ME910C1 - mPCIe
HW Design Guide

1VV0301642 Rev. 1 – 2020-02-11

TELIT
TECHNICAL
DOCUMENTATION

[11.2017]

Mod.0818 2017-11 Rev.0

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

- ME910C1-WW

Contents

List of Tables

List of Figures

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 ME910C1 Mini PCIe Adapter (mPCIe).

1.2. Audience

This document is intended for Telit customers, especially system integrators, about to implement their applications using the Telit ME910C1 Mini PCIe Adapter.

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

[1] ME910C1 Hardware User Guide 1VV0301351
[2] ME910C1 AT Command User Guide 80529ST10815A
[3] mPCIe_IFBD_HW_USER_GUIDE 1VV0301483
[4] PCI Express Mini Card Electromechanical Specification Revision 2.1

2. GENERAL PRODUCT DESCRIPTION

2.1. Overview

The aim of this document is to present possible and recommended hardware solutions useful for developing a product with the Telit ME910C1-mPCIe module.
ME910C1-mPCIe is Telit platform for Mini PCIe applications, such as M2M applications, table PC, based on the following technologies:

- LTE / WCDMA networks for data communication
- Designed for industrial grade quality

In its most basic use case, ME910C1-mPCIe can be applied as a wireless communication front-end for mobile products, offering mobile communication features to an external host CPU through its rich interfaces. ME910C1-mPCIe can further support customer software applications and security features. ME910C1-mPCIe provides a software application development environment with sufficient system resources for creating rich on-board applications. Thanks to a dedicated application processor and embedded security resources, product developers and manufacturers can create products that guarantee fraud prevention and tamper evidence without extra effort for additional security precautions.
ME910C1-mPCIe hardware is available in different board and band variants as listed in the chapter §2.2 Product Variants and Frequency Bands

2.2. Product Variants and Frequency Bands

ME910C1 modules bands combinations are listed below:

Product	2G Band	4G Band	Region
ME910C1-NA		2, 4, 12	North America
ME910C1-WW	2, 3, 5, 8	1, 3, 5, 8, 18, 19, 26, 28	World Wide

Table 1 Product Variants and Frequency Bands

Refer to Chapter §14 Reference Table of RF Bands Characteristics for details information about frequencies and bands.

2.3. Target market

ME910C1-mPCIe can be used for wide variety applications, where low power consumption and low cost are required while sufficient data rates are achieved:

- Applications using the mPCIe connector
- Notebook PC
- M2M applications

2.4. Main features

Function	Features
Modem	• Multi-RAT cellular modem for voice and data communication • LTE FDD Catx data rates per the module variant used. • Carrier aggregation is not supported • GSM/GPRS/EDGE (when available) • Regional variants with optimal choice of RF bands • coverage of countries and MNOs • State-of-the-art GNSS solution with GPS/GLONASS/BeiDou/Galileo/QZSS receiver
USIM ports – dual voltage	• Class B and Class C support • Hot swap support • Clock rates up to 4 MHz
Application processor	Application processor to run customer application code • Flash + DDR are large enough to allow for customer's own software applications

Interfaces	• USB2.0 – USB port is typically used for:
	  • Flashing of firmware and module configuration
	  • Production testing
	  • Accessing the Application Processor's file system
	  • AT command access
	  • High-speed WWAN access to external host
	  • Diagnostic monitoring and debugging
	  • Communication between Java application environment and an external host CPU
	  • NMEA data to an external host CPU
	• Peripheral Ports – I2S, UART
	• GPIOs
	• Antenna ports

Form factor	Full-Mini Card 52 pin, 50.95mm x 30mm x 1mm.
Environment and quality requirements	The entire module is designed and qualified by Telit for satisfying the environment and quality requirements.
Single supply module	The module generates all its internal supply voltages.
RTC	No dedicated RTC supply, RTC is supplied by 3V3_AUX

Table 2 Main features

2.5. TX Output Power

Technology	Power (dBm)
2G LB	32 (when available)
2G HB	29 (when available)
4G FDD	23 @1RB

Table 3 TX Output Power

2.6. RX Sensitivity

Technology	Sensitivity (dBm)
2G	-107 (when available)
4G FDD (BW=5 MHz)	-102

Table 4 RX Sensitivity

2.7. Mechanical specifications

2.7.1. Dimensions

The overall dimensions of ME910C1-mPCIe family are:

- Length: 50.95 mm, +0/-0.3mm
- Width: 30 mm, +0/-0.3mm
- Thickness : 3.2 mm, +/-0.15mm (Version with SIM holder : 4.78 mm, +/-0.15mm)

2.7.2. Weight

The nominal weight of the mPCIe card is about 7 grams.

2.8. Temperature range

Case	Range	Note
Operating Temperature Range	–20°C ~ +55°C	The module is fully functional(*) in all the temperature range, and it fully meets the 3GPP specifications.
	–40°C ~ +85°C	The module is fully functional (*) in all the temperature range. However, there may be some performance deviations in this extended range relative to 3GPP requirements, which means that some RF parameters may deviate from the 3GPP specification in the order of a few dB. For example: receiver sensitivity or maximum output power may be slightly degraded
Storage and non-operating Temperature Range	–40°C ~ +105°C	Storage temperature is not intended for mPCIe in his transport tray, wich cannot be heated over 65°C.

Table 5 Temperature range

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

3. PINS ALLOCATION

3.1. Pin-out

ME910C1 mPCIe Pinout follows the mPCIe specification [4]

Pin	Signal	I/O	Function	Type	Comment
Power Supply					
2	3V3_AUX	-	3.3V Main Power Supply	Power	
39	3V3_AUX	-	3.3V Main Power Supply	Power	
41	3V3_AUX	-	3.3V Main Power Supply	Power	
52	3V3_AUX	-	3.3V Main Power Supply	Power	
4	GND	-	Ground		
9	GND	-	Ground		
15	GND	-	Ground		
18	GND	-	Ground		
21	GND	-	Ground		
26	GND	-	Ground		
27	GND	-	Ground		
29	GND	-	Ground		
34	GND	-	Ground		
35	GND	-	Ground		
37	GND	-	Ground		
40	GND	-	Ground		

Pin	Signal	I/O	Function	Type	Comment
43	GND	-	Ground		
50	GND	-	Ground		
USB Interface					
36	USB D-	I/O	USB differential Data (-)		
38	USB D+	I/O	USB differential Data (+)		
UART					
3	UART_RX	I	Serial data input (RX) from DTE	1.8V	Not available in some HW variants
5	UART_TX	O	Serial data output (TX) to DTE	1.8V	Not available in some HW variants
17	UART_RTS	O	Output Request To Send signal (RTS) to DTE	1.8V	Not available in some HW variants
19	UART_CTS	I	Input for Clear To Send signal (CTS) from DTE	1.8V	Not available in some HW variants
I2S – Digital Voice Interface (DVI)					
45	PCM_CLK	I/O	Digital Audio Interface (BIT Clock)	1.8V	Not available in some HW variants
47	PCM_TX	O	Digital Audio Interface (TX Out of the card)	1.8V	Not available in some HW variants
49	PCM_RX	I	Digital Audio Interface (RX Into the card)	1.8V	Not available in some HW variants
51	PCM_SYNC	I/O	Digital Audio Interface (Frame_Sync)	1.8V	Not available in some HW variants
16	REF_CLK	O	Reference clock for external Codec	1.8V	Not available in some HW variants
SIM Card Interface					
8	SIMVCC	I/O	External SIM signal SIM Power Supply	1.8 / 3V	
10	SIMIO	I/O	External SIM signal Data I/O	1.8 / 3V	
12	SIMCLK	O	External SIM signal Clock	1.8 / 3V	
14	SIMRST	O	External SIM signal Reset	1.8 / 3V	

Pin	Signal	I/O	Function	Type	Comment
Miscellaneous Functions					
1	WAKE_N	O	Active Low output signal Wake Up signal to the host system	3V3_AUX	
6	1V5	O	1V5 Power Supply	Power	Not Used
20	W_DISABLE_N	I	Active Low Input Signal: • Shutdowns • Wireless disabling (Flight mode)	3V3_AUX	Already has an internal 100K PU to 3V3_AUX
22	PERST_N	I	Active Low Input Signal • Shutdowns	3V3_AUX	Should be externally PU to 3V3_AUX
24	3V3	-	3.3V Digital Power Supply	Power	Not Used
28	1V5	O	1V5 Power Supply	Power	Not Used
42	LED_WWAN_N	O	Open Drain circuitry LED driving, for module's status indication		LED should be PU externally in series to 3V3_AUX
48	1V5	O	1V5 Power Supply	Power	Not Used
Reserved					
7	Reserved	-			
11	Reserved	-			
13	Reserved	-			
16	Reserved	-			
23	Reserved	-			
25	Reserved	-			
30	Reserved	-			
31	Reserved	-			
32	Reserved	-			
33	Reserved	-			
44	Reserved	-			
46	Reserved	-			

Table 6 Pin-out

	WARNING: Reserved pins must be left flowting.

	WARNING: 3V3 and 1V5 Power Supply at Connector are not used in the board. They can be left conneceted or not connected to any existing power.

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

The external power supply must be connected to 3V3_AUX signal and must fulfil the following requirements:

Table 7 Power Supply Requirements

Nominal Supply Voltage	3.3V
Supply Voltage Range	3.0V ~ 3.6V
Max ripple on module input supply	30mV

NOTE:
The Operating Voltage Range 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 cause a Power Off of the module.
Overshoot voltage (regarding MAX Extended Operating Voltage) and drop in voltage (regarding MIN Extended Operating Voltage) MUST never be exceeded.
The "Extended Operating Voltage Range" is intended as the worse case between this document and those related to the module mounted and can be used only in non standard mPCIe application, custom design, with completely assumption and application of the HW User Guide [1] suggestions.

4.2. Power Consumption

For the complete power consumption specification, please refer to the specific Module's HW User Guide [1].

4.3. General Design Rules

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

- The electrical design
- The thermal design
- The PCB layout.

4.3.1. Electrical Design Guidelines

The electrical design of the power supply depends strongly from the power source where this power is drained.

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

4.3.1.1. +5V Source Power Supply Design Guidelines

- The desired output for the power supply is 3.3V. Since there's not a big difference between the input and output voltage values, a linear regulator can be used.
- When using a linear regulator, a proper heat sink shall be necessary in order to dissipate the generated heat.
- Since 5V is generally supplied directly from USB, take care not having more than 10uF at input and that USB give appropriate amount of current, about 1A.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks close to the Module, a 100µF capacitor is usually suited.
- Make sure the low ESR capacitor on the power supply output rated at least 10V.

An example of linear regulator with 5V input and 3A@3V3 output is shown here below.

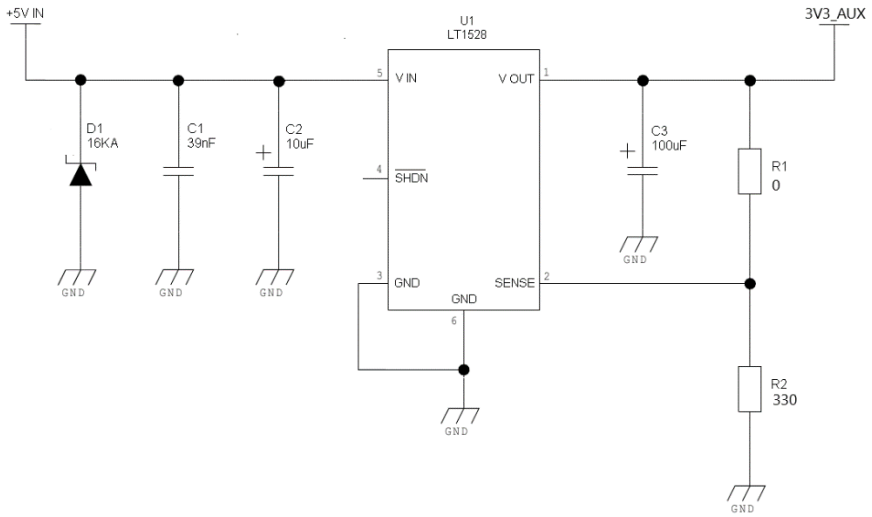


Figure 1 Linear regulator with 5V input and 3.3V output

4.3.1.2. +12V Source Power Supply Design Guidelines

- The desired output for the power supply is 3.3V. Due to the big difference between the input and output voltage values together with the current sinked, the linear regulator in the example above is capable but not efficient at high current sink and shall not be used. A switching power supply will be preferable because of its better efficiency.
- When using a switching regulator, a 500kHz or more switching frequency regulator is preferable because of its smaller inductor size and its faster transient response. This allows the regulator to respond quickly to the current peaks absorption.
- In any case the frequency and Switching design selection is related to the application to be developed due to the fact the switching frequency could also generate EMC interferences.
- For car PB battery the input voltage can rise up to 15.8V and this should be kept in mind when choosing components: all components in the power supply must withstand this voltage.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks, a 100µF capacitor is usually suited.
- Make sure the low ESR capacitor on the power supply output is rated at least 10V.
- For Car applications, a spike protection diode should be inserted close to the power input, in order to clean the supply from spikes.

An example of switching regulator with VIN=4V-36V input and 2.5A@3V3 output is shown here below.

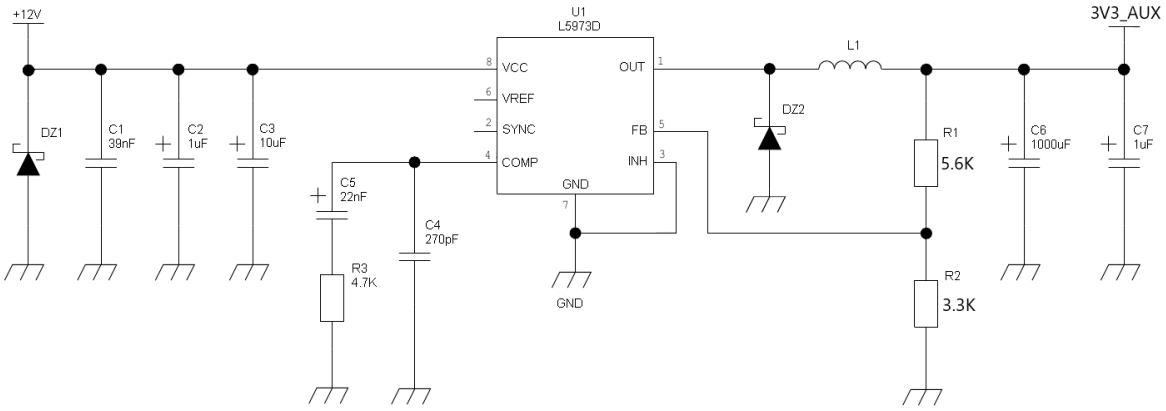


Figure 2 Switching regulator with 4V-36V input and 3.3V output

4.3.2. Thermal Design Guidelines

The thermal design of the application board and the power supply heat sink should be done with the following specifications:

- Typical LTE average current consumption during ME910C1 mPCIe transmission at maximum Power level and minimum input volage: 700 mA
- Average current during idle (USB enabled): 30 mA
- Average current during idle (USB disabled): 5 mA
- Average current during airplane mode (USB disabled): 2 mA

Considering the very low current during Idle, especially if the Power Saving function is enabled, it is possible to consider from the thermal point of view that the device absorbs significant current mainly during Data session. In LTE mode, the ME910C1 mPCIe emits RF signals continuously during transmission. Therefore, you must pay special attention how to dissipate the heat generated.

The ME910C1 mPCIe card is designed to distribute the heat from the module IC's to the whole PCB invìcreasing as much as possible the heart dissipation.

In order to achieve the best performance, the application board copper layers should be used to dissipate the heat out of the mPCIe card.

In order to ensure proper thermal flow from the mPCIe card to the application board, the mPCIe card bottom side should be thermally connected to the application's board top side via proper thermal pad.

The area of which the thermal pad is attached to on the application board must be designed as a large ground pad (with solder mask exposed).

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

4.3.3. Power Supply PCB layout Guidelines

Some ME910C1 versions have GSM capabilities. The GSM system is made in a way that the RF transmission is not continuous, else it is packed into bursts at a base frequency of about 216 Hz, and the relative current peaks can be as high as about 2.4A. Average current should be considered 1A. Therefore the power supply has to be designed in order to withstand with these current peaks and average without big voltage drops; this means that both the electrical design and the board layout must be designed for this current flow. If the voltage drop during the peak current absorption is too high, then the device may even shutdown as a consequence of the input supply voltage drop.

	NOTE: The electrical design for the Power supply should be made ensuring it will be capable of a peak current output of at least 2.4 A.

As seen on the electrical design guidelines the power supply shall have a low ESR capacitor on the output to help during the current peaks and protect the supply, specially DC/DC, from positive and negative spikes. Negative spikes can demage the module. The placement of this component 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 ME910C1-mPCIe power input pads or in the case the power supply is a switching type it can be placed close to the inductor to cut the ripple provided the PCB trace from the capacitor to the ME910C1-mPCIE is wide enough to ensure a dropless connection even during the 2A current peaks.
- A protection diode must be placed close to the input connector where the power source is drained.
- The PCB traces from the input connector to the power regulator IC must be wide enough to ensure no voltage drops occur when a 2A current peak is absorbed.
- Any PCB power traces to the ME910C1-mPCIE and the Bypass capacitors must be wide enough to ensure no significant voltage drops occur. This is for the same reason as previous point. Try to keep this trace as short as possible.
- To reduce the EMI due to switching, it is important to keep very small the mesh involved; thus the input capacitor, the output diode (if not embodied in the IC) and the regulator have to form a very small loop. This is done in order to reduce the radiated field (noise) at the switching frequency (100-500 kHz usually).
- A ground island around Switching regulator components on top layer but well connected to the common system ground plane in inner layer can help to reduce noise distribution and consequent spurious generation.
- The placement of the power supply on the board should be done in such a way to guarantee that the high current return paths in the ground plane are not overlapped to any noise sensitive circuitry as the microphone amplifier/buffer or earphone amplifier.
- The power supply input cables should be kept separate from noise sensitive lines such as microphone/earphone cables.

- The insertion of an EMI filter on 3V3_AUX pins is suggested in those designs where antenna is placed close to battery or supply lines.

  A ferrite bead like Murata BLM18EG101TN1 or Taiyo Yuden P/N FBMH1608HM101 can be used for this purpose, they are good low band pass filter with frequency cut about 100MHz.

The below figure shows the recommended circuit:

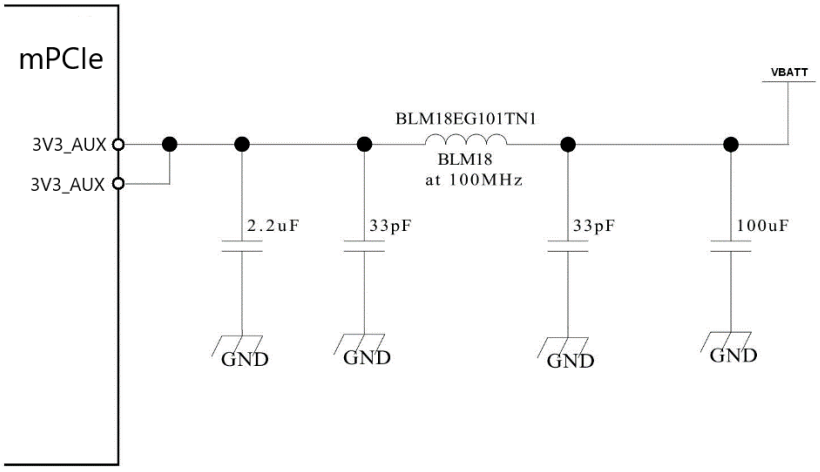


Figure 3 Power supply EMI filtering recommended circuit

5. ELECTRICAL SPECIFICATION

5.1. Absolute Maximum Ratings – Not Operational

	Caution – A deviation from the value ranges listed below may harm the module.

Symbol	Parameter	Min	Max	Unit
3V3_AUX	Main Supply Voltage at pins 3V3_AUX	-0.5	4.2	[V]

Table 8 Absolute Maximum Ratings – Not Operational

5.2. Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
T_{amb}	Ambient temperature	-40	+25	+85	[°C]
3V3_AUX	Main Supply Voltage at pins 3V3_AUX	3.0	3.3	3.6	[V]
I_{3V3_AUX}	Peak current to be used to dimension decoupling capacitors at pins 3V3_AUX	-	-	2400	[mA]

Table 9 Recommended Operating Conditions

6. DIGITAL SECTION

6.1. Logic Levels

All digital signals are powered from the internal module's V_{IO} power bank, V_{IO}=1.8V.
All control signals are powered from the external 3V3_AUX power bank, 3V3_AUX=3.3V.

ABSOLUTE MAXIMUM RATINGS:

Parameter	Min	Max
Input High Voltage on digital signals (CMOS 1.8) with respect to ground when 3V3_AUX is supplied	-0.3V	2.1V
Input High Voltage on digital signals (CMOS 1.8) with respect to ground when 3V3_AUX is not supplied	-0.3V	0.3V

Table 10 Absolute Maximum Rating digital signals (CMOS 1.8V)

Parameter	Min	Max
Input Voltage on control signals with respect to ground when 3V3_AUX is supplied	-0.3V	5V
Input Voltage on control signals with respect to ground when 3V3_AUX is not supplied	-0.3V	0.3V

Table 11 Absolute Maximum Rating for control signal

OPERATING RANGE DIGITAL SIGNALS (CMOS 1.8V):

Parameter	Min	Max
Input High Voltage	1.2V	1.85V
Input Low Voltage	0V	0.6V
Output High Voltage	1.4V	1.8V
Output Low Voltage	0V	0.45V
Pull-Up Resistance	10kΩ	390kΩ
Pull-Down Resistance	10kΩ	390kΩ
Input Capacitance	--	5pF
Input Leakage Current	-1uA	+1uA
Drive Strength	2mA	3mA

Table 12 Operating range digital signals (CMOS 1.8V)

OPERATING RANGE – SIM CARD PADS @2.95V:

Parameter	Min	Max
Input High Level	2.1V	3.1V
Input Low Level	-0.3V	0.55V
Output High Level	2.25V	3.1V
Output Low Level	0V	0.4V
Input Leakage Current	-10uA	10uA
Pull-Up Resistance	10kΩ	100kΩ
Pull-Down Resistance	10kΩ	100kΩ
Input Capacitance		5pF

Table 13 Operating Range SIM Card Pads

6.2. Power On

The ME910C1-mPCIe will automatically Power ON as soon as VBATT applies to the module and W_DISABLE_N and PERST_N are HI. The module is ready for use after HW power Up and SW initialization process complets. For this reason, it is impossible to access ME910C1-PCIe during the initialization state.

As shown below the ME910C1-mPCIe becomes operational (in the Activation state) at least 20 seconds after power is applied:

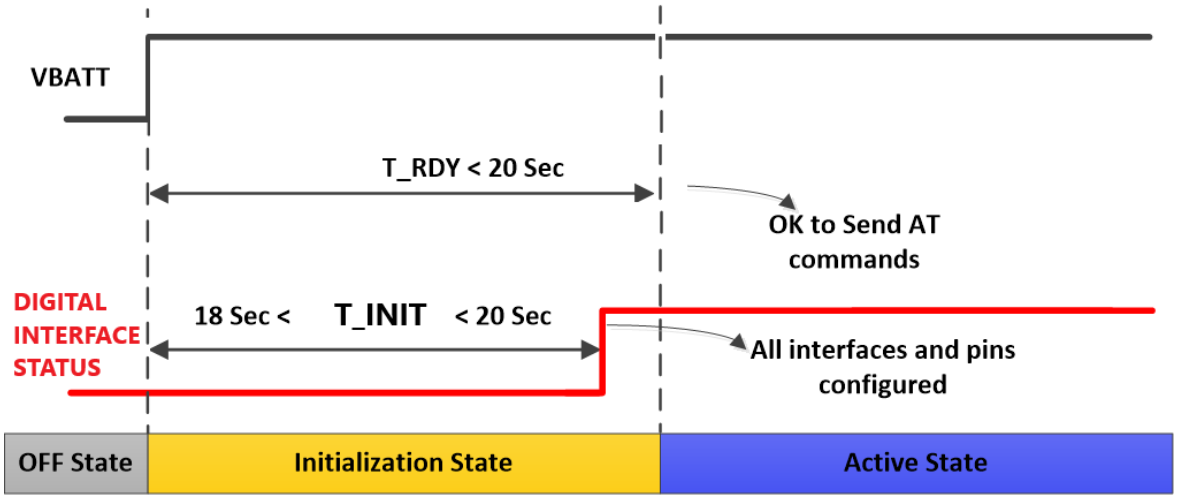
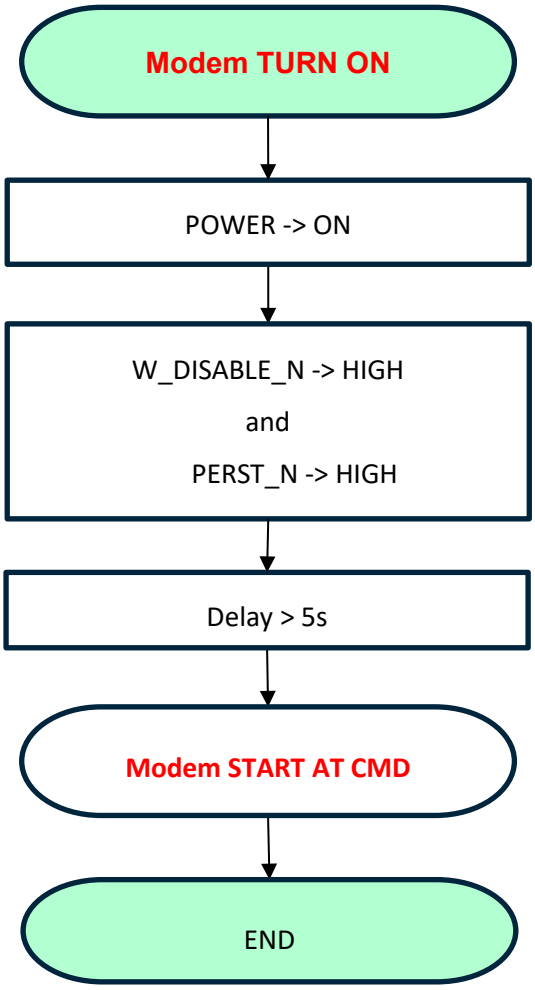


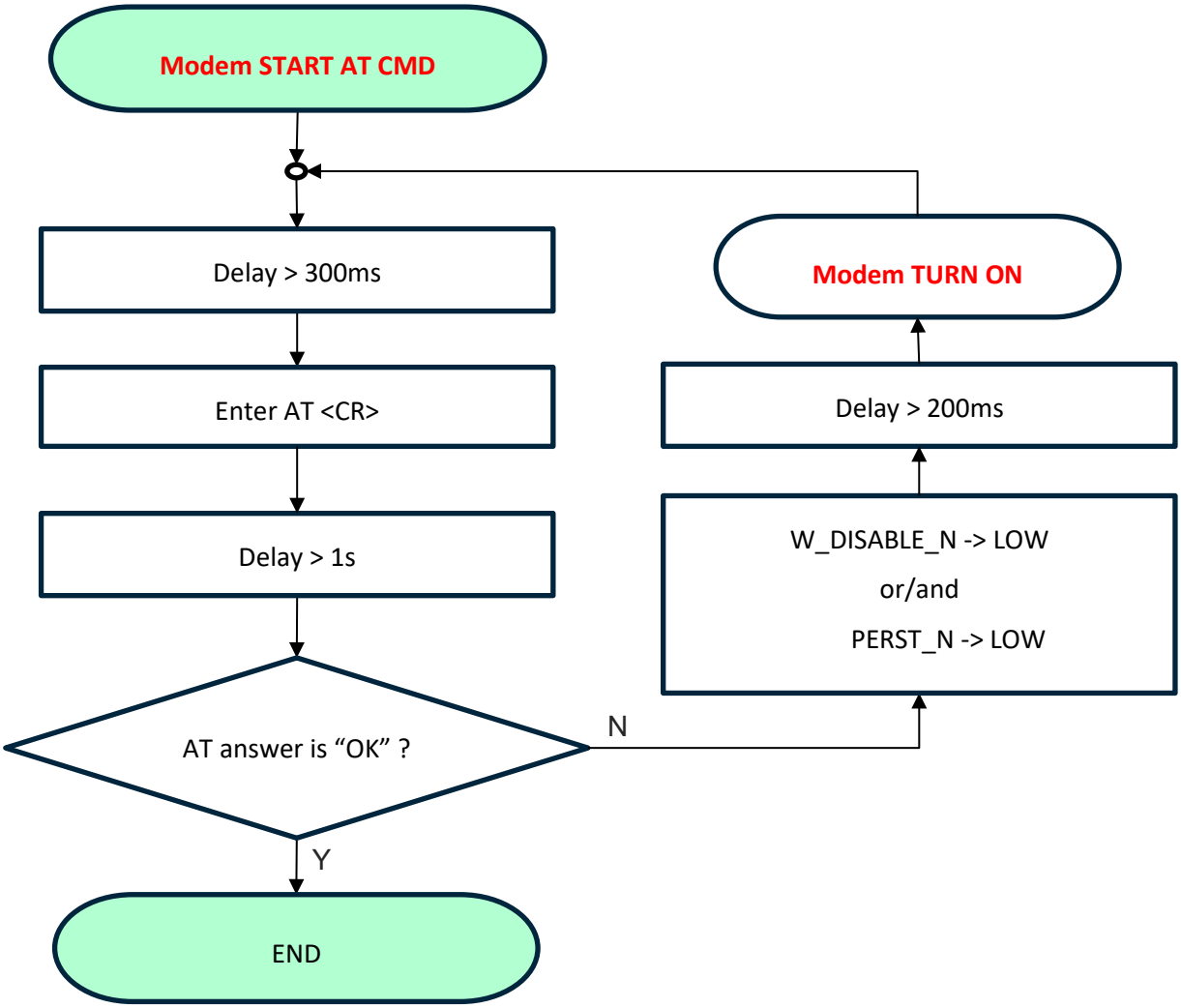
Figure 4 Power On Timing Diagram.

	Note: To Turn ON the ME910C1-mPCIe module give the 3V3_AUX and release both the PERST_N and W_DISABLE_N pins, they must not be asserted Low.

The following flow chart shows the proper ”MODEM TURN ON” procedure:



The following flow chart shows the proper “MODEM START AT COMMAND” procedure:



6.3. Unconditional Restart

To unconditionally restart the ME910C1-mPCIe, the signals PERST_N and W_DISABLE_N must be tied low for at least 200 milliseconds and then released.

The unconditional hardware restart must always be implemented on the application board as the software must be able to use it as an emergency exit procedure.
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 stuck waiting for some network or SIM responses.

W_DISABLE_N and PERST_N are in open drain configuration.
PERST_N needs an external pull up resistor to 3V3_AUX.
W_DISABLE_N have already an internal pull up 100K resistor to 3V3_AUX.

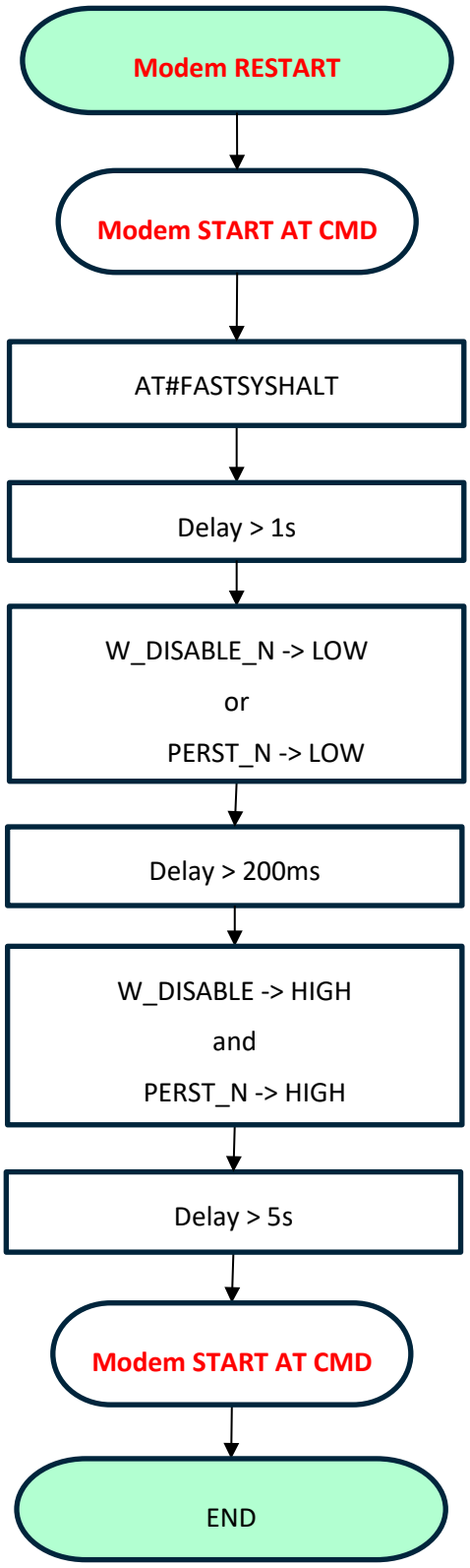
PIN DESCRIPTION

Signal	Function	I/O	PIN
W_DISABLE_N	Active Low, unconditional shutdown	I	20
PERST_N	Active Low, unconditional shutdown	I	22

Table 14 W_DISABLE_N and PERST_N

	WARNING: The W_DISABLE and PERST_N signals are hardware unconditional SHUTDOWN and must not be used during normal shutdown operation of the device since it does not detach the device from the network and can harm the memory content. It shall be kept as an emergency exit procedure. To use W_DISABLE_N and PERST_N as Unconditional Hardware Shutdown first Safety Prepare the module to it, by using the AT commands: AT#SYSHALT or AT#FASTSYSHALT. See AT command [2]. Not following the recommended Power OFF and RESTART procedure void the warranty.

The following flow chart shows the proper “MODEM RESTART” procedure:



6.4. Power OFF procedure

To turn OFF the ME910C1-mPCIe module, the W_DISABLE_N and/or PERST_N signals must be asserted Low.

For proper shutdown operation with correct network detach and memory access disable, first prepare the module to shutdown by using AT#SYSHALT command. If a fast shutdown is necessary, without waiting from network detach, use the AT#FASTSYSHALT instead.

The duration of the finalization state can differ according to the current status of the module, so a fix value cannot be defined.

If AT#SYSHALT is used it could take about 15s before it can turn off, depending on network, while if used AT#FASTSYSHALT it will take less than 1s.

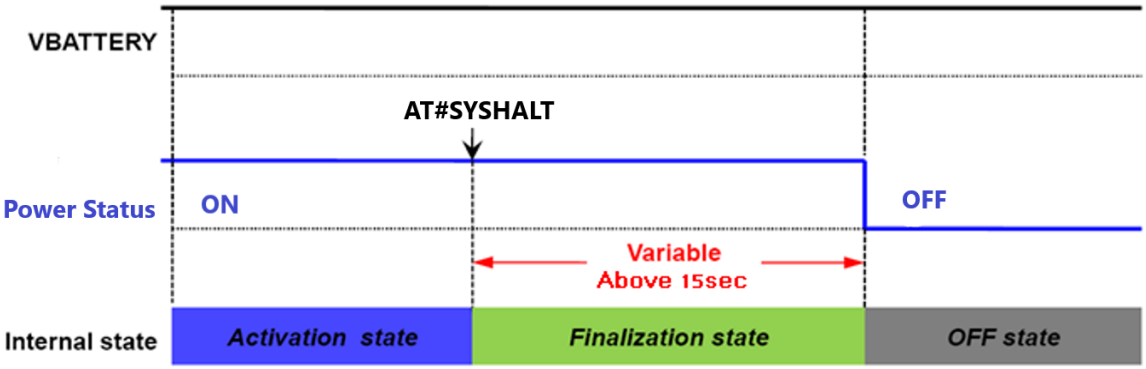


Figure 5 Shutdown using AT#SYSHALT Command

⚠	WARNING: The W_DISABLE and PERST_N signals are hardware unconditional SHUTDOWN and must not be used during normal shutdown operation of the device since it does not detach the device from the network and can harm the memory content. It shall be kept as an emergency exit procedure. To use W_DISABLE_N and PERST_N as Unconditional Hardware Shutdown first Safety Prepare the module to it, by using the AT commands: AT#SYSHALT or AT#FASTSYSHALT. See AT command [2]. Not following the recommended Power OFF and RESTART procedure void the warranty.

6.5. Control signals

Pin	Signal	I/O	Function	Type
1	WAKE_N	O	Open Drain Output Signal Wake Up signal to the host	3V3_AUX
20	W_DISABLE_N	I	Active Low Input Signal Shutdown Wireless disabling (Airplane mode)	3V3_AUX
22	PERST_N	I	Active Low Input Signal Shutdown	3V3_AUX
42	LED_WWAN_N	O	Open Drain Output Signal LED driving, for module's status indication	3V3_AUX

Table 15 Control signals

Parameters	Min	Max
Input High Voltage	2.0	3V3_AUX
Input Low Voltage	-0.5V	0.8V
Output High Voltage	3V3_AUX -0.5V	3V3_AUX
Output Low Voltage	3V3_AUX -0.5V	3V3_AUX

Table 16 Control signal operating levels

6.5.1. WAKE_N

WAKE_N output has already internal 10K PU to 3V3_AUX, so no external pull-up is needed.

WAKE_N is driven by an Open Drain circutry.

WAKE_N signal is SW managed and not active by default.

Configure it usign event monitoring AT command AT#EVMONI [2].

	NOTE: WAKE_N is not supported in host using PCI Express Mini Card Electromechanical Specification Revision 1.1 and below.

Software example using the RING signal to control the WAKEUP signal.

For more information read *Event Monitor Application Note 80000NT10028a*.

```
AT#ENAEVMONI=0                          // disable all events
AT#GPIO=3,0,1                           // Set GPIO3=>'0', "WAKE signal reset"
AT#ENAEVMONICFG=3,1,2                   // AT port setting
AT#EVMONI="RING",0,1,3                  // event 0-RING, after 3 rings
AT#EVMONI="RING",0,0,"AT#GPIO=3,1,1"    // GPIO3=>'1', "WAKE signal active"
AT#EVMONI="RING",1                      // event 0-RING enabled
AT#EVMONI="GPIO1",1,1,3                 // event 1-GPIO3
AT#EVMONI="GPIO1",1,2,1                 // when goes hi
AT#EVMONI="GPIO1",1,3,5                 // after 5s
AT#EVMONI="GPIO1",1,0," AT#GPIO=3,0,1"  // Set GPIO3=>'0', "WAKE signal reset"
AT#EVMONI="GPIO1",1                     // event 1-GPIO3 enabled
AT#ENAEVMONI=1                          // enable all events
```

6.5.2. W_DISABLE_N and PERST_N

W_DISABLE_N and PERST_N are both used for unconditionally shutdown the mPCIe. Whenever one of these signals is pulled low, the module shutdowns. After releasing both signals the module restarts. The module has already an internal Power On Reset control and do not need other externel componets.

	NOTE: Do not use W_DISABLE_N and PERST_N to power cycle without first preparing the module to shutdown. Read more at chapter §6.4 Power OFF Procedure.

6.5.3. LED_WWAN_N

LED_WWAN_N is driven by the module according the PCI Express Mini Card Electromechanical Specification Revision 2.1. If desired, LED behavior can be configured by adjusting software settings [2]. The LED circuit driver is in an Open Drain configuration. LED can be directly connected to LED_WWAN_N through a PU series resistor to 3V3_AUX.

	NOTE: This LED_WWAN_N signal is not active by default. Refer to AT#SLED description in the AT Command User Guide [2].

6.6. Hardware Interfaces

Following table below summarize all hardware interfaces available.

Interface	ME910C1-mPCIe
USB	USB2.0
UART	HS-UART (up to 4 Mbps)
Audio I/F	I2S/PCM
USIM	Dual voltage (1.8V/2.85V)
Antenna ports	2 for Cellular, 1 for GNSS

Table 17 Hardware Interfaces

6.6.1. USB Port

The ME910C1-mPCIe module includes a Universal Serial Bus (USB) transceiver, which operates at USB high-speed (480 Mbits/sec). It can also operate with USB full-speed hosts (12 Mbits/sec).

It is compliant with the USB 2.0 specification and can be used for control and data transfers as well as for diagnostic monitoring and firmware update.

The USB port is typically the main interface between the ME910C1-mPCIe module and OEM hardware.

Table Below lists the USB interface signals:

Signal	Pin No	Usage
USB_D-	36	Minus (-) line of the differential, bi-directional USB signal to/from the peripheral device
USB_D+	38	Plus (+) line of the differential, bi-directional USB signal to/from the peripheral device

Table 18 USB Interface

	NOTE: The USB_D+ and USB_D- signals have a clock rate of 480 MHz. The signal traces must be routed carefully. Minimize trace lengths, number of vias, and capacitive loading. The impedance value should be as close as possible to 90 Ohms differential and well isolated from other digital signals.

	NOTE: Even if USB communication is not used, it is still highly recommended to place an optional USB connector on the application board. At least test points of the USB signals are required since the USB physical communication is needed in the case of SW update.

6.6.2. Serial Port

The serial port is typically a secondary interface between the ME910C1-mPCIe module and OEM hardware.

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

The most common configurations are:

- RS232 PC com port
- Microcontroller UART

Depending on the serial port ineterfaces on the OEM hardware, you will need an extra components for voltage level translation. It is important to satisfy the condition in which during Shutdown, OFF or Power cycling, any external signal should be floating to avoid module's latchup and damage.

When mPCIe UART is directly connetd to a PC an RS232 translator is necessary, see more details in §6.6.2.1 RS232 Level Translator

The levels for the UART are CMOS 1.8V as described in §6.1 Logic Levels

List of the signal interconnections between RS232 and UART in the ME910C1-mPCIe:

RS232 Pin No.	Signal	mPCIe Pin No.	UART Function	Notes
2	RXD <-> UART_TX	5	Transmit Line	ME910C1-mPCIe UART Output transmit line
3	TXD <-> UART_RX	3	Receive Line	ME910C1-mPCIe UART Input receive line
5	GND	4,9,15….	Ground	Ground
7	RTS <-> UART_CTS	19	Request to Send	ME910C1-mPCIe UART Input controlling the Hardware flow control
8	CTS <-> UART_RTS	17	Clear to Send	ME910C1-mPCIe UART Output controlling the Hardware flow control

Table 19 Modem Serial Port 1 Signals

NOTE:
To avoid a back-powering effect, it is recommended to avoid having any High logic level signal applied to the digital pins of the module when it shutdowns, during OFF or Power Cycling.

NOTE:
For minimum implementations, only the TXD and RXD lines need to be connected. The other lines can be left open if the host software allow it and is correctly set.

6.6.2.1. RS232 Level Translation

To interface the ME910C1-mPCIe UART with a RS232 PC COM Port, a voltage level translator is required. This level translator must:

- Invert the electrical signal in both directions
- Change the level from V_{IO} level to RS232 level: from 0/1.8V to +15/-15V.

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 UART V_{IO}, in our case V_{IO}=1.8V, to the RS232 level. The receiver is the translator from the RS232 levels to V_{IO} levels of the UART.

To translate the whole set of control lines of the UART, the following is required:

- 1 driver
- 1 receiver

	NOTE: The digital input lines operate at 1.8V CMOS. Use a level voltage translator to correctly interface to them.

RS232 Level Adaption Circuitry Example:

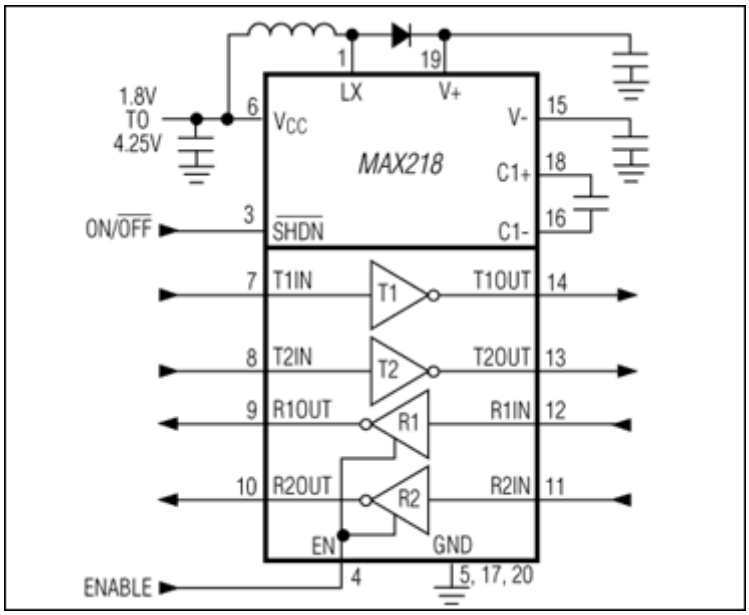


Figure 6 UART Level Adapter Example

NOTE:

In case of high speed access, higher than 1Mbps, the lines should be designed carefully to avoid signal degradation and noise generation.

The RS232 serial port lines are usually connected to a DB9 connector as shown in a Figure below. Signal names and directions are named and defined from the DTE point of view. RS232 Serial Port Lines Connection Layout:

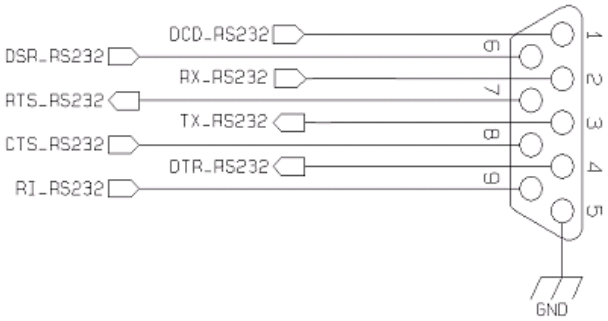


Figure 7 RS232 DB-9 pinout

6.7. SIM Interface

The SIM pins provide the connections necessary to interface to a SIM holder located at the host device. Voltage levels over this interface comply with 3GPP standards.

SIMIN line is not at the connector and it is internally grounded.

In this mPCIE variants onboard SIM holder and eSIM are not mounted.

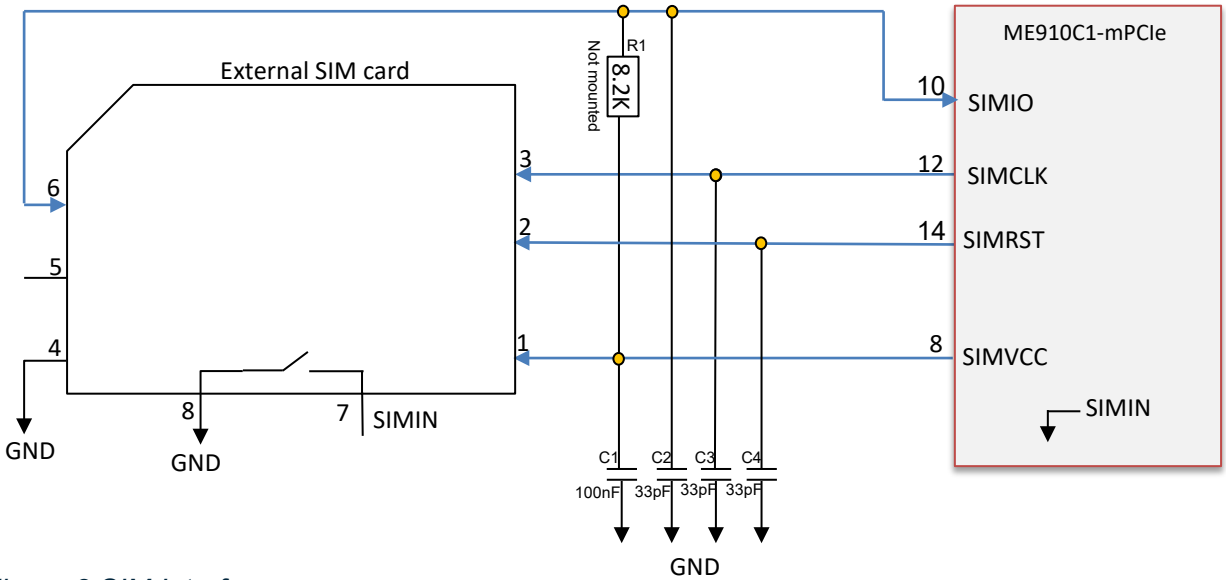


Figure 8 SIM Interface

Pin	Signal	I/O	Function	Type
8	SIMVCC	O	External SIM signal – Power supply for the SIM	1.8 / 3V
10	SIMIO	I/O	External SIM signal – Data I/O	1.8 / 3V
12	SIMCLK	O	External SIM signal – Clock	1.8 / 3V
14	SIMRST	O	External SIM signal – Reset	1.8 / 3V

Table 20 SIM Interface signals

7. RF SECTION

7.1. Bands Variants

Please refer to the table provided in section 2.2

7.2. TX and RX characteristics

Please refer to the Module's Hardware User guide for the details

7.3. Antenna requirements

7.3.1. Antenna Connectors

The ME910C1 Mini PCIe adapter is equipped with a set of 50 Ω RF U.FL. connectors from Hirose U.FL-R-SMT-1.

The available connectors are:

- Main RF antenna (ANT)
- GNSS Antenna (GPS)

See the picture on the right for their position on the interface.

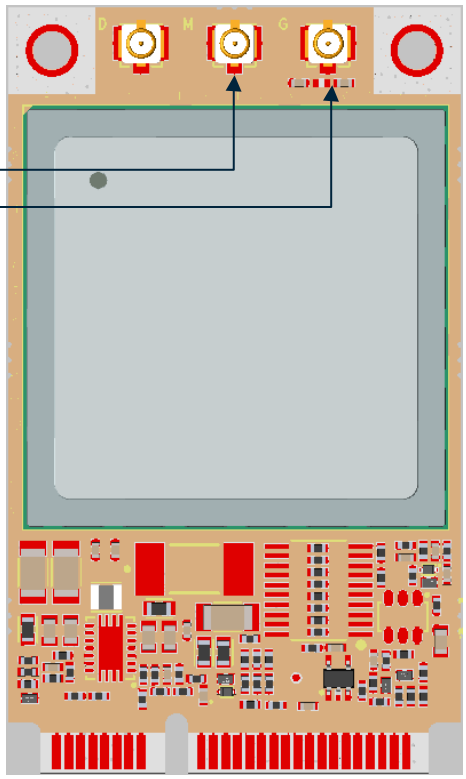


Figure 9 U.FL Antenna Connectors

The presence of all the connectors is depending on the product characteristics and supported functionalities.

For more information about mating connectors search fo RF U.FL female cable up to 3GHz.

For example the U.FL-LP-xxx from Hirose

http://www.hirose.com/

The antenna connection is one of the most important aspect in the full product design as it strongly affects the product overall performances, hence read carefully and follow the requirements and the guidelines for a proper design.

The ME910C1-mPCIe adapter is provided with three RF connectors.

The available connectors are:

- Main RF antenna (ANT)
- GNSS Antenna (GPS)

Connecting cables between the module and the antenna must have 50 Ω impedance.
If the impedance of the module is mismatched, RF performance is reduced significantly.
If the host device is not designed to use the module's diversity or GPS antenna, terminate the interface with a 50Ω load.

7.3.2. Main GSM/LTE Antenna Requirements

The antenna for the ME910C1-mPCIe device must meet the following requirements:

Item	Value
Frequency range	The customer must use the most suitable antenna band width for covering the frequency bands provided by the network operator while using the Telit module. The bands supported by each variant of the ME910C1 module family are provided in Section §2.2 Product Variants and Frequency Bands
Gain	Gain < 3 dBi
Impedance	50 Ohm
Input power	> 33 dBm(2 W) peak power in GSM > 24 dBm average power in WCDMA & LTE
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfill all regulatory requirements)

Table 21 Main Antenna Requirements

7.3.3. GNSS Antenna Requirements

ME910C1 mPCIe board does not supports active antenna. If you want to us an active antenna, the bias circuit should be done externally.

In case of GNSS active antenna, It is recommended to follow:

• An external active antenna (17dB typ. Gain, GPS only)

• An external active antenna plus GNSS pre-filter (17dB typ. Gain)

	NOTE: The external GNSS pre-filter is required for the GLONASS application. The GNSS pre-filter must meet the following requirements: Source and load impedance = 50 Ohm • Insertion loss (1575.42–1576.42 MHz) = 1.4 dB (Max) • Insertion loss (1565.42–1585.42 MHz) = 2.0 dB (Max) • Insertion loss (1597.5515–1605.886 MHz) = 2.0 dB (Max)

	NOTE: It is recommended to add a DC block to the customer's GPS application to prevent damage to the ME910C1-mPCIe module due to unwanted DC voltage.

7.3.3.1. Combined GNSS Antenna

The use of a combined RF/GNSS antenna is NOT recommended. This solution can generate an extremely poor GNSS reception. In addition, the combination of antennas requires an additional diplexer, which adds significant power loss in the RF path.

7.3.3.2. Linear and Patch GNSS Antenna

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

	NOTE: Please refer to the Module's Hardware User Guide for detailed information about GPS operating modes and RF signal requirements.

8. MECHANICAL DESIGN

8.1. Mechanical Dimensions

The ME910C1-mPCIe overall dimensions are:

- Length: 50.95 mm
- Width: 30 mm
- Thickness 3.2 mm (Version with SIM holder : 4.78 mm)
- Weight: 7 gr

8.1.1. Mechanical Drawing

8.1.2. Top View

The figure below shows mechanical top view of the ME910C1-mPCIe, dimension are in mm.

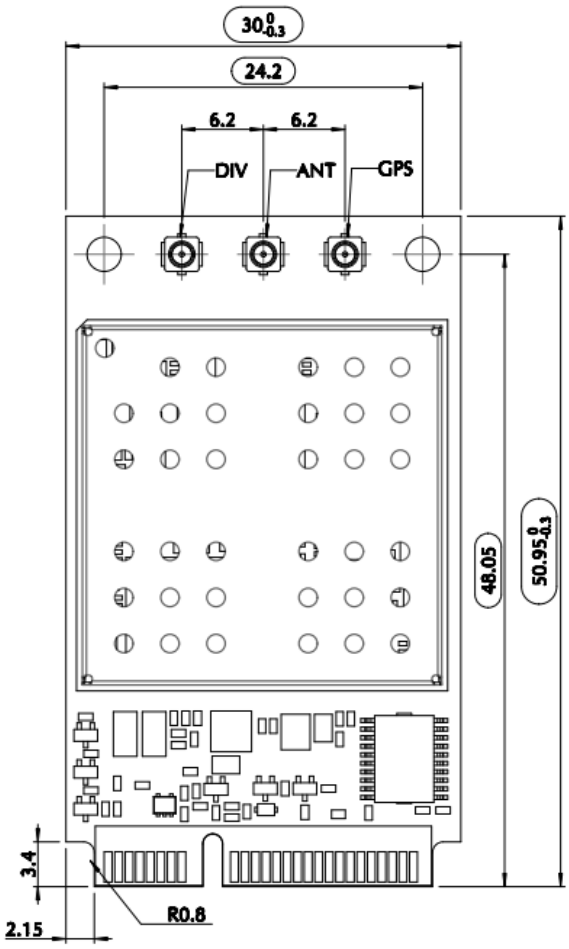


Figure 10 ME910C1-mPCIe Top View

8.1.3. Bottom View

The figure below shows mechanical top view of the ME910C1-mPCIe, dimension are in mm.

The figure shows the eSIM and SIM holder although by default they are not mounted.

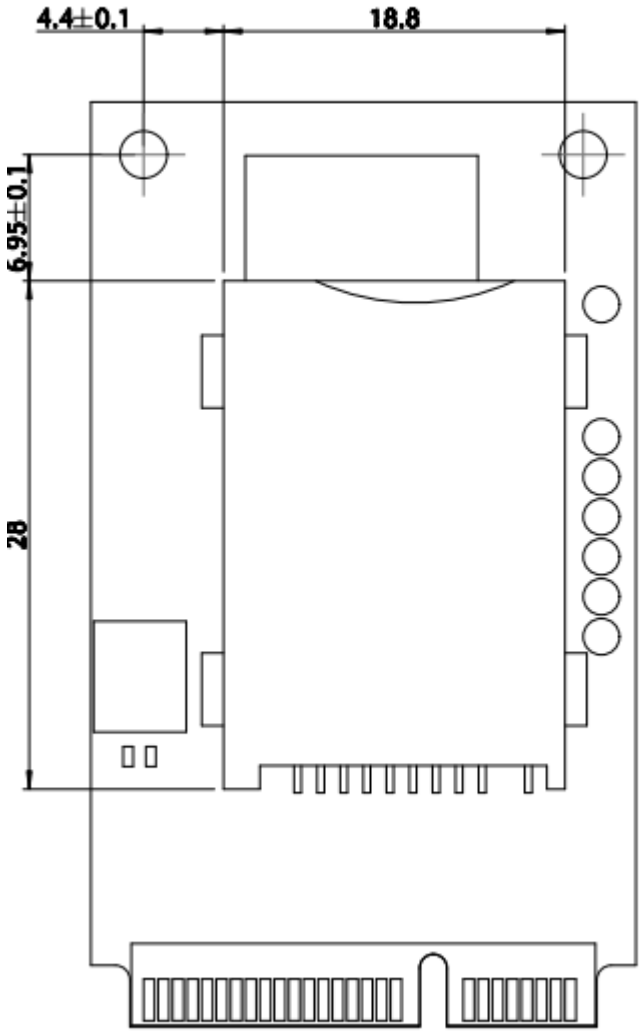


Figure 11 ME910C1-mPCIe Bottom View

8.1.4. Side View

The figure below shows mechanical side view of the ME910C1-mPCIe, dimension are in mm.

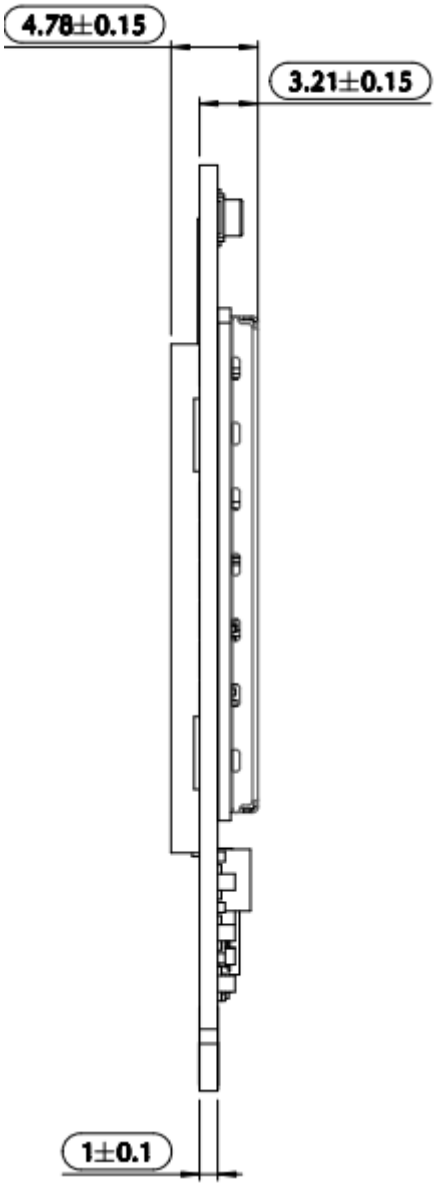


Figure 12 ME910C1-mPCIe Side View

9. APPLICATION PCB DESIGN

The ME910C1-mPCIe modules have been designed in order to be compliant with a standard lead-free SMT process.

9.1. Recommended footprint for the application

ME910C1-mPCIe modules fits any full mPCIe 52 pin socket and latch connectors compliant with PCI Express Mini Card Electromechanical Specification Revision 2.1

Given below example of board connector (MM60-52B1-E1-R650, JAE) and latch (MM60-EZH059-B5-R650, JAE) footprint for reference only:

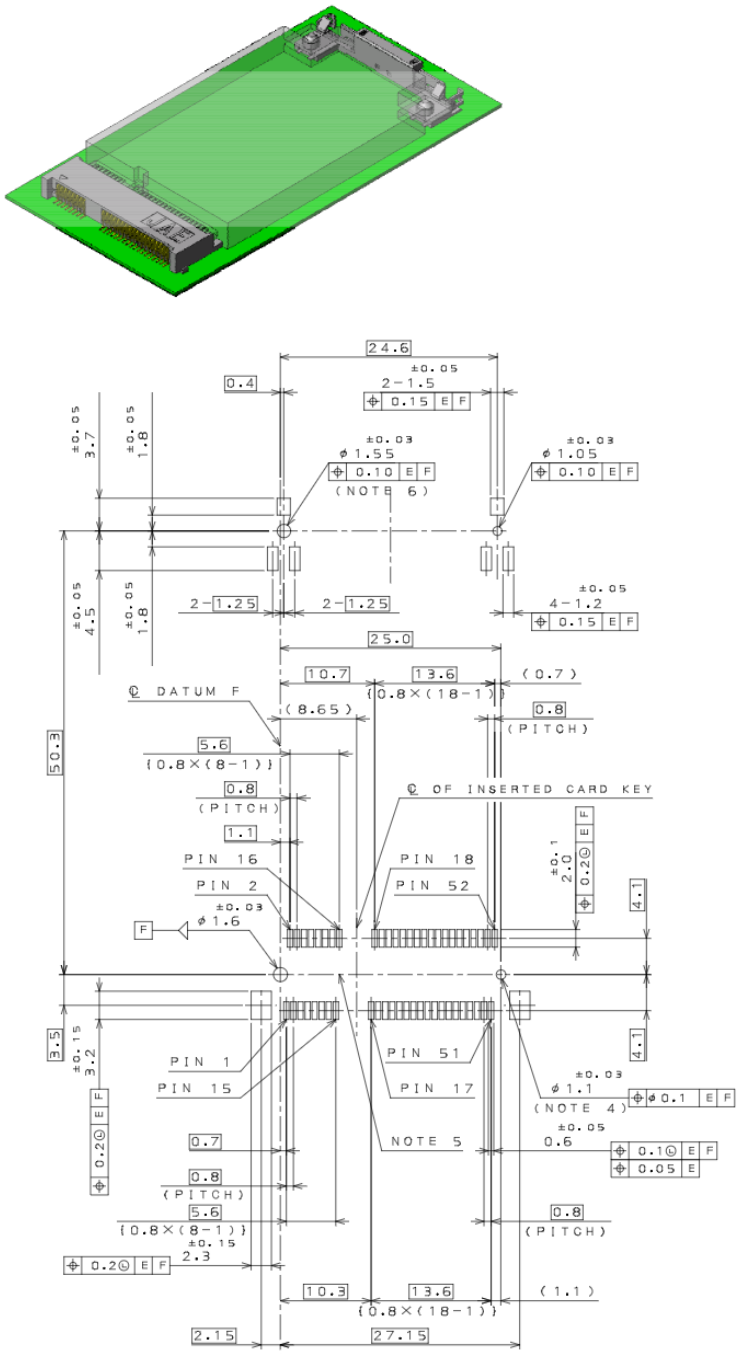


Figure 13 ME910C1-mPCIe Footprint Reference

10. EMC RECOMMENDATIONS

All ME910C1-mPCIe signals are provided with some EMC protection. Nevertheless, the accepted level differs according to the specific pin.

EMC Recommendations:

Pad	Signal	I/O	Function	HBM	CDM
All Pins					
	All pins		All functions	2KV	500V
Antenna					
	Antenna connectors	Analog I/O	Antenna connectors	2KV	500V

Table 22 EMC Recommendations

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

11. PACKING SYSTEM

11.1. Tray

The ME910C1-mPCIe modules are packaged on trays of 20 pieces each:

Modules per Tray	Trays per Envelope	Modules per Envelope	Envelopes per Carton Box	Modules per Box
20	5 + 1 empty	100	5	500

Table 23 Tray Packing

Order Type	Quantity
Minimum Order Quantity (MOQ)	20
Standard Packing Quantity (SPQ)	500

Table 24 Packing Quantities

Tray organization is shown in the figure below

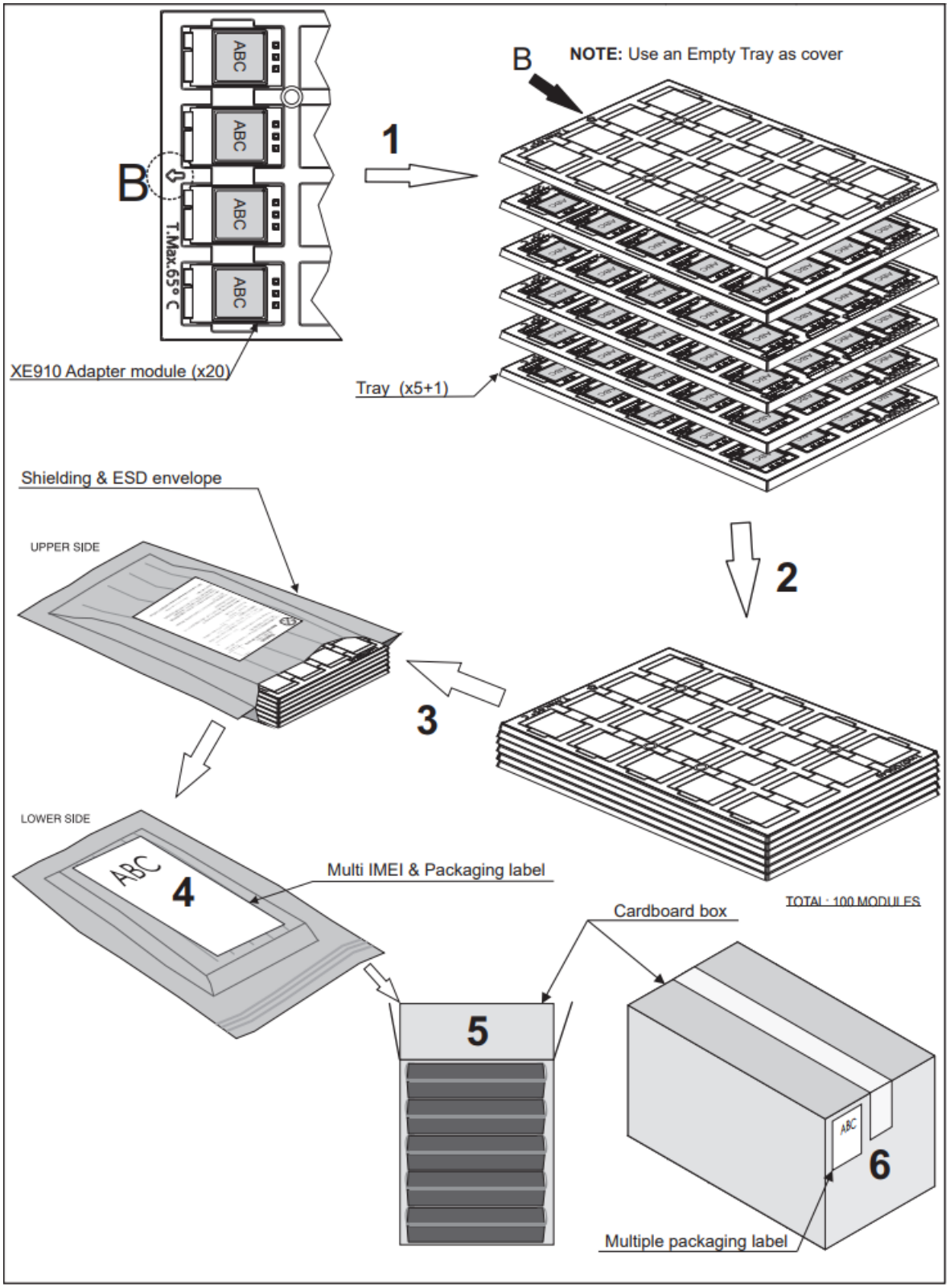


Figure 14 ME910C1-mPCIe Tray organization

11.2. Tray Drawing

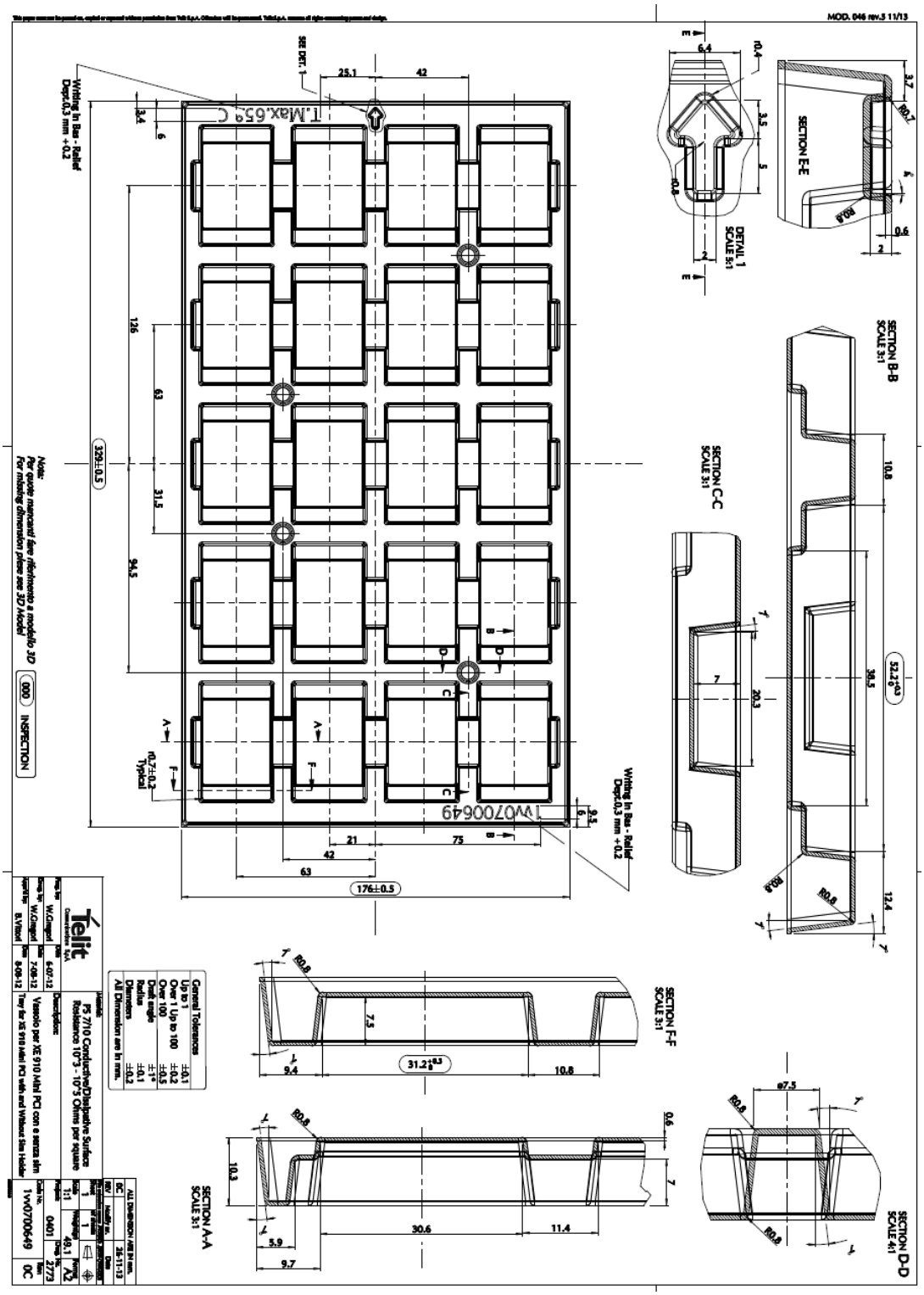


Figure 15 ME910C1-mPCIe Tray Drawing

WARNING:
These trays can withstand a maximum temperature of 65°C.

11.3. Moisture sensitivity

The ME910C1-mPCIe is a Moisture Sensitive Device level 3, in according with standard IPC/JEDEC J-STD-020, take care all the relatives requirements for using this kind of components.

Moreover, the customer has to 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

12. CONFORMITY ASSESSMENT ISSUES

12.1. Declaration of Conformity

Hereby, Telit Communications S.p.A declares that the ME910C1-mPCIe 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

13. SAFETY RECOMMENDATIONS

13.1. 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 equipment must be evaluated in the final installation”

“Equipment must be supplied by ES1, PS1 circuits according to the standard EN 62368-1.”

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/

14. REFERENCE TABLE OF RF BANDS CHARACTERISTICS

Mode	Freq. Tx (MHz)	Freq. Rx (MHz)	Channels	Tx-Rx Offset
PCS 1900	1850.2 ~ 1909.8	1930.2 ~ 1989.8	512 ~ 810	80 MHz
DCS 1800	1710 ~ 1785	1805 ~ 1880	512 ~ 885	95 MHz
GSM 850	824.2 ~ 848.8	869.2 ~ 893.8	128 ~ 251	45 MHz
EGSM 900	890 ~ 915	935 ~ 960	0 ~ 124	45 MHz
	880 ~ 890	925 ~ 935	975 ~ 1023	45 MHz
LTE 2100 – B1	1920 ~ 1980	2110 ~ 2170	Tx: 18000 ~ 18599 Rx: 0 ~ 599	190 MHz
LTE 1900 – B2	1850 ~ 1910	1930 ~ 1990	Tx: 18600 ~ 19199 Rx: 600 ~ 1199	80 MHz
LTE 1800 – B3	1710 ~ 1785	1805 ~ 1880	Tx: 19200 ~ 19949 Rx: 1200 ~ 1949	95 MHz
LTE AWS – B4	1710 ~ 1755	2110 ~ 2155	Tx: 19950 ~ 20399 Rx: 1950 ~ 2399	400 MHz
LTE 850 – B5	824 ~ 849	869 ~ 894	Tx: 20400 ~ 20649 Rx: 2400 ~ 2649	45 MHz
LTE 2600 – B7	2500 ~ 2570	2620 ~ 2690	Tx: 20750 ~ 21449 Rx: 2750 ~ 3449	120 MHz
LTE 900 – B8	880 ~ 915	925 ~ 960	Tx: 21450 ~ 21799 Rx: 3450 ~ 3799	45 MHz
LTE 1800 – B9	1749.9 ~ 1784.9	1844.9 ~ 1879.9	Tx: 21800 ~ 2149 Rx: 3800 ~ 4149	95 MHz
LTE AWS+ – B10	1710 ~ 1770	2110 ~ 2170	Tx: 22150 ~ 22749 Rx: 4150 ~ 4749	400 MHz
LTE 700a – B12	699 ~ 716	729 ~ 746	Tx: 23010 ~ 23179 Rx: 5010 ~ 5179	30 MHz
LTE 700c – B13	777 ~ 787	746 ~ 756	Tx: 23180 ~ 23279 Rx: 5180 ~ 5279	-31 MHz

Mode	Freq. Tx (MHz)	Freq. Rx (MHz)	Channels	Tx-Rx Offset
LTE 700PS – B14	788 ~ 798	758 ~ 768	Tx: 23280 ~ 23379 Rx: 5280 ~ 5379	-30 MHz
LTE 700b – B17	704 ~ 716	734 ~ 746	Tx: 23730 ~ 23849 Rx: 5730 ~ 5849	30 MHz
LTE 800 – B19	830 ~ 845	875 ~ 890	Tx: 24000 ~ 24149 Rx: 6000 ~ 6149	45 MHz
LTE 800 – B20	832 ~ 862	791 ~ 821	Tx: 24150 ~ 24449 Rx: 6150 ~ 6449	-41 MHz
LTE 1500 – B21	1447.9 ~ 1462.9	1495.9 ~ 1510.9	Tx: 24450 ~ 24599 Rx: 6450 ~ 6599	48 MHz
LTE 1900+ – B25	1930 ~ 1995	1850 ~ 1915	Tx: 26040 ~ 26689 Rx: 8040 ~ 8689	80 MHz
LTE 850+ – B26	814 ~ 849	859 ~ 894	Tx: 26690 ~ 27039 Rx: 8690 ~ 9039	45 MHz
LTE 700 – B28A	703 ~ 733	758 ~ 788	Tx: 27210 ~ 27510 Rx: 9210 ~ 9510	55 MHz
LTE 700 – B28	703 ~ 748	758 ~ 803	Tx: 27210 ~ 27659 Rx: 9210 ~ 9659	55 MHz
LTE AWS-3 – B66	1710 ~ 1780	2210 ~ 2200	Tx: 131972-132671 Rx: 66436-67335	400 MHz
LTE600 – B71	663 ~ 698	617 ~ 652	Tx: 133122-133471 Rx: 68568-68935	46 MHz
LTE TDD 2600 – B38	2570 ~ 2620	2570 ~ 2620	Tx: 37750 ~ 38250 Rx: 37750 ~ 38250	0 MHz
LTE TDD 1900 – B39	1880 ~ 1920	1880 ~ 1920	Tx: 38250 ~ 38650 Rx: 38250 ~ 38650	0 MHz
LTE TDD 2300 – B40	2300 ~ 2400	2300 ~ 2400	Tx: 38650 ~ 39650 Rx: 38650 ~ 39650	0 MHz

Mode	Freq. Tx (MHz)	Freq. Rx (MHz)	Channels	Tx-Rx Offset
LTE TDD 2500 – B41M	2555 ~ 2655	2555 ~ 2655	Tx: 40265 ~ 41215 Rx: 40265 ~ 41215	0 MHz

Table 25 Reference Table of RF Bands

15. ACRONYMS

TTSC	Telit Technical Support Centre
USB	Universal Serial Bus
HS	High Speed
DTE	Data Terminal Equipment
UMTS	Universal Mobile Telecommunication System
WCDMA	Wideband Code Division Multiple Access
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
UART	Universal Asynchronous Receiver Transmitter
HSIC	High Speed Inter Chip
SIM	Subscriber Identification Module
SPI	Serial Peripheral Interface
ADC	Analog – Digital Converter
DAC	Digital – Analog Converter
I/O	Input Output
GPIO	General Purpose Input Output
CMOS	Complementary Metal – Oxide Semiconductor
MOSI	Master Output – Slave Input
MISO	Master Input – Slave Output
CLK	Clock
MRDY	Master Ready

SRDY	Slave Ready
CS	Chip Select
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
CDM	ESD – Charged Device Model
HBM	ESD – Human Body Model
mPCIe	Mini PCIe Adapter

Table 26 Acronyms

16. DOCUMENT HISTORY

Revision	Date	Changes
0	2019-12-17	First Issue
1	2020-02-11	Document Revision

Table 27 Document History

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 2017-11 Rev.0

[11.2017]