WE866C3
HW Design Guide

1VV0301495 Rev. 7 – 2019-03-19

TELIT
TECHNICAL
DOCUMENTATION

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

NOTICE

While reasonable efforts have been made to assure the accuracy of this document, Telit assumes no liability resulting from any inaccuracies or omissions in this document, or from use of the information obtained herein. The information in this document has been carefully checked and is believed to be reliable. However, no responsibility is assumed for inaccuracies or omissions. Telit reserves the right to make changes to any products described herein and reserves the right to revise this document and to make changes from time to time in content hereof with no obligation to notify any person of revisions or changes. Telit does not assume any liability arising out of the application or use of any product, software, or circuit described herein; neither does it convey license under its patent rights or the rights of others.

It is possible that this publication may contain references to, or information about Telit products (machines and programs), programming, or services that are not announced in your country. Such references or information must not be construed to mean that Telit intends to announce such Telit products, programming, or services in your country.

COPYRIGHTS

This instruction manual and the Telit products described in this instruction manual may be, include or describe copyrighted Telit material, such as computer programs stored in semiconductor memories or other media. Laws in the Italy and other countries preserve for Telit and its licensors certain exclusive rights for copyrighted material, including the exclusive right to copy, reproduce in any form, distribute and make derivative works of the copyrighted material. Accordingly, any copyrighted material of Telit and its licensors contained herein or in the Telit products described in this instruction manual may not be copied, reproduced, distributed, merged or modified in any manner without the express written permission of Telit. Furthermore, the purchase of Telit products shall not be deemed to grant either directly or by implication, estoppel, or otherwise, any license under the copyrights, patents or patent applications of Telit, as arises by operation of law in the sale of a product.

COMPUTER SOFTWARE COPYRIGHTS

The Telit and 3rd Party supplied Software (SW) products described in this instruction manual may include copyrighted Telit and other 3rd Party supplied computer programs stored in semiconductor memories or other media. Laws in the Italy and other countries preserve for Telit and other 3rd Party supplied SW certain exclusive rights for copyrighted computer programs, including the exclusive right to copy or reproduce in any form the copyrighted computer program. Accordingly, any copyrighted Telit or other 3rd Party supplied SW computer programs contained in the Telit products described in this instruction manual may not be copied (reverse engineered) or reproduced in any manner without the express written permission of Telit or the 3rd Party SW supplier. Furthermore, the purchase of Telit products shall not be deemed to grant either directly or by implication, estoppel, or otherwise, any license under the copyrights, patents or patent applications of Telit or other 3rd Party supplied SW, except for the normal non-exclusive, royalty free license to use that arises by operation of law in the sale of a product.

USAGE AND DISCLOSURE RESTRICTIONS

I. License Agreements

The software described in this document is the property of Telit and its licensors. It is furnished by express license agreement only and may be used only in accordance with the terms of such an agreement.

II. Copyrighted Materials

Software and documentation are copyrighted materials. Making unauthorized copies is prohibited by law. No part of the software or documentation may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language or computer language, in any form or by any means, without prior written permission of Telit

III. High Risk Materials

Components, units, or third-party products used in the product described herein are NOT fault-tolerant and are NOT designed, manufactured, or intended for use as on-line control equipment in the following hazardous environments requiring fail-safe controls: the operation of Nuclear Facilities, Aircraft Navigation or Aircraft Communication Systems, Air Traffic Control, Life Support, or Weapons Systems (High Risk Activities"). Telit and its supplier(s) specifically disclaim any expressed or implied warranty of fitness for such High-Risk Activities.

IV. Trademarks

TELIT and the Stylized T Logo are registered in Trademark Office. All other product or service names are the property of their respective owners.

V. Third Party Rights

The software may include Third Party Right software. In this case you agree to comply with all terms and conditions imposed on you in respect of such separate software. In addition to Third Party Terms, the disclaimer of warranty and limitation of liability provisions in this License shall apply to the Third-Party Right software.

TELIT HEREBY DISCLAIMS ANY AND ALL WARRANTIES EXPRESS OR IMPLIED FROM ANY THIRD PARTIES REGARDING ANY SEPARATE FILES, ANY THIRD PARTY MATERIALS INCLUDED IN THE SOFTWARE, ANY THIRD PARTY MATERIALS FROM WHICH THE SOFTWARE IS DERIVED (COLLECTIVELY “OTHER CODE”), AND THE USE OF ANY OR ALL THE OTHER CODE IN CONNECTION WITH THE SOFTWARE, INCLUDING (WITHOUT LIMITATION) ANY WARRANTIES OF SATISFACTORY QUALITY OR FITNESS FOR A PARTICULAR PURPOSE.

NO THIRD PARTY LICENSORS OF OTHER CODE SHALL HAVE ANY LIABILITY FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING WITHOUT LIMITATION LOST PROFITS), HOWEVER CAUSED AND WHETHER MADE UNDER CONTRACT, TORT OR OTHER LEGAL THEORY, ARISING IN ANY WAY OUT OF THE USE OR DISTRIBUTION OF THE OTHER CODE OR THE EXERCISE OF ANY RIGHTS GRANTED UNDER EITHER OR BOTH THIS LICENSE AND THE LEGAL TERMS APPLICABLE TO ANY SEPARATE FILES, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

APPLICABILITY TABLE

PRODUCTS

- WE866C3-P

Contents

1. INTRODUCTION

1.1. Scope

This document introduces the Telit WE866C3 module and presents possible and recommended hardware solutions for developing a product based on this module.

Obviously, this document cannot include every hardware solution or every product that can be designed. Where the suggested hardware configurations need not be considered mandatory, the information given should be used as a guide and a starting point for properly developing your product with the Telit module.

1.2. Audience

This document is intended for Telit customers, especially system integrators, about to implement their applications using the Telit module.

1.3. Contact Information, Support

For general contact, technical support services, technical questions and report documentation errors contact Telit Technical Support at:

- TS-EMEA@telit.com
- TS-AMERICAS@telit.com
- TS-APAC@telit.com
- TS-SRD@telit.com

Alternatively, use:

http://www.telit.com/support

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

http://www.telit.com

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. 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.

1.5. Related Documents

- LE910Cx HW Design Guide 1VV0301298
- Telit EVB User Guide 1VV0301249
- LE910Cx Multi Technology Interface Board TLB - HW User Guide 1VV0301508

2. GENERAL PRODUCT DESCRIPTION

2.1. Overview

The WE866C3 is a low power and low-cost wireless module solution based on Qualcomm QCA9377-3. It supports 1×1 IEEE 802.11a/b/g/n/ac WLAN standards and BT 4.2 + HS + BLE, enabling seamless integration of WLAN/BT and low energy. It is a perfect companion solution for Telit cellular modules such as LE910Cx or LE920A4.
WE866C3 supports low-power SDIO 3.0 interface for WLAN and a UART/PCM interface for BT. WE866C3 also supports BT-WLAN coexistence and uses the 2 wire ISM-LTE coexistence interface.

2.2. Block Diagram

The following figure shows a high-level block diagram of WE866C3 module and its major functional blocks.

- Power supply
- SDIO
- PCM and UART
- RF Antenna

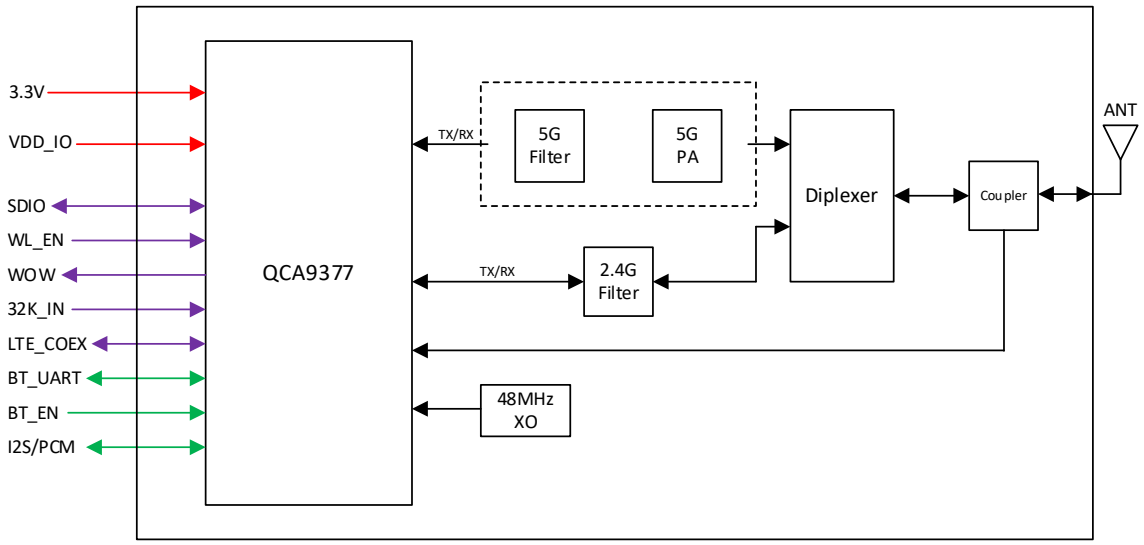


Figure 1 Module Block Diagram

2.3. Product Variants

WE866C3 variants are listed below:

Product	Description
WE866C3-P	1x1 WIFI/BT wireless module

2.4. Target Market

WE866C3 can be used in IoT applications complementing client data availability coverage of the Cellular modems, with low power and low cost, for example:

- Bridging LTE / WLAN
- Industrial floor
- Healthcare instrument data terminals
- Smart Home automation and remote control

2.5. Main Features

Feature	Specification
Power	Main supply voltage: 3.3V VIO supply voltage: 1.8V or 3.3V
Interfaces	WLAN SDIO 3.0 BT UART BT PCM/I2S LTE Coexistence UART (WCI) Low frequency 32.768KHz sleep clock Single Antenna port, 50 Ohm Control signals
Supported Data Rate	802.11a (5GHz): 6, 9, 12, 18, 24, 36, 48, 54Mbps 802.11b (2.4GHz): 1, 2, 5.5, 11Mbps 802.11g (2.4GHz): 6, 9, 12, 18, 24, 36, 48, 54Mbps 802.11n (2.4GHz/5GHz): • 20Mhz BW: Up to 72.2Mbps using short GI (MCS0-7) • 40Mhz BW: Up to 144.4Mbps using short GI (MCS0-7) 802.11ac (5GHz): HT20 (MCS0-8), VHT40 (MCS0-9), VHT80 (MCS0-9)
Transmission Power	802.11a / 54Mbps: 14 dbm 802.11b / 11Mbps: 18 dbm 802.11g / 54Mbps: 15 dbm 802.11n / HT20 (MCS7): 15 dbm 802.11ac / HT20 (MCS0): 15.5 dbm 802.11ac / VHT40 (MCS9): 11 dbm 802.11ac / VHT80 (MCS9): 10.5 dbm

Data Standard	IEEE 802.11a/b/g/n/ac
Operating Modes	Access Point Station
Modulation	BPSK, QPSK, CCK, 16QAM, 64QAM, 256QAM
Mechanical	Size: 15±0.15 x 13±0.15 x 2.15±0.15 mm Package: LGA Weight: 1g
Temperature Range	Operating: -30°C to +85°C [1)] Storage and non-operating: -40°C to +105°C ⚠ Operating the module at -40°C may result in unintended operation of the module yet without causing any perpetual harm to the module.
RoHS	All hardware components are fully compliant with EU RoHS directive

Notes:

1) The module complies with IEEE standard.

3. PINS ALLOCATION

3.1. Pin Type Definition

Type	Description
DI	Digital Input
DO	Digital Output
PD	Pull-Down
PU	Pull-Up
OD	Open-Drain Output
B	Bi-Directional
AI	Analog/RF Input
AO	Analog/RF Output
P	Power Input

Pins directions are with respect to the WE866C3 module.

3.2. Pin-out

Pin	Pin name	Pin Reference Voltage	Pin Type	Pin Description
	BT UART interface			
B3	BT_CTS	VIO	DI	Bluetooth HCI-UART CTS signal
B4	BT_RTS	VIO	DO	Bluetooth HCI-UART RTS signal
A5	BT_RXD	VIO	DI	Bluetooth HCI-UART RXD signal
A4	BT_TXD	VIO	DO	Bluetooth HCI-UART TXD signal
	BT PCM interface			
C6	BT_I2S_SDI	VIO	DI, PU	Bluetooth PCM/I2S Input signal, Internal Pull-Up
C5	BT_I2S_WS	VIO	B	Bluetooth PCM/I2S Frame Sync signal
D5	BT_I2S_SCK	VIO	B, PD	Bluetooth PCM/I2S Bit CLK signal
D6	BT_I2S_SDO	VIO	DO	Bluetooth PCM/I2S output signal
	Low power Clock signal			
B5	LF_CLK_IN	VIO	DI, PD	External low–power 32.768 kHz clock input
	Host wake pins			
D4	WOW	VIO	OD, PU	Wake on Wireless. WIFI/BT Wakeup host. Active high, Internal Pull-Up
	SDIO 3.0 interface			
D7	SDIO_CLK	VIO	DI, PU	SDIO clock signal Input, Internal Pull-Up
E7	SDIO_CMD	VIO	B	SDIO CMD line signal
C7	SDIO_D0	VIO	B	SDIO data bus D0
B6	SDIO_D1	VIO	B	SDIO data bus D1
A6	SDIO_D2	VIO	B, PU	SDIO data bus D2, Internal Pull-Up
B7	SDIO_D3	VIO	B	SDIO data bus D3
	Coexistence and control signals			

Pin	Pin name	Pin Reference Voltage	Pin Type	Pin Description
C3	LTE_UART_RX	VIO	DI, PU	Secondary UART - LTE coexistence UART RXD / AUX UART RXD
C4	LTE_UART_TX	VIO	DO	Secondary UART - LTE coexistence UART_TXD / AUX_UART_TXD
G5	WL_EN	VIO	DI, PD	WLAN enable (Active high)
G6	BT_EN	VIO	DI, PD	Bluetooth enable (Active high)
	RF Antennas			
D1	ANT1	A	AI, AO	Antenna 1 - Main Antenna for modules with a single antenna configuration
G3	RFU ANT2	NA	NA	Reserved for Antenna 2.
	Power			
A1	VDD_3.3V	3.13 V to 3.46 V	P	Main Input voltage (WIFI & BT)
A2	VDD_3.3V	3.13 V to 3.46 V	P	Main Input voltage (WIFI & BT)
A3	VDDIO	1.8 V or 3.3 V	P	Voltage supply for all I/O signals (1.71V - 3.46V)
G1	GND	–	–	Power Ground
A7	GND	–	–	Power Ground
B1	GND	–	–	Power Ground
B2	GND	–	–	Power Ground
C1	GND	–	–	Power Ground
C2	GND	–	–	Power Ground
D2	GND	–	–	Power Ground
E1	GND	–	–	Power Ground
E2	GND	–	–	Power Ground
F1	GND	–	–	Power Ground
F2	GND	–	–	Power Ground
F3	GND	–	–	Power Ground
F4	GND	–	–	Power Ground
G2	GND	–	–	Power Ground
G4	GND	–	–	Power Ground
G7	GND	–	–	Power Ground
	Factory use			
D3	RFU	NC	-	Reserved for future use. No connect.
E3	RFU	NC	-	Reserved for future use. No connect.
E4	RFU	NC	-	Reserved for future use. No connect.
E5	RFU	NC	-	Reserved for future use. No connect.
E6	RFU	NC	-	Reserved for future use. No connect.
F5	RFU	NC	-	Reserved for future use. No connect.
F6	RFU	NC	-	Reserved for future use. No connect.
F7	RFU	NC	-	Reserved for future use. No connect.

3.3. LGA Pads Layout

	A	B	C	D	E	F	G
1	VDD_3.3V	GND	GND	ANT1	GND	GND	GND
2	VDD_3.3V	GND	GND	GND	GND	GND	GND
3	VDDIO	BT_CTS (I)	LTE_UART_RX (I)	RFU	RFU	GND	RFU (ANT2)
4	BT_TXD (O)	BT_RTS (O)	LTE_UART_TX (O)	WOW (OD)	RFU	GND	GND
5	BT_RXD (I)	LF_CLK_IN (I)	BT_I2S_WS (I)	BT_I2S_SCK (I)	RFU	RFU	WL_EN (I)
6	SDIO_D2	SDIO_D1	BT_I2S_SDI (I)	BT_I2S_SDO (O)	RFU	RFU	BT_EN (I)
7	GND	SDIO_D3	SDIO_D0	SDIO_CLK (I)	SDIO_CMD	RFU	GND

TOP VIEW

WARNING

Reserved pins must not be connected.

4. 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.

4.1. Power Supply Requirements

There are 2 power supply inputs to the module. The main power supply, connected to VDD_3.3V input and the VDDIO input, each must fulfil the following requirements:

VDD_3.3V Input	Minimum	Maximum
Absolute Maximum Voltage	-0.3 V	3.65 V
Nominal Supply Voltage	3.3 V	-
Normal Operating Voltage Range	3.135 V	3.465 V
VDDIO Input	**Minimum**	**Maximum**
Absolute Maximum Voltage	-0.3 V	4.0 V
Nominal Supply Voltage	1.8V or 3.3V	-
Normal Operating Voltage Range	1.71 V	3.46 V

NOTE:
The Maximum Voltage MUST never be exceeded; care must be taken when designing the application's power supply section to avoid having an excessive voltage drop.
If the voltage drop is exceeding the limits it could lead to degradation of performance or cause a Power Off of the module.

4.2. Power Consumption

The below tables provides the typical current consumption values of the module for the various available modes.

4.2.1. Typical Power Consumption for WLAN Low-Power States

Mode	Total power consumption [mA] (VDDIO = 1.8V)	Mode Description
Standby	0.2	Deep Sleep
Power Save, 2.4GHz	1.3	DTIM=1
	0.8	DTIM=3
	0.6	DTIM=10
Power Save, 5GHz	1.5	DTIM=1
	0.9	DTIM=3
	0.7	DTIM=10

4.2.2. Typical Power Consumption for WLAN Continuous Rx [2.4 GHz]

Rate	Total power consumption [mA] (VDDIO = 1.8V)
11b 1Mbps	60
11b 11Mbps	62
11g 54Mbps	70
MCS0 HT20	67
MCS7 HT20	69

4.2.3. Typical Power Consumption for WLAN Continuous Rx [5 GHz]

Rate	Total power consumption [mA] (VDDIO = 1.8V)
MCS0 HT20	96
MCS7 HT20	94
MCS8 VHT20	112
MCS0 HT40	94
MCS7 HT40	99
MCS8 VHT40	115
MCS9 VHT40	100
MCS7 VHT80	130
MCS8 VHT80	162
MCS9 VHT80	131

4.2.4. Typical Power Consumption for WLAN Continuous Tx [2.4 GHz]

Rate	Total power consumption [mA] (VDDIO = 1.8V)
11b 1Mbps	365
11b 11Mbps	362
11g 54Mbps	340
MCS0 HT20	348
MCS7 HT20	335

4.2.5. Typical Power Consumption for WLAN Continuous Tx [5 GHz]

Rate	Total power consumption [mA] (VDDIO = 1.8V)
MCS0 HT20	495
MCS7 HT20	432
MCS8 VHT20	422
MCS0 HT40	475
MCS7 HT40	435
MCS8 VHT40	432
MCS9 VHT40	429
MCS7 VHT80	440
MCS8 VHT80	438
MCS9 VHT80	436

4.2.6. Typical Power Consumption for BT

Rate	Total power consumption [mA] (VDDIO = 1.8V)
Continuous Rx burst	25
Continuous TX Class 2 (+4 dBm)	42
Continuous TX Class 2 (+12.5 dBm)	70
1.28 sec page scan (non-interlaced)	0.36
1.28 sec LE ADV	0.23
1.28 sec Sniff as master	0.21
1.28 sec Sniff as slave	0.26

NOTE:

Current consumptions specification refers to typical samples and typical material.

Values represent an average measurement done over few seconds.

Values may vary depending on network and environmental conditions.

Power consumptions values obtained with VDD_3.3V = 3.3V and VDDIO = 1.8V.

NOTE:

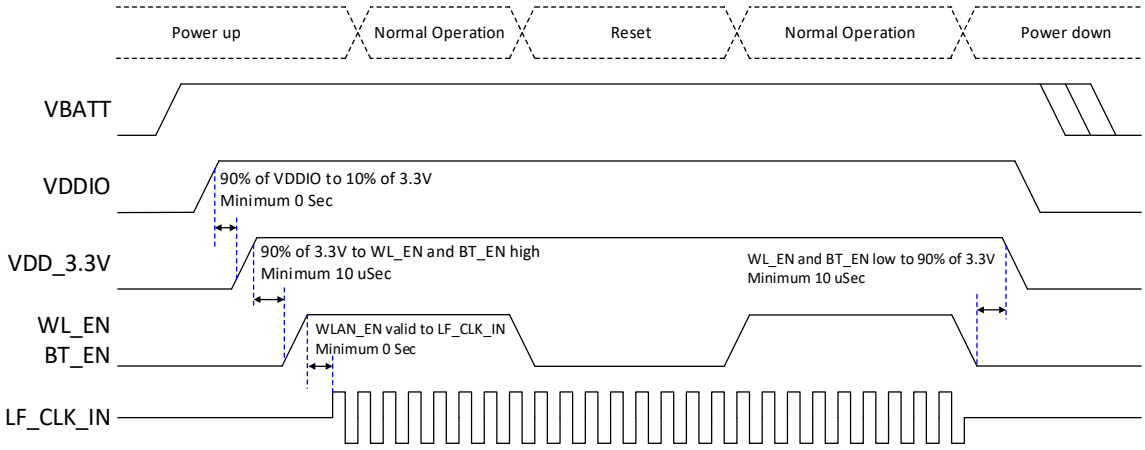
Current consumption is measured at the system level and is the sum of both VDD_3.3V and VDDIO current consumpotions.

NOTE:

Current consumption related to WLAN and BT TX cases are measured at typical TX output power as listed in 6.2.

4.3. Power Supply Sequencing

The recommended power sequence between VDD_3.3V and VDDIO inputs is shown below:



Notes:

1. VDDIO voltage should match VIO voltage of the host. In some applications, it may connect to 3.3 V matching the Host VIO voltage.

2. All host interface signals must stay floating or low before valid power on sequence WL_EN/BT_EN = ”High”, and after WL_EN/BT_EN = “Low”.

WARNING:
Please carefully follow the recommended power Up/Down sequencing. Not following the recommended procedure might damage the device and consequently void the warranty.

5. DIGITAL SECTION

5.1. DC Electrical Characteristics

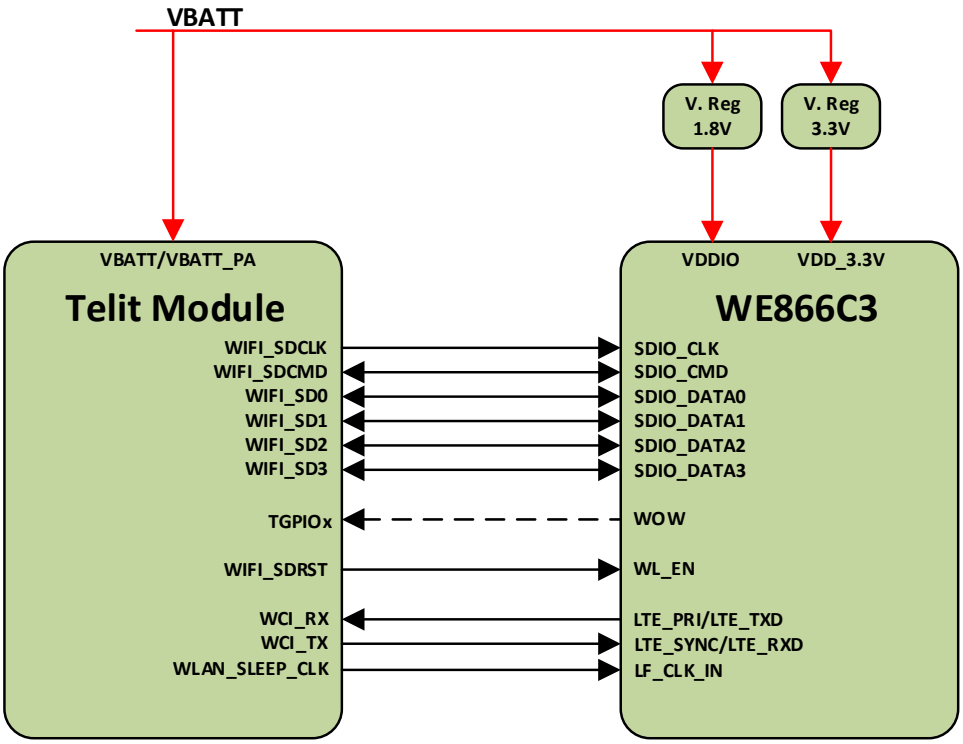
Parameter	Min	Typical	Max	Unit
High-level input voltage	0.7 * VDDIO	-	VDDIO + 0.3	V
Low-level input voltage	-0.3	-	0.3 * VDDIO	V
Input low leakage current (VIN = 0 V Supply = VDDIO max)	-5.0	0	5.0	µA
Input pull resistor (Up or down)	-	1.8V IO: 120 3.3V IO: 70	-	kΩ
High-level output voltage	VDDIO - 0.4	-	VDDIO	V
Low-level output voltage	0	-	0.4	V
High-level output current	3	-	-	mA
Low-level output current	-	-	-11	mA
Input capacitance	-	-	3	pF

5.2. Interface Ports and Signals

5.2.1. WLAN Interfaces

The following figure shows the WLAN related interface connection between the WE866C3 module and the LTE modem module.

The following clauses describe the various interfaces



5.2.1.1. SDIO Interface

SDIO is the main interface used for WLAN Data and control.

The WE866C3 has a 4-bit SDIO port which supports SDIO3.0 standard with up to 200Mhz clock. The figure above shows the SDIO interface connection diagram.

5.2.1.2. WL_EN

WL_EN is used to control the WLAN function of WE866C3 module. When WL_EN is at a high level, WLAN function will be enabled.

5.2.1.3. WOW

WOW (Wake on Wireless) signal purpose is to wake up the Modem module. When WOW signal is driven low it can wake up the modem module.

NOTE:

The corresponding modem GPIO which is used for wakeup should support sleep wakeup functionality.

The selection of the modem GPIO input should be performed according to software driver recommended input.

5.2.1.4. LF_CLK_IN

The LF_CLK_IN 32 kHz clock is used in low-power modes such as IEEE power-save and sleep. It serves as a timer to determine when to wake up to receive beacons in various power-save schemes and to maintain basic logic operations when in sleep.

The module does not require an external 32 kHz clock. By default, it utilizes its internal clock shared with the WLAN and BT subsystem.

If the end application has a more accurate 32 kHz clock (as in the case of using the Telit LTE module solution), then it can be supplied externally via the LF_CLK_IN pin. The LF_CLK_IN pin must be grounded when using the default internal clock mode.

If an external 32 kHz clock is used, the requirements are:

Parameter	Min	Typical	Max	Unit
Frequency	-	32.768	-	KHz
Rise/Fall time	1	-	100	nS
Duty Cycle	15	-	85	%
Frequency stability	-200	-	200	Ppm
Input High Voltage	0.8 x VDDIO	-	VDDIO + 0.2	V
Input Low Voltage	-0.3	-	0.2 x VDDIO	V

5.2.1.5. Coexistence UART Interface

Wireless Local Area Network (WLAN) and Bluetooth® (BT) share the same 2.4GHz ISM bands. LTE network bands (band 38/40/41 for TDD and band 7 for FDD uplink) are adjacent to the WLAN bands and as such can cause severe de-sensing of the WLAN receive. In the same way, WLAN transmission can cause severe de-sensing of the LTE receive path.

Interference is mostly relevant due to adjacent bands and the limited isolation when both reside in the same platform.

This interference can be mitigated to some extent with by sharing communication and network related information between LTE modem and WLAN/BT device.

This information is communicated between the 2 entities over the coexistence UART.

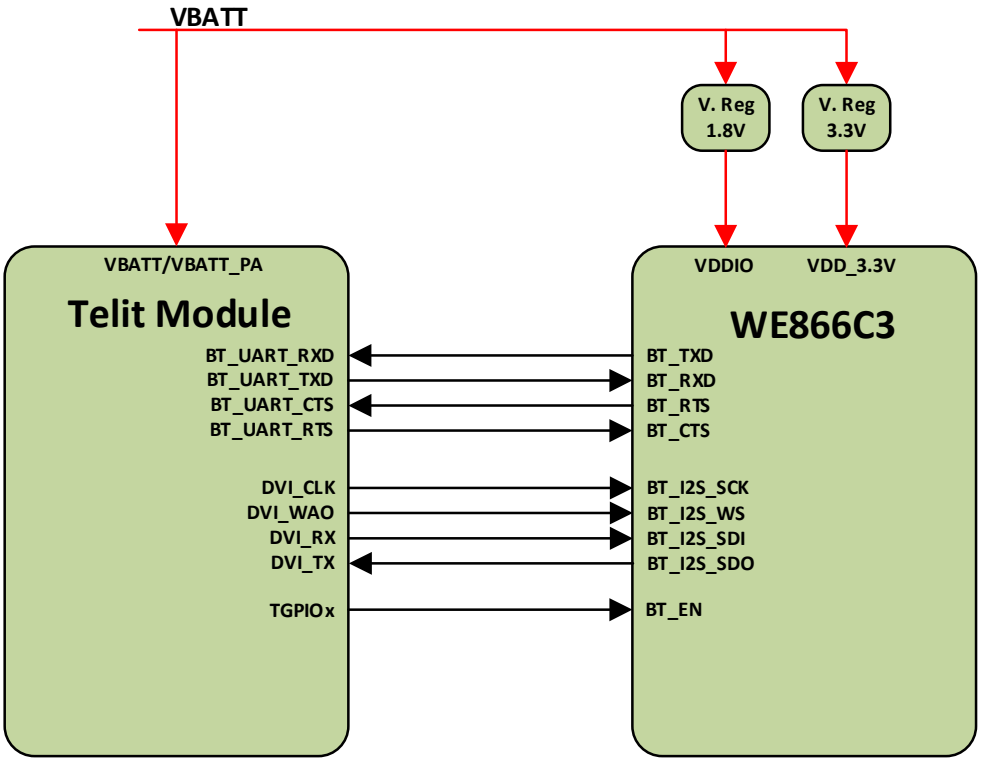
NOTE:

The coexistance interface can be used only with Telit recommended bundling of LTE modem and WE866C3.

5.3. BT Interface

The following figure shows the BT interface connection between the WE866C3 module and the modem module.

The BT controller consists of BT radio and digital baseband blocks. It is controlled by the host through the UART. The BT audio interface can be configured to UART/PCM (I2S). The BT power on/off is controlled through BT_EN.



5.3.1.1. BT HCI-UART

The BT HCI-UART provides a communication interface between the host and BT controller.

5.3.1.2. PCM/I2S

This is the synchronous interface for audio data.

The BT synchronous audio interface can support either PCM or I2S protocols.

The BT asynchronous audio interface is for a stereo audio A2DP profile through HCI-UART.

Supports multiple codec types:

- Narrowband speech with integrated CVSD codec over PCM or HCI
- Wideband speech with integrated SBC codec over PCM or HCI

The BT controller can configure the interface to master or slave mode for PCM or I2S. It defaults to slave mode to avoid driving PCM_SYNC and PCM_CLK signals.

The maximum I2S clock frequency is supported up to 2.4 MHz

5.3.1.3. BT_EN

This signal enables or disables BT by asserting or de-esserting it from the host.

6. RF SECTION

6.1. RF Frequencies

The following table is listing the supported frequencies:

Parameter	Conditions	
WLAN Center channel frequency for 2.4 GHz	Center frequency at 5 MHz spacing	2.412 – 2.484 GHz
WLAN Center channel frequency for 5 GHz	Center frequency at 5 MHz spacing	4.9 – 5.925 GHz
BT Frequency range	BT Specification: 2.4 ≤ f ≤ 2.4835 Center frequency f = 2402 + k, where k is the channel number.	2402 – 2480 MHz

6.2. TX Output Power

The following clauses lists the measured TX output power of WE866C3.

Measurements are averaged and are done at the module Antenna pad.

The output power listed in the following tables indicates the highest level which allows to meet the 802.11x standard with regards to ACLR and EVM values.

6.2.1. TX Output Power at Room Temperature

The tables below are measured at 25°C with VDD_3.3V = 3.3V and VDDIO=1.8V.

6.2.1.1. 802.11b (2.4GHz)

Modulation	Data rate	CHL/CHM/CHH	Units
BPSK	1 Mbps	18	dBm
QPSK	2 Mbps	18	dBm
CCK	5.5Mbps	18	dBm
CCK	11 Mbps	18	dBm

6.2.1.2. 802.11g (2.4GHz)

Modulation	Data rate	CHL/CHM/CHH	Units
BPSK	6 Mbps	16.5	dBm
BPSK	9 Mbps	16.5	dBm
QPSK	12 Mbps	16.5	dBm
QPSK	18 Mbps	16.5	dBm
16 QAM	24 Mbps	15.5	dBm
16 QAM	36 Mbps	15.5	dBm
64 QAM	48 Mbps	15,5	dBm
64 QAM	54 Mbps	15	dBm

6.2.1.3. 802.11n, Channel BW = 20MHz (2.4GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	16.5	dBm
QPSK	MCS1	16,5	dBm
QPSK	MCS2	16,5	dBm
16 QAM	MCS3	16	dBm
16 QAM	MCS4	16	dBm
64 QAM	MCS5	15,5	dBm
64 QAM	MCS6	15,5	dBm
64 QAM	MCS7	15	dBm

6.2.1.4. 802.11n, Channel BW = 40MHz (2.4GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	15	dBm
QPSK	MCS1	15	dBm
QPSK	MCS2	15	dBm
16 QAM	MCS3	14,5	dBm
16 QAM	MCS4	14.5	dBm
64 QAM	MCS5	13.5	dBm
64 QAM	MCS6	13.5	dBm
64 QAM	MCS7	13	dBm

6.2.1.5. 802.11a (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	6 Mbps	16.5	dBm
BPSK	9 Mbps	16.5	dBm
QPSK	12 Mbps	16.5	dBm
QPSK	18 Mbps	16.5	dBm
16 QAM	24 Mbps	16.5	dBm
16 QAM	36 Mbps	16.5	dBm
64 QAM	48 Mbps	14.5	dBm
64 QAM	54 Mbps	14	dBm

6.2.1.6. 802.11n/ac, Channel BW = 20MHz (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	15.5	dBm
QPSK	MCS1	15.5	dBm
QPSK	MCS2	15.5	dBm
16 QAM	MCS3	15	dBm
16 QAM	MCS4	15	dBm
64 QAM	MCS5	14	dBm
64 QAM	MCS6	13.5	dBm
64 QAM	MCS7	13 (ac Only)	dBm

6.2.1.7. 802.11n/ac, Channel BW = 40MHz (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	15.5	dBm
256 QAM	MCS9	11 (ac Only)	dBm

6.2.1.8. 802.11ac, Channel BW = 80MHz (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	15.5	dBm
256 QAM	MCS9	10.5	dBm

6.2.1.9. Bluetooth TX power

BT Spec	Modulation	CHL/CHM/CHH	Units
BR	GFSK	3.9	dBm
EDR	π/4 DQPSK	2.4	dBm
	8DPSK	2	dBm
BLE	GFSK	-5.2	dBm

6.2.2. TX Output Power at Cold Temperature

The tables below are measured at -40°C with VDD_3.3V = 3.3V and VDDIO=1.8V.

6.2.2.1. 802.11b (2.4GHz)

Modulation	Data rate	CHL/CHM/CHH	Units
BPSK	1 Mbps	18.5	dBm
QPSK	2 Mbps	18.5	dBm
CCK	5.5Mbps	18.5	dBm
CCK	11 Mbps	18.5	dBm

6.2.2.2. 802.11g (2.4GHz)

Modulation	Data rate	CHL/CHM/CHH	Units
BPSK	6 Mbps	17	dBm
BPSK	9 Mbps	17	dBm
QPSK	12 Mbps	17	dBm
QPSK	18 Mbps	17	dBm
16 QAM	24 Mbps	16	dBm
16 QAM	36 Mbps	16	dBm
64 QAM	48 Mbps	16	dBm
64 QAM	54 Mbps	15.5	dBm

6.2.2.3. 802.11n, Channel BW = 20MHz (2.4GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	17	dBm
QPSK	MCS1	17	dBm
QPSK	MCS2	17	dBm
16 QAM	MCS3	16.5	dBm
16 QAM	MCS4	16.5	dBm
64 QAM	MCS5	16	dBm
64 QAM	MCS6	16	dBm
64 QAM	MCS7	15.5	dBm

6.2.2.4. 802.11n, Channel BW = 40MHz (2.4GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	15.5	dBm
QPSK	MCS1	15.5	dBm
QPSK	MCS2	15.5	dBm
16 QAM	MCS3	15	dBm
16 QAM	MCS4	15	dBm
64 QAM	MCS5	14	dBm
64 QAM	MCS6	14	dBm
64 QAM	MCS7	13.5	dBm

6.2.2.5. 802.11a (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	6 Mbps	17	dBm
BPSK	9 Mbps	17	dBm
QPSK	12 Mbps	17	dBm
QPSK	18 Mbps	17	dBm
16 QAM	24 Mbps	17	dBm
16 QAM	36 Mbps	17	dBm
64 QAM	48 Mbps	15	dBm
64 QAM	54 Mbps	14.5	dBm

6.2.2.6. 802.11n/ac, Channel BW = 20MHz (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	16	dBm
QPSK	MCS1	16	dBm
QPSK	MCS2	16	dBm
16 QAM	MCS3	15.5	dBm
16 QAM	MCS4	15.5	dBm
64 QAM	MCS5	14.5	dBm
64 QAM	MCS6	14	dBm
64 QAM	MCS7	13.5(ac Only)	dBm

6.2.2.7. 802.11n/ac, Channel BW = 40MHz (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	16	dBm
256 QAM	MCS9	11 .5(ac Only)	dBm

6.2.2.8. 802.11ac, Channel BW = 80MHz (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	16	dBm
256 QAM	MCS9	11	dBm

6.2.3. TX Output Power at Hot Temperature

The tables below are measured at +85°C with VDD_3.3V = 3.3V and VDDIO=1.8V.

6.2.3.1. 802.11b (2.4GHz)

Modulation	Data rate	CHL/CHM/CHH	Units
BPSK	1 Mbps	17.5	dBm
QPSK	2 Mbps	17.5	dBm
CCK	5.5Mbps	17.5	dBm
CCK	11 Mbps	17.5	dBm

6.2.3.2. 802.11g (2.4GHz)

Modulation	Data rate	CHL/CHM/CHH	Units
BPSK	6 Mbps	16	dBm
BPSK	9 Mbps	16	dBm
QPSK	12 Mbps	16	dBm
QPSK	18 Mbps	16	dBm
16 QAM	24 Mbps	15	dBm
16 QAM	36 Mbps	15	dBm
64 QAM	48 Mbps	15	dBm
64 QAM	54 Mbps	14.5	dBm

6.2.3.3. 802.11n, Channel BW = 20MHz (2.4GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	16	dBm
QPSK	MCS1	16	dBm
QPSK	MCS2	16	dBm
16 QAM	MCS3	15.5	dBm
16 QAM	MCS4	15.5	dBm
64 QAM	MCS5	15	dBm
64 QAM	MCS6	15	dBm
64 QAM	MCS7	14.5	dBm

6.2.3.4. 802.11n, Channel BW = 40MHz (2.4GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	14.5	dBm
QPSK	MCS1	14.5	dBm
QPSK	MCS2	14.5	dBm
16 QAM	MCS3	14	dBm
16 QAM	MCS4	14	dBm
64 QAM	MCS5	13	dBm
64 QAM	MCS6	13	dBm
64 QAM	MCS7	12.5	dBm

6.2.3.5. 802.11a (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	6 Mbps	16	dBm
BPSK	9 Mbps	16	dBm
QPSK	12 Mbps	16	dBm
QPSK	18 Mbps	16	dBm
16 QAM	24 Mbps	16	dBm
16 QAM	36 Mbps	16	dBm
64 QAM	48 Mbps	14	dBm
64 QAM	54 Mbps	13,5	dBm

6.2.3.6. 802.11n/ac, Channel BW = 20MHz (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	15	dBm
QPSK	MCS1	15	dBm
QPSK	MCS2	15	dBm
16 QAM	MCS3	14.5	dBm
16 QAM	MCS4	14.5	dBm
64 QAM	MCS5	13.5	dBm
64 QAM	MCS6	13	dBm
64 QAM	MCS7	12.5(ac Only)	dBm

6.2.3.7. 802.11n/ac, Channel BW = 40MHz (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	15	dBm
256 QAM	MCS9	10.5(ac Only)	dBm

6.2.3.8. 802.11ac, Channel BW = 80MHz (5GHz)

Modulation	Data rate Index	CHL/CHM/CHH	Units
BPSK	MCS0	15	dBm
256 QAM	MCS9	10	dBm

6.3. Receiver Sensitivity

The following clauses lists the receiver sensitivity WE866C3.

Measurements are done at the module Antenna pad with 10% packet error rate.

6.3.1. Receiver Sensitivity at Room Temperature

All measurements data are taken at 25°C and VDDIO=1.8V.

6.3.1.1. 802.11b (2.4GHz)

Modulation	Data rate	Typical sensitivity	Units
BPSK	1 Mbps	-93	dBm
QPSK	2 Mbps	-91	dBm
CCK	5.5Mbps	-88	dBm
CCK	11 Mbps	-87	dBm

6.3.1.2. 802.11g (2.4GHz)

Modulation	Data rate	Typical sensitivity	Units
BPSK	6 Mbps	-89	dBm
BPSK	9 Mbps	-88	dBm
QPSK	12 Mbps	-87	dBm
QPSK	18 Mbps	-85	dBm
16 QAM	24 Mbps	-82	dBm
16 QAM	36 Mbps	-78	dBm
64 QAM	48 Mbps	-74	dBm
64 QAM	54 Mbps	-73	dBm

6.3.1.3. 802.11n, Channel BW = 20MHz (2.4GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-88	dBm
QPSK	MCS1	-85	dBm
QPSK	MCS2	-83	dBm
16 QAM	MCS3	-80	dBm
16 QAM	MCS4	-76	dBm
64 QAM	MCS5	-71	dBm
64 QAM	MCS6	-70	dBm
64 QAM	MCS7	-69	dBm

6.3.1.4. 802.11n, Channel BW = 40MHz (2.4GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-85	dBm
QPSK	MCS1	-82	dBm
QPSK	MCS2	-80	dBm
16 QAM	MCS3	-77	dBm
16 QAM	MCS4	-73	dBm
64 QAM	MCS5	-68	dBm
64 QAM	MCS6	-67	dBm
64 QAM	MCS7	-66	dBm

6.3.1.5. 802.11a (5GHz)

Modulation	Data rate	Typical sensitivity	Units
BPSK	6 Mbps	-90	dBm
BPSK	9 Mbps	-89	dBm
QPSK	12 Mbps	-88	dBm
QPSK	18 Mbps	-86	dBm
16 QAM	24 Mbps	-83	dBm
16 QAM	36 Mbps	-79	dBm
64 QAM	48 Mbps	-75	dBm
64 QAM	54 Mbps	-74	dBm

6.3.1.6. 802.11n/ac, Channel BW = 20MHz (5GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-89	dBm
QPSK	MCS1	-86	dBm
QPSK	MCS2	-84	dBm
16 QAM	MCS3	-81	dBm
16 QAM	MCS4	-77	dBm
64 QAM	MCS5	-72	dBm
64 QAM	MCS6	-71	dBm
64 QAM	MCS7	-70	dBm

6.3.1.7. 802.11n/ac, Channel BW = 40MHz (5GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-86	dBm
64 QAM	MCS7	-67	dBm
256 QAM	MCS8	-65	dBm
256 QAM	MCS9	-64	dBm

6.3.1.8. 802.11ac, Channel BW = 80MHz (5GHz)

Modulation	Data rate Index	Typical sensitivity	Units
256 QAM	MCS8	-63	dBm
256 QAM	MCS9	-62	dBm

6.3.1.9. Bluetooth (BER < 0.1%)

BT Spec	Modulation	Typical sensitivity	Units
BR	GFSK	-91	dBm
EDR	π/4 DQPSK	-90	dBm
	8DPSK	-83	dBm
BLE	GFSK	-94	dBm

6.3.2. Receiver Sensitivity at Cold Temperature

All measurements data are taken at -40°C and VDDIO=1.8V.

6.3.2.1. 802.11b (2.4GHz)

Modulation	Data rate	Typical sensitivity	Units
BPSK	1 Mbps	-94	dBm
QPSK	2 Mbps	-92	dBm
CCK	5.5Mbps	-89	dBm
CCK	11 Mbps	-88	dBm

6.3.2.2. 802.11g (2.4GHz)

Modulation	Data rate	Typical sensitivity	Units
BPSK	6 Mbps	-90	dBm
BPSK	9 Mbps	-89	dBm
QPSK	12 Mbps	-88	dBm
QPSK	18 Mbps	-86	dBm
16 QAM	24 Mbps	-83	dBm
16 QAM	36 Mbps	-79	dBm
64 QAM	48 Mbps	-75	dBm
64 QAM	54 Mbps	-73	dBm

6.3.2.3. 802.11n, Channel BW = 20MHz (2.4GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-89	dBm
QPSK	MCS1	-86	dBm
QPSK	MCS2	-84	dBm
16 QAM	MCS3	-81	dBm
16 QAM	MCS4	-77	dBm
64 QAM	MCS5	-72	dBm
64 QAM	MCS6	-71	dBm
64 QAM	MCS7	-70	dBm

6.3.2.4. 802.11n, Channel BW = 40MHz (2.4GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-86	dBm
QPSK	MCS1	-83	dBm
QPSK	MCS2	-81	dBm
16 QAM	MCS3	-78	dBm
16 QAM	MCS4	-74	dBm
64 QAM	MCS5	-69	dBm
64 QAM	MCS6	-68	dBm
64 QAM	MCS7	-67	dBm

6.3.2.5. 802.11a (5GHz)

Modulation	Data rate	Typical sensitivity	Units
BPSK	6 Mbps	-91	dBm
BPSK	9 Mbps	-90	dBm
QPSK	12 Mbps	-89	dBm
QPSK	18 Mbps	-87	dBm
16 QAM	24 Mbps	-84	dBm
16 QAM	36 Mbps	-80	dBm
64 QAM	48 Mbps	-76	dBm
64 QAM	54 Mbps	-75	dBm

6.3.2.6. 802.11n/ac, Channel BW = 20MHz (5GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-90	dBm
QPSK	MCS1	-87	dBm
QPSK	MCS2	-85	dBm
16 QAM	MCS3	-82	dBm
16 QAM	MCS4	-78	dBm
64 QAM	MCS5	-73	dBm
64 QAM	MCS6	-72	dBm
64 QAM	MCS7	-71	dBm

6.3.2.7. 802.11n/ac, Channel BW = 40MHz (5GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-87	dBm
64 QAM	MCS7	-68	dBm
256 QAM	MCS8	-66	dBm
256 QAM	MCS9	-65	dBm

6.3.2.8. 802.11ac, Channel BW = 80MHz (5GHz)

Modulation	Data rate Index	Typical sensitivity	Units
256 QAM	MCS8	-64	dBm
256 QAM	MCS9	-63	dBm

6.3.3. Receiver Sensitivity at Hot Temperature

All measurements data are taken at +85°C and VDDIO=1.8V.

6.3.3.1. 802.11b (2.4GHz)

Modulation	Data rate	Typical sensitivity	Units
BPSK	1 Mbps	-92	dBm
QPSK	2 Mbps	-90	dBm
CCK	5.5Mbps	-87	dBm
CCK	11 Mbps	-86	dBm

6.3.3.2. 802.11g (2.4GHz)

Modulation	Data rate	Typical sensitivity	Units
BPSK	6 Mbps	-88	dBm
BPSK	9 Mbps	-87	dBm
QPSK	12 Mbps	-86	dBm
QPSK	18 Mbps	-84	dBm
16 QAM	24 Mbps	-81	dBm
16 QAM	36 Mbps	-77	dBm
64 QAM	48 Mbps	-73	dBm
64 QAM	54 Mbps	-72	dBm

6.3.3.3. 802.11n, Channel BW = 20MHz (2.4GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-87	dBm
QPSK	MCS1	-84	dBm
QPSK	MCS2	-82	dBm
16 QAM	MCS3	-79	dBm
16 QAM	MCS4	-75	dBm
64 QAM	MCS5	-70	dBm
64 QAM	MCS6	-69	dBm
64 QAM	MCS7	-68	dBm

6.3.3.4. 802.11n, Channel BW = 40MHz (2.4GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-84	dBm
QPSK	MCS1	-81	dBm
QPSK	MCS2	-79	dBm
16 QAM	MCS3	-76	dBm
16 QAM	MCS4	-72	dBm
64 QAM	MCS5	-67	dBm
64 QAM	MCS6	-66	dBm
64 QAM	MCS7	-65	dBm

6.3.3.5. 802.11a (5GHz)

Modulation	Data rate	Typical sensitivity	Units
BPSK	6 Mbps	-89	dBm
BPSK	9 Mbps	-88	dBm
QPSK	12 Mbps	-87	dBm
QPSK	18 Mbps	-85	dBm
16 QAM	24 Mbps	-82	dBm
16 QAM	36 Mbps	-78	dBm
64 QAM	48 Mbps	-74	dBm
64 QAM	54 Mbps	-73	dBm

6.3.3.6. 802.11n/ac, Channel BW = 20MHz (5GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-86	dBm
QPSK	MCS1	-85	dBm
QPSK	MCS2	-83	dBm
16 QAM	MCS3	-80	dBm
16 QAM	MCS4	-76	dBm
64 QAM	MCS5	-71	dBm
64 QAM	MCS6	-70	dBm
64 QAM	MCS7	-69	dBm

6.3.3.7. 802.11n/ac, Channel BW = 40MHz (5GHz)

Modulation	Data rate Index	Typical sensitivity	Units
BPSK	MCS0	-85	dBm
64 QAM	MCS7	-66	dBm
256 QAM	MCS8	-64	dBm
256 QAM	MCS9	-63	dBm

6.3.3.8. 802.11ac, Channel BW = 80MHz (5GHz)

Modulation	Data rate Index	Typical sensitivity	Units
256 QAM	MCS8	-62	dBm
256 QAM	MCS9	-61	dBm

7. DESIGN GUIDELINES

7.1. General PCB Design Guidelines

- Ground stitch any ground planes to improve thermal dissipation.
- The VDD_3.3V main power rail must support > 700 mA (average).
- It is recommended to place a 10µF capacitor near the VDD_3.3V pins and a 2.2µF on the VDDIO pin.
- Keep power traces as wide as possible to lower the risk of IR drop.
- Wherever possible, add 30% current margin for all trace widths.

7.2. SDIO Interface

The SDIO bus is the WLAN host interface and should be treated as a high-speed bus. Any design issue related SDIO signal integrity will result in lower bus speed thus lower data throughput.

The recommendations below should be followed during the design:

- Do not break the ground reference plane below any of the SDIO traces.
- Total trace length should be less than 4-inch and maximum 20 pF.
- SDIO signals trace length should be matched
  - Reduce SDIO bus length as much as possible
  - Use SDIO_CLK as the target length.
  - Allow max of ±1mm variance with respect to SDIO_CLK
- Spacing between traces: 2~3 times of trace width.
- Trace impedance: 50 Ω±10%
- Continue GND plane under top/bottom of SDIO traces are required.
- SDIO clock must be well isolated and via shielded where possible.

7.3. Voltage Regulator

This section describes the VDD_3.3V power regulator requirements for designs using the WE866C3. It is intended for selecting the proper DC-DC regulator in the platform. There are a couple of options for supplying the required VDD_3.3V input such as Buck-boost, Buck or a Boost power regulator.

7.3.1. Recommended Regulators

Manufacturer	Type	Part number
Texas Instruments	buck-boost	TPS630242
Texas Instruments	buck	LM3281

Please refer to vendor reference design for typical application and PCB layout requirements.

7.3.2. Regulator Operating Conditions

Below table shows the recommended operating conditions of the VDD_3.3V Buck-Boost voltage regulator:

Parameter	Condition	Min	Typ	Max	Unit
Input Voltage range		2.5		4.75	V
Shutdown supply current			1	5	uA
Quiescent current	IOUT=0mA, VOUT=3.3V		30	60	uA
Output voltage			3.3		V
Load Current		0.9			A
Output Voltage accuracy (output voltage should be maintained within these limits during all conditions including line voltage, load current variations)	PWM mode	-2	2	2	%
	PFM mode	-4	4	4	%
Output ripple voltage	PWM mode			20	mVpp
	PFM mode			50	mVpp
Power efficiency	Vout=3.3V, Iout=1300mA	85	90		%
	Vout=3.3V, Iout=1mA	80	85		%
Overshoot/Undershoot	IOUT = 0.2A to 1.2A IOUT = 1.2A to 0.2A			100	mV
Startup time	Buck mode, time taken for VOUT to reach 95% of its nominal value. VIN=4V, IOUT=200mA		1		mS
	Boost mode, time taken for VOUT to reach 95% of its nominal value. VIN=3V, IOUT=200mA		2		mS
Switching frequency		1.5		6	MHz
PFM mode	Output current to enter PFM mode		100		mA
Short circuit current limit			2.5		A

7.4. Antenna Requirements

7.4.1. Main Antenna

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

The antenna and antenna transmission line on PCB for a Telit device shall fulfil the following requirements:

Frequency Range	Requirements
2.412 ~ 2.484GHz	2.412~2.484GHz 4.9~5.925GHz
VSWR	< 2:1 recommended
Gain (dBi)	1 typical
Max Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical

7.4.2. Antenna Cable

Type	Requirements
2.412 ~ 2.484GHz	Cable insertion loss <1dB
4.9 ~ 5.925GHz	Cable insertion loss <1dB

7.4.3. Antenna Design

When using the WE866C3, since there's no antenna connector on the module, the antenna must be connected to the WE866C3 antenna pad by means of a transmission line implemented on the PCB.

This transmission line shall fulfil the following requirements:

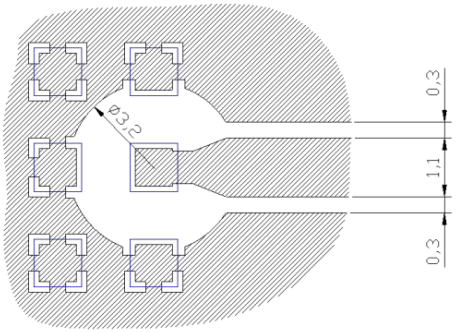
Item	Value
Characteristic Impedance	50 Ohm
Max Attenuation	0.3 dB
Coupling	Coupling with other signals shall be avoided
Ground Plane	Cold End (Ground Plane) of antenna shall be equipotential to the module ground pins

The transmission line should be designed according to the following 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.
- Avoid right angles whenever possible and route on the top layer only.
- 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 every 2mm at least.
- Place EM noisy devices as far as possible from module antenna line.
- Keep the antenna line far away from the module power supply lines.
- If you have EM noisy devices around the PCB hosting the module, 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 cases where EMI is not a concern, using a micro strip on the superficial copper layer for the antenna line is recommended as the line attenuation will be lower than a buried one.

NOTE:
The following image is showing the suggested layout for the Antenna pad connection (dimensions in mm):



7.4.4. Antenna Installation Guidelines

Install the antenna in a place with WiFi signal coverage.

Antenna shall not be installed inside metal cases.

Antenna shall be installed according to antenna manufacturer instructions.

8. MECHANICAL DESIGN

8.1. Mechanical Dimensions

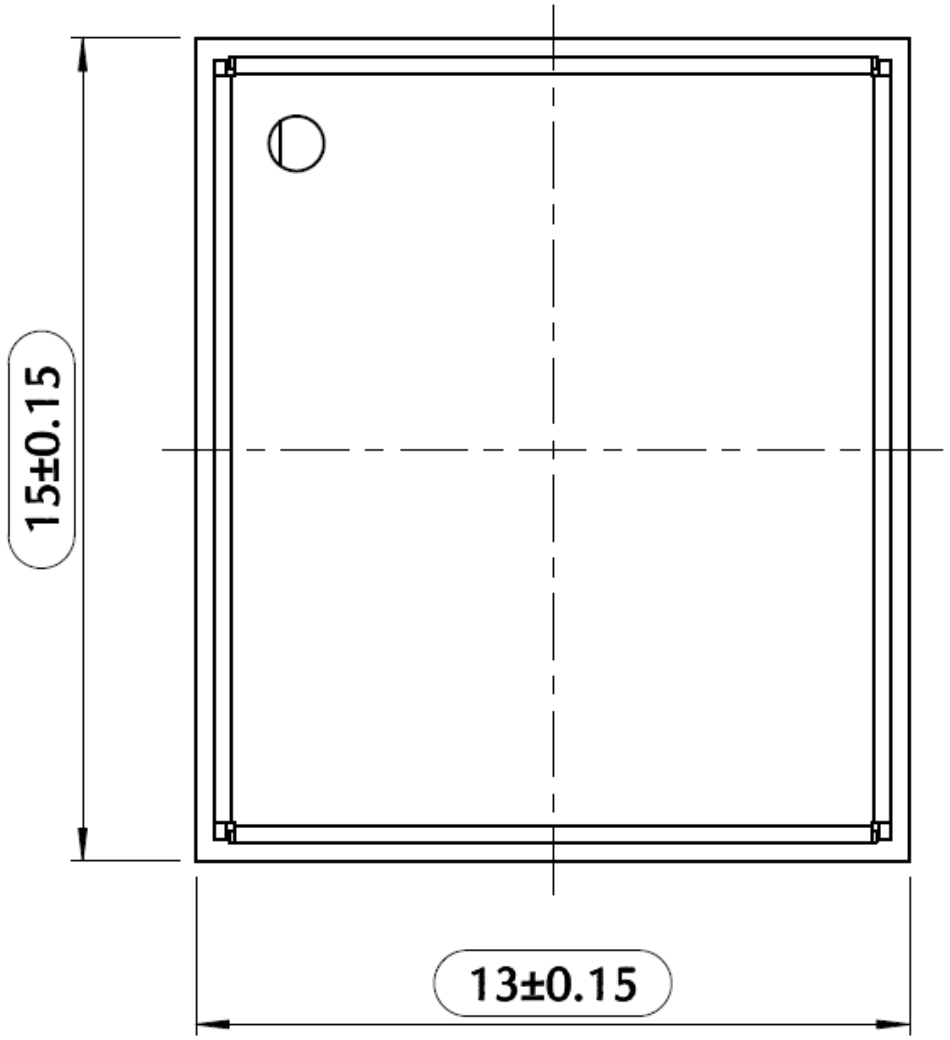
The WE866C3 overall dimensions are:

- Length: 15 mm
- Width: 13 mm
- Thickness: 2.15 mm
- Weight: 1 g

8.1.1. Mechanical Drawing

8.1.2. Top View

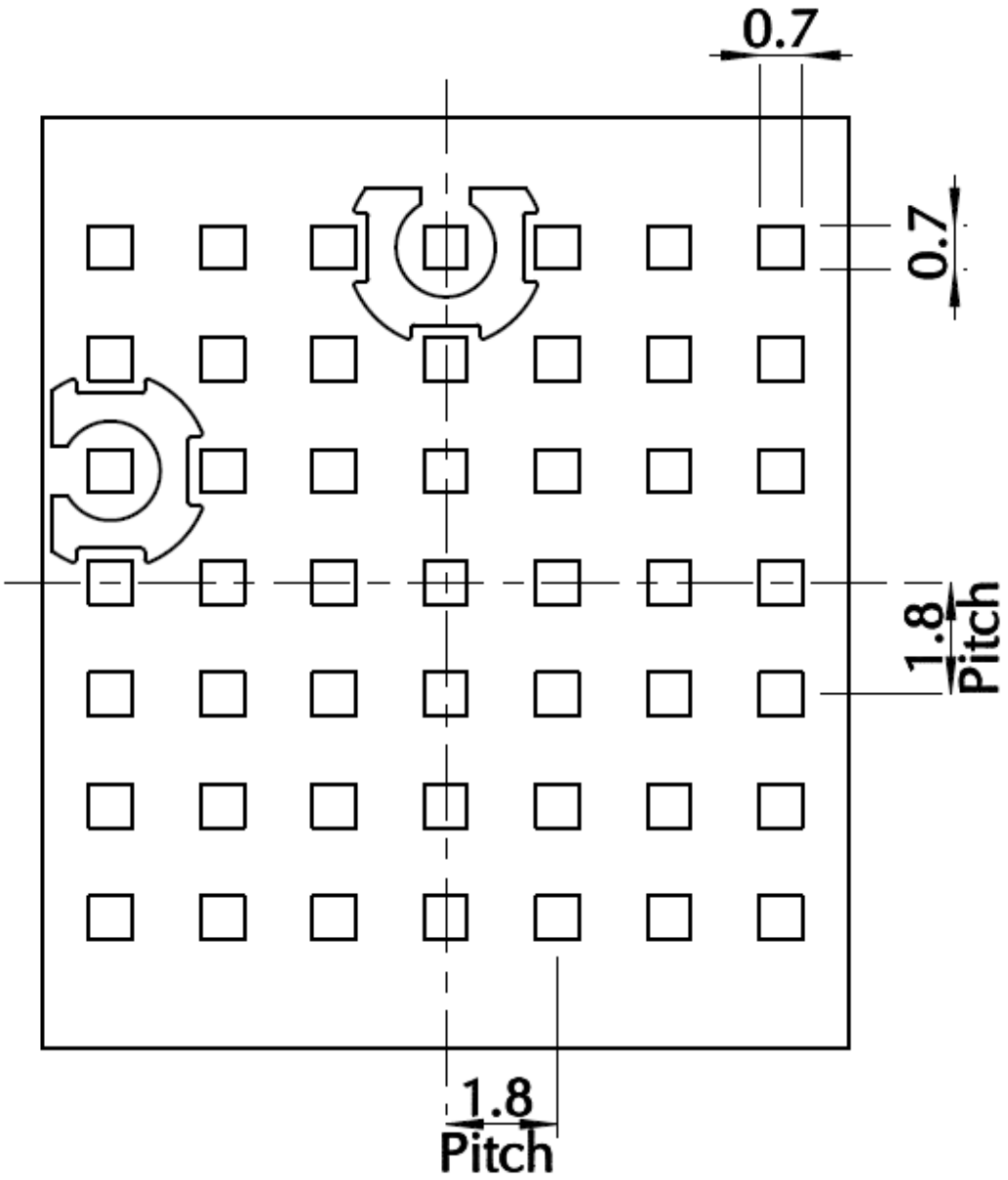
The figure below shows the mechanical top view of the WE866C3



Dimensions are in mm

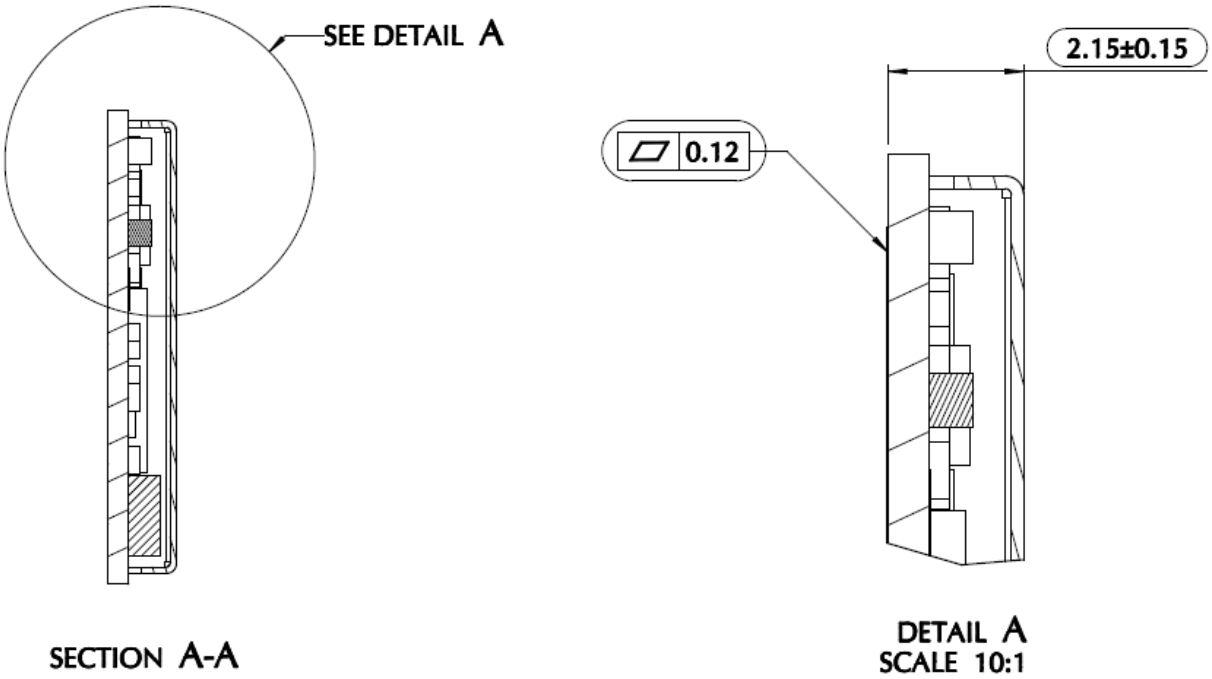
8.1.3. Bottom View

The figure below shows the mechanical Bottom view of the WE866C3



8.1.4. Side View

The figure below shows mechanical side view of the WE866C3



9. APPLICATION PCB DESIGN

The modules have been designed to be compliant with a standard lead-free SMT process

9.1. Recommended Footprint for the Application

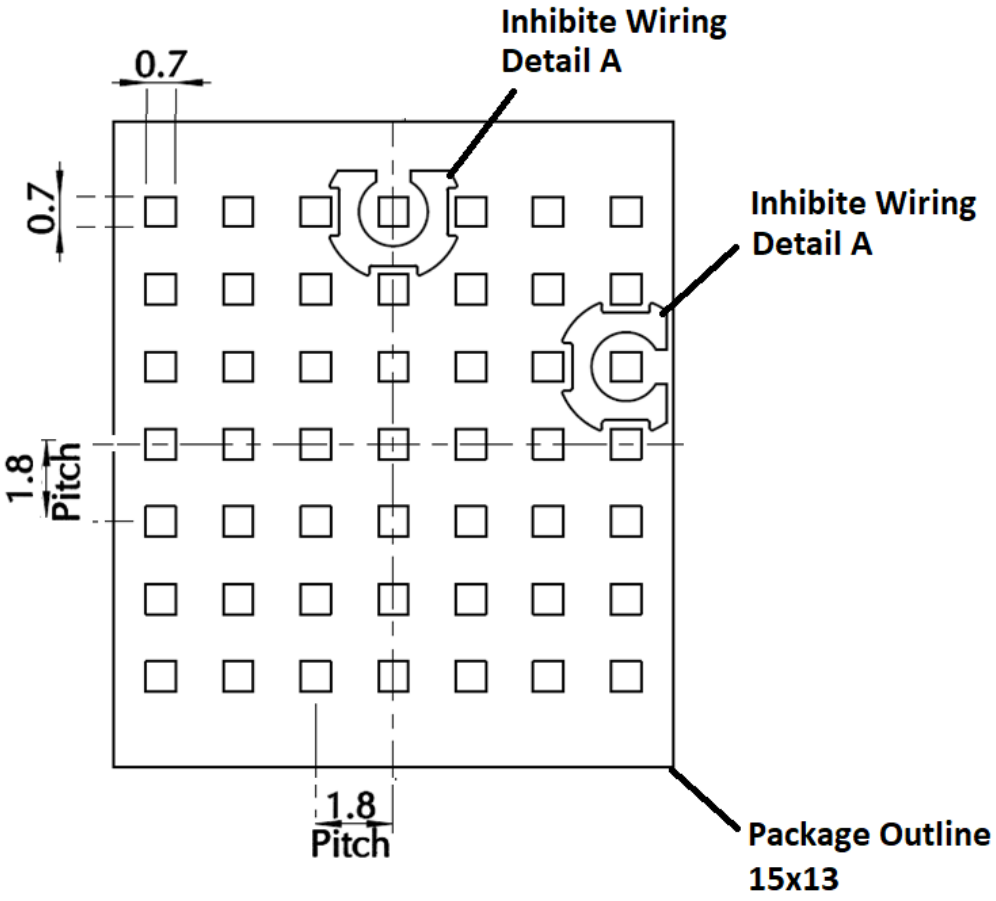
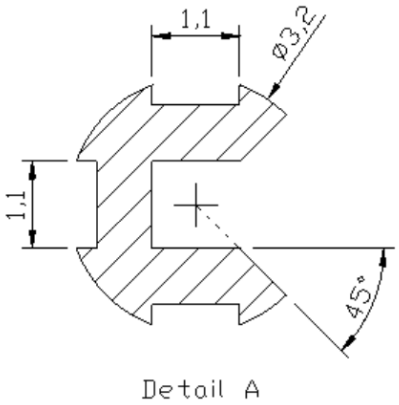


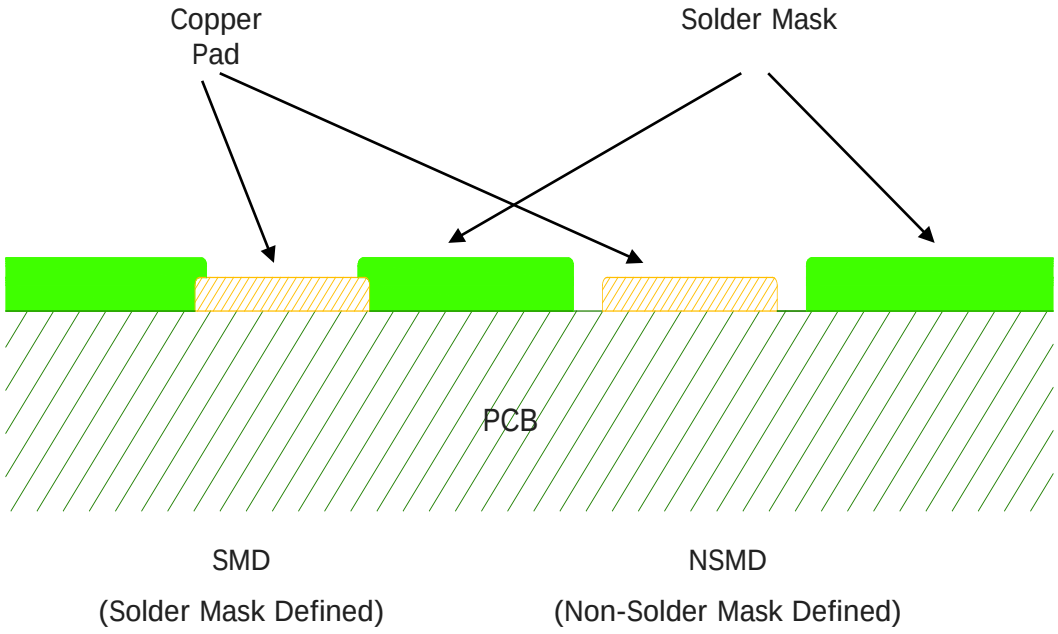
Figure 2 Copper Pad Outline Top View



In order to easily rework the module, it is suggested to add a 1.5 mm placement 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.
The area under WIRING INHIBIT (see figure above) must be clear from signal or ground paths.

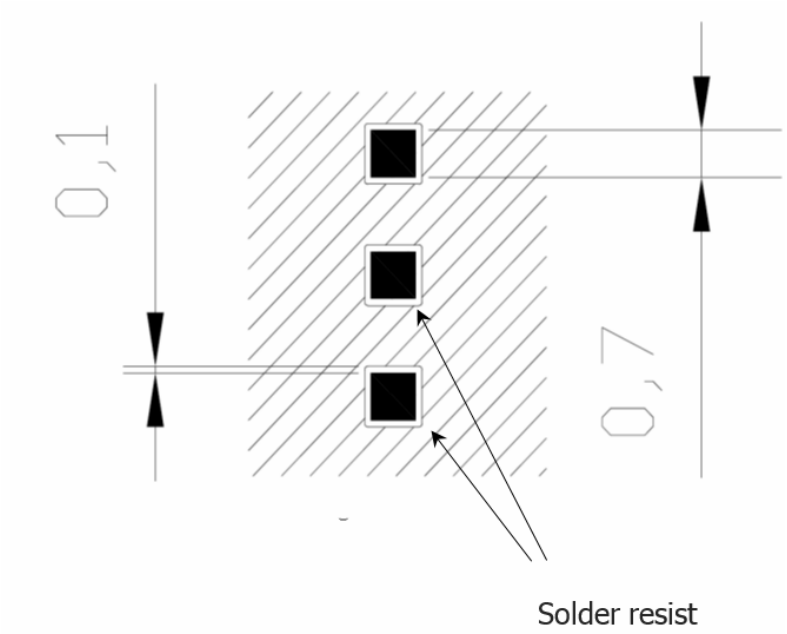
9.2. PCB Pad Design

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

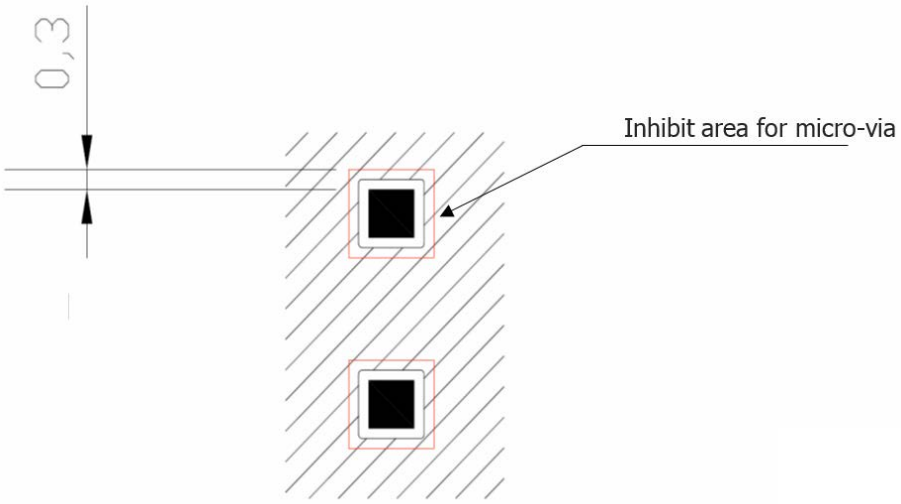


9.3. PCB Pad Dimensions

The recommendation for the PCB pads dimensions are described in the following image (dimensions in mm)



It is not recommended to place via or micro-via not covered by solder resist in an area of 0,3 mm around the pads unless it carries the same signal of the pad itself



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

Recommendations for PCB pad surfaces:

Finish	Layer Thickness (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 wettability of tin-lead solder paste on the described surface plating is better compared to lead-free solder paste.

It is not necessary to panel the application's PCB, however in that case it is suggested to use milled contours and predrilled board breakouts; scoring or v-cut solutions are not recommended.

9.4. Stencil

Minimum stencil thickness recommended is 125um (5mil)

9.5. Solder Paste

We recommend using only "no clean" solder paste in order to avoid the cleaning of the modules after assembly.

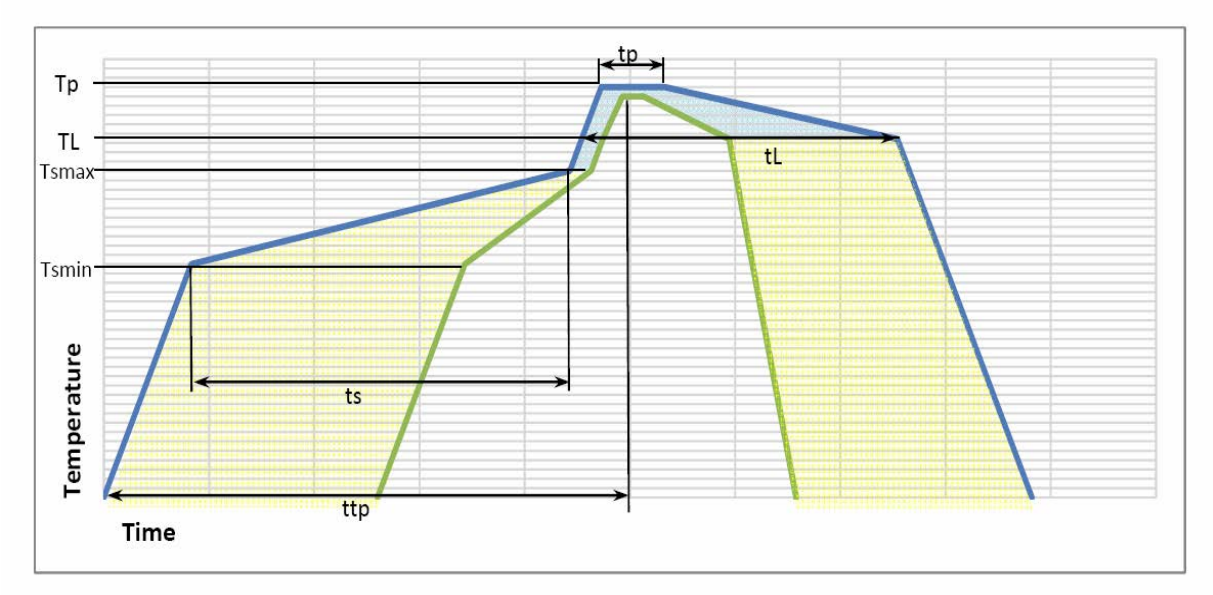
9.6. Cleaning

In general, cleaning the module mounted on the carrier board is not recommended.

- Residues between module and host board cannot be easily removed with any cleaning method.
- Cleaning with water or any organic solvent can lead to capillary effects where the cleaning solvent is absorbed into the gap between the module and the host board or even leak inside the module (due to the gap between the module shield and PCB) . The combination of soldering flux residues and encapsulated solvent could lead to short circuits between conductive parts. The solvent could also damage the module label.
- Ultrasonic cleaning could damage the module permanently. Especially for crystal oscillators where the risk of damaging is very high.

9.7. Solder Reflow

Recommended solder reflow profile



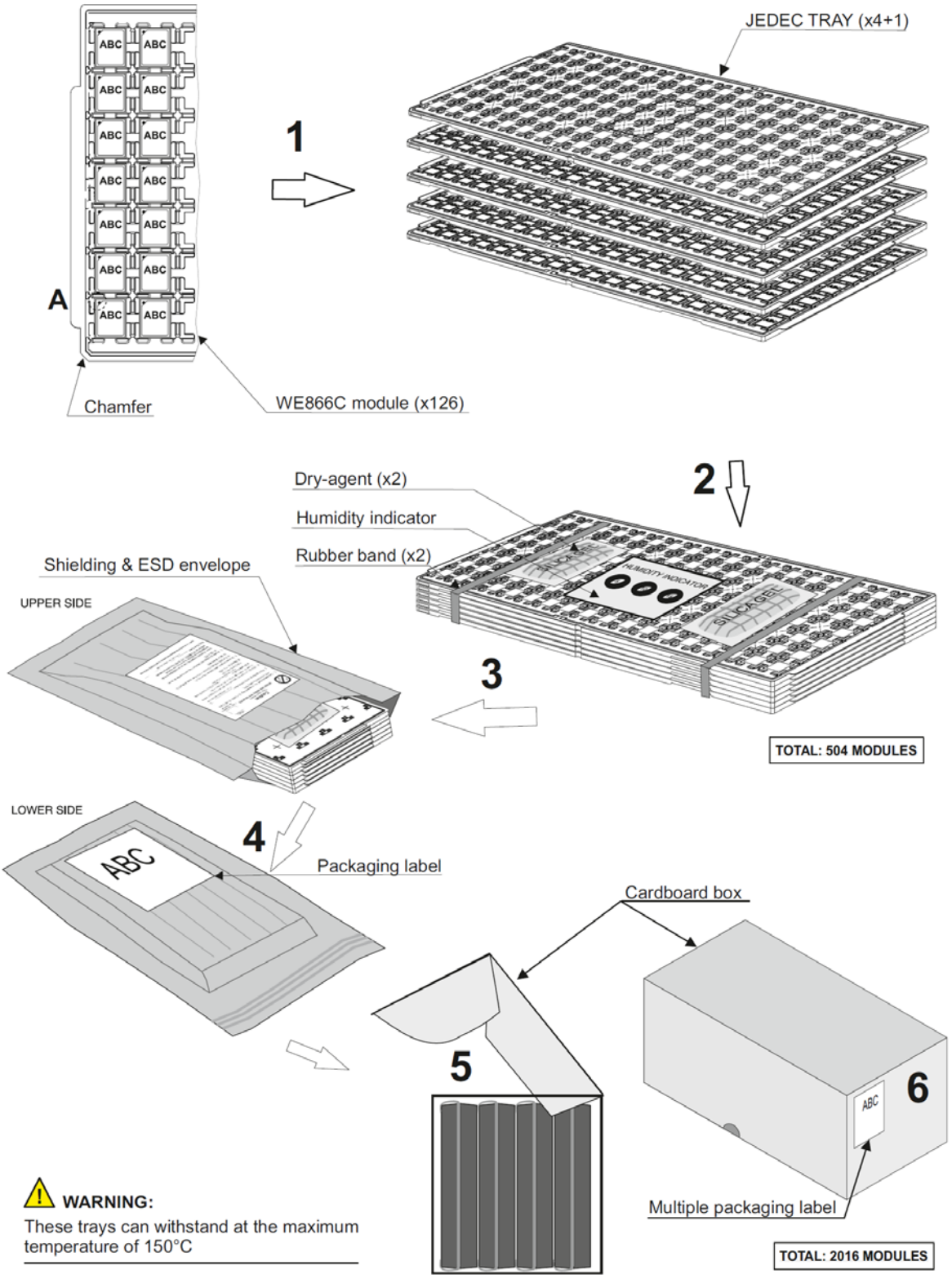
Profile Feature	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max
Preheat – Temperature Min (Tsmin) – Temperature Max (Tsmax) – Time (min to max) (ts)	 150°C 200°C 60-180 seconds
Tsmax to TL – Ramp-up rate	 3°C/second max
Time maintained above: – Temperature (TL) – Time (tL)	 217°C 60-150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

WARNING:
The module withstands one reflow process only.

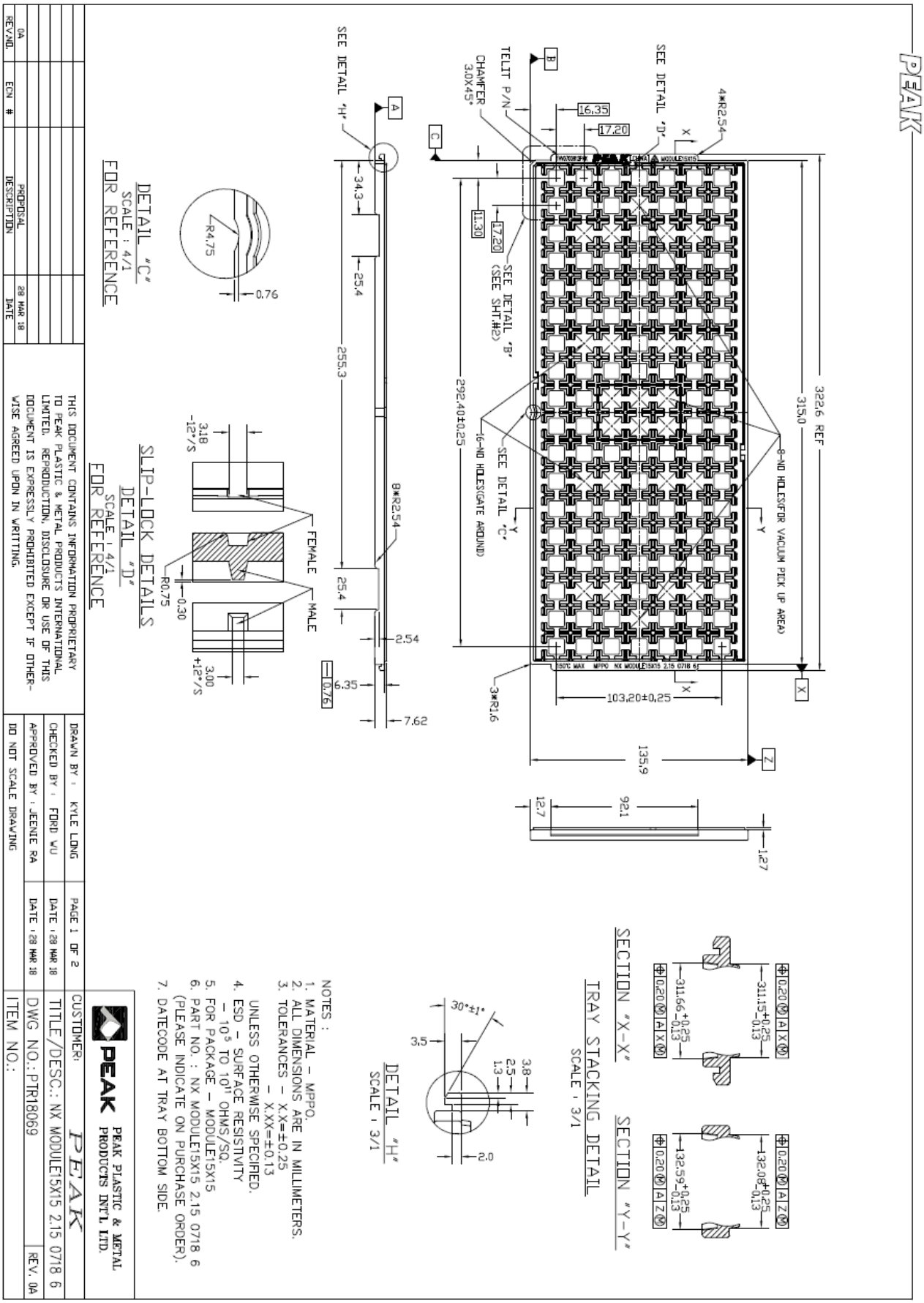
10. PACKING SYSTEM

10.1. Tray

The WE866C3 modules are packaged on trays of 126 pieces each. These trays can be used in SMT processes for pick & place handling.



10.2. Tray Drawing



10.3. Moisture Sensitivity

The module is a Moisture Sensitive Device level 3, in accordance with standard IPC/JEDEC J-STD-020. Customer should take care about all the related requirements for using this kind of components.

Moreover, the customer must take care of the following conditions:

a) Calculated shelf life in sealed bag: 12 months at <40°C and <90% relative humidity (RH).

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

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

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

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

11. CONFORMITY ASSESSMENT ISSUES

11.1. Declaration of Conformity

Hereby, Telit Communications S.p.A declares that the NB IOT Module is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address: http://www.telit.com\red

12. SAFETY RECOMMENDATIONS

12.1. 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 the 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 correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conformed to the security and fire prevention regulations. The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. Same cautions have to be taken for the SIM, checking carefully the instruction for its use. Do not insert or remove the SIM when the product is in power saving mode.

The system integrator is responsible for the functioning of the final product; therefore, care has to be taken to the external components of the module, as well as 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 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 equipment introduced on the market. All of the relevant information is available on the European Community website:

http://ec.europa.eu/enterprise/sectors/rtte/documents/

The text of the Directive 99/05 regarding telecommunication equipment is available,

while the applicable Directives (Low Voltage and EMC) are available at:

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

13. ACRONYMS

TTSC	Telit Technical Support Center
USB	Universal Serial Bus
HS	High Speed
DTE	Data Terminal Equipment
UART	Universal Asynchronous Receiver Transmitter
I/O	Input Output
GPIO	General Purpose Input Output
CMOS	Complementary Metal – Oxide Semiconductor
CLK	Clock
RTC	Real Time Clock
PCB	Printed Circuit Board
ESR	Equivalent Series Resistance
VSWR	Voltage Standing Wave Radio
VNA	Vector Network Analyzer
RED	Radio Equipment Directive

14. DOCUMENT HISTORY

Revision	Date	Changes
1	2018-02-07	First issue
2	2018-03-16	Updated mechanical drawings Added note related to reflow cycles
3	2018-04-26	General updates following marketing samples verification Updating package information Update RF power values
4	2018-07-05	Updated TX Output power
5	2018-10-23	Updated current consumption values Updated TX Output power values
6	2019-02-14	Updated Operating temperature range Updated Packing system
7	2019-03-19	Added a note regarding Operating Temperature Range under section 2.5 Main Features

SUPPORT INQUIRIES

Link to **www.telit.com** and contact our technical support team for any questions related to technical issues.

www.telit.com

Telit Communications S.p.A.
Via Stazione di Prosecco, 5/B
I-34010 Sgonico (Trieste), Italy

Telit IoT Platforms LLC
5300 Broken Sound Blvd, Suite 150
Boca Raton, FL 33487, USA

Telit Wireless Solutions Inc.
3131 RDU Center Drive, Suite 135
Morrisville, NC 27560, USA

Telit Wireless Solutions Co., Ltd.
8th Fl., Shinyoung Securities Bld.
6, Gukjegeumyung-ro8-gil, Yeongdeungpo-gu
Seoul, 150-884, Korea

Telit Wireless Solutions Ltd.
10 Habarzel St.
Tel Aviv 69710, Israel

Telit Wireless Solutions
Technologia e Servicos Ltda
Avenida Paulista, 1776, Room 10.C
01310-921 São Paulo, Brazil

Mod.0818 2017-01 Rev.0

[01.2017]