ME910C1/ML865C1/NE910C1 A-GPS Application Note

80529NT11738A Rev. 1 – 2019-07-08

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[01.2017]

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APPLICABILITY TABLE

PRODUCTS

- ME910C1 SERIES
- NE910C1 SERIES
- ML865C1 SERIES

CONTENTS

1. INTRODUCTION

The present document provides the reader with a guideline concerning the use of the Assisted GPS (A-GPS) provided by the Telit's Modules of the ME910 family.

1.1. Scope

The Application Note covers the Secure User Plane Location (SUPL) standard created by the OMA standardization body.

1.2. Audience

This document is intended for those users that need to develop applications dealing with LoCation Service (LCS).

1.3. Contact Information, Support

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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 Quick Start Guide*, 80529NT11661A
- *[2] ME910C1/NE910C1/ML865C1 AT Commands Reference Guide*, 80529ST10815A

2. BACKGROUND INFORMATION

2.1. A Brief GPS Introduction

The detailed description of the GPS system is beyond the scope of this document.

The reader that is interested in deepening this topic should refer to the dedicated literature; hereafter only the basic concepts are mentioned. GPS system is based on a constellation of 24 satellites distributed equally among six circular orbital planes; the height of the orbits is about 20200 km. Orbits in this height are referred to as medium earth orbit (MEO).

Each satellite moves along a known orbit and is equipped with an atomic clock: GPS receivers use the time information regularly transmitted by the satellites and the time elapsed for receiving this signal from each satellite to calculate their positional information.

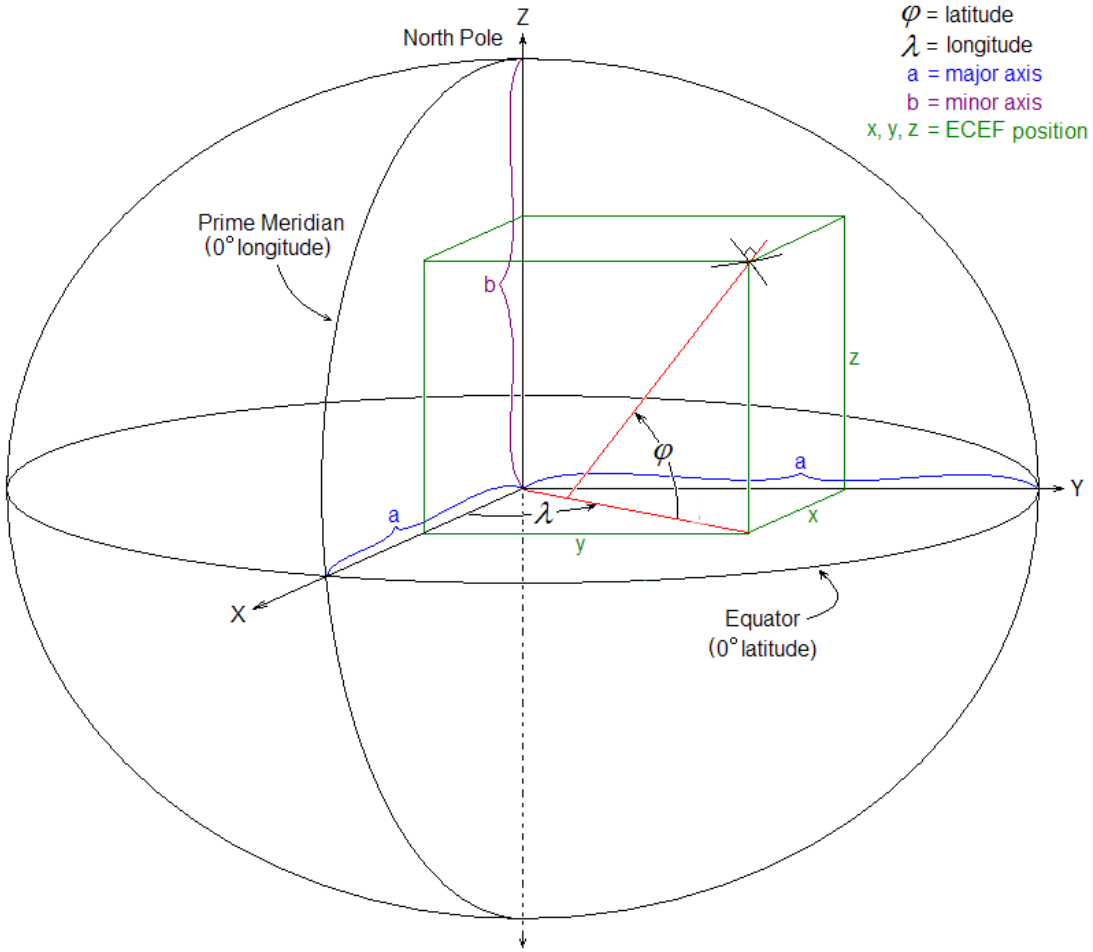

Figure 2-1 ECEF coordinate system [source: https://en.wikipedia.org]

Telit GPS receivers use as default the geodetic reference (datum) WGS-84, an ECEF (Earth Centered, Earth Fixed) coordinate system that consists in an ellipsoid approximating the total mass of the Earth, as shown in Fig. 2-1.
WGS-84 provides a worldwide common grid system that may be translated into local coordinate systems or map datums. Many reference ellipsoids are used throughout the world: a specific reference is chosen to minimize the local differences between the geoid

and the ellipsoid separation or other mapping distortions. Local map datums are a best fit to the local shape of the earth and are not valid worldwide.

2.2. GNSS – Global Navigation Satellite System

In addition to the GPS constellation, other satellite navigation systems are currently in operation or under development. The working principles of these systems are analogous to the GPS' ones presented in the previous section.

When the system has global coverage, it may be termed Global Navigation Satellite System (**GNSS**).

Galileo (European Union), **BeiDou** (China), **GPS** (USA), **GLONASS** (Russia) are the GNSSs currently in operation, although Galileo and Beidou are not yet fully operational. Furthermore, additional regional navigation and augmentation systems are under development (**QZSS**, **NAVIC**, etc.).

2.3. Time to First Fix (TTFF)

One of the parameters characterizing the performance of a GNSS receiver is the Time to First Fix (TTFF). TTFF indicates the time required for a GNSS device to get and process adequate satellite signals and data to provide accurate positional information (a "fix").

GNSS receivers use the following sets of data to provide accurate position

- Satellite signals,
- Timing information (e.g. GPS time),
- Almanac data,
- Ephemeris data.

If a GNSS device has been turned off for a long period of time the acquired information can expire and, when it is turned on again, it will take longer to re-acquire these data sets, resulting in a longer "Time to First Fix". One way to speed up the TTFF is to use the Assisted-GPS (A-GPS) Positioning Technique.

A-GPS is based on the use of a data connection (e.g. a cellular network) to provide predicted satellite information from an A-GPS server to the GNSS receiver. With the help of this data, the receiver is usually able to achieve a positional fix faster than using live-data only. Although the term "A-GPS" is commonly used, the server-based data can refer to other constellations as well (e.g. GLONASS predictions).

A "cold" start indicates the scenario in which the GNSS receiver must get all data in order to start navigation and may take up to several minutes.

A "warm" start indicates the scenario in which the GNSS has most of the data it needs in memory, and will start quickly, a minute or less.

A "hot" start refers to the scenario in which the receiver has all the data from the satellites (time, almanac, ephemeris) and only needs to calculate the positional solution. The fix is usually acquired in few seconds.

In other words, the use of A-GPS allows the device to start in a condition similar to "warm" and "hot", hence speeding up the TTFF.

3. GNSS SOLUTION

3.1. Standalone GNSS

Standalone (or autonomous) GNSS mode is a feature that allows the GNSS receiver, installed on the cellular module, to perform First Fixing activity without assistance data coming from the network. The GNSS receiver estimates position directly from satellites (GPS, GLONASS, etc.) in line of sight.

To set up the GNSS receiver in standalone mode the user should go through the following steps provided as example. It should be noted that, although modern cellular modules integrate a GNSS receiver rather than a GPS one, the AT commands still refer to GPS for legacy reasons.

Switch off/on the module and restore the default GNSS parameters in order to start from a known GNSS setting.

AT$GPSRST

OK

Delete the GPS information stored in NVM. It is the history buffer interfacing the GPS receiver to the module. This action is not mandatory; it should be performed only if you need to clean the buffer:

AT$GPSNVRAM=15,0

OK

Check that after history buffer cleaning no GPS information is available

AT$GPSACP

$GPSACP:

OK

Start the GNSS receiver in standalone mode:

AT$GPSP=1

OK

For enabling unsolicited messages of GNSS data in NMEA format, refer to [2]. In this example, only RMC sentence is enabled:

AT$GPSNMUN=3,0,0,0,0,1,0

OK

This command enables the GNSS data stream format and reserve the AT interface port for the NMEA stream only.

After a time-interval depending from the environmental characteristic of the location where the GNSS receiver operates (outside, inside, city, etc.), the continuous streaming of RMC sentences becomes populated.

To stop the NMEA stream enter the following escape sequence:

+++

```
Sent>> AT$GPSNMUN=3,0,0,0,0,1,0

CONNECT

$GPRMC,,V,,,,,,,,,N*53
$GPRMC,,V,,,,,,,,,N*53
$GPRMC,,V,,,,,,,,,N*53
$GPRMC,,V,,,,,,,,,N*53
$GPRMC,133730.59,A,3913.660425,N,00904.126908,E,0.0,,090119,0.1,W,A*03
$GPRMC,133731.99,A,3913.660437,N,00904.126912,E,0.0,,090119,0.1,W,A*06
$GPRMC,133733.00,A,3913.659701,N,00904.127000,E,0.0,0.0,090119,0.1,W,A*2D

Sent>> +++
```

Figure 3-1 Enabling the NMEA stream, RMC sentence only

For enabling additional NMEA sentences containing information on other constellations (e.g. GLONASS or GALILEO), refer to the following commands described in [2]:

AT$GPSGLO

AT$GPSNMUN

AT$GPSNMUNEX

Finally, for polling the current location:

AT$GPSACP

$GPSACP:152324.000,4542.8396N,01344.2874E,3.00,310.0,3,000.00,0.00,0.00,200412,05

OK

3.2. A-GPS – Secure User Plane Location (SUPL) – Ms-Based

As mentioned in previous sections, Assisted GPS mode is a feature that allows the GNSS receiver to perform its First Fix faster using assistance data, usually provided over the cellular network.

The ME910 series supports the following type of A-GPS

- Secure User Plane Location (SUPL) was proposed by OMA

3.2.1.1. MS-Based mode

In MS-Based mode, the module requires assistance data to the SLP Server. The A-GPS receiver, installed on the module, receives the signals from the visible satellites and with the help of the data received from the SLP Server calculates its position.

For the MS-Based mode, an example is provided below. It should be noted that in this configuration an example of SUPL Server is provided: however, it is responsibility of the user to select the appropriate server fitting their needs.

The following assumptions have been made:

- the module is powered off;
- the GNSS antenna is connected and placed in sight of satellites (must be able to receive GNSS signal);
- cellular antenna is connected;
- SIM card is inserted;
- APN is already set.

Firstly, turn on the cellular module.

If required, delete the GNSS information stored in NVM. It is the history buffer between the GNSS device and the module. This action is not mandatory and must be performed only if cleaning the buffer is needed:

AT$GPSNVRAM=15,0

OK

Check that after history buffer cleaning no GNSS information are available (command response should be empty and have no location information)

AT$GPSACP

$GPSACP: OK

Set the SUPL version support to 2.0

AT$SUPLV=2

OK

Set the location's Quality of Service (QoS). AT$GPSSAV command can be used to save GPS parameters into NVM.

AT$GPSQOS=50,50,150,0

OK

Set the selected SLP address and port number (default 7275):

AT$LCSSLP=<slp_address_type>,<slp_address>,7275

For example:

AT$LCSSLP=1,"supl.dummySUPLwebsite.com",7276

OK

Request the IMSI of the module

AT+CIMI //replies with IMSI of the module

Configure the SET ID, for example IMSI:

AT$LCSTER=1,"xxxxxxxx",0,0 //where xxxxxxxx is the IMSI of the module

OK

Lock <cid> for SUPL use:

AT$LCSLK=1,<cid>

For example:

AT$LCSLK=1,1

OK

Activate the PDP context

AT#SGACT=1,1 //returns a list of IP addresses for the specified context

Start the SET Initiated Session using the MS-Based mode:

AT$GPSSLSR=1,1,,,,,1

OK

Now poll the acquired position through AT$GPSACP command until location information is returned.

AT$GPSACP

$GPSACP:152324.000,4542.8396N,01344.2874E,3.00,310.0,3,000.00,0.00,0.00,200412,05

OK

It must be returned within few seconds (less than ten seconds)

Example:

```
AT$GPSSLSR=1,1,,,,,1
OK
AT$GPSACP
$GPSACP: ,,,,,1,,,,,

OK
AT$GPSACP
$GPSACP: ,,,,,1,,,,,

OK
AT$GPSACP
$GPSACP: ,,,,,1,,,,,

OK
AT$GPSACP
$GPSACP: 125129.008,3341.9146S,15106.0871E,0.0,-24.0,2,0.0,0.0,0.0,010219,00

OK
AT$GPSACP
$GPSACP: 125131.000,3341.8312S,15105.9603E,2.3,198.2,3,266.9,2.0,1.1,010219,05

OK
AT$GPSACP
$GPSACP: 125133.000,3341.8272S,15105.9641E,1.2,176.5,3,0.0,0.0,0.0,010219,07

OK
AT$GPSACP
$GPSACP: 125134.000,3341.8271S,15105.9643E,1.2,180.2,3,0.0,0.0,0.0,010219,07

OK
```

4. GLOSSARY AND ACRONYMS

	Description
3GPP	Third Generation Partnership Project
A-GPS	Assisted-Global Positioning System
C-Plane	Network Control Plane Network
DTE	Data Terminal Equipment
ECEF	Earth-Centered Earth-Fixed
GMLC	Gateway Mobile Location Center
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
LCS	LoCation Service
MO-LR	Mobile Originated-Location Request
MS	Mobile Station
MT-LR	Mobile Terminated-Location Request
NMEA	National Marine Electronics Association
NVM	Non-Volatile Memory
OMA	Open Mobile Alliance
PDP	Packet Data Protocol
SET	SUPL Enable Terminal
S-GNSS	Standalone-Global Navigation Satellite System
S-GPS	Standalone-Global Positioning System
SLP	SUPL Location Platform
SMLC	Serving Mobile Location Center
SMS	Short Message Service
SSL	Secure Socket Layer
SUPL	Secure User Plane Location
TTFF	Time to First Fix
UART	Universal Asynchronous Receiver Transmitter
URC	Unsolicited Result Code

5. DOCUMENT HISTORY

Revision	Date	Changes
0	2019-02-14	First issue
1	2019-07-08	Updated applicability table

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ME910C1/NE910C1/ML865C1 PSM Application Note

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APPLICABILITY TABLE

PRODUCTS

- ME910C1-NA
- ME910C1-NV
- ME910C1-J1
- ME910C1-AU
- ME910C1-K1
- ME910C1-E1
- ME910C1-WW
- ME910C1-E2
- NE910C1-E1
- NE910C1-NA
- ML865C1-EA
- ML865C1-NA

CONTENTS

1. INTRODUCTION

1.1. Scope

The ME910C1 includes unique advanced features in order to support the PSM according to 3GPP Rel-12.

The aim of this document is the description of the suggested Application design to use this functionality.

1.2. Audience

This document is intended for Telit customers, who are integrators, about to implement their applications using our ME910C1 modules.

1.3. Contact Information, Support

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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

- ME910C1 HW User Guide, 1VV0301210
- ML865C1 HW User Guide, 1VV0301493
- ME910C1 AT Commands Reference Guide, 80471ST10691A
- Telit EVK2 User Guide, 1vv0300704

2. OVERVIEW

The aim of this document is the description of some hardware solutions useful for developing a product with the Telit ME910C1 module.

In this document all the basic functions of a mobile phone will be taken into account; for each one of them a proper hardware solution will be suggested and eventually the wrong solutions and common errors to be avoided will be evidenced. Obviously this document cannot embrace the whole hardware solutions and products that may be designed. The wrong solutions to be avoided shall be considered as mandatory, while the suggested hardware configurations shall not be considered mandatory, instead the information given shall be used as a guide and a starting point for properly developing your product with the Telit ME910C1 module. For further hardware details that may not be explained in this document refer to the Telit ME910C1 Product Description document where all the hardware information is reported.

NOTICE:

EN) The integration of the LTE **ME910C1** cellular module within user application shall be done according to the design rules described in this manual.

(IT) L'integrazione del modulo cellulare LTE **ME910C1** all'interno dell'applicazione dell'utente dovrà rispettare le indicazioni progettuali descritte in questo manuale.

(DE) Die Integration des **ME910C1** LTE Mobilfunk-Moduls in ein Gerät muß gemäß der in diesem Dokument beschriebenen Kunstruktionsregeln erfolgen.

(SL) Integracija LTE **ME910C1** modula v uporabniški aplikaciji bo morala upoštevati projektna navodila, opisana v tem priročniku.

(SP) La utilización del modulo LTE **ME910C1** debe ser conforme a los usos para los cuales ha sido deseñado descritos en este manual del usuario.

(FR) L'intégration du module cellulaire LTE **ME910C1** dans l'application de l'utilisateur sera faite selon les règles de conception décrites dans ce manuel.

(HE) האינטגרטור מתבקש ליישם את ההנחיות המפורטות במסמך זה בתהליך האינטגרציה של המודם הסלולרי **ME910C1** עם המוצר.

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3. PSM DESCRIPTION

3.1. PSM Procedure Overview

The Power Saving Mode (PSM) in 3GPP Rel12 allows the Module to skip idle mode tasks for a longer time period while still maintaining the NAS context. The functionality is available on M1/NB1 on the ME910C1 / NE910C1 Series.

This feature permits to reduce the overall power consumption when there is no required data activity with the network for a long time.

This saves the power also related to the Paging activity.

The PSM reduces the signaling load between the ME910C1 and the network on NAS level (24.301 Rel.12 chapter 5.3.11) compared to a standard attach/detach procedure.

Within the attach/RAU/TAU procedure the UE indicates that it supports PSM and the network confirms/accepts PSM usage by sending two different timers (T3324 and T3412 extended Value) in the confirmation message.

The timer T3324 specifies an active period after the RAU/TAU procedure the UE has to follow the normal idle mode procedures (paging reception, measurements,..).

After timer T3324 expires the Module enters PSM state, i.e. it disables all AS/NAS activities until the next periodic RAU/TAU update.

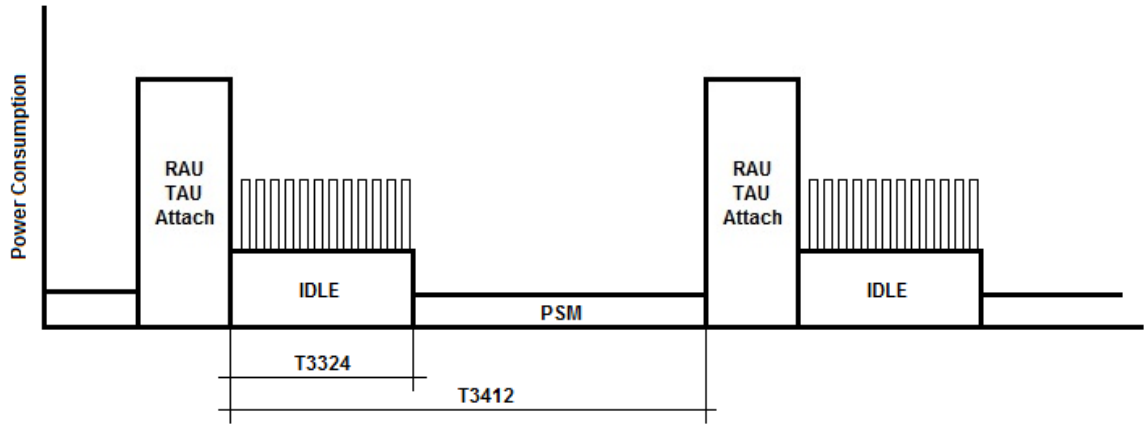
Timer T3412 extended value is defining the time between two subsequent RAU/TAU procedures and starts togheter with T3324.This implies that the time in which the module will be NOT reachable by the network (inactivity period) is given by T3412_ext - T3324.

Before the inactivity period starts the complete NAS context needs to be stored and reused when accessing the network again.

The Module can leave the PSM mode at any point in time when there is MO data or when periodic TAU timer expires.

The PSM is only intended for those Modules that can tolerate a high MT Call latency.

The 3GPP standard does not specify current limits to be satisfied or power reduced to when PSM is used by the module. Only the signaling reduction (i.e. Not doing a reattach but just a RAU/TAU procedure) is defined.



3.2. PSM for ME910C1

ME910C1 implements PSM features and allows the user to activate PSM by sending the specific AT command AT+CPSMS as described in [x] AT Command User Guide

As soon As PSM has been accepted by the network (i.e. Timers have been received in TAU Accept message) T3324 starts and ME910 is in IDLE state with default module functionality.

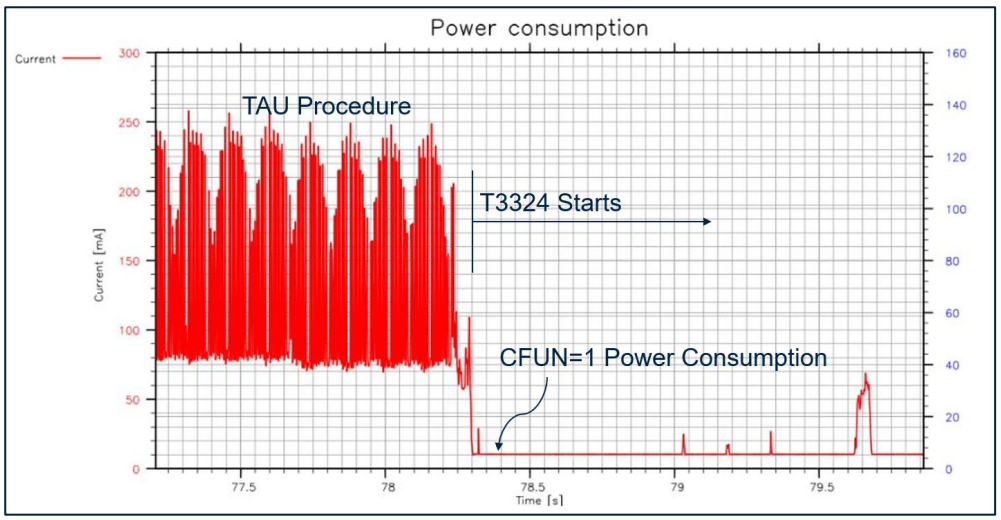
Since default functionality for ME910 (and all Telit modules) is CFUN=1 the current absortion for the module will be equal to standard idle CFUN=1 state and around 10-11 mA.

As T3324 expires the module enters the PSM state which is basically an OFF state with RTC running in the background bringing the current consumption level to around 8,5 uA.

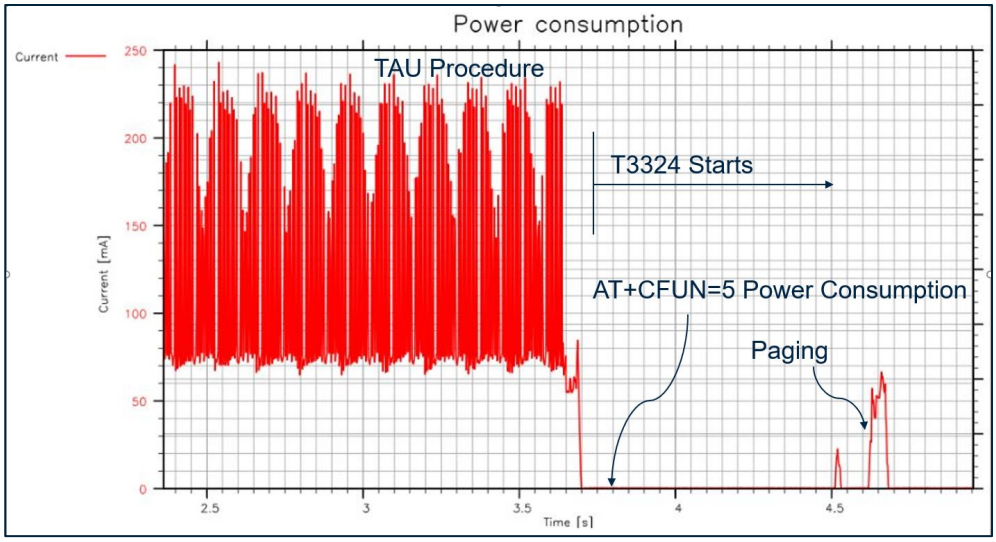
Users willing to decrease the power consumption during T3324 can combine AT+CFUN states (e.g. AT+CFUN=5 and Asserting low the DTR pin) with PSM as shown in the below figures.

When AT+CFUN=5 is used during T3324 the specific functionality allows to save current still keeping module synchronized and reachable the network

PSM activation and CFUN=1 (default)



PSM activation and CFUN=5



An example of command to activating PSM for ME910 is as follows:

AT+CPSMS=1,,," & T3412 & "," & T3324

T3412= 10000011 -> 90 sec

T3324= 00001010 -> 20 sec

With these settings the module will send TAU every 90 sec and will stay IDLE for 20 sec. This is true when using a network simulator because in a real environment the final decision of which timers have to be applied is taken by the network that can accept the proposed timers or decide to send its own timers. If different timers are sent back by the network then DUT must apply the Network timers.

The nature of PSM and the current consumption profile suggest that the major efficiency is achieved when T3412 is longer than 5-6 hours.

If an application cannot support modules being out of connection for so long but it is still willing to redure power then eDRX feature should be evaluated.

Telit implementation of PSM includes a SW check that avoids UE to enter PSM mode if the settings of T3412 and T3324, are such that the next wake up would happen before a preconfigured minimum time duration 60s.

As a result of this check the following precondition will need to be verified for the PSM to be activated : T3412-T3324 > 60 sec

The above is to avoid an incorrect use of PSM resulting in higher current consumption due to shut down and reboot compared to the current consumption in idle state in 60s.

4. EXTENDED DRX (EDRX)

4.1. eDRX Procedure Overview

extended DRX (eDRX) is an extension of the discontinuous reception (DRX). DRX is a technic used during RRC IDLE to reduce UE power consumption that periodically listen to the paging channel and sleep in between two different paging listening events.

eDRX tries to enhance the power consumption increasing the sleeping period, but this has to be done in coordination with the network that will know about this extension and will cache paging requests directed to the UE.

eDRX features defines to different timers

Paging Time Window (PTW) : the window in which the UE will behaves in DRX mode

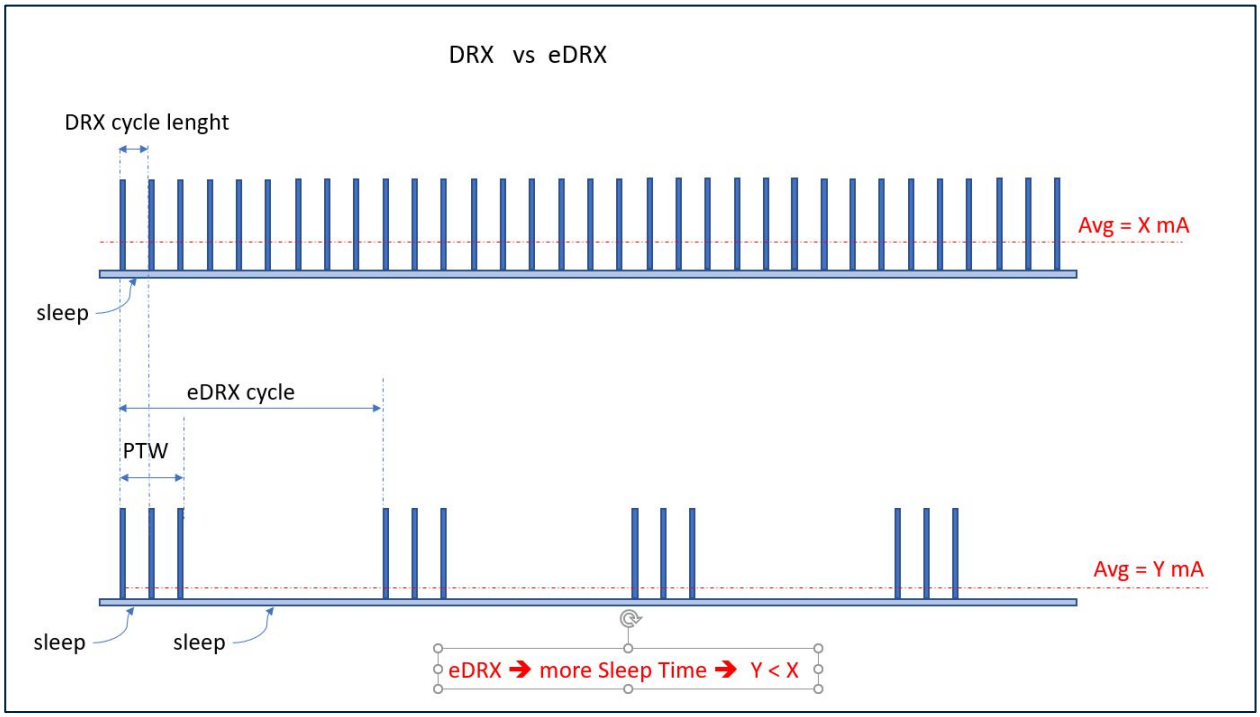
eDRX cycle : the time between the start of two different and subsequent time windows

these two timers are exchanged between UE and Network by means of Attach or TAU/RAU Accept message.

When eDRX is activated by means of the specific command the DRX activitiy is stopped for a longer period and the module remains in sleep and not listening the paging channel anymore till the end of the eDRX cycle. In other words the UE will not be reachable from the network from the end of the PTW to the end of the eDRX cycle.

Below is a pictures that explain the differences between DRX and eDRX.

Fig 2. DRX vs eDRX comparison



For CAT M technology in a test environment scenario the following command will set PTW=20,48 and eDRXcycle=81,92 (see AT command user guide for detailed definition)

at#cedrxs=1,4,"0101","1111"

Regarding the current profile for eDRX and ME910 it has to be said that the sleep current between paging occurrence and during the long sleep has a value of around 0,8 mA so when eDRX is used in combination with AT+CFUN=5 or 0 that allows to achieve average current consumption values less than 1mA in most cases.

eDRX is a different procedure in respect PSM that is practically OFF when PSM is activated but has to pay in terms of consumption to wakeup from PSM because a BOOT+CAMP+ TAU is needed.

That means that there is a breakeven point that suggest to use eDRX for applications that requires the module to be available very often and in any case at maximum every few hours , if the module can sleep more time the PSM feature must be evaluated because it could be more efficient from power consumption point of view.

Note. *PSM and eDRX are not mutually exclusive and can work togheter. If PSM and eDRX are applied at the same time eDRX will basically work during the PSM idle time reducing the power consumption within the T3324.*

5. HARDWARE CONTROLS

5.1. ME910C1 pins related to PSM Mode

Pin	Signal	I/O	Function	Type	Comment
R12	ON_OFF/WAKE*	I	Input command for power ON and to wake from deep sleep mode	Digital 1.8V	Active low, connected to open drain or open collector
R11	VAUX PWRMON	O	1.8V LDO output Power ON monitor	Supply 1.8V	
R13	HW_SHUTDOWN*	I	HW Unconditional Shutdown	Digital 1.8V	Active low, connected to open drain or open collector

5.2. ML865C1 pins related to PSM Mode

Pin	Signal	I/O	Function	Type	Comment
7	WAKE	I	Input command for power ON and to wake from deep sleep mode	Digital 1.8V	Active high, weak internal pull-down
51	VAUX PWRMON	O	1.8V LDO output Power ON monitor	Supply 1.8V	
55	HW_SHUTDOWN*	I	HW Unconditional Shutdown	Digital 1.8V	Active low, connected to open drain or open collector

5.3. CONTROL PINS DESCRIPTION

5.3.1. ON_OFF*/WAKE* (ME910C1)

ON_OFF*/WAKE* is the pin that turns on the system after VBATT and VBATT_PA is applied to ME910C1. Moreover, this pin can make an asynchronous wakeup of the system from the PSM Mode, before the scheduled event of timer T3412 expired.

To make asynchronous exit from PSM mode ON_OFF*/WAKE* pin must be set LOW for at least 5 seconds.

NOTE:

Don't use any pull up resistor on the ON_OFF*/WAKE* line, it is internally pulled up. Using pull up resistor may bring to latch up problems on the ME910C1 power regulator and improper power on/off of the module. The line ON_OFF*/WAKE* must be connected only in open collector or open drain configuration.

5.3.2. WAKE (ML865C1)

WAKE line can make an asynchronous wakeup of the system from the PSM Mode, before the scheduled event of timer T3412 expired.

To make asynchronous exit from PSM mode WAKE pin must be set HIGH for at least 5 seconds. In all other conditions WAKE pin must be set LOW.

NOTE:

WAKE line is active high (1.8V), and there is a weak internal pull-down (about 200K).

5.3.3. VAUX/PWRMON

There is no pin dedicated to PSM status indicator, host can only detect deep sleep mode by monitoring of VAUX/PWRMON output pin.

5.3.4. HW_SHUTDOWN*

During PSM mode, HW_SHUTDOWN toggle has no effect. The use of HW_SHUTDOWN* pin is valid only when ME910C1 has VAUX/PWRMON output HI.

5.4. SIM interface

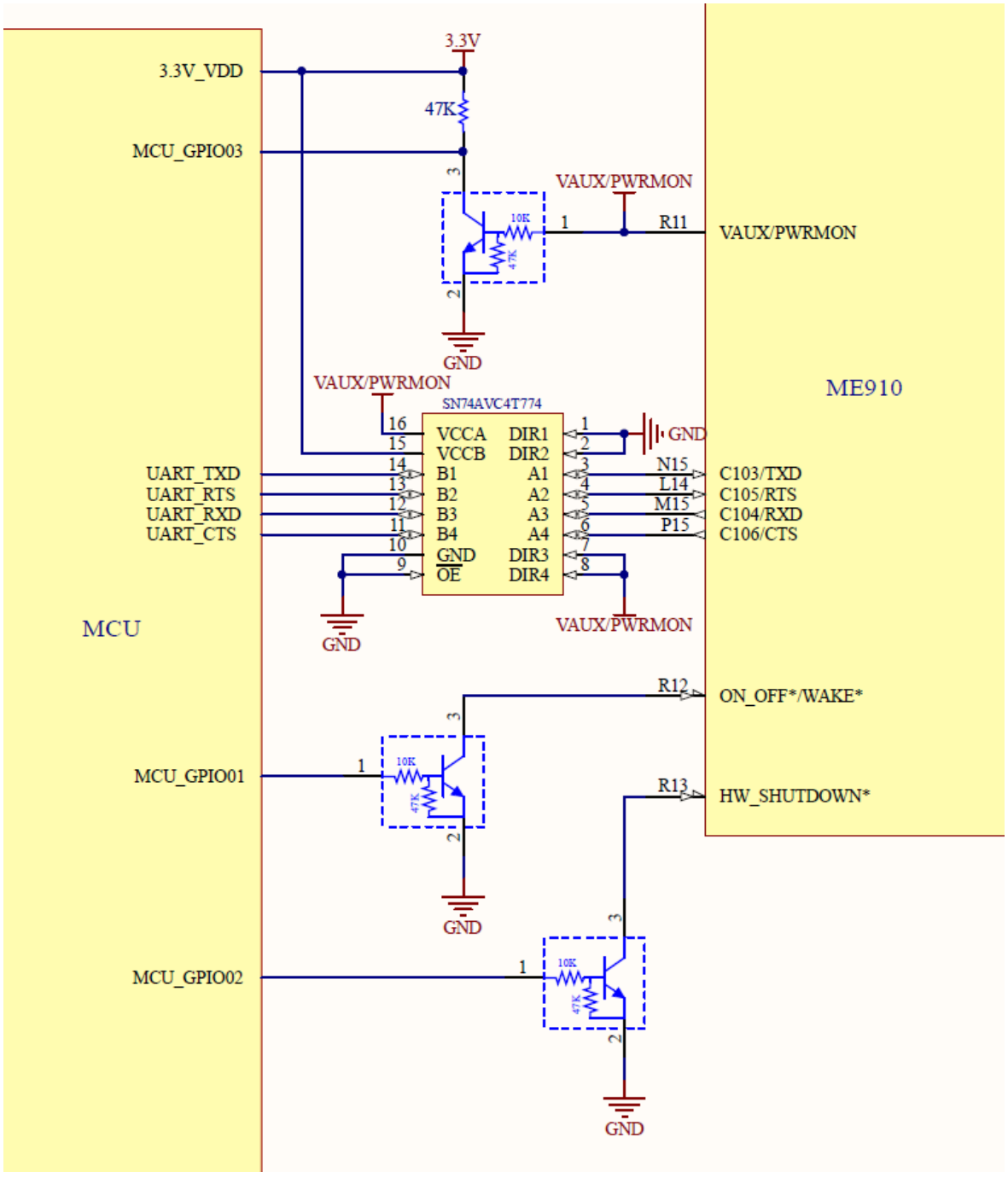
SIM interface is powered down when ME910C1 enters in PSM mode to ensure minimal power consumption
For this reason SIM PIN, if enabled, should be managed in every scheduled wake, or can simply be disabled.

5.5. PSM configuration

PSM has to be configured by the command AT+CPSMS.
The command controls whether the UE wants to apply PSM or not, as well as the requested extended periodic RAU value and the requested GPRS READY timer value in GERAN/UTRAN, the requested extended periodic TAU value in E-UTRAN and the requested Active Time value.
Examples:
AT+ CPSMS=0 → disable the use of PSM
AT+CPMS= 1,,,"01100001","01100010"→ PSM Mode is set to enabled and module enters in PSM after a minute (T3324 = 33) and stay in this mode for two minute (T3412 = 162).
For additional details on AT+CPMS command please refer to the ME910C1 AT commands Reference Guide

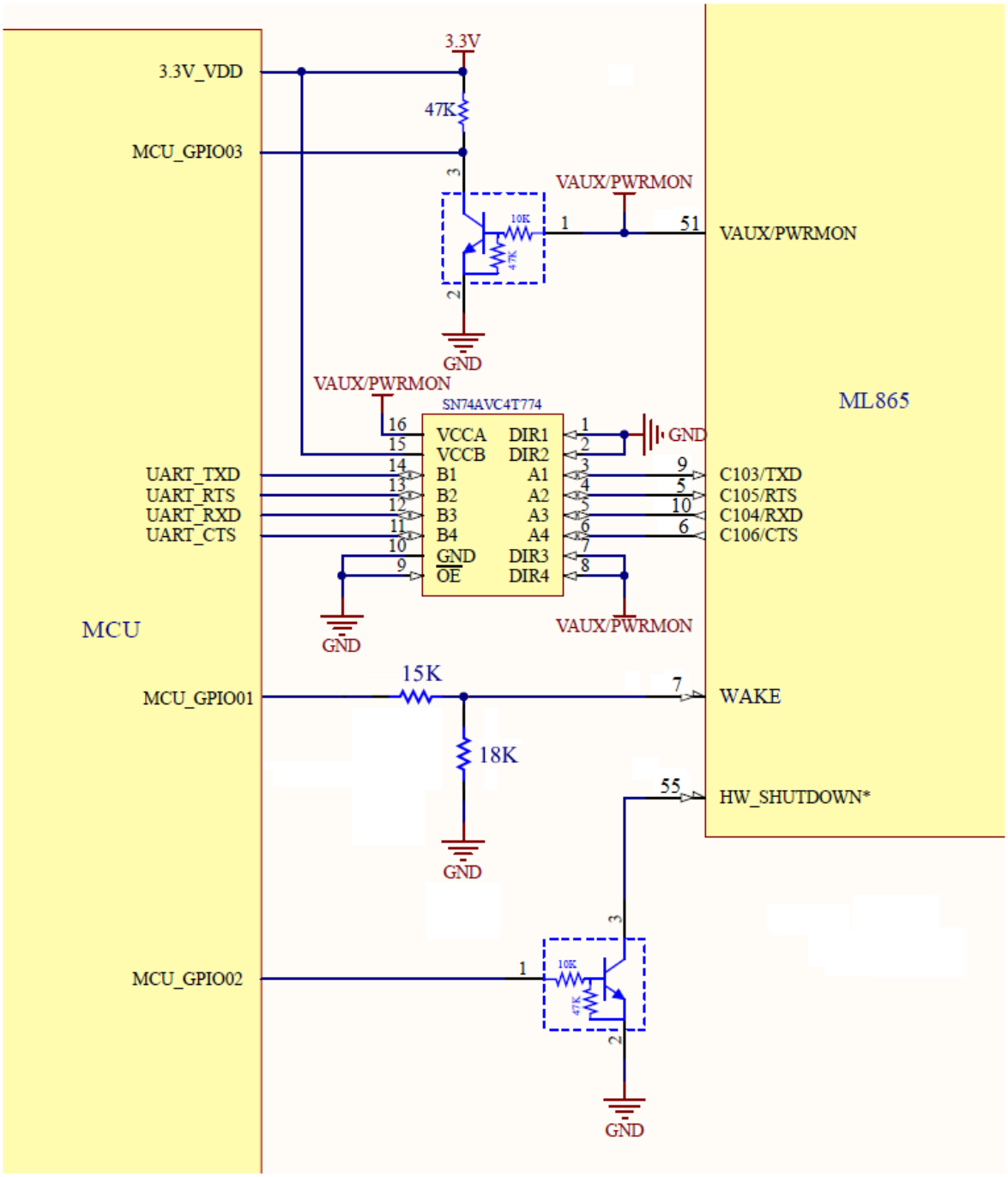
When Periodic Update Timer expires (T3324), ME910C1 turns off until the next scheduled wake-up time.

5.6. Hardware application example



WARNING:

If MCU and its digital interface has 1.8V supply, UART can be directly connected but all MCU output lines must be set to 0V in OFF and in PSM state to avoid backpowering.



WARNING:

If MCU and its digital interface has 1.8V supply, UART and WAKE can be directly connected but all MCU output lines must be set to 0V in OFF and in PSM state to avoid backpowering. MCU_GPIO01 must be totem pole type.

6. GLOSSARY AND ACRONYMS

	Description
TTSC	Telit Technical Support Centre
USB	Universal Serial Bus
HS	High Speed
DTE	Data Terminal Equipment
LTE	Long Term Evolution
PSM	Power Saving Mode according to 3GPP Rel.12
AS	Access Stratum
NAS	Non-Access Stratum
RAU	Routing Area Update
TAU	Tracking Area Update
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
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

7. DOCUMENT HISTORY

Revision	Date	Changes
0	2018-02-08	First Issue
1	2019-03-04	Updated Applicability table and Paragraph 3. Added Par.4. Added ML865C1

SUPPORT INQUIRIES

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

www.telit.com

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Mod. 0809 2017-01 Rev.8

xE910
Global Form Factor Application Note

80000NT10060A Rev. 19– 2018-11-13

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DOCUMENTATION

[01.2017]

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APPLICABILITY TABLE

PRODUCTS

- GE910-QUAD
- GE910-QUAD V3
- UE910 V2 SERIES
- UE910-EU V2 AUTO
- UE910 SERIES
- HE910 SERIES
- CE910-DUAL
- CE910-SC
- DE910-DUAL
- DE910-SC
- LE910 SERIES
- LE910 V2 SERIES
- LE910C1
- LE910D1
- ME910C1
- NE910C1

CONTENTS

1. INTRODUCTION

The information presented in this document is believed to be accurate and reliable. However, no responsibility is assumed by Telit Communications S.p.A. for its use, nor any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent rights of Telit Communications S.p.A. other than for circuitry embodied in Telit products. This document is subject to change without notice.

1.1. Scope

Scope of this document is the description of some hardware solutions useful for developing an application compatible with the products: LE910C1, LE910D1 and ME910C1, in order to highlight the minor differences between the above mentioned products

1.2. 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

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.

1.3. 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.

1.4. Related Documents

The following is a list of applicable documents downloadable from the Download Zone section of Telit's website http://www.telit.com

- GE910 Telit AT Commands Reference Guide (80000ST10025A)
- Telit 3G Modules AT Commands Reference Guide (80378ST10091A)
- DE910 AT Commands Reference Guide (30392NT110791A)
- CE910 AT Commands Reference Guide (80399ST10110A)
- UE910 V2 AT Commands Reference Guide (80419ST10124A)
- LE910 AT Commands Reference Guide (80407ST10116A)
- LE910-V2 AT Commands Reference Guide (80446ST10707A)
- LE910Cx AT Commands Reference Guide (80490ST10778A)

- GE910 Hardware User Guide (1vv0300962)
- HE910 Hardware User Guide (1vv0300925)
- DE910 Hardware User Guide (1vv0300951)
- CE910 Hardware User Guide (1vv0301010)
- UE910 Hardware User Guide (1VV0301012)
- UE910 V2 Hardware User Guide (1VV0301065)
- LE910 Hardware User Guide (1vv030108)
- LE910-V2 Hardware User Guide (1VV0301200)
- LE910-Cx Hardware User Guide (1VV0301298)
- ME910C1 Hardware User Guide (1VV0301351)

- GE910 Family Digital Voice Interface Application Note (80000NT10099A)
- HE/UE910 Digital Voice Interface Application Note (80000NT10050A)
- DE/CE910, UE910-V2 DVI Application Note (80000NT10101A)
- LE910 Digital Voice Interface Application Note (80000NT11246A)

- Telit Modules Software User Guide (1VV0300784)
- xE910 RTC Backup Application Note (80000NT10072A)
- Antenna Detection Application Note (80000NT10002A)
- Telit_HE_UE_UL_Family_Ports_Arrangements (1VV0300971)

2. OVERVIEW

In this document all the basic functions of a mobile phone will be taken into account; for each one of them a proper hardware solution will be suggested and eventually the wrong solutions and common errors to be avoided will be evidenced. Obviously, this document cannot embrace the whole hardware solutions and products that may be designed. The wrong solutions to be avoided shall be considered as mandatory, while the suggested hardware configurations shall not be considered mandatory, instead the information given shall be used as a guide and a starting point for properly developing your product with the described modules. For further hardware details that may not be explained in this document refer to the Telit Product Description documents where all the hardware information is reported.

The integration of the xE910 cellular module within user application shall be done according to the design rules described in this manual.

The Unified Form Factor (UFF) is a concept of a products family characterized by the same mechanical and electrical form factor with different radio access technology.

This new approach protects customer's investment by giving you the possibility to migrate with the simple plug-and-play switch of your module with other wireless modules in the Unified Form Factor range without changing your application. In this way, Telit offers easy access to different cellular technologies, certifications or bandwidth. For example if you develop applications based on today's mobile operator GSM/GPRS cellular technology if required it might be upgraded in the future to higher data speed capability such as UMTS/HSDPA or LTE.

The main advantages are summarized below:

- Increase of the efficiency in the use of the investments assigned to the development of the application (NRE), resulting in higher ROI, thus justifying the business choice of the UFF products;
- Products that are designed to bring technology enhancements to the integrators, such as higher data rates and new wireless standards while maintaining backwards compatibility in form factor and logical interfaces;
- Ease of integration;
- Telit as a single supplier of wireless modems;
- The customer can focus on its core business and application, not the management of operations and procurement required for wireless modems;
- One single application for different markets.

Telit, acknowledging the requirements of the developers, has taken great care to minimize any difference in the interface of the products with the Unified Form Factor; nevertheless some minor differences are still present. Differences are mainly due by the fact that different technologies have different electrical and mechanical characteristics, however, the application can, with some care, easily accommodate multiple wireless modems.

This document has been created to guide you when developing applications based on Unified Form Factor concept by pointing out module differences.

3. MECHANICAL DIMENSIONS

The Telit xE910 family overall dimensions are:

MODULE	LENGTH [MM]	WIDTH [MM]	THICKNESS [MM]
HE910	28.20	28.20	2.20
GE910	28.20	28.20	2.25
GE910-V3	28.20	28.20	2.25
DE910	28.20	28.20	2.05
CE910	28.20	28.20	2.05
UE910	28.20	28.20	2.20
LE910-V2	28.20	28.20	2.20
UE910-V2	28.20	28.20	2.20
LE910	28.20	28.20	2.20
LE910C1	28.2	28.20	2.20
LE910D1-E1	28.20	28.20	2.10
ME910C1/NE910C1	28.20	28.20	2.10

In a common design application, which is going to use multiple models, we recommend to consider the highest dimensions as reference.

Note:

The 3D drawings/models versions are available separately, and they are provided in IGES format. Please contact the Telit Technical Support to get the models.

4. MODULE CONNECTIONS

4.1. Common pin-out

Pin	Signal	I/O	Function	Type	Comment
USB HS Communication Port					
B15	USB_D+	I/O	USB differential Data (+)	USB 2.0	Not present in GE910-V3
C15	USB_D-	I/O	USB differential Data (-)	USB 2.0	Not present in GE910-V3
A13	VUSB	I	Power sense for the internal USB transceiver.	USB 2.0	Not present in GE910-V3; for LE910C1 Power is 2.5V – 5.5V
A14	USB_ID	AI	USB ID		Activated only for LE910C1
MAIN UART: PROG. / DATA + HW FLOW CONTROL					
N15	C103/TXD	I	Serial data input from DTE	CMOS 1.8V	
M15	C104/RXD	O	Serial data output to DTE	CMOS 1.8V	
P15	C106/CTS	O	Output for Clear to Send signal (CTS) to DTE	CMOS 1.8V	

L14	C105/RTS	I	Input for Request to send signal (RTS) from DTE	CMOS 1.8V	
P14	C107/DSR	O	Output for (DSR) to DTE	CMOS 1.8V	For LE910C1 Alternate Fn GPIO_32
M14	C108/DTR	I	Input for (DTR) from DTE	CMOS 1.8V	For LE910C1 Alternate Fn GPIO_34
N14	C109/DCD	O	Output for (DCD) to DTE	CMOS 1.8V	For LE910C1 Alternate Fn GPIO_33
R14	C125/RING	O	Output for Ring (RI) to DTE	CMOS 1.8V	For LE910C1 Alternate Fn GPIO_31
Power Supply					
M1	VBATT	-	Main power supply (Baseband)	Power	
M2	VBATT	-	Main power supply (Baseband)	Power	
N1	VBATT_PA	-	Main power supply (Radio PA)	Power	
N2	VBATT_PA	-	Main power supply (Radio PA)	Power	
P1	VBATT_PA	-	Main power supply (Radio PA)	Power	
P2	VBATT_PA	-	Main power supply (Radio PA)	Power	

SIM Card Interface 1					
A3	SIMVCC1	-	External SIM signal – Power supply for the SIM	1.8 / 3V	For LE910C1 1.8V\2.85V
A7	SIMRST1	O	External SIM signal – Reset	1.8 / 3V	For LE910C1 1.8V\2.85V
A5	SIMIO	I/O	External SIM signal - Data I/O	1.8 / 3V	For LE910C1x 1.8V\2.85V
A6	SIMCLK1	O	External SIM signal – Clock	1.8 / 3V	For LE910C1 1.8V\2.85V
A4	SIMIN1	I	External SIM signal – Presence (active low)	1.8V	For LE910C1 1.8V
SIM Card Interface 2 – Optional only for LE910C1					
C1	SIMCLK2	O	External SIM 2 signal - clk	1.8/2.85V	
D1	SIMRST2	O	External SIM 2 signal – reset	1.8/2.85V	
C2	SIMIO2	I\O	External SIM 2 signal – Data I\O	1.8/2.85V	
G4	SIMIN2	I	External SIM 2 signal – Presense	1.8/2.85V	
D2	SIMVCC2	-	External SIM 2 signal – Power supply for SIM 2	1.8/2.85V	

Miscellaneous Functions					
R11	VAUX/PWRMON	O	Supply Output for external accessories	1.8V	
R12	ON_OFF*	I	Switching power ON or OFF (toggle command)	Internally PU to VRTC	Connect in Open-Drain
R13	HW_SHUTDOWN*	I	HW unconditional shutdown (Active Low)	Internally PU	Connect in Open-Drain
C14	VRTC	-	RTC power supply input when VBATT is OFF and Regulated voltage output when VBATT is ON		Pin is reserved for: LE910D1\C1 and ME910 for all other xE910 Pin is used for xxxx
B1	ADC_IN1	AI	Analog/Digital Converter Input 1	Analog	
H4	ADC_IN2	AI	Analog/Digital Converter Input 2	Analog	
D7	ADC_IN3	AI	Analog/Digital Converter Input 3	Analog	
SGMII Interface					
E4	SGMII_RX_P	AI	SGMII receive – plus	PHY	Pin is active only for LE910C1
F4	SGMII_RX_M	AI	SGMII receive – minus	PHY	Pin is active only for LE910C1

D5	SGMII_TX_P	AO	SGMII transmit – plus	PHY	Pin is active only for LE910C1
D6	SGMII_TX_M	AO	SGMII transmit – minus	PHY	Pin is active only for LE910C1
HSIC Interface					
A12	HSIC_DATA	I/O	High-speed inter-chip interface - data	1.2V	Reserved for ME910
A11	HSIC_STB	I/O	High-speed inter-chip interface - strobe	1.2V	Reserved for ME910
H15	HSIC_SLAVE_WAKEUP	I	Slave Wake Up	1.8V	Reserved for ME910
F15	HSIC_HOST_WAKEUP	O	Host Wake Up	1.8V	
K15	HSIC_SUSPEND_REQUEST	O	Slave Suspend Request	1.8V	
J15	HSIC_HOST_ACTIVE	I	Active Host Indication	1.8V	
D13	VDD_IO1	I	VDD_IO1 Input		Activated only for HE910
E13	1V8_SEL	O	1V8 SEL for VDD_IO1		Activated only for HE910

I2C Interface					
B11	I2C_SCL	I/O	I2C clock	1.8V	Activated for LE910C1 only for coded usage
B10	I2C_SDA	I/O	I2C Data	1.8V	Activated for LE910C1 only for coded usage
Digital Voice Interface (DVI)					
B9	DVI_WA0	I/O	Digital Audio Interface WA0	CMOS 1.8V	PCM
B6	DVI_RX	I	Digital Audio Interface RX	CMOS 1.8V	PCM
B7	DVI_TX	O	Digital Audio Interface TX	CMOS 1.8V	PCM
B8	DVI_CLK	I/O	Digital Audio Interface CLK	CMOS 1.8V	PCM
B12	REF_CLK	O	Reference clock for external Codec	CMOS 1.8V	Activated only for LE910C1
Analog Interface					
B2	EAR+	O	Analog Audio Interface (EAR+)		Not available on UE910-xxD/UE910-GL

B3	EAR-	O	Analog Audio Interface (EAR-)		Not available on UE910-xxD/UE910-GL
B4	MIC+	I	Analog Audio Interface (MIC+)		Not available on UE910-xxD/UE910-GL
B5	MIC-	I	Analog Audio Interface (MIC-)		Not available on UE910-xxD/UE910-GL
Telit GPIO's					
C8	GPIO_01	I/O	Telit GPIO_01 STAT_LED	CMOS 1.8V	
C9	GPIO_02	I/O	Telit GPIO_02	CMOS 1.8V	
C10	GPIO_03	I/O	Telit GPIO_03	CMOS 1.8V	
C11	GPIO_04	I/O	Telit GPIO_04	CMOS 1.8V	
B14	GPIO_05	I/O	Telit GPIO_05	CMOS 1.8V	
C12	GPIO_06	I/O	Telit GPIO_06	CMOS 1.8V	
C13	GPIO_07	I/O	Telit GPIO_07	CMOS 1.8V	
K15	GPIO_08	I/O	Telit GPIO_08	CMOS 1.8V	

L15	GPIO_09	I/O	Telit GPIO_09	CMOS 1.8V	
G15	GPIO_10	I/O	Telit GPIO_10	CMOS 1.8V	
D13	VDD_IO1	I	VDD_IO1 Supply Input		
E13	VIO_1V8	O	Supply for VDD_IO1 (1.8V)	1.8V	Activated only for LE910C1 and for HE910
RF SECTION					
K1	ANTENNA	I/O	Main RF Antenna	RF	
F1	ANT_DIV	I	Diversity Antenna Input (50 ohm)	RF	Reserved for: GE910; ME910; CE910
GPS SECTION					
R9	ANT_GPS	I	GPS antenna (50 Ohm)	RF	
R7	GPS_LNA_EN	O	Enables the external regulator for GPS LNA	1.8V	Reserved for CE910 and GE910-QuadV3
N9	GPS_SYNC	O	GPS sync signal for Dead Reckoning	1.8V	Activated only for LE910C1
J14	GNSS_NMEA_TX	O	UART NMEA Output	1.8V	Activated only for GE910-QUAD. For other xE910 modules - Reserved

K14	GNSS_NMEA_RX	I	UART NMEA Input	1.8V	Activated only for GE910-QUAD. For other xE910 modules - Reserved
WiFi (SDIO) Interface					
N13	WiFi_SD_CMD	O	WiFi SD Command	1.8V	WiFi enabled only for LE910C1
L13	WiFi_SD_CLK	O	WiFi SD Clock	1.8V	WiFi enabled only for LE910C1
J13	WiFi_SD_DATA0	I\O	WiFi SD Serial Data 0	1.8V	WiFi enabled only for LE910C1
M13	WiFi_SD_DATA1	I\O	WiFi SD Serial Data 1	1.8V	WiFi enabled only for LE910C1
K13	WiFi_SD_DATA2	I\O	WiFi SD Serial Data 2	1.8V	WiFi enabled only for LE910C1
H13	WiFi_SD_DATA3	I\O	WiFi SD Serial Data 03	1.8V	WiFi enabled only for LE910C1
L12	WiFi_SDRST	O	WiFi Reset/Power enable control	1.8V	WiFi enabled only for LE910C1
M11	WLAN_SLEEP_CLK	O	WiFi Sleep clock output	1.8V	WiFi enabled only for LE910C1
M10	RFCLK2_QCA	O	WiFi low noise RF clock ouput	1.8V	WiFi enabled only for LE910C1

LTE-WiFi co-existence					
M8	WCI_TX	O	Wireless coexistence interface TXD	1.8V	WiFi enabled only for LE910C1
M9	WCI_RX	I	Wireless coexistence interface RXD		WiFi enabled only for LE910C1
SPI – Serial Peripheral Interface / AUX UART					
D15	SPI_MOSI/TX_AUX	O	Serial auxiliary data output from DCE (modem)	1.8V	Not available for: GE910-QUAD V3; CE910; LE910
E15	SPI_MISO/ RX_AUX	I	Serial auxiliary data input to DCE	1.8V	Not available for: GE910-QUAD V3; CE910; LE910
F15	SPI_CLK	O	SPI Clock output	1.8V	Not available for: GE910-QUAD V3; CE910; LE910
H14	SPI_CS/GPIO11	O	SPI Chip select output / GPIO11	1.8V	Activated for only for LE910C1
H15	SPI_MRDY				Activated for only for HE910
J15	SPI_SRDY				Activated for only for HE910

GROUND PINS
E1, G1, H1, J1, L1, A2, E2, F2, G2, H2, J2, K2, L2, R2, M3, N3, P3, R3, M4, N4, P4, R4, N5, P5, R5, N6, P6, R6, P8, R8, P9, P10, R10, M12, B13, P13, E14

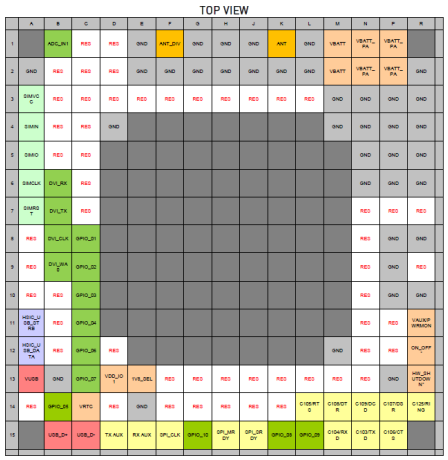
Warning:
RESERVED pins reported above must not be connected.
SIM signals for DE910 and CE910 are present only for future compatibility and support of Removable User Identity Module (R-UIM).

ME910 Only D13-E13 pins can be connected together in order to be compatible with HE910 module.

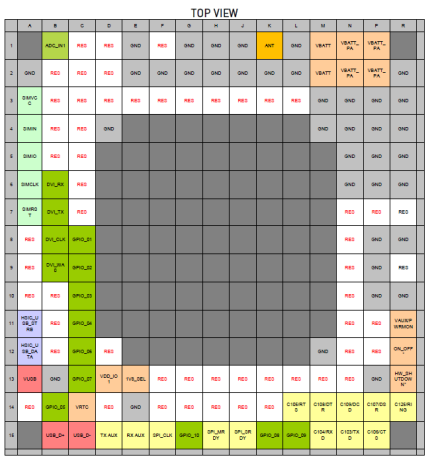
LE910C1 does npt support CFUN=5 (power save mode. In order to function power save mode LE910 DTR must be connected.

LE910C1 includes HW solution for dual SIM. Currently not support by SW.

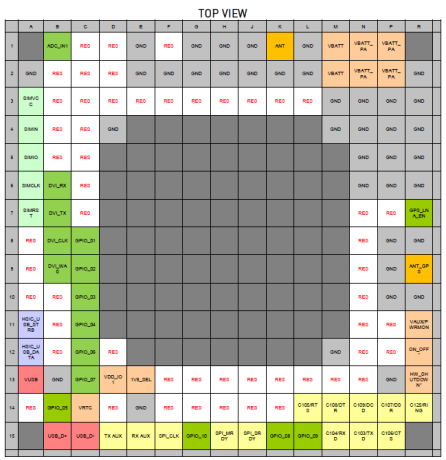
HE910-D



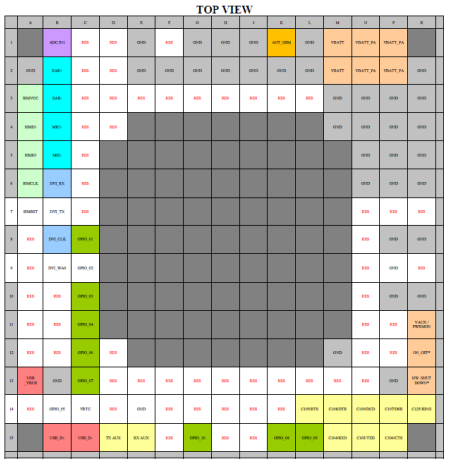
HE910-EUD\EUR\NAD\NAR\GL



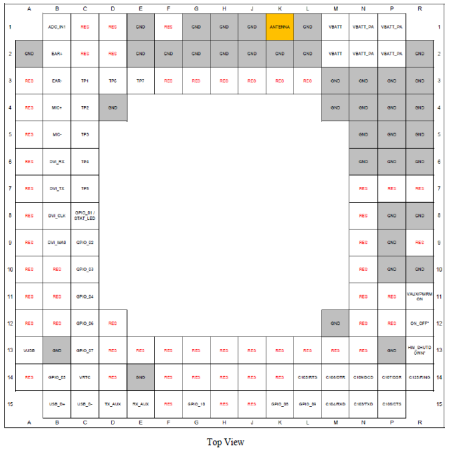
HE910-EUG\NAG



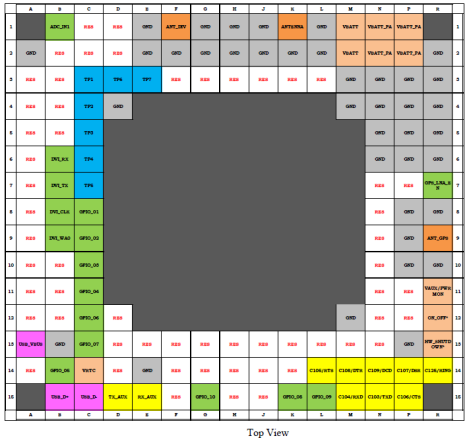
GE910-QUAD



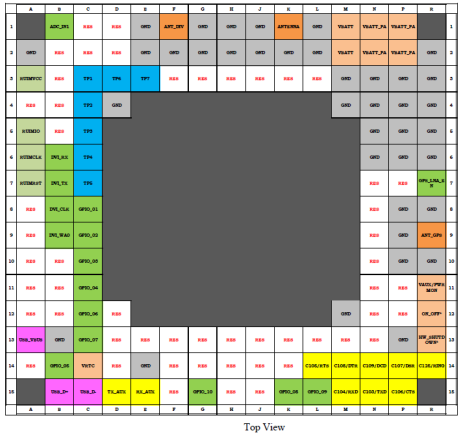
CE910- SL



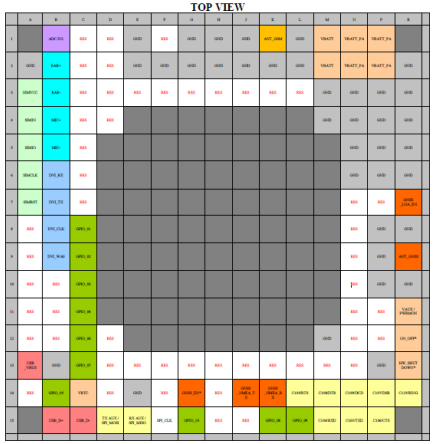
DE910-DUAL



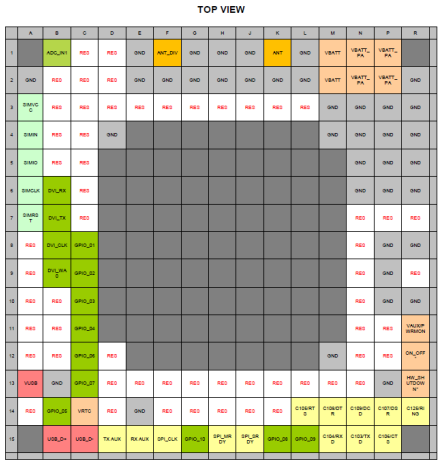
DE910-SC



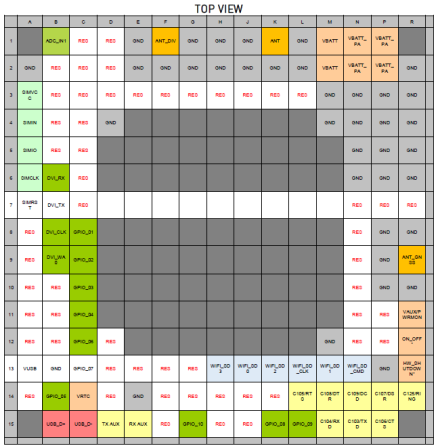
GE910-QUAD\V3\GNS



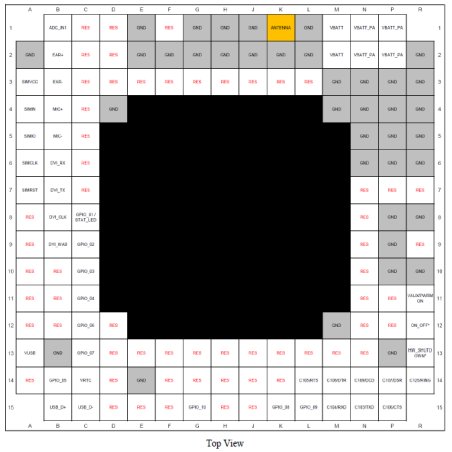
LE910-NA\SV V2



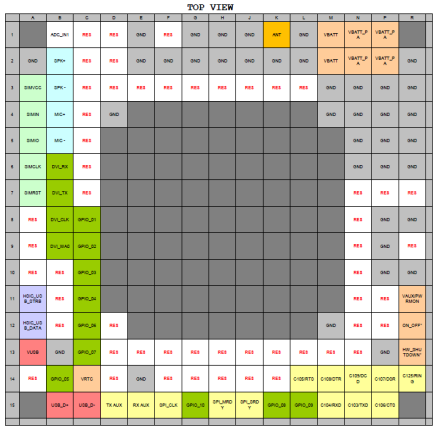
LE910-NAG\EUG\SVG\SKG



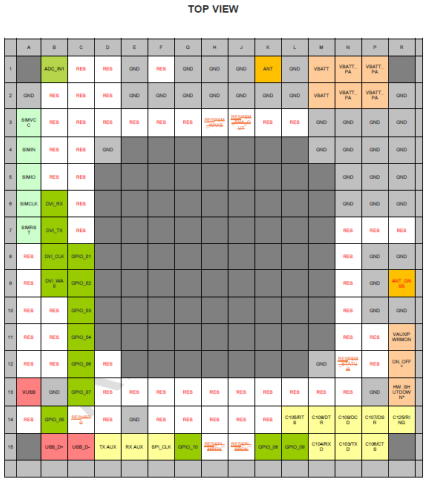
UE910-NA\SV V2



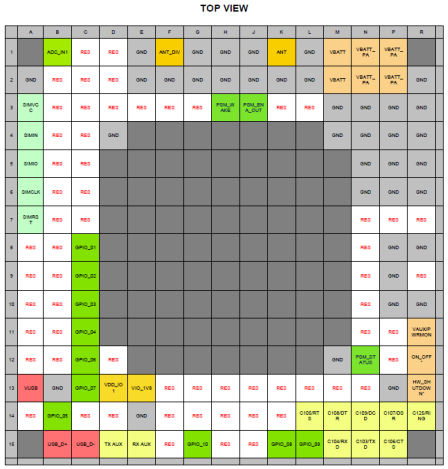
UE910-NAG\EUR\NAR\NAD\GL



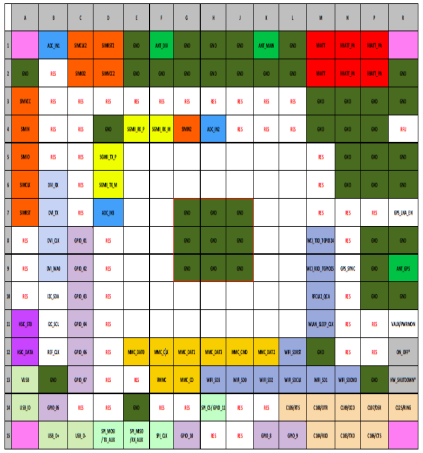
ME910C1/NE910C1



LE910D1-E1



LE910C1



NOTE:

The following pins are unique for the LE910Cx and may not be supported on other (former or future) xE910 family. Special care must be taken when designing the application board if future compatibility is required

REF_CLK

SPI_CS

USB_ID

I2C_SCL

I2C_SDA

ADC_IN2

ADC_IN3

The LE910Cx is a new series in the xE910 form factor

The LE910Cx is fully backward compatible to the previous xE910 in terms of:

- Mechanical dimensions
- Package and pin-map

To support the extra features and additional interfaces, the LE910Cx introduces more pins compared to the xE910.

The extra pins of the LE910Cx can be considered as optional if not needed and can be left unconnected (floating) if not used.

In this case, the new LE910Cx can be safely mounted on existing carrier boards designed for the previous xE910.

The additional pins of the LE910Cx are shown in Figure 3 (marked as Green)

5. PIN-OUT DIFFERENCES

5.1. Digital\Analog Audio

xE910 family Audio is configured differently some of modules support only Analog Audio or Digital (DVI) and some of the modules support both configurations. For modules supporting Analog and Digital Intenal coded is included in module.

Digital (DVI) Pinout:

Pin	Signal	I/O	Function	Type	Comment
Digital Voice Interface					
B9	DVI_WAO	O	Ear signal output, phase +	B-PD 1.8V	PCM_SYNC
B6	DVI_RX	I	Ear signal output, phase +	B-PD 1.8V	PCM_DIN
B7	DVI_TX	O	Microphone signal input; phase +	B-PD 1.8V	PCM_DOUT
B8	MIC-	O	Microphone signal input; phase -	B-PD 1.8V	PCM_CLK
B12*	REF_CLK	O	Audio Master Clock	B-PD 1.8V	I2S_MCLK Activated for LE910C1 only

Analog Pinout:

Pin	Signal	I/O	Function	Type	Comment
Analog Voice Interface					
B2	EAR+	O	Analog Voice Interface (EAR+)		
B3	EAR-	O	Analog Voice Interface (EAR-)		
B4	MIC+	I	Analog Voice Interface (MIC+)		
B5	MIC-	I	Analog Voice Interface (MIC-)		

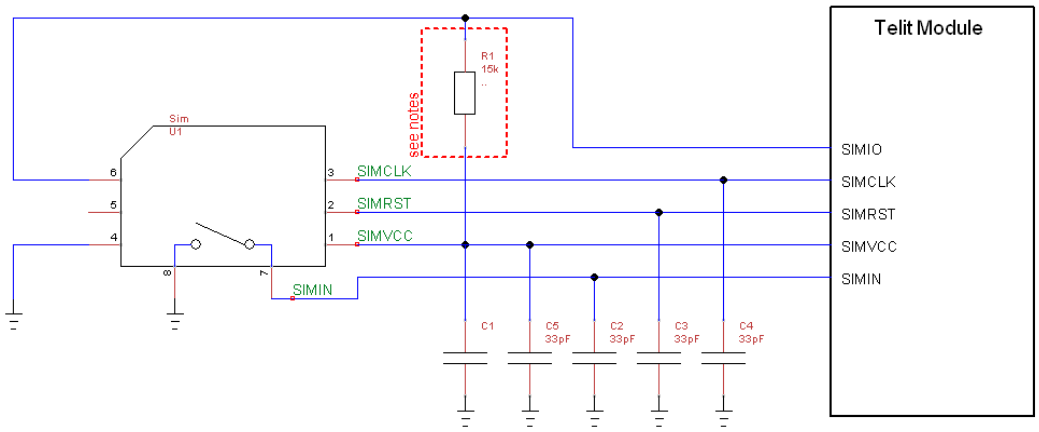
xE910 Audio configurations summary:

Module + Region Variant	Analog	Digital	Codec
LE910C1-NA\NS\AP	NA	Enabled – Pins:B6;B7;B8;B9; B12	External required
LE910D1	NA	NA	NA
HE190-D\GL EUR\EUG\EUD NAG\NAR\NAD	NA	Enabled – Pins:B6;B7;B8;B9	External required
CE910-B\DUAL CE910-SC	Enabled – Pins:B2;B3;B4;B5	Enabled – Pins:B6;B7;B8;B9	Internal
DE910-B\DUAL DE910-SC	NA	Enabled – Pins:B6;B7;B8;B9	External required
LE910 - EUG\NAG\NVG\ SVG\SKG	NA	Enabled – Pins:B6;B7;B8;B9	External required
LE910-NA\SV\EU _V2	NA	Enabled – Pins:B6;B7;B8;B9	External required
UE910- GL EUR\EUD\NAR\NAD	Enabled – Pins:B2;B3;B4;B5	Enabled – Pins:B6;B7;B8;B9	Internal
UE910-EU\V2	Enabled – Pins:B2;B3;B4;B5	Enabled – Pins:B6;B7;B8;B9	Internal
GE910-QUAD\V3\GNSS	Enabled – Pins:B2;B3;B4;B5	Enabled – Pins:B6;B7;B8;B9	Internal
ME910C1	NA	Enabled – Pins:B6;B7;B8;B9	External required
NE910C1	NA	Enabled – Pins:B6;B7;B8;B9	External required

6. SIM CONNECTION

GSM, UMTS and LTE devices have SIM port interface; the pinout is reported in figure below. CDMA devices has variants that support RUIM (needed for some countries). SIM holder can be no-mount if CDMA devices, without RUIM support, are mounted.

The figure below illustrates in particular how the application side should be designed, and what values the components should have.



The minimum value of C1 can vary depending on the module; in the table below you have the recommended values. The maximum for all modems is 1uF.

Module	C1
HE910	100nF
DE910	-
GE910	220nF
GE910-V3	220nF
CE910	-
UE910	100nF
LE910-V2	100nF
UE910-V2	100nF
LE910	100nF
LE910C1	100nF
LE910D1-E1	Cap value btw: 100nF to 1uF
ME910C1	Cap value btw: 100nF to 1uF
NE910C1	Cap value btw: 100nF to 1uF

7. FREQUENCY BANDS

xE910 family supports 2G, 3G and 4G technologies. Every module supports different band frequency hence in case of upgrading or changing between different modules better to verify supported bands for main and diversity ports.

Below are two summary tables for main and diversity:

Module + Region Variant	LTE FDD	LTE TDD	HSPA+	TD-SCDMA	2G	CDMA
LE910C1-NA	B2, B4, B12	N\A	B1, B2, B4, B5, B8	-	GSM850, 900 DCS, PCS	
LE910C1-NS	B2, B4, B5, B12, B25, B26	N\A	-	-	-	
LE910C1-AP	B1, B3, B5, B8, B28	N\A	B1, B5, B8	-	-	
LE910D1	B2O, B3, B31	N\A				
HE190-D\GL	N\A	N\A	B1, B2, B4, B5, B8		GSM 850, 900 DCS, PCS	
HE190-EUR\EUG\EUD	N\A	N\A			GSM 850, 900 DCS, PCS	
HE190-NAG\NAR\NAD	N\A	N\A			GSM 850, 900 DCS, PCS	
CE910-B\DUAL CE910-SC	N\A	N\A	N\A	N\A	N\A	800/1900MHz 800MHz
DE910-B\DUAL DE910-SC	N\A	N\A	N\A	N\A	N\A	800/1900MHz 800MHz

Module + Region Variant	LTE FDD	LTE TDD	HSPA+	TD-SCDMA	2G	CDMA
LE910-EUG	B20, B3, B7		B5,B8,B1		GSM 900, DCS	
LE910-NAG	B17, B5, B4, B2		B5, B2		GSM 850, PCS	
LE910-SVG	B13, B4	N\A	N\A	N\A	N\A	N\A
LE910-SKG	B3, B5					
LE910-NA_V2	B2, B4, B5, B12, B13		B2, B5			
LE910-SV_V2	B2, B4, B13					
UE910-EUR\EUD			B1, B8		GSM900, DCS	
UE910-NAR\NAD			B2, B5		GSM850, PCS	
UE910-GL			B1, B2, B5, B8		GSM 850, 900 DCS, PCS	
UE910-EU V2			B1, B8		GSM900, DCS	
UE910-NA V2			B2, B5		GSM850, PCS	
GE910-QUAD\V3					GSM 850, 900 DCS, PCS	
ME910C1-NV	B4,B13					
ME910C1-NA	B2,B4,B12,B13					

ME910C1-E1	B3,B8,B20	
ME910C1-AU	B3, B5,B8,B28	
ME910C1-K1	B3,B5,B8,B26	
ME910C1-J1	B1,B3,B8,B18,B19,B26	
ME910C1-E2	B3,B8,B20	GSM850, GSM900, DCS1800, PCS1900
ME910C1-WW	B1,B2,B3,B4,B5,B8,B12,B13,B18,B19,B20,B26,B28	GSM850, GSM900, DCS1800, PCS1900
NE910C1-E1	B8,B20	
NE910C1-NA	B2,B4,B12,B13	

7.1. Diversity

Module + Region Variant	LTE FDD	LTE TDD	HSPA+	TD-SCDMA
LE910C1-NA	B2, B4, B12	N\A	B1, B2, B4, B5, B8	
LE910C1-NS	B2, B4, B5, B12, B25, B26	N\A	-	
LE910C1-AP	B1, B3, B5, B8, B28	B38, B39, B40, B41	B1, B5, B8	
LE910D1	B2O, B3, B31			
HE190-D\GL			B1, B2, B5, B8 GSM850\900, DCS, PCS	
HE190-EUR\EUG\EUD			Not Supported	
HE190- NAG\NAR\NAD			Not Supported	
CE910-B\DUAL\SC			Not Supported	
DE910-B\DUAL\DSC			800/1900MHz 800MHz	
LE910-EUG	B2O, B3, B31		B1, B5, B8	
LE910-NAG	B2, B4, B5, B12, B17		B2, B5	
LE910-NVG	B4, B13		B2, B5	
LE910-SVG	B4, B13		Not Supported	
LE910-SKG	B3, B5			
LE910-NA_V2	B2, B4, B5, B12, B13		B2, B5	
LE910-SV_V2	B2, B4, B13		B2	
UE910-EUR\EUD			Not Supported	
UE910-NAR\NAD			Not Supported	
UE910-GL			Not Supported	
UE910-EU V2			Not Supported	
UE910-NA V2			Not Supported	
GE910-QUAD\V3\GNSS				Not Supported

ME910C1-NV	Not Supported
ME910C1-NA	Not Supported
ME910C1-E1	Not Supported
ME910C1-AU	Not Supported
ME910C1-K1	Not Supported
ME910C1-J1	Not Supported
ME910C1-E2	Not Supported
ME910C1-WW	Not Supported

As of dec. 2014, PTCRB updated PPMD document section 11.10.6 Feature/Function Set for Integrated Devices, and in the last revision the Diversity is not anymore among the exception features that may not match the modem capabilities. This means that if the assembled modem supports Diversity antenna, then in order to get PTCRB approval (and subsequent US carrier approval) the application MUST have a diversity antenna.

If the RX Diversity is not used/connected, disable the Diversity functionality using the AT#RXDIV command (ref to the AT User guide for the proper syntax) and leave the pad F1 unconnected

8. GPS

xE910 family Modules support GNSS or GPS, GNSS\GPS RF port is Pin R9. xE910 GNSS Antenna configuration could be Passive or Active antenna, this depends on the Pin out configuration and is detailed at table below.

Pad R7, GPS_LNA_EN, is used only when GNSS is present, becomes UNCONNECTED and can be left connected in a xE910 common design.

Module + Region Variant	Supported Mode	LNA Enable	Passive\ Active Ant.
LE910C1-NA\NS\AP	GNSS	Enabled	Active
LE910D1	NA	NA	NA
HE910-DG	GPS	Enabled	Both
HE910-D\GL	NA	NA	NA
HE910-EUR\EUG\EUD	GPS only for EUG	Enabled	Both
HE190- NAG\NAR\NAD	GPS only for NAG	Enabled	Both
CE910-B\DUAL\SC	NA	NA	NA
DE910-B\DUAL DE910-SC	GNSS	Enabled	Both
LE910 - EUG\NAG\NVG\ SVG\SKG	GNSS	Disabled	Passive
LE910-NA\SV_V2	NA	NA	NA
UE910-EUR\EUD\NAR\NAD\GL	NA	NA	NA
UE910-EU\NA V2	NA	NA	NA
GE910-QUAD\V3\GNSS	GNSS only for GE901-GNSS	Enabled	Both
ME910C1	GNSS	Disabled	TBD

9. AUXILIARY INTERFACE

General Pinout:

The Auxiliary serial ports are presented in all xE910 family products, except for UE910-V2. Please refer to table below summarizing type of auxiliary interface.

Pin	Signal	I/O	Function	Type	Comment
SPI / AUX UART					
D15	SPI_MOSI/ TX_AUeX	O	Serial auxiliary data output from DCE (modem)	1.8V	Shared with SPI_MOSI
E15	SPI_MISO/ RX_AUX	I	Serial auxiliary data input to DCE	1.8V	Shared with SPI_MISO
F15	SPI_CLK	O	SPI Clock output	1.8V	Only for LE910C1
H15	SPI_CS/GP IO11	O	SPI Chip select output / GPIO11	1.8V	Only for LE910C1
J15					

Auxiliary Interface Summary:

Module + Region Variant	SPI	UART	Comments
LE910C1-NA\NS\AP	Enabled – Pins: D15;E15; F15; H15	Enabled – Pins: D15; E15	
LE910D1	Enabled – Pins: D15;E15;	Enabled – Pins: D15; E15	
HE190-D\GL	Enabled – Pins: D15;E15; F15; H15;J15	Enabled – Pins: D15; E15	Pins F15; H15; J15 are shared with HSIC USB ports
HE190-EUR\EUG\EUD	Enabled – Pins: D15;E15; F15; H15;J15	Enabled – Pins: D15; E15	Pins F15; H15; J15 are shared with HSIC USB ports
HE190-NAG\NAR\NAD	Enabled – Pins: D15;E15; F15; H15;J15	Enabled – Pins: D15; E15	Pins F15; H15; J15 are shared with HSIC USB ports
CE910-B\DUAL\SC	NA	Enabled – Pins: D15; E15	
DE910-B\DUAL DE910-SC	NA	Enabled – Pins: D15; E15	

LE910 - EUG\NAG\NVG\SVG\ SKG	NA	Enabled – Pins: D15; E15	
LE910-NA\SV - V2	Enabled – Pins: D15;E15;F15	Enabled – Pins: D15; E15	
UE910 - EUR\EUD\NAR\ NAD\GL	Enabled – Pins: D15;E15; F15; H15;J15	Enabled – Pins: D15; E15	Pins F15; H15 are shared with HSIC USB ports
UE910-EU\NA V2	NA	NA	
GE910-QUAD\V3\GNSS	Enabled – Pins: D15;E15;F15	Enabled –Pins: D15; E15	
GE910-QUAD V3	NA	Enabled – Pins: D15; E15	
ME910C1	Enabled –Pins: D15;E15;F15	Enabled – Pins: D15; E15	

Due to the shared functions, when the SPI port is used, it is not possible to use the AUX_UART port and vice versa.

10. USB PORT

The USB port is presented in all xE910 family, several modules also support USB HSIC (High Speed).

USB can be used for the following purposes: communication with external peripheral devices, debug monitor. Please refer to Pinout table and USB difference table summary.

The following table is listing the available signals:

Pin	Signal	I/O	Function	Type	Comment
USB HS 2.0 Communication Port					
B15	USB_D+	I/O	USB differential Data (+)		90 Ohms differential
C15	USB_D-	I/O	USB differential Data (-)		90 Ohms differential
A13	VUSB	I	Power sense for the internal USB transceiver.		
A14		AI	USB ID		Enabled only for LE910C1

10.1. USB HSIC

Pin	Signal	I/O	Function	Type	Comment
USB HSIC					
A12	HSIC_USB_DATA	I/O	data signal	CMOS 1.2V	
A11	HSIC_USB_STRB	I/O	strobe signal	CMOS 1.2V	
H15	HSIC_SLAVE_WAKEUP	I	Slave Wake Up	CMOS 1.8V	Shared with SPI_MRDY
F15	HSIC_HOST_WAKEUP	O	Host Wake Up	CMOS 1.8V	Shared with SPI CLK
K15	HSIC_SUSPEND_REQUEST	O	Slave Suspend Request	CMOS 1.8V	Shared with GPIO_08
J15	HSIC_HOST_ACTIVE	I	Active Host Indication	CMOS 1.8V	Shared with SPI_SRDY

10.2. USB interface summary table:

Module + Region Variant	USB	USB HSIC	Comments
LE910C1-NA\NS\AP	Enabled – Pins: B15; C15; A13; A14	Enabled – Pins: A12; A11	
LE910D1	Enabled – Pins: B15; C15; A13	NA	
HE190-D\GLEUR\EUG\EUD\ NAG\NAR\NAD	Enabled – Pins: B15; C15; A13	Enabled – Pins: A12; A11; H15; F15; K15; J15; D13; E13	Pins F15; H15 and J15 are shared with SPI ports. K15 shared with GPIO8.
CE910-B\DUAL\SC	Enabled – Pins: B15; C15; A13	NA	
DE910-B\DUAL\SC	Enabled – Pins: B15; C15; A13	NA	
LE910 - EUG\NAG\NVG \SVG\SKG	Enabled – Pins: B15; C15; A13	NA	
LE910-NA\SV - V2	Enabled – Pins: B15; C15; A13	NA	
UE910 - EUR\EUD\NAR\ NAD\GL	Enabled – Pins: B15; C15; A13	Enabled – Pins: A12; A11; H15; F15; K15; J15;	Pins F15; H15 and J15 are shared with SPI ports. K15 shared with GPIO8
UE910-EU\NA V2	Enabled – Pins: B15; C15; A13	NA	
GE910-QUAD\V3\GNSS	Enabled – Pins: B15; C15; A13	NA	
ME910C1-NV\NA\ E1\E2\AU\K\\J1\WW	Enabled – Pins: B15; C15; A13	NA	

We recommend adding USB PCB connector pads for convenient access for network certification testing, firmware upgrade and module debug logs. The USB connector can be “DNP” until needed. This may be more convenient than just test points alone.

Due to the shared functions, when the USB HSIC port is used, it is not possible to use the SPI or GPIO_08 and vice versa

In a xE910 common design the USB HSIC port should not be used.

11. POWER ON

To turn ON/OFF the xE910, Pad ON_OFF* must be tied low for few seconds and then released; the devices of xE910 family have a different minimum time the ON_OFF must be tied low in order to be sure that the module turns ON; with 5 seconds you can turn ON all xE910 products. Same procedure for Turning OFF.

Module	Interval
HE910	5sec
DE910	1sec
GE910	5sec
GE910-V3	5sec
CE910	1.5sec
UE910	5sec
LE910-V2	5sec
UE910-V2	1sec
LE910	1sec
LE910C1	1sec
LE910D1-E1	1sec
ME910C1	1sec

Don't use any pull up resistor on the ON_OFF* line, it is internally pulled up. Using pull up resistor may bring to latch up problems on the HE910 power regulator and improper power on/off of the module. The line ON_OFF* must be connected only in open collector or open drain configuration.

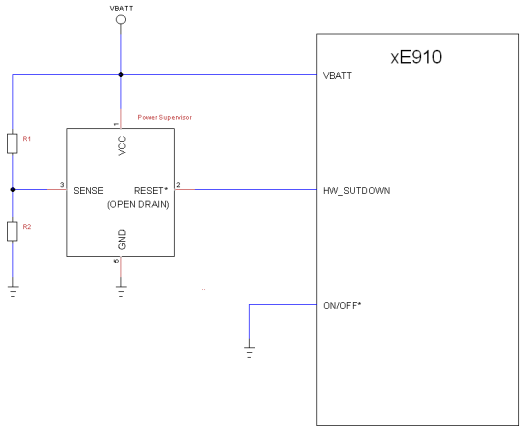
To check if the device has powered on, the hardware line PWRMON should be monitored.

It is mandatory to avoid sending data to the serial ports during the first 200ms of the module start-up.

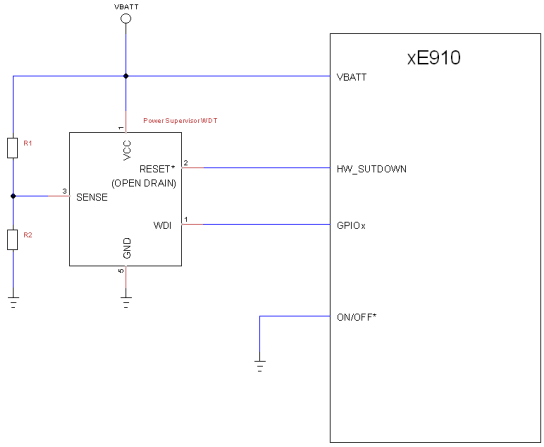
In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the HE910 when the module is powered off or during an ON/OFF transition

Warning:

For some xE910 family products it is recommended set the ON_OFF* line LOW to power on the module **only after VBATT is higher than 3.22V**. If you need the module automatically turn-on when VBATT is applied you can tie to ground the ON_OFF pin but in this case the slew-rate of VBATT must be > 150V/s. In this case the safest option is to use a power supply supervisor connected to the HW_SUTDOWN pin of the module as indicated in figure below:



This is just an example: R1 and R2 determine the threshold voltage at which the RESET* is released, R1 and R2 should be choose in order to have a threshold up to 3.22V.
If you need the module to automatically turn on and there isn't a MCU on the board, it is better having a power supervisor with WDT as indicated in the example below:

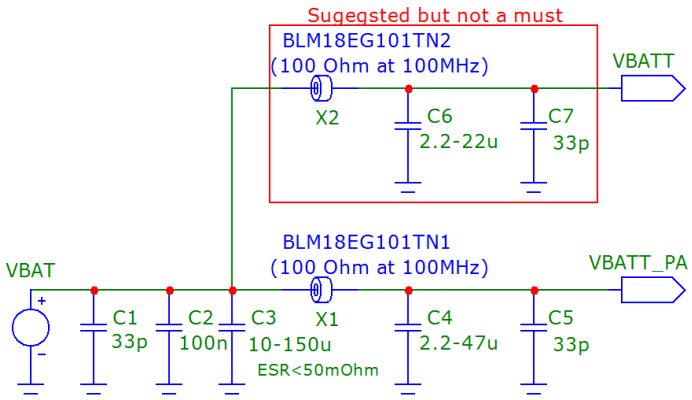


In this case you need a python script that toggles the GPIOx; in this way the module is reset in case it remains stuck for some reason.

12. 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.

To improve EMI filtering an EMI suppression circuitry must be added on modem's VBATT_PA, and if possible also on VBATT. Follow schematic on figure below.



12.1. Power Supply Requirements

The external power supply must be connected to VBATT & VBATT_PA signals and must fulfill the following requirements:

Module	Nominal Supply Voltage	Normal Operating Voltage Range	Extended Operating Voltage Range
GE910/GE910-V3	3.8V	3.40V - 4.20V	3.10V* - 4.50V
DE910	3.8V	3.40V - 4.20V	3.30V - 4.50V
HE910	3.8V	3.40V - 4.20V	3.10V* - 4.50V
CE910	3.8V	3.40V - 4.20V	3.40V - 4.50V
UE910	3.8V	3.40V - 4.20V	3.10V* - 4.50V
LE910	3.8V	3.40V - 4.20V	3.10V - 4.35V
LE910-V2	3.8V	3.40V - 4.20V	3.10V - 4.50V
UE910-V2	3.8V	3.40V - 4.20V	3.40V - 4.50V
LE910C1	3.8V	3.40V - 4.20V	3.30V - 4.20V
LE910D1	3.8V	3.40V - 4.20V	3.10V - 4.50V
ME910C1	3.8V	3.40V - 4.20V	3.10V - 4.50V

	*On HE910, GE910, GE910-V3 and UE910 the Power supply must be higher than 3.22 V to power on the module, when the module is ON the voltage level on VBATT can go to 3.1V.
	The Operating Voltage Range MUST never be exceeded; care must be taken in order to fulfil min/max voltage requirement.
	Overshoot voltage (regarding MAX Extended Operating Voltage) and drop in voltage (regarding MIN Extended Operating Voltage) MUST never be exceeded; The “Extended Operating Voltage Range” can be used only with completely assumption and application of the HW User guide suggestions.
	The electrical design for the Power supply should be made ensuring it will be capable of a peak current output of at least 2 A.
	For a xE910 common design the voltage level of the power supply should stay in the **Normal Operating voltage Rate**.
	In order to avoid latch-up issues we recommend particular care be taken such that no digital pins connected to the modem of the modem remain high when the modem is turned off.

13. LOGIC LEVEL SPECIFICATIONS

The following tables show the logic level specifications for xE910 family of products:

Absolute Maximum Ratings - Not Functional (Input level on any digital pin (CMOS 1.8V) with respect to ground)

Module	Min	Max	comment
HE910	-0.3V	2.1V	
DE910	-0.3V	2.3V	
GE910	-0.3V	2.7V	
GE910-V3	-0.3V	2.7V	
CE910	-0.3V	2.3V	
UE910	-0.3V	2.1V	
LE910-V2	-0.3V	2.1V	
UE910-V2	-0.3V	2.3V	
LE910C1	-0.3V	2.16V	
LE910D1	-0.3V	VDD_IO1 +0.3V	
ME910C1	-0.3V	2.1V	

Operating Range - Interface levels (1.8V CMOS)

	Input LOW level		Input HIGH level		Output LOW level		Output HIGH level	
Module	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
HE910	0.0V	0.35V	1.5V	1.9V	0.0V	0.10V	1.6V	1.9V
DE910	0.0V	0.35V	1.5V	2.1V	0.0V	0.45V	1.35V	1.8V
GE910	0.0V	0.35V	1.5V	1.9V	0.0V	0.20V	1.6V	1.9V
GE910-V3	0.0V	0.35V	1.3V	1.9V	0.0V	0.20V	1.6V	1.9V
CE910	0.0V	0.35V	1.5V	2.1V	0.0V	0.45V	1.35V	1.8V
UE910	0.0V	0.35V	1.5V	1.9V	0.0V	0.10V	1.6V	1.9V
LE910-V2	0.0V	0.35V	1.5V	1.9V	0.0V	0.20V	1.6V	1.9V
UE910-V2	0.0V	0.35V	1.5V	2.1V	0.0V	0.45V	1.35V	1.8V

LE910C1	0.0V	0.35V	1.5V	2.1V	0.0V	0.45V	1.35V	1.8V
LE910D1	0.0V	0.35V	1.55V	1.9V	0V	0.8V	1.35V	1.8V
ME910C1	0.0V	0.35V	1.5V	1.9V	0.0V	0.20V	1.6V	1.9V

Current characteristics

	Output Current	Input Current
HE910	1mA	1µA
DE910	2mA	30µA
GE910	1mA	1µA
GE910-V3	1mA	1µA
CE910	2mA	30µA
UE910	1mA	1µA
LE910-V2	1mA	1µA
UE910-V2	2mA	30µA
LE910C1	1mA	1µA
LE910D1	TBD	10µA
ME910C1	1mA	1µA

14. SERIAL PORTS

Two serial ports are available in the LE910C1, LE910D1 and ME910 modules. Two serial ports are available on the module:

MODEM SERIAL PORT

MODEM SERIAL PORT 2 (Auxiliary)

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

- RS232 PC com port
- Microcontroller UART @ 1.8V (Universal Asynchronous Receive Transmit)
- Microcontroller UART @ 5V or other voltages different from 1.8V

Depending from the type of serial port on the OEM hardware a level translator circuit may be needed to make the system work. On the ME910C1 the ports are CMOS 1.8.

The main serial port UART is the serial interface between the module and OEM hardware it is a full UART with hardware flow control. Modem's main UART directions are referred to the Data Terminal Equipment (DTE) (external controller). TXD is an input and RXD is an output for Telit.

The second auxiliary UART port has only 2 or 4 signals, for LE910D1 and ME910 only 2 signals including RX and TX and its baud rate is fix to 115200. For Module LE910C1 there are 4 signals, with extra of CLK and CS (Chip Select) on Rx and Tx. The modem's auxiliary UART directions are referred to Data Communication Equipment (DCE) (modem). TX_AUX is an output and RX_AUX is an input for Telit.

PU/PD Resistor on UART pins are not necessary, and could have negative effects, since resistor divider will be created if we take into account PU/PD inside the modem.

Internal PU/PD may vary depending on modem used.

For deep power saving using *AT+CFUN=5*, the modem controls the DTR and VUSB status (only for products that support USB). Only when DTR is OFF, C108/DTR='HI' or floating, and VUSB is OFF, 'LOW' or floating, modem is allowed to enter into deep power saving mode; otherwise, if DTR is ON, C108/DTR='LOW', **OR** VUSB is ON, VUSB='HI'; modem remains always awake. **Avoid leaving both DTR and/or VUSB opened or tied to fixed values, we suggest connecting, at least one, to a controller and the other can be left floating**.

15. GENERAL PURPOSE I/O

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

- Input
- Output
- Alternate function (internally controlled)

xE910 family of products use the same number of GPIOs with the same pin-out.

For some products at start-up during the BOOT of the software some GPIO can be set as output with LOW level for a small amount of time, for this reason a direct connection of any GPIO to an output that is HIGH when the module is turning ON is not recommended.

For complete information about GPIOs refer to the Hardware User Guides.

16. ADC CONVERTER

Modules LE910C1, LE910D1 and ME910 support an ADC input, also useful for antenna detection purposes, see Antenna Detection Application Note. The following table is showing the electrical ADC characteristics for each modem:

	Input Voltage range		AD conversion	Resolution	Input Resistance
Module	Min	Max	bit	Max	Min
HE910	0.0V	1.2V	10	1.2mV	1MΩ
DE910	0.0V	1.2V	8	10mV	1MΩ
GE910	0.0V	1.3V	10	1.3mV	1MΩ
GE910-V3	0.0V	1.3V	10	1.3mV	1MΩ
CE910	0.0V	1.2V	12	1mV	1MΩ
UE910	0.0V	1.2V	10	1mV	1MΩ
LE910-V2	0.0V	1.2V	10	1.2mV	1MΩ
UE910-V2	0.0V	1.2V	8	10mV	1MΩ
LE910	0.0V	1.3V	10	1.3mV	1MΩ
LE910C1	0.1v	1.7V	8	6.6mV	-
LE910D1	0V	1.2V	10	1.2mV	-
ME910C1	0V	1.2V	10	1.2mV	1MΩ

In a common design limit maximum input voltage to 1.2V.

17. VAUX/PWRMON POWER OUTPUT

A regulated power supply output is provided in order to supply small devices from the module. This output is active when the module is ON and goes OFF when the module is shut down. The operating range characteristics are slightly different on the four products of the xE910 family, as reported below:

	Output Voltage			Output Current	Bypass capacitor inside the module
Module	Min	Typ	Max	Max	Typ
HE910	1.78V	1.80V	1.82V	60mA	1uF
DE910	1.77V	1.80V	1.83V	200mA	2.2uF
GE910	1.77V	1.80V	1.83V	50mA	1uF
GE910-V3	1.77V	1.80V	1.83V	50mA	1uF
CE910	1.77V	1.80V	1.83V	200mA	2.2uF
UE910	1.78V	1.80V	1.82V	60mA	1uF
LE910-V2	1.78V	1.80V	1.82V	60mA	1uF
UE910-V2	1.77V	1.80V	1.83V	200mA	1uF
LE910	1.75V	1.80V	1.85V	100mA	1uF
LE910C1	1.75V	1.80V	1.85V	100mA	1uF
LE910D1	1.78V	1.80V	1.82V	60mA	1uF
ME910C1	1.78V	1.80V	1.82V	60mA	1uF

18. RTC BACKUP

The VRTC pin brings out the Real Time Clock supply, which is separate from the rest of the digital part, allowing having only RTC going on when all the other parts of the device are off.

To this power output pin, a backup circuit can be added in order to increase the RTC autonomy during power off of the battery. Devices must not be powered from this pin.

For more information see the document “xE910 RTC Backup Application Note 80000NT10072A”.

This feature is not available for CE910.

19. DOCUMENT HISTORY

Revision	Date	Changes
0	2011-12-01	First issue
1	2011-12-14	Layout review
2	2012-03-15	Added DE910
3	2012-04-10	Added CE910
4	2012-06-06	Added ADC, VAUX and thickness data for GE910, clarification on HW SHUTDOWN behavior, added SIMVCC C1 values, removed SPI reference for CDMA products.
5	2012-08-01	DVI for CE910 under development
6	2012-08-21	Added chapter for RTC backup, R12 and R13 type modification
7	2012-12-05	Digital Audio (Chapter 12.2) changed Updated 3 Mechanical Dimensions for CE910 Added in 4.1 Common Pin-out, pull up resistance information of SIMIN, ON_OFF*, HW_SHUTDOWN* for DE910/CE910. Added important note on USB access in Chapter 10
8	2013-03-25	Updated 4.2 Pin-out differences, SIMIN is reserved for DE/CE910 Digital Voice Interface is changed from Reserved to Supported for CE910 Updated 6.1 Power supply Requirements, added values of extended operating voltage range for DE/CE910
9	2013-08-30	Added UE910
10	2013-10-01	Added UE910 V2
11	2014-01-08	Changed GE910 A13 pin from RESERVED to VUSB Added warning for HE910 GPIOs
12	2014-04-24	Added LE910
13	2014-09-12	Updated 4.2 Pin-out differences, SIMIN description for LE910
14	2015-10-12	Layout review. Added chapter 5.2 (ON/OFF procedure). Added note in chapter 6.1 regarding the minimum voltage allowed for HE910, UE910 and GE910. Added notes in chapter 4.2.3. Added critical note in chapter 9 about GPIO behavior during boot process. Added LE910-V2 and GE910-V3.

15	2015-12-04	Modified Chapter 4.2.6 SPI PORT
16	2017-04-06	Added LE910C1; LE910D1-E1 and ME910. In addition added summary tables for: Bands – Main + Diversity Audio configuration USB Interface Turn ON Interval SPI\UART interface
17	2017-06-25	Updated Document Layout with latest template.
18	2018-09-27	Updated Document with last ME910C1 versions

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

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