



NE310L2 Power Consumption

Application Note

80668NT11920A Rev. 0- 2021-07-28

APPLICABILITY TABLE

PRODUCTS
NE310L2-W1

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1. INTRODUCTION

1.1. Scope

Aim of this document is to describe power states of NE310L2-W1, consumption measurements and highlight basic steps to reproduce them in a test lab environment.

1.2. Audience

This document is intended for Telit customers, in particular system integrators, who are going to implement their applications using our NE310L2 modules.

1.3. Contact Information, Support

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- TS-AMERICAS@telit.com
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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 the user feedback on our information.

1.4. Symbol Convention



Danger: This information **MUST** be followed or catastrophic equipment failure or personal injury may occur.



Warning: Alerts the user on important steps about the module integration.



Note/Tip: Provides advice and suggestions that may be useful when integrating the module.



Electro-static Discharge: Notifies the user to take proper grounding precautions before handling the product.

Table 1: Symbol Conventions

All dates are in ISO 8601 format, that is. YYYY-MM-DD.

1.5. Related Documents

80668ST11067A NE310L2 AT Commands Reference Guide

1VW0301711 NE310L2 HW Design Guide

1VW0301732, Telit EVB 2.0 User Guide

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2.3. Safety Recommendations

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

- it can interfere with other electronic devices, particularly in environments such as hospitals, airports, aircrafts, etc.
- there is a risk of explosion such as gasoline stations, oil refineries, etc. It is the responsibility of the user to enforce the country regulation and the specific environment regulation.

Do not disassemble the product; any mark of tampering will compromise the warranty validity. We recommend following the instructions of the hardware user guides for correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conformed to the security and fire prevention regulations. The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. Same cautions have to be taken for the SIM, checking carefully the instruction for its use. Do not insert or remove the SIM when the product is in power saving mode.

The system integrator is responsible for the functioning of the final product. Therefore, the external components of the module, as well as any project or installation issue, have to be handled with care. Any interference may cause the risk of disturbing the GSM network or external devices or having an impact on the security system. Should there be any doubt, please refer to the technical documentation and the regulations in force. Every module has to be equipped with a proper antenna with specific characteristics. The antenna has to be installed carefully in order to avoid any interference with other electronic devices and has to guarantee a minimum distance from the body (20 cm). In case this requirement cannot be satisfied, the system integrator has to assess the final product against the SAR regulation.

The equipment is intended to be installed in a restricted area location.

The equipment must be supplied by an external specific limited power source in compliance with the standard EN 62368-1:2014.

The European Community provides some Directives for the electronic equipment introduced on the market. All of the relevant information is available on the European Community website: https://ec.europa.eu/growth/sectors/electrical-engineering_en

3. POWER MEASUREMENT SETUP PREPARATION

Power measurements will use a standard EVB 2.0 and TLB connected to it.

- EVB is powered by its standard power supply (12V)
- NE310L2-W1 in TLB is powered from an external Source Meter (e.g. Otii) or from a power supply with a multimeter connected in series with DIRECT SUPPLY of EVB
- NE310L2-W1 should be wiredly connected to a NBIOT network simulator (e.g. R&S CMW500/290) to perform measurements in controlled and reliable scenario; live network parameters are out of control and may cause higher power consumption.

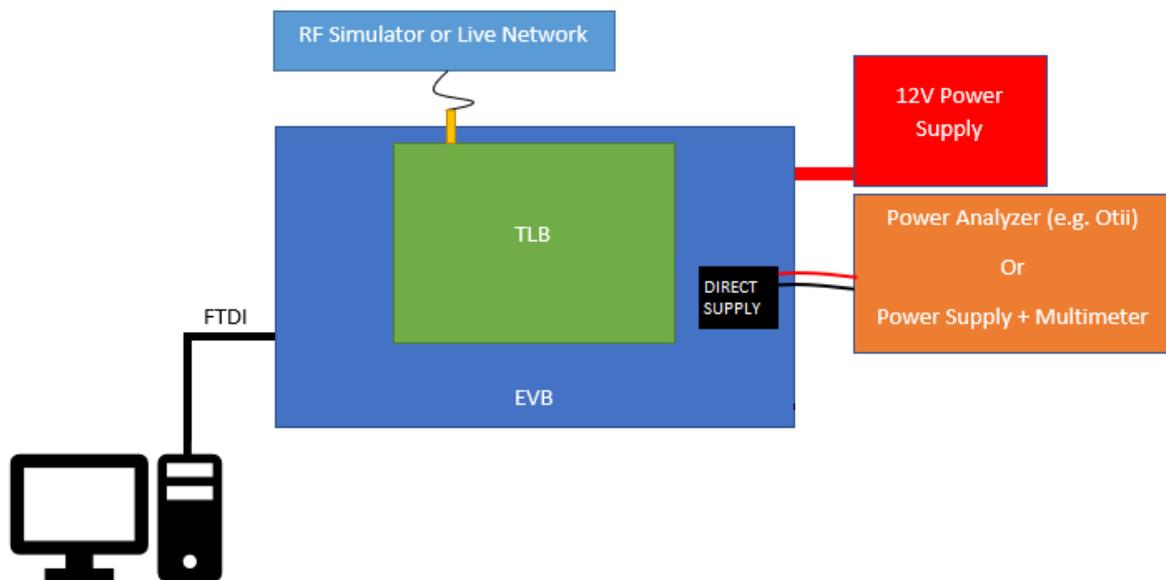


Figure 1: Power Consumption Setup Block Diagram



Figure 2: Otii setup with EVB/TLB

3.1. EVB/TLB configurations

3.1.1. EVB

EVB should be powered with its standard 12V power supply and Type-C-USB cable has to be connected from Type-C USB S0601 (FTDI) connector to a personal computer in order to access the NE310L2-W1 serial port.

A Test SIM Card is needed to register the module to the network simulator and has to be inserted into SIM 1 SLOT.

3.1.2. TLB

NE310L2-W1 has to be powered from TP301 of EVB.

- **Jumper configuration**
 - Configure the EVB DIRECT SUPPLY (PL302 of EVB) jumpers as in Figure 3:

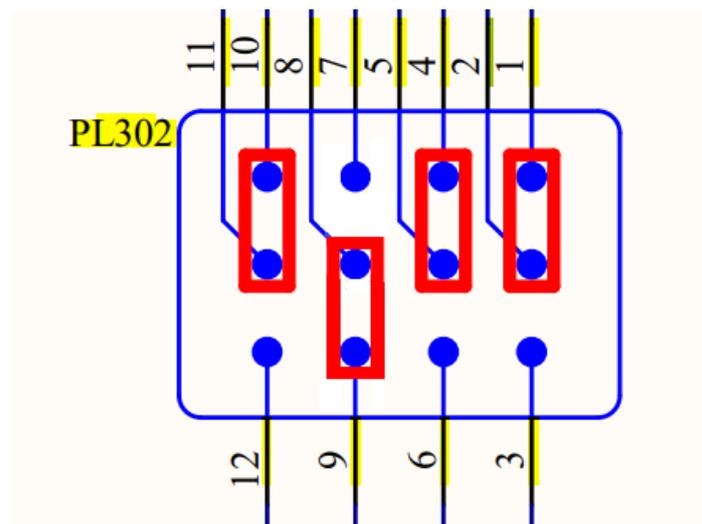


Figure 3: PL302 power switch selector configuration

- **Power connections**
 - Connect the positive pole of the power supply to TP301/1-2 of EVB
 - Connect the negative pole of the power supply to TP301/3-4 (GND) of EVB
 - Sense wires can be connected to the same pins.

- Voltage level to be set is **3.8V**

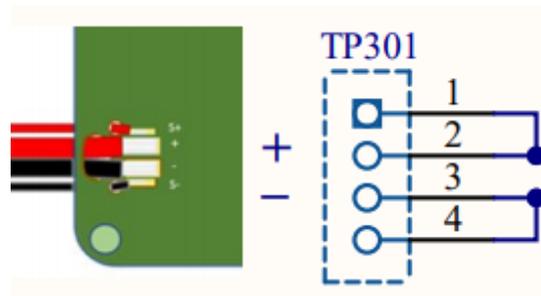


Figure 4: TP301 power connections

3.2. Commands and hardware pins

3.2.1. AT Commands

AT commands below have to be preliminary sent in order to properly configure the NE310L2-W1 for power saving measurements.

These settings are automatically stored so they have to be made at once.

AT%SETACFG="pm.conf.sleep_mode","enable"	→ Enable power save
AT%SETACFG="pm.conf.max_allowed_pm_mode","dh0"	→ Set the lowest deep hibernation mode
AT%SETACFG="pm.hifc.mode","C"	→ Configure power save Engine
AT%SETACFG="pm.conf.uart_inactivity",0	→ Inactivity serial port timeout
ATZ	→ Reboot the module

3.2.2. Hardware PIN

ON/OFF signal will be used to control NE310L2-W1 power saving, it could be controlled from both EVB ON/OFF button and EVB SW401 (AUTO_ON) switch.

- ON/OFF button pressed or EVB SW401 (AUTO_ON) switch set to ON: NE310L2-W1 fully operative - > ON/OFF line tied low

- ON/OFF button released or EVB SW401 (AUTO ON) switch set to OFF: NE310L2-W1 in power saving -> ON/OFF line tied high

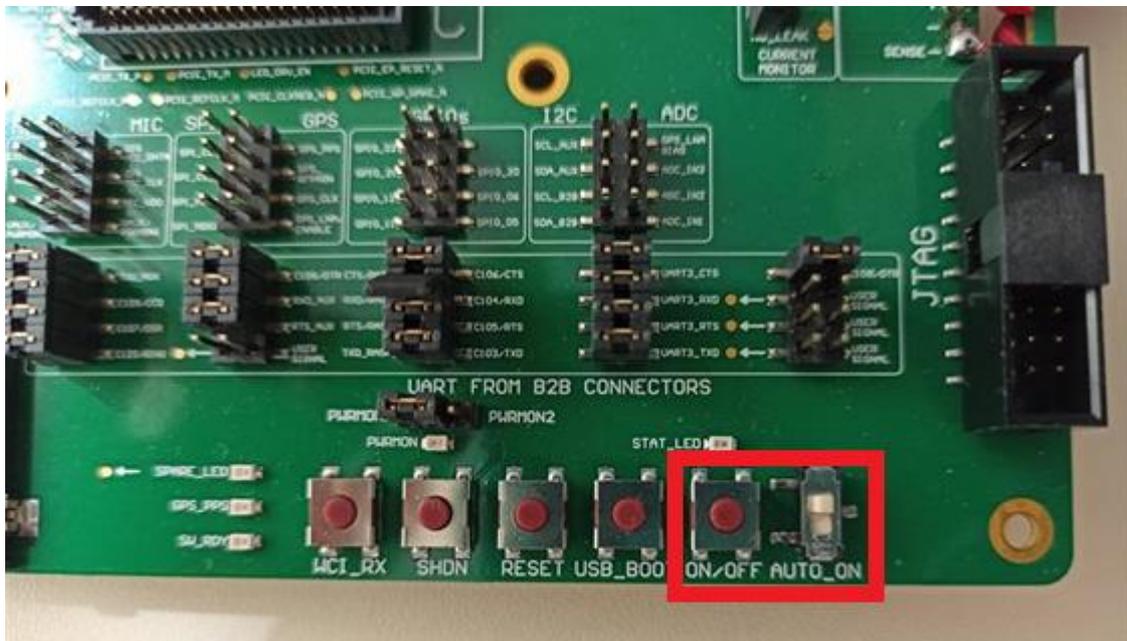


Figure 5: ON/OFF button and SW401 (AUTO_ON) switch

4. MEASUREMENTS DESCRIPTION

4.1. IDLE state, CFUN1 measurement

In IDLE state/cfun1 NE310L2-W1 is fully operative, serial port is available for AT commands, module is registered to the network with RRC layers in IDLE state (not connected).



Note: as described in 4.2.2 , ON/OFF button pressed or EVB SW401 (AUTO_ON) switch set to ON to have NE310L2-W1 fully operative

4.1.1. Steps and AT commands

In order to perform the IDLE measurement the following steps have to be executed:

- Configure and enable network simulator
 - Paging cycle 2,56 seconds
 - Disable “Keep RRC connection”
 - Sub Carrier Spacing 15KHz
- Enable power supply of NE310L2-W1, it will automatically power on
- Keep ON/OFF button pressed (or set EVB SW401 (AUTO_ON) switch to ON)
- Wait network attach and that RRC connection is released, use below AT commands to check network registration state:

```

AT+COPS?
+COPS: 0,0,"<network name>",9 <- NBIOT (9)
OK
AT+CREG?
+CREG: 0,1 <- registered
OK

```

- Start power consumption measure. Expected result is an average current of around 9-10 mA
- Below picture shows how the current profile will look like:

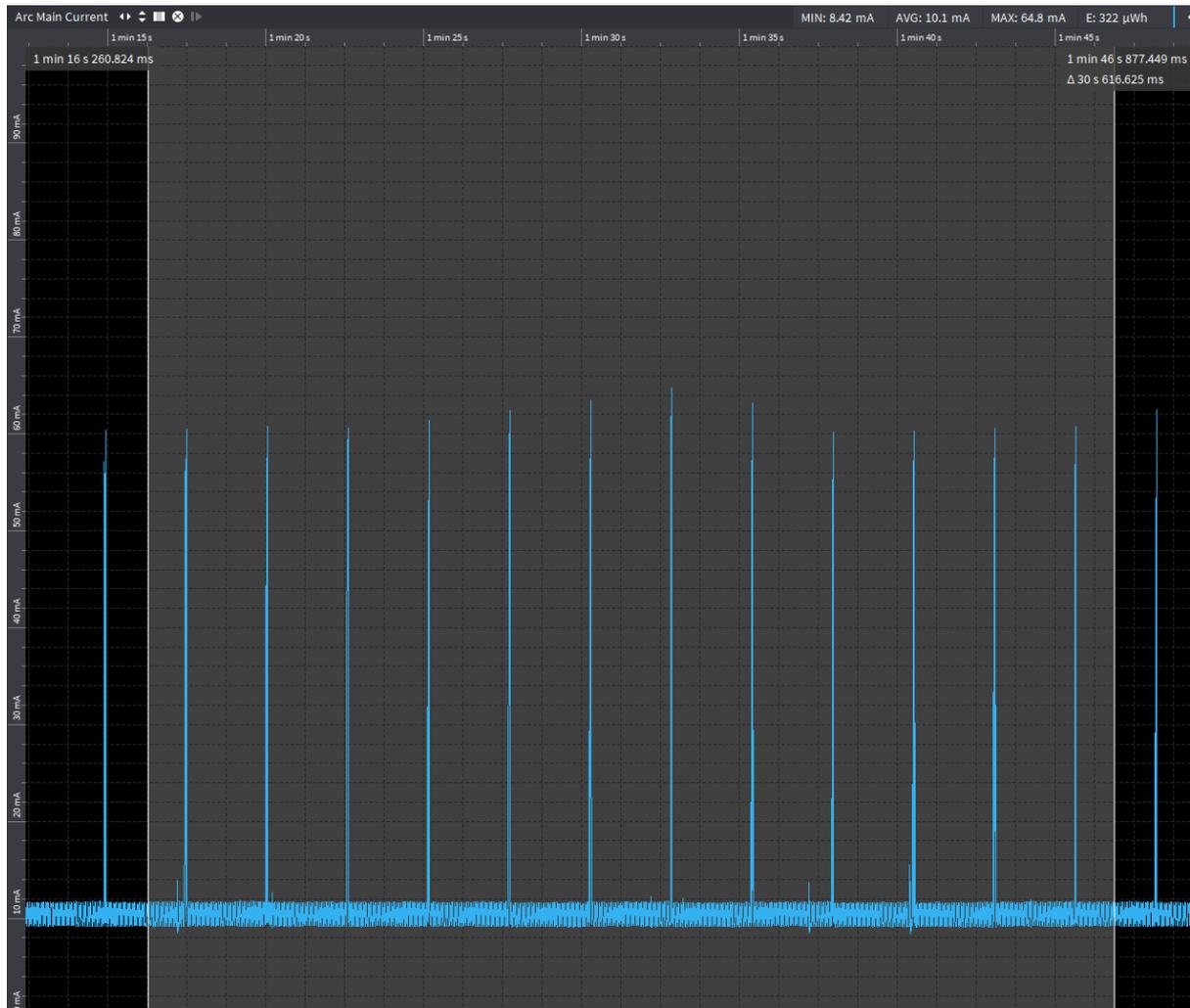


Figure 6: IDLE (CFUN1-Like) power consumption

4.2. IDLE state, low power measurement

In IDLE state low power (Telit CFUN5-Like), NE310L2-W1 is in sleep mode, means that it is registered to the network and listening for network pagings. ***Serial port is not available for AT commands.*** It can be manually awakened by using the ON/OFF line if AT commands have to be sent



Note: as described in 4.2.2 , ON/OFF button released or EVB SW401 (AUTO_ON) switch set to OFF to have NE310L2-W1 in sleep state

4.2.1. Steps and AT commands

In order to perform the Low power IDLE measurement the following steps are required:

- Configure and enable network simulator
 - Paging cycle 2,56 seconds
 - Disable “Keep RRC connection”
 - Sub Carrier Spacing 15KHz
- Enable power supply of NE310L2-W1, it will automatically power on
- Keep ON/OFF button pressed (or set EVB SW401 (AUTO_ON) switch to ON) – mandatory only if AT command interface is needed
- Be sure that commands in 3.2.1 have been sent
- Wait network attach and that RRC connection is released, use below AT commands to check network registration state

AT+COPS?

+COPS: 0,0,"<network name>",9 <- NBIOT (9)

OK

AT+CREG?

+CREG: 0,1 <- registered

OK

- Release ON/OFF button (or set EVB SW401 (AUTO_ON) switch to OFF)
- Start power consumption measure, expected result is average current of 1.5 mA
- To correctly evaluate the average consumption use the markers including a multiple paging occurrences including the same number of sleep periods (distance in time between the 2 markers should be a multiple value of the DRX paging set on the simulator).

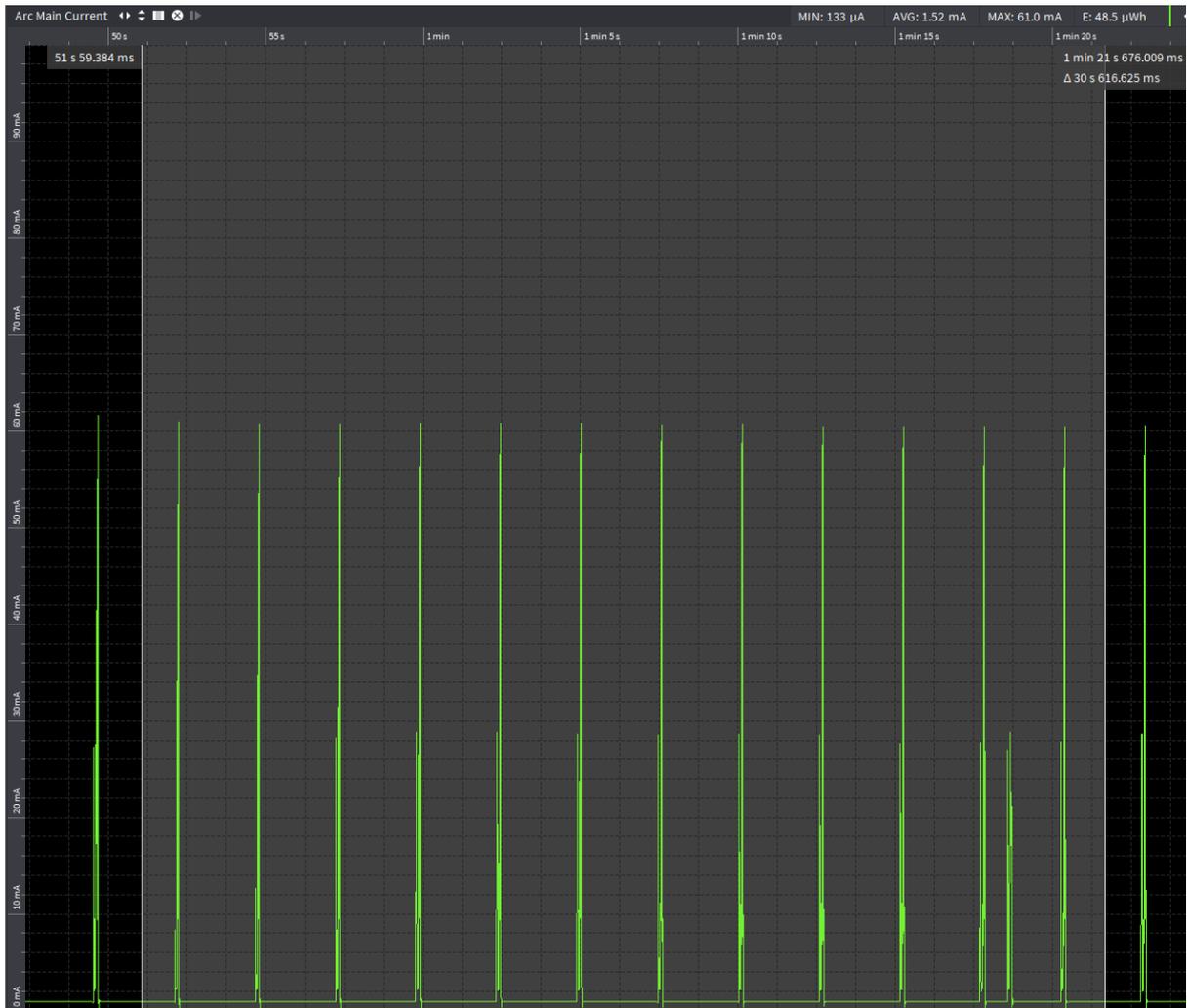


Figure 7: Idle low power (CFUN5 - Like) power measurement

4.3. PSM

The Power Saving Mode (PSM) introduced in 3GPP Rel12 allows the Module to skip idle mode tasks for a longer time period while still maintaining the NAS context.

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 but has the drawback for the module to not be reachable for the time it is in PSM.

The PSM reduces the signaling load between the NE310L2-W1 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 together 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.

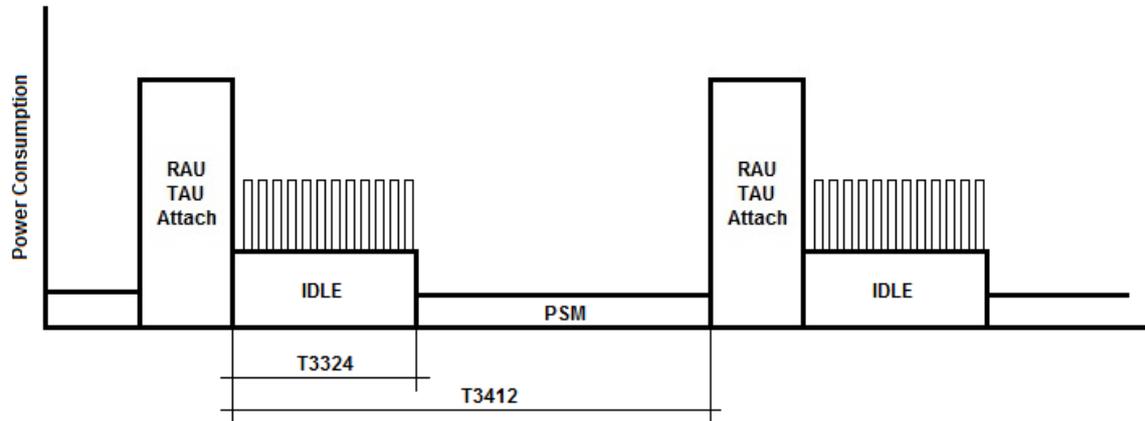


Figure 8: PSM timers

4.3.1. NE310L2-W1 PSM

NE310L2-W1 default configuration allows PSM only if the T3412 is longer than 40 minutes otherwise the module does not enter into the minimum power consumption state

T3412 smaller than 40 minutes can be forced with the AT command below

AT%TSTLTE="PowerTests","DHOMINSLEEPTIME","1"

NE310L2-W1 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 NE310 is in IDLE state with default module functionality and current consumption depending on the ON/OFF line state .

As T3324 expires, if ON/OFF line is tied low 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 2 uA.

Users willing to decrease the power consumption during T3324 can combine a power saving state with PSM.

An example of command to activating PSM for NE310L2-W1 is as follows:

AT+CPSMS=1,, 1000011,00001010

where

T3412= 1000011 / 131 -> 90 sec

T3324= 00001010 / 10 -> 20 sec

+CPSMS command accepts both binary and decimal values for timers

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 force 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 reduce power, then eDRX feature should be evaluated.

4.3.2. Steps and AT commands

In order to perform the PSM measurement the below steps are needed:

- Configure and enable network simulator
 - Paging cycle 2,56 seconds
 - Disable “Keep RRC connection”
 - Sub Carrier Spacing 15KHz
 - Enable “PSM allowed”
- Enable power supply of NE310L2-W1, it will automatically power on
- Keep ON/OFF button pressed (or set EVB SW401 (AUTO_ON) switch to ON)
- Be sure that commands in 3.2.1 have been sent
- Wait network attach and that RRC connection is released, use below AT commands to check network registration state

AT+COPS?

+COPS: 0,0,"<network name>",9 <- NBIOT (9)

OK

AT+CREG?

+CREG: 0,1 <- registered

OK

- Enable PSM
 - AT+CPSMS=1,,,161,5 - (T3412=161->60s, T3324=5->10s)**
- Release ON/OFF button (or set EVB SW401 (AUTO_ON) switch to OFF)
- Start power consumption measure. An expected value of around 1.7 uA should be obtained

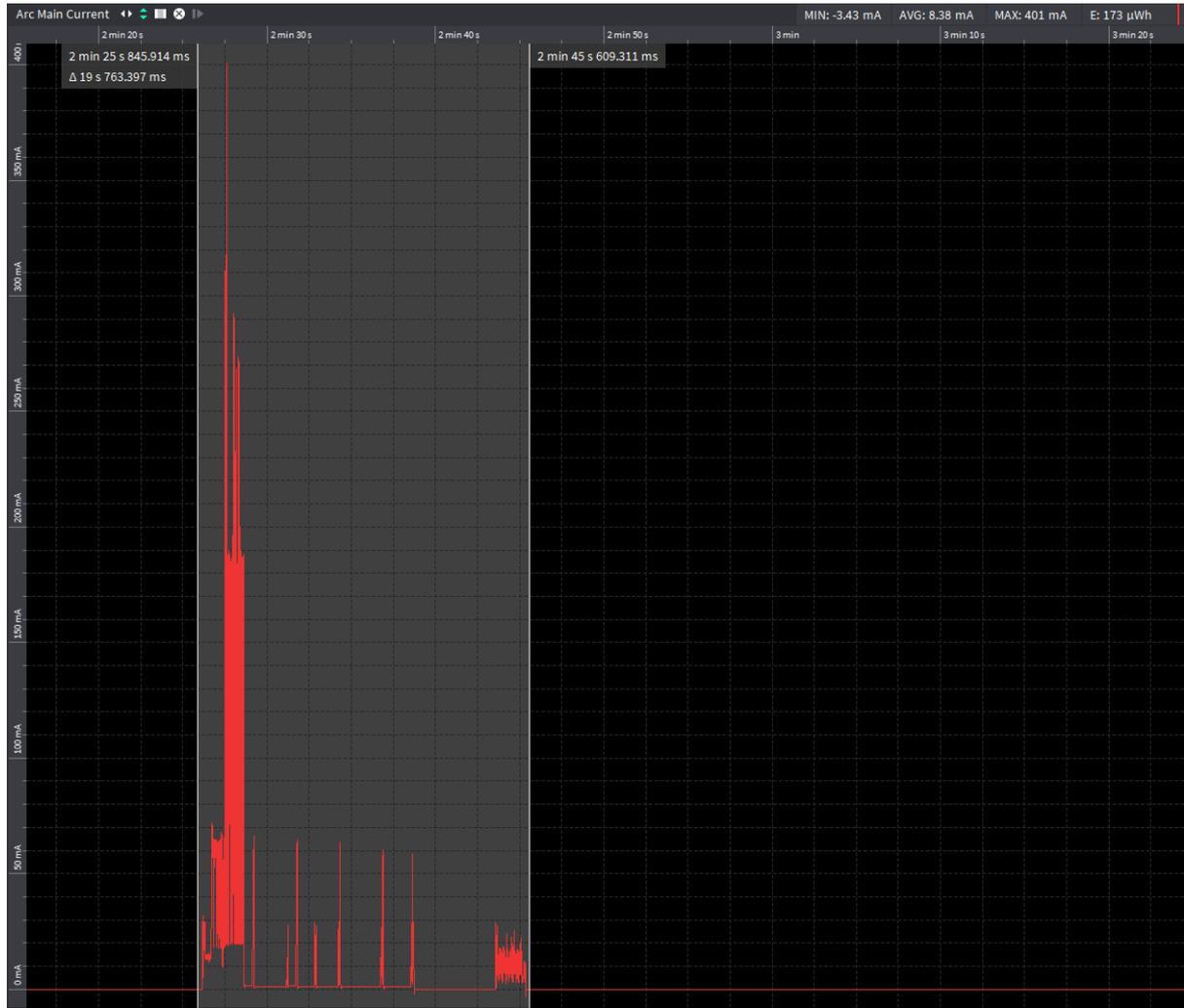


Figure 9: PSM wake up with T3324 window .



Figure 10: PSM phase

4.4. Extended DRX (EDRX)

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 activity 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 picture that explain the differences between DRX and eDRX.

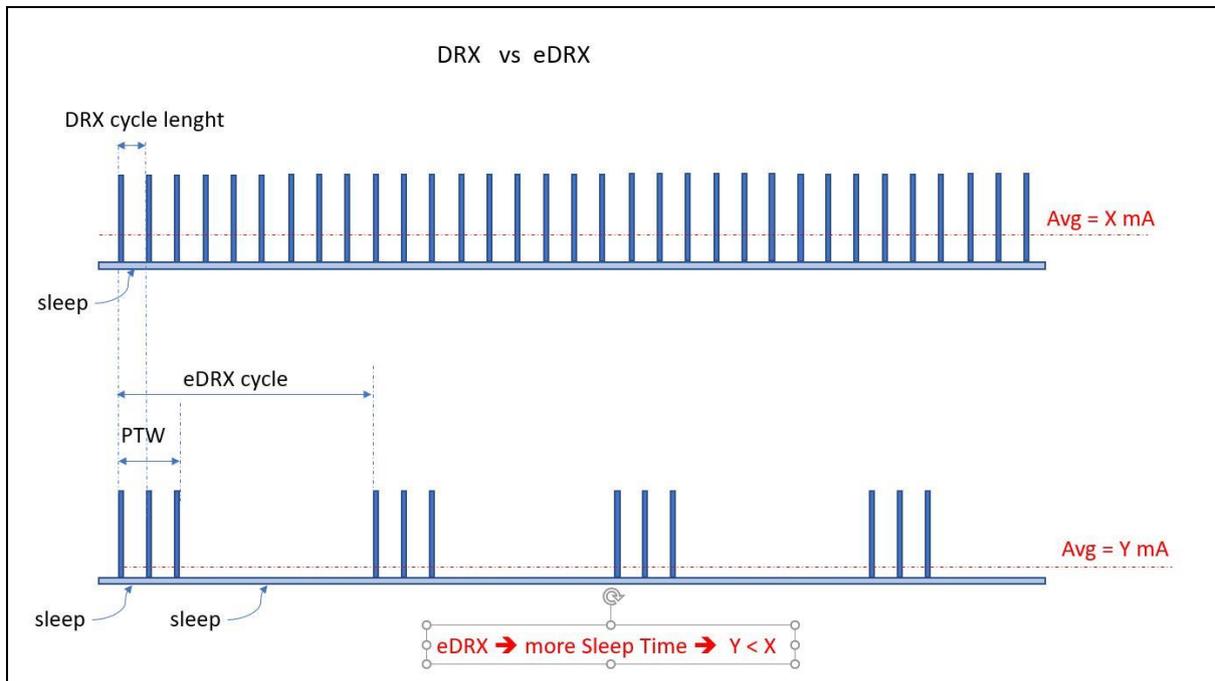


Figure 11: DRX vs eDRX comparison

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 wake up 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 together. 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.

4.4.1. NE310L2-W1 eDRX

For NBiot technology in a test environment scenario the following command will set eDRX cycle=81,92 s (see AT command user guide for detailed definition)

AT+CEDRXS=1,5, 0101

Where Req_eDRX=5 or 0101 -> 81.92 s

+CEDRXS command accepts both binary and decimal values for timers

When eDRX is used in combination with the CFUN5-Like state (OnOff line tied low) that allows to achieve best average current consumption values.

NE310L2-W1 supports eDRX SIM Suspend mode, this feature should be supported by the sim too and it allows to reduce current consumption average to lowest value.

If the SIM does not support eDRX suspend mode the same consumption values can be achieved for test purposes only by using a specific test command (see next paragraph)

4.4.1.1. Steps and AT Commands

In order to perform the eDRX measurement follows steps below:

- Configure and enable network simulator
 - Paging cycle 2,56 seconds
 - Disable “Keep RRC connection”
 - Sub Carrier Spacing 15KHz
 - Enable eDRX support, set PTW=2,56 s, eDRX=81,92 s, paging=1,28 s
- Enable power supply of NE310L2-W1, it will automatically power on
- Keep ON/OFF button pressed (or set EVB SW401 (AUTO_ON) switch to ON)
- Be sure that command in §3.2.1 have been sent
- **Optionally give the following commands if eDRX with SIM Suspend is going to be tested and SIM doesn't support the suspend feature**
 - AT+CFUN=0
 - AT%**CUSTWA**="EDRXUSIMACT", 2
 - AT+CFUN=1



Warning: EDRXUSIMACT is a test command provided to enable customer to evaluate SIM suspend feature when an Uicc with SIM suspend is not available. This command is for test only so please contact TS-EMEA@telit.com for any other related need.

- Wait network attach and that RRC connection is released, use below AT commands to check network registration state

AT+COPS?

+COPS: 0,0,"<network name>",9 <- NBIOT (9)

OK

AT+CREG?

+CREG: 0,1 <- registered

OK

- Enable eDRX

AT+CEDRXS=1,5,5

- Release ON/OFF button (or set EVB SW401 (AUTO_ON) switch to OFF)
- Start power consumption measure and record value.

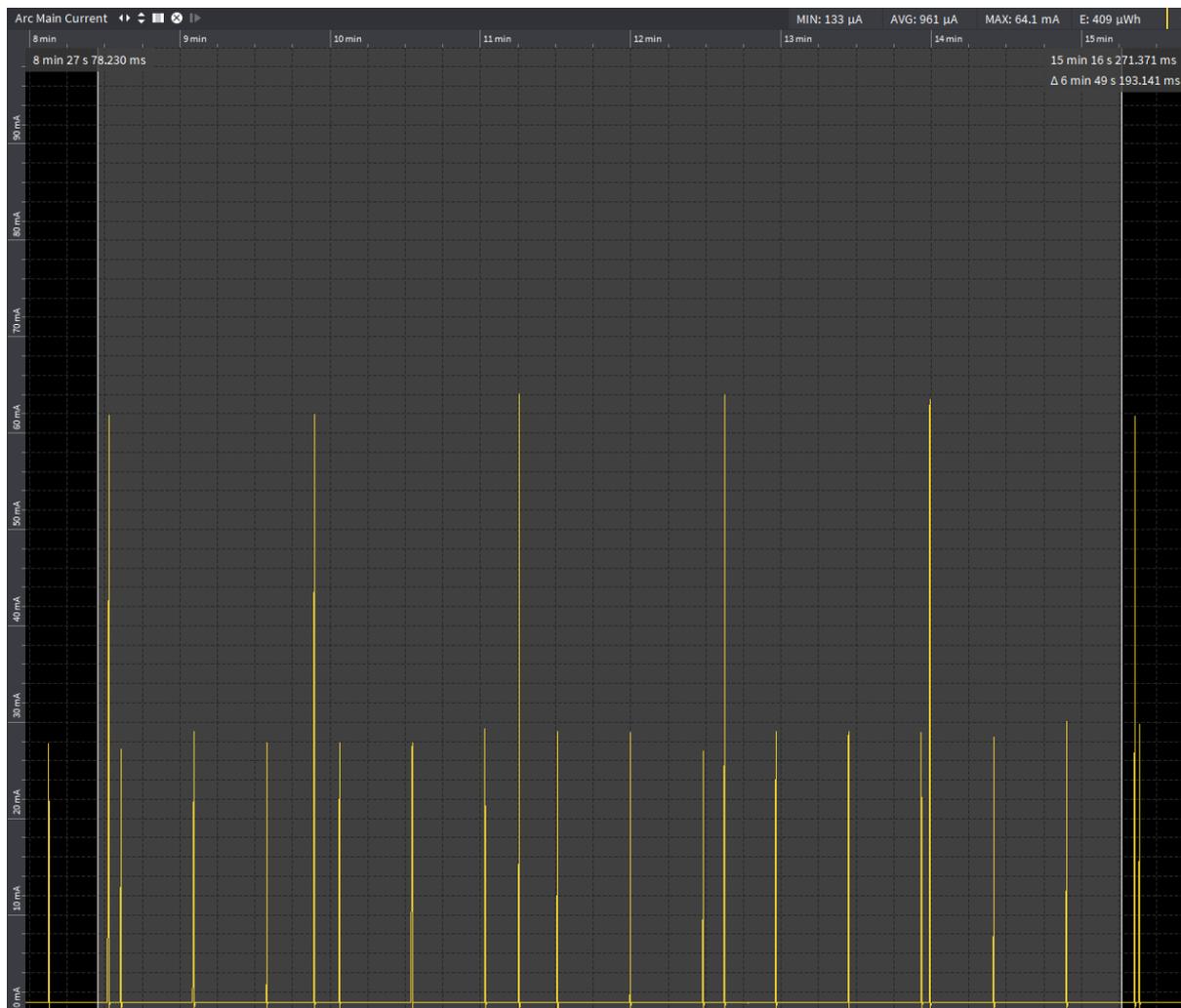


Figure 12: eDRX power consumption without sim suspend

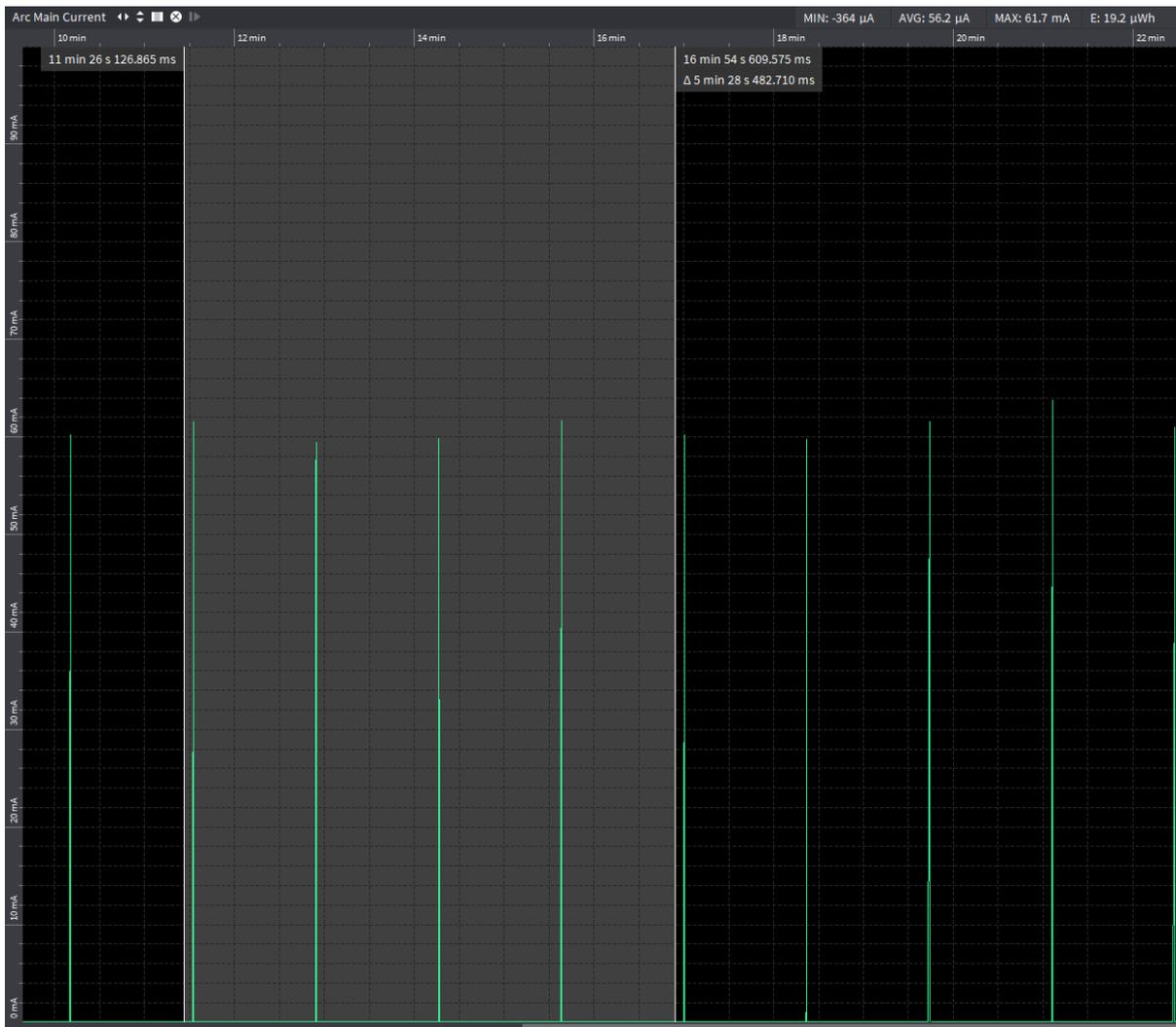


Figure 13: eDRX power consumption with sim suspend PTW=1PO. PTW=2.56, iDRX=2.56sec, eDRX=81.92 sec

4.5. Connected Mode

When NE310L2-W1 exchanges data with the network, both Mobile Originated (SMS send, packet data sending, TAU...) and Mobile Terminated (SMS receiving, packet data receiving...) it goes to connected RRC mode state.

Power consumption of this state may depend on network conditions (band, channel, signal strength, base station distance, allocated resource, etc.), mobile transmission could be at different power level.

NE310L2-W1 maximum allowed TX power level is 23dBm.

4.5.1. Steps and AT commands

In order to perform the Connected mode measurement, follow steps below:

- Configure and enable network simulator
 - Paging cycle 2,56 seconds
 - Disable “Keep RRC connection”
 - Sub Carrier Spacing 15KHz
 - Upload nominal Power 23dBm
 - 12 SC, RU 1ms, TBS=5, QPSK
- Enable power supply of NE310L2-W1, it will automatically power on
- Keep ON/OFF button pressed (or set EVB SW401 (AUTO_ON) switch to ON)
- Wait network attach and that RRC connection is released, use below AT commands to check network registration state:


```

AT+COPS?
+COPS: 0,0,"<network name>",9 <- NBIOT (9)
OK
AT+CREG?
+CREG: 0,1 <- registered
OK
            
```
- Start a RRC connection from network simulator
- Start power consumption measure, expected result is average current of about 47.6 mA and a peak of around 400 mA

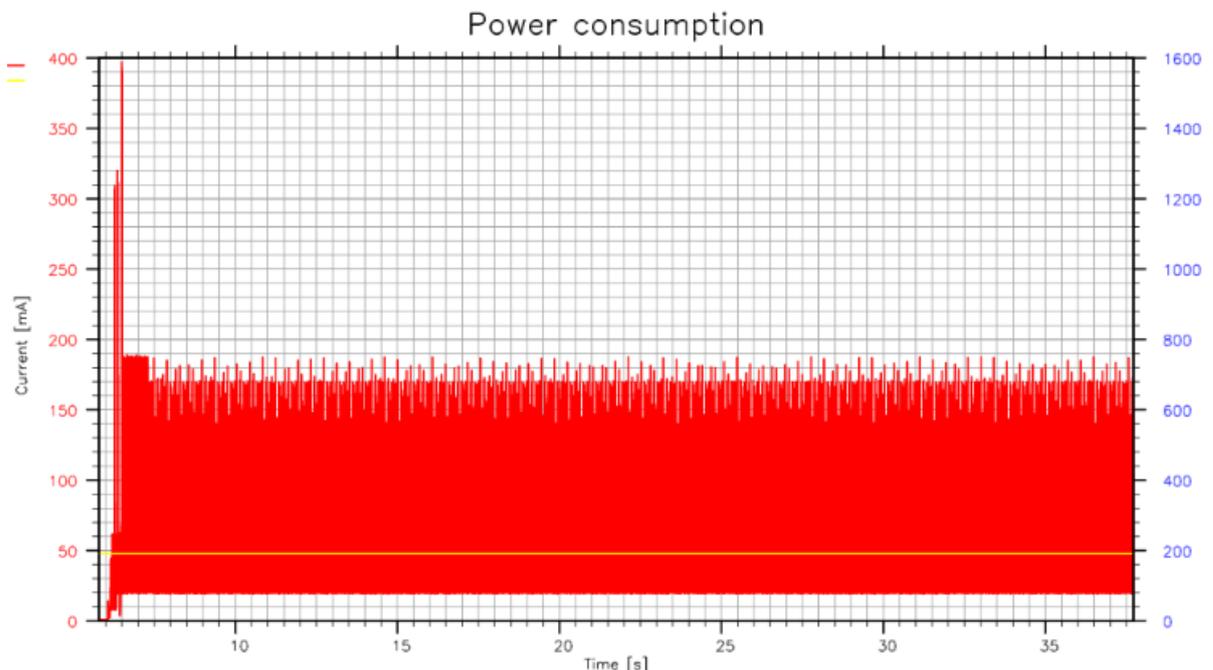


Figure 14: RRC connection

5. POWER CONSUMPTION TABLE

	Average Current [mA]	Note
IDLE Full Operative CFUN=1	9.25	P2.56s
IDLE Low Power (Telit CFUN 5 like)	0.760	P2.56s
PSM – power saving state	0.0017	
eDRX with sim suspend feature	0.059	eDRX 81.92s, PTW 2.56 s, P2,56 s
eDRX without sim suspend feature	0.155	eDRX 81.92s, PTW 2.56 s, P2,56 s
RRC connected	47.6	15KHz, 12 SC, RU 1ms, TBS=5, QPSK, 23dBm, Band 20, Paging 2.56 s



Note/Tip: Measured values with a nominal voltage of 3.8 V.

6. GLOSSARY

PSM	Power Saving Mode
RRC	Radio Resource Control
DRX	Discontinuous Reception
eDRX	Extended DRX mode
PTW	Paging Time Window
TAU	Tracking Area Update
RAU	Routing Area Update
AS	Access Stratum
NAS	Non Access Stratum
MO	Mobile Originated
MT	Mobile Terminated
UE	User Equipment
RTC	Real Time Clock
Nbiot	Narrow Band Internet Of Things
I2C	Inter Integrated Circuit
I/O	Input Output
PCB	Printed Circuit Board
PDP	Packet Data Protocol
RSSI	Radio Signal Strength Information
RTC	Real Time Clock
SIM	Subscriber Identification Module
TATC	Telit AT Controller
TTSC	Telit Technical Support Centre
UART	Universal Asynchronous Receiver Transmitter
URC	Unsolicited Result Code
USB	Universal Serial Bus

7. DOCUMENT HISTORY

Revision	Date	Changes
0	28/07/2021	First Issue



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