xE910 RTC Backup Application Note

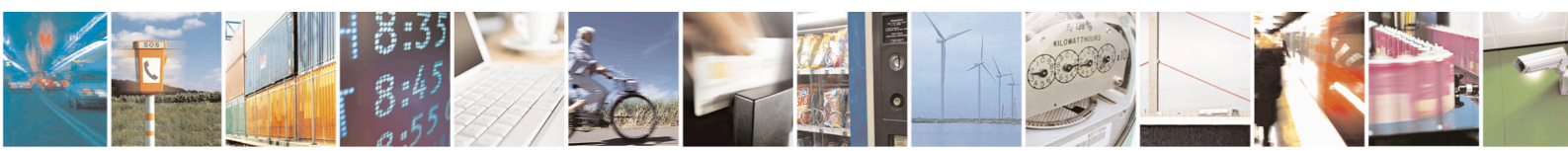
80000NT10072A - Rev.5 – 2015-01-30

Making machines talk.

APPLICABILITY TABLE

PRODUCT
HE910 (*)
HE910-D
HE910-GA
HE910-EUG
HE910-EUR
HE910-EUD
HE910-NAG
HE910-NAR
HE910-NAD
UE910-EUR
UE910-EUD
UE910-NAR
HE910-NAD
GE910-QUAD
GE910-GNSS
GE910-QUAD V3
DE910
CE910
HE910 V2
UE910 V2

(*) HE910 is the “type name” of the products marketed as HE910-G & HE910-DG



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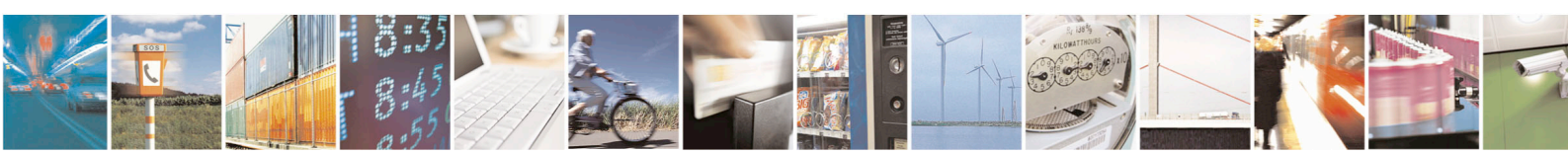

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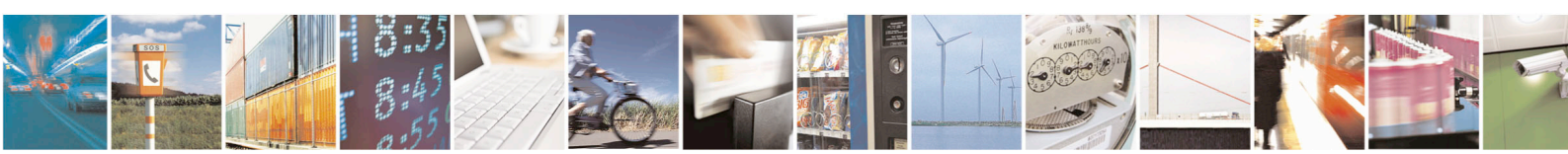

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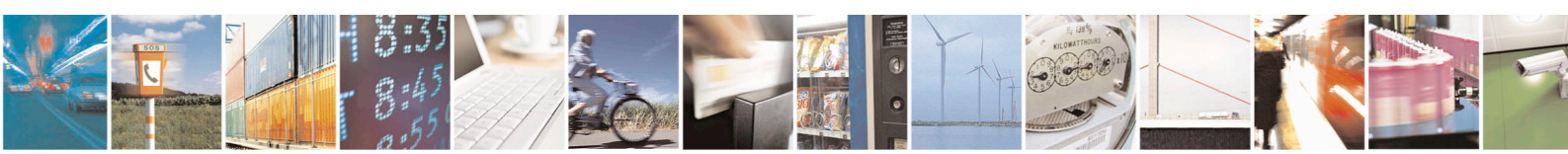


1. Introduction

1.1. Scope

Scope of this document is to give an overview of how to implement in a customer's application a backup battery/capacitor on the Telit modules.

1.2. Audience

This document is intended for customers designing with Telit modules.

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

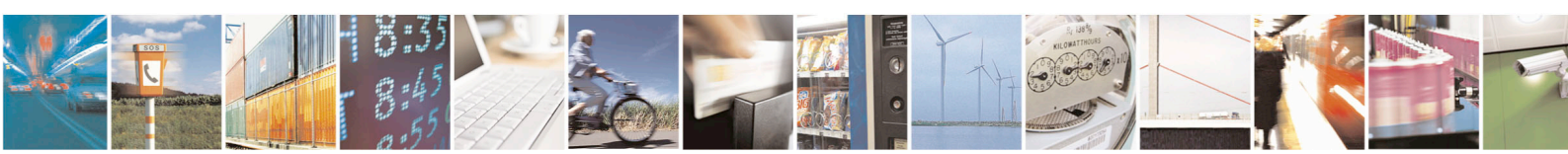
For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

http://www.telit.com

To register for product news and announcements or for product questions contact Telit Technical Support Center (TTSC).

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. Document Organization

This document contains the following chapters:

"Chapter 1: "Introduction" provides a scope for this document, target audience, contact and support information, and text conventions.

"Chapter 2: "Overview" gives an overview of the Application Note.

"Chapter 3: "RTC Backup Implementation" contains the suggestions on how to implement the RTC backup.

1.5. Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

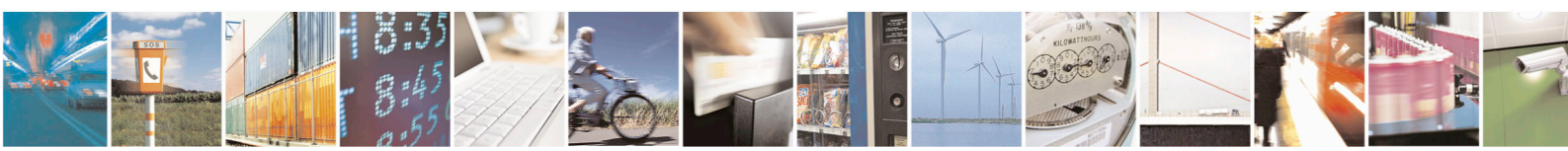
Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

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.

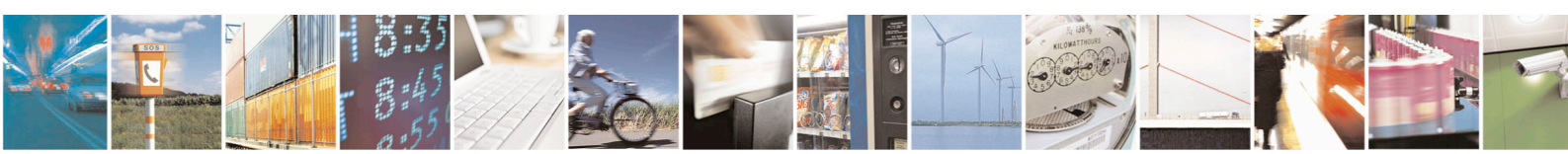
1.6. Related Documents

- HE910 Hardware User Guide, 1vv0300925
- UE910 Hardware User Guide, 1vv0301012
- GE910 Hardware User Guide, 1vv0300962
- DE910 Hardware User Guide, 1vv0300951
- CE910 Hardware User Guide, 1vv0301010
- HE910 V2 Hardware User Guide, 1vv0301064
- UE910 V2 Hardware User Guide, 1vv0301065



1.7. Document History

Revision	Date	Changes
ISSUE#0	2012-07-27	First ISSUE
ISSUE#1	2012-08-08	Added DE910 and CE910
ISSUE#2	2013-04-29	Added UE910, GE910-GNSS, HE910 V2 and UE910 V2
ISSUE#3	2013-11-08	Added GE910-QUAD V3
ISSUE#4	2014-12-18	Added a description of a keep alive capacitor for CE910 and DE910 in the chapter 3.2
ISSUE#5	2015-01-30	Updated info about the series resistor and the charging circuit in chapters 3.2.2 and 3.3



2. Overview

The aim of this document is the description of some hardware solutions useful to implement an RTC Backup battery/capacitor for the xE910 Telit Modules.

In this document the RTC section will be taken into account; for each product variant 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 xE910 module.

NOTICE:
(EN) The integration of the GSM/GPRS/WCDMA **xE910** cellular module within user application shall be done according to the design rules described in this manual.

(IT) L'integrazione del modulo cellulare GSM/GPRS/WCDMA **xE910** all'interno dell'applicazione dell'utente dovrà rispettare le indicazioni progettuali descritte in questo manuale.

(DE) Die Integration des **xE910** GSM/GPRS/WCDMA Mobilfunk-Moduls in ein Gerät muß gemäß der in diesem Dokument beschriebenen Kunstruktionsregeln erfolgen.

(SL) Integracija GSM/GPRS/WCDMA **xE910** modula v uporabniški aplikaciji bo morala upoštevati projektna navodila, opisana v tem priročniku.

(SP) La utilización del modulo GSM/GPRS/WCDMA **xE910** debe ser conforme a los usos para los cuales ha sido deseñado descritos en este manual del usuario.

(FR) L'intégration du module cellulaire GSM/GPRS/WCDMA **xE910** 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 **xE910** עם המוצר.

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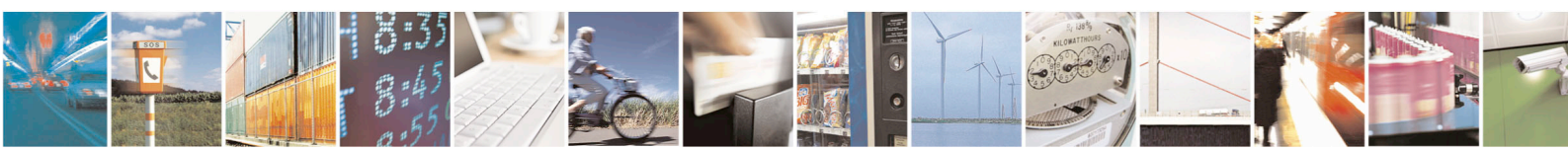


3. RTC Backup Implementation

3.1. Pin out

The full pin out of the products is shown in the Hardware User Guides.

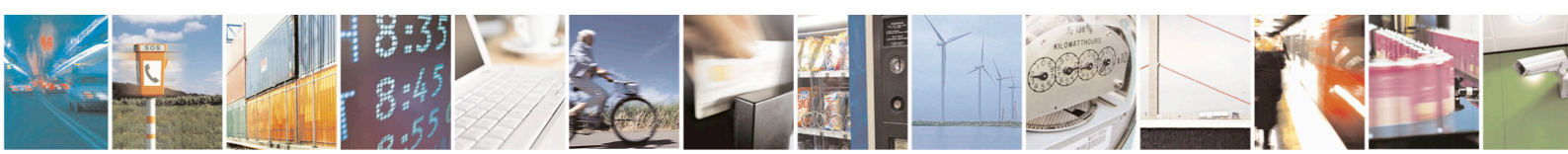
The RTC backup pin is described in the next chapters including also its electrical characteristics.

3.1.1. HE910 products family

The signal is present on the pad C14 of the product's pinout.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.71	1.8	1.89	V	
Output current	IRTC	1			mA	VBATT > 3.1V; VRTC = 1.8V
Reverse Current(*)	IRev		2		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.1		V	

(*)VBATT has to be connected at least one time



3.1.2. UE910 products family

The signal is present on the pad C14 of the product's pinout.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.71	1.8	1.89	V	
Output current	IRTC	1			mA	VBATT > 3.1V; VRTC = 1.8V
Reverse Current(*)	IRev		2		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.1		V	

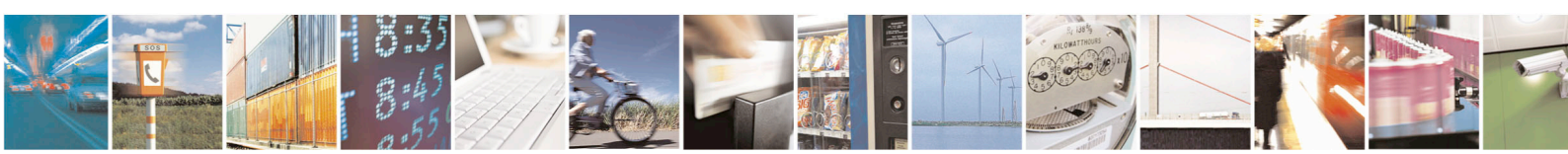
(*)VBATT has to be connected at least one time

3.1.3. GE910-QUAD

The signal is present on the pad C14 of the product's pinout.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	2.18	2.3	2.41	V	
Output current	IRTC	1			mA	VBATT > 3.1V; VRTC = 2.3V
Reverse Current(*)	IRev		2		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.1		V	

(*)VBATT has to be connected at least one time



3.1.4. GE910-GNSS

The signal is present on the pad C14 of the product's pinout.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	2.18	2.3	2.41	V	
Output current	IRTC	1			mA	VBATT > 3.1V; VRTC = 2.3V
Reverse Current(*)	IRev		60		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.1		V	

(*)VBATT has to be connected at least one time

3.1.5. GE910-QUAD V3

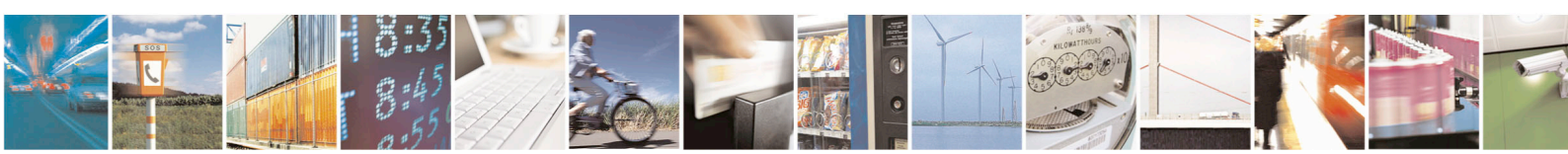
The signal is present on the pad C14 of the product's pinout.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	2.18	2.3	2.41	V	
Output current	IRTC	1			mA	VBATT > 3.1V; VRTC = 2.3V
Reverse Current(*)	IRev		2		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.1		V	

(*)VBATT has to be connected at least one time

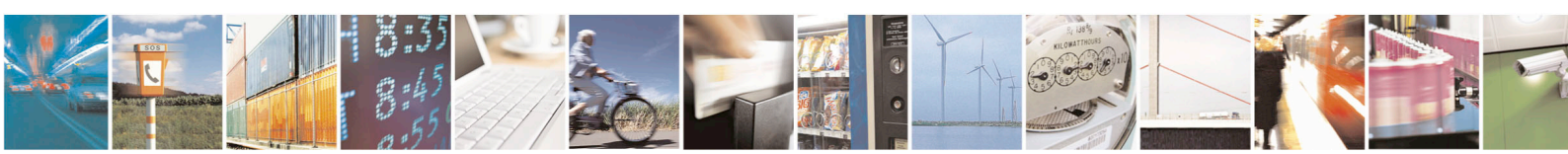
3.1.6. DE910 / HE910 V2

The signal is present on the pad C14 of the product's pinout.



Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	2.5	3.1	3.2	V	
Output current	IRTC	100			µA	VBATT > 3.3V VRTC = 3.1V
Reverse Current(*)	IRev		1.1		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		2.0		V	

(*)VBATT has to be connected at least one time



3.1.7. UE910 V2

The signal is present on the pad C14 of the product's pinout.

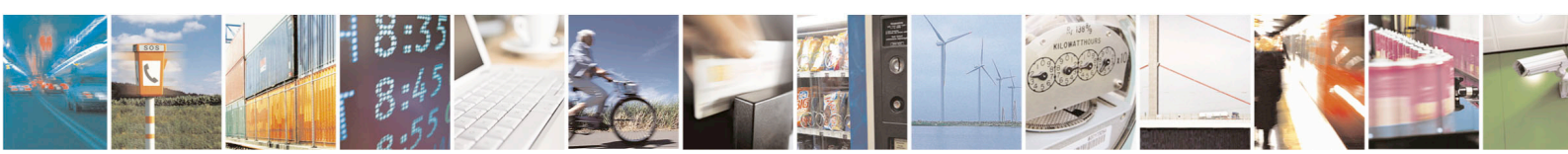
Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	3.0	3.1	3.2	V	
Output current	IRTC	100			µA	VBATT > 3.3V VRTC = 3.1V
Reverse Current(*)	IRev		2.0		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.5		V	

(*)VBATT has to be connected at least one time

3.1.8. CE910

The CE910 module is provided by an internal RTC section but its reference supply is VBATT.

So, in order to maintain active the RTC programming, VBATT should not be removed



3.2. Backup Capacitor

The first solution for the RTC backup is adding a capacitor to the VRTC pin.
In case of the CDMA/EVDO product as CE910 and DE910 family, VRTC also supplies reference power to check the time interval from Sudden Momentary Power Loss. So, a 6.8uF keep alive capacitor instead on the VRTC port of CE910/DE910 is recommended.

3.2.1. Calculating Backup Capacitor

In order to define the backup capacitor value for the RTC, knowing the time, we have to consider the following parameters:

- VRTC – The Starting voltage of the capacitor (Volt)
- $VRTC_{MIN}$ – The minimum voltage acceptable for the RTC circuit. (Volt)
- IRev (Ampere) – The current consumption of the RTC circuitry when VBATT = 0
- B_{Time} - Backup Time (Hours)

If we assume that the RTC draws a constant current while running from VRTC (VBATT=0), then calculating the backup capacitor in Farad would use the formula:

$$C = \frac{B_{Time} * IRev}{VRTC - VRTC_{MIN}} * 3600$$

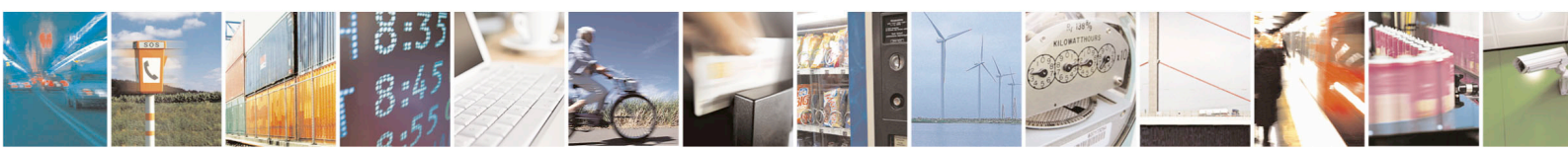
If we have the capacitor value and we want to calculate the Backup Time the formula will be:

$$B_{Time} = \frac{C * (VRTC - VRTC_{MIN})}{IRev * 3600}$$

For example if we have the following data:

- VRTC = 1.8 V
- $VRTC_{MIN}$ = 1.1V
- IRev = 2 µA
- B_{Time} = 96 hours (4 days)

The necessary capacitor will be around 1F.



On Figure 1 is reported a simple example of Backup Capacitor connection where capacitor Cooper/Bussmann KR-5R5H105-R is used.

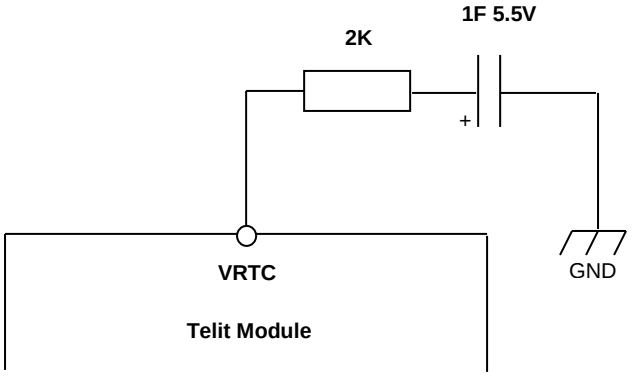


Figure 1

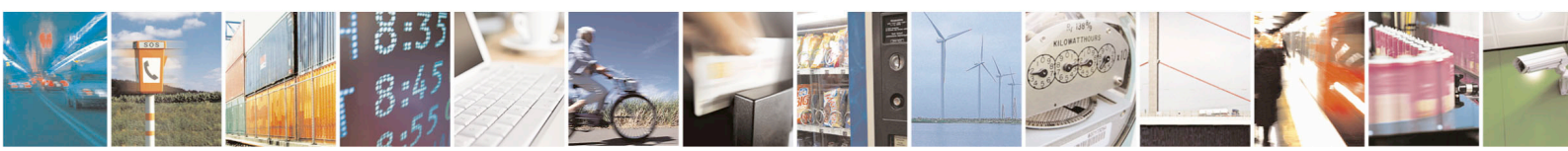
NOTES:

GE910-QUAD: with ON/OFF line connected to GND the IRev will be around 100 µA. Please consider this for the backup time calculation.

NOTES:

GE910-GNSS and GE910-QUAD V3: with ON/OFF line connected to GND the IRev will be around 180 µA. Please consider this for the backup time calculation.

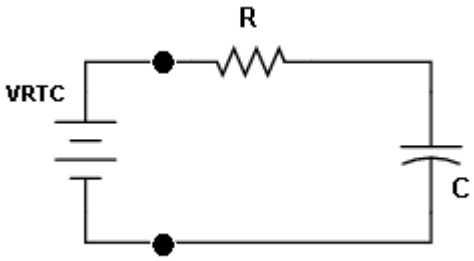
WARNING:
HE910, CE910, DE910, HE910 V2, UE910 V2, UE910
: with HW_SHUTDOWN* line connected to GND the IRev will be around 360uA. Never connect HW_SHUTDOWN* line to GND when backup battery/capacitor is used and VBATT = 0. RTC data could be lost.



3.2.2. Charging the Backup Capacitor

In order to define the Charging time of the RTC's Backup capacitor we have to consider the following parameters:

- Capacitor Value (e.g. 1 F)
- Capacitor Starting Voltage (e.g. 0V)
- Series Resistor



The time constant of the circuit is R*C. We could consider the capacitor charged after a period of 5T.

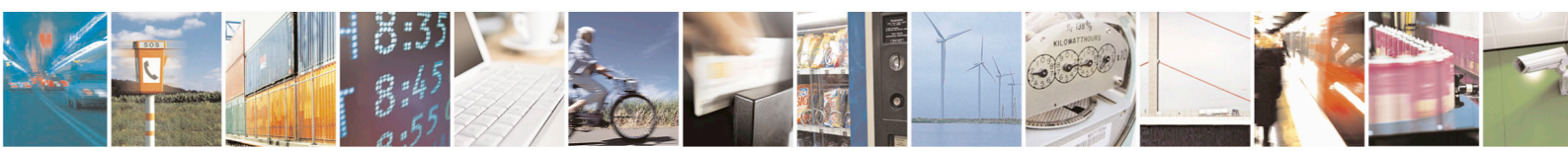
WARNING:
In order to guarantee the correct module start-up, the current drawn by VRTC pin don't must exceed 1mA. For this reason, the minimum required series resistor is around 2K Ohm (**1.8K Ohm** for HE910 and UE910, **2.3K Ohm** for GE910-QUAD, GE910-GNSS, GE910-QUAD V3. No need extra series resistor for CE910, DE910, UE910 V2, HE910 V2, and LE910 family. This guarantee the correct module start-up even if the backup capacitor is completely discharged (voltage on capacitor=0V).

When the RTC is supplied only by the capacitor, the voltage drop over the 2K resistor is:

Vr= 2K Ohm * (2 uA) = 4 mV.

This voltage drop is negligible and doesn't affect the circuit functionality.

Considering the above considerations the charging time will be: 5 * 2K Ohm * 1F = 10000 sec (2,78 hours)



3.3. Backup Battery

The second solution for the RTC backup is using a lithium primary battery. The operative voltage for VRTC is lower than the voltage of primary lithium battery (3V nominal). It is necessary to put a LDO voltage regulator in the circuit as suggested circuit is reported on Figure 2. In case of the CE910, DE910, UE910 V2, HE910 V2, and LE910 family, you can directly connect a backup battery to the VRTC port since a programmable charging circuit including the series resistor is inside of the Telit module.

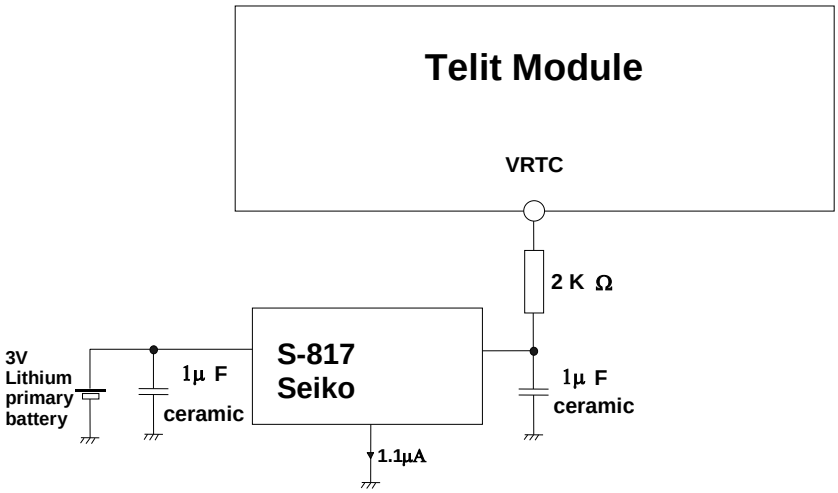
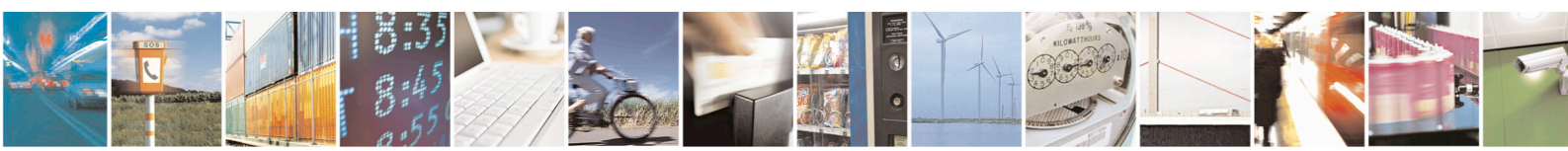


Figure 2

The S-817 Seiko Instruments Inc. LDO has a typical quiescent current value of 1.1 µA. When VBATT is not applied the VRTC Reverse Current (IRev) is 2 uA (see Paragraph 2.1.1). Considering a typical capacity of 220 mAh for a Lithium Primary we can calculate briefly the life time of the battery when VBATT is not applied.

$$\frac{220000\ \mu Ah}{(1.1+2)\mu A} = 70968\ hours \rightarrow more\ than\ 8\ years$$

When VBATT voltage is present, the VRTC voltage exceeds the S-817 output voltage, so the current for the Lithium Primary Battery is typically 1.1 µA and the Lithium Primary Battery duration will be increased.



NOTES:

GE910-QUAD: with ON/OFF line connected to GND the IRev will be around 100 µA. Please consider this for the backup time calculation.

NOTES:

GE910-GNSS: with ON/OFF line connected to GND the IRev will be around 180 µA. Please consider this for the backup time calculation.

WARNING:
HE910, UE910, CE910, DE910, HE910 V2, UE910 V2
: with HW_SHUTDOWN* line connected to GND the IRev will be around 360uA. Never connect HW_SHUTDOWN* line to GND when backup battery/capacitor is used and VBATT = 0. RTC data could be lost.

WARNING:

In this configuration VBATT has to be applied at least one time to setup the RTC circuit of the modem.