, as well as to any project or installation issue. The risk of disturbing the GSM network or external devices or having impact on the security cannot be avoided. 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 these requirements cannot be satisfied, the system integrator has to assess the final product against the SAR regulation EN 50360.

The European Community provides some Directives for the electronic equipments introduced on the market. All the relevant information's are available on the European Community website:
http://ec.europa.eu/enterprise/sectors/rtte/documents/

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

http://ec.europa.eu/enterprise/sectors/electrical/