ME310G1/ME910G1/ML865G1 PSM Application Note

80617NT11830A Rev. 1 – 2021-03-01

TELIT
TECHNICAL
DOCUMENTATION

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APPLICABILITY TABLE

PRODUCTS

- ME310G1-W1
- ME310G1-WW
- ME310G1-WWV
- ME910G1-W1
- ME910G1-WW
- ME910G1-WWV
- ML865G1-WW

CONTENTS

1. INTRODUCTION

1.1. Scope

The ME310G1/ME910G1/ML865G1 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 ME310G1/ME910G1/ML865G1 modules.

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

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:

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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] 80617ST10991A ME310G1/ME910G1/ML865G1 AT Commands Reference Guide
[2] 1VV0301588 ME310G1 Hardware Design Guide
[3] 1VV0301593 ME910G1 Hardware Design Guide
[4] 1VV0301632 ML865G1 Hardware Design Guide

2. OVERVIEW

The aim of this document is the description of some hardware solutions useful for developing a product with the Telit ME310G1/ME910G1/ML865G1 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 ME310G1/ME910G1/ML865G1 module. For further hardware details that may not be explained in this document refer to the Telit ME310G1/ME910G1/ML865G1 Product Description document where all the hardware information is reported.

NOTICE:

EN) The integration of the LTE **ME310G1/ME910G1/ML865G1** cellular module within user application shall be done according to the design rules described in this manual.

(IT) L'integrazione del modulo cellulare LTE **ME310G1/ME910G1/ML865G1** all'interno dell'applicazione dell'utente dovrà rispettare le indicazioni progettuali descritte in questo manuale.

(DE) Die Integration des **ME310G1/ME910G1/ML865G1** LTE Mobilfunk-Moduls in ein Gerät muß gemäß der in diesem Dokument beschriebenen Kunstruktionsregeln erfolgen.

(SL) Integracija LTE **ME310G1/ME910G1/ML865G1** modula v uporabniški aplikaciji bo morala upoštevati projektna navodila, opisana v tem priročniku.

(SP) La utilización del modulo LTE **ME310G1/ME910G1/ML865G1** 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 **ME310G1/ME910G1/ML865G1** 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 **ME310G1/ME910G1/ML865G1** 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 ME310G1/ME910G1/ML865G1 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 ME310G1/ME910G1/ML865G1 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.

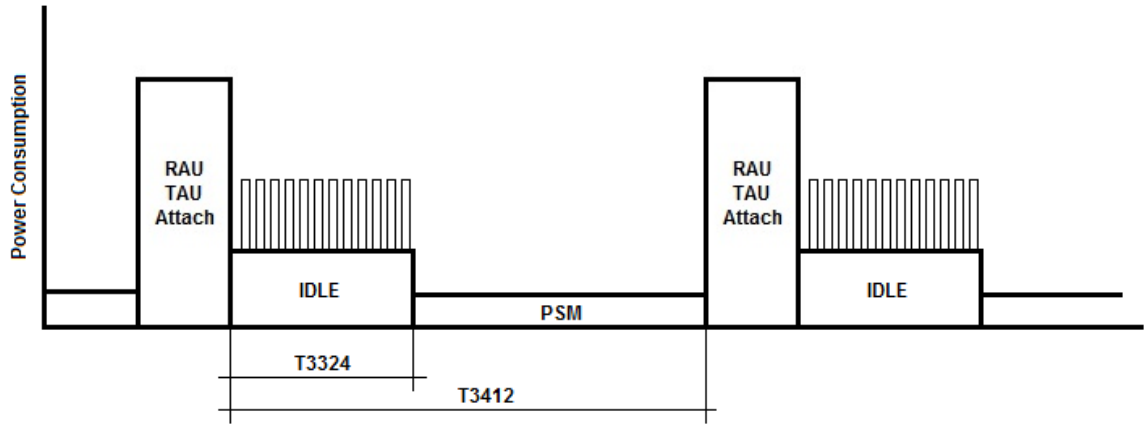
Timer T3412 extended value is defining the time between two subsequent RAU/TAU procedures and starts togheter with T3324.This implies that the time in which the module will be NOT reachable by the network (inactivity period) is given by T3412_ext - T3324.

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 ME310G1/ME910G1/ML865G1

ME310G1/ME910G1/ML865G1 implements PSM features and allows the user to activate PSM by sending the specific AT command AT+CPSMS as described in [1].

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.

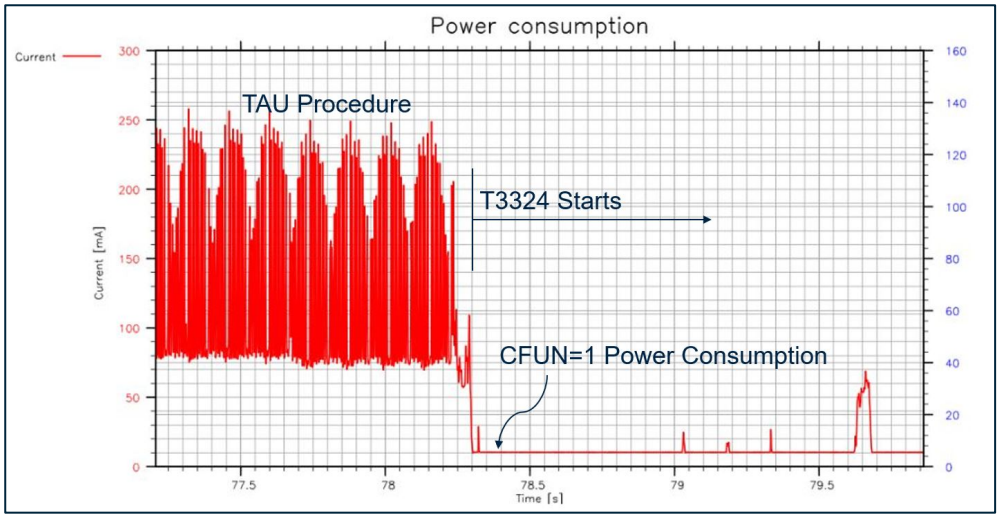
Since default functionality for ME910 (and all Telit modules) is CFUN=1 the current absortion for the module will be equal to standard idle CFUN=1 state and around 8-9 mA.

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 3 uA.

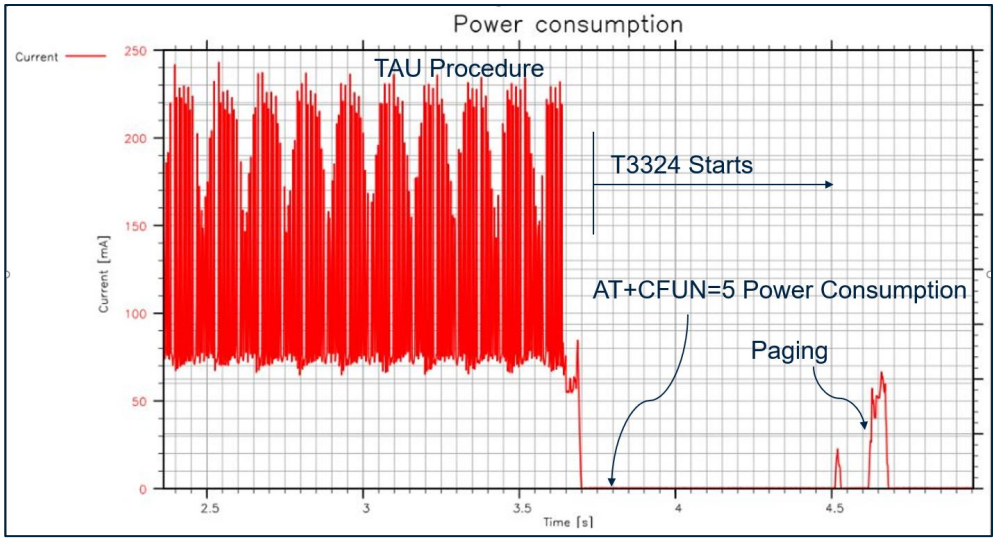
Users willing to decrease the power consumption during T3324 can combine AT+CFUN states (e.g. AT+CFUN=5 and Asserting low the DTR pin) with PSM as shown in the below figures.

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 ME310G1/ME910G1/ML865G1 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. Standard 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

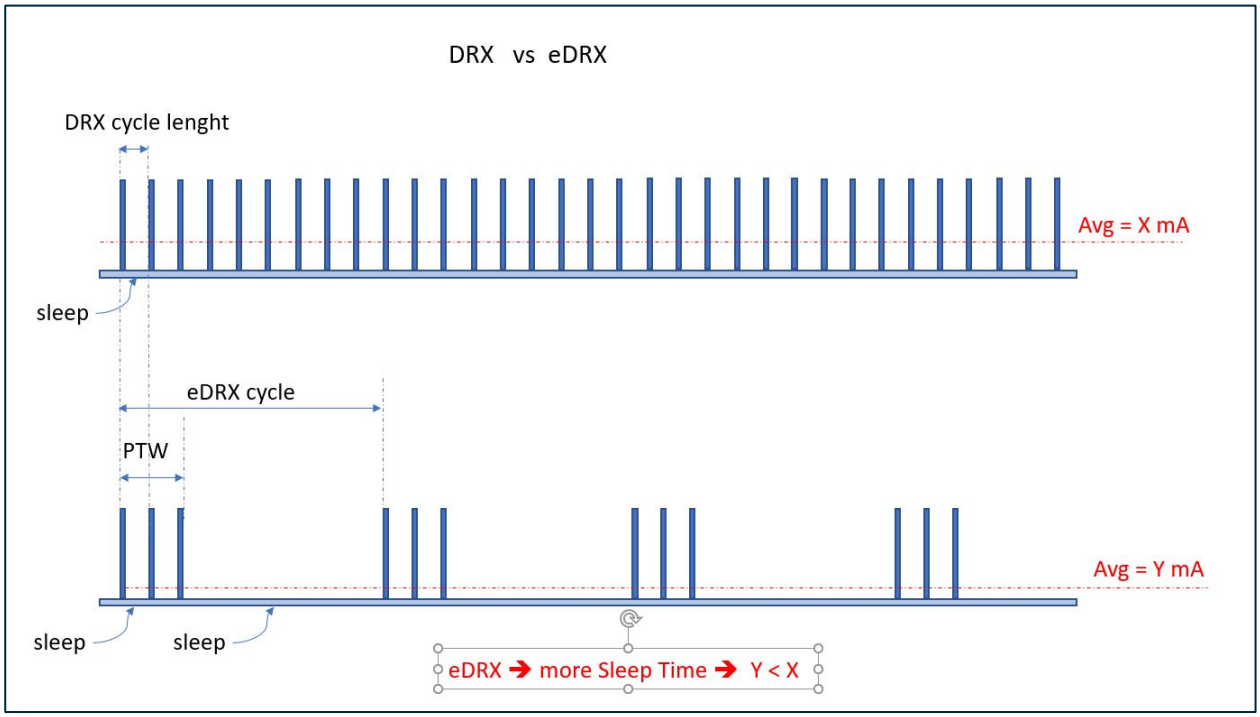
eDRX cycle : the time between the start of two different and subsequent time windows

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, it has to be said that the sleep current between paging occurrence and during the long sleep has a value of around 0,45 mA so when eDRX is used in combination with AT+CFUN=5 or 0 that allows to achieve average current consumption values close to 0,6 mA or less 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.*

4.2. PSM in between eDRX Procedure Overview

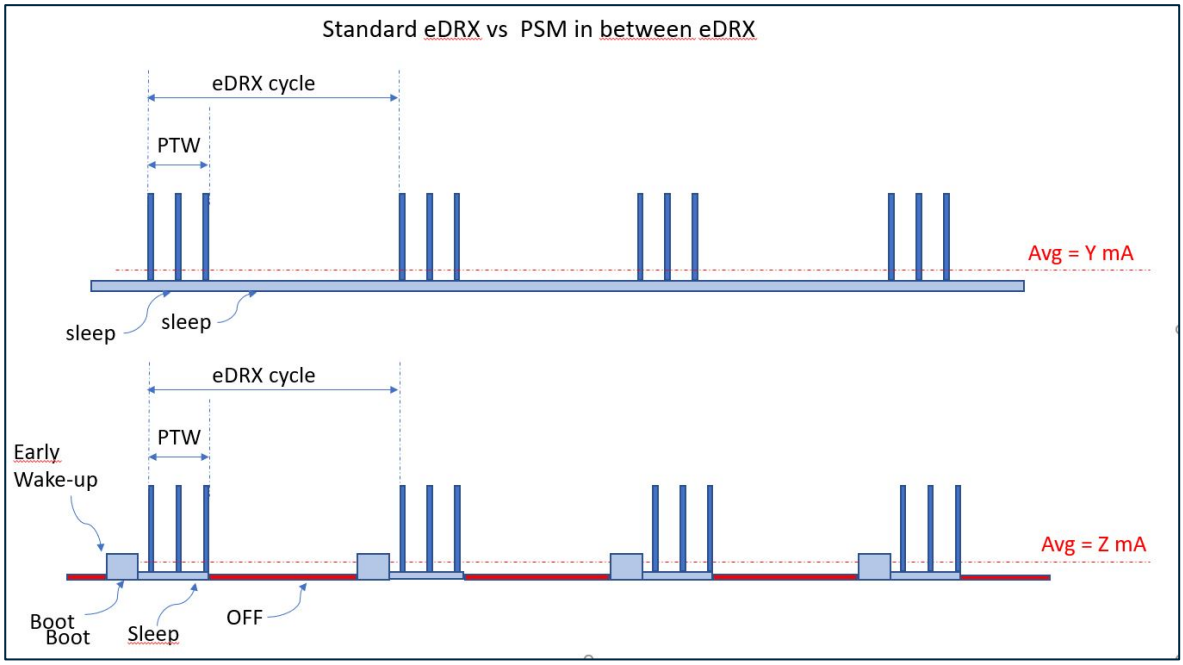
PSM in between eDRX make use of a proprietary power solution so **it is a different power / timing implementation of the standard eDRX** depicted in 4.1.

In standard eDRX when the system is not listening to the paging channel can go to **"sleep"** which means that the module is just in low power mode but it is on and can immediately wake up if needed.

This mode is efficient when eDRX cycle is short but the full power balance can be further improved for long eDRX cycles (equals or greater than 167 sec) switching completely OFF (PSM) the module when there is no need for listening to paging channel.

This change in the power will have an impact on the wake-up timing requiring to anticipate the wake because the module will need to boot and be ready when the paging window arrives. This case is shown in the picture below and compared to standard eDRX

Fig 3. standard DRX vs PSM inbetween eDRX comparison



This advanced eDRX modality, as anticipated earlier, becomes more efficient when eDRX cycle is equal or longer than 167 sec. this is because the power consumption saved during OFF (3 uA like in PSM) is greater that the additional power consumption needed during the tiny boot (which is close to 45 mAs).

To set this modality,

AT#CPSMS=1,,,90,20,**8** *value 8 is used to enable PSM in between eDRX (*)*

AT#REBOOT

to enable eDRX in catm :

AT#CEDRXS=1,**4**,"1010","0111" ➔ PTW = 10,28 sec eDRX cycle= 327,68 sec

to enable eDRX in NBiot :

AT#CEDRXS=1,**5**,"1010","0111" ➔ PTW = 10,28 sec eDRX cycle= 327,68 sec

(*) PSM in between is a special modality which is not compatible with standard PSM. While standard eDRX can be combined and used togheter with PSM , PSM in between eDRX it is not and to use PSM again a new configuration command and reboot has to be given as below:

AT#CPSMS=1,,,90,20,**4** *value 4 is used to enable standard PSM*

AT#REBOOT command is needed for the new configuration to take effect

5. HARDWARE CONTROLS

5.1. Pins related to PSM Mode

5.1.1. ME310G1

Pin	Signal	I/O	Function	Type	Comment
N16	ON_OFF*/WAKE*	I	Input command for power ON and to wake from deep sleep mode	Digital 1.8V	Active low
R1	PWRMON	O	Power ON Monitor	Digital 1.8V	

5.1.2. ME910G1

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 (only ME910G1/ML865G1) Power ON monitor	Supply 1.8V	VAUX is available
R13	HW_SHUTDOWN*	I	HW Unconditional Shutdown	Digital 1.8V	Active low, connected to open drain or open collector

5.1.3. ML865G1

Pin	Signal	I/O	Function	Type	Comment
7	ON_OFF/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

5.2. CONTROL PINS DESCRIPTION

5.2.1. ME310G1

5.2.1.1. ON_OFF*/WAKE*

ON_OFF*/WAKE* is the pin that turns on the system after VBATT and VBATT_PA is applied to ME310G1. 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 ME310G1 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.

5.2.1.2. PWRMON

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

5.2.2. ME910G1

5.2.2.1. ON_OFF*/WAKE*

ON_OFF*/WAKE* is the pin that turns on the system after VBATT and VBATT_PA is applied to ME910G1. 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 ME910G1 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.

5.2.2.2. 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.

5.2.2.3. HW_SHUTDOWN*

During PSM mode, HW_SHUTDOWN* toggle has no effect. The use of HW_SHUTDOWN* pin is valid only when ME910G1 has VAUX/PWRMON pin output HI.

5.2.3. ML865G1

5.2.3.1. ON_OFF/WAKE

ON_OFF/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 ON_OFF/WAKE pin must be set HIGH for at least 5 seconds. In all other conditions ON_OFF/WAKE pin must be set LOW.

NOTE:

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

5.2.3.2. 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.

5.2.3.3. HW_SHUTDOWN*

During PSM mode, HW_SHUTDOWN toggle has no effect. The use of HW_SHUTDOWN* pin is valid only when ML865G1 has VAUX/PWRMON output HI.

5.3. SIM interface

SIM interface is powered down when ME310G1/ME910G1/ML865G1 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.

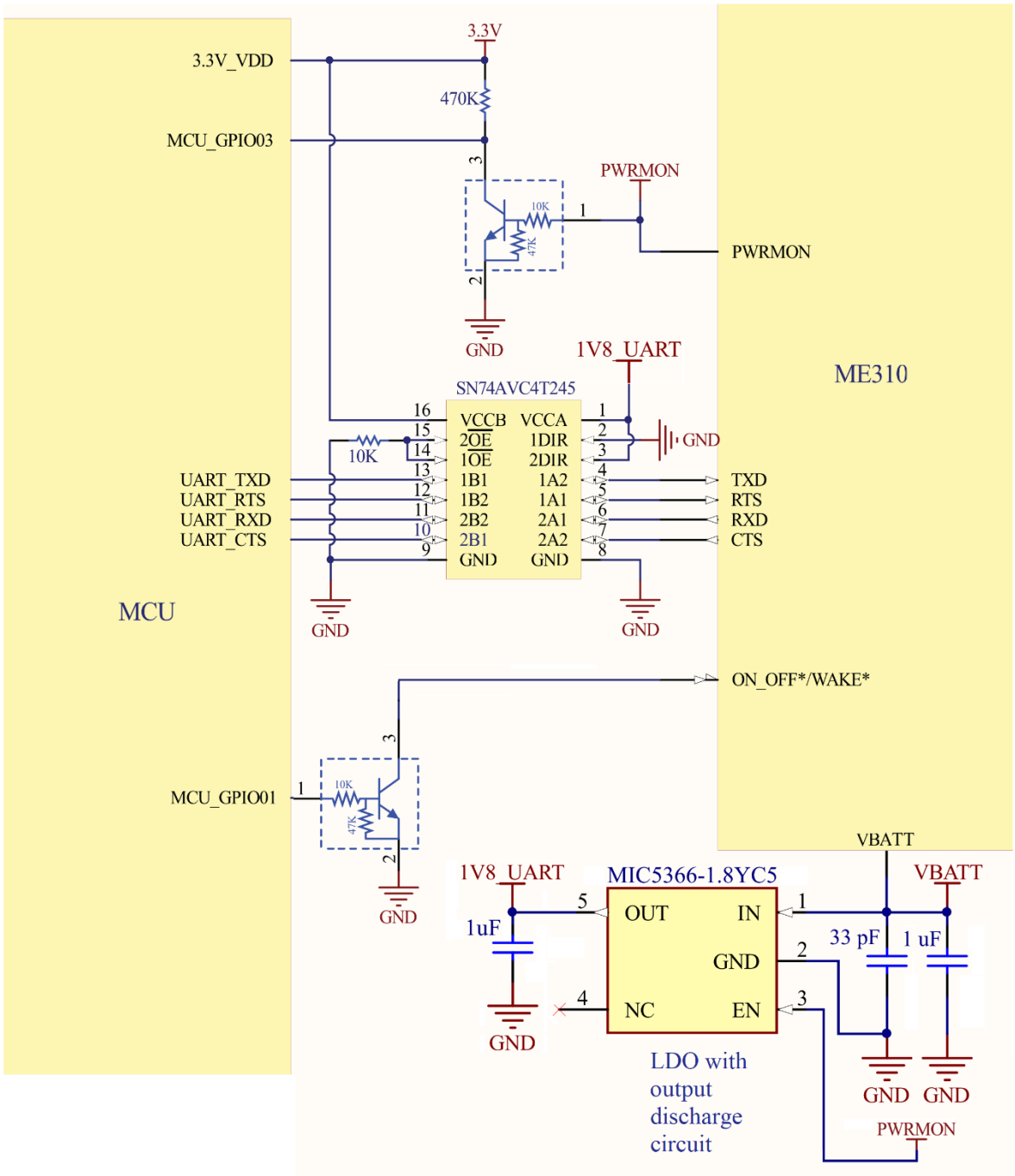
5.4. PSM configuration

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 ME310G1/ME910G1/ML865G1 AT commands Reference Guide

When Periodic Update Timer expires (T3324), ME310G1/ME910G1/ML865G1 turns off until the next scheduled wake-up time.

5.5. Hardware application examples

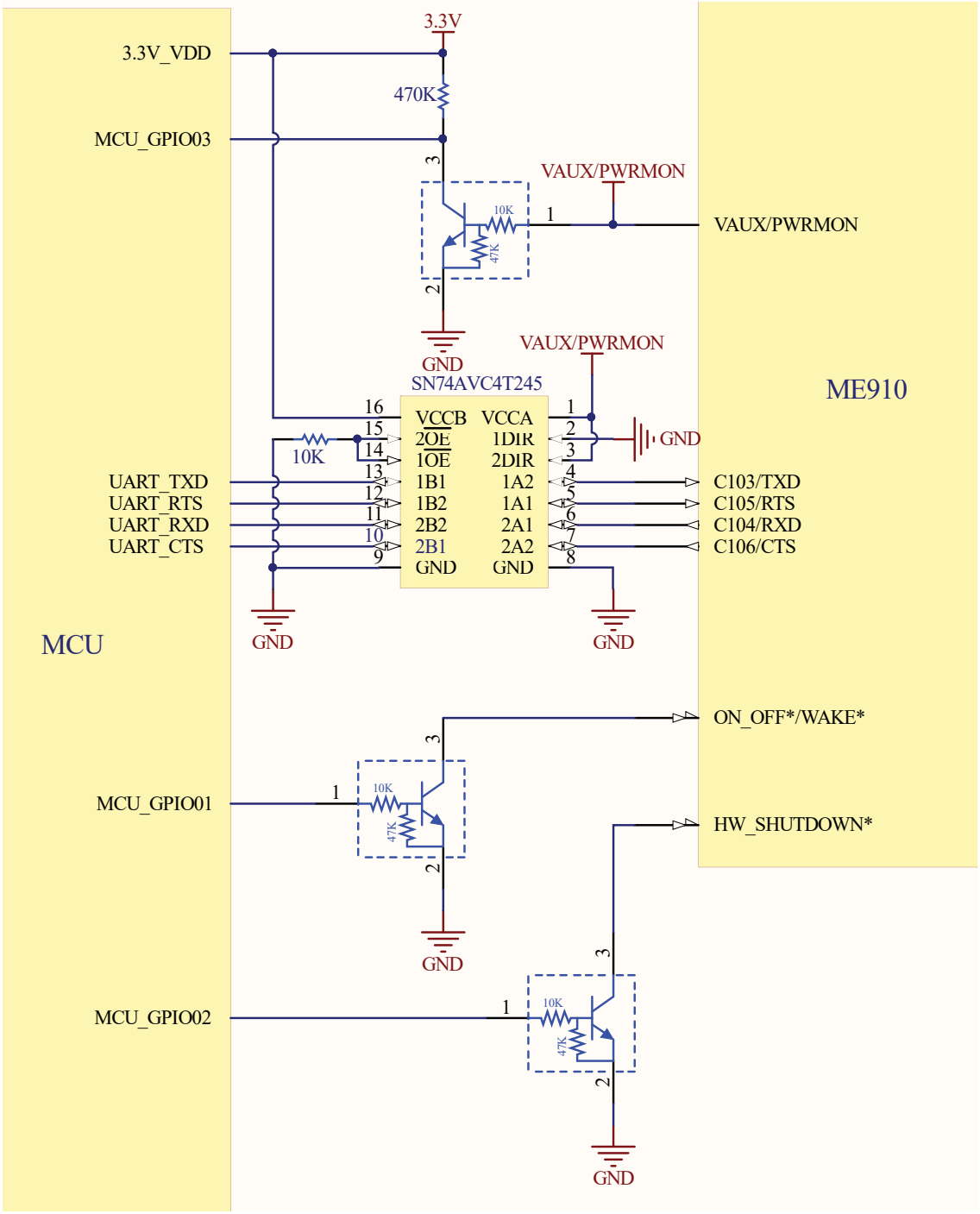
5.5.1. ME310G1



WARNING:

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

5.5.2. ME910G1



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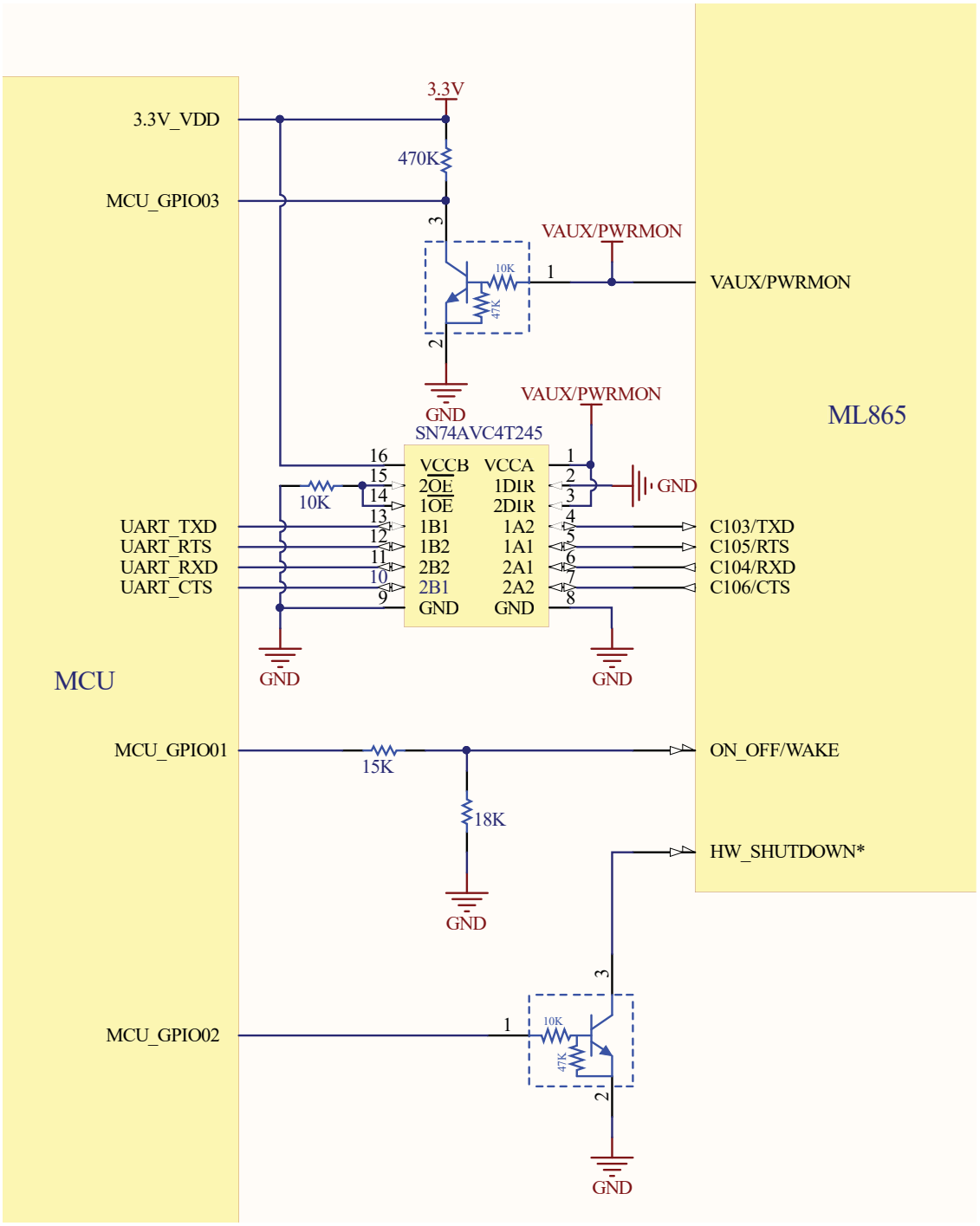
If MCU and its digital interface has 1.8V supply, UART and ON_OFF*/WAKE* can be directly connected but all MCU output lines of the UART **must be set to 0V in OFF and in PSM state to avoid backpowering.** MCU_GPIO01 must be totem pole type.

5.5.3. ML865G1



WARNING:

If MCU and its digital interface has 1.8V supply, UART and ON_OFF/WAKE can be directly connected but all MCU output lines of UART **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	2020-05-06	First Issue
1	2021-03-01	Section 5.5, Hardware application examples update

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