HE863 Family
Hardware User Guide

1vv0300891 Rev.4 – 2011-02-25

Making machines talk.

APPLICABLE PRODUCT

PRODUCT
HE863-EUD
HE863-EUR
HE863-EUG
HE863-NAD
HE863-NAR
HE863-NAG
HE863-AUD
HE863-AUG

Disclaimer

The information contained in this document is the proprietary information of Telit Communications S.p.A. and its affiliates ("TELIT").
The contents are confidential and any disclosure to persons other than the officers, employees, agents or subcontractors of the owner or licensee of this document, without the prior written consent of Telit, is strictly prohibited.
Telit makes every effort to ensure the quality of the information it makes available. Notwithstanding the foregoing, Telit does not make any warranty as to the information contained herein, and does not accept any liability for any injury, loss or damage of any kind incurred by use of or reliance upon the information.
Telit disclaims any and all responsibility for the application of the devices characterized in this document, and notes that the application of the device must comply with the SAFETY standards of the applicable country, and where applicable, with the relevant wiring rules.

Telit reserves the right to make modifications, additions and deletions to this document due to typographical errors, inaccurate information, or improvements to programs and/or equipment at any time and without notice.
Such changes will, nevertheless be incorporated into new editions of this document.

Contents

1. Introduction

1.1. Scope

The aim of this document is the description of some hardware solutions useful for developing a product with the Telit HE863-EUD/NAD/AUD/EUG/NAG/AUG/EUR/NAR module. All the features and solutions detailed are applicable to all HE863 family, whereas "family" is intended the modules listed in the applicability table.

When a specific feature is applicable to a specific product, it will be clearly highlighted.

1.2. Audience

This document is intended for Telit customers, who are integrators, about to implement their applications using our HE863-EUD/NAD/AUD/EUG/NAG/AUG/EUR/NAR module.

1.3. Contact Information, Support

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

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

Alternatively, use:

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

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

http://www.telit.com

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

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

Telit appreciates feedback from the users of our information.

1.4. Document Organization

This document contains the following chapters:

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

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

Chapter 3: "HE863 Family Mechanical Dimensions" deals with the layout.

Chapter 4: "HE863 Family Module Connections"

Chapter 5: "Hardware Commands " How to control the module via hardware

Chapter 6: "Power Supply" deals on supply and consumption.

Chapter 7: "Antenna(s)" The antenna connection and board layout design are the most important parts in the full product design

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

Chapter 9: "Serial ports"

Chapter 10: "USB Port"

Chapter 11: "Audio Section " Refers to the audio blocks and electrical characteristics of the Base Band Chip .

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

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

Chapter 14 "Mounting the HE863 Family on your board"

Chapter 15 "SIM holder design guide"

Chapter 16 "Antenna detection design guide"

Chapter 17: "Conformity Assessments Issues" provides some fundamental hints about the conformity assessment that the final application might need.

Chapter 18: "Safety Recommendations" provides some safety recommendations that must be followed by the customer in the design of the application that makes use of the HE863 Family.

1.5. Text Conventions

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

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

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

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

1.6. Related Documents

- HE863 Product Description, 80377ST10081a
- HE863 AT Command Manual, 80377ST10083a
- HE863 Software User Guide , 1vv0300893

1.7. Document History

Revision	Date	Changes
Rev.0	2010-07-23	First issue
Rev.1	2010-07-27	Updated 4 HE863-EUD Modules Connections Updated 4.1 PIN-OUT Updated 5.2 Initialization and Activation state(TBD) Updated 5.3 Turning off the HE863-EUD Updated 5.4 Summary of Turning ON and OFF the HE863-EUD(TBD) Updated 8.1 Reset Signal Updated 14 SIM holder design guides Removed 17.1 The schematics of the HE863 interface board
Rev.2	2010-10-13	Added HE863-NAD/AUD/EUG/NAG/AUG characteristics Added 2.1 HE863 Family Product Specification Added 7.4 GPS Antenna Requirements(HE863-EUG/NAG/AUG only) Added 7.5 GPS Antenna-PCB Line Guidelines(HE863-EUG/NAG/AUG only) Added 7.6 GPS Antenna-Installation Guidelines(HE863-EUG/NAG/AUG only) Added 11 AUDIO Section(HE863-EUG/NAG/AUG only) Added 13 DAC and ADC section Updated 4 HE863 Family Modules Connections Updated 5.2 Initialization and Activation state Updated 6.1 Power Supply Requirements Updated 7 Antenna(s) Updated 9.2 RS232 Level Translation Renumbered chapters.
Rev.3	2010-11-24	Added HE863-EUR/NAR Updated 1 Introduction Updated 2.1 HE863 Family Product Specification Updated 4 HE863 Family Modules Connections Updated 6.1 Power Supply Requirements Updated 7 GSM/WCDMA Antenna Requirements Updated 11 AUDIO Section(HE863-EUR/EUG/NAR/NAG/AUG only)
Rev.4	2011-02-23	Updated 4.1 HE863-EUD/NAD/AUD PIN-OUT Updated 4.2 HE863-EUR/NAR PIN-OUT Updated 4.3 HE863-EUG/NAG/AUG PIN-OUT Updated 5.1 Turning On the HE863 Removed 5.4 Summary of Turning ON and OFF Updated 6.1 Power Supply Requirements Updated 6.2.2 Thermal Design Guidelines Updated 8.1 Reset Signal Updated 11 Audio Section Updated 12 General Purpose I/O Updated 13 DAC And ADC Section Updated 15.2 SIM interface

		Added 16 Antenna detection design guide

2. Overview

The aim of this document is the description of some hardware solutions useful for developing a product with the Telit HE863 Family 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 must be considered as mandatory, while the suggested hardware configurations must not be considered mandatory, instead the information given must be used as a guide and a starting point for properly developing your product with the Telit HE863 Family module.

.

NOTICE:

The integration of the GSM/GPRS/EDGE/UMTS/HSPA HE863 Family cellular module within user application must be done according to the design rules described in this manual.

The information presented in this document is believed to be accurate and reliable. However, no responsibility is assumed by Telit Communication S.p.A. for its use, such as any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent rights of Telit Communication S.p.A. other than for circuitry embodied in Telit products. This document is subject to change without notice.

2.1. HE863 Family Product Specification

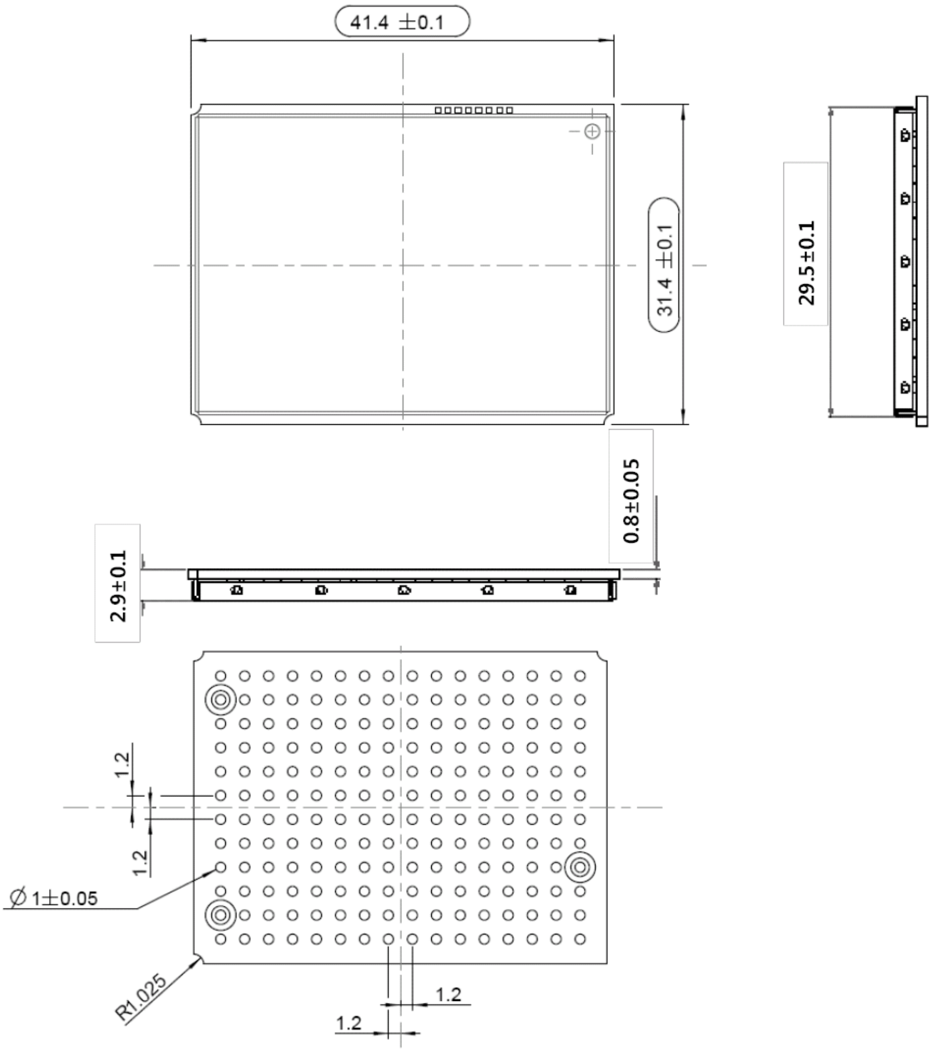
ITEM	FEATURE					
	HE863-EUD	HE863-EUR	HE863-EUG	HE863-NAD	HE863-NAR	HE863-NAG
Air interface	▪ Dual-band UMTS/HSPA 2100/900 ▪ Quad-Band GSM850/900 /1800/1900 ▪ Data only	▪ Dual-band UMTS/HSPA 2100/900 ▪ Quad-Band GSM850/900 /1800/1900	▪ Dual-band UMTS/HSPA 2100/900 ▪ Quad-Band GSM850/900 /1800/1900 ▪ Standalone GPS	▪ Dual-band UMTS/HSPA 1900/850 ▪ Quad-Band GSM850/900 /1800/1900 ▪ Data only	▪ Dual-band UMTS/HSPA 1900/850 ▪ Quad-Band GSM850/900 /1800/1900	▪ Dual-band UMTS/HSPA 1900/850 ▪ Quad-Band GSM850/900 /1800/1900 ▪ Standalone GPS
Size	41.4(L)X31.4(W)X2.9(T)					
Data Service	▪ HSPA UL 5.8Mbps, DL 7.2Mbps ▪ EDGE UL 118kbps, DL 236.8Kbps, ▪ GPRS UL 42.8kbps, DL 85.6 Kbps					
Interface	▪ 189 Balls Grid Array interface ▪ 22 general I/O ports maximum including multi-functional I/Os ▪ Status LED output ▪ 3 A/D converters ▪ 1 D/A converter (PWM output) ▪ Full RS232 CMOS UART: baud rate up to 6Mbps ▪ Reserved two wires CMOS UART for debugging ▪ USB 2.0, baud rate up to 480Mbps ▪ 1.8V/3V SIM interface					
Antenna	External Antenna					
Audio	▪ 2 pairs of analog audio interface ▪ PCM interface for Digital audio (Audio only for HE863-EUG/EUR/NAG/NAR/AUG)					
Message	SMS (MO/MT)					
SIM Card	Support 1.8 and 3V UICC					

ITEM	FEATURE					
	HE863-AUD	HE863-AUG	HE863-AUG			
Air interface	▪ Dual-band UMTS/HSPA 2100/850 ▪ Quad-Band GSM850/900 /1800/1900 ▪ Data only	▪ Dual-band UMTS/HSPA 2100/850 ▪ Quad-Band GSM850/900 /1800/1900	▪ Dual-band UMTS/HSPA 2100/850 ▪ Quad-Band GSM850/900 /1800/1900 ▪ Standalone GPS			
Size	41.4(L)X31.4(W)X2.9(T)					
Data Service	▪ HSPA UL 5.8Mbps, DL 7.2Mbps ▪ EDGE UL 118kbps, DL 236.8Kbps, ▪ GPRS UL 42.8kbps, DL 85.6 Kbps					
Interface	▪ 189 Balls Grid Array interface ▪ 22 general I/O ports maximum including multi-functional I/Os ▪ Status LED output ▪ 3 A/D converters ▪ 1 D/A converter (PWM output) ▪ Full RS232 CMOS UART: baud rate up to 6Mbps ▪ Reserved two wires CMOS UART for debugging ▪ USB 2.0, baud rate up to 480Mbps ▪ 1.8V/3V SIM interface					
Antenna	External Antenna					
Audio	▪ 2 pairs of analog audio interface ▪ PCM interface for Digital audio (Audio only for HE863-EUG/EUR/NAG/NAR/AUG)					
Message	SMS (MO/MT)					
SIM Card	Support 1.8 and 3V UICC					

3. HE863 Family Mechanical Dimensions

The Telit HE863 Family module overall dimensions are:

- Length: 41.4 mm
- Width: 31.4 mm
- Thickness: 2.9 mm



4. HE863 Family Module Connections

The HE863 Family features a 189 Balls Grid Array: in the following sections a description of the available signals and their position in the balls layout is presented.

4.1. HE863-EUD/NAD/AUD PIN-OUT

Ball	Signal	I/O	Function	Internal Pull up	Type
SIM card interface					
H11	SIMCLK	O	External SIM signal – Clock		1.8 / 3V
G12	SIMRST	O	External SIM signal – Reset		1.8 / 3V
F12	SIMIO	I/O	External SIM signal - Data I/O		1.8 / 3V
E12	SIMIN(TBD)	I	External SIM signal – Presence (active low)		1.8
H12	SIMVCC	-	External SIM signal – Power supply for the SIM		1.8 / 3V
USB SIM(RESERVED)					
F11	USB_SIM_D+ (TBD)	I/O	USB SIM data (+), TBD		1.8V/3.0V
G11	USB_SIM_D- (TBD)	I/O	USB SIM data (-), TBD		1.8V/3.0V
Trace					
N4	TX_TRACE	O	Tx data for diagnostic monitor		CMOS 1.8V
N3	RX_TRACE	I	Rx data for diagnostic monitor		CMOS 1.8V
Prog. / Data + HW Flow Control					
M4	C125/RING (TBD)	O	Output for Ring indicator signal (RI) to DTE		CMOS 1.8V
M3	C109/DCD (TBD)	O	Output for Data set ready signal (DSR) to DTE		CMOS 1.8V
L3	C108/DTR (TBD)	I	Input for Data terminal ready signal (DTR) from DTE		CMOS 1.8V

Ball	Signal	I/O	Function	Internal Pull up	Type
L4	C107/DSR (TBD)	O	Output for Data set ready signal (DSR) to DTE		CMOS 1.8V
K4	C106/CTS	O	Output for Clear to send signal (CTS) to DTE		CMOS 1.8V
K3	C105/RTS	I	Input for Request to send signal (RTS) from DTE		CMOS 1.8V
J4	C104/RXD	O	Serial data output to DTE		CMOS 1.8V
J3	C103/TXD	I	Serial data input (TXD) from DTE		CMOS 1.8V
USB					
S8	USB_VBUS		Power supply for the internal USB transceiver		5V
S9	USB_ID(TBD)	AI	Analog input used to sense whether a peripheral device is connected.		Analog
R9	USB_D+	I/O	USB differential Data (+)		3.3V
R8	USB_D-	I/O	USB differential Data (-)		3.3V
DAC and ADC					
S4	DAC_OUT	AO	Digital/Analog converter output		Analog
S5	ADC_IN3	AI	Analog/Digital converter input 3/GPS ANT current detection		Analog
R5	ADC_IN2	AI	Analog/Digital converter input 2/GPS ANT voltage detection		Analog
R4	ADC_IN1	AI	Analog/Digital converter input 1/GPS ANT voltage detection		Analog
Miscellaneous Functions					
G5	RESET*	I	Reset input	Pull up	2.3V
C9	VRTC_2V3	AO	VRTC Backup capacitor		Power
B11	STAT_LED	O	Status indicator LED		CMOS 1.8V
G4	ON_OFF*	I	Input command for switching power ON or OFF (toggle command)	Pull up	2.3V
D10	PWRMON	O	Power ON Monitor		CMOS 1.8V

Ball	Signal	I/O	Function	Internal Pull up	Type
A3	RF_ANT	-	Antenna for GSM/WCDMA – 50 ohm		RF
P7	MODEM_RDY (TBD)	O	Indicates that the boot sequence completed successfully		CMOS 1.8V
R6	WAKEUP(TBD)	O	Wake up signal to external host system		CMOS 1.8V
P6	SLEEP(TBD)	I	Input for entering sleep mode		CMOS 1.8V
S6	CALL_KEY(TBD)	I	Input for make/answer a call (toggle command)		CMOS 1.8V
G6	EMG_PWR_OFF (TBD)	I	Input for emergency power off	Pull up	CMOS 1.8V
N8	MODE1(TBD)		Mode select 1(TBD)		
N9	MODE2(TBD)		Mode select 2(TBD)		
	SPI(TBD)		6 pins for SPI (F4,D4,F5,E4,D5,C11)		
E5	VAUX1	-	Power output for external accessories		Power
GPIO					
L11	TGPIO_22	I/O	Configurable GPIO #22		CMOS 1.8V
K12	TGPIO_21	I/O	Configurable GPIO #21		CMOS 1.8V
M11	TGPIO_20	I/O	Configurable GPIO #20		CMOS 1.8V
P10	TGPIO_19	I/O	Configurable GPIO #19		CMOS 1.8V
M9	TGPIO_18	I/O	Configurable GPIO #18		CMOS 1.8V
M7	TGPIO_17	I/O	Configurable GPIO #17		CMOS 1.8V
N10	TGPIO_16	I/O	Configurable GPIO #16		CMOS 1.8V
M12	TGPIO_15	I/O	Configurable GPIO #15		CMOS 1.8V
P11	TGPIO_14	I/O	Configurable GPIO #14		CMOS 1.8V
N11	TGPIO_13	I/O	Configurable GPIO #13		CMOS 1.8V
L12	TGPIO_12	I/O	Configurable GPIO #12		CMOS 1.8V
P12	TGPIO_11	I/O	Configurable GPIO #11		CMOS 1.8V
M8	TGPIO_10	I/O	Configurable GPIO #10		CMOS 1.8V

Ball	Signal	I/O	Function	Internal Pull up	Type
N12	TGPIO_09	I/O	Configurable GPIO #09		CMOS 1.8V
B10	TGPIO_08	I/O	Configurable GPIO #08		CMOS 1.8V
E9	TGPIO_07	I/O	Configurable GPIO #07		CMOS 1.8V
E10	TGPIO_06 / ALARM	I/O	Configurable GPIO #06 / ALARM		CMOS 1.8V
F10	TGPIO_05	I/O	Configurable GPIO #05		CMOS 1.8V
F9	TGPIO_04	I/O	Configurable GPIO #04		CMOS 1.8V
K11	TGPIO_03	I/O	Configurable GPIO #03		CMOS 1.8V
G9	TGPIO_02	I/O	Configurable GPIO #02		CMOS 1.8V
J11	TGPIO_01	I/O	Configurable GPIO #01		CMOS 1.8V
Power Supply					
C1	VBATT		Main power supply		Power
D1	VBATT		Main power supply		Power
	GND		52 pins for Ground (A2,A5,A12,B2,B3,B4,B5,B9,C2, C10,D6,D9,E1,E6,E11,F1,F6,G10, H5,H6,H7,H8,H9,H10,J5,J10,J12, K5,K10,L5,L6,L7,L8,L9,L10,M2, M5,M10,N6,N7,P8,P9,R1,R2,R3, R7,R10,R11,R12,S3,S7,S10)		Power
Reserved					
	RESERVED		9 pins reserved (J8,J7,J6,K9,K8,K7,K6,N5,M6)		
	RESERVED		20 pins reserved (D3,E3,F3,G3,H3,D2,E2,F2,C4,C3, H2,J2,G2,K2,L1,K1,G1,J1,L2,H1)		
	RESERVED		7 pins reserved (P5,P3,P2,M1,N1,N2,P1)		
	RESERVED		9 pins reserved (G7,E7,D7,D8,E8,F8,G8,D11,F7)		

Ball	Signal	I/O	Function	Internal Pull up	Type
	RESERVED		6 pins reserved (C5,B8,C7,C8,B7,C6)		
	RESERVED		17 pins reserved (A7,A8,C12,J9,A1,A6,A9,A10,A11,B1,B6,B12,D12,H4,P4,S1,S12)		

NOTE:

RESERVED Pins must be UNCONNECTED BUT BE SOLDERED.

NOTE:

If not used, almost all pins must be left disconnected.

4.2. HE863-EUR/NAR PIN-OUT

Ball	Signal	I/O	Function	Internal Pull up	Type
Audio					
J6	EAR_MT+	AO	Earphone signal output, phase +		Audio
J7	EAR_MT-	AO	Earphone signal output, phase -		Audio
J8	EAR_HF+	AO	Handsfree signal output, phase + (Single ended)		Audio
K6	MIC_MT+	AI	Mic signal input, phase +		Audio
K7	MIC_MT-	AI	Mic signal input, phase -		Audio
K8	MIC_HF+	AI	Handsfree mic signal input, phase +		Audio
K9	MIC_HF-	AI	Handsfree mic signal input, phase -		Audio
PCM interface					
M7	TGPIO_17/ PCM_SYNC	I/O	GPIO 17/PCM sync signal of digital voice interface		CMOS 1.8V
M6	PCM_CLOCK	I/O	PCM clock of digital voice interface		CMOS 1.8V
M8	TGPIO_10/ PCM_TX	I/O	PCM data output of digital voice interface		CMOS 1.8V
M9	TGPIO_18/ PCM_RX	I/O	PCM data input of digital voice interface		CMOS 1.8V
SIM card interface					
H11	SIMCLK	O	External SIM signal – Clock		1.8 / 3V
G12	SIMRST	O	External SIM signal – Reset		1.8 / 3V
F12	SIMIO	I/O	External SIM signal - Data I/O		1.8 / 3V
E12	SIMIN(TBD)	I	External SIM signal – Presence (active low)		1.8
H12	SIMVCC	-	External SIM signal – Power supply for the SIM		1.8 / 3V
USB SIM(TBD)					
F11	USB_SIM_D+	I/O	USB SIM data (+), TBD		1.8V/3.0V

Ball	Signal	I/O	Function	Internal Pull up	Type
	(TBD)				
G11	USB_SIM_D- (TBD)	I/O	USB SIM data (-), TBD		1.8V/3.0V
Trace					
N4	TX_TRACE	O	Tx data for diagnostic monitor		CMOS 1.8V
N3	RX_TRACE	I	Rx data for diagnostic monitor		CMOS 1.8V
Prog. / Data + HW Flow Control					
M4	C125/RING (TBD)	O	Output for Ring indicator signal (RI) to DTE		CMOS 1.8V
M3	C109/DCD (TBD)	O	Output for Data set ready signal (DSR) to DTE		CMOS 1.8V
L3	C108/DTR (TBD)	I	Input for Data terminal ready signal (DTR) from DTE		CMOS 1.8V
L4	C107/DSR (TBD)	O	Output for Data set ready signal (DSR) to DTE		CMOS 1.8V
K4	C106/CTS	O	Output for Clear to send signal (CTS) to DTE		CMOS 1.8V
K3	C105/RTS	I	Input for Request to send signal (RTS) from DTE		CMOS 1.8V
J4	C104/RXD	O	Serial data output to DTE		CMOS 1.8V
J3	C103/TXD	I	Serial data input (TXD) from DTE		CMOS 1.8V
USB					
S8	USB_VBUS		Power supply for the internal USB transceiver		5V
S9	USB_ID(TBD)	AI	Analog input used to sense whether a peripheral device is connected.		Analog
R9	USB_D+	I/O	USB differential Data (+)		3.3V
R8	USB_D-	I/O	USB differential Data (-)		3.3V
DAC and ADC					
S4	DAC_OUT	AO	Digital/Analog converter output		Analog

Ball	Signal	I/O	Function	Internal Pull up	Type
S5	ADC_IN3	AI	Analog/Digital converter input 3/GPS ANT current detection		Analog
R5	ADC_IN2	AI	Analog/Digital converter input 2/GPS ANT voltage detection		Analog
R4	ADC_IN1	AI	Analog/Digital converter input 1/GPS ANT voltage detection		Analog
Miscellaneous Functions					
G5	RESET*	I	Reset input	Pull up	2.3V
C9	VRTC_2V3	AO	VRTC Backup capacitor		Power
B11	STAT_LED	O	Status indicator LED		CMOS 1.8V
G4	ON_OFF*	I	Input command for switching power ON or OFF (toggle command)	Pull up	2.3V
D10	PWRMON	O	Power ON Monitor		CMOS 1.8V
A3	RF_ANT	-	Antenna for GSM/WCDMA – 50 ohm		RF
P7	MODEM_RDY (TBD)	O	Indicates that the boot sequence completed successfully		CMOS 1.8V
R6	WAKEUP(TBD)	O	Wake up signal to external host system		CMOS 1.8V
P6	SLEEP(TBD)	I	Input for entering sleep mode		CMOS 1.8V
S6	CALL_KEY(TBD)	I	Input for make/answer a call (toggle command)		CMOS 1.8V
N5	AXE (TBD)	I	Input for handsfree switching		CMOS 1.8V
G6	EMG_PWR_OFF (TBD)	I	Input for emergency power off	Pull up	CMOS 1.8V
N8	MODE1(TBD)		Mode select 1(TBD)		
N9	MODE2(TBD)		Mode select 2(TBD)		
	SPI(TBD)		6 pins for SPI (F4,D4,F5,E4,D5,C11)		
E5	VAUX1	-	Power output for external accessories		Power
GPIO					

Ball	Signal	I/O	Function	Internal Pull up	Type
L11	TGPIO_22	I/O	Configurable GPIO #22		CMOS 1.8V
K12	TGPIO_21	I/O	Configurable GPIO #21		CMOS 1.8V
M11	TGPIO_20	I/O	Configurable GPIO #20		CMOS 1.8V
P10	TGPIO_19	I/O	Configurable GPIO #19		CMOS 1.8V
N10	TGPIO_16	I/O	Configurable GPIO #16		CMOS 1.8V
M12	TGPIO_15	I/O	Configurable GPIO #15		CMOS 1.8V
P11	TGPIO_14	I/O	Configurable GPIO #14		CMOS 1.8V
N11	TGPIO_13	I/O	Configurable GPIO #13		CMOS 1.8V
L12	TGPIO_12	I/O	Configurable GPIO #12		CMOS 1.8V
P12	TGPIO_11	I/O	Configurable GPIO #11		CMOS 1.8V
N12	TGPIO_09	I/O	Configurable GPIO #09		CMOS 1.8V
B10	TGPIO_08	I/O	Configurable GPIO #08		CMOS 1.8V
E9	TGPIO_07	I/O	Configurable GPIO #07		CMOS 1.8V
E10	TGPIO_06 / ALARM	I/O	Configurable GPIO #06 / ALARM		CMOS 1.8V
F10	TGPIO_05	I/O	Configurable GPIO #05		CMOS 1.8V
F9	TGPIO_04	I/O	Configurable GPIO #04		CMOS 1.8V
K11	TGPIO_03	I/O	Configurable GPIO #03		CMOS 1.8V
G9	TGPIO_02	I/O	Configurable GPIO #02		CMOS 1.8V
J11	TGPIO_01	I/O	Configurable GPIO #01		CMOS 1.8V
Power Supply					
C1	VBATT		Main power supply		Power
D1	VBATT		Main power supply		Power
	GND		52 pins for Ground (A2,A5,A12,B2,B3,B4,B5,B9,C2, C10,D6,D9,E1,E6,E11,F1,F6,G10, H5,H6,H7,H8,H9,H10,J5,J10,J12, K5,K10,L5,L6,L7,L8,L9,L10,M2, M5,M10,N6,N7,P8,P9,R1,R2,R3,		Power

Ball	Signal	I/O	Function	Internal Pull up	Type
			R7,R10,R11,R12,S3,S7,S10)		
Reserved					
	RESERVED		20 pins reserved (D3,E3,F3,G3,H3,D2,E2,F2,C4,C3, H2,J2,G2,K2,L1,K1,G1,J1,L2,H1)		
	RESERVED		7 pins reserved (P5,P3,P2,M1,N1,N2,P1)		
	RESERVED		9 pins reserved (G7,E7,D7,D8,E8,F8,G8,D11,F7)		
	RESERVED		6 pins reserved (C5,B8,C7,C8,B7,C6)		
	RESERVED		17 pins reserved (A7,A8,C12,J9,A1,A6,A9,A10,A11,B1,B6,B12,D12,H4,P4,S1,S12)		

NOTE:

RESERVED Pins must be UNCONNECTED but be soldered.

NOTE:

If not used, almost all pins must be left disconnected.

4.3. HE863-EUG/NAG/AUG PIN-OUT

Ball	Signal	I/O	Function	Internal Pull up	Type
Audio					
J6	EAR_MT+	AO	Earphone signal output, phase +		Audio
J7	EAR_MT-	AO	Earphone signal output, phase -		Audio
J8	EAR_HF+	AO	Handsfree signal output, phase + (Single ended)		Audio
K6	MIC_MT+	AI	Mic signal input, phase +		Audio
K7	MIC_MT-	AI	Mic signal input, phase -		Audio
K8	MIC_HF+	AI	Handsfree mic signal input, phase +		Audio
K9	MIC_HF-	AI	Handsfree mic signal input, phase -		Audio
PCM interface					
M7	TGPIO_17/ PCM_SYNC	I/O	GPIO 17/PCM sync signal of digital voice interface		CMOS 1.8V
M6	PCM_CLOCK	I/O	PCM clock of digital voice interface		CMOS 1.8V
M8	TGPIO_10/ PCM_TX	I/O	PCM data output of digital voice interface		CMOS 1.8V
M9	TGPIO_18/ PCM_RX	I/O	PCM data input of digital voice interface		CMOS 1.8V
SIM card interface					
H11	SIMCLK	O	External SIM signal – Clock		1.8 / 3V
G12	SIMRST	O	External SIM signal – Reset		1.8 / 3V
F12	SIMIO	I/O	External SIM signal - Data I/O		1.8 / 3V
E12	SIMIN(TBD)	I	External SIM signal – Presence (active low)		1.8
H12	SIMVCC	-	External SIM signal – Power supply for the SIM		1.8 / 3V
USB SIM(TBD)					

Ball	Signal	I/O	Function	Internal Pull up	Type
F11	USB_SIM_D+ (TBD)	I/O	USB SIM data (+), TBD		1.8V/3.0V
G11	USB_SIM_D- (TBD)	I/O	USB SIM data (-), TBD		1.8V/3.0V
Trace					
N4	TX_TRACE	O	Tx data for diagnostic monitor		CMOS 1.8V
N3	RX_TRACE	I	Rx data for diagnostic monitor		CMOS 1.8V
Prog. / Data + HW Flow Control					
M4	C125/RING (TBD)	O	Output for Ring indicator signal (RI) to DTE		CMOS 1.8V
M3	C109/DCD (TBD)	O	Output for Data set ready signal (DSR) to DTE		CMOS 1.8V
L3	C108/DTR (TBD)	I	Input for Data terminal ready signal (DTR) from DTE		CMOS 1.8V
L4	C107/DSR (TBD)	O	Output for Data set ready signal (DSR) to DTE		CMOS 1.8V
K4	C106/CTS	O	Output for Clear to send signal (CTS) to DTE		CMOS 1.8V
K3	C105/RTS	I	Input for Request to send signal (RTS) from DTE		CMOS 1.8V
J4	C104/RXD	O	Serial data output to DTE		CMOS 1.8V
J3	C103/TXD	I	Serial data input (TXD) from DTE		CMOS 1.8V
USB					
S8	USB_VBUS		Power supply for the internal USB transceiver		5V
S9	USB_ID(TBD)	AI	Analog input used to sense whether a peripheral device is connected.		Analog
R9	USB_D+	I/O	USB differential Data (+)		3.3V
R8	USB_D-	I/O	USB differential Data (-)		3.3V
DAC and ADC					

Ball	Signal	I/O	Function	Internal Pull up	Type
S4	DAC_OUT	AO	Digital/Analog converter output		Analog
S5	ADC_IN3	AI	Analog/Digital converter input 3/GPS ANT current detection		Analog
R5	ADC_IN2	AI	Analog/Digital converter input 2/GPS ANT voltage detection		Analog
R4	ADC_IN1	AI	Analog/Digital converter input 1/GPS ANT voltage detection		Analog
Miscellaneous Functions					
G5	RESET*	I	Reset input	Pull up	2.3V
C9	VRTC_2V3	AO	VRTC Backup capacitor		Power
B11	STAT_LED	O	Status indicator LED		CMOS 1.8V
G4	ON_OFF*	I	Input command for switching power ON or OFF (toggle command)	Pull up	2.3V
D10	PWRMON	O	Power ON Monitor		CMOS 1.8V
A3	RF_ANT	-	Antenna for GSM/WCDMA – 50 ohm		RF
S1	GPS_ANT	-	Antenna for GPS – 50 ohm GPS_ANT for HE863-EUG/NAG/AUG only		RF
P7	MODEM_RDY (TBD)	O	Indicates that the boot sequence completed successfully		CMOS 1.8V
R6	WAKEUP(TBD)	O	Wake up signal to external host system		CMOS 1.8V
P6	SLEEP(TBD)	I	Input for entering sleep mode		CMOS 1.8V
S6	CALL_KEY(TBD)	I	Input for make/answer a call (toggle command)		CMOS 1.8V
N5	AXE (TBD)	I	Input for handsfree switching		CMOS 1.8V
G6	EMG_PWR_OFF (TBD)	I	Input for emergency power off	Pull up	CMOS 1.8V
N8	MODE1(TBD)		Mode select 1(TBD)		
N9	MODE2(TBD)		Mode select 2(TBD)		
	SPI(TBD)		6 pins for SPI		

Ball	Signal	I/O	Function	Internal Pull up	Type
			(F4,D4,F5,E4,D5,C11)		
E5	VAUX1	-	Power output for external accessories		Power
GPIO					
L11	TGPIO_22	I/O	Configurable GPIO #22		CMOS 1.8V
K12	TGPIO_21	I/O	Configurable GPIO #21		CMOS 1.8V
M11	TGPIO_20	I/O	Configurable GPIO #20		CMOS 1.8V
P10	TGPIO_19	I/O	Configurable GPIO #19		CMOS 1.8V
N10	TGPIO_16	I/O	Configurable GPIO #16		CMOS 1.8V
M12	TGPIO_15	I/O	Configurable GPIO #15		CMOS 1.8V
P11	TGPIO_14	I/O	Configurable GPIO #14		CMOS 1.8V
N11	TGPIO_13	I/O	Configurable GPIO #13		CMOS 1.8V
L12	TGPIO_12	I/O	Configurable GPIO #12		CMOS 1.8V
P12	TGPIO_11	I/O	Configurable GPIO #11		CMOS 1.8V
N12	TGPIO_09	I/O	Configurable GPIO #09		CMOS 1.8V
B10	TGPIO_08	I/O	Configurable GPIO #08		CMOS 1.8V
E9	TGPIO_07	I/O	Configurable GPIO #07		CMOS 1.8V
E10	TGPIO_06 / ALARM	I/O	Configurable GPIO #06 / ALARM		CMOS 1.8V
F10	TGPIO_05	I/O	Configurable GPIO #05		CMOS 1.8V
F9	TGPIO_04	I/O	Configurable GPIO #04		CMOS 1.8V
K11	TGPIO_03	I/O	Configurable GPIO #03		CMOS 1.8V
G9	TGPIO_02	I/O	Configurable GPIO #02		CMOS 1.8V
J11	TGPIO_01	I/O	Configurable GPIO #01		CMOS 1.8V
Power Supply					
C1	VBATT		Main power supply		Power
D1	VBATT		Main power supply		Power
	GND		52 pins for Ground (A2,A5,A12,B2,B3,B4,B5,B9,C2,		Power

Ball	Signal	I/O	Function	Internal Pull up	Type
			C10,D6,D9,E1,E6,E11,F1,F6,G10, H5,H6,H7,H8,H9,H10,J5,J10,J12, K5,K10,L5,L6,L7,L8,L9,L10,M2, M5,M10,N6,N7,P8,P9,R1,R2,R3, R7,R10,R11,R12,S3,S7,S10)		
Reserved					
	RESERVED		20 pins reserved (D3,E3,F3,G3,H3,D2,E2,F2,C4,C3, H2,J2,G2,K2,L1,K1,G1,J1,L2,H1)		
	RESERVED		7 pins reserved (P5,P3,P2,M1,N1,N2,P1)		
	RESERVED		9 pins reserved (G7,E7,D7,D8,E8,F8,G8,D11,F7)		
	RESERVED		6 pins reserved (C5,B8,C7,C8,B7,C6)		
	RESERVED		16 pins reserved (A7,A8,C12,J9,A1,A6,A9,A10,A11,B1,B6,B12,D12,H4,P4,S12)		

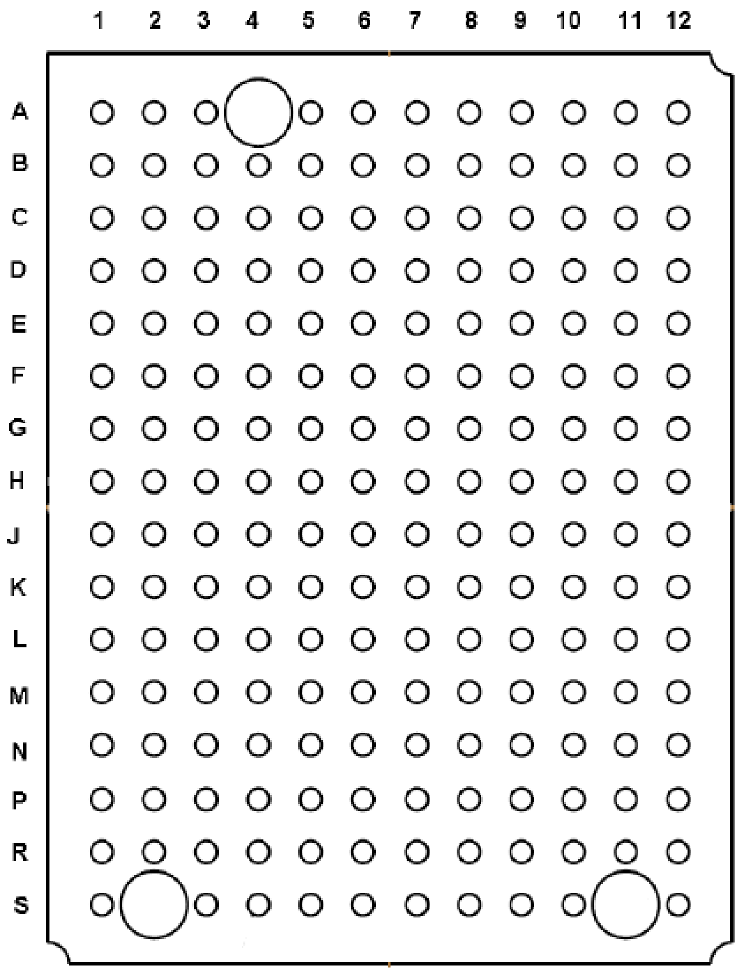
NOTE:

RESERVED Pins must be UNCONNECTED but be soldered.

NOTE:

If not used, almost all pins must be left disconnected.

4.4. BALLS LAYOUT



TOP VIEW

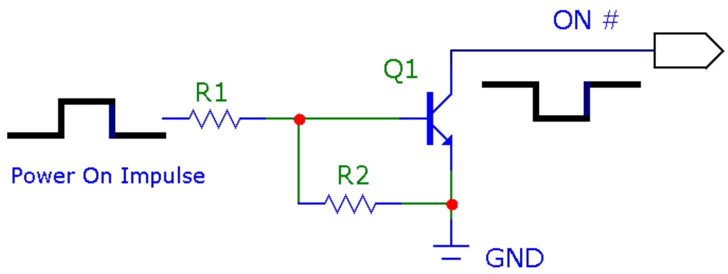
5. Hardware Commands

5.1. Turning ON the HE863

To turn on HE863 Family, the pad ON# must be tied low for at least 1 second and then released.

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

A simple circuit to do it is:



NOTE:

The HE863 Family turns fully on by supplying power more than 3.2V to the VBATT pads because of the first connect power on feature. This feature could be done only when Vbatt equals to almost 0V at the beginning. Normally the high value capacitor will be mounted on Vbatt line so the user should have a wait enoughly since vbatt is disabled till the remaining voltage on Vbatt is fully dischaged in order to do re-start by this feature.

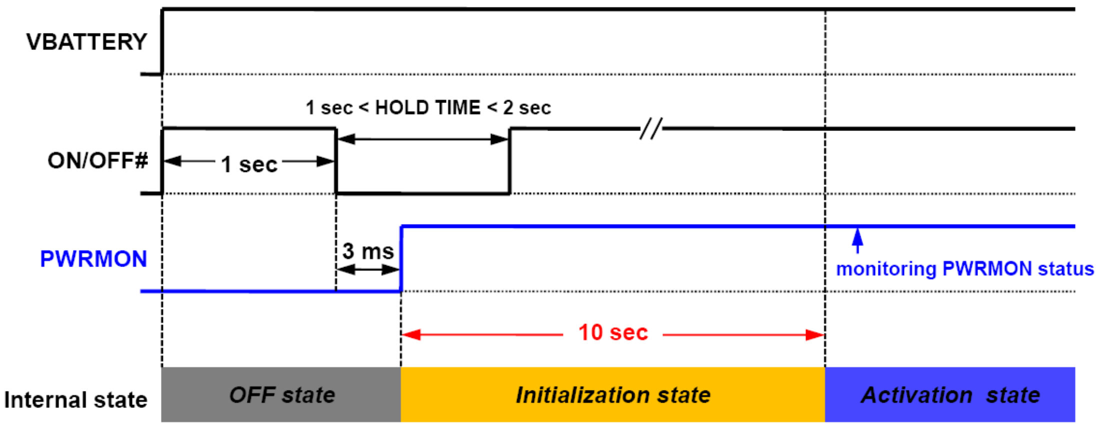
Because the discharge time depends upon the capacitance on Vbatt in the application it should be definitely considered in the application side.

HE863 Family has dozens uF on Vbatt line inside.

5.2. Initialization and Activation state

Upon turning on HE863 Family, HE863 Family is not activated yet because the boot sequence of HE863 Family is still going on internally. It takes about 10 seconds to complete the initializing the module internally.

For this reason, it would be useless to try to access HE863 Family during Initialization state as below. To get the desirable stability, HE863 Family needs at least 10 seconds after the PWRMON goes High.



During the *Initialization state*, any kind of AT-command is not available. DTE must be waiting for the *Activation state* to communicate with HE863 Family.

NOTE:

To check if the HE863 Family has powered on, the hardware line PWRMON must be monitored. When PWRMON goes high, the module has powered on.

NOTE:

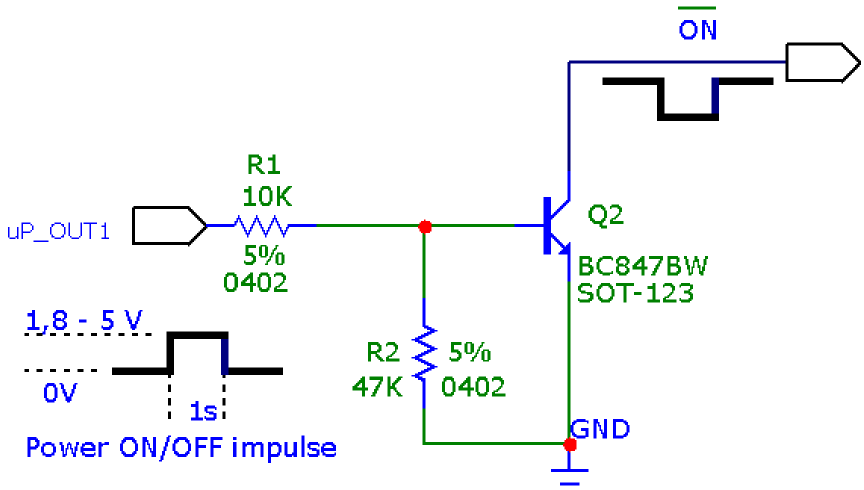
Do not use any pull up resistor on the ON# line, it is internally pulled up. Using pull up resistor may bring to latch up problems on the HE863 Family power regulator and improper power on/off of the module. The line ON# must be connected only in open collector configuration.

NOTE:

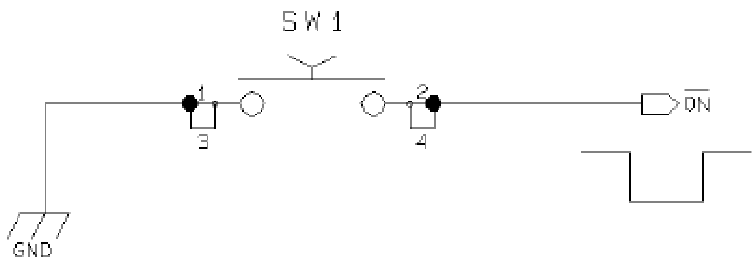
In this document all the lines are inverted. Active low signals are labeled with a name that ends with a "#" or with a bar over the name.

For example:

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



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



5.3. Turning OFF the HE863

The turning off the device can be done by below way:

- via AT command only (see HE863 Software User Guide)

TIP:

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

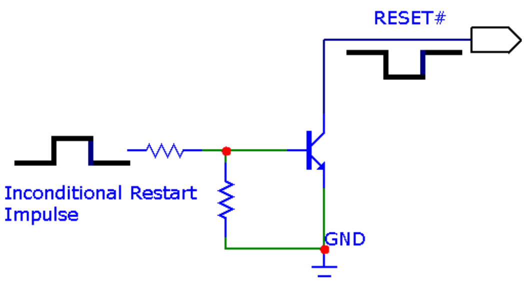
5.3.1. Hardware Unconditional Restart

WARNING:

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

To unconditionally restart the HE863 Family, the pad RESET# must be tied low for at least 200 milliseconds and then released.

A simple circuit to do it is:



NOTE:

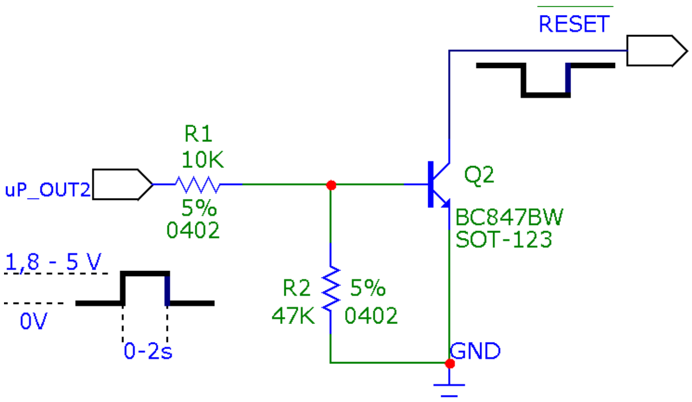
Do not use any pull up resistor on the RESET# line or any totem pole digital output. Using pull up resistor may bring to latch up problems on the HE863 Family power regulator and improper functioning of the module. The line RESET# must be connected only in open collector configuration

TIP:

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

For example:

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



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

6. Power Supply

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

6.1. Power Supply Requirements

The HE863 Family power requirements are:

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

HE863-EUD/NAD/AUD/EUG/NAG/AUG/EUR/NAR			
Mode		Average(mA)	Mode Description
IDLE mode			Standby mode; no call in progress; GPS OFF (GPS for HE863-EUG/NAG/AUG only)
AT+CFUN=0	-	60uA	Shutdown mode(Power off)
AT+CFUN=1	WCDMA	34	Normal mode; full functionality of the module
	GSM	33	
AT+CFUN=4	WCDMA	33	Disabled TX and RX; modules is not registered on the network
	GSM	33	
AT+CFUN=5	WCDMA	4/2*	CFN=5 full functionality with power saving; Module registered on the network can receive incoming call and SMS
	GSM	4/2*	
WCDMA TX and RX mode with GPS OFF			GPS OFF (GPS for HE863-EUG/NAG/AUG only)
WCDMA Voice	600		WCDMA voice channel
WCDMA data	600		WCDMA data channel
HSDPA	680		HSDPA data channel
HSUPA	610		HSUPA data channel
GSM TX and RX mode with GPS OFF			GPS OFF (GPS for HE863-EUG/NAG/AUG only)
GSM Voice	250		GSM voice channel
GPRS Class12	650		GPRS data channel
EDGE Class12	470		EDGE data channel

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

HE863-EUG/NAG/AUG only			
Mode		Average(mA)	Mode Description
IDLE mode with GPS ON full power mode*			Standby mode; no call in progress; GPS ON
AT+CFUN=1	WCDMA	62	
	GSM	61	
AT+CFUN=4	WCDMA	61	
	GSM	61	
AT+CFUN=5	WCDMA	54/53*	
	GSM	54/53*	
WCDMA TX and RX mode with GPS ON full power mode*			
WCDMA Voice		630	WCDMA voice channel
WCDMA Data		630	WCDMA data channel
HSDPA		710	HSDPA data channel
HSUPA		630	HSUPA data channel
GSM TX and RX mode with GPS ON full power mode*			
GSM Voice		280	GSM voice channel
GPRS Class12		670	GPRS data channel
EDGE Class12		500	EDGE data channel

* except external active GPS antenna

TIP:

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

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

6.2. General Design Rules

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

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

6.2.1. Electrical Design Guidelines

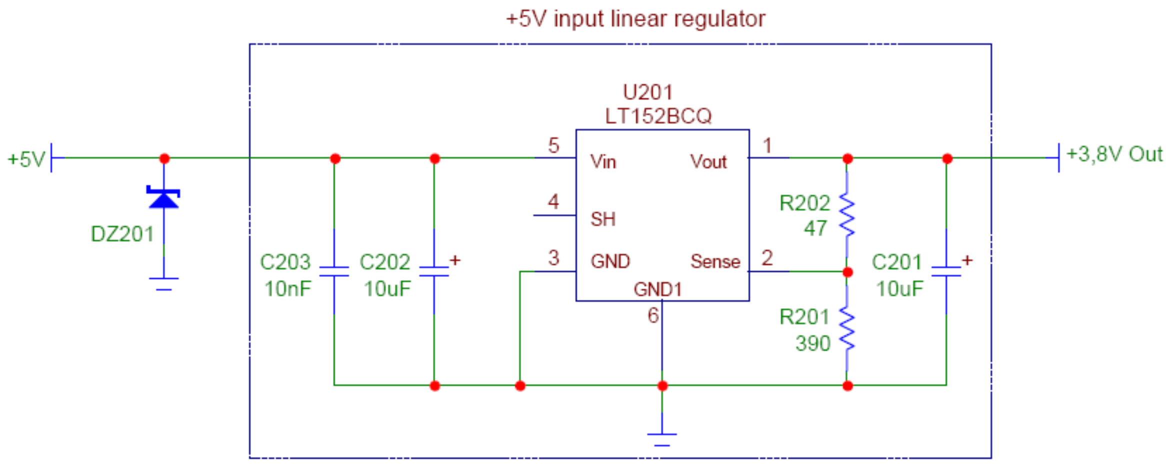
The electrical design of the power supply depends strongly on the power source where this power is drained. We will distinguish them into two categories:

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

6.2.1.1. + 5V Input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence there is not a big difference between the input source and the desired output and a linear regulator can be used. A switching power supply will not be suited because of the low drop-out requirements.
- When using a linear regulator, a proper heat sink must be provided in order to dissipate the power generated.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks close to HE863 Family, a 100μF tantalum capacitor is usually suited.
- Make sure the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.
- A protection diode must be inserted close to the power input, in order to save HE863 Family from power polarity inversion.

An example of linear regulator with 5V input is:

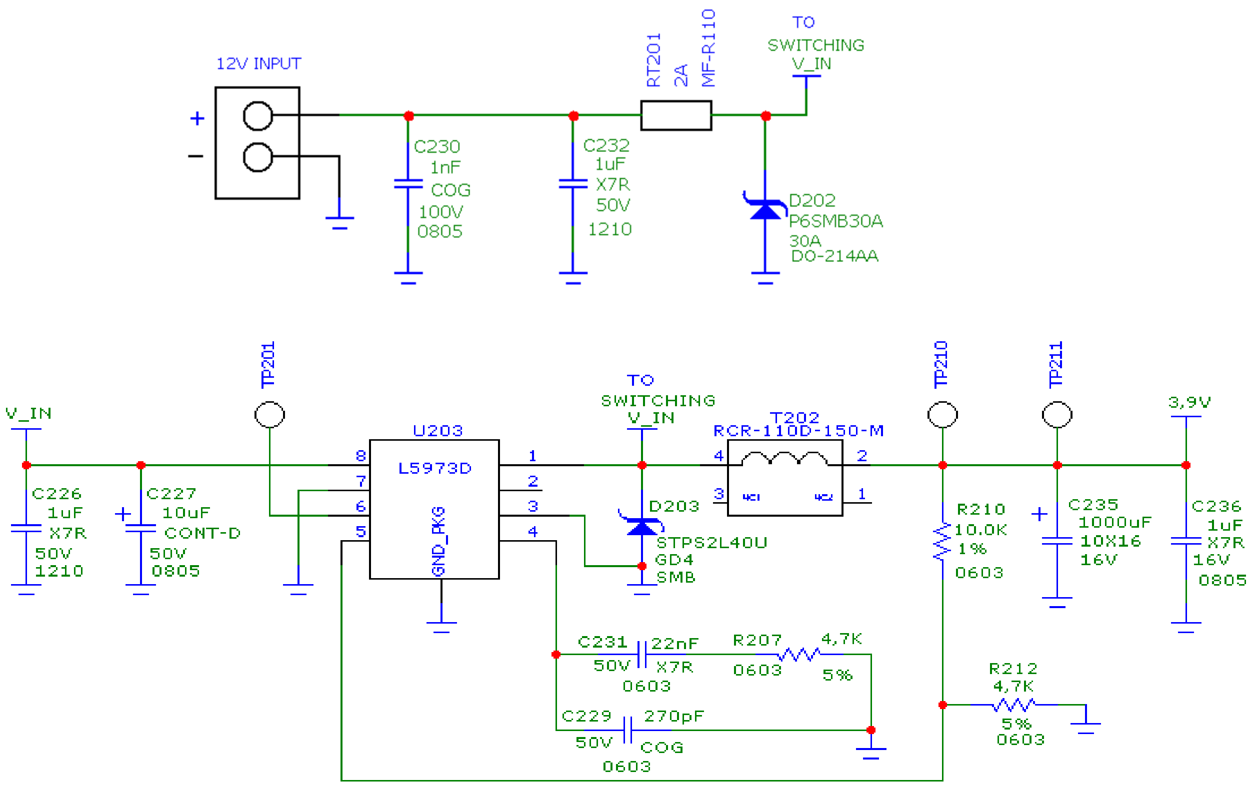


6.2.1.2. +12V Input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence due to the big difference between the input source and the desired output, a linear regulator is not suited and must not be used. A switching power supply will be preferable because of its better efficiency especially with the 2A peak current load represented by HE863 Family.
- When using a switching regulator, a 500 kHz or more switching frequency regulator is preferable because of its smaller inductor size and its faster transient response. This allows the regulator to respond quickly to the current peaks absorption.
- In any case, the frequency and Switching design selection is related to the application to be developed due to the fact the switching frequency could also generate EMC interferences.
- For car PB battery the input voltage can rise up to 15.8V and this must be kept in mind when choosing components: all components in the power supply must withstand this voltage.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks. A 100μF tantalum capacitor is usually suited for this.
- Make sure the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.
- For Car applications a spike protection diode must be inserted close to the power input, in order to clean the supply from spikes.

- A protection diode must be inserted close to the power input, in order to save HE863 Family 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

6.2.2. Thermal Design Guidelines

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

- Average current consumption during WCDMA/HSPA transmission @PWR level max : 710mA
- Average current consumption during class12 GPRS transmission @PWR level max : 670mA
- Average GPS current during GPS ON (Power Saving disabled) in HE863-EUG/NAG/AUG : 55mA

NOTE:

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

NOTE:

The thermal design for the Power supply must be made keeping an average consumption at the max transmitting level during calls of 750mA rms plus 100mA rms for GPS in tracking mode in HE863-EUG/NAG/AUG.

Considering the very low current during idle, especially if Power Saving function is enabled, it is possible to consider from the thermal point of view that the device absorbs current significantly only during calls.

If we assume that the device stays in transmission for short periods of time (let us say few minutes) and then remains for quite a long time in idle (let us say one hour), then the power supply has always the time to cool down between the calls and the heat sink could be smaller than the calculated for 850mA maximum RMS current. There could even be a simple chip package (no heat sink).

Moreover in average network conditions the device is requested to transmit at a lower power level than the maximum and hence the current consumption will be less than 850mA (TBD, 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 HE863 Family, you can consider it to be during transmission 1W max during CSD/VOICE calls and 2W max during class12 GPRS upload. This generated heat will be mostly conducted to the ground plane under the HE863 Family; you must ensure that your application can dissipate heat.

In the WCDMA/HSPA mode, since HE863 Family emits RF signals continuously during transmission, you must pay special attention how to dissipate the heat generated.

The current consumption will be up to about 710mA in HSPA continuously at the maximum TX output power (23dBm). Thus, you must arrange the PCB area as large as possible under HE863 Family which you will mount.

You must mount HE863 Family on the large ground area of your application board and make many ground vias to dissipate the heat.

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

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

6.2.3. Power Supply PCB Layout Guidelines

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

- The Bypass low ESR capacitor must be placed close to the Telit HE863 Family power input pads, or in the case the power supply is a switching type, it can be placed close to the inductor to cut the ripple if the PCB trace from the capacitor to HE863 Family is wide enough to ensure a drop-less connection even during the 2A current peaks.
- The protection diode must be placed close to the input connector where the power source is drained.
- The PCB traces from the input connector to the power regulator. IC must be wide enough to ensure no voltage drops to occur when the 2A current peaks are absorbed. Note that this is not made in order to save power loss but especially to avoid the voltage drops on the power line at the current peaks frequency of 216 Hz that will reflect on all the components connected to that supply (also introducing the noise floor at the burst base frequency.) For this reason while a voltage drop of 300-400 mV may be acceptable from the power loss point of view, the same voltage drop may not be acceptable from the noise point of view. If your application does not have audio interface but only uses the data feature of the Telit HE863 Family, then this noise is not so disturbing and power supply layout design can be more forgiving.
- The PCB traces to HE863 Family and the Bypass capacitor must be wide enough to ensure no significant voltage drops to occur when the 2A

current peaks are absorbed. This is a must for the same above-mentioned reasons. Try to keep this trace as short as possible.

- The PCB traces connecting the Switching output to the inductor and the switching diode must be kept as short as possible by placing the inductor and the diode very close to the power switching IC (only for switching power supply). This is done in order to reduce the radiated field (noise) at the switching frequency (usually 100-500 kHz).
- The use of a good common ground plane is suggested.
- The placement of the power supply on the board must be done in a way to guarantee that the high current return paths in the ground plane are not overlapped to any noise sensitive circuitry as the microphone amplifier/buffer or earphone amplifier.
- The power supply input cables must be kept separately from noise sensitive lines such as microphone/earphone cables.

7. Antenna(s)

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

7.1. GSM/WCDMA Antenna Requirements

As suggested on the Product Description, the antenna for a Telit HE863 Family device must fulfill the following requirements:

GSM / WCDMA Antenna Requirements			
Frequency range	Depending by frequency band(s) provided by the network operator, the customer must use the most suitable antenna for that/those band(s)		
Bandwidth	HE863-EUD/EUR/EUG	HE863-NAD/NAR/NAG	HE863-AUD/AUG
	70 MHz in GSM850, 80 MHz in GSM900, 170 MHz in DCS & 140 MHz in PCS 80 MHz in WCDMA900, 250 MHz in WCDMA2100	70 MHz in GSM850, 80 MHz in GSM900, 170 MHz in DCS & 140 MHz in PCS 70 MHZ in WCDMA850, 140 MHz in WCDMA1900	70 MHz in GSM850, 80 MHz in GSM900, 170 MHz in DCS & 140 MHz in PCS 70 MHz in WCDMA850, 250 MHz in WCDMA2100
Gain	Gain < 3dBi		
Impedance	50 Ohm		
Input power	> 33dBm(2 W) peak power in GSM > 24dBm Average power in WCDMA		
VSWR absolute max	<= 10:1		
VSWR recommended	<= 2:1		

When using the Telit HE863 Family, since there's no antenna connector on the module, the antenna must be connected to the HE863 Family through the PCB with the antenna pad using a 50 Ohm 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 HE863 Family, then a PCB line is needed in order to connect with it or with its connector.

This line of transmission shall fulfill the following requirements:

ANTENNA LINE ON PCB REQUIREMENTS	
Impedance	50 ohm
Max Attenuation	0,3 dB
No coupling with other signals allowed	
Cold End (Ground Plane) of antenna shall be equipotential to the HE863 Family ground pins.	

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

This device is to be used only for mobile and fixed application. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. End-Users must be provided with transmitter operation conditions for satisfying RF exposure compliance. OEM integrators must ensure that the end user has no manual instructions to remove or install the HE863 Family module. Antennas used for this OEM module must not exceed 3dBi gain for mobile and fixed operating configurations.

7.2. GSM/WCDMA 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 via holes once per 2mm at least;
- Place EM noisy devices as far as possible from HE863 Family antenna line;
- Keep the antenna line far away from the HE863 Family power supply lines;
- If you have EM noisy devices around the PCB hosting the HE863 Family, 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 HE863 Family, by using a strip-line on the superficial copper layer for the antenna line, the line attenuation will be lower than a buried one;

7.3. GSM/WCDMA Antenna – Installation Guidelines

- Install the antenna in a place covered by the GSM/WCDMA 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.

7.4. GPS Antenna Requirements (HE863-EUG/NAG/AUG only)

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

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

- Supply voltage referred to VBATT (Must accept values from 3.4 to 4.2 V DC)
- Supply enable controlled internally by the BB.

When using the Telit HE863-EUG/NAG/AUG, since there's no antenna connector on the module, the antenna must be connected to the HE863-EUG/NAG/AUG through the PCB with the antenna pad using a 50 Ohm 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 HE863-EUG/NAG/AUG, then a PCB line is needed in order to connect with it or with its connector.

This line of transmission shall fulfill the following requirements:

ANTENNA LINE ON PCB REQUIREMENTS	
Impedance	50 ohm
No coupling with other signals allowed	
Cold End (Ground Plane) of antenna shall be equipotential to the HE863-EUG/NAG/AUG ground pins.	

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

This device is to be used only for mobile and fixed application.

7.5. GPS Antenna-PCB Line Guidelines (HE863-EUG/NAG/AUG only)

- Ensure that the antenna line impedance is 50 ohm;
- Keep the antenna line on the PCB as short as possible to reduce the loss.
- Antenna line must have uniform characteristics, constant cross section, avoid meanders and abrupt curves;
- Keep, 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 HE863-EUG/NAG/AUG antenna line;
- Keep the antenna line far away from the HE863-EUG/NAG/AUG power supply lines;
- Keep the antenna line far away from the HE863-EUG/NAG/AUG WCDMA/GSM RF lines;
- If you have EM noisy devices around the PCB hosting the HE863-EUG/NAG /AUG, 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 HE863-EUG/NAG /AUG, by using a strip-line on the superficial copper layer for the antenna line, the line attenuation will be lower than a buried one;

7.6. GPS Antenna-Installation Guidelines (HE863-EUG/NAG/AUG only)

- The HE863-EUG/NAG/AUG due to its characteristics of sensitivity is capable to perform a Fix inside the buildings. (In any case the sensitivity could be affected by the building characteristics i.e. shielding)
- The Antenna must not be co-located or operating in conjunction with any other antenna or transmitter;

- Antenna shall not be installed inside metal cases
- Antenna shall be installed also according Antenna manufacturer instructions.

8. Logic Level Specifications

Where not specifically stated, all the interface circuits work at 1.8V CMOS logic levels. The following table shows the logic level specifications used in the Telit HE863 Family interface circuits:

For 1.8V CMOS signals:

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	-0.15V	+3.0 V

Operating Range - Interface levels

Level	Min	Max
Input high level	1.26V	2.0 V
Input low level	-0.2V	0.36V
Output high level	1.6V	1.8V
Output low level	0V	0.2V

8.1. Reset Signal

Signal	Function	I/O	BGA Ball
RESET	Phone reset	I	G5

RESET is used to reset the HE863 Family module. Whenever this signal is pulled low, HE863 Family is reset. When the device is reset it stops all operations. After the release of the reset HE863 Family is unconditionally shut down, without doing any detach operations from the network where it is registered. This behavior is not a proper shutdown because the device is requested to issue a detach request on turn off. For this reason, the Reset signal must not be used for normally shutting down the device, but only as an emergency exit in the rare case the device remains stuck waiting for some network response.

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

NOTE:

Do not use this signal to power off HE863 Family.

Use AT#SHDN command to perform this function.

Reset Signal Operating levels:

Signal	Min	Max
RESET Input high	2.0V*	2.6V
RESET Input low	0V	0.2V

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

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

9. Serial Ports

The serial port on the Telit HE863 Family is the interface between the module and OEM hardware.

2 serial ports are available on the module:

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

9.1. Modem Serial Port

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

- RS232 PC com port;
- microcontroller UART @ 1.8V – 2.0V (Universal Asynchronous Receive Transmit) ;

Depending on the type of serial port on the OEM hardware, a level translator circuit may be needed to make the system work. The only configuration that does not need a level translation is the 1.8V – 2.0V UART.

The serial port on HE863 Family is a +1.8V UART with all the 7 RS232 signals. It differs from the PC-RS232 in signal polarity (RS232 is reversed) and levels. The levels for HE863 Family UART are the CMOS levels:

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	-0.15V	+3.0 V

Operating Range - Interface levels

Level	Min	Max
Input high level	1.26V	2.0 V
Input low level	-0.2V	0.36V
Output high level	1.6V	1.8V
Output low level	0V	0.2V

The signals of the HE863 Family serial port are:

RS232 Pin Number	Signal	HE863 Family Ball	Name	Usage
1	DCD - dcd_uart (TBD)	M3	Data Carrier Detect	Output from the HE863 Family that indicates the carrier presence
2	RXD - Tx_uart	J4	Transmit line *see Note	Output transmit line of HE863 Family UART
3	TXD - Rx_uart	J3	Receive line *see Note	Input receive of the HE863 Family UART
4	DTR - dtr_uart (TBD)	L3	Data Terminal Ready	Input to the HE863 Family that controls the DTE READY condition
5	GND	All GND	Ground	ground
6	DSR - dsr_uart (TBD)	L4	Data Set Ready	Output from the HE863 Family that indicates the module is ready
7	RTS - rts_uart	K3	Request to Send	Input to the HE863 Family that controls the Hardware flow control
8	CTS - cts_uart	K4	Clear to Send	Output from the HE863 Family that controls the Hardware flow control
9	RI - ri_uart (TBD)	M4	Ring Indicator	Output from the HE863 Family that indicates the Incoming call condition

TIP:

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

NOTE:

According to V.24, RX/TX signal names are referred to the application side, therefore on the HE863 Family side these signal are on the opposite direction: TXD on the application side will be connected to the receive line (here named TXD/ rx_uart) of the HE863 Family serial port and vice versa for RX.

9.2. RS232 Level Translation

In order to interface the Telit HE863 Family 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 0/1.8V to +15/-15V.

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

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

By convention the driver is the level translator from the 0-1.8V UART to the RS232 level. The receiver is the translator from the RS232 level to 0-1.8V UART.

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

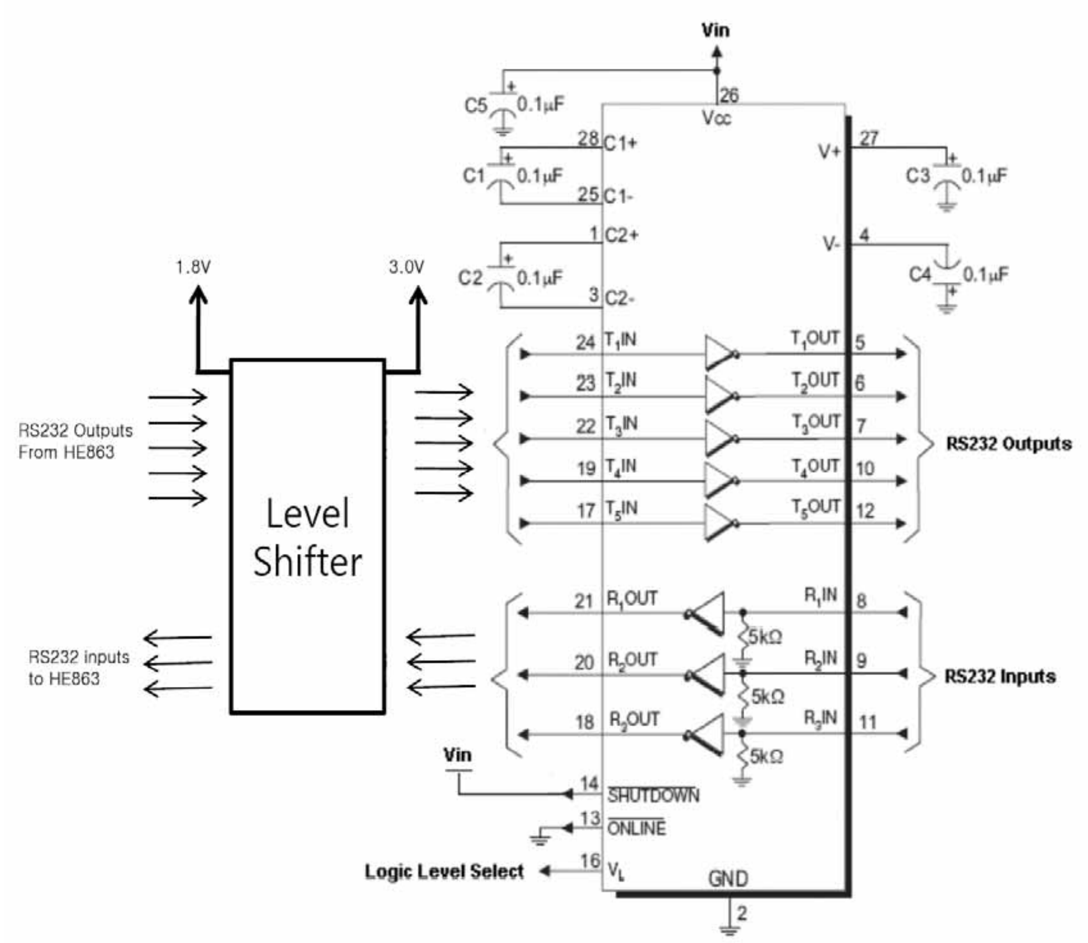
- 5 drivers
- 3 receivers

NOTE:

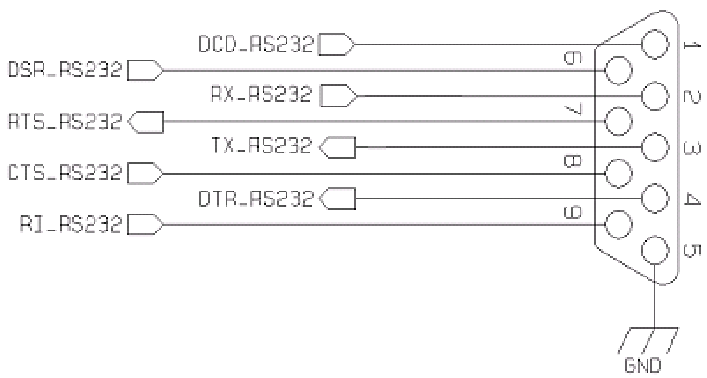
The digital input lines working at 1.8V CMOS have an absolute maximum input voltage of 3.6V; therefore the level translator IC shall not be powered by the +3.8V supply of the module. Instead, it must be powered from a +1.8V / +2.0V (dedicated) power supply.

This is because in this way the level translator IC outputs on the module side (i.e. HE863 Family inputs) will work at +3.8V interface levels, damaging the module inputs.

An example of level translation circuitry of this kind is:



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



10. USB Port

The HE863 Family module includes a Universal Serial Bus (USB) transceiver, which operates at USB low-speed (1.5Mbits/sec), USB full-speed (12Mbits/sec) and USB high-speed (480Mbits/sec).

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

The table below describes the USB interface signals:

Signal	HE863 Family Ball	Usage
USB_VBUS	S8	Power supply for the internal USB transceiver. This pin is configured as an analog input or an analog output depending upon the type of peripheral device connected.
USB_D-	R8	Minus (-) line of the differential, bi-directional USB signal to/from the peripheral device
USB D+	R9	Plus (+) line of the differential, bi-directional USB signal to/from the peripheral device
USB_ID (TBD)	S9	Analog input used to sense whether a peripheral device is connected and if connected, to determine the peripheral type, host or slave

TIP:

The HE863 Family does NOT support host device operation at the moment, that is, it works as a slave device.

11. Audio Section (HE863-EUR/EUG/NAR/NAG/AUG only)

The *Baseband* chip was developed for the cellular phones, which needed two separated amplifiers both in *RX* and in *TX* section.
A couple of amplifiers had to be used with internal audio transducers while the other couple of amplifiers had to be used with external audio transducers.
To distinguish the schematic signals and the Software identifiers, two different definitions were introduced, with the following meaning:

- internal audio transducers → ***HS/MT differential/Single ended type*** (from ***H****and****S****et* or ***M****icro****T****elephone*)
- external audio transducers → ***HF*** only single-ended output type (from ***H****ands****F****ree*)

Actually the acronyms have not the original importance.
In other words this distinction is not necessary, being the performances between the two blocks like the same.

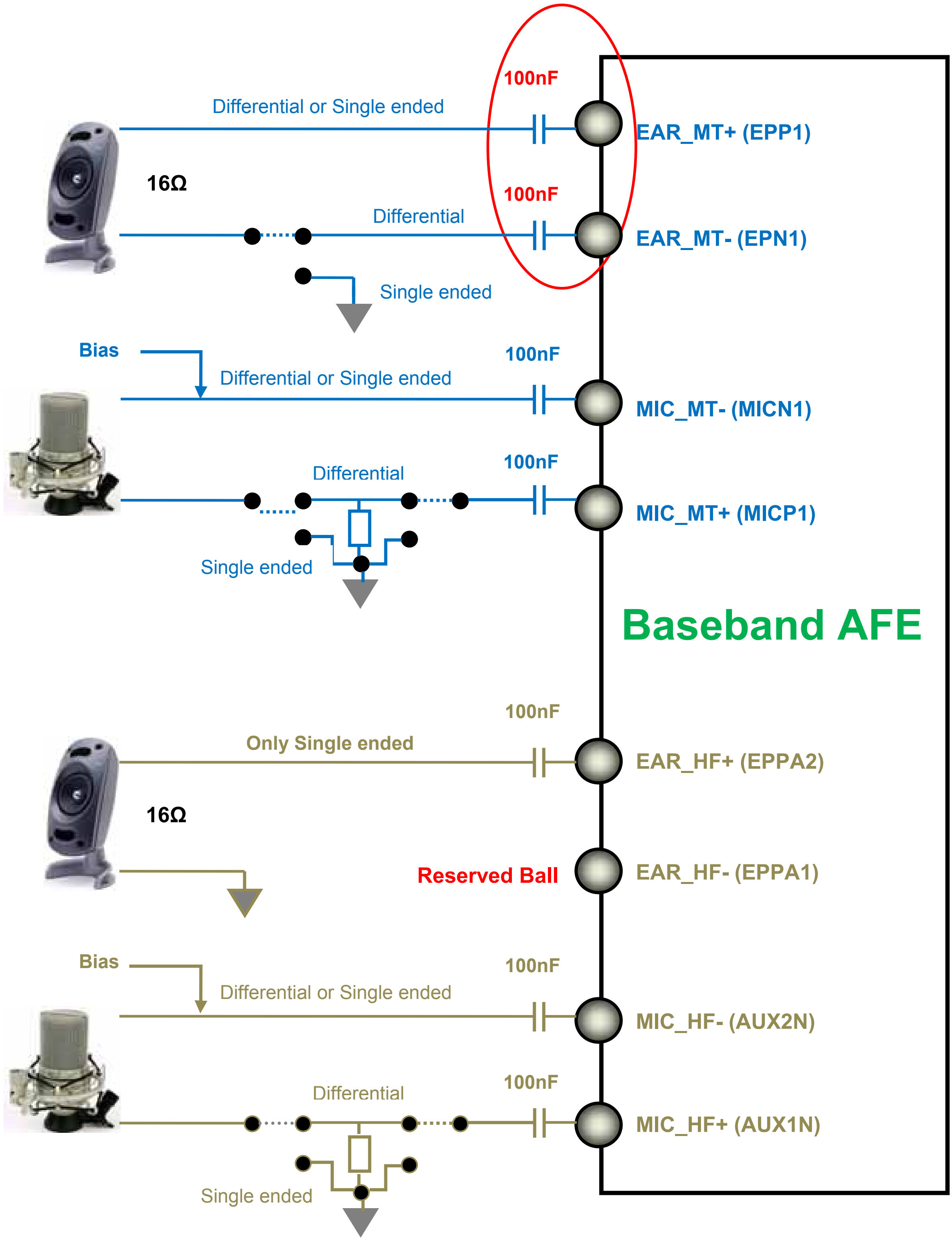
Only if the customer needs higher output power to the speaker, he has a constraint.
Otherwise the choice could be done in order to overcome the PCB design difficulties.

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

11.1. Selection mode

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

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


100nF
Differential or Single ended
EAR_MT+ (EPP1)
16Ω
100nF
Differential
EAR_MT- (EPN1)
Single ended
Bias
100nF
Differential or Single ended
MIC_MT- (MICN1)
Differential
100nF
MIC_MT+ (MICP1)
Single ended
Baseband AFE
100nF
Only Single ended
EAR_HF+ (EPPA2)
16Ω
Reserved Ball
EAR_HF- (EPPA1)
Bias
100nF
Differential or Single ended
MIC_HF- (AUX2N)
Differential
100nF
MIC_HF+ (AUX1N)
Single ended

11.2. Microphone Characteristics

TIP:

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

11.2.1. Input Lines (*MIC1 and MIC2*) Characteristics (TBD)

Line coupling	
Line type	
Coupling capacitor	
Differential input impedance	
Differential input voltage	

11.3. OUTPUT LINES (*Speaker*)

We suggest driving the load differentially from both output drivers, thus the output swing will double and the need for the output coupling capacitor avoided.
If a particular OEM application needs a *Single Ended Output* configuration the output power will be reduced four times.
The OEM circuitry shall be designed to reduce the common mode noise typically generated on the ground plane and to get the maximum power output from the device (low resistance tracks).

(*) WARNING:

Using single ended configuration, the unused output line <u>must</u> be left open.

Not respecting this constraint, the output stage will be damaged.

DANGER:

Using HS/MT, the serial capacitors below 100nF must be connected in the output lines.

The handsfree mode only supports single ended type and reserved HF- Ball must be opened.

11.3.1. Output Lines Characteristics (TBD)

Line coupling differential	DC
single-ended	AC
Output load impedance differential	16 Ω
Differential output impedance	
Signal bandwidth	150 - 4000 Hz @ -3 dB
Differential output voltage (typ.)	1060 mV_{rms}/16 Ω
Max Output Power @ 16 Ω	
Max load capacitance	

Table 3. ***"Ear_MT" Output*** (*EAR_EPP1* differential amplifier)

Line coupling differential	
single-ended	
Output load impedance single-ended	16 Ω (≤ 26)
S.E. output impedance	≤ 0,5 Ω @ 1.02kHz
signal bandwidth	150 - 4000 Hz @ -3 dB
Differential output voltage (typ.)	833 mV_{rms}/16 Ω
Max Output Power @ 16Ω	
Max load capacitance	

Table 4. ***"Ear_HF" Output*** (*EAR_EPPA2* amplifiers)

12. General Purpose I/O

The general-purpose I/O pads can be configured to act in three different ways:

- input
- output
- alternate function (internally controlled)

Input pads can only be read and report the digital value (high or low) present on the pad at the read time; output pads can only be written or queried and set the value of the pad output; an alternate function pad is internally controlled by the HE863 Family firmware and acts depending on the function implemented.

The following GPIOs are available on the HE863 Family.

Ball	Signal	I/O	Function	Type	Drive strength	Default State	ON_OFF State	Note
J11	TGPIO_01	I/O	GPIO01 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
G9	TGPIO_02	I/O	GPIO02 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
K11	TGPIO_03	I/O	GPIO03 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
F9	TGPIO_04	I/O	GPIO04 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
F10	TGPIO_05	I/O	GPIO05 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
E10	TGPIO_06	I/O	GPIO06 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	Alternate function (ALARM)
E9	TGPIO_07	I/O	GPIO07 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
B10	TGPIO_08	I/O	GPIO08 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
N12	TGPIO_09	I/O	GPIO09 Configurable	CMOS 1.8V	2mA	INPUT	LOW	

			GPIO					
M8	TGPIO_10	I/O	GPIO10 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	Alternate function (PCM_TX) -R/-G only
P12	TGPIO_11	I/O	GPIO11 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
L12	TGPIO_12	I/O	GPIO12 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
N11	TGPIO_13	I/O	GPIO13 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
P11	TGPIO_14	I/O	GPIO14 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
M12	TGPIO_15	I/O	GPIO15 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
N10	TGPIO_16	I/O	GPIO16 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
M7	TGPIO_17	I/O	GPIO17 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	Alternate function (PCM_SYNC) -R/-G only
M9	TGPIO_18	I/O	GPIO18 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	Alternate function (PCM_RX) -R/-G only
P10	TGPIO_19	I/O	GPIO19 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
M11	TGPIO_20	I/O	GPIO20 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	
K12	TGPIO_21	I/O	GPIO21 Configurable GPIO	CMOS 1.8V	2mA	INPUT	HIGH	
L11	TGPIO_22	I/O	GPIO22 Configurable GPIO	CMOS 1.8V	2mA	INPUT	LOW	

Not all GPIO pads support all these three modes:

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

Some alternate functions for HE863 Family may be added if needed.

12.1. Logic Level Specifications

Where not specifically stated, all the interface circuits work at 1.8V CMOS logic levels.

The following table shows the logic level specifications used in the HE863 Family interface circuits:

For 1.8V CMOS signals:

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	-0.15V	+3.0 V

Operating Range - Interface levels

Level	Min	Max
Input high level	1.26V	2.0 V
Input low level	-0.2V	0.36V
Output high level	1.6V	1.8V
Output low level	0V	0.2V

12.2. Using a GPIO Pad as Input

The GPIO pads, when used as inputs, can be connected to a digital output of another device and report its status, provided this device has interface levels compatible with the 1.8V CMOS levels of the GPIO.

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

12.3. Using a GPIO Pad as Output

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

12.4. Using the Alarm Output GPIO6

The GPIO6 pad, when configured as Alarm Output, is controlled by the HE863 Family 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 HE863 Family controlling microcontroller or application at the alarm time, giving you the possibility to program a timely system wake-up to achieve some periodic actions and completely turn off either the application or the HE863 Family during sleep periods. This will dramatically reduce the sleep consumption to few μA.

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

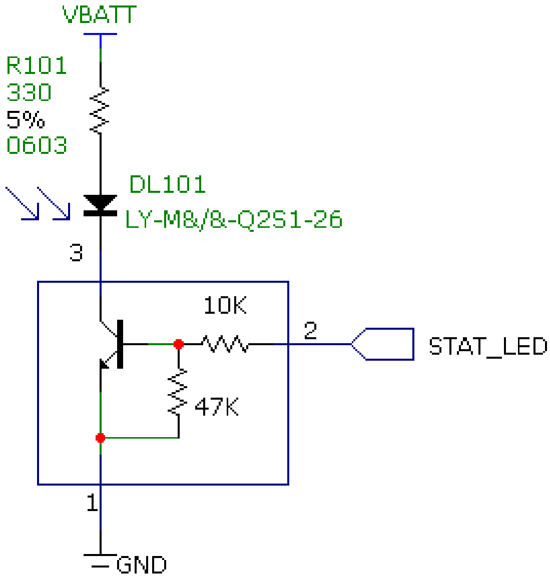
NOTE:

During RESET the line is set to HIGH logic level.

12.5. Indication of Network Service Availability

The STAT_LED pin status shows information on the network service availability and Call status. In the HE863 Family modules, the STAT_LED usually needs an external transistor to drive an external LED. Because of the above, the status indicated in the following table is reversed with respect to the pin status:

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



12.6. RTC Bypass Out

The VRTC pin brings out the Real Time Clock supply, which is separate from the rest of the digital part, allowing having only RTC going on when all the other parts of the device are off. To this power output a backup capacitor can be added in order to increase the RTC autonomy during power off of the battery.

NOTE:

NO devices must be powered from this pin.

12.7. 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	1.75V	1.8V	1.85V
Output current			100mA
Output bypass capacitor (Inside the module)			1μF

13. DAC and ADC section

13.1. DAC Converter

13.1.1. Description

The HE863 Family module provides a Digital to Analog Converter. The signal (named DAC_OUT) is available on BGA Ball S4 of the HE863 Family module.

The on board DAC is a 16-bit converter, able to generate an analogue value based on a specific input in the range from 0 up to 65535 but recalibrated in the range from 0 to 1023. However, an external low-pass filter is necessary.

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

The precision is 1023 steps, so if we consider that the maximum voltage is 1.8V, the integrated voltage could be calculated with the following formula:

Integrated output voltage = 1.8 * value / 1023

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

13.1.2. Enabling DAC

An AT command is available to use the DAC function. The command is:AT#DAC[=<enable>[,<value>]]

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

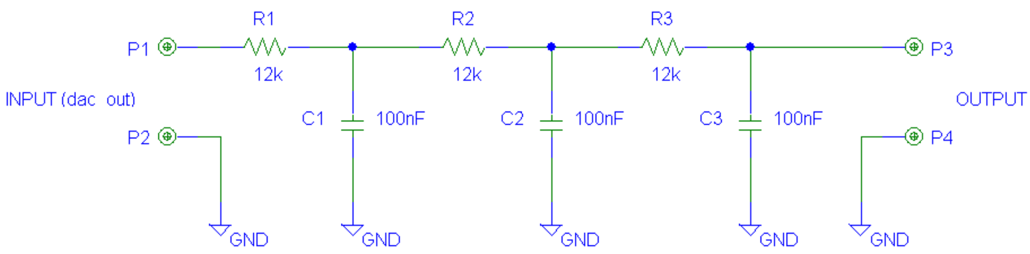
it must be present if <enable>=1

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

NOTE:

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

13.1.3. Low Pass Filter Example



13.2. ADC Converter

13.2.1. Description

The on board ADCs are 10-bit converters. They are able to read a voltage level in the range of 0-1.2 volts applied on the ADC pin input and store and convert it into 10 bit word.

	Min	Max	Units
Input Voltage range	0	1.2	Volt
AD conversion	-	10	bits
Resolution	-	< 1.2	mV

The HE863 Family module provides 3 Analog to Digital Converters. The input lines are:

ADC_IN1 is available on BGA Ball R4 of the HE863 Family module.

ADC_IN2 is available on BGA Ball R5 of the HE863 Family module.

ADC_IN3 is available on BGA Ball S5 of the HE863 Family module.

13.2.2. Using ADC Converter

An AT command is available to use the ADC function.

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

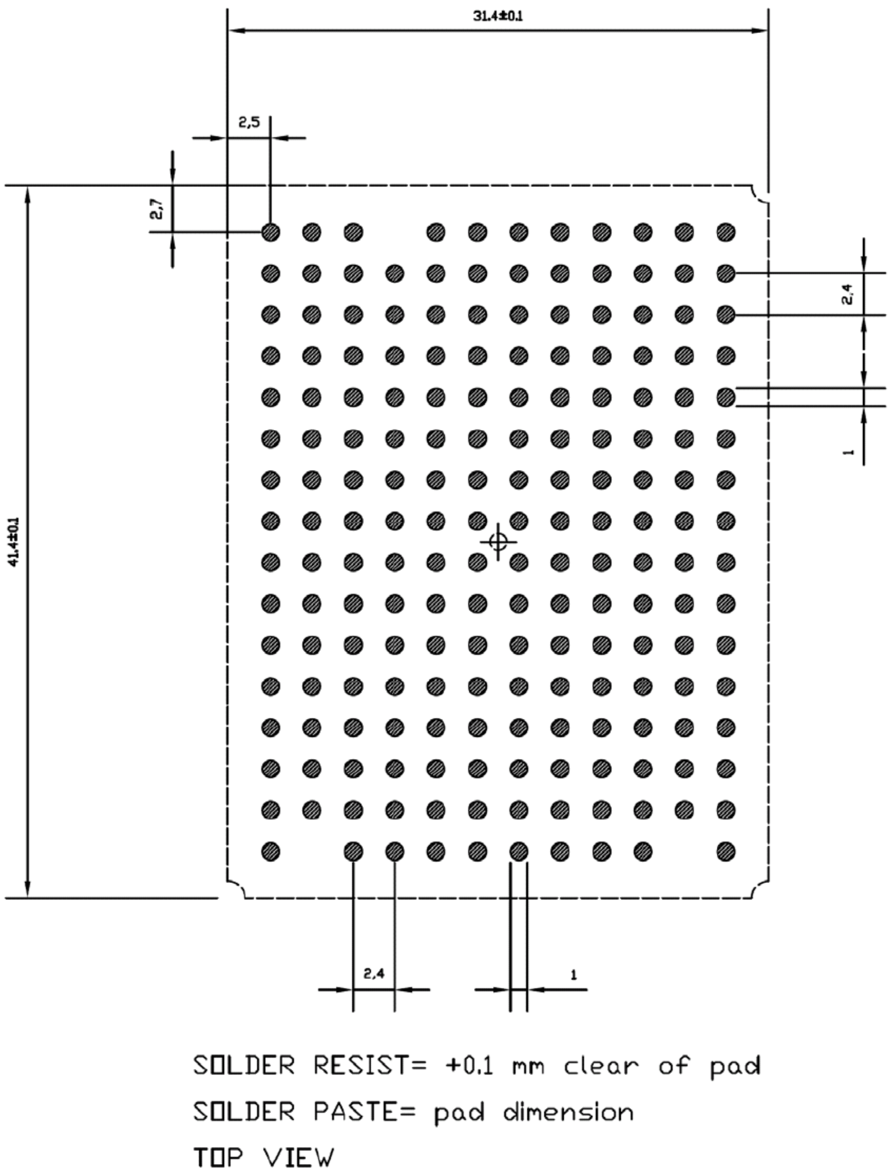
Refer to SW User Guide or AT Commands Reference Guide for the full description of this function.

14. Mounting the HE863 Family on your board

14.1. General

The Telit HE863 Family module has been designed in order to be compliant with a standard lead-free SMT process.

14.1.1. Recommended footprint for the application



14.1.2. Suggested Inhibit Area

In order to easily rework the HE863 Family it is suggested to consider on the application a 1.5mm Inhibit area around the module.

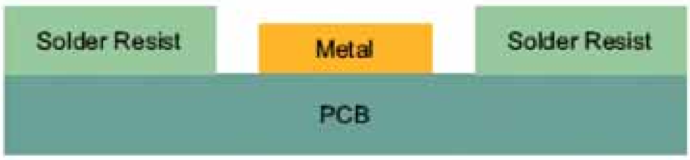
It is also suggested, as common rule for an SMT component, to avoid having a mechanical part of the application in direct contact with the module.

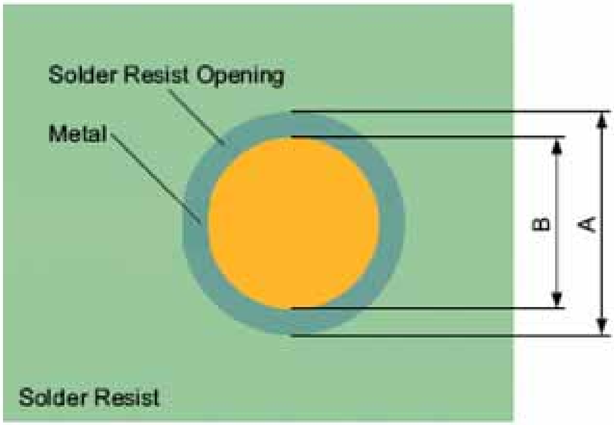
14.1.3. Stencil

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

14.1.4. PCB Pad Design

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

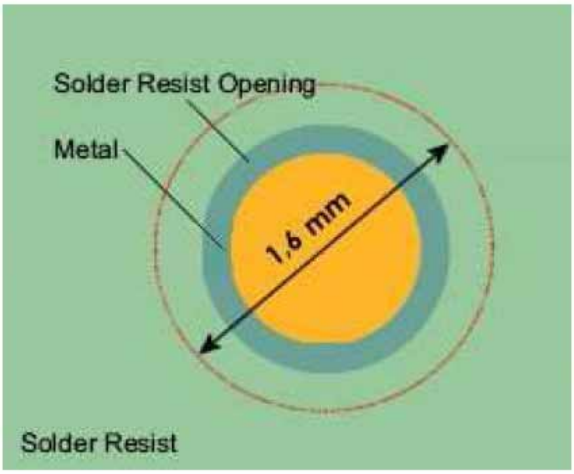




Recommendations for PCB pad dimensions

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, unless the microvia carries the same signal of the pad itself.



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

Recommendations for PCB pad surfaces:

Finish	Layer tickness [um]	Properties
Electro-less Ni / Immersion Au	3-7 / 0,05-0,15	good solder ability protection, high shear force values

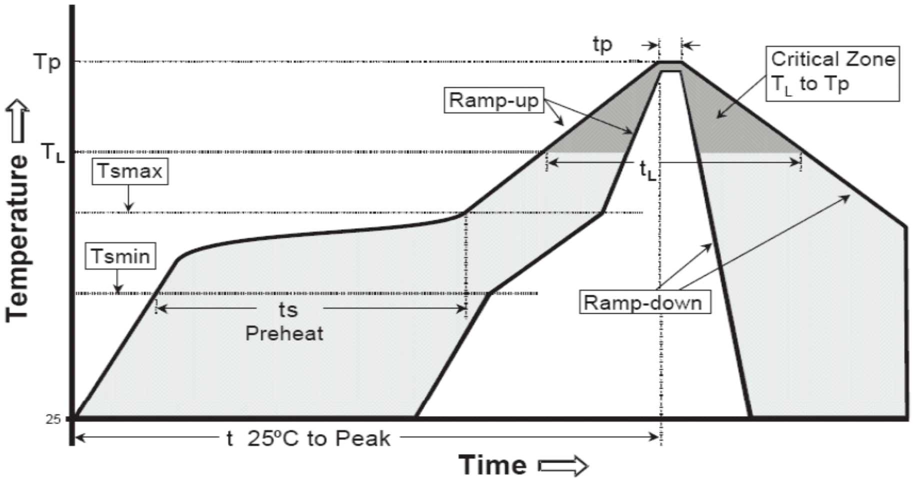
The PCB must be able to resist the higher temperatures, which are occurring at the lead-free process. This issue should be discussed with the PCB-supplier. Generally, the wet-ability of tin-lead solder paste on the described surface plating is better compared to lead-free solder paste.

14.1.5. Solder paste

	Lead free
Solder paste	Sn / Ag / Cu

14.1.6. HE863 Family 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.

WARNING:

HE863 Family module can accept only one reflow process.

14.2. DEBUG OF THE HE863 Family IN PRODUCTION

To test and debug the mounting of HE863 Family, we strongly recommend foreseeing test pads on the host PCB, in order to check the connection between the HE863 Family itself and the application and to test the performance of the module connecting it with an external computer. Depending on the customer application, these pads include, but are not limited to the following signals:

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

15. SIM holder design guide

15.1. Overview

In HE863 Family modules there are five pins for SIM card holder connection.

These lines are:

SIMVCC	(SIM Power supply)
SIMRST	(SIM Reset)
SIMIO	(SIM Data)
SIMIN	(SIM Presence/Absence) (TBD)
SIMCLK	(SIM Clock)

SIM connection must take in account of three key issues:

1) Data Integrity: standard rules for digital layout and routing must be followed taking in consideration that SIMCLK has frequency of 3.57 MHz and SIMIO has 9600Bps baud rate.

2) EMI/EMC: this is a key aspect to consider designing an application based on TELIT modules with internal antenna and/or without a proper-shielded box.
Some of these conditions may occur:

- Antenna picks-up digital noise coming from SIM card lines.
- Antenna radiated field may interfere digital lines.
- Digital lines (in particular clock) may radiate spurious in the surrounding space.

To overcome all these potential problems, connection lines must be kept as short as possible and shielded.
SIM-holder position has to be as far as possible from antenna.
RF bypass capacitors (10pF…33pF) closed to SIM card SIM-holder are another good care.
When connection is not short, insertion of 10..100ohm resistor with 10..33pF capacitor (RC filter) is a good caution to improve EMI from SIMCLK line.
Do not insert resistor on SIMVCC, SIMRST and SIMIO lines, their use is not supported by SIM electrical interface.

3) ESD: take standard ESD caution if application based on TELIT module has SIM holder with contacts reachable from human body.

NOTE:

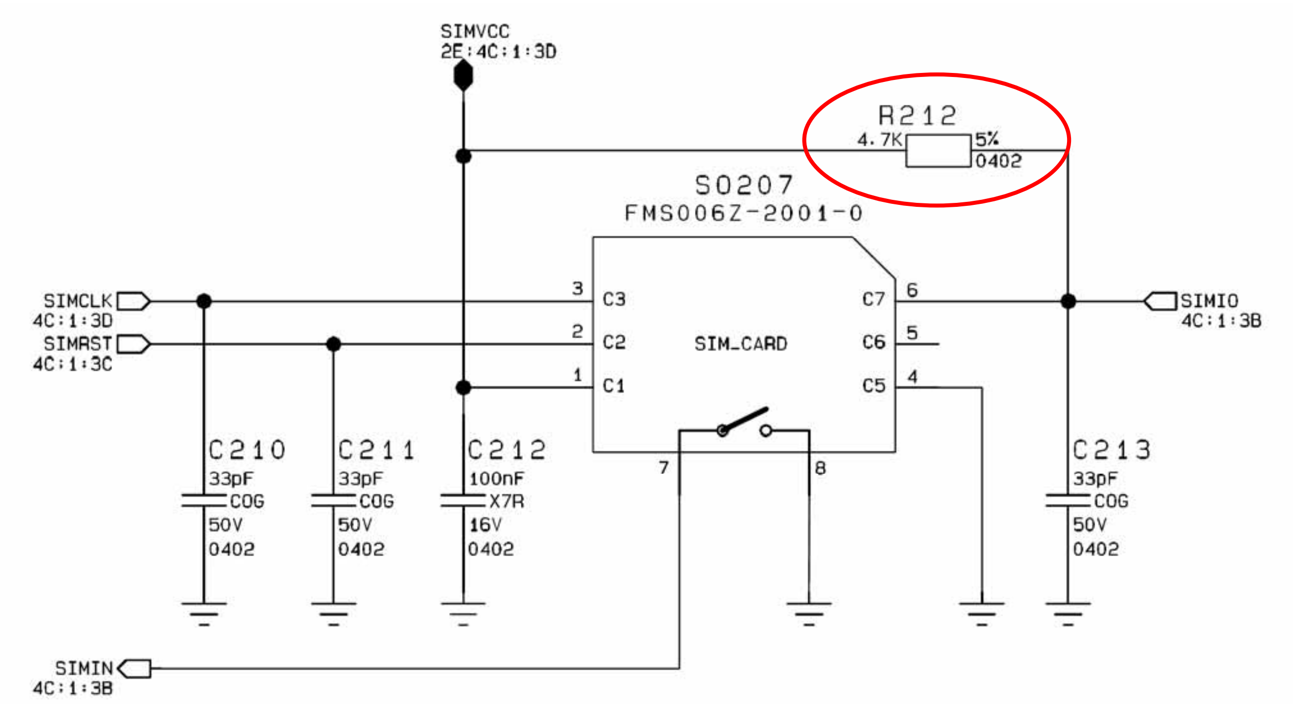
SIMIN doesn't require any pull-up resistor. It is built in.

SIM card is detected inserted when this line is short to ground.(TBD)

If in the application the SIM holder doesn't foresee the switch for the presence/absence of the SIM card, the SIMIN line must be connected to ground.

15.2. SIM interface

When designing SIM interface on the application boards, the following schematics are recommended.



Special attention should be paid to the value of Resistor R212.

3GPP specifications define that the rise time and the fall

time of the IO signal shall not exceed 1 usec.

R212 and C213 are very closely related to the rise time and

the fall time of the SIMIO signal.

It can differ depending on the application board therefore it should be considered at the customer point of view.

It means that the values of C210,C211,C212,C213 and R212 may be necessary to be optimized according to the application design.

Telit highly recommends that the customers should verify the relating specification when they design.

But in general there will be no issue if above schematics were made on the application board.

HE863 products already have R212=4.7kohm and C213=33pF on SIMIO line internally.

16. Antenna detection design guide

The following assumes that the application is using a commonly found 10KΩ DC terminated antenna.

The figure below outlines the reference implementation, please keep in mind that these components are in the RF path and care must be taken when implementing this circuit.

The Vaux is a 1.8V regulated power source output from the module.

ADC is a 0 ~ 1200mV 10-bit Analog to Digital Converter input.

The software assumes the use of the ADC1 input and GPIO13 port of the module for this purpose.

For the detailed operation of this function, please find AT#GSMAD command in the HE863 AT Command Manual.

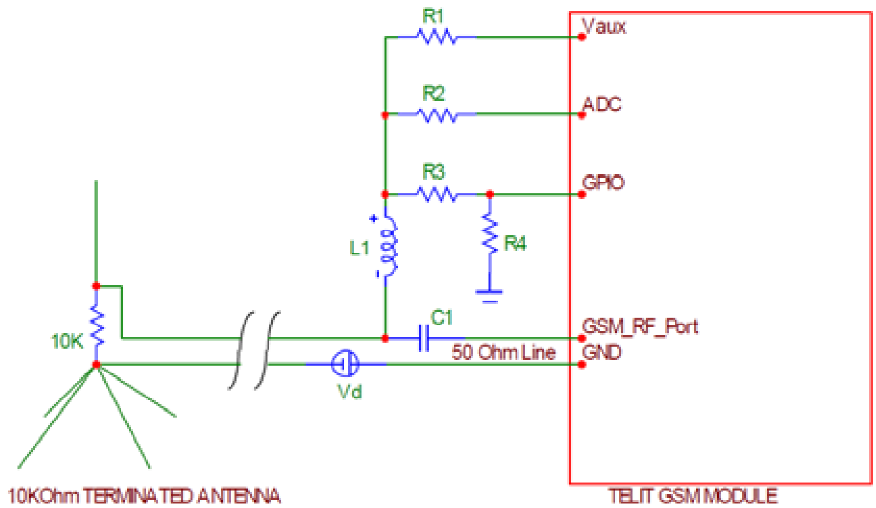


Figure 1, Antenna Diagnostics reference schematic.

Component	Value
R1	68KΩ
R2	15KΩ
R3	68KΩ
R4	68KΩ
L1	47nH
C1	33pF

17. Safety Recommendations

Read carefully!

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

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

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

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

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

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

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

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

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

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

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

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