GE863-PRO^3

Hardware User Guide

1vv0300773a Rev. 1 DRAFT - 24/04/08

Making machines talk.

Contents

This document is relating to the following products:

GE863-PRO3	3990250691
GE863-PRO3 with Linux	3990250698

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1 Overview

The scope of this document is the description of some hardware solutions useful for developing a product with the **Telit *GE863-PRO^3* module**.
In this document all the basic functions of a M2M device will be taken into account; for each one of them a proper hardware solution will be suggested and eventually the wrong solutions and common errors to be avoided will be evidenced. Obviously this document cannot embrace the whole hardware solutions and products that may be designed. The wrong solutions to be avoided shall be considered as mandatory, while the suggested hardware configurations shall not be considered mandatory, instead the information given shall be used as a guide and a starting point for properly developing your product with the **Telit *GE863-PRO^3* module**. For further hardware details that may not be explained in this document refer to the Telit GE863-PRO^3 Product Description document.

NOTICE

(EN) The integration of the GSM/GPRS GE863-PRO^3 cellular module within user application shall be done according to the design rules described in this manual.

(IT) L'integrazione del modulo cellulare GSM/GPRS GE863-PRO^3 all'interno dell'applicazione dell'utente dovrà rispettare le indicazioni progettuali descritte in questo manuale.

(DE) Die integration des GE863-PRO^3 GSM/GPRS Mobilfunk-Moduls in ein Gerät muß gemäß der in diesem Dokument beschriebenen Kunstruktionsregeln erfolgen

(SL) Integracija GSM/GPRS GE863-PRO^3 modula v uporabniški aplikaciji bo morala upoštevati projektna navodila, opisana v tem piročniku.

(SP) La utilización del modulo GSM/GPRS GE863-PRO^3 debe ser conforme a los usos para los cuales ha sido deseñado descritos en este manual del usuario.

(FR) L'intégration du module cellulaire GSM/GPRS GE863-PRO^3 dans l'application de l'utilisateur sera faite selon les règles de conception décrites dans ce manuel.

(HE) האינטגרטור מתבקש ליישם את ההנחיות המפורטות במסמך זה בתהליך האינטגרציה של המודם הסלולרי *GE863-PRO^3* עם המוצר.

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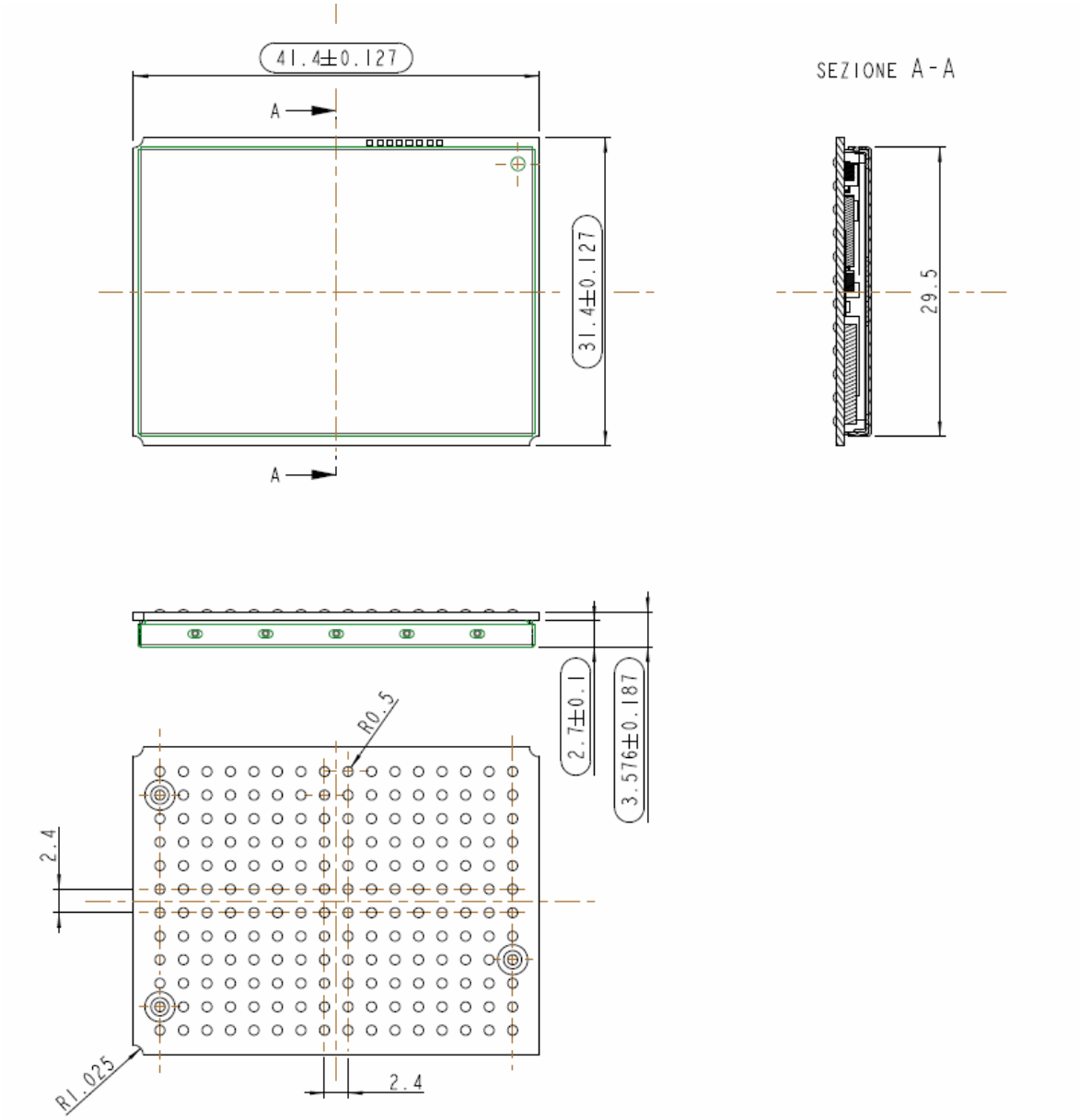
2 GE863-PRO^3 Mechanical Dimensions

The **Telit GE863-PRO^3 module** overall dimension are:

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



3 GE863-PRO^3 module connections

3.1 BALL-OUT

Ball	Signal	I/O	Main Function	Internal Pull up	ARM/ GSM	Type
A1	RESERVED	-	RESERVED (3)	-	-	-
A2	GND	-	Ground	-	-	Power
A3	ANTENNA	O	GSM Antenna output - 50 ohm	-	GSM	RF
A4	RESERVED	-	RESERVED (3)	-	-	-
A5	GND	-	Ground	-	-	Power
A6	EAR_HF+	AO	Handsfree ear output, phase +		GSM	Audio
A7	EAR_HF-	AO	Handsfree ear output, phase -		GSM	Audio
A8	EAR_MT+	AO	Handset earphone signal output, phase -		GSM	Audio
A9	EAR_MT-	AO	Handset earphone signal output, phase +		GSM	Audio
A10	TX_TRACE		TX data for Debug (1)		GSM	CMOS 2.8V
A11	RX_TRACE		RX data for Debug (1)			CMOS 2.8V
A12	GND	-	Ground	-	-	Power
B1	RESERVED	-	RESERVED (3)	-	-	-
B2	GND	-	Ground	-	-	Power
B3	GND	-	Ground	-	-	Power
B4	GND	-	Ground	-	-	Power
B5	GND	-	Ground	-	-	Power
B6	MIC_HF+	AI	Handsfree microphone input; phase +		GSM	Audio
B7	MIC_HF-	AI	Handsfree microphone input; phase -		GSM	Audio
B8	MIC_MT+	AI	Handset microphone signal input; phase+		GSM	Audio
B9	MIC_MT-	AI	Handset microphone signal input; phase-		GSM	Audio
B10	GPIO4 / BUZZER	I/O	GPIO4 / BUZZER output		GSM	CMOS 2.8V
B11	STAT_LED	O	Status indicator led		GSM	CMOS 1.8V
B12	SIMIN	I/O	External SIM signal - Presence (active low)	47KΩ	GSM	CMOS 2.8V
C1	VBATT	-	Main GSM power supply		GSM	Power

Ball	Signal	I/O	Main Function	Internal Pull up	ARM/ GSM	Type
C2	VBATT	-	Main GSM power supply		GSM	Power
C3	VRTC	AO	VRTC Backup capacitor		GSM-ARM	Power
C4	C125/RING	O	Output for Ring indicator signal (RI) to DTE		GSM	CMOS 2.8V
C5	C107/DSR	O	Output for Data set ready signal (DSR) to DTE		GSM	CMOS 2.8V
C6	C108/DTR	I	Input for Data terminal ready signal (DTR) from DTE		GSM	CMOS 2.8V
C7	C109/DCD	O	Output for Data carrier detect signal (DCD) to DTE		GSM	CMOS 2.8V
C8	C105/RTS	I	Input for Request to send signal (RTS) from DTE		GSM	CMOS 2.8V
C9	C106/CTS	O	Output for Clear to send signal (CTS) to DTE		GSM	CMOS 2.8V
C10	GPIO7/ RFTXDISABLE	I/O	GPIO7 / RFTXDISABLE		GSM	CMOS 2.8V
C11	SIMRST	O	External SIM signal – Reset		GSM	1.8/3V ONLY
C12	SIMIO	I/O	External SIM signal - Data I/O		GSM	1.8/3V ONLY
D1	CHARGE	AI	Charger input		GSM	Power
D2	VAUX1	-	Power output for external accessories		GSM	-
D3	RESERVED	-	RESERVED (3)	-	-	-
D4	PB25	I/O	ARM PIO Controller B pin 25		ARM	CMOS 3.1V
D5	PB22	I/O	ARM PIO Controller B pin 22		ARM	CMOS 3.1V
D6	PB24	I/O	ARM PIO Controller B pin 24		ARM	CMOS 3.1V
D7	PB23	I/O	ARM PIO Controller B pin 23		ARM	CMOS 3.1V
D8	PB26	I/O	ARM PIO Controller B pin 26		ARM	CMOS 3.1V
D9	PB27	I/O	ARM PIO Controller B pin 27		ARM	CMOS 3.1V
D10	GND	-	Ground	-	-	Power
D11	SIMVCC	-	External SIM signal – Power (2)		GSM	1.8/3V ONLY
D12	SIMCLK	O	External SIM signal – Clock		GSM	1.8/3V ONLY
E1	GND	-	Ground	-	-	Power
E2	PWRMON	O	Power ON Monitor		GSM	CMOS 2.8V
E3	RESERVED	-	RESERVED (3)	-	-	-
E4	ON_OFF*-GSM	I	Input command for switching power ON or OFF to GSM Engine (toggle command).	47KΩ	GSM	Pull up to VBATT
E5	RESET*-GSM	I	GSM Engine Reset input		GSM	
E6	GPIO1 / JDR	I/O	GPIO1 Configurable general purpose I/O pin / Jammer Detect Output (2)		GSM	CMOS 2.8V
E7	GPIO5	I/O	GPIO5 Configurable general purpose I/O pin		GSM	CMOS 2.8V
E8	GPIO3 / RFTXMON	I/O	GPIO3 Configurable general purpose I/O pin /		GSM	CMOS 2.8V
E9	C103/TXD	I	Serial data input (TXD) from DTE		GSM	CMOS 2.8V

Ball	Signal	I/O	Main Function	Internal Pull up	ARM/ GSM	Type
E10	C104/RXD	O	Serial data output to DTE		GSM	CMOS 2.8V
E11	PB8	I/O	ARM PIO Controller B pin 8		ARM	CMOS 3.1V
E12	PB9	I/O	ARM PIO Controller B pin 9		ARM	CMOS 3.1V
F1	PB13	I/O	ARM PIO Controller B pin 13		ARM	CMOS 3.1V
F2	PC30	I/O	ARM PIO Controller C pin 30		ARM	CMOS 1.8V-A
F3	PC21	I/O	ARM PIO Controller C pin 21		ARM	CMOS 1.8V-A
F4	PC28	I/O	ARM PIO Controller C pin 28		ARM	CMOS 1.8V-A
F5	PC29	I/O	ARM PIO Controller C pin 29		ARM	CMOS 1.8V-A
F6	NRST	I	RESET ARM	1 KΩ	ARM	CMOS 3.1V
F7	ON/OFF*-AP	I	Input command for turning power ON or OFF to ARM Engine (active high command).	47KΩ	ARM	Pull up to VBATT2
F8	SHDN	O	Shutdown Control Output		ARM	CMOS VRTC
F9	PB4	I/O	ARM PIO Controller B pin 4		ARM	CMOS 3.1V
F10	PB5	I/O	ARM PIO Controller B pin 5		ARM	CMOS 3.1V
F11	PC8	I/O	ARM PIO Controller C pin 8		ARM	CMOS 1.8V-A
F12	PC10	I/O	ARM PIO Controller C pin 10		ARM	CMOS 1.8V-A
G1	PB12	I/O	ARM PIO Controller B pin 12		ARM	CMOS 3.1V
G2	RESERVED	-	RESERVED (3)	-	-	-
G3	PC31	I/O	ARM PIO Controller C pin 31		ARM	CMOS 1.8V-A
G4	GPIO2 / PCMCLK	I/O	GPIO2 Configurable general purpose I/O pin	4.7KΩ	GSM	CMOS 2.8V
G5	GPIO8 / PCMWAO	I/O	GPIO8 Configurable general purpose I/O pin		GSM	CMOS 2.8V
G6	GPIO6 / PCMTX	I/O	GPIO6 Configurable general purpose I/O pin		GSM	CMOS 2.8V
G7	GPIO9 – PCMRX	I/O	GPIO9 Configurable general purpose I/O pin		GSM	CMOS 2.8V
G8	RESERVED	-	RESERVED (3)	-	-	-
G9	PA5	I/O	ARM PIO Controller A pin 5		ARM	CMOS 3.1V
G10	PA4	I/O	ARM PIO Controller A pin 4		ARM	CMOS 3.1V
G11	PB10	I/O	ARM PIO Controller B pin 10		ARM	CMOS 3.1V
G12	PB11	I/O	ARM PIO Controller B pin 11		ARM	CMOS 3.1V
H1	PB6	I/O	ARM PIO Controller B pin 6		ARM	CMOS 3.1V
H2	PB29	I/O	ARM PIO Controller B pin 29		ARM	CMOS 3.1V
H3	GND	-	Ground	-	-	Power
H4	PB20	I/O	ARM PIO Controller B pin 20		ARM	CMOS 3.1V
H5	PB21	I/O	ARM PIO Controller B pin 21		ARM	CMOS 3.1V
H6	PB19	I/O	ARM PIO Controller B pin 19		ARM	CMOS 3.1V
H7	PB18	I/O	ARM PIO Controller B pin 18		ARM	CMOS 3.1V
H8	RESERVED	-	RESERVED (3)	-	-	-

Ball	Signal	I/O	Main Function	Internal Pull up	ARM/ GSM	Type
H9	PC18	I/O	ARM PIO Controller C pin 18		ARM	CMOS 1.8V-A
H10	PB0	I/O	ARM PIO Controller B pin 0		ARM	CMOS 3.1V
H11	PB2	I/O	ARM PIO Controller B pin 2		ARM	CMOS 3.1V
H12	PB1	I/O	ARM PIO Controller B pin 1		ARM	CMOS 3.1V
J1	PB7	I/O	ARM PIO Controller B pin 7		ARM	CMOS 3.1V
J2	PB28	I/O	ARM PIO Controller B pin 28		ARM	CMOS 3.1V
J3	RESERVED	-	RESERVED (3)	-	-	-
J4	PB16	I/O	ARM PIO Controller B pin 16		ARM	CMOS 3.1V
J5	PB17	I/O	ARM PIO Controller B pin 17		ARM	CMOS 3.1V
J6	PC15	I/O	ARM PIO Controller C pin 15		ARM	CMOS 1.8V-A
J7	PC14	I/O	ARM PIO Controller C pin 14		ARM	CMOS 1.8V-A
J8	RESERVED	-	RESERVED (3)	-	-	-
J9	PC4	I/O	ARM PIO Controller C pin 4		ARM	CMOS 1.8V-A
J10	PC5	I/O	ARM PIO Controller C pin 5		ARM	CMOS 1.8V-A
J11	PC19	I/O	ARM PIO Controller C pin 19		ARM	CMOS 1.8V-A
J12	PC20	I/O	ARM PIO Controller C pin 20		ARM	CMOS 1.8V-A
K1	PA23	I/O	ARM PIO Controller A pin 23		ARM	CMOS 3.1V
K2	PA29	I/O	ARM PIO Controller A pin 29		ARM	CMOS 3.1V
K3	TMS	I	JTAG ARM - Test Mode Select	Pull Down	ARM	CMOS 3.1V
K4	TCK	I	JTAG ARM – Test Clock		ARM	CMOS 3.1V
K5	RTCK	O	JTAG ARM – Returned Test Clock		ARM	CMOS 3.1V
K6	PA25	I/O	ARM PIO Controller A pin 25		ARM	CMOS 3.1V
K7	PC13	I/O	ARM PIO Controller C pin 13		ARM	CMOS 1.8V-A
K8	PC6	I/O	ARM PIO Controller C pin 6		ARM	CMOS 1.8V-A
K9	PC7	I/O	ARM PIO Controller C pin 7		ARM	CMOS 1.8V-A
K10	PB3	I/O	ARM PIO Controller B pin 3		ARM	CMOS 3.1V
K11	HDMA	A	USB Host Port A Data -		ARM	USB
K12	HDPA	A	USB Host Port A Data +		ARM	USB
L1	PA24	I/O	ARM PIO Controller A pin 24		ARM	CMOS 3.1V
L2	OSCSEL	I	Slow Clock Oscillator Selection	Pull Down	ARM	CMOS VRTC
L3	NTRST	I	JTAG ARM - Test Reset	Pull Up	ARM	CMOS 3.1V
L4	TDI	I	JTAG ARM - Test Data Input		ARM	CMOS 3.1V
L5	TDO	O	JTAG ARM - Test Data Output		ARM	CMOS 3.1V
L6	JTAGSEL	I	JTAG ARM – JTAG Type Selection	Pull Down	ARM	CMOS 3.1V
L7	PA28	I/O	ARM PIO Controller A pin 28		ARM	CMOS 3.1V
L8	PA27	I/O	ARM PIO Controller A pin 27		ARM	CMOS 3.1V
L9	PA26	I/O	ARM PIO Controller A pin 26		ARM	CMOS 3.1V

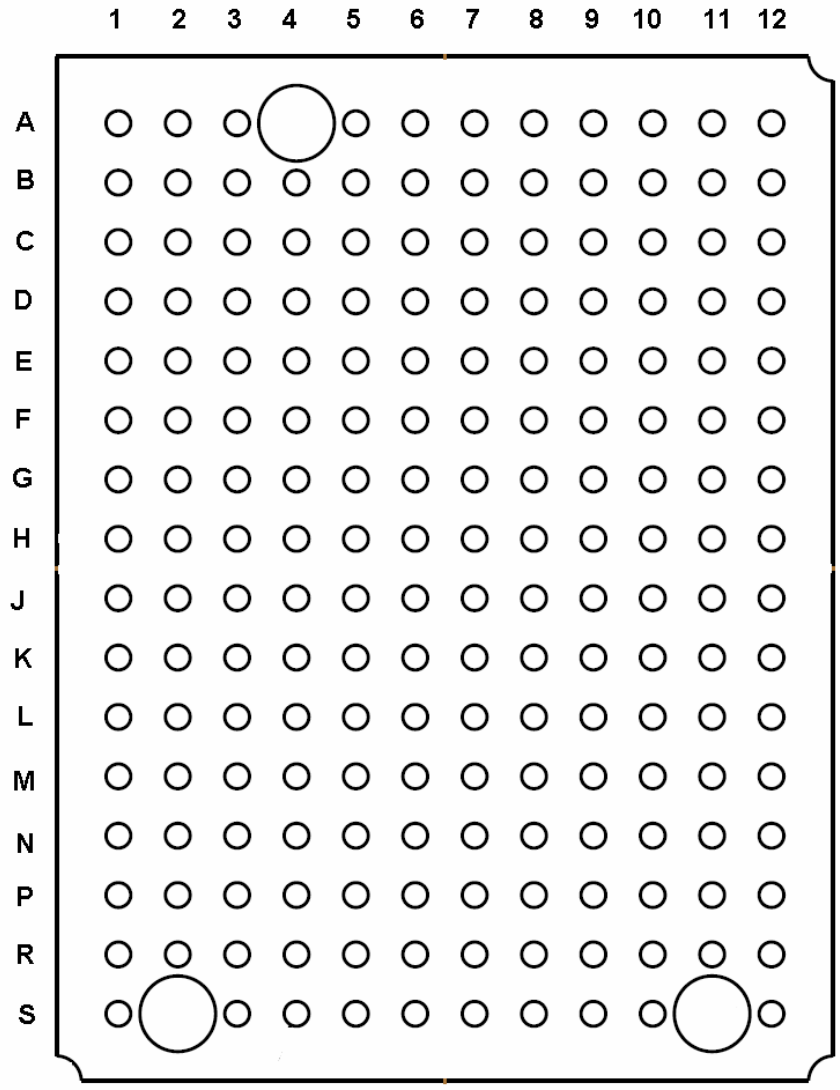
Ball	Signal	I/O	Main Function	Internal Pull up	ARM/ GSM	Type
L10	GND	-	Ground	-	-	Power
L11	HDMB	A	USB Host Port B Data -		ARM	USB
L12	HDPB	A	USB Host Port B Data +		ARM	USB
M1	XIN32	I	Slow Clock Oscillator Input		ARM	CMOS VRTC
M2	XOUT32	O	Slow Clock Oscillator Output		ARM	CMOS VRTC
M3	RESERVED	-	RESERVED (3)	-	-	-
M4	RESERVED	-	RESERVED (3)	-	-	-
M5	PB14	I/O	ARM PIO Controller B pin 14		ARM	CMOS 3.1V
M6	PB15	I/O	ARM PIO Controller B pin 15		ARM	CMOS 3.1V
M7	PC22	I/O	ARM PIO Controller C pin 22		ARM	CMOS 1.8V-A
M8	PC9	I/O	ARM PIO Controller C pin 9		ARM	CMOS 1.8V-A
M9	PA3	I/O	ARM PIO Controller A pin 3		ARM	CMOS 3.1V
M10	PA2	I/O	ARM PIO Controller A pin 2		ARM	CMOS 3.1V
M11	PA1	I/O	ARM PIO Controller A pin 1		ARM	CMOS 3.1V
M12	PA0	I/O	ARM PIO Controller A pin 0		ARM	CMOS 3.1V
N1	PA11	I/O	ARM PIO Controller A pin 11		ARM	CMOS 3.1V
N2	PA10	I/O	ARM PIO Controller A pin 10		ARM	CMOS 3.1V
N3	PA9	I/O	ARM PIO Controller A pin 9		ARM	CMOS 3.1V
N4	PA31	I/O	ARM PIO Controller A pin 31		ARM	CMOS 3.1V
N5	PA30	I/O	ARM PIO Controller A pin 30		ARM	CMOS 3.1V
N6	PB31	I/O	ARM PIO Controller B pin 31		ARM	CMOS 3.1V
N7	GND	-	Ground	-	-	Power
N8	PC16	I/O	ARM PIO Controller C pin 16		ARM	CMOS 1.8V-A
N9	PC17	I/O	ARM PIO Controller C pin 17		ARM	CMOS 1.8V-A
N10	RESERVED	-	RESERVED (3)	-	-	-
N11	DDM	A	USB Device Port Data -		ARM	USB
N12	DDP	A	USB Device Port Data +		ARM	USB
P1	PA6	I/O	ARM PIO Controller A pin 6		ARM	CMOS 3.1V
P2	PA7	I/O	ARM PIO Controller A pin 7		ARM	CMOS 3.1V
P3	PA8	I/O	ARM PIO Controller A pin 8		ARM	CMOS 3.1V
P4	PC12	I/O	ARM PIO Controller C pin 12		ARM	CMOS 1.8V-A
P5	PB30	I/O	ARM PIO Controller B pin 30		ARM	CMOS 3.1V
P6	PC0	I/O	ARM PIO Controller C pin 0		ARM	CMOS 3.1V
P7	PC1	I/O	ARM PIO Controller C pin 1		ARM	CMOS 3.1V
P8	PC2	I/O	ARM PIO Controller C pin 2		ARM	CMOS 3.1V
P9	PC3	I/O	ARM PIO Controller C pin 3		ARM	CMOS 3.1V
P10	PA22	I/O	ARM PIO Controller A pin 22		ARM	CMOS 3.1V

Ball	Signal	I/O	Main Function	Internal Pull up	ARM/ GSM	Type
P11	3.1V_OUT	OA	ARM 3.1V Power Output		ARM	-
P12	VBATT2	-	Main ARM Power Supply		ARM	Power
R1	GND	-	Ground	-	-	Power
R2	GND	-	Ground	-	-	Power
R3	GND	-	Ground	-	-	Power
R4	PA21	I/O	ARM PIO Controller A pin 21		ARM	CMOS 3.1V
R5	PA18	I/O	ARM PIO Controller A pin 18		ARM	CMOS 3.1V
R6	PA17	I/O	ARM PIO Controller A pin 17		ARM	CMOS 3.1V
R7	PA19	I/O	ARM PIO Controller A pin 19		ARM	CMOS 3.1V
R8	PA16	I/O	ARM PIO Controller A pin 16		ARM	CMOS 3.1V
R9	RESERVED	-	RESERVED (3)	-	-	-
R10	GND	-	Ground	-	-	Power
R11	GND	-	Ground	-	-	Power
R12	GND	-	Ground	-	-	Power
S1	RESERVED	-	RESERVED (3)	-	-	-
S2	RESERVED	-	RESERVED (3)	-	-	-
S3	GND	-	Ground	-	-	Power
S4	PA20	I/O	ARM PIO Controller A pin 20		ARM	CMOS 3.1V
S5	PA14	I/O	ARM PIO Controller A pin 14		ARM	CMOS 3.1V
S6	PA15	I/O	ARM PIO Controller A pin 15		ARM	CMOS 3.1V
S7	PA12	I/O	ARM PIO Controller A pin 12		ARM	CMOS 3.1V
S8	PA13	I/O	ARM PIO Controller A pin 13		ARM	CMOS 3.1V
S9	RESERVED	-	RESERVED (3)	-	-	-
S10	GND	-	Ground	-	-	Power
S11	RESERVED	-	RESERVED (3)	-	-	-
S12	RESERVED	-	RESERVED (3)	-	-	-

(1) For the exclusive use of the Technical Support Service
(2) On this pin a maximum of 10nF bypass capacitor is allowed.
(3) Reserved Pins must be left UNCONNECTED

3.2 BALLS LAYOUT

TOP VIEW



3.3 ARM Port IO multiplexing

ARM PIO Controller A multiplexing

IO linel	Peripheral A	Peripheral B	Comments	Reset State	Boot State
PA0	SPI0_MISO	MCDB0	Connected to internal dataflash SO (1)	I/O	SPI0_MISO
PA1	SPI0_MOSI	MCCDB	Connected to internal dataflash SI (1)	I/O	SPI0_MOSI
PA2	SPI0_SPCK		Connected to internal dataflash CLK (1)	I/O	SPI0_SPCK
PA3	SPI0_NPCS0	MCDB3		I/O	SPI0_NPCS0
PA4	RTS2	MCDB2		I/O	I with Pull-up
PA5	CTS2	MCDB1		I/O	I with Pull-up
PA6	MCDA0			I/O	I with Pull-up
PA7	MCCDA			I/O	I with Pull-up
PA8	MCCK			I/O	I with Pull-up
PA9	MCDA1			I/O	I with Pull-up
PA10	MCDA2	ETX2		I/O	I with Pull-up
PA11	MCDA3	ETX3		I/O	I with Pull-up
PA12	ETX0			I/O	I with Pull-up
PA13	ETX1			I/O	I with Pull-up
PA14	ERX0			I/O	I with Pull-up
PA15	ERX1			I/O	I with Pull-up
PA16	ETXEN			I/O	I with Pull-up
PA17	ERXDV			I/O	I with Pull-up
PA18	ERXER			I/O	I with Pull-up
PA19	ETXCK			I/O	I with Pull-up
PA20	EMDC			I/O	I with Pull-up
PA21	EMDIO			I/O	I with Pull-up
PA22	ADTRG	ETXER		I/O	I with Pull-up
PA23	TWD	ETX2		I/O	I with Pull-up
PA24	TWCK	ETX3		I/O	I with Pull-up
PA25	TCLK0	ERX2		I/O	I with Pull-up
PA26	TIOA0	ERX3		I/O	I with Pull-up
PA27	TIOA1	ERXCK		I/O	I with Pull-up
PA28	TIOA2	ECRS		I/O	I with Pull-up
PA29	SCK1	ECOL		I/O	I with Pull-up
PA30	SCK2	RXD4		I/O	I with Pull-up
PA31	SCK0	TXD4		I/O	I with Pull-up

ARM PIO Controller B multiplexing

IO linel	Peripheral A	Peripheral B	Comments	Reset State	Boot State
PB0	SPI1_MISO	TIOA3		I/O	I with Pull-up
PB1	SPI1_MOSI	TIOB3		I/O	I with Pull-up
PB2	SPI1_SPCK	TIOA4		I/O	I with Pull-up
PB3	SPI1_NPCS0	TIOA5		I/O	I with Pull-up
PB4	TXD0			I/O	I with Pull-up
PB5	RXD0			I/O	I with Pull-up
PB6	TXD1	TCLK1		I/O	I with Pull-up
PB7	RXD1	TCLK2		I/O	I with Pull-up
PB8	TXD2			I/O	I with Pull-up
PB9	RXD2			I/O	I with Pull-up
PB10	TXD3	ISI_D8		I/O	I with Pull-up
PB11	RXD3	ISI_D9		I/O	I with Pull-up
PB12	TXD5	ISI_D10		I/O	I with Pull-up
PB13	RXD5	ISI_D11		I/O	I with Pull-up
PB14	DRXD			I/O	I with Pull-up
PB15	DTXD			I/O	I with Pull-up
PB16	TK0	TCLK3		I/O	I with Pull-up
PB17	TF0	TCLK4		I/O	I with Pull-up
PB18	TD0	TIOB4		I/O	I with Pull-up
PB19	RD0	TIOB5		I/O	I with Pull-up
PB20	RK0	ISI_D0		I/O	I with Pull-up
PB21	RF0	ISI_D1		I/O	I with Pull-up
PB22	DSR0	ISI_D2		I/O	I with Pull-up
PB23	DCD0	ISI_D3		I/O	I with Pull-up
PB24	DTR0	ISI_D4		I/O	I with Pull-up
PB25	RI0	ISI_D5		I/O	I with Pull-up
PB26	RTS0	ISI_D6		I/O	I with Pull-up
PB27	CTS0	ISI_D7		I/O	I with Pull-up
PB28	RTS1	ISI_PCK		I/O	I with Pull-up
PB29	CTS1	ISI_VSYNC		I/O	I with Pull-up
PB30	PCK0	ISI_HSYNC		I/O	I with Pull-up
PB31	PCK1	ISI_MCK		I/O	I with Pull-up

ARM PIO Controller C multiplexing

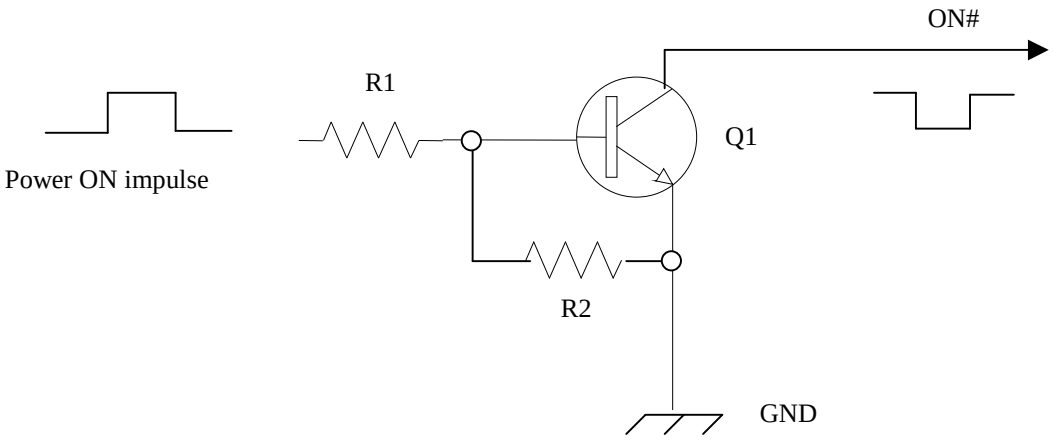
IO linel	Peripheral A	Peripheral B	Comments	Reset State	Boot State
PC0	SCK3	AD0		I/O	I with Pull-up
PC1	PCK0	AD1		I/O	I with Pull-up
PC2	PCK1	AD2		I/O	I with Pull-up
PC3	SPI1_NPCS3	AD3		I/O	I with Pull-up
PC4	A23	SPI1_NPCS2		A23	I with Pull-up
PC5	A24	SPI1_NPCS1		A24	I with Pull-up
PC6	TIOB2	CFCE1		I/O	I with Pull-up
PC7	TIOB1	CFCE2		I/O	I with Pull-up
PC8	NCS4/CFCS0	RTS3		I/O	I with Pull-up
PC9	NCS5/CFCS1	TIOB0		I/O	I with Pull-up
PC10	A25/CFRNW	CTS3		A25	I with Pull-up
PC11	NCS2	SPI0_NPCS1	Connected to internal dataflash CS line NOT AVAILABLE on the Balls	I/O	SPI0_NPCS1
PC12	IRQ0	NCS7		I/O	I with Pull-up
PC13	FIQ	NCS6		I/O	I with Pull-up
PC14	NCS3/NANDCS	IRQ2		I/O	I with Pull-up
PC15	NWAIT	IRQ1		I/O	I with Pull-up
PC16	D16	SPI0_NPCS2		I/O	SPI0_NPCS2 with pull-up
PC17	D17	SPI0_NPCS3		I/O	SPI0_NPCS3 with pull-up
PC18	D18	SPI1_NPCS1		I/O	I with Pull-up
PC19	D19	SPI1_NPCS2		I/O	I with Pull-up
PC20	D20	SPI1_NPCS3		I/O	I with Pull-up
PC21	D21	EF100		I/O	I with Pull-up
PC22	D22	TCLK5		I/O	I with Pull-up
PC23	D23		Enable of 6MHz internal ARM Oscillator (active High) NOT AVAILABLE on the Balls	I/O	O HIGH
PC24	D24		NOT AVAILABLE on the Balls	I/O	-
PC25	D25		NOT AVAILABLE on the Balls	I/O	-
PC26	D26		NOT AVAILABLE on the Balls	I/O	-
PC27	D27		NOT AVAILABLE on the Balls	I/O	-
PC28	D28			I/O	I with Pull-up
PC29	D29		GPIO that rises to keep externally ARM alive	I/O	O HIGH
PC30	D30			I/O	I with Pull-up
PC31	D31			I/O	I with Pull-up

TIP: For further documentation on ARM processor refer to ATMEL AT91SAM9260 datasheet

4 Hardware Commands

4.1 Turning ON the GE863-PRO^3 GSM Engine

To turn on the GE863-PRO^3 GSM/GPRS engine the pad ON_OFF*-GSM must be tied low for at least 1 second and then released.
The maximum current that can be drained from the ON_OFF*-GSM pad is 0,1 mA.
A simple circuit to do it is:



NOTE: don't use any pull up resistor on the ON# line, it is internally pulled up. Using pull up resistor may bring to latch up problems on the GE863-PRO3 power regulator and improper power on/off of the module. The line ON# must be connected only in open collector configuration.

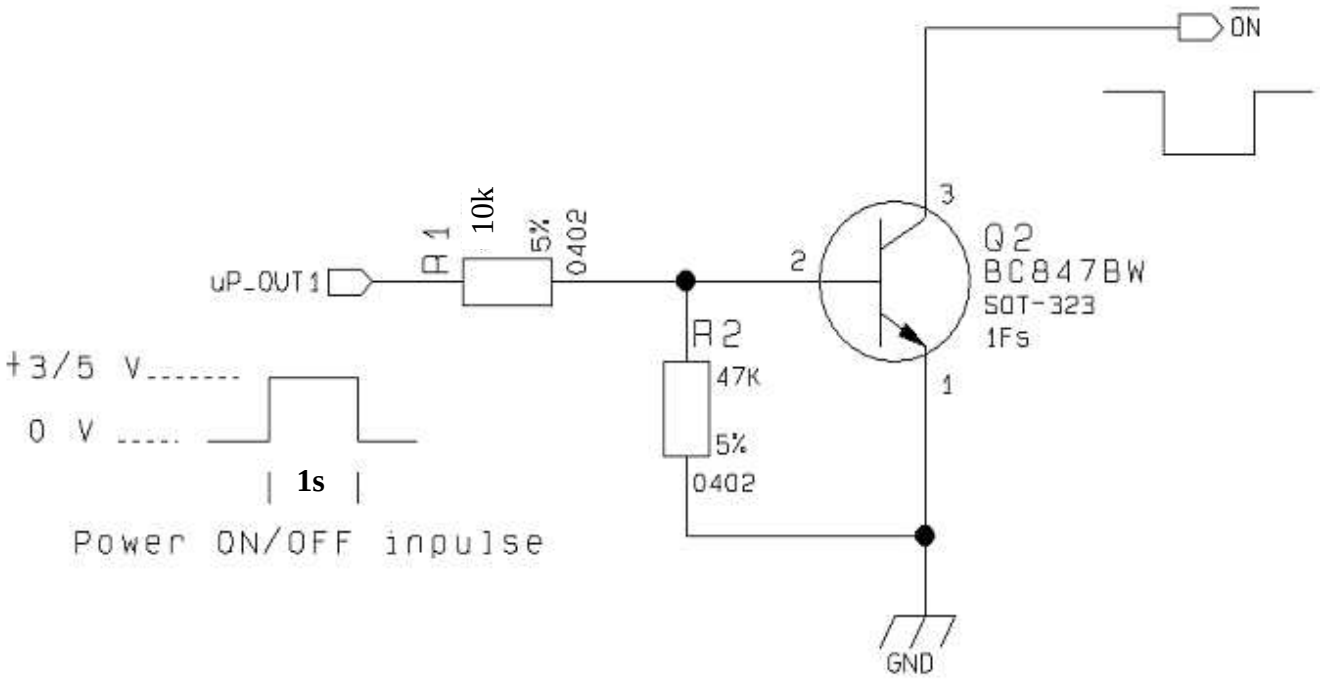
NOTE: In this document all the lines that are inverted, hence have active low signals are labeled with a name that ends with a "" or with a bar over the name.*

NOTE: The GE863-PRO3 turns fully on also by supplying power to the Charge pad (Module provided with a battery on the VBATT pads).

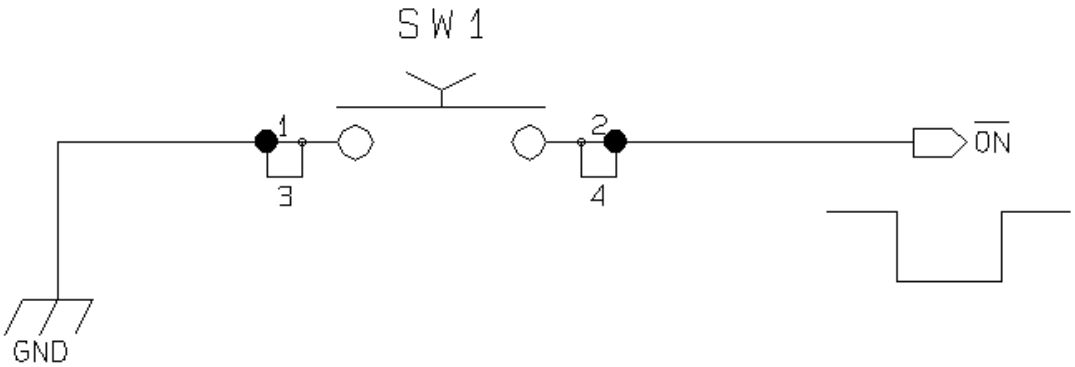
TIP: To check if the device has powered on, the hardware line PWRMON should be monitored. After 900ms the line raised up the device could be considered powered on.
PWRMON line rises up also when supplying power to the Charge pad

For example:

1- Let's assume you need to drive the ON_OFF*-GSM pad with a totem pole output of a +3/5 V microcontroller (uP_OUT1):



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



4.2 Turning OFF the GE863-PRO3 GSM Engine

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

- by software command (see GE863- GE863-PRO3 Software User Guide)
- by hardware shutdown

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

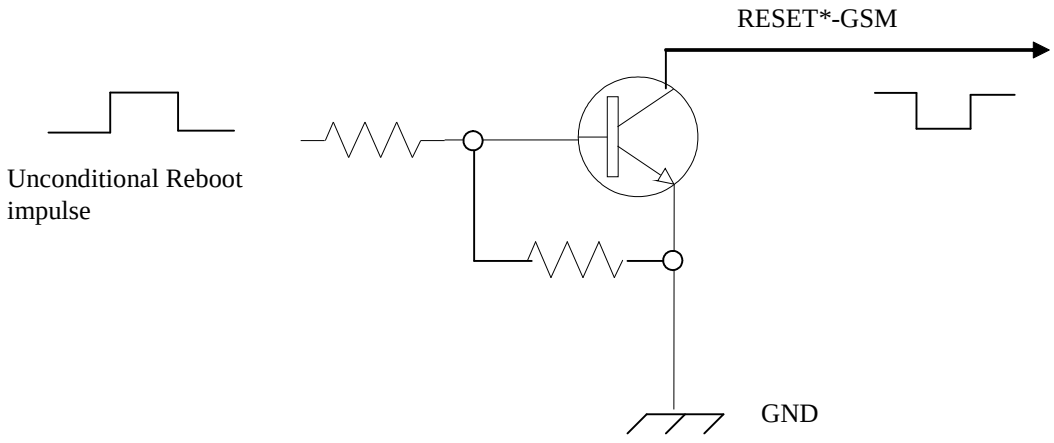
4.2.1 Hardware shutdown

To turn OFF the GE863-PRO3 the pad ON_OFF*-GSM must be tied low for at least 1 second and then released.
The same circuitry and timing for the power on shall be used.
The device shuts down after the release of the ON_OFF*-GSM pad.

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

4.3 Hardware Unconditional Reboot of GSM Engine

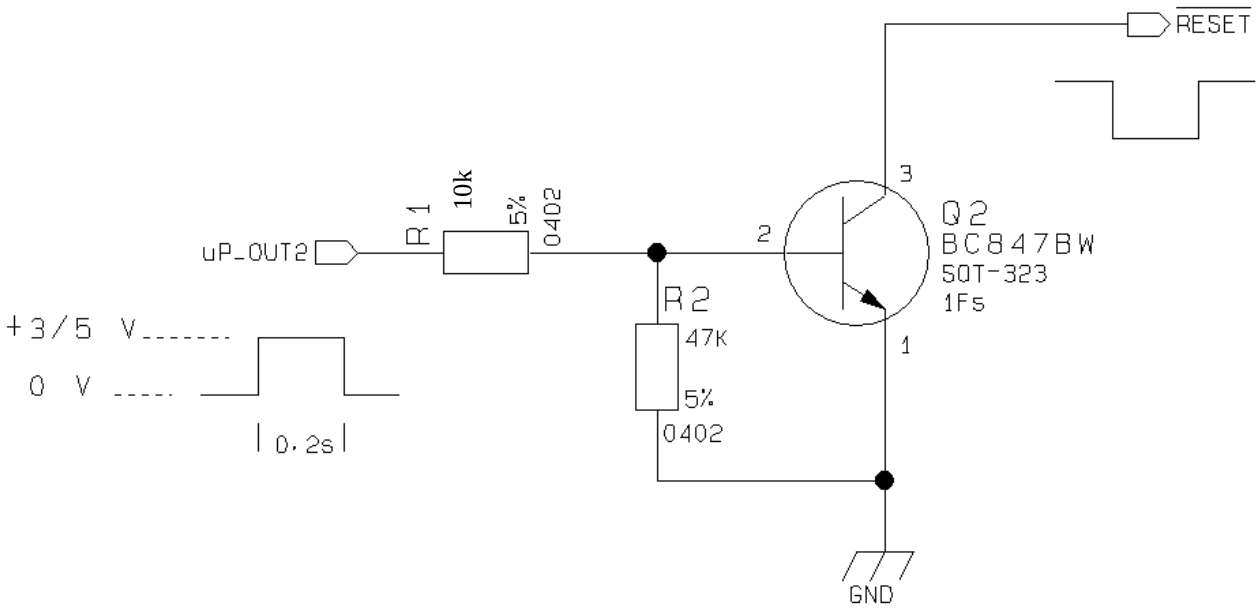
To unconditionally Reboot the GE863-PRO3 , the pad RESET*-GSM must be tied low for at least 200 milliseconds and then released.
The maximum current that can be drained from the RESET*-GSM pad is 0,15 mA.
A simple circuit to do it is:



NOTE: don't use any pull up resistor on the RESET*-GSM line nor any totem pole digital output. Using pull up resistor may bring to latch up problems on the GE863-PRO3 power regulator and improper functioning of the module. The line RESET*-GSM must be connected only in open collector configuration.

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

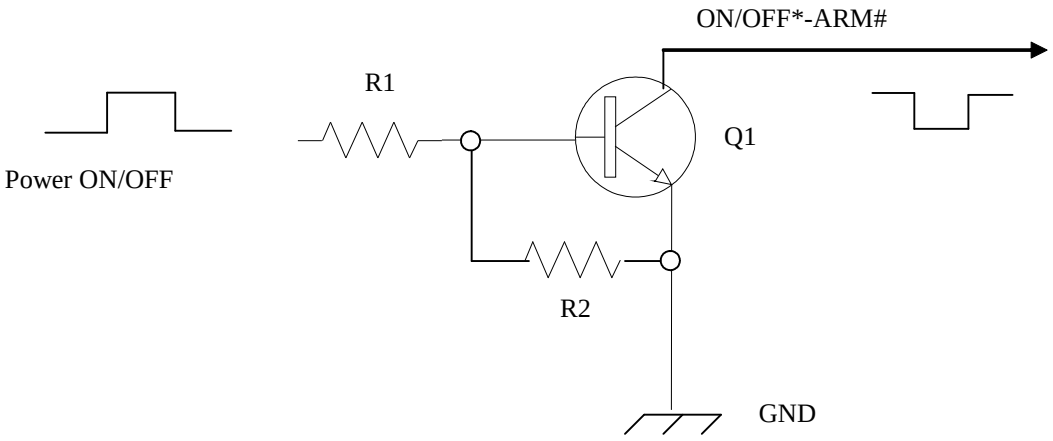
For example:
1- Let's assume you need to drive the RESET*-GSM (RESET) pad with a totem pole output of a +3/5 V microcontroller (uP_OUT2):



4.4 Turning ON/OFF the GE863-PRO3 ARM

To turn on the GE863-PRO3 ARM the pad ON_OFF*-ARM must be tied low and kept low, when pin is raised (released) the ARM will shutdown.
The maximum current that can be drained from the ON_OFF*-ARM pad is 0,1 mA.

A simple circuit to do it is:



NOTE: don't use any pull up resistor on the ON/OFF*ARM line, it is internally pulled up to VBATT2. Using pull up resistor may bring to latch up problems on the GE863-PRO^3 power regulator and improper power on/off of the module. The line ON/OFF*-ARM must be connected only in open collector configuration or tied to ground (if ARM needs to stay always on).

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

TIP: To check if the device has powered on, the hardware line 3.1V_OUT can be monitored.

It is possible to use also the SHDN line to turn ON the device with the ARM RTC trigger by connecting it to the ON/OFF*-ARM pin through a transistor buffer.
After the Initial bootstrap, the line PC29 goes HIGH allowing the device to keep itself on;
If you need a toggle command to turn on/off the device, then you can use the line PC29 to keep the ARM on after it's start-up and connect the on/off button to the ON/OFF*ARM pin through a buffer transistor while connecting it to a GPIO to sense it's toggling (e.g. PC31) for shutting down the ARM by lowering the PC29 pin.

TIP: To Keep the ARM ON you can use the PC29 pin that goes high right after the bootstrap

5 Power Supply

The power supply circuitry and board layout are a very important part in the full product design and they strongly reflect on the product overall performances, hence read carefully the requirements and the guidelines that will follow for a proper design.
In the GE863-PRO3 the power supply inputs of the GSM engine and the ARM processor part have been kept separate, VBATT is the input for the GSM part, VBATT2 is the input for ARM.
It is possible to connect together the two power inputs since they have compatible ranges, but if it is desired the two power supplies can be kept separate.
The only power supply in common between the ARM and GSM engine is the RTC voltage which is generated by the GSM engine from VBATT power source and supplies both the GSM RTC and the ARM VDDBU part including the shutdown controller, rtc, 32 KHz oscillator. For this reason if it is planned to remove VBATT power supply, then a backup battery shall be provided on VTRC pin that guarantees that VRTC is still available.

NOTE: if you plan to remove VBATT power source, then you must provide an appropriate backup battery/capacitor on the VRTC pin in order to be able to turn on properly the ARM part when supplying VBATT2 only power pin.

5.1 GSM Power Supply Requirements

POWER SUPPLY	
Nominal Supply Voltage	3.8 V
Max Supply Voltage	4.2 V
Supply voltage range	3.4 V - 4.2 V

GE863-PRO3 GSM Engine		
Mode	**Average (mA)**	**Mode description**
IDLE mode		Stand by mode; no call in progress
AT+CFUN=1	24,0	Normal mode: full functionality of the module
AT+CFUN=4	22,0	Disabled TX and RX; module is not registered on the network
AT+CFUN=0 or AT+CFUN=5	7,20 / 3,56[1]	Power saving: CFUN=0 module registered on the network and can receive voice call or an SMS; but it is not possible to send AT commands; module wakes up with an unsolicited code (call or SMS) or rising RTS line. CFUN=5 full functionality with power saving; module registered on the network can receive incoming calls and SMS
RX mode		GSM Receiving data mode
1 slot in downlink	53,0	
2 slot in downlink	66,0	
3 slot in downlink	79,0	
4 slot in downlink	89,0	

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

GSM TX and RX mode		GSM Sending data mode
Min power level	78,0	
Max power level	200,0	
GPRS (class 10) TX and RX mode		GPRS Sending data mode
Min power level	124,0	
Max power level	371,0	

The GSM system is made in a way that the RF transmission is not continuous, else it is packed into bursts at a base frequency of about 216 Hz, the relative current peaks can be as high as about 2A. Therefore the power supply has to be designed in order to withstand with these current peaks without big voltage drops; this means that both the electrical design and the board layout must be designed for this current flow. If the layout of the PCB is not well designed a strong noise floor is generated on the ground and the supply; this will reflect on all the audio paths producing an audible annoying noise at 216 Hz; if the voltage drop during the peak current absorption is too much, then the device may even shutdown as a consequence of the supply voltage drop.

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

5.2 ARM Power Supply Requirements

POWER SUPPLY	
Nominal Supply Voltage	3.8 V
Operating Supply voltage range	3.4 V - 4.2 V
Absolute Maximum voltage range	3.30 – 4.5 V

GE863-PRO3		
Mode	**Typical Average (mA)**	**Mode description**
Off	< 2 µA (TBD)	
Full Speed	140 (TBD)	ARM is operational at full speed 200MHz CPU Clock , Main Clock 100 MHz and all peripherals active
Slow Clocking	1 (TBD)	ARM is running on slow clock with peripherals disabled

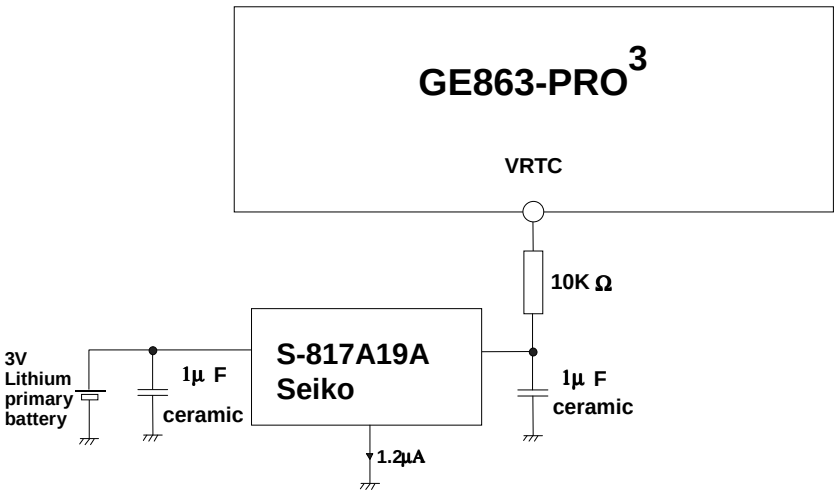
5.3 VRTC Backup supply

The RTC of the GPRS Engine and the RTC & Shutdown controller of the ARM part are supplied by VRTC. This voltage supply is generated by a low quiescent current regulator inside the module that takes its power from VBATT pins. Since this voltage supply is needed to correctly boot the ARM part, if it is planned to remove the VBATT supply and still turn on the ARM part supplied by VBATT2, then an appropriate power supply must be provided to the VRTC pin.

To obtain several working years for the Real Time Clock of the GPRS engine and the RTC, 32KHz oscillator & Shutdown controller of the ARM part without VBATT power supply voltage, it is needed to make use of a lithium primary battery to supply the RTC circuits in the Telit Module.

The operative voltage for VRTC is lower than the voltage of primary lithium battery (3V nominal).
It is therefore necessary to put a LDO voltage regulator in the circuit.

The suggested circuit is:



The quoted current intensity are without VBATT power supply for the module.
The S-817A19A Seiko LDO has a value of **1.2µA Typ** for the quiescent current. Without VBATT power supply voltage, the VRTC Reverse Current is **7- 8 µA Typ**. (depending on OSCSEL pin status)
At ambient temperature 20℃, the BR2032 coin type (Panasonic 190 mAh) should be sufficient for 2-3 years with **typical current intensity**. The CR2032 coin type Panasonic 220 mAh) has an improved behaviour at low and high temperatures.
When the VBATT voltage is present, the VRTC voltage exceeds the S-817 output voltage, so the current from the Lithium Primary Battery is only **1.2µA Typ (or less)**.

NOTE: the 2-3 years are given considering the worst case (VBATT always off)

5.4 General Design Rules

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

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

5.4.1 Electrical design Guidelines

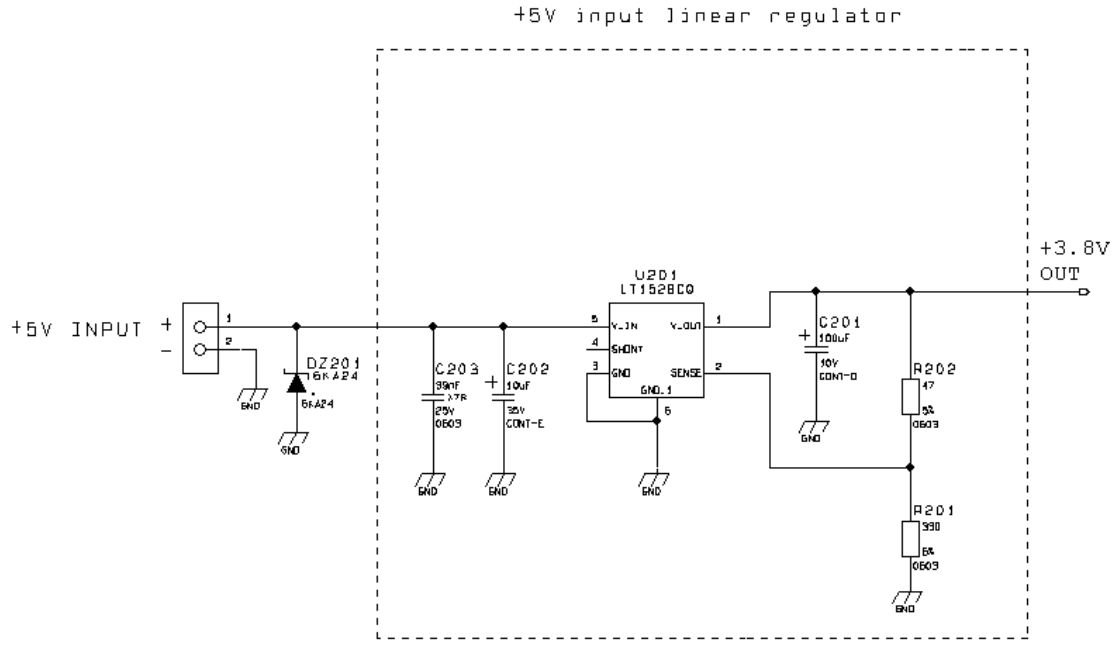
The electrical design of the power supply depends strongly from the power source where this power is drained. We will distinguish them into three categories:

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

5.4.1.1 + 5V input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence there's not a big difference between the input source and the desired output and a linear regulator can be used. A switching power supply will not be suited because of the low drop out requirements.
- When using a linear regulator, a proper heat sink shall be provided in order to dissipate the power generated.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks close to the GE863-PRO3 , 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 should be inserted close to the power input, in order to save the GE863-PRO3 from power polarity inversion.

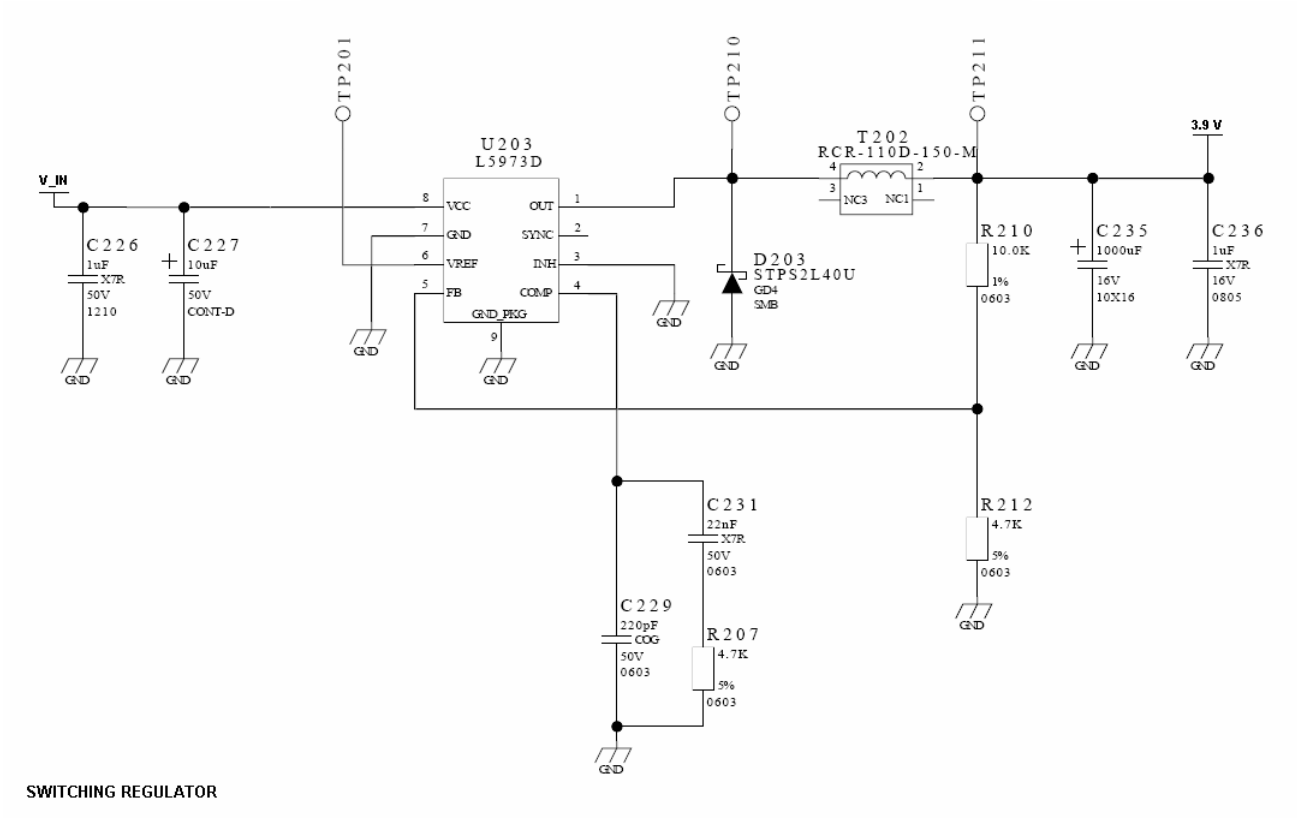
An example of linear regulator with 5V input is:



5.4.1.2 + 12V input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence due to the big difference between the input source and the desired output, a linear regulator is not suited and shall not be used. A switching power supply will be preferable because of its better efficiency especially with the 2A peak current load represented by the GE863-PRO3.
- When using a switching regulator, a 500kHz or more switching frequency regulator is preferable because of its smaller inductor size and its faster transient response. This allows the regulator to respond quickly to the current peaks absorption.
- For car PB battery the input voltage can rise up to 15,8V and this should be kept in mind when choosing components: all components in the power supply must withstand this voltage.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks, a 100µF tantalum capacitor is usually suited.
- Make sure the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.
- For Car applications a spike protection diode should be inserted close to the power input, in order to clean the supply from spikes.
- A protection diode should be inserted close to the power input, in order to save the GE863-PRO3 from power polarity inversion. This can be the same diode as for spike protection.

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



SWITCHING REGULATOR

5.4.1.3Battery Source Power Supply Design Guidelines

- The desired nominal output for the power supply is 3.8V and the maximum voltage allowed is 4.2V, hence a single 3.7V Li-Ion cell battery type is suited for supplying the power to the Telit GE863-PRO3 module.
  The three cells Ni/Cd or Ni/MH 3,6 V Nom. battery types or 4V PB types ***MUST NOT BE USED DIRECTLY*** since their maximum voltage can rise over the absolute maximum voltage for the GE863-PRO3 and damage it.

NOTE: DON'T USE any Ni-Cd, Ni-MH, and Pb battery types directly connected with GE863-PRO3 . Their use can lead to overvoltage on the GE863-PRO3 and damage it. USE ONLY Li-Ion battery types.

- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks, a 100µF tantalum capacitor is usually suited.
- Make sure the low ESR capacitor (usually a tantalum one) is rated at least 10V.
- A protection diode should be inserted close to the power input, in order to save the GE863-PRO3 from power polarity inversion. Otherwise the battery connector should be done in a way to avoid polarity inversions when connecting the battery.
- The battery capacity must be at least 500mAh in order to withstand the current peaks of 2A; the suggested capacity is from 500mAh to 1000mAh.

5.4.1.4 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 in a battery voltage measure, indicating roughly its charge status. If the battery is deeply discharged, that means its voltage is lower than the trickle charging threshold, then the charge must start slowly possibly with a current limited pre-charging process where the current is kept very low with respect to the fast charge value: the trickle charging.
During the trickle charging the voltage across the battery terminals rises; when it reaches the fast charge threshold level the charging process goes into fast charge phase.
During the fast charge phase the process proceeds with a current limited charging; this current limit depends on the required time for the complete charge and from the 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 then 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 the constant voltage final chargers, the constant voltage phase (final charge) must not start before the battery voltage has reached its maximum value, otherwise the battery capacity will be highly reduced.

The final charge can be of two different types: constant voltage or pulsed. GE863-PRO3 uses constant voltage.
The constant voltage charge proceeds with a fixed voltage regulator (very accurately set to the maximum battery voltage) and hence the current will decrease 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 the charge continues with pulses. Usually the pulse charge works in the following manner: the charge is stopped for some time, let's 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 will become longer, hence the duty-cycle of the pulses will decrease. 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 for 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-PRO3 internal charging algorithm, so that the battery once charged is left discharging down to a certain threshold so that it is cycled from full charge to slight discharge even if the battery charger is always inserted. This guarantees that anyway 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 battery 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, GE863-PRO3 internal charger does it.

As you can see, the charging process is not a trivial task to be done; moreover all these operations should start only if battery temperature is inside a charging range, usually 5℃ - 45℃.
The GE863-PRO3 measures the temperature of its internal component, in order to satisfy this last requirement, it's not exactly the same as the battery temperature but in common application the two temperature should not differ too much and the charging temperature range should be guaranteed.

NOTE: For all the threshold voltages, inside the GE863-PRO3 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 will be in CFUN4; to activate the normal mode a command AT+CFUN=1 has to be provided. This is also possible using the POWER ON.
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 will go back to CFUN4.

5.4.2 Thermal Design Guidelines

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

- *Average current consumption during transmission @PWR level max:* *500mA*
- *Average current consumption during transmission @ PWR level min:* *100mA*
- *Average current during Power Saving:* *4mA*
- *Average current during idle (Power Saving disabled)* *24mA*
- *Average current consumption of ARM@ full speed* *140 mA*

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

Considering the very low current during idle, especially if Power Saving function is enabled, it is possible to consider from the thermal point of view that the device absorbs current significantly only during calls.
If we assume that the device stays into transmission for short periods of time (let's say few minutes) and then remains for a quite long time in idle (let's say one hour), then the power supply has always the time to cool down between the calls and the heat sink could be smaller than the calculated one for 500mA maximum RMS current, or even could be the simple chip package (no heat sink).
Moreover in the average network conditions the device is requested to transmit at a lower power level than the maximum and hence the current consumption will be less than the 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.
For the heat generated by the GE863-PRO3 , you can consider it to be during transmission 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-PRO3 ; you must ensure that your application can dissipate it.

5.4.3 Power Supply PCB layout Guidelines

As seen on the electrical design guidelines the power supply shall have a low ESR capacitor on the output to cut the current peaks and a protection diode on the input to protect the supply from spikes and polarity inversion. The placement of these components is crucial for the correct working of the circuitry. A misplaced component can be useless or can even decrease the power supply performances.

- The Bypass low ESR capacitor must be placed close to the Telit GE863-PRO3 power input pads or in the case the power supply is a switching type it can be placed close to the inductor to cut the ripple, provided the PCB trace from the capacitor to the GE863-PRO3 is wide enough to ensure a dropless connection even during the 2A current peaks.
- The protection diode must be placed close to the input connector where the power source is drained.
- The PCB traces from the input connector to the power regulator IC must be wide enough to ensure a minimum voltage drop occur when the 2A current peaks are absorbed. Note that this is not made in order to save power loss but especially to avoid the voltage drops on the power line at the current peaks frequency of 216 Hz that will reflect on all the components connected to that supply, introducing the noise floor at the burst base frequency. For this reason while a voltage drop of 300-400 mV may be acceptable from the power loss point of view, the same voltage drop may not be acceptable from the noise point of view. If your application doesn't have audio interface but only uses the data feature of the Telit GE863-PRO3, then this noise is not so disturbing and power supply layout design can be more forgiving.
- The PCB traces to the GE863-PRO3 and the Bypass capacitor must be wide enough to ensure no significant voltage drops occur when the 2A current peaks are absorbed. This is for the same reason as previous point. Try to keep this trace as short as possible.
- The PCB traces connecting the Switching output to the inductor and the switching diode must be kept as short as possible by placing the inductor and the diode very close to the power switching IC (only for switching power supply). This is done in order to reduce the radiated field (noise) at the switching frequency (100-500 kHz usually).
- The use of a good common ground plane is suggested.
- The placement of the power supply on the board should 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 should be kept separate from noise sensitive lines such as microphone/earphone cables.

6 Antenna

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

6.1 GSM Antenna Requirements

As suggested on the Product Description the antenna and antenna line on PCB for a Telit GE863-PRO3 device shall fulfil the following requirements:

ANTENNA REQUIREMENTS	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth	70 MHz in GSM850, 80 MHz in GSM900, 170 MHz in DCS & 140 MHz PCS band
Gain	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-PRO3, since there's no antenna connector on the module, the antenna must be connected to the GE863-PRO3 through the PCB with the antenna pad using a 50 Ω transmission line.

In the case that the antenna is not directly developed on the same PCB, hence directly connected at the antenna pad of the GE863-PRO3, then a PCB line is needed in order to connect with it or with its connector.

This line of transmission shall fulfil the following requirements:

ANTENNA LINE ON PCB REQUIREMENTS	
Impedance	50 ohm
Max Attenuation	0,3 dB
No coupling with other signals allowed	
Cold End (Ground Plane) of antenna shall be equipotential to the GE863-PRO3 ground pins	

Furthermore if the device is developed for the US market and/or Canada market, it shall 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. OEM integrators must ensure that the end user has no manual instructions to remove or install the GE863-PRO3 module. Antennas used for this OEM module must not exceed 3dBi gain for mobile and fixed operating configurations.

6.2 GSM Antenna - PCB line Guidelines

- Ensure that the antenna line impedance is 50 ohm;
- Keep the antenna line on the PCB as short as possible, since the antenna line loss shall be less than 0,3 dB;
- Antenna line must have uniform characteristics, constant cross section, avoid meanders and abrupt curves;
- Keep, if possible, one layer of the PCB used only for the Ground plane;
- Surround (on the sides, over and under) the antenna line on PCB with Ground, avoid having other signal tracks facing directly the antenna line track;
- The ground around the antenna line on PCB has to be strictly connected to the Ground Plane by placing vias once per 2mm at least;
- Place EM noisy devices as far as possible from GE863-PRO3 antenna line;
- Keep the antenna line far away from the GE863-PRO3 power supply lines;
- If you have EM noisy devices around the PCB hosting the GE863-PRO3 , such as fast switching ICs, take care of the shielding of the antenna line by burying it inside the layers of PCB and surround it with Ground planes, or shield it with a metal frame cover.
- If you don't have EM noisy devices around the PCB of GE863-PRO3 , by using a strip-line on the superficial copper layer for the antenna line, the line attenuation will be lower than a buried one;

6.3 GSM Antenna - installation Guidelines

- Install the antenna in a place covered by the GSM signal.
- The Antenna must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter;
- Antenna shall not be installed inside metal cases
- Antenna shall be installed also according Antenna manufacturer instructions.

6.4 Electro Magnetic Interference - Guidelines

The GE863-PRO^3 has been particularly designed in order to keep to a minimum the Electro Magnetic Interferences between the ARM part and the GSM/GPRS engine, however especially the ARM part remains a noisy device that must be threaten with care in order to avoid that its EMI affect the GPRS part through an external coupling.

Therefore:

- Keep fast ARM lines far away from Antenna line in order to avoid direct coupling;
- Keep fast ARM lines buried in the inner layers, with Ground Layers [fenced with vias] on the top/bottom layers;
- If your lines are long, place a series resistor [in the range of 47Ω – 100 Ω] close to the GE863-PRO^3 ARM ball to reduce the ringing and the EM emissions of the signal
- If your PCB lines are very long, place a terminator resistor close to the device line end.

6.5 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-PRO3 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
Voltage on Buffered pins	-0.3V	25V

Operating Range - Interface levels (CMOS 2.8V)

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

Operating Range - Interface levels (CMOS 1.8V)

Level	Min	Max
Input high level	1.6V	3.3V
Input low level	0V	0.4V
Output high level	1,65V	2.2V
Output low level	0V	0.35V

Operating Range - Interface levels (CMOS 3.1V)

Level	Min	Max
Input high level	2.0V	3.4V
Input low level	-0.3V	0.8V
Output high level	2.7V	3.2V
Output low level	0V	0.4V

Operating Range - Interface levels (CMOS 1.8V-A)

Level	Min	Max
Input high level	1.3V	2.1V
Input low level	-0.3V	0.5V
Output high level	1.35V	1.9V
Output low level	0V	0.45V

Operating Range - Interface levels (CMOS VRTC)

Level	Min	Max
Input high level	1.3V	2.1V
Input low level	-0.3V	0.5V
Output high level	1.3V	2.0V
Output low level	0V	0.5V

GSM GPIO Current characteristics

Level	Typical
Output Current	1mA
Input Current	1uA

CMOS 3.1V Current characteristics

Level	Typical
Max Output Current	16 mA
Input Current	1uA

CMOS 1.8V-A Current characteristics

Level	Typical
Max Output Current	4 mA
Input Current	1uA

6.5.1 GSM Reset signal

Signal	Function	I/O	Bga Ball
RESET*-GSM	Phone reset	I	E5

RESET*-GSM is used to reset the **GE863-PRO3 modules GSM engine**. Whenever this signal is pulled low, the GSM/GPRS engine is reset. When the device is reset it stops any operation. After the release of the reset the GSM/GPRS engine is unconditionally shut down, without doing any detach operation from the network where it is registered. This behaviour is not a proper shut down because any GSM device is requested to issue a detach request on turn off. For this reason the Reset signal must not be used to normally shutting down the device, but only as an emergency exit in the rare case the device remains stuck waiting for some network response.
The RESET*-GSM is internally controlled on start-up to achieve always a proper power-on reset sequence, so there's no need to control this pin on start-up. It may only be used to reset a device already on that is not responding to any command.

***NOTE**: do not use this signal to power off the **GE863-PRO3 GSM engine**. Use the ON/OFF*-GSM signal to perform this function or the AT#SHDN command.*

Reset Signal Operating levels:

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

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

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

7 Serial Ports

The serial port on the Telit GE863-PRO3 is the core of the interface between the module engine and the ARM processor.

2 serial ports are available on the module engine:

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

6+1(DBG) serial ports are available on the ARM part.

No direct connection is present between the two parts, on the hosting PCB the two serial ports need to be interconnected. It is up to the user to select whatever serial port is most suited on the ARM part to exchange data with the GPRS engine; however the USART0 port on the ARM is the only supporting the full RS232 line signaling and should be preferred.
In the ball-out of the GE863-PRO3 the balls of the MODEM SERIAL port and ARM USART0 are placed one next the other, allowing an easy routing of the connection.

7.1 MODEM SERIAL PORT

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

- RS232 PC com port
- microcontroller UART @ 2.8V – 3.1V (Universal Asynchronous Receive Transmit)

Depending from the type of serial port on the OEM hardware a level translator circuit may be needed to make the system work. The only configuration that doesn't need a level translation is the 2.8V – 3.1V UART and hence the GE863-PRO3 GPRS engine can be directly connected with the ARM serial port @ 3.1V CMOS.
The serial port on the GE863-PRO3 GPRS engine is a +2.8V UART with all the 7 RS232 signals, While the serial ports on the ARM part are +3.1V UART.
GE863-PRO3 serial ports differ from the PC-RS232 in the signal polarity (RS232 is reversed) and levels. The levels for the GE863-PRO3 UART are the CMOS levels:

The signals of the GE863-PRO3 GPRS engine serial port are:

RS232 Pin Number	Signal	GE863-PRO3 Ball	Name	Usage
1	DCD - dcd_uart	C7	Data Carrier Detect	Output from the GE863-PRO3 GPRS engine that indicates the carrier presence
2	RXD - tx_uart	E10	Transmit line *see Note	Output transmit line of GE863-PRO3 GPRS engine
3	TXD - rx_uart	E9	Receive line *see Note	Input receive of the GE863-PRO3 GPRS engine
4	DTR - dtr_uart	C6	Data Terminal Ready	Input to the GE863-PRO3 GPRS engine that controls the DTE READY condition
5	GND	All GND	Ground	Ground
6	DSR - dsr_uart	C5	Data Set Ready	Output from the GE863-PRO3 GPRS engine that indicates the module is ready
7	RTS - rts_uart	C8	Request to Send	Input to the GE863-PRO3 GPRS engine that controls the Hardware flow control
8	CTS - cts_uart	C9	Clear to Send	Output from the GE863-PRO3 GPRS engine that controls the Hardware flow control
9	RI - ri_uart	C4	Ring Indicator	Output from the GE863-PRO3 GPRS engine 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-PRO3 GPRS engine side these signal are on the opposite direction: TXD on the ARM application side will be connected to the receive line (here named TXD/ rx_uart) of the GE863-PRO3 GPRS engine serial port and viceversa for RX.

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

7.2 RS232 level translation

In order to interface the Telit GE863-PRO3 with a PC com port or a RS232 (EIA/TIA-232) application a level translator is required. This level translator must

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

Actually, the RS232 UART 16450, 16550, 16650 & 16750 chipsets accept signals with lower levels on the RS232 side (EIA/TIA-562) , allowing for a lower voltage-multiplying ratio on the level translator. Note that the negative signal voltage must be less than 0V and hence some sort of level translation is always required.
The simplest way to translate the levels and invert the signal is by using a single chip level translator. There are a multitude of them, differing in the number of driver and receiver and in the levels (be sure to get a true RS232 level translator not a RS485 or other standards).
By convention the driver is the level translator from the 0-3V UART level to the RS232 level, while the receiver is the translator from RS232 level to 0-3V UART.

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

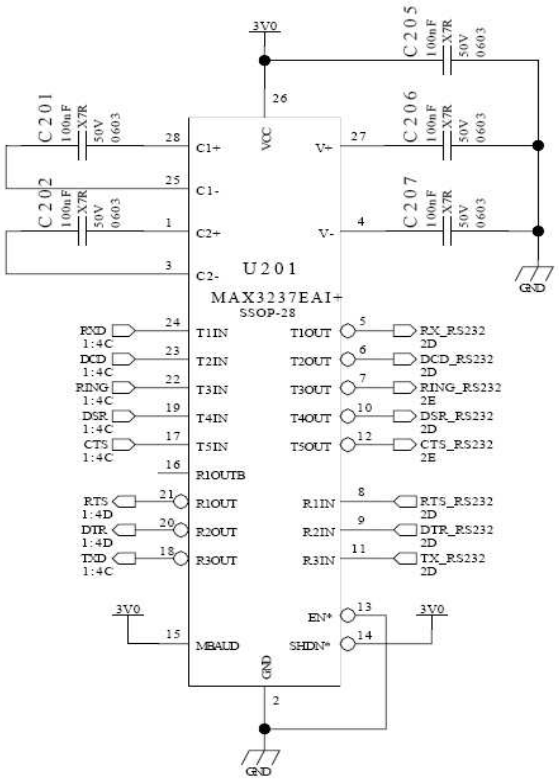
- 5 driver
- 3 receiver

NOTE: The digital input lines working at 2.8V/3.1VCMOS have an absolute maximum input voltage of 3,75V; therefore the level translator IC shall not be powered by the +3.8V supply of the module. Instead it shall be powered from a +2.8V / +3.1V (dedicated or 3.1V_OUT) power supply.
This is because in this way the level translator IC outputs on the module side (i.e. GE863-PRO3 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-PRO3 GPRS firmware, the serial port on the Telit GE863-PRO3 shall be available for translation into RS232 and either it's controlling ARM device shall be placed into tristate, disconnected or as a gateway for the serial data when module reprogramming occurs.
Only RXD, TXD, GND and the On/off module turn on pad are required to the reprogramming of the module, the other lines are unused.
All applicator shall include in their design such a way of reprogramming the GE863-PRO3 .

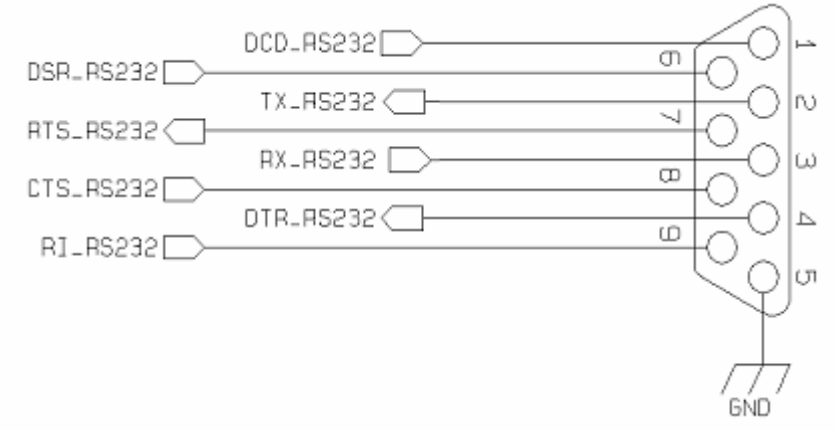
NOTE: In order to be able to do in circuit reprogramming of the GE863-PRO3 ARM Application software, the serial port DEBUG on the Telit GE863-PRO3 shall be available for translation into RS232 when module reprogramming occurs.
Only DRXD, DTXD, GND and the On/off*-AP module turn on pad are required to the reprogramming of the module, the other lines are unused.
All applicator shall include in their design such a way of reprogramming the GE863-PRO3.

An example of level translation circuitry of this kind is:



RS232 LEVEL TRSANSLATOR

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

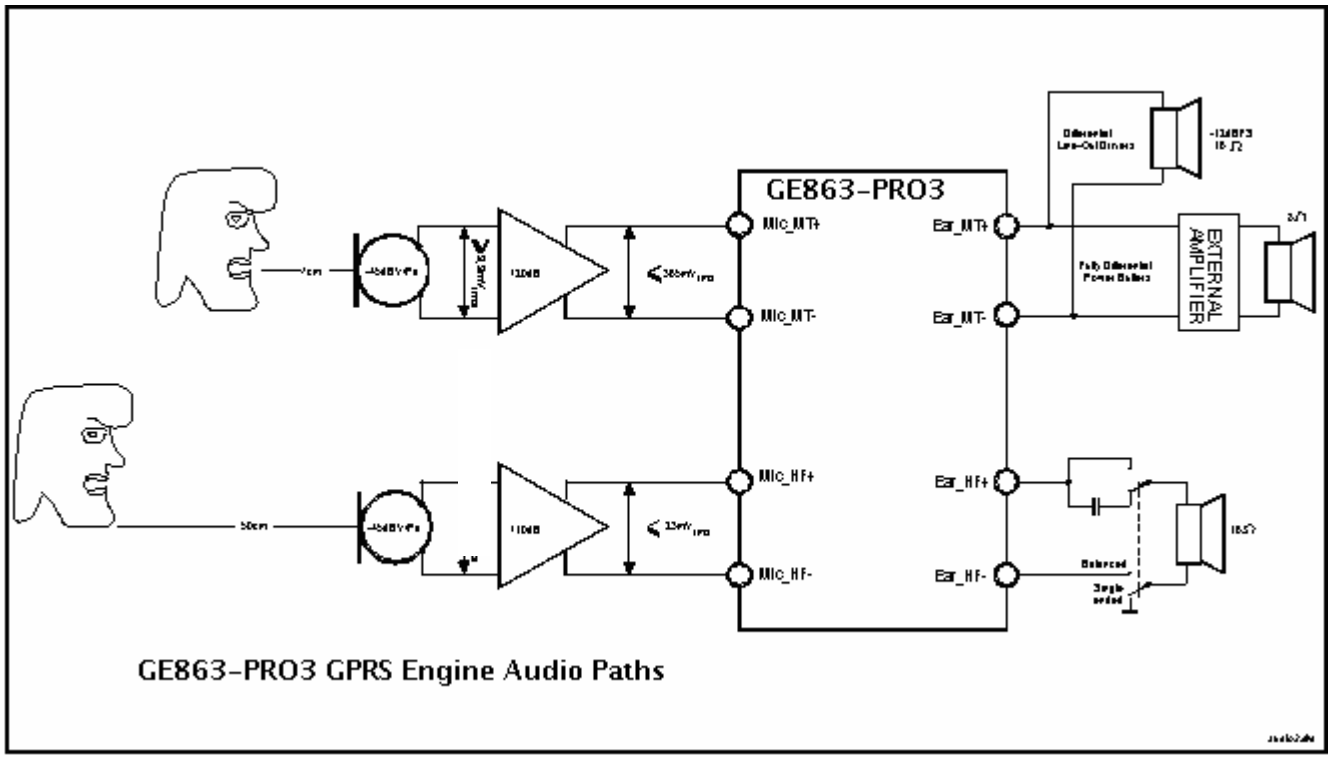


8 Audio Section Overview

The Base Band Chip of the GE863-PRO3 GPRS engine provides two different audio blocks; both in transmit (*Uplink*) and in receive (*Downlink*) direction:

"*MT lines*" should be used for handset function,
"*HF lines*" is suited for hands -free function (car kit).

These two blocks can be active only one at a time, selectable by AT command. The audio characteristics are equivalent in transmit blocks, but are different in the receive ones and this should be kept in mind when designing.



GE863-PRO3 GPRS Engine Audio Paths

8.1 Microphone Paths Characteristic and Requirements

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

TIP: due to the difference in the echo canceller type, the "Mic_MT" audio path is suited for Handset applications, while the "Mic_HF"audio path is suited for hands-free function (car kit). The Earphone applications should be made using the "Mic_HF" audio path but DISABLING the echo canceller by software AT command. If the echo canceller is left active with the Earphone, then some echo might be introduced by the echo cancel algorithm.

"Mic_MT" 1st differential microphone path

• line coupling	AC
• line type	balanced
• coupling capacitor	≥ 100nF
• differential input resistance	50kΩ
• differential input voltage	≤ 1,03V_{pp} (365mV_{rms})
• microphone nominal sensitivity	-45 dBV_{rms}/Pa
• analog gain suggested	+ 20dB
• echo canceller type	handset

"Mic_HF" 2nd differential microphone path

• line coupling	AC
• line type	balanced
• coupling capacitor	≥ 100nF
• differential input resistance	50kΩ
• differential input voltage	≤ 65mV_{pp} (23mV_{rms})
• microphone nominal sensitivity	-45 dBV_{rms}/Pa
• analog gain suggested	+10dB
• echo canceller type	car kit hands-free

TIP: definition of the nominal sensitivity of the microphone lines .

The nominal sensitivity of the microphone lines indicates the voltage level on the GE863-PRO3 pins present during "*normal spoken*" conditions.
For a handset , the "*normal spoken"* conditions take place when the talker mouth is 7cm far from the microphone ; under these conditions the voice will produce an acoustic pressure of *-4,7dBPa @1kHz* on the microphone membrane .

TIP: electrical equivalent signal and operating voice levels .

At "*normal spoken*" conditions, a microphone having the suggested nominal sensitivity of -*45dBV$_{rms}$/Pa* , will produce

the electrical equivalent signal : $MicLevel = (-45) + (-4.7) = -49.7\ dB_{Vrms}$

that means : $MicVoltage = 10^{(-49.7/20)} = 3.3 * 10^{-3}\ V_{rms}$

During a call, this level varies according to the volume of the talker voice; usually the following rough thumb rule for the dynamic range may be used :

1) the talker is screaming . This is the *strongest voice level* condition: the signal increases by +20dB;
2) the talker is whispering. This is the *lowest voice level* condition: the voice level decreases by –50dB.

These changes must be considered for designing the external microphone amplifier.

TIP: example of external microphone amplifier calculation .

Let's suppose to use the *1stdifferential* microphone path .In this case the maximum differential input voltage to "*Mic_MT*" lines is 365mV$_{rms}$(1,03V$_{pp}$) corresponding to –8,76dBV.
Now we can calculate the maximum voltage gain of an external microphone amplifier G_A :

$$[(MicLevel + 20dB) + G_A] = -8{,}76dBV$$

$$[-49{,}7 + 20 + G_A] = -8{,}76$$

$$-40{,}9 + 20 = -G_A$$

$$G_A = 20{,}94dB \longrightarrow$$ you can set G_A= ***+20dB*** to use standard resistor values .

TIP: environment consideration .

For *hands-free/car kit* microphone, you must take into account the voice attenuation, due to the distance between the microphone itself and the talker, when designing the external microphone amplifier.
Not only, you must consider that the microphone will pick up also ambient noise; to overcome this problem it is preferable to set the gain of the microphone *10dB* lower with respect to the calculated value for a nominal sensitivity. The corresponding reduction in signal level will be compensated by an increased voice volume of the talker which will speak louder because of the ambient noise.
For a car cabin usually the distance between the microphone itself and the talker is *40/50cm* ; in these conditions the attenuation can be considered as a thumb rule around *20dB* .

For the earphone we shall distinguish two different types: the earphones having the microphone sustained close to the mouth and the ones having the microphone on the earpiece cable.
The same considerations for the additional voice attenuation due to the distance from the microphone and the noise pick up can be made for the earphone having the microphone on the earpiece cable, while the other kind of earphone shall be threaten as a handset.

TIP: how to compensate the losses in car cabin hands-free condition.

The voice signal , that in the "normal spoken" conditions produces on the microphone membrane an acoustic pressure of -4,7dBPa at 1kHz , will have a further attenuation of 20dB due the 50cm distance .

Therefore a microphone having the suggested nominal sensitivity of -45dBV$_{rms}$/Pa,will produce a lower electrical

equivalent signal : $MicLevel = (-45) + (-4.7)-20 = -69.7$

that means : $MicVoltage = 10^{(-49.7 / 20)} = 0,33* 10^{-3}$

Setting the "microphone gain" at +10dB (3 times), the signal in the nominal conditions on the "Mic_HF" inputs s of GE863-PRO3 Telit Module will be :

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

Hence in these conditions the signal level on the"***Mic_HF***" input pads of the GE863-PRO3 is 10 dB (3 times) lower than the nominal, as suggested.

8.2 General Design Rules

There are several configurations for the audio paths, but the most effective difference is between balanced and unbalanced microphone configuration.
It is highly recommended to keep the whole microphone path balanced even if this means having 2 wires connecting the microphone instead of one needed (plus ground) in the unbalanced case. The balanced circuitry is more suited because of its good common mode noise rejection, reducing the *216 Hz* burst noise produced during the GSM transmissions.

- Where possible use balanced microphone circuitry
- Keep the microphone traces on the PCB and wires as short as possible.
- If your application requires an unbalanced microphone, then keep the lines on the PCB balanced and "unbalance" the path close to the microphone wire connector if possible.
- For the microphone biasing voltage use a dedicated voltage regulator and a capacitor multiply circuit.
- Make sure that the microphone traces in the PCB don't cross or run parallel to noisy traces (especially the power line)
- If possible put all around to the microphone lines a ground trace connected to the ground plane by several vias. This is done in order to simulate a shielded trace on the PCB.
- The biasing circuit and eventually the buffer can be designed in the same manner for the internal and external microphones.

8.3 Other considerations

If your application is a hands-free/car kit scenario , but you need to put microphone and speaker inside the same box :

- try to have the maximum possible distance between them, at least 7cm ;
- since the microphone type is very important, if you use an omni-directional one (and this is the typical application) please seal it on the rear side (no back cavity) in order not to collect unwanted signals ;
- try to make divergent the main axes of the two devices .

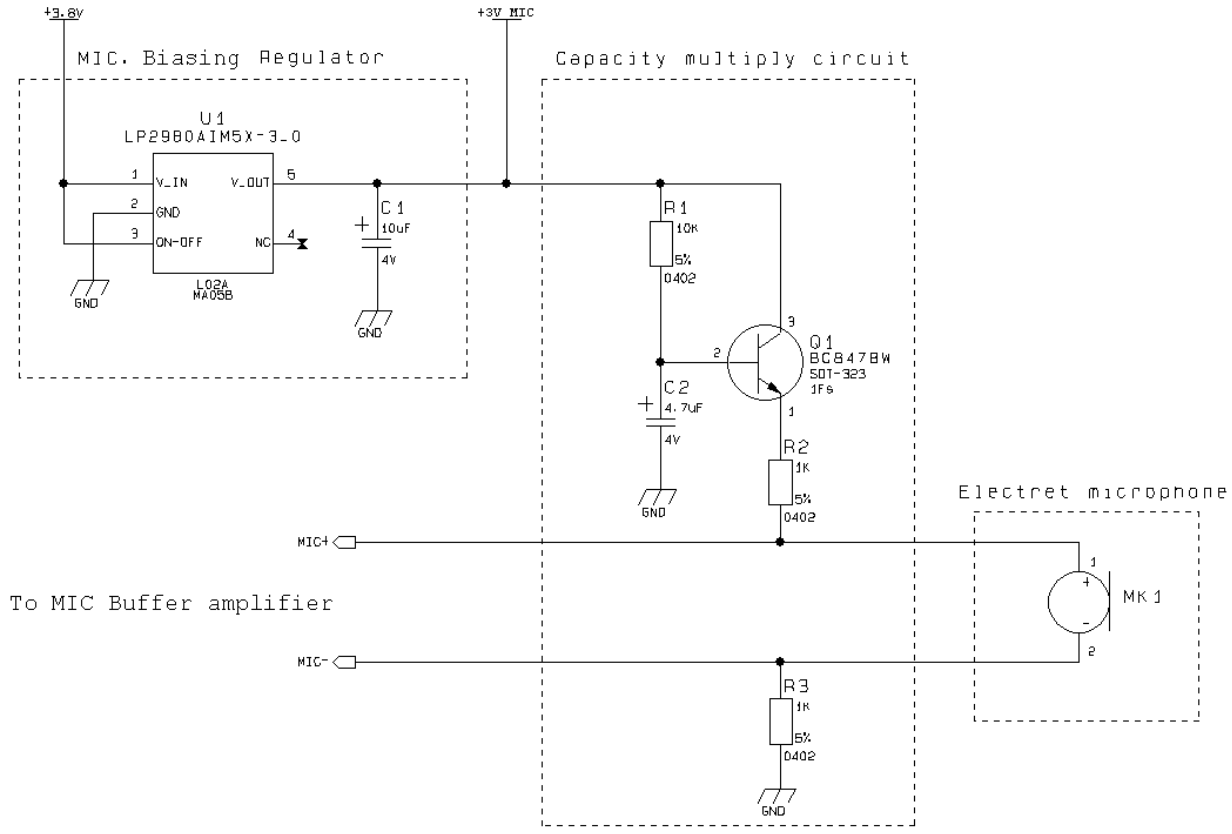
8.4 Microphone Biasing

The electret microphones usually need a biasing voltage to work properly. Refer to your microphone provider for the characteristics required.

NOTE: The microphones have a hot wire were the positive biasing must be connected. Usually it is indicated by a + symbol or a red point. If the polarity of the bias is reversed, then the microphone will not work properly. For this reason be sure to respect the mic. biasing polarity.

8.4.1 Balanced Microphone Biasing

The balanced microphone bias voltage should be obtained from a dedicated voltage regulator, in order to eliminate the noise present on the power lines. This regulator can be the same for all the audio paths. The microphone should be supplied from a capacitor multiply circuit.
For example a circuit for the balanced microphone biasing can be:



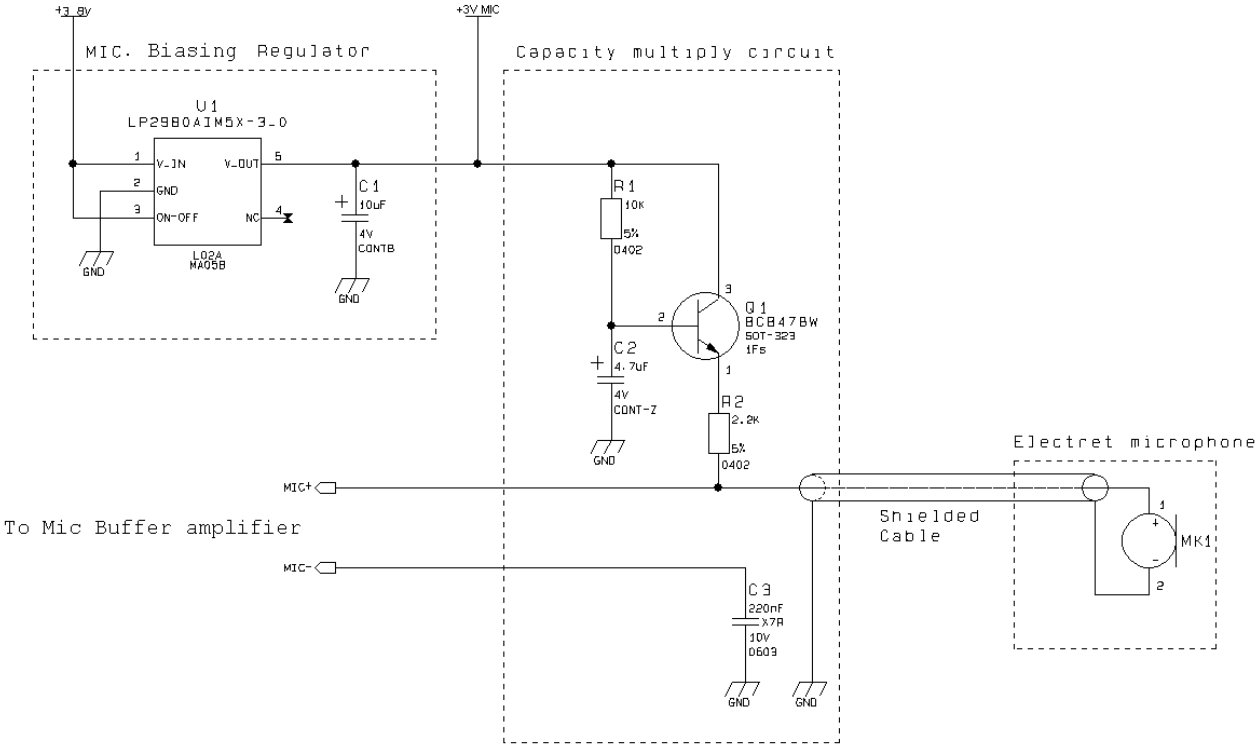
NOTE: In the balanced application the resistors R2 and R3 must have the same value to keep the circuit balanced.

NOTE: The cable to the microphone should not be shielded, instead a twisted pair cable shall be used.

NOTE: The microphone sensitivity changes with the value of R2 and R3. Usually the microphones are characterized with 2kΩ biasing resistance, so try to keep the sum of R2 and R3 around 2kΩ. Refer to your microphone manufacturer for the mic. characteristics.

8.4.2 Unbalanced Microphone Biasing

The unbalanced microphone biasing voltage should be obtained from a dedicated voltage regulator, in order to eliminate the noise present on the power lines. This regulator can be the same for all the audio paths. The microphone should be supplied from a capacitor multiply circuit.
For example a circuit for the unbalanced microphone biasing can be:



NOTE: In the unbalanced application the capacitor C3 shall be > 200nF otherwise the frequency response will be cut at low band frequencies (down to 300Hz). This capacitor can be placed close to the MIC- pad (MIC_HF- or MIC_MT- depending on the audio path chosen) or if possible it should be placed close to the shielded cable connector. If the ground return path is well designed, then it is possible to eliminate the C3 capacitor, provided the buffer is close to the mic. input.

NOTE: The cable to the microphone should be shielded.

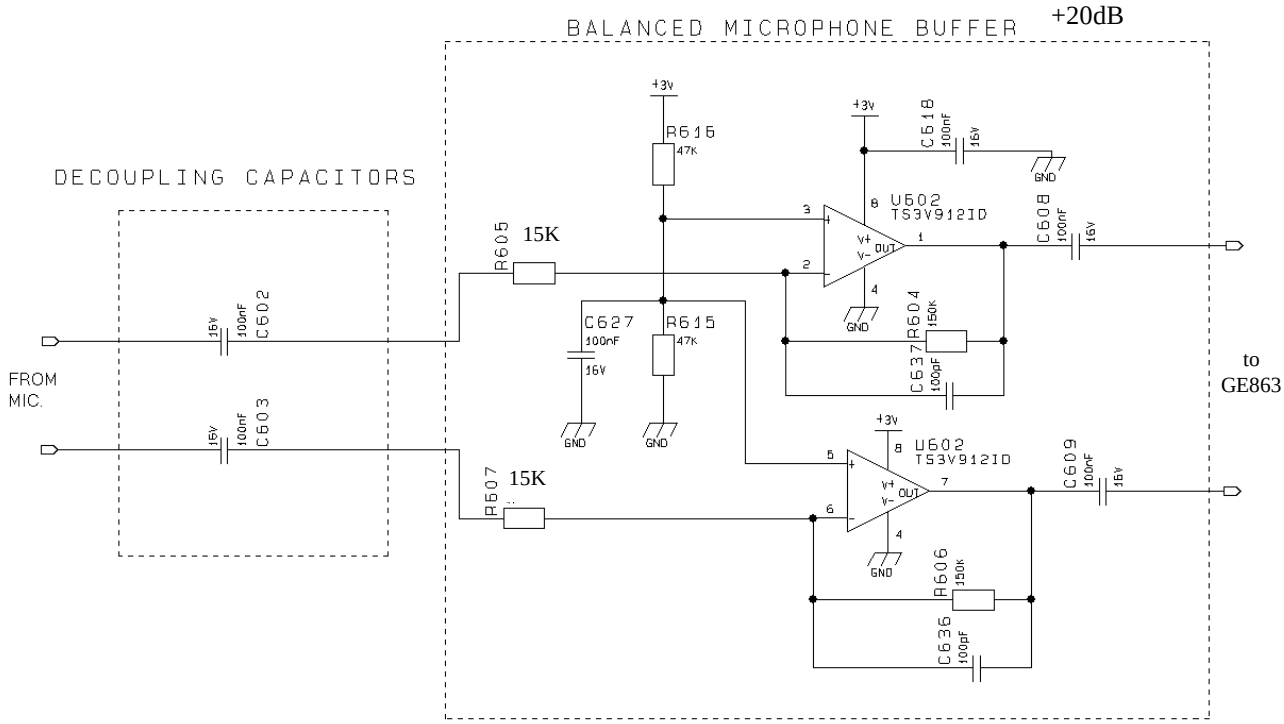
NOTE: The microphone changes with the value of R2. Usually the microphone sensitivity is characterized with 2kΩ biasing resistance, so try to keep the value of R2 around 2kΩ. For mic. characteristics refer to the manufacturer.

8.5 Microphone Buffering

As seen previously, a microphone shall be connected to the input pins of the GE863-PRO3 through a buffer amplifier that boosts the signal level to the required value.
Again the buffered microphone circuitry can be balanced or unbalanced: where possible it is always preferable a balanced solution. The buffering circuit shall be placed close to the microphone or close to the microphone wire connector.

8.5.1 Buffered Balanced Mic

A sample circuit can be:



This circuit has a gain of 10 times (+20 dB), and is therefore suited for the "***Mic_MT*** " input if you have a microphone with a sensitivity close to the suggested one *(-45 dBV$_{rms}$/Pa)*. If your microphone has a different sensitivity or if the buffer is connected to the "***Mic_HF*** " inputs , then a gain adjustment shall be done by changing resistors R604 and R606 (if the required value is not a standard one , you can change R605 e R607) and as a consequence the capacitors C636 and C637 to maintain the bandwidth 150-4000Hz (at -3dB).

The buffer gain is given by the formula:

$$Gain = \frac{R604}{R605} = \frac{R606}{R607}$$

The C636 and C637 capacitors are placed in order to cut off the gain at higher frequencies than the transmitted GSM band, the cutoff frequency (-3dB) should be 3500Hz in order to have -1dB at 3kHz. The cutoff frequency is given by the formula:

$$freq. = \frac{1}{2\pi * R604 * C637} = \frac{1}{2\pi * R606 * C636} \text{ [Hz]}$$

TIP: example of calculation .

*Let's assume you have a microphone with a sensitivity of -45 dBV_{rms}/Pa and you want to use it in 1st differential microphone path ("**Mic_MT**" inputs) in "normal spoken" conditions at acoustic pressure of -4.7dBPa.*
As reported at page 33 , the electrical level output from the microphone will be :

$MicLevel = (-45) + (-4.7) = -49.7\ dB_{Vrms}$

corresponding to: $MicVoltage = 10^{(-49.7 / 20)} = 3.3 * 10^{-3}\ V_{rms}$

*When the talker is screaming ,we will have a signal of 330 mV_{rms} on the "**Mic_MT**" inputs due to a 20dB higher Mic Level (see TIP 1) with a buffer gain G_A :*

G_A** =20 log (AmplifierOutput / MicVoltage) =20 log (330 * 10^{-3})/(33 * 10^{-3}) = 20 log 10=**20dB

The corresponding values for the resistors on the buffer could be (if we keep the input resistance 10kΩ)

$R604 = R606 = gain * R607 = gain * R605 = 10 * 15 = 150\ k\Omega$

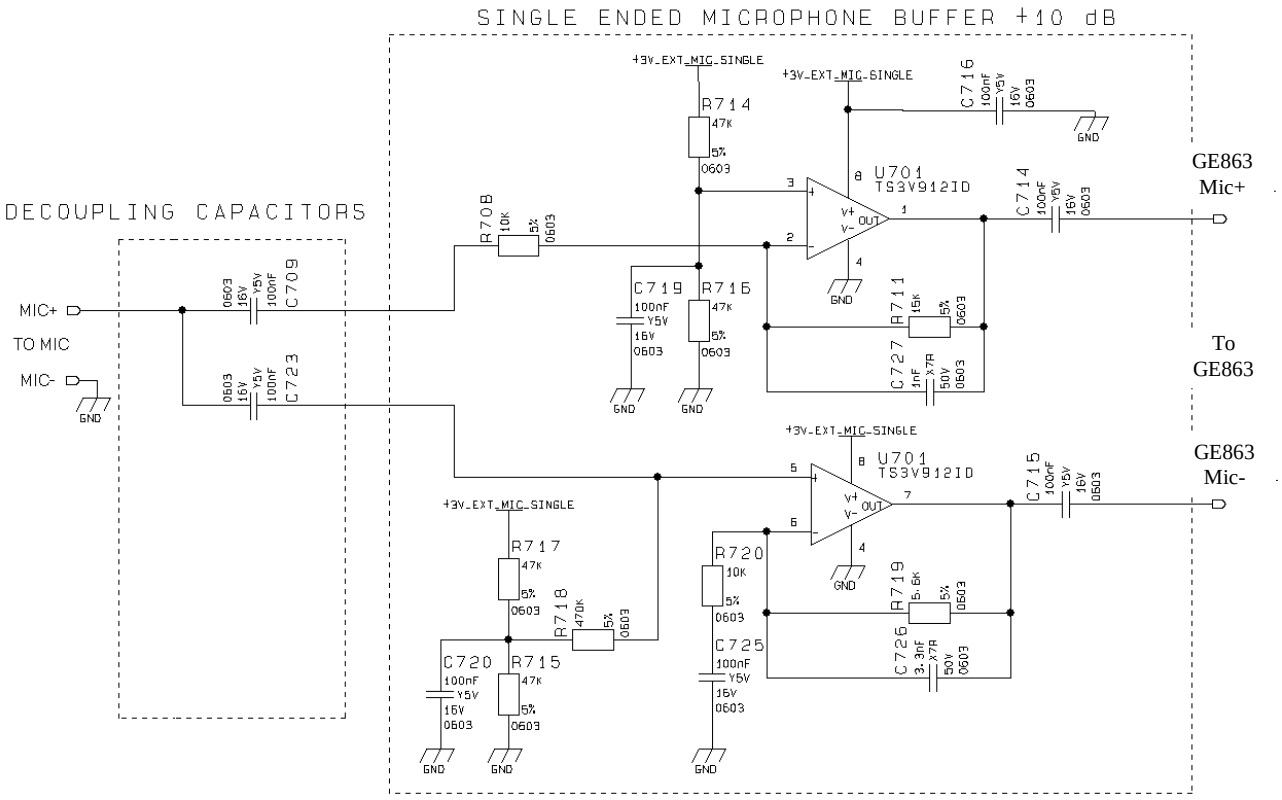
The commercial values of 150kΩ & 15kΩ are then chosen.

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

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

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

8.5.2 Buffered Unbalanced (Single Ended) Microphone



The above schematic can be used for a single ended (*buffered unbalanced*) microphone; the required biasing circuitry is not included. Note also that the capacitor C3 is not needed.
The gains of the two amplifiers are given by the formulas:

$$Gain(\text{not inverting buffer}) = 1 + \frac{R719}{R720} \qquad Gain(\text{inverting buffer}) = \frac{R711}{R708}$$

Assigning half of overall gain to each amplifier, you will obtain the requested gain because of doubling the microphone signal path; in fact by the use of two amplifiers (the upper as “inverting” and the lower as “not inverting” configuration) we obtain an additional +6dB gain (2 times) .

Remember: the “not inverting“ amplifier section gain shall not be less than 1 .
Like for the balanced buffered microphone, the amplifier overall gain can be modify changing the value of resistor R719/R720 and R711 and as a consequence the capacitors C726 and C727. It is advisable to change R708 only if you have difficulty to find a commercial value for R711; in this case change R708 as little as possible.

The -3dB bandwidth is given by the approximated formula (considering C725 >> C726):

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

The buffer bandwidth at -3dB shall be 4KHz.
Note that the biasing of the operational amplifier is given for the inverting amplifier by the series divider R714-R715. The 100nF capacitor C719 is needed to filter the noise that could be coupled to that divider. For the not inverting operational amplifier the biasing is given by a different divider R715-R717 with the capacitor C720 and through a series resistor R718 of 470KΩ.

TIP: example of calculation.

*Llet's assume you have a microphone with a sensitivity of -45dBV$_{rms}$/Pa and you want to use it in 2nd differential microphone path ("**Mic_HF**" inputs) in "normal spoken" conditions at acoustic pressure of -4.7dBPa.*
As reported at page XX , the electrical level output from the microphone will be :

$$MicLevel = (-45) + (-4.7) = -49.7\ dBV_{rms}$$

but we have to consider 20dB loss due to the higher distance from the mouth of the talker (50cm) .

$$MicLevel = (-49.7) + (-20) = -69.7\ dBV_{rms}$$

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

*In order to have a signal of 1 mV$_{rms}$ at the **"Mic_HF"** inputs , as suggested at **TIP** "**environment consideration** ",*

the buffer must have a gain $G_A = \text{"Mic\_HF"} / MicVoltage = (1*10^{-3})/(0{,}33*10^{-3}) = 3$ or +10 dB

*Keeping in mind that " balancing the line will double the signal", to calculate the resistor values assign half of required gain **G$_A$** to each amplifier section . And therefore **G$_S$** =1,5times (or +3,52dB) .*

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

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

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

*The commercial values of **15kΩ** and **5.6kΩ** be accepted .*
As a consequence of the assigned values of the resistors, the nominal values of C726 and C727 are :

***C726**= 1/ (2π*4000*R719)= 7.10 *10 $^{-9}$ F*

***C727**= 1/ (2π*4000*R711)= 2,65 *10 $^{-9}$ F*

*modified in **6,8nF** (f_{c1}=4181Hz) and **2,7nF** (f_{c2}=3931Hz) because of commercial values .*

9 OUTPUT LINES (Speaker)

9.1 Short description

The Telit GE863-PRO3 provides two audio paths in receive section. Only one of the two paths can be active at a time, selectable by *AXE* hardware line or by AT command.

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

→ the *"**Ear_MT**"* lines *EPN1* and *EPP1* are the *Differential Line-Out Drivers* ; they can drive an external amplifier or directly a ***16 Ω earpiece*** at –12dBFS (*) ;
→ the "***Ear_HF***" lines *EPPA1_2* and *EPPA2* are the *Fully Differential Power Buffers ;* they can directly drive a *16**Ω** speaker* in differential (*balanced*) or single ended (*unbalanced*) operation mode .

(*) *FS* : acronym of *Full Scale.* It is equal to 0dB, the maximum Hardware Analog Receive Gain of BaseBand Chip.

The *"**Ear_MT**"* audio path should be used for handset function, while the "***Ear_HF***" audio path is suited for hands-free function (car kit).

Both receiver outputs are B.T.L. type (Bridged Tie Load) and the OEM circuitry shall be designed bridged to reduce the common mode noise typically generated on the ground plane and to get the maximum power output from the device; however also a single ended circuitry can be designed for particular OEM application needs.

9.2 Output Lines Characteristics

"Ear_MT" Differential Line-out Drivers Path

- line coupling: DC
- line type: bridged
- output load resistance : ≥ 14 Ω
- internal output resistance: 4 Ω (typical)
- signal bandwidth: 150 - 4000 Hz @ -3 dB
- max. differential output voltage 1310 mV_{rms} (typ, open circuit)
- differential output voltage 328mVrms /16 Ω @ -12dBFS
- SW volume level step - 2 dB
- number of SW volume steps 10

"Ear_HF" Power Buffers path

- line coupling: DC
- line type: bridged
- output load resistance : ≥ 14 Ω
- internal output resistance: 4 Ω (>1,7 Ω)
- signal bandwidth: 150 - 4000 Hz @ -3 dB
- max. differential output voltage 1310 mV_{rms} (typ, open circuit)
- max. single ended output voltage 656 mV_{rms} (typ, open circuit)
- SW volume level step - 2 dB
- number of SW volume steps 10

9.3 General Design Rules

There are several configurations for the audio output path, but the various design requirements can be grouped into three different categories:

- handset earphone (low power, typically a handset)
- hands-free earphone (low power, typically a earphone)
- car kit speakerphone (high power, typically a speaker)

The three groups have different power requirements, usually the first two applications need only few mW of power, which can be directly drained from the GE863-PRO3 pads, provided a suited speaker is used. This direct connect design is the cheaper and simpler solution and will be suited for the most of the earphone design requirements. There's no need to decouple the output ear lines if a suited earpiece is connected. For the last group, the speakerphone, a power amplifier is required to raise the output power up to 5-10W required in a car cabin application.
All the designs shall comply with the following guidelines:

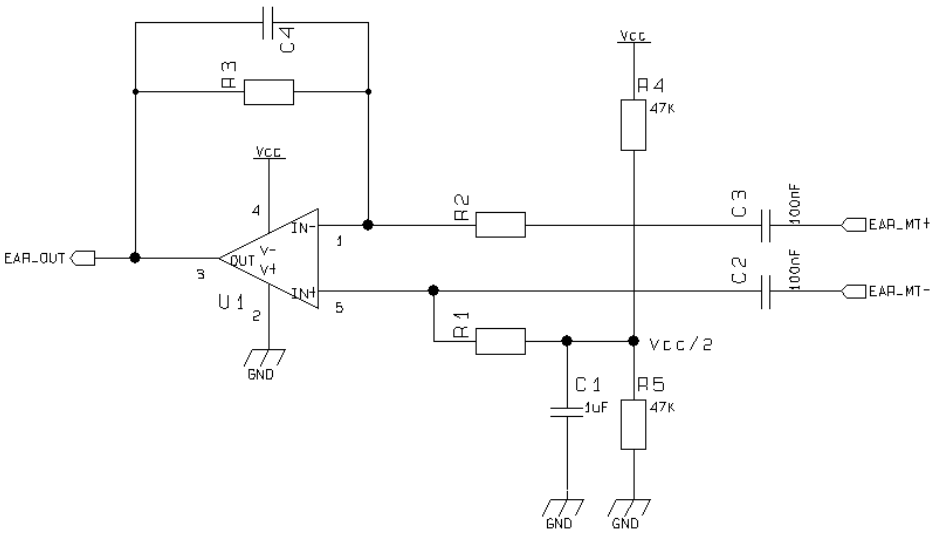
- Where possible use a bridged earphone circuitry, to achieve the maximum power output from the device.
- Keep the earphone traces on the PCB and wires as short as possible.
- If your application requires a single ended earpiece and you want a direct connection, then leave one of the two output lines open and use only the other referred to ground. Remember that in this case the power output is 4 times lower than the bridged circuit and may not be enough to ensure a good voice volume.
- Make sure that the earphone traces in the PCB don't cross or run parallel to noisy traces (especially the power line)
- The cable to the speaker shall be a twisted pair with both the lines floating for the bridged output type, shielded with the shield to ground for the single ended output type.

9.3.1 Noise Filtering

The I/O of the PCB should have a noise filter close to the connector, to filter the high frequency GSM noise. The filter can be a Π formed by 2 capacitor and a inductance, with the one capacitor of *39pF - 0603* case, and the other capacitor of *1nF - 0603*; the inductance shall have a value of *39µH* .

9.4 Handset Earphone Design

As seen previously, a 16Ω earpiece can be directly connected to the output pads EAR_MT+ and EAR_MT- of the *GE863-PRO3*.
This solution is often the more cost effective, reducing the components count to a minimum. There are several limitations to the use of this solution: speaker direct connect imposes the speaker characteristics to be almost exactly the suggested ones, otherwise the power output may be reduced (if speaker impedance is bigger than 16Ω) or the *GE863-PRO3* ear port may be damaged (if speaker impedance is less than 15Ω).
The other limitation of the speaker direct connection is the power output capability of the *GE863-PRO3* which is limited and for some particular applications may not be enough.
For these reasons, when the power output of the *GE863-PRO3* is not enough or if the speaker characteristics are different from the suggested, then it is preferable to use an amplifier to increase the power and current output capabilities.
Again the output from the *GE863-PRO3* is bridged and both lines should be used, where possible, as inputs to the power amplifier. This ensures a higher common mode rejection ratio, reducing the GSM current busts noise on the speaker output.
In this case the "***EAR_MT***" lines from the *GE863-PRO3* should be AC coupled with a ceramic capacitor of 100nF (or bigger) .
It is always desirable to have a mute control on the amplifier, in order to turn it off while the device is not sending signal to the output, in this manner the amplifier background noise which may be audible during idle conditions is cut off.
A principle schematic may be:

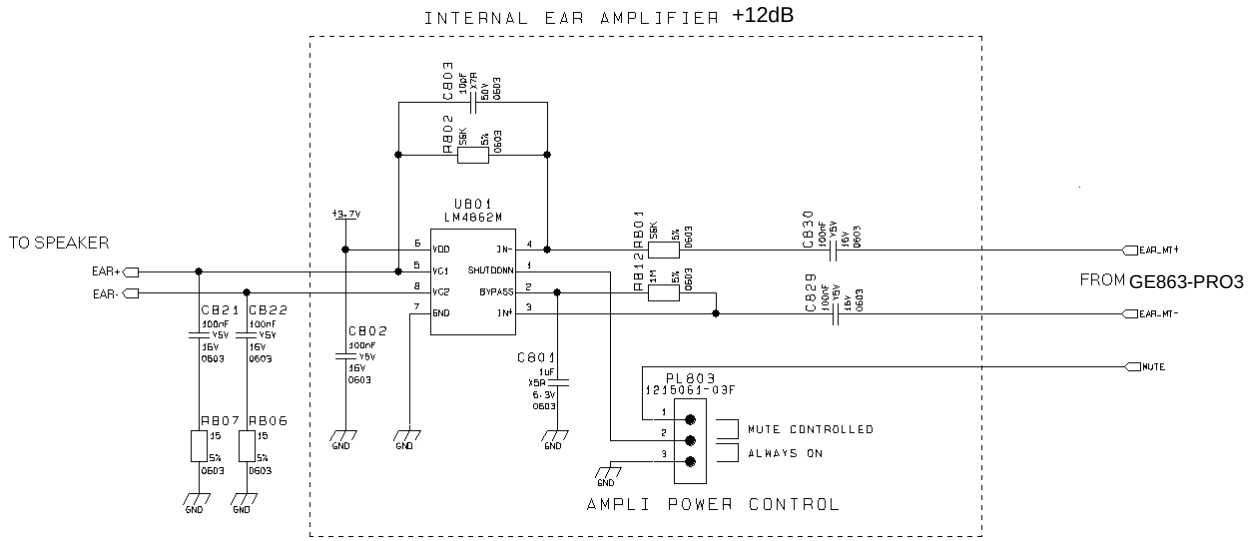


The resulting gain and high pass cut can be obtained with the formula:

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

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

And an example of internal Ear amplifier could be:



Some amplifier require a low impedance load at high frequency in order to avoid auto oscillation, this can be made with a capacitor (*100nF*) in series with a resistor (*15Ω*).

When designing your application, remember to provide an adequate bypass capacitor to the amplifier and place it close to the power input pin of the IC, keeping the traces as short as possible.

9.5 Hands-Free Earphone (Low Power) Design

The same design considerations made for the handset are valid for the hands-free earphone.

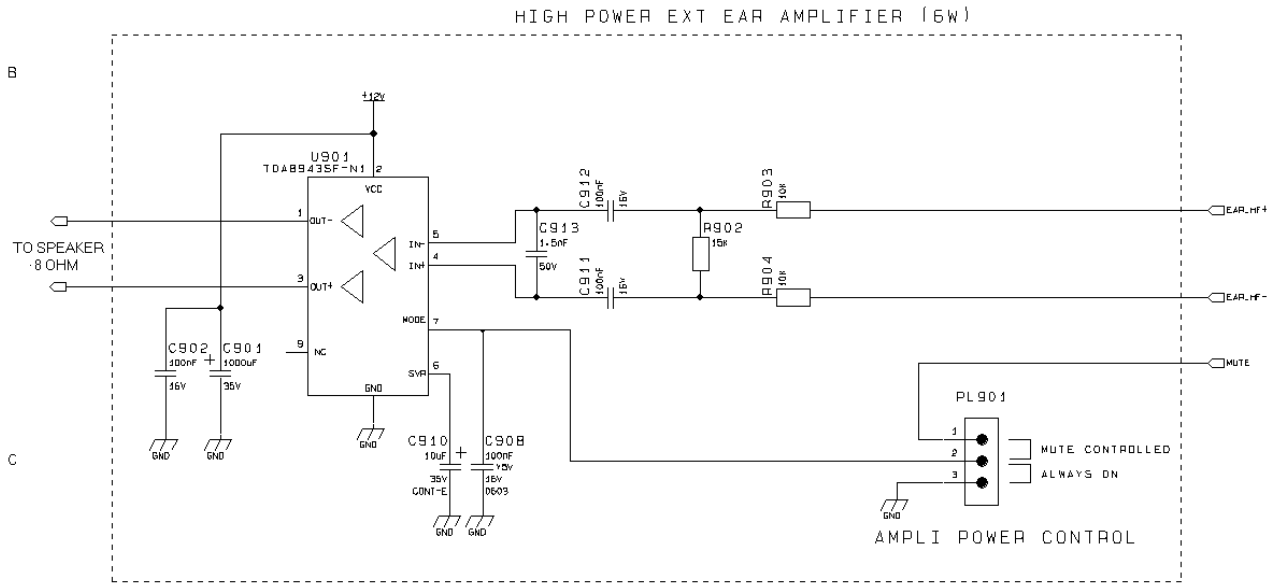
9.6 Car Kit Speakerphone Design

For the car kit speaker phone function the power output requirement is usually at least 4W, therefore an amplifier is needed to boost the *GE863-PRO3* output.
The design of the amplifier shall comply with the following guidelines:

- The input to the amplifier MUST be taken from the "***Ear_HF***" audio path of the *GE863-PRO3*, because of its echo canceller parameters suited to a car cabin use.
- The amplifier shall have a gain of 30-40 times (29-32 dB) to provide the desired output power of 5-10W with the signal from the *GE863-PRO3* "***Ear_HF***" audio output lines.
- If the amplifier has a fixed gain then it can be adjusted to the desired value by reducing the input signal with a resistor divider network.
- The amplifier shall have a mute control to be used while not in conversation. This results in two benefits: eliminating the background noise when not in conversation and saving power.
- The power to the amplifier should be decoupled as much as possible from the *GE863-PRO3* power supply, by either keeping separate wires and placing bypass capacitors of adequate value close to the amplifier power input pads.
- The biasing voltage of the amplifier shall be stabilized with a low ESR (e.g. a tantalum) capacitor of adequate value.

NOTE: The GE863-PRO3 audio path connected to the car kit hands-free amplifier MUST be "Ear_HF" one, otherwise the echo cancellation will not be done due to the difference in the echo canceller characteristics of the GE863-PRO3 internal audio path from the external audio path.

Example of car kit amplifier schematic.



9.7 The Evaluation Kit for Telit GE863-PRO^3 Modules

9.7.1 Short Description

Telit supplies the Evaluation Kit for Telit GE863-PRO^3 modules *to* assist the designer in developing his own applications based on GE863-PRO^3 Telit module.

The GE863-PRO^3 *EVK* is formed by a mother board *and* a *dedicated Telit module Interface Board with* RF antenna connectors.
It provides a fully functional solution for a complete M2M application.
The motherboard has a power supply and is equipped with SIM card housing, RS 232 serial port level translator, direct USB2.0 Host & Device connection, Smartcard ISO7816 slot, SD-MMC Card slot and 10/100 Mb Ethernet.

The only items you have to provide are:

1) a personal computer or microcontroller ;
2) a SIM card with a valid Network subscription;
3) a power supply

The connection between the GE863-PRO^3 *EVK* and your PC (or other DTE) are realized by standard *RS232* ports.

The communications between the application ARM and Telit GPRS Engine is realized connecting the Asynchronous Serial Interfaces of the module's ARM&GSM/GPRS by setting appropriately the Jumpers.
Furthermore the communications between ARM and GSM/GPRS can be analyzed with two "sniffed" serial ports that can report both sides of the ARM-GSM/GPRS serial channel.

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-PRO3 :

Ball	Signal	I/O	Function	Type	Input / output current	Default State	ON_OFF state	State during Reset	Note
E6	GPIO1	I/O	GPIO01 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	LOW		Alternate function (JDR)
55	GPIO2	I/O	GPIO02 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	HIGH	HIGH	4.7K Pull Up
32	GPIO3	I/O	GPIO03 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	LOW		Alternate function (RFTXMON)
53	GPIO4	I/O	GPIO05 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	LOW		Alternate function (BUZZER)
54	GPIO5	I/O	GPIO06 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	LOW		
51	GPIO6	I/O	GPIO07 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	LOW		
6	GPIO7	I/O	GPIO08 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	LOW		Alternate function (RF Transmission Control)
5	GPIO8	I/O	GPIO09 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	LOW		
4	GPIO9	I/O	GPIO10 Configurable GPIO	CMOS 2.8V	1uA / 1mA	INPUT	LOW		

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-PRO3 firmware and acts depending on the function implemented.

All GPIO pads are 2.8V CMOS signals and their interface levels are the same specified in the paragraph 6.5.

10.1 Using a GPIO Pad as INPUT

The GPIO pads, when used as inputs, can be connected to a digital output of another device and report its status, provided this device has interface levels compatible with the 2.8V CMOS levels of the GPIO.
If the digital output of the device to be connected with the GPIO input pad has interface levels different from the 2.8V CMOS, then it can be buffered with an open collector transistor with a 47K pull up to 2.8V.

10.2 Using a GPIO Pad as OUTPUT

The GPIO pads, when used as outputs, can drive 2.8V CMOS digital devices or compatible hardware. When set as outputs, the pads have a push-pull output and therefore the pull-up resistor may be omitted.

10.3 Using the RF Transmission Control GPIO7

The GPIO7 pin, when configured as RF Transmission Control Input, permits to disable the Transmitter when the GPIO is set to Low by the application.

10.4Using the RFTXMON Output GPIO3

The GPIO3 pin, when configured as RFTXMON Output, is controlled by the GE863-PRO3 module and will rise 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.

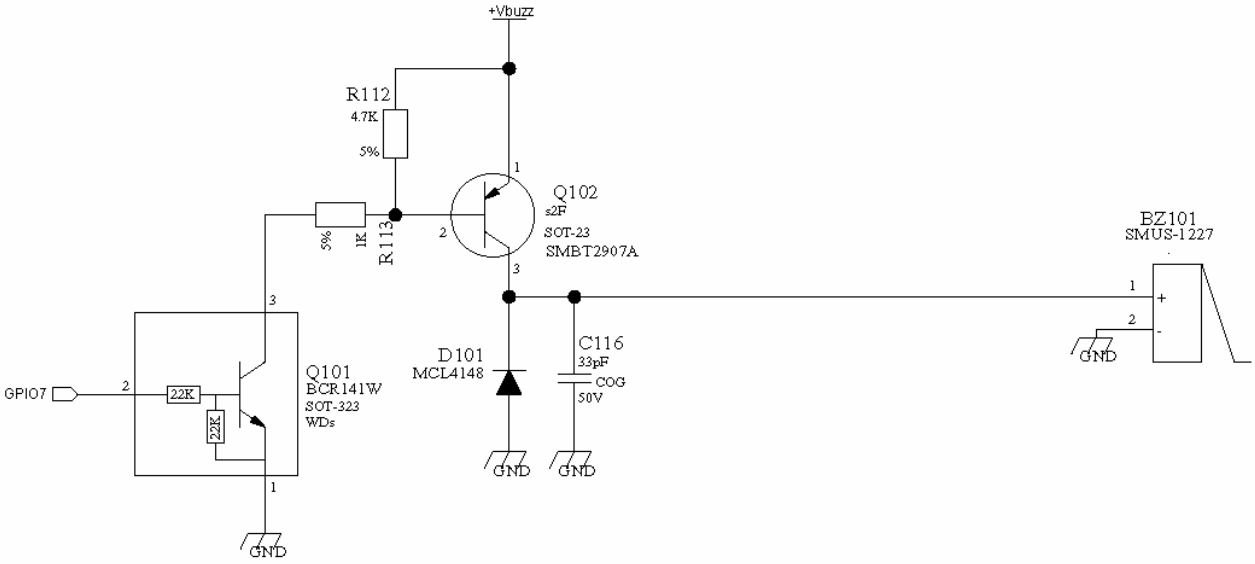
The line rises up 300ms before first TX burst and will became again LOW from 500ms to 1sec after last TX burst.

10.5 Using the Alarm Output

The GPRS Engine GPIO pads, when configured as Alarm Output, can be controlled by the GE863-PRO3 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-PRO3 application processor at the alarm time, giving you the possibility to program a timely system wake-up to achieve some periodic actions and completely turn off both the application processor and the GE863-PRO3 during sleep periods, dramatically reducing the sleep consumption to few µA.
In battery-powered devices this feature will greatly improve the autonomy of the device.

10.6 Using the Buzzer Output GPIO4

The GPIO4 pad, when configured as Buzzer Output, is controlled by the GE863-PRO3 module and will drive with appropriate square waves a Buzzer driver.
This permits to your application to easily implement Buzzer feature with ringing tones or melody played at the call incoming, tone playing on SMS incoming or simply playing a tone or melody when needed by your application.



A sample interface scheme is included below to give you an idea of how to interface a Buzzer to the GPIO7:

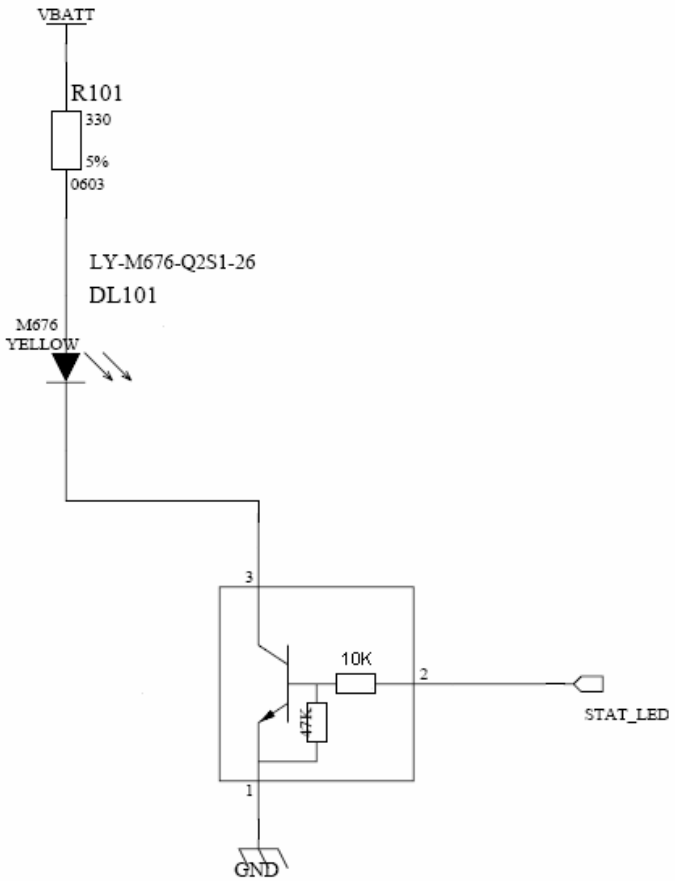
NOTE: To correctly drive a buzzer a driver must be provided, its characteristics depend on the Buzzer and for them refer to your buzzer vendor.

10.7 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 usually needs an external transistor to drive an external LED.
Therefore, the status indicated in the following table is reversed with respect to the pin status.

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

10.8



RTC Bypass out

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

10.9VAUX1 power output

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

Operating Range – VAUX1 power supply

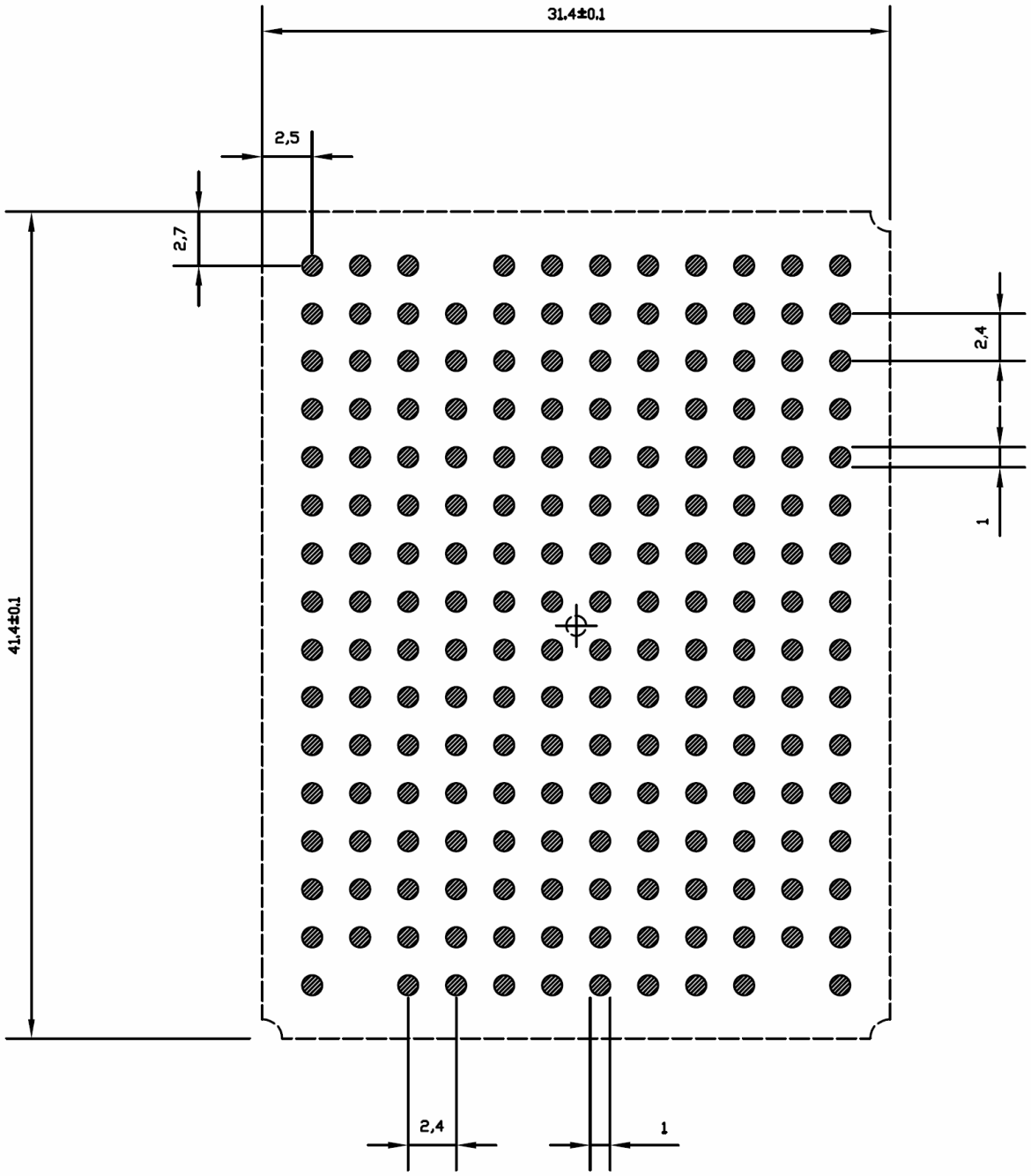
	Min	Typical	Max
Output voltage	2.75V	2.85V	2.95V
Output current			100mA
Output bypass capacitor			2.2µF

11 Mounting the GE863-PRO^3 on the Application Board

11.1 General

The **Telit GE863-PRO3 module** has been designed in order to be compliant with a standard lead-free SMT process

11.1.1 Recommended footprint for the application

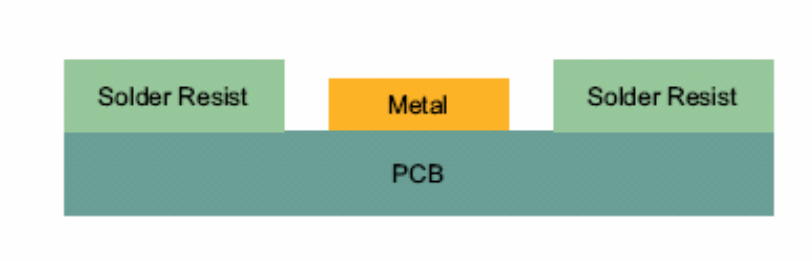


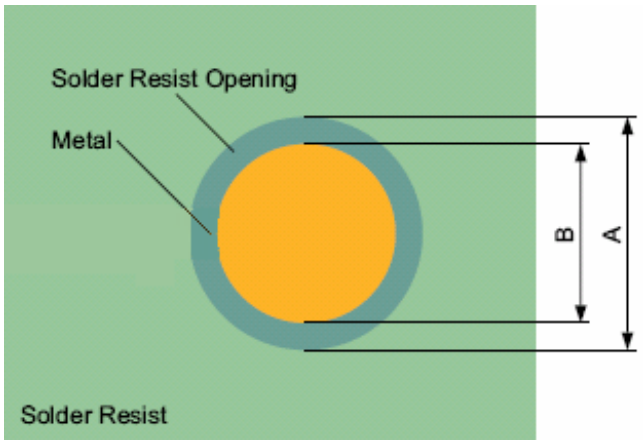
11.1.2 Stencil

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

11.1.3 PCB pad Design

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

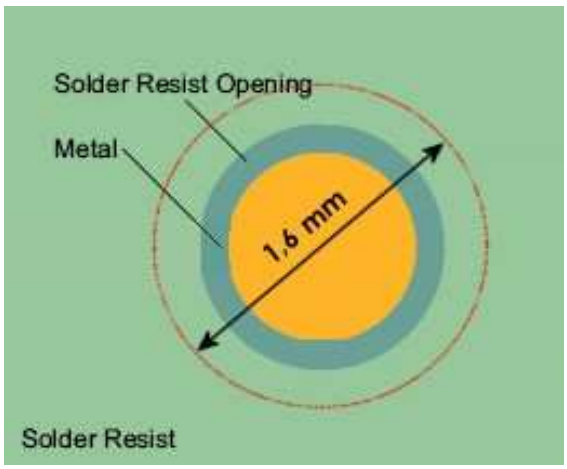




Recommendations for PCB pad dimensions

Ball pitch [mm]	2,4
Solder resist opening diameter A [mm]	1,10
Metal pad diameter B [mm]	1 ± 0.05

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



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

Recommendations for PCB pad surfaces:

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

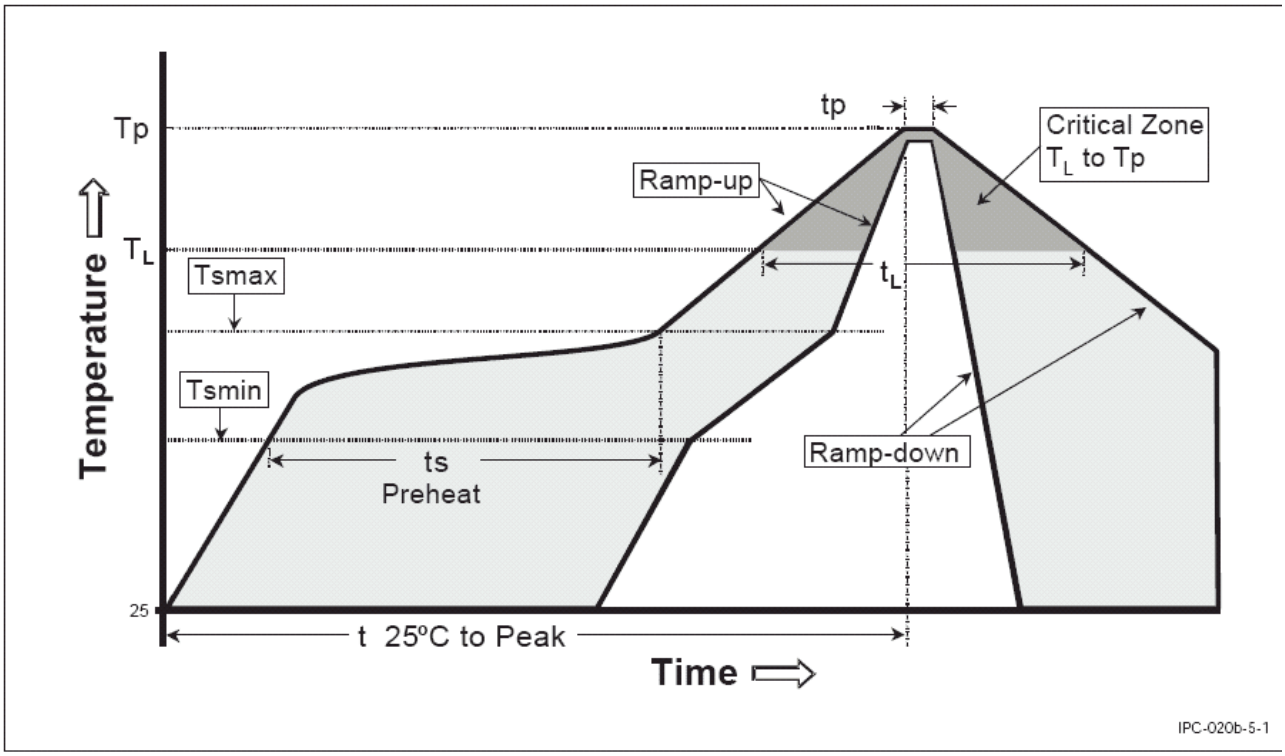
The PCB must be able to resist the higher temperatures, which are occurring at the lead-free process. This issue should be discussed with the PCB-supplier. Generally, the wet-ability of tin-lead solder paste on the described surface plating is better compared to lead-free solder paste.

11.1.4 Solder paste

	Lead free
Solder paste	Sn/Ag/Cu

11.1.5 GE863-PRO3 Solder Reflow

The following is the recommended solder reflow profile



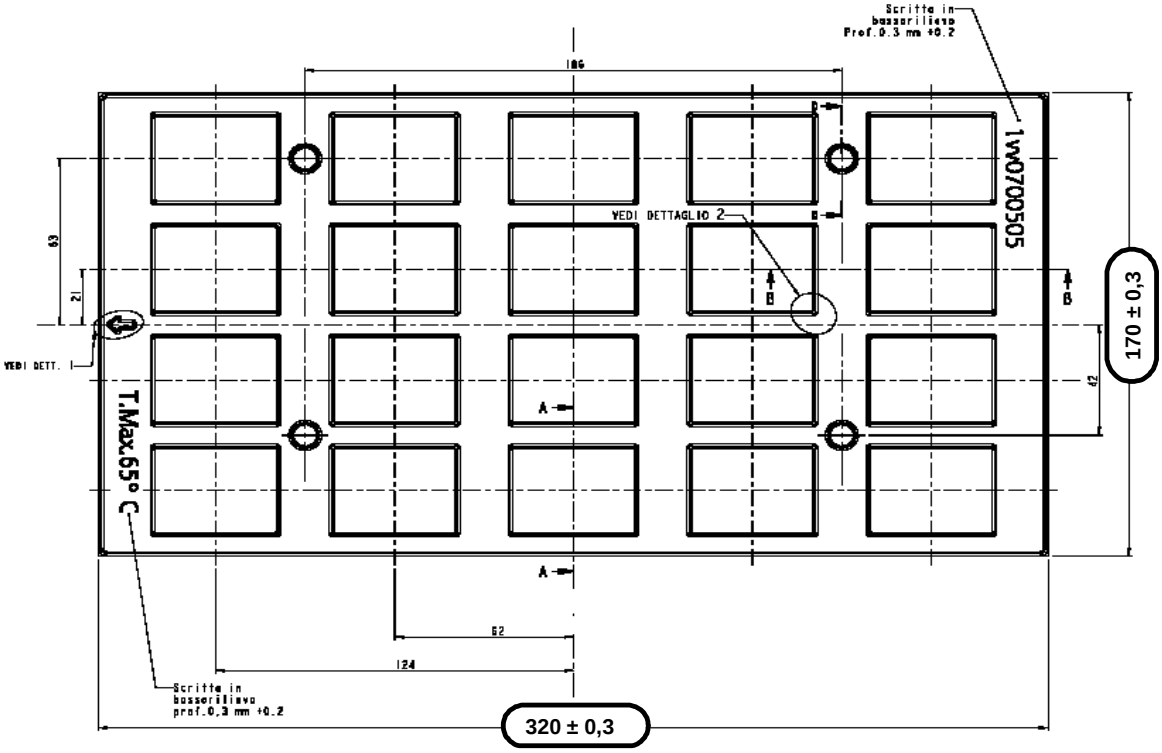
Profile Feature	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3℃/second max
Preheat: **– Temperature Min (Tsmin)** **– Temperature Max (Tsmax)** **– Time (min to max) (ts)**	 150℃ 200℃ 60-180 seconds
Tsmax to TL: **– Ramp-up Rate**	 3℃/second max
Time maintained above: **– Temperature (TL)** **–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

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

NOTE: GE863-PRO3 module can accept only one reflow process

11.1.6 Packing System

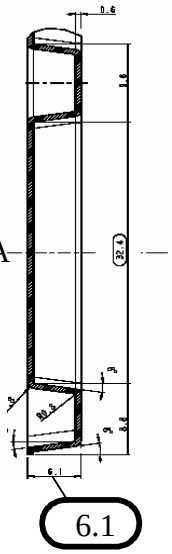
According to SMT processes for pick & place movement requirements, **Telit GE863-PRO3 modules** are packaged on trays, each tray contains 20 pieces. Tray dimensions are:



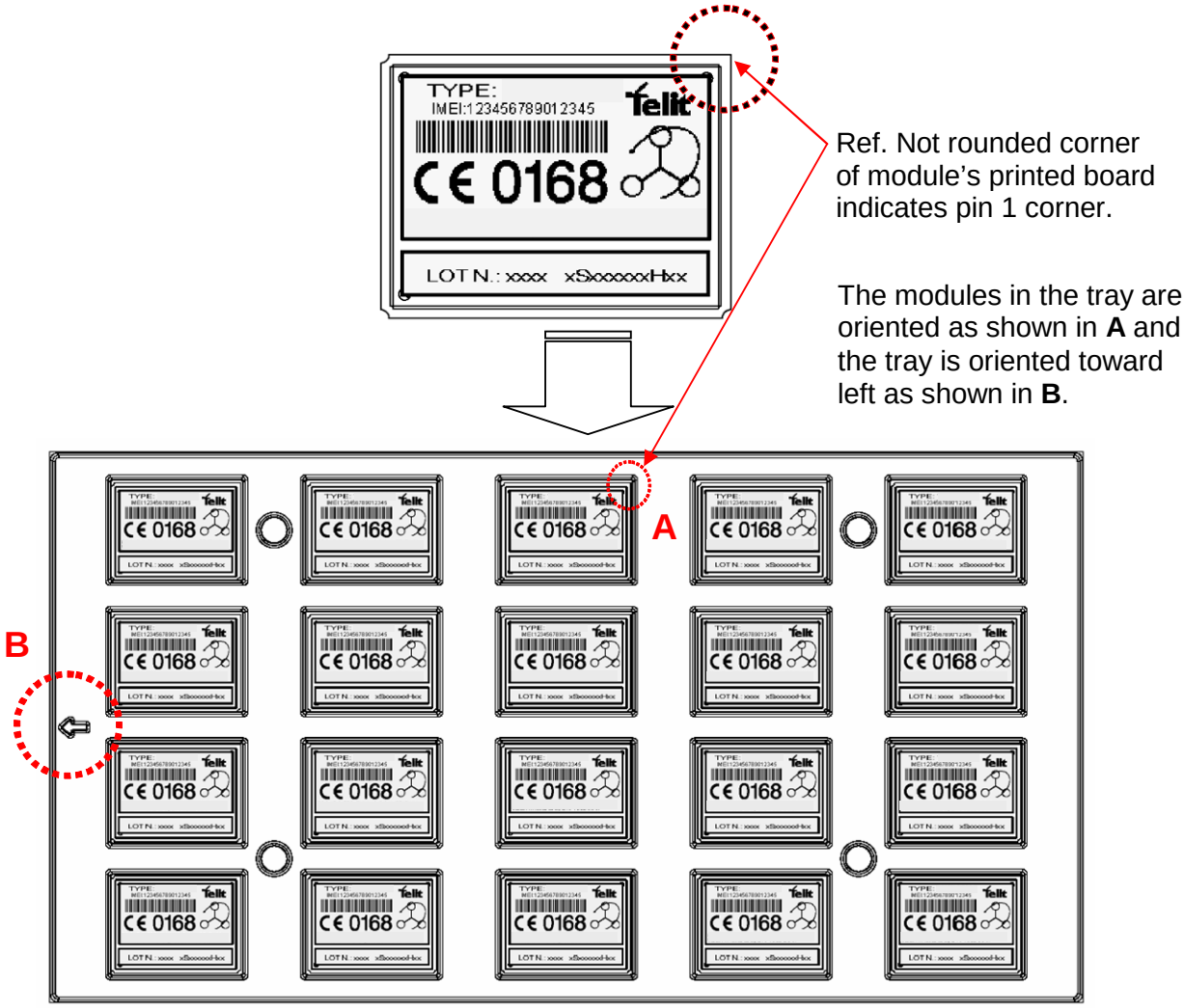
All quotes are in mm, general tolerance ± 0.1

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

Section A-A



Modules orientation on tray:



11.1.7 Moisture Sensibility

The level of moisture sensibility of **Telit GE863-PRO3 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 shall be 12 month 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℃ / 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 shall be 168 hours if the condition b) “IPC/JEDEC J-STD-033A paragraph 5.2” is respected

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

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

12 Conformity Assessment Issues

The GE863-PRO3 module is assessed to be conform to the R&TTE Directive as stand-alone product, so If the module is installed in conformance with Telit installation instructions it will require no further evaluation under Article 3.2 of the R&TTE Directive and do not require further involvement of a R&TTE Directive Notified Body for the final product.
In all other cases, or if the manufacturer of the final product is in doubt then the equipment integrating the radio module must be assessed against Article 3.2 of the R&TTE Directive**.**

In all cases assessment of the final product must be made against the Essential requirements of the R&TTE Directive Articles 3.1(a) and (b), safety and EMC respectively, and any relevant Article 3.3 requirements.

The GE863-PRO3 module is conform with the following European Union Directives:

- R&TTE Directive 1999/5/EC (Radio Equipment & Telecommunications Terminal Equipments)
- Low Voltage Directive 73/23/EEC and product safety
- Directive 89/336/EEC for conformity for EMC

In order to satisfy the essential requisite of the R&TTE 99/5/EC directive, the GE863-PRO3 module is compliant with the following standards:

- GSM (Radio Spectrum). Standard: EN 301 511 and 3GPP 51.010-1
- EMC (Electromagnetic Compatibility). Standards: EN 301 489-1 and EN 301 489-7
- LVD (Low Voltage Directive) Standards: EN 60 950

In this document and the Hardware User Guide, all the information you may need for developing a product meeting the R&TTE Directive is included.

Furthermore the **Telit GE863-PRO^3 modules** are FCC Approved as module to be installed in other devices. These devices have 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 ID is required.

The GE863-PRO3 module is conform with the following US Directives:

- Use of RF Spectrum. Standards: FCC 47 Part 24 (GSM850 - GSM 1900)
- EMC (Electromagnetic Compatibility). Standards: FCC47 Part 15

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Telit Communications S.p.A. may void the user's authority to operate the equipment.

To meet the FCC's RF exposure rules and regulations:

- The system antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all the persons and must not be co-located or operating in conjunction with any other antenna or transmitter.
- The system antenna(s) used for this module must not exceed 3 dBi for mobile and fixed or mobile operating configurations.

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.

The **Telit GE863-PRO^3 module** complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- this device may not cause harmful interference, and
- this device must accept any interference received, including interference that may cause undesired operation.

For questions regarding your product or this FCC declaration, contact:

Telit wireless solutions Inc.
Americas

3131 RDU Center Drive,
USA – 27560 Morrisville, NC 27560, USA
Phone: +1 888 846 9773
Fax: + 1 888 846 9774
e-mail: americas.info@telit.com

To identify this product, refer to the Part, Series, or Model number found on the product.

13 SAFETY RECOMMANDATIONS

READ CAREFULLY

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

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

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

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

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

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

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

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

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

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

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

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

14 Document Change Log

Revision	Date	Changes
ISSUE #0	21/01/08	First release
ISSUE #1		11 - Mounting the GE863-PRO3 on the Application Board – updated 12 - Conformity Assessment Issues updated

GE863-PRO^3 Product Description

80285ST10036a Rev. 1 DRAFT- 24/04/08

Making machines talk.

This document is relating to the following products:

GE863-PRO^3 3 990 250 691

Contents

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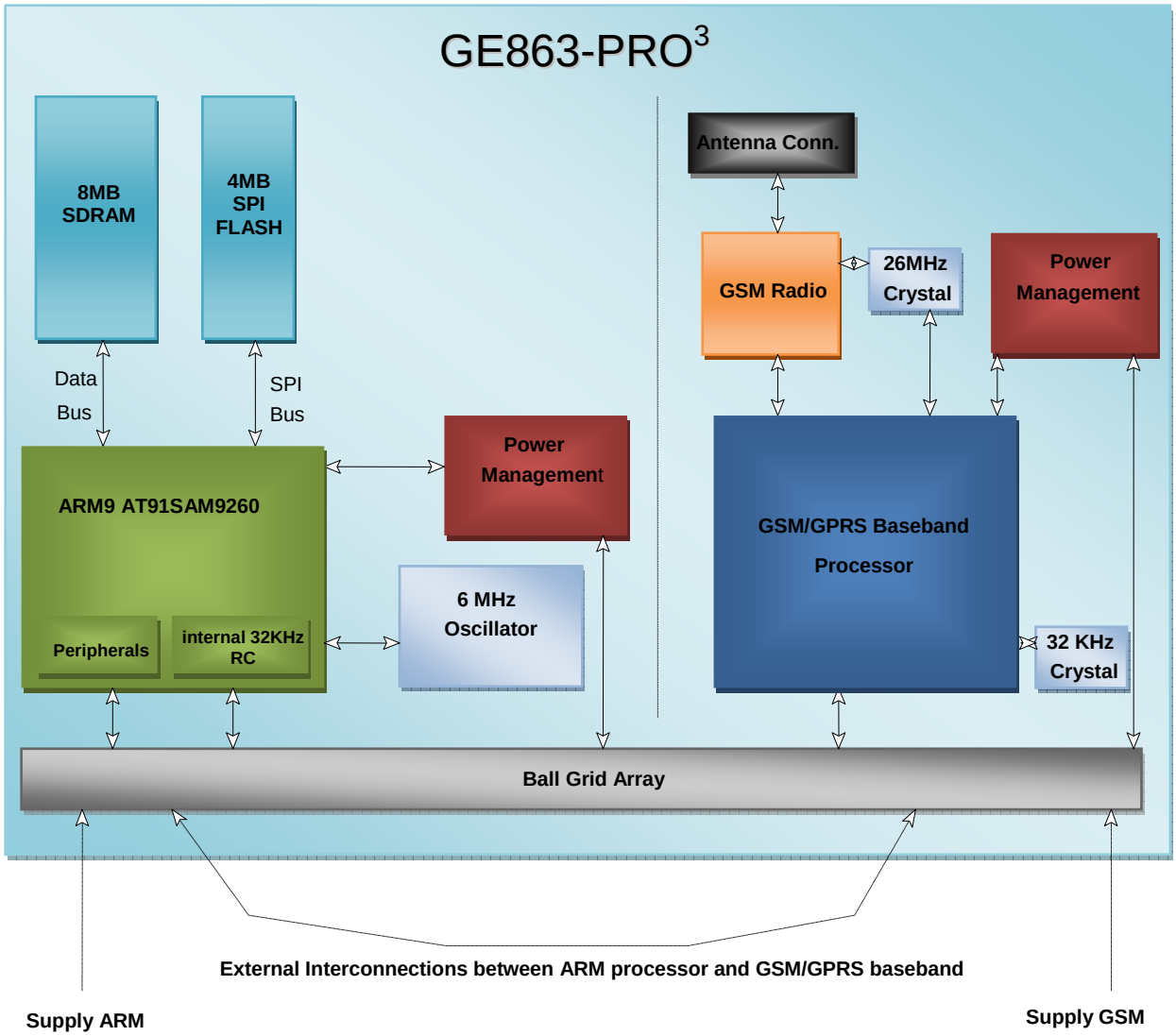
1 Overview

The GE863-PRO^3 is the Telit latest product generation deriving from the top reliable BGA GE863 product family now including a quad-band GSM/GPRS class 10 engine as well as a dedicated ARM9 application processor (the ATMEL standard microcontroller AT91SAM9260) and FLASH & RAM memories.



This innovative dual core architecture allows one consistent product for all global GSM networks that is also capable of managing complex and demanding customer applications, giving impressive advantages in terms of

- ☑ final application time-to-market
- ☑ final application cost reduction by saving R&D, approvals & certifications, logistic & production costs
- ☑ production yield by BoM part count reduction
- ☑ optimization of final application total cost of ownership (increased reliability of integrated architecture compared to the discrete one)
- ☑ final application overall dimension (exploiting the compact telit design)

The proven unique Telit Ball-Grid-Array (BGA) package concept enables a very low profile and a small product size to design extremely compact applications using location technology. Since all connectors are eliminated, the solution cost is significantly reduced compared to conventional mounting concepts.

Furthermore thanks to the successful cooperation with ATMEL, the dimensions of the ARM package have been considerably decreased so that our clients can reduce the dimensions of the entire system that integrates GPRS, the additional processor and the memories, giving a competitive advantage in comparison to a non integrated architecture and maintaining at the same time the flexibility of a standard ATMEL ARM9 product (AT91SAM9260)

With its low profile design and extended programming capabilities in C++ and/or Python, fast ROM and RAM plus power management, 4MB serial flash (expandible) and 8MB SDRAM (standard) expandable up to 64MB for custom designs, the Telit GE863-PRO^3 is the perfect and complete hardware platform for all compact complex and individual customer solutions.

Interfaces such as SPI, IIC, SD/MMC and USB give connectivity to external peripherals (camera, keyboard, display), complementary short range wireless technologies (Wi-Fi, Bluetooth, ZigBee) and position location technology (GPS) for which Telit can offer you complete reference designs.

The ARM core also includes real-time OS (LINUX), multitasking and fully available 200MIPS, fundamental for complex and demanding real-time applications. However Telit can also provide products without operating system giving with these an unlimited possibility for clients who want to use their own system environment on our modules.

As a part of Telit's corporate policy of environmental protection, all products comply to the RoHS (Restriction of Hazardous Substances) directive of the European Union (EU Directive 2002/95/EG).

Other than the above mentioned features, the Telit dual-core GE863-PRO^3 maintains the following functionalities:

- **EASY GPRS (AT driven embedded TCP/IP protocol stack, including FTP client)**
- **EASY SCAN (full GSM frequency scanning)**
- **JAMMING DETECT & REPORT (detect the presence of disturbing devices)**

- **CMUX**
- **SAP (SIM Access Profile)**
- **Multisocket**

From the interface point of view, the GE863-PRO^3 provides the following:

- **1 Full GSM engine RS232 UART, CMOS level (ASC0) interface for AT commands:**
  - **Auto-bauding from 2.4 up to 57.6 Kbps**
  - **Fixed baud rate up to 115.2 Kbps**
- **1 FULL ARM9 RS232 USART, CMOS level (UART0) interface for AT command drive**
- **3 Four wires ARM9 RS232 USART, CMOS level**
- **2 Two wires ARM9 RS232 UART, CMOS level**
- **2 ARM9 SPI interfaces for up to 18 slaves**
- **1 ARM9 Image Sensor Interface ITU-B 601/656**
- **1 ARM9 IIC bus**
- **1 ARM9 ISO7816 T0/T1 SAM/Smartcard interface**
- **1 ARM9 SD/MMC Multimedia Card Interface**
- **1 ARM9 Synchronous Serial Controller (I2S) interface for digital audio**
- **1 ARM9 Ethernet controller**
- **4 ARM9 ADC with ADC trigger input**
- **6 ARM9 DAC (PWM)**
- **1 ARM9 USB Device port**
- **2 ARM9 USB Host port**
- **2 ARM9 clock output pins**
- **1 ARM9 Debug Trace Serial port**
- **1 ARM9 JTAG debug port**
- **2 analog GSM audio path**
- **SIM card interface, 3 volts and 1.8 volts**
- **90 ARM9 + 9 GSM GPIO ports (max)**
- **1 GSM buzzer output**
- **1 GSM alarm output**
- **1 GSM led status output indicator**

In order to meet the competitive OEM and vertical market stringent requirements, Telit supports its customers with a dedicated Technical Support Policy with:

- **Telit GE863-PRO^3 Evaluation Kit** to help you to develop your application;
- a Website with all updated information available;

- a high level technical support to assist you in your development;

For more updated information concerning product Roadmap and availability, technical characteristics, commercial and other issues, please check on the Telit website www.telit.com > Products > Modules.

NOTE: Some of the performances of the **Telit GE863-PRO^3 modules** depend on the SW version installed on the module itself.
The **Telit GE863-PRO^3 SW** group is continuously working in order to add new features and improve the overall performances.
The **Telit GE863-PRO^3 modules** are easily upgradeable by the developer using the **Telit GE863-PRO^3 module** Flash Programmer.

2 General Product Description

The **Telit GE863-PRO^3 module** includes the GSM/GPRS engine plus a dedicated ARM9 application processor and memories.
The two processors [GSM/GPRS engine & Application processor] are kept as much as possible distinct: they have different power sources but with the same voltage range, so that, either power management can be optimized, by splitting GSM and application supplies, or cost can be optimized, by using the same power source to supply the two parts.
Furthermore in order to give the maximum flexibility the two engines can be operated independently each other.

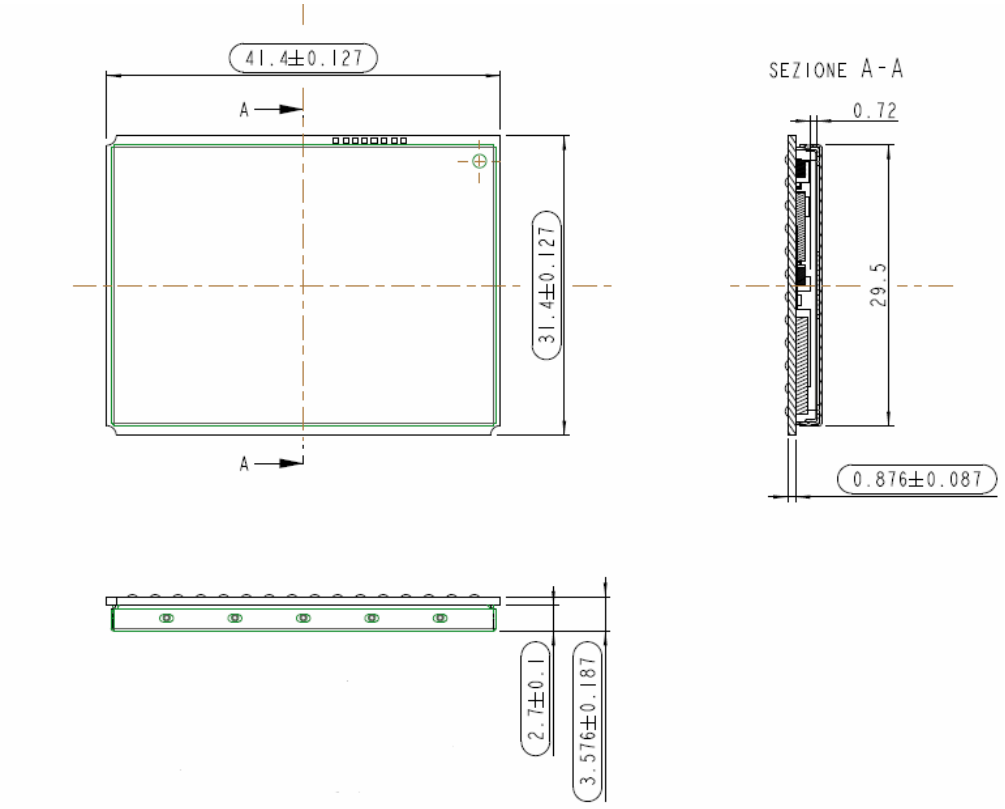
NOTE: The illustrations in this Product Description are only schematic and do not assure fidelity to construction or layout details, finishes, writings or colors.

2.1 Dimensions

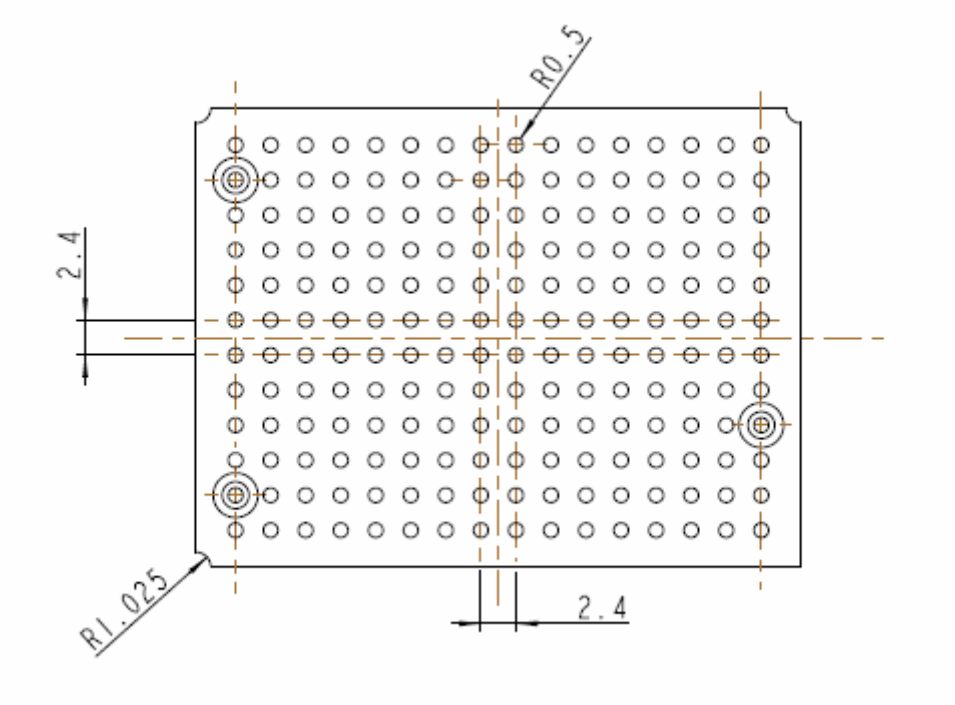
The **Telit GE863-PRO^3 module** overall dimensions are:

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

The layout of the **Telit GE863-PRO^3 module** is shown in the following figure:


41.4±0.127
A
A
31.4±0.127
SEZIONE A-A
0.72
29.5
0.876±0.087
2.7±0.1
3.576±0.187

Top View



Bottom View

2.2 Weight

The **Telit GE863-PRO3** module weight is 9 gr.

2.3 Environmental requirements

The **Telit GE863-PRO^3 module** is compliant to the applicable ETSI reference documentation GSM 05.05 Release1998.

2.3.1 Temperature range

	GE863-PRO^3
Temperature in normal operating conditions	–10℃ ÷ +55℃
Temperature in extreme operating conditions*	–35℃ ÷ +85℃ (TBD)
Temperature in not functional conditions	–40℃ ÷ +85℃

* Temperature exceeding the range of normal functional conditions can affect the sensitivity, the performance and the MTBF of the module.

2.3.2 Vibration Test (non functional)

- 10 ÷12Hz ASD = 1.92m 2 /s 3
- 12 ÷ 150Hz –3dB/oct

2.3.3 RoHS compliance

The Telit GE863-PRO^3 module family is fully compliant to EU regulation on RoHS.

3 GSM/GPRS Engine

3.1 Operating Frequency

The operating frequencies in GSM, DCS, PCS modes are conform to the GSM specifications.

Mode	Freq. TX (MHz)	Freq. RX (MHz)	Channels (ARFC)	TX - RX offset
E-GSM-900	890.0 - 914.8	935.0 - 959.8	0 – 124	45 MHz
	880.2 - 889.8	925.2 - 934.8	975 - 1023	45MHz
GSM-850	824.2 - 848.8	869.2 - 893.8	128 - 251	45 MHz
DCS-1800	1710.2 - 1784.8	1805.2 - 1879.8	512 – 885	95 MHz
PCS-1900	1850.2 - 1909.8	1930.2 - 1989.8	512 - 810	80 MHz

3.2 Transmitter output power

GSM–850 / 900

The Telit GE863-PRO3 modules in GSM–850 / 900 operating mode are of **class 4** in accordance with the specification which determine the nominal **2W** peak RF power (**+33dBm**) on 50 Ohm.

DCS–1800 / PCS–1900

The Telit GE863-PRO3 modules in DCS–1800/PCS–1900 operating mode are of **class 1** in accordance with the specifications, which determine the nominal **1W** peak RF power (**+30dBm**) on 50 Ohm.

3.3 Reference sensitivity

GSM–850 / 900

The sensitivity of the Telit GE863-PRO3 modules according to the specifications for the class 4 GSM–850/900 portable terminals is **–107 dBm** typical in normal operating conditions.

DCS–1800 / PCS-1900

The sensitivity of the Telit GE863-PRO3 modules according to the specifications for the class 1 portable terminals DCS-1800 / PCS-1900 is **–106 dBm** typical in normal operating conditions.

3.4 Antenna

3.4.1 GSM Antenna

The antenna that the customer chooses to use, should fulfill the following requirements:

Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s).
Bandwidth	70 MHz in GSM 850, 80 MHz in GSM 900, 170 MHz in DCS, 140 MHz PCS band

For further information please refer to the GE863-PRO3 Hardware User Guide.

3.5 Supply voltage

The external power supply must be connected to VBATT signal pin (see Hardware User Guide) and must fulfill the following requirements:

Nominal operating voltage	3.8 V
Operating voltage range	3.4 V – 4.2 V
Absolute Minimum voltage	3.30V
Absolute Maximum voltage	4.50 V

NOTE: Operating voltage range must never be exceeded; care must be taken in order to fulfill absolute min/max voltage requirements.

3.6 Power consumption

The typical current consumption of the GSM/GPRS part of the Telit GE863-PRO3 module is:

Power off current (typical)	< 28 µA;
Stand–by current (GSM Idle)	< 17 mA (< 4 mA using command AT+CFUN)
Operating current in voice channel	< 200 mA @ worst network conditions
Operating current in GPRS class 10	< 370 mA @ worst network conditions

The total power consumption of GE863-PRO3 is the sum of the consumptions of GSM and ARM9 processor part.

3.7 Embodied Battery charger

The battery charger is suited for a 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 typical	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 pins of the GE863-PRO3.

3.8 User Interface

The user interface of the **Telit GE863-PRO3** GSM/GPRS engine is managed by AT commands specified on the ITU-T V.250, GSM 07.07 and GSM 07.05 specifications.

3.9 Speech Coding

The **Telit GE863-PRO3 modules** voice codec supports the following rates:

- Half Rate
- Full rate
- Enhanced Full Rate
- Adaptive Multi Rate

3.10 SIM Reader

The Telit GE863-PRO3 modules support phase 2 GSM11.14 - SIM 1.8V and 3V. For 5V SIM cards, an external level translator can be added. All models need an external SIM card holder.

3.11 SMS

The Telit GE863-PRO3 modules support the following SMS types, in text and PDU mode:

- Mobile Terminated (MT) class 0 – 3 with signaling of new incoming SMS, SIM full, SMS read
- Mobile Originated class 0 – 3 with writing, memorize in SIM and sending
- Cell broadcast compatible with CB DRX with signaling of new incoming SMS.

3.12 Real Time Clock and Alarm

The Telit GE863-PRO3 modules GSM/GPRS engine support the Real Time Clock and Alarm functions through AT commands; furthermore anyone of the GSM/GPRS GPIO available can be configured as alarm output pin to indicate the alarm with a hardware line output.
The Voltage Output of the RTC power supply is provided on a pin so that a backup capacitor can be added to increase the RTC autonomy.

3.13 Data/fax transmission

The **Telit GE863-PRO3 modules** support:

- Packed Data transfer GPRS Class 10, Multi-slot Class B
- CSD up to 14.4 Kbps
- Fax service, Class 1 Group 3

3.14 Local security management

The local security management can be done with the lock of Subscriber Identity module (SIM), and security code request at power–up.

3.15 Call control

The call cost control function is supported.

3.16 Phonebook

This function allows storing of the telephone numbers in SIM memory. The capability depends on SIM version and embedded memory.

3.17 Characters management

The **Telit GE863-PRO3 modules** support the IRA character set (International Reference Alphabet), in TEXT mode and IRA/UCS2/GSM/ISO-8859-1/PCCP437 in PDU mode.

3.18 SIM related functions

The activation and deactivation of the numbers stored in phone book, FDN, ADN and PINs are supported. The extension at the PIN2 for the PUK2 insertion capability for lock condition is supported too.

3.19 Call status indication

The call status indication by AT commands is supported.

3.20 Automatic answer (Voice, Data or FAX)

After a specified number of rings, the module will automatically answer. The user can set the number of rings by means of the command ATS0=<n>.

3.21 Supplementary services (SS)

The following supplementary services are supported:

- Call Barring,
- Call Forwarding,
- Calling Line Identification Presentation (CLIP),
- Calling Line Identification Restriction (CLIR),
- Call Waiting, other party call Waiting Indication,
- Call Hold, other party Hold / Retrieved Indication,
- Closed User Group supplementary service (CUG),
- Advice of Charge,
- Unstructured SS Mobile Originated (MO)

3.22 Acoustic signalling

The acoustic signals of **Telit GE863-PRO3 modules** on the selected acoustic device are the following:

- Call waiting;
- Ringing tone;
- SMS received tone;
- Busy tone;
- Power on/off tone;
- Off Hook dial tone;
- Congestion tone;
- Connected tone;
- Call dropped;
- No service tone;
- Alarm tone.

3.23 Buzzer output

The General Purpose I/O pin GPIO7 can be configured to output the BUZZER output signal, with only an external MOSFET/transistor and a diode a Buzzer can be directly driven.
The ringing tone and the other signaling tones can be redirected to this Buzzer output with a specific AT command.

3.24 RF Transmission Monitor

As alternate function of the GPIO5, the GE863-PRO3 provide the RF transmission monitor. When the alternate function is activated, the pin of GPIO5 changes to HIGH every time the module transmits an RF signal and remains HIGH for the duration of the transmission sequence, i.e. it does not change with every GSM signal burst.

3.25 EMC

Compliant to EN301-489-1 and EN301-489-7 and all applicable GSM Specifications. Compliant to Directive 1999/05/CE.

3.26 Logic level specifications

Where not specifically stated, all the interface circuits of the GSM/GPRS engine work at 2.8V CMOS logic levels. To get more detailed information about the logic level specifications used in the **Telit GE863-PRO3** interface circuits please consult the Hardware User Guide.

3.27 Reset signal

The RESET is used to reset the GSM/GPRS engine of the **Telit GE863-PRO3 modules**. Whenever this signal is pulled low, the GSM/GPRS engine is rebooted. When the device is reset it stops any operation. After the release of the reset the GSM/GPRS engine is unconditionally rebooted, without doing any detach operation from the network where it is registered to. This behavior is not like a proper shut down because any GSM device is requested to issue a detach request on turn off. For this reason the Reset signal must be used only as an emergency exit in the rare case the device remains stucked waiting for some network response.

NOTE: do not use this signal to power off the Telit GE863-PRO3 module. Use the ON/OFF signal to perform this function or the AT#SHDN command.

3.28 RTC Bypass out

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

3.29 VAUX1 power output

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

Operating Range – VAUX1 power supply

	Min	Typical	Max
Output voltage	2.75V	2.85V	2.95V
Output current			100mA / 50mA
Output bypass capacitor			2.2µF

3.30 Audio levels specifications

The audio of the **Telit GE863-PRO3 modules** is organized into two main paths:

- Internal path (called also MT)
- External path (called also HF)

These two paths are meant respectively for handset and headset/hands-free use.

The **Telit GE863-PRO3 modules** have a built in echo canceller and a noise suppressor, tuned separately for the two audio paths; for the internal path the echo canceller parameters are suited to cancel the echo generated by a handset, while for the external audio path they are suited for a hands-free use.

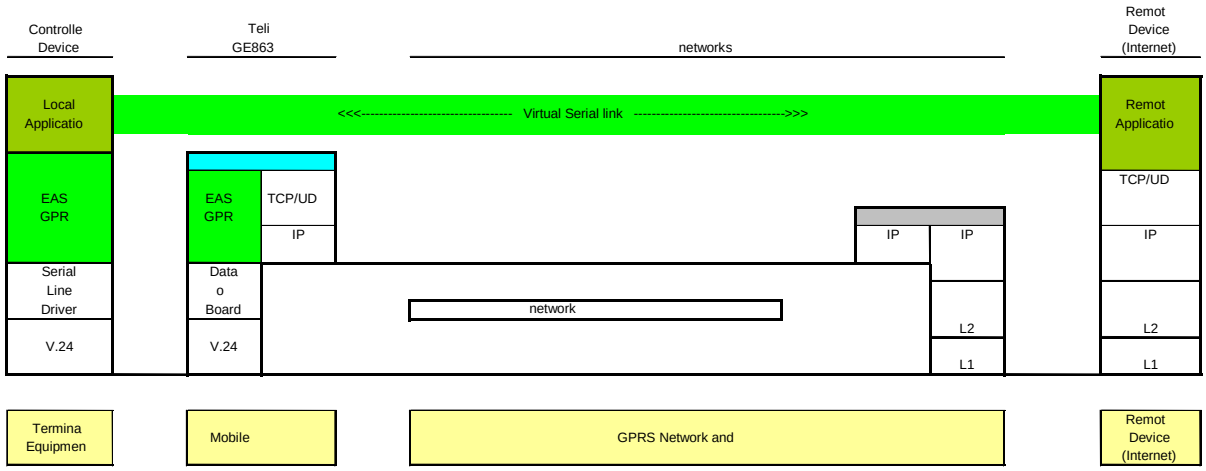
For more information on the audio refer to the GE863-PRO3 Hardware User Guide.

3.31 Software Features

3.31.1 Enhanced Easy GPRS Extension

3.31.1.1 Overview

The Easy GPRS feature allows a **Telit GE863-PRO3 modules** user to contact a device in Internet and establish with it a raw data flow over the GPRS and Internet networks.
This feature can be seen as a way to obtain a "virtual" serial connection between the Application Software on the Internet machine involved and the controller of the **Telit GE863-PRO3 modules**, regardless of all the software stacks underlying.
An example of the protocol stack involved in the devices is reported:



This particular implementation allows to the devices interfacing to the **Telit GE863-PRO3 modules** the use of the GPRS and Internet packet service without the need to have an internal TCP/IP stack since this function is embedded inside the module.
Easy GPRS overcomes some of the known limitations of the previous implementation and implements some new features such as:

- Keep the GPRS context active even after the closing of a socket, allowing the application to keep the same IP address;
- Also Mobile terminated (incoming) connections can be made, now it is possible to receive incoming TCP connection requests;

- A new internal firewall has been implemented in order to guarantee a certain level of security on internet applications.

3.31.1.2 Easy GPRS definition

The Easy GPRS feature provides a way to replace the need of an Internet TCP/IP stack at the terminal equipment side. The steps that will be required to obtain a virtual serial connection (that is actually a socket) to the Internet peer are:

- Configuring the GPRS Access
- Configuring the embedded TCP/IP stack behavior
- Defining the Internet Peer to be contacted
- Request the GPRS and socket connections to be opened (host is connected)
- Exchange raw data
- Close the socket and GPRS context

All these steps are achieved through AT commands.

As for common modem interface, two logical statuses are involved: command mode and data traffic mode:

- In Command Mode (CM), some AT commands are provided to configure the Data Module Internet stack and to start up the data traffic.
- In data traffic mode (Socket Mode, SKTM), the client can send/receive a raw data stream which will be encapsulated in the previously configured TCP / IP packets which will be sent to the other side of the network and vice versa. Control plane of ongoing socket connection is deployed internally to the module.

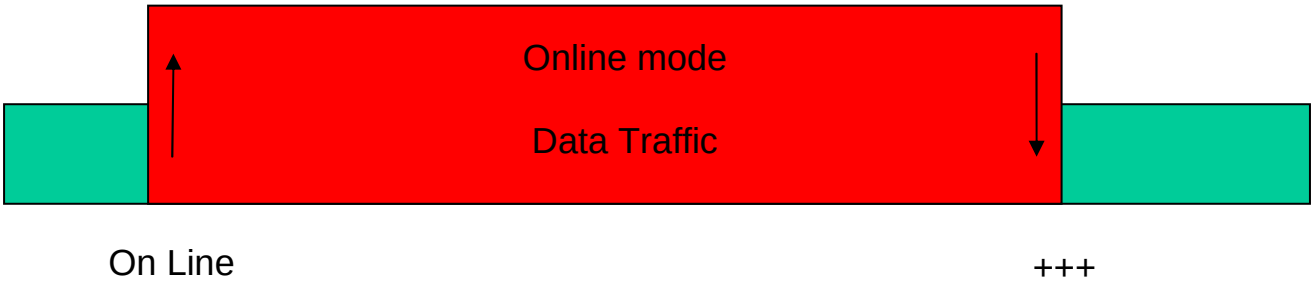
For more detailed information regarding GPRS please consult Easy GPRS User Guide and AT Commands Reference Guide.

3.31.2 Multisocket

New functionality of the Telit modules, multisocket is an extension of Telit Easy GPRS feature, which allows the user to have two contexts activated (that means two different IP address), more than one socket connection (with a maximum of 6) and simultaneous FTP client service.

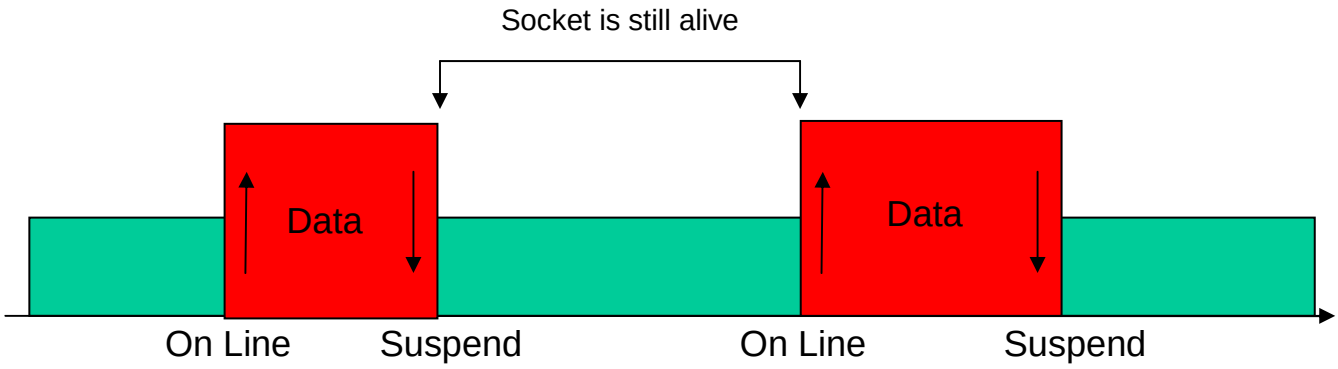
The basic idea of multisocket is the possibility of suspend a socket connection with the escape sequence +++.

With IP Easy we can use a SKTD to open a socket connection and go online. After online activities we use +++ sequence to close the connection (see the figure below).



Where the green part represents the module command mode while the red part is the online mode.

Now, the online mode can be suspended with the escape sequence by using the multisocket feature. During suspend mode the data received by the socket will be buffered. These data will be displayed after socket resumption, as shown in the figure below:



This new feature allows the user to switch between online mode and command mode without closing the connection and eventually opening another socket (or resuming the suspended one) or FTP connection.

Another feature is the possibility to associate any socket connection to a specific context, this means that we can use different IP addresses for the connections (max 2). Socket identifier is called Connection Id (selects which socket we want to use from 1 up to 6) and every Connection Id is associated to a context.

For more detailed information please consult Multisocket User Guide.

3.31.3 Jammed Detect & Report Extension

3.31.3.1 Overview

The Jammed Detect & Report feature allows a **Telit GE863-PRO3 module** to detect the presence of a disturbing device such as a Communication Jammer and give indication to the user and/or send a report of that to the network.

This feature can be very important in alarm, security and safety applications that rely on the module for the communications. In these applications, the presence of a Jammer device can compromise the whole system reliability and functionality and therefore shall be recognized and reported either to the local system for countermeasure actions or to the network providing remote actions.
An example scenario could be an intrusion detection system that uses the module for sending the alarm indication for example with an SMS to the system owner, and thief incomes using a Jammer to prevent any communication between the GSM module and the network.

In such a case, the module detects the Jammer presence even before the break in and can trigger an alarm siren, other communication devices (PSTN modem) or directly report this condition to the network that can provide further security services for example sending SMS to the owner or police. Obviously this last service depends also from network infrastructure support and it may not be supported by some networks.

3.31.4 CMUX

CMUX (Converter-Multiplexer) is a multiplexing protocol implemented in the Telit module that can be used to send any data, SMS, fax, TCP data.

3.31.4.1 Product architecture

The Multiplexer mode enables one serial interface to transmit data to four different customer applications. This is achieved by providing four virtual channels using a Multiplexer (Mux).

This is especially advantageous when a fax/data/GPRS call is ongoing. Using the Multiplexer features, e.g. controlling the module or using the SMS service can be done via the additional channels without disturbing the data flow; access to the second UART is not necessary.

Furthermore, several accesses to the module can be created with the Multiplexer. This is of great advantage when several independent electronic devices or interfaces are used.

To access the three virtual interfaces, both the GSM engine and the customer application must contain Mux components, which communicate over the multiplexer protocol.

In Multiplexer mode, AT commands and data are encapsulated into packets. Each packet has channel identification and may vary in length.

3.31.4.2 Implementation feature and limitation

- 7.10 CMUX Basic Option used
- CMUX implementation support four full DLCI (Serial Port)
- CMUX can operate only at Fixed rate, if AT+CMUX is sent with IPR=0 an Error is returned, with a maximum rate of 115200
- Every instance has its own user profile storage in NVM
- Independent setting of unsolicited message.
- In case of GPS product one serial port can be dedicated to NMEA output.
- Every Instance has its own independent flow control.

NOTE: More details about the Multiplexer mode are available in the Cmux User Guide.

3.31.5 SAP: SIM Access Profile

3.31.5.1 Product architecture

The SAP feature allow the module to use the SIM of a remote SIM Server. This feature is implemented using special AT Command on a Virtual circuit of the CMUX interface.

3.31.5.2 Implementation feature

- SAP is based on 7.10 CMUX Basic Option used
- Only SAP Client features
- Logic HW flow control is recommended on the Virtual instance selected for the SAP command.

3.31.5.3 Remote SIM Message Command Description

The module sends request commands to the client application through a binary message that is crowned in the CMUX message. The client application shall extract the message and send it to the SAP server, through the appropriate protocols (e.g. by RFCOMM, that is the Bluetooth serial port emulation entity).
The client application shall extract all the messages sent by SAP server and put them in the CMUX message, to sent to the module.

The module satisfies the following feature requirements:

- Connection management
- Transfer APDU
- Transfer ATR
- Power SIM on
- Report Status
- Error Handling

Every feature needs some procedures support:

Feature	Procedure
Connection Management	Connect
	Report Status
	Transfer ATR
	Disconnection Initiated by the Client
	Disconnection Initiated by the Server
Transfer APDU	Transfer APDU
Transfer ATR	Transfer ATR
Power SIM on	Power SIM on

	Transfer ATR
Report Status	Report Status
Error Handling	Error Response

Report Status, Disconnection Initiated by the Server and Error Response are independent messages sent by server. The other procedures consist of couples of messages, started by client.

NOTE: More details about the SAP are available in the SAP User Guide.

3.31.6 AT Commands

The **Telit GE863-PRO3 modules** can be driven via the serial interface using the standard AT commands[1].

The Telit GE863-PRO3 modules are compliant with:

- Hayes standard AT command set, in order to maintain the compatibility with existing SW programs.
- ETSI GSM 07.07 specific AT command and GPRS specific commands.
- ETSI GSM 07.05 specific AT commands for SMS (Short Message Service) and CBS (Cell Broadcast Service)
- FAX Class 1 compatible commands

Moreover the **Telit GE863-PRO3 modules** support also Telit proprietary AT commands for special purposes.
For a detailed description of GE863 modules AT Commands refer to document AT Commands Reference Guide, code 80000ST10025a.

[1] The AT is an ATTENTION command and is used as a prefix to other parameters in a string. The AT command combined with other parameters can be set up in the communications package or typed in manually as a command line instruction.

4 ARM9 Application Engine

4.1 General Description

The Application engine is an ATMEL AT91SAM9260 and comprises an ARM926EJ-S processor with fast ROM and RAM plus power management and 8Mbyte SDRAM 100MHz and a 4Mbyte serial flash.
The ARM926EJ-S has a full set of peripherals ranging from several USART to the USB Host controller, allowing almost any connectivity to be achieved.
The ARM has two clock sources, a 6MHz crystal oscillator clock source providing the main clock that can be multiplied up to 200MHz and the internal RC slow clock source providing 32KHz. If more accuracy in the 32KHz clock is needed, then an external 32KHz crystal can be added.

4.2 Supply voltage

The external power supply must be connected to VBATT2 signal pin (see Hardware User Guide) and must fulfill the following requirements:

Nominal operating voltage	3.8 V
Operating voltage range	3.4 V – 4.2 V
Absolute Minimum voltage	3.30V
Absolute Maximum voltage	4.50 V

NOTE: Operating voltage range must never be exceeded; care must be taken in order to fulfill absolute min/max voltage requirements.

4.3 Power consumption

The typical current consumption of the ARM9 part of the **Telit GE863-PRO3 module** is:

Power off current (typical)	< 1.5 µA
Stand–by current @ slow clocking	1 mA [TBD]
Operating current typical @ 200MHz	140 mA [TBD]

The total power consumption of GE863-PRO3 is the sum of the consumptions of GSM and ARM9 processor part.

4.4 USARTs

The Application processor has 1 Full (9 wires) RS232 USART , 3 USART with Hardware Flow Control, 2 two wire UARTs.

4.5 SPI bus

The Application processor has 2 set of Serial Peripheral Interfaces buses, SPI0 and SPI1. Each of these SPI bus has four Chip Select lines, that can be encoded to provide access to 15 peripherals [with external CS decoding].
The CS1 of the SPI0 bus is internally connected to the Serial Flash, hence SPI0 cannot use encoded CS and therefore only 3 other devices can be connected to the SPI0 interface. SPI1 bus can use the encoding.
The SPI busses support Master, Multiple Master or Slave mode.

The SPI bus consists of two data lines and two control lines:

• Master Out Slave In (MOSI): This data line supplies the output data from the master shifted into the input(s) of the slave(s).
• Master In Slave Out (MISO): This data line supplies the output data from a slave to the input of the master. There may be no more than one slave transmitting data during any particular transfer.
• Serial Clock (SPCK): This control line is driven by the master and regulates the flow of the data bits. The master may transmit data at a variety of baud rates; the SPCK line cycles once for each bit that is transmitted.
• Chip Select (NPCS): This control line allows slaves to be turned on and off by hardware.

All combinations of Clock Polarity (CPOL) and Clock Phase (CPHA) is supported by the bus.

4.6 Image Sensor Interface

The Image Sensor Interface (ISI) connects a CMOS-type image sensor to the processor and provides image capture in various formats. It does data conversion, if necessary, before the storage in memory through DMA.
The ISI supports color CMOS image sensor and grayscale image sensors with a reduced set of functionalities.

It supports two modes of synchronization:

- Hardware with ISI_VSYNC and ISI_HSYNC signals
- International Telecommunication Union Recommendation ITU-R BT.656-4 Startof-Active-Video (SAV) and End-of-Active-Video (EAV) synchronization sequence.

Using EAV/SAV for synchronization reduces the pin count (ISI_VSYNC, ISI_HSYNC are not used).
The polarity of the synchronization pulse is programmable to comply with the sensor signals.

4.7 IIC bus

The IIC bus interconnects components on a two-wire bus, made up of one clock line and one data line with speeds of up to 400 Kbits per second, based on a byte-oriented transfer format.
The IIC is programmable as a master or a slave with sequential or single-byte access. Multiple master capability is supported. Arbitration of the bus is performed internally and puts the IIC in slave mode automatically if the bus arbitration is lost.
A configurable baud rate generator permits the output data rate to be adapted to a wide range of core clock frequencies.

4.8 ISO7816 T0/T1 Interface

The ARM9 USART can be used according to ISO7816 T0/T1 operating mode. This mode permits interfacing with Smart cards and Security Access Modules (SAM) communicating through an ISO7816 link. Both T = 0 and T = 1 protocols defined by the ISO7816 specification are supported.

4.9 MultiMedia Card interface

The Application processor provides a full MCI interface.
The MultiMedia Card Interface (MCI) supports the MultiMedia Card (MMC) Specification V3.11, the SDIO Specification V1.1 and the SD Memory Card Specification V1.0. The MCI operates at a rate of up to 100 MHz and supports the interfacing of 2 slot(s).
Each slot may be used to interface with a MultiMediaCard bus (up to 30 Cards) or with a SD Memory Card. Only one slot can be selected at a time (slots are multiplexed).
The SD Memory Card communication is based on a 9-pin interface (clock, command, four data and three power lines) and the MultiMedia Card on a 7-pin interface (clock, command, one data, three power lines and one RFU).
The SD Memory Card interface also supports MultiMedia Card operations.

4.10 Sinchronous Serial Controller

The application processor provides a Sinchronous serial controller that can support several serial synchronous communication protocols such as: I2S, Short Frame Sync, Long Frame Sync.
With this peripheral the processor can be interfaced with Audio Codecs, Fast DAC, Fast ADC.

4.11 Ethernet controller

The Application processor provides an Ethernet controller compatible with the 10Mb/s -100Mb/s IEEE 802.3 standard that can be used to interface the Telit GE863-PRO3 to a LAN. It fully supports Media Independent Interface (MII) or Reduced Media Independent Interface (RMII) standards to PHY transceivers with MDIO controlling interface.

4.12 ADC with ADC trigger

The application processor provides an Analog Digital Converters with an ADC trigger input and a 4-to-1 analog multiplexer, making possible the conversion of up to 4 analog lines.
The characteristic of the ADC are:

	Min	Max	Units
Voltage range	3.0	3.1	Volt
AD conversion	8	10	bits
ADC clock frequency	0	5	MHz
Max sampling rate		312	kS per second

4.13 DAC Converter

The Application processor is able to generate a PWM signal based on a specific percentage of duty cycle decided by the user. An external filter is necessary to convert the PWM signal into a constant voltage.

	Min	Max	Units
Voltage range	3.0	3.1	Volt
Duty Cycle range	0	100	%
Resolution	1	1	%

4.14 USB Device port

The application Processor provides one USB Device port compliant to the Universal Serial Bus (USB) V2.0 full-speed device specifications.

4.15 USB Host port

The application Processor provides two USB Host ports compliant to the Universal Serial Bus (USB) V2.0 full-speed and low speed specifications and to the Open Host Controller Interface (OHCI) standard.
The USB Host Port integrates a root hub and transceivers on downstream ports. It provides several high-speed half-duplex serial communication ports at a baud rate of 12 Mbit/s.
Up to 127 USB devices and the USB hub can be connected to the USB host in the USB “tiered star” topology.

4.16 Clock outputs

The Application processor provides two programmable clock outputs that can output:

- Slow clock
- Main Clock
- PLLA clock
- PLLB clock

With a prescaler that can divide the source clock by a factor ranging from 1 to 64.

4.17 GPIO ports

The Application processor provides 90 General Purpose I/O multiplexed with the peripheral pins.
This pins can be moved with the Parallel I/O (PIO) controller in blocks of 32 pins or manually one by one.
Each IO pin can be fully configured as Input, Output, Open Drain or not, with or without internal Pull-ups, with or without Input Glitch filter.

4.18 JTAG Debug Interface

The application processor provides a JTAG interface for debugging compatible with IEEE1149.1 JTAG Boundary-scan protocol.

4.19 Debug UART

The application processor supports also a debug UART that can support the Debug Communication Channel (DCC) protocol.

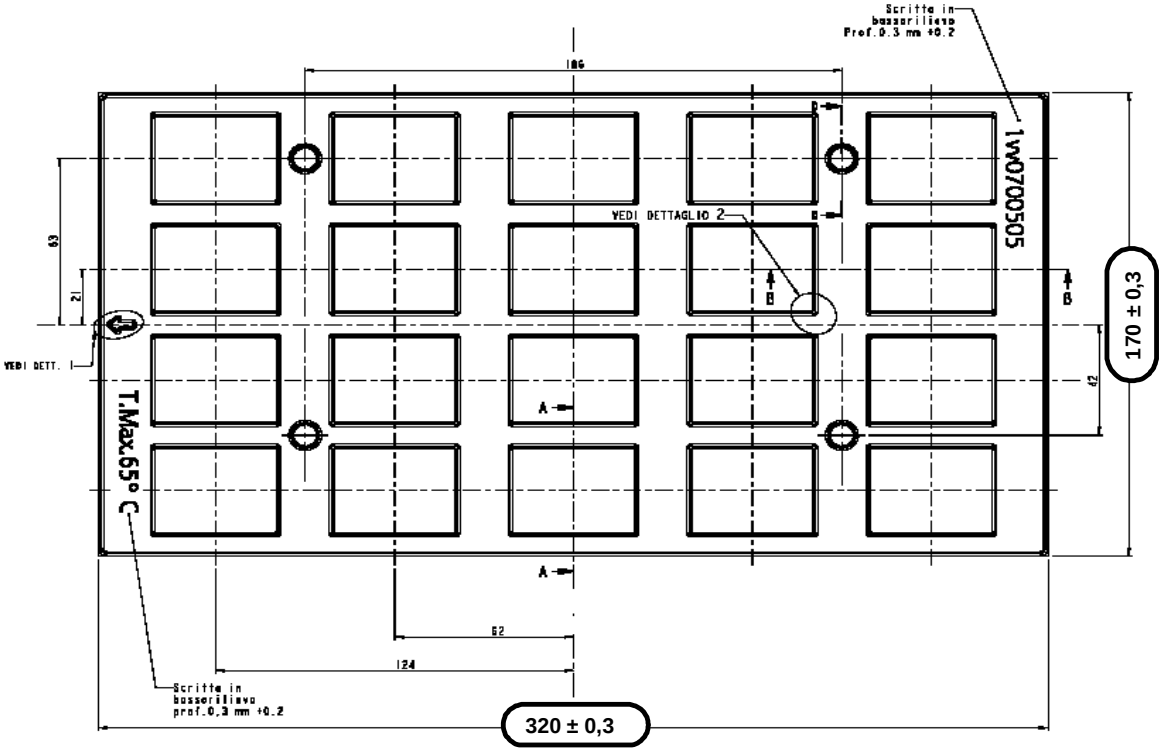
5 Mounting the GE863-PRO^3 on the Application Board

5.1.1 General

The **Telit GE863-PRO^3 module** has been designed in order to be compliant with a standard lead-free SMT process. For detailed information about PCB pad design and conditions to use in SMT process please consult Hardware User Guide.

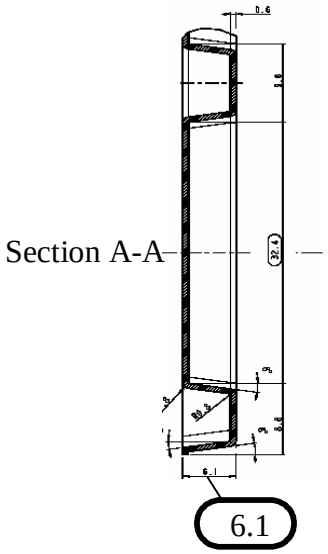
5.1.2 Packing system

According to SMT processes for pick & place movement requirements, **Telit GE863-PRO^3 modules** are packaged on trays, each tray contains 20 pieces. Tray dimensions are:

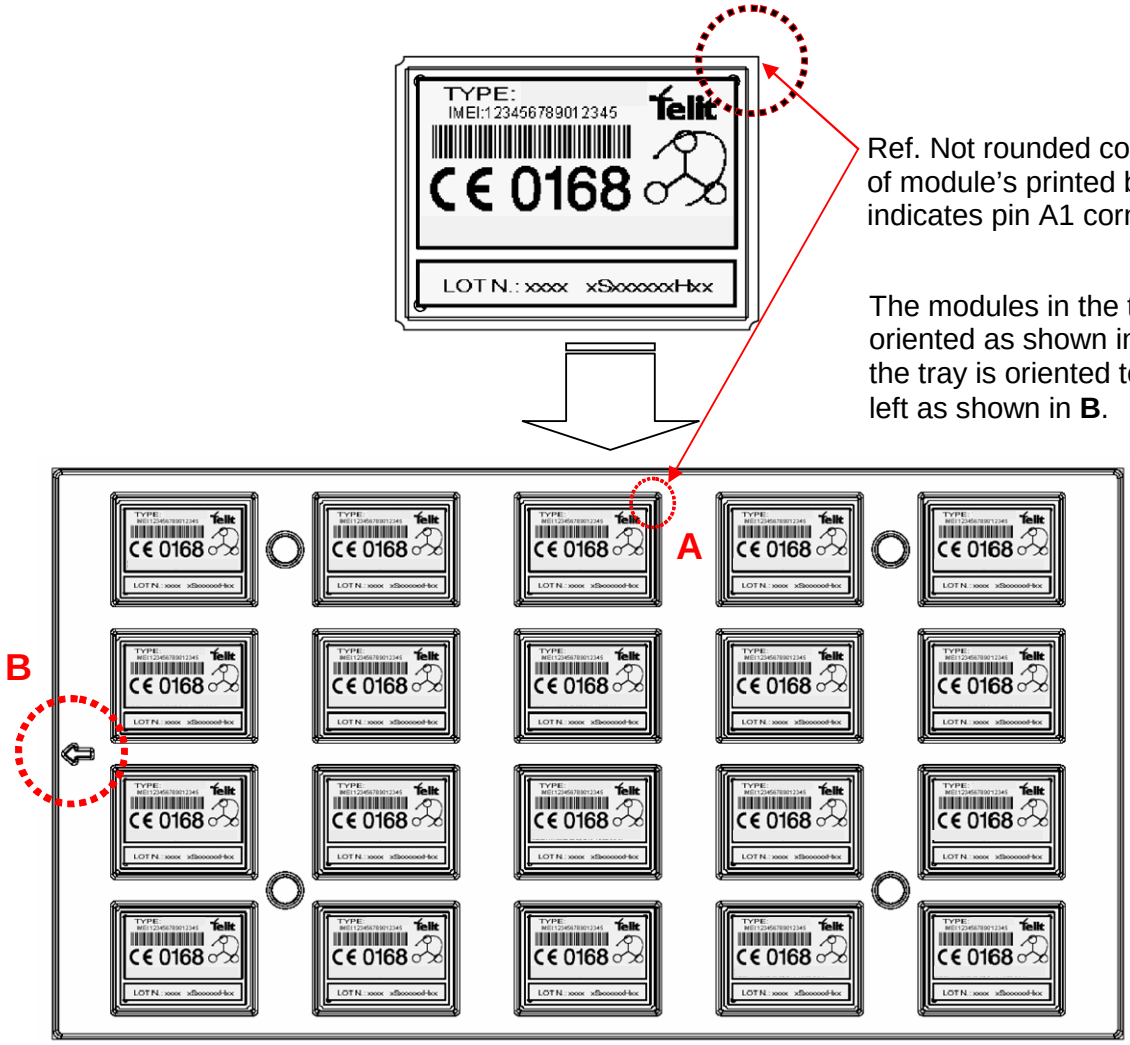


All quotes are in mm, general tolerance ± 0.1

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



Modules orientation on tray:



6 Evaluation Kit EVK-PRO3

In order to assist you in the development of your **Telit GE863-PRO3 module** based application, Telit can supply an **Evaluation Kit EVK-PRO3** with appropriate power supply, SIM card holder, RS232 serial port level translator and USB host & device, SD Card holder, SAM Card holder, Ethernet and antenna connection.

The development of the applications utilizing the **Telit GE863-PRO3 module** must present a proper design of all the interfaces towards and from the module (e.g. power supply, audio paths, level translators), otherwise a decrease in the performances will be introduced or, in the worst case, a wrong design can even lead to an operating failure of the module.

In order to assist the hardware designer in his design phase, the EVK board presents a series of different solutions, which will cover the most common design requirements on the market, and which can be easily integrated in the OEM design as building blocks or can be taken as starting points to develop a specific one.

For a detailed description of the **Telit GE863-PRO3 Evaluation Kit** refer to the documentation provided with the Telit GE863-PRO3 Hardware User Guide and User Manual.

7 Conformity Assessment Issues

The **Telit GE863-PRO3 modules** are assessed to be conform to the R&TTE Directive.
If the module is installed in conformance with Telit installation instructions it will require no further evaluation under **Article 3.2** of the R&TTE Directive and do not require further involvement of an 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 the 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.

The **Telit GE863-PRO3 modules** are conforming to the following European Union Directives:

- R&TTE Directive 1999/5/EC (Radio Equipment & Telecommunications Terminal Equipments)
- Low Voltage Directive 73/23/EEC and product safety
- Directive 89/336/EEC for conformity for EMC

In order to satisfy the essential requisite of the R&TTE 99/5/EC directive, the GE863-PRO3 module is compliant with the following standards:

- GSM (Radio Spectrum). Standard: EN 301 511 and 3GPP 51.010-1
- EMC (Electromagnetic Compatibility). Standards: EN 301 489-1 and EN 301 489-7
- LVD (Low Voltage Directive) Standards: EN 60 950

Furthermore the **Telit GE863-PRO3 modules** are FCC Approved as module to be installed in other devices. These devices have 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 ID is required.

The **Telit GE863-PRO3 modules** are conforming to the following US Directives:

- Use of RF Spectrum. Standards: FCC 47 Part 24 (GSM850 - GSM 1900)
- EMC (Electromagnetic Compatibility). Standards: FCC47 Part 15

The GE863-PRO3 module 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.

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Telit Communications S.p.A. may void the user's authority to operate the equipment.

To meet the FCC's RF exposure rules and regulations:

- The 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 antenna(s) used for this module must not exceed 3 dBi for mobile and fixed or mobile operating configurations.

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.
Interference statement:

The **Telit GE863-PRO^3 module** complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- this device may not cause harmful interference, and
- this device must accept any interference received, including interference that may cause undesired operation.

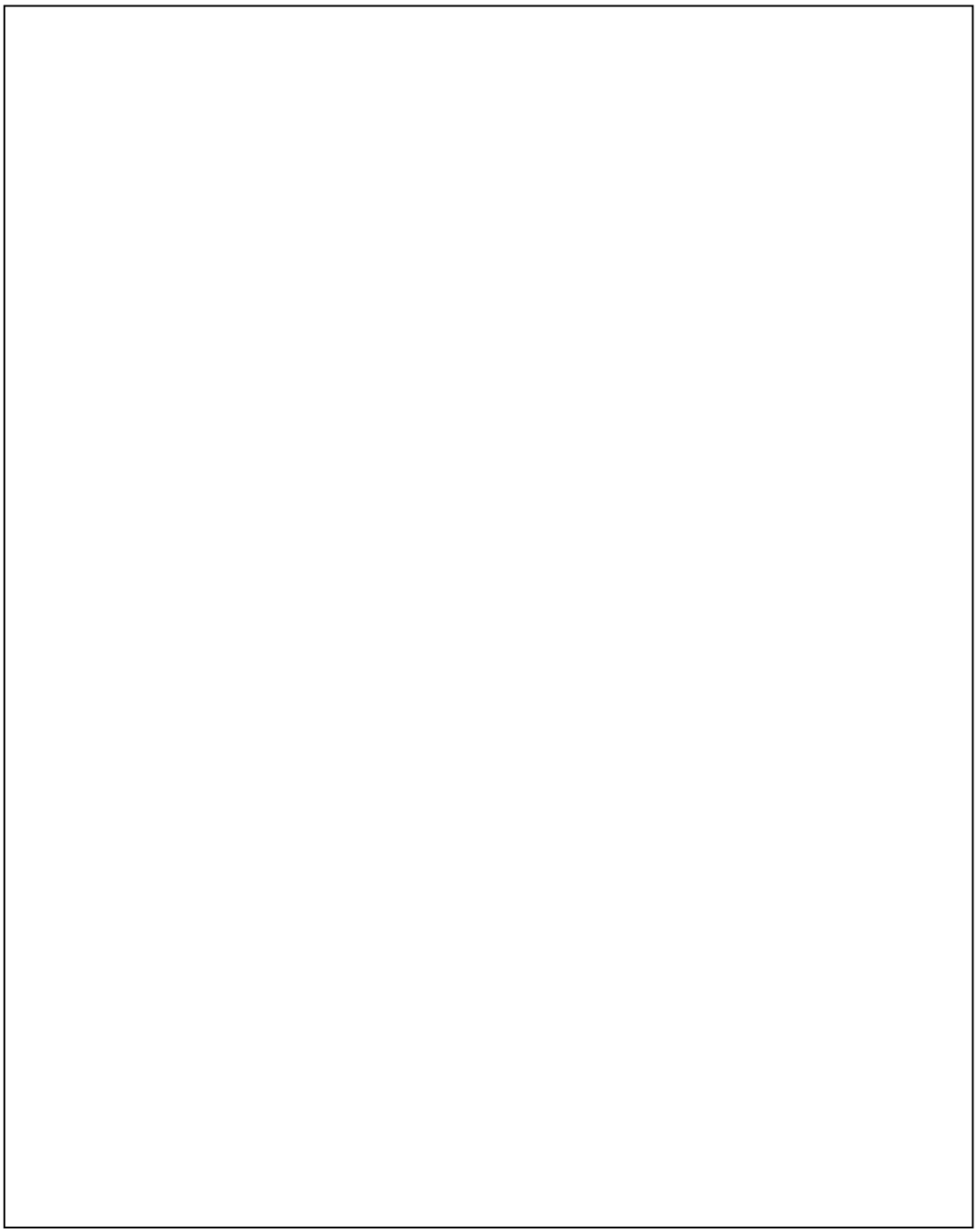
For questions regarding your product or this FCC declaration, contact:

Telit wireless solutions Inc.
Americas

3131 RDU Center Drive,
USA – 27560 Morrisville, NC 27560, USA
Phone: +1 888 846 9773
Fax: + 1 888 846 9774
e-mail: americas.info@telit.com

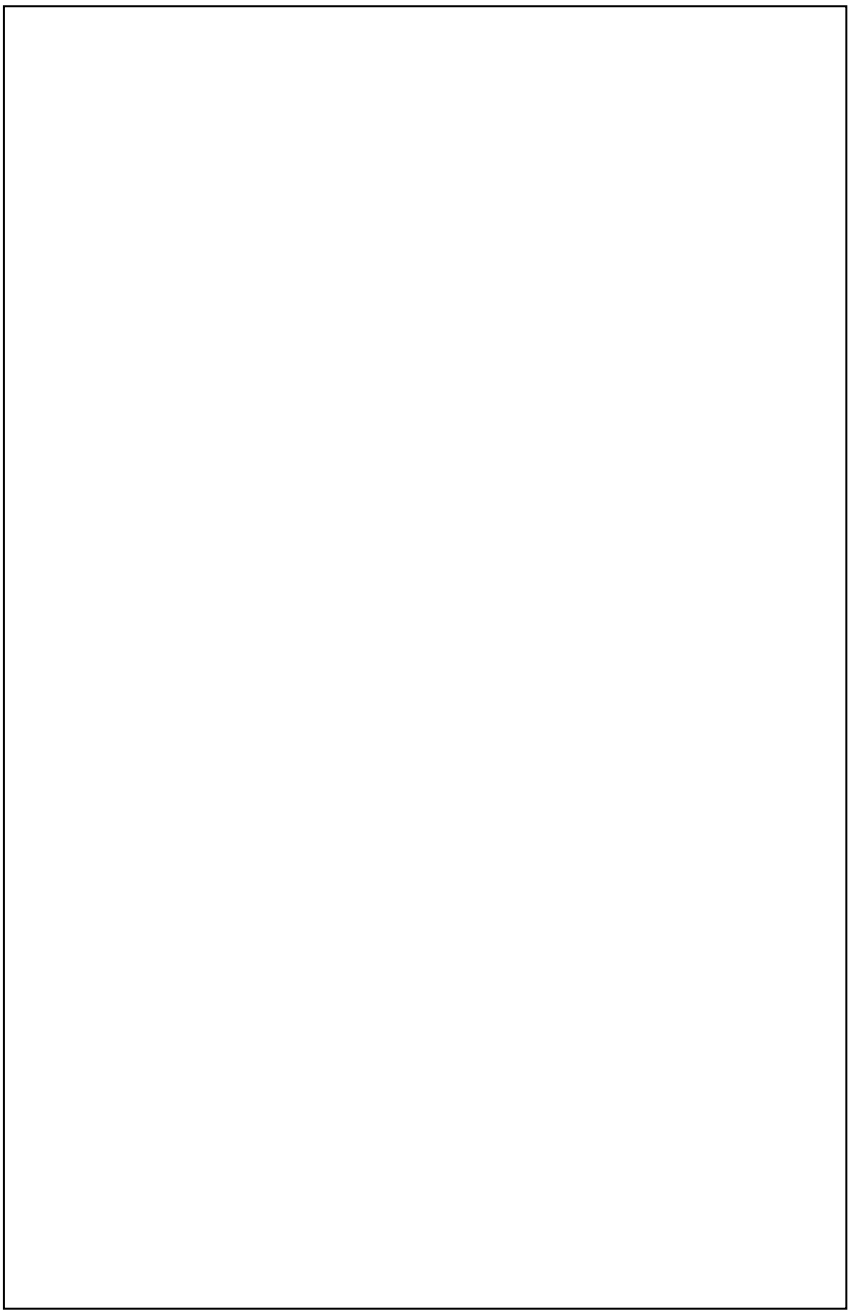
To identify this product, refer to the Part, Series, or Model number found on the product.

7.1 GE863-PRO^3: Conformity Assessment

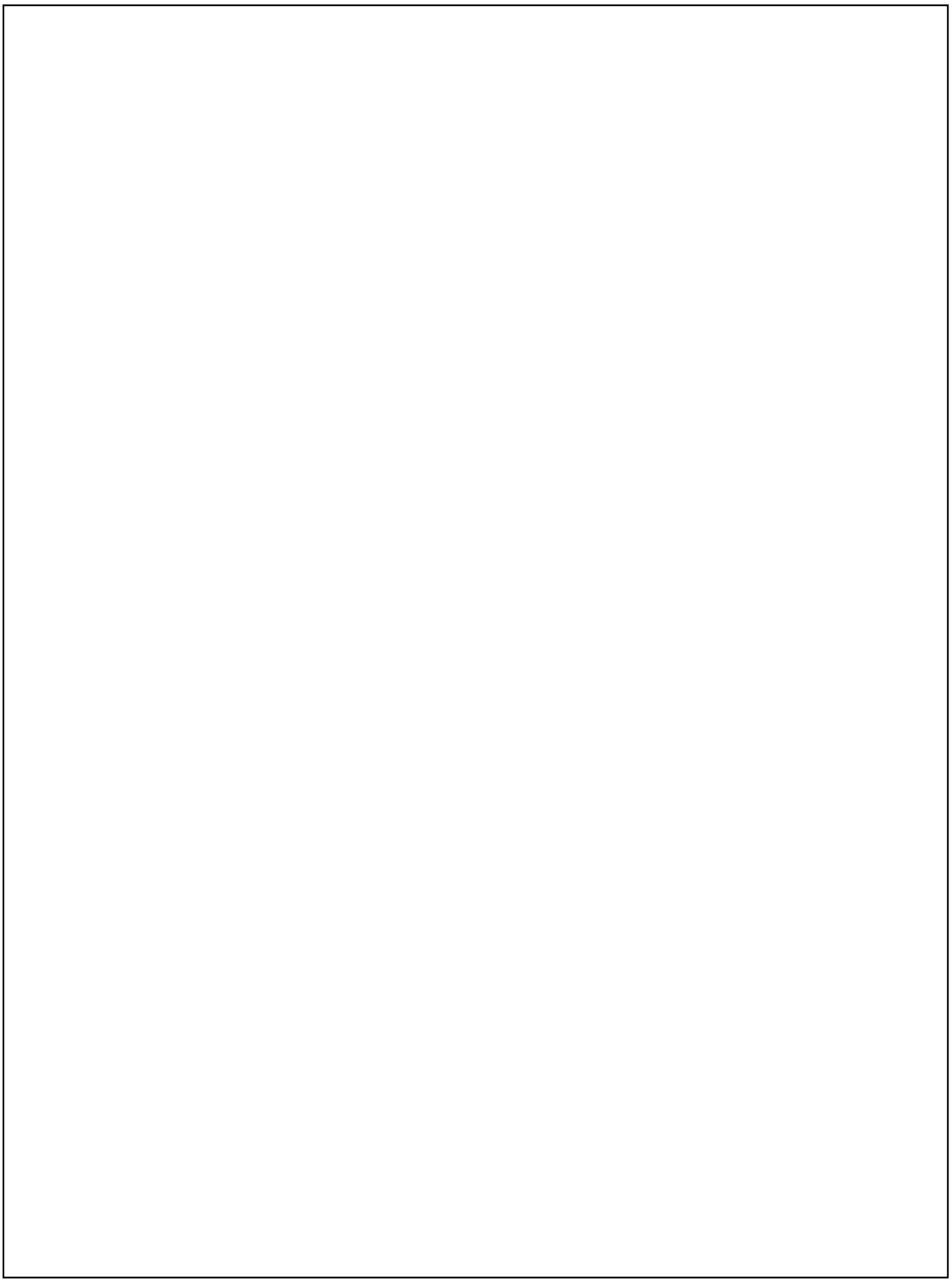


7.2 GE863-PRO^3: FCC Equipment Authorization

7.3 GE863- PRO^3 : IC Equipment Authorization



7.4 GE863-PRO^3: RoHS certificate



8 Safety Recommandations

READ CAREFULLY

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

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

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

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

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

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

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

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

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

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

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

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

9 GE863-PRO^3 Technical Support

Telit's technical support to **GE863-PRO^3** wireless modem customers consists in:

• Technical documentation: available for download into the Website www.telit.com >Products >Modules > selected model.
• Engineering support: accessible via E-Mail service with 48 hr replies assured under normal conditions.

10 List of acronyms

ACM	Accumulated Call Meter
ADC	Analog Digital Converter
ASCII	American Standard Code for Information Interchange
AT	Attention commands
BGA	Ball Grid Array (of solder balls on surface mount devices)
CB	Cell Broadcast
CBS	Cell Broadcasting Service
CCM	Call Control Meter
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Restriction
CMOS	Complementary Metal-Oxide Semiconductor
CR	Carriage Return
CSD	Circuit Switched Data
CTS	Clear To Send
DAI	Digital Audio Interface
DCD	Data Carrier Detected
DCE	Data Communications Equipment
DRX	Data Receive
DSR	Data Set Ready
DTA	Data Terminal Adaptor
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi Frequency
DTR	Data Terminal Ready
EMC	Electromagnetic Compatibility
ETSI	European Telecommunications Equipment Institute
FTA	Full Type Approval (ETSI)
FTP	File Transfer Protocol
GGA	Global Positioning System Fix Data
GLL	Geographic Posotion – Latitude/Longitude
GPS	Global Positioning System, based on reception of signals from orbiting satellites
GPIO	General Purpose Input/Output
GPRS	General Radio Packet Service
GSA	GPS receiver operating mode, SVs used for navigation, and DOP values.
GSM	Global System for Mobile communication
GSV	Number of SVs in view, PRN numbers, elevation, azimuth & SNR values.
HF	Hands Free
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
IRA	International Reference Alphabet

ITU	International Telecommunications Union
IWF	Inter-Working Function
JTAG	Joint Test Action Group
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LF	Linefeed
ME	Mobile Equipment
MMC	Multi Media Card
MMI	Man Machine Interface
MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
NMEA	National Marine Electronics Association
OEM	Other Equipment Manufacturer
PB	Phone Book
PDU	Protocol Data Unit
PH	Packet Handler
PIN	Personal Identity Number
PLMN	Public Land Mobile Network
PPS	Precision Positioning Service
PUCT	Price per Unit Currency Table
PUK	PIN Unblocking Code
PWM	Pulse Width Modulation
RACH	Random Access Channel
RLP	Radio Link Protocol
RMC	Recommended Minimum Specific GPS/TRANSIT Data
RMS	Root Mean Square
RoHS	Reduction of Hazardous Substances
RTS	Ready To Send
RI	Ring Indicator
SAM	Security Authentication Module
SCA	Service Center Address
SD	Secure Digital
SIM	Subscriber Identity Module
SMD	Surface Mounted Device
SMS	Short Message Service
SMSC	Short Message Service Center
SPS	Standard Positioning Service
SS	Supplementary Service
SPI	Serial Peripheral Interface
TIA	Telecommunications Industry Association
TTFF	Time To First Fix
UART	Universal Asynchronous Receiver/Transmitter
UDUB	User Determined User Busy
USB	Universal Serial Bus

USSD	Unstructured Supplementary Service Data
USART	Universal Sinchronous Asynchronous Receiver/Transmitter
VTG	Actual track made good and speed over ground

11 Document Change Log

Revision	Date	Changes
ISSUE#0	24/08/07	Initial Release