xE910 RTC Backup Application Note

80000NT10072A Rev. 6 – 2017-02-10

TELIT
TECHNICAL
DOCUMENTATION

[01.2017]

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

NOTICE

While reasonable efforts have been made to assure the accuracy of this document, Telit assumes no liability resulting from any inaccuracies or omissions in this document, or from use of the information obtained herein. The information in this document has been carefully checked and is believed to be reliable. However, no responsibility is assumed for inaccuracies or omissions. Telit reserves the right to make changes to any products described herein and reserves the right to revise this document and to make changes from time to time in content hereof with no obligation to notify any person of revisions or changes. Telit does not assume any liability arising out of the application or use of any product, software, or circuit described herein; neither does it convey license under its patent rights or the rights of others.

It is possible that this publication may contain references to, or information about Telit products (machines and programs), programming, or services that are not announced in your country. Such references or information must not be construed to mean that Telit intends to announce such Telit products, programming, or services in your country.

COPYRIGHTS

This instruction manual and the Telit products described in this instruction manual may be, include or describe copyrighted Telit material, such as computer programs stored in semiconductor memories or other media. Laws in the Italy and other countries preserve for Telit and its licensors certain exclusive rights for copyrighted material, including the exclusive right to copy, reproduce in any form, distribute and make derivative works of the copyrighted material. Accordingly, any copyrighted material of Telit and its licensors contained herein or in the Telit products described in this instruction manual may not be copied, reproduced, distributed, merged or modified in any manner without the express written permission of Telit. Furthermore, the purchase of Telit products shall not be deemed to grant either directly or by implication, estoppel, or otherwise, any license under the copyrights, patents or patent applications of Telit, as arises by operation of law in the sale of a product.

COMPUTER SOFTWARE COPYRIGHTS

The Telit and 3rd Party supplied Software (SW) products described in this instruction manual may include copyrighted Telit and other 3rd Party supplied computer programs stored in semiconductor memories or other media. Laws in the Italy and other countries preserve for Telit and other 3rd Party supplied SW certain exclusive rights for copyrighted computer programs, including the exclusive right to copy or reproduce in any form the copyrighted computer program. Accordingly, any copyrighted Telit or other 3rd Party supplied SW computer programs contained in the Telit products described in this instruction manual may not be copied (reverse engineered) or reproduced in any manner without the express written permission of Telit or the 3rd Party SW supplier. Furthermore, the purchase of Telit products shall not be deemed to grant either directly or by implication, estoppel, or otherwise, any license under the copyrights, patents or patent applications of Telit or other 3rd Party supplied SW, except for the normal non-exclusive, royalty free license to use that arises by operation of law in the sale of a product.

USAGE AND DISCLOSURE RESTRICTIONS

I. License Agreements

The software described in this document is the property of Telit and its licensors. It is furnished by express license agreement only and may be used only in accordance with the terms of such an agreement.

II. Copyrighted Materials

Software and documentation are copyrighted materials. Making unauthorized copies is prohibited by law. No part of the software or documentation may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language or computer language, in any form or by any means, without prior written permission of Telit

III. High Risk Materials

Components, units, or third-party products used in the product described herein are NOT fault-tolerant and are NOT designed, manufactured, or intended for use as on-line control equipment in the following hazardous environments requiring fail-safe controls: the operation of Nuclear Facilities, Aircraft Navigation or Aircraft Communication Systems, Air Traffic Control, Life Support, or Weapons Systems (High Risk Activities"). Telit and its supplier(s) specifically disclaim any expressed or implied warranty of fitness for such High Risk Activities.

IV. Trademarks

TELIT and the Stylized T Logo are registered in Trademark Office. All other product or service names are the property of their respective owners.

V. Third Party Rights

The software may include Third Party Right software. In this case you agree to comply with all terms and conditions imposed on you in respect of such separate software. In addition to Third Party Terms, the disclaimer of warranty and limitation of liability provisions in this License shall apply to the Third Party Right software.

TELIT HEREBY DISCLAIMS ANY AND ALL WARRANTIES EXPRESS OR IMPLIED FROM ANY THIRD PARTIES REGARDING ANY SEPARATE FILES, ANY THIRD PARTY MATERIALS INCLUDED IN THE SOFTWARE, ANY THIRD PARTY MATERIALS FROM WHICH THE SOFTWARE IS DERIVED (COLLECTIVELY “OTHER CODE”), AND THE USE OF ANY OR ALL THE OTHER CODE IN CONNECTION WITH THE SOFTWARE, INCLUDING (WITHOUT LIMITATION) ANY WARRANTIES OF SATISFACTORY QUALITY OR FITNESS FOR A PARTICULAR PURPOSE.

NO THIRD PARTY LICENSORS OF OTHER CODE SHALL HAVE ANY LIABILITY FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING WITHOUT LIMITATION LOST PROFITS), HOWEVER CAUSED AND WHETHER MADE UNDER CONTRACT, TORT OR OTHER LEGAL THEORY, ARISING IN ANY WAY OUT OF THE USE OR DISTRIBUTION OF THE OTHER CODE OR THE EXERCISE OF ANY RIGHTS GRANTED UNDER EITHER OR BOTH THIS LICENSE AND THE LEGAL TERMS APPLICABLE TO ANY SEPARATE FILES, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

APPLICABILITY TABLE

PRODUCTS

- 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-SC
- HE910-V2
- UE910-V2

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

CONTENTS

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 Info and 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.

1.4. 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

- 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

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.

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.

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			mA	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			mA	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 3-1 is reported a simple example of Backup Capacitor connection where capacitor Cooper/Bussmann KR-5R5H105-R is used.

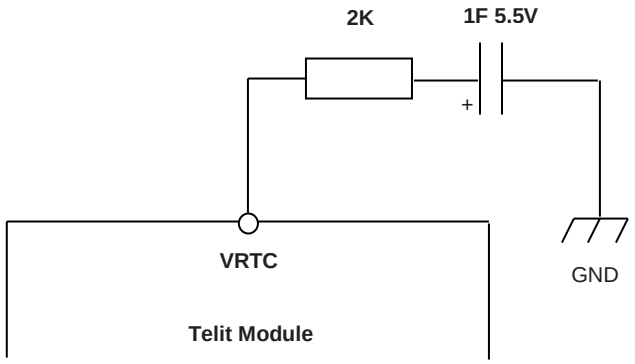

Figure 3-1 simple example of Backup Capacitor connection

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

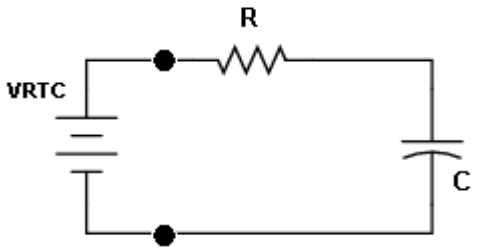

Figure 3-2 Charging

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 3-3. 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.

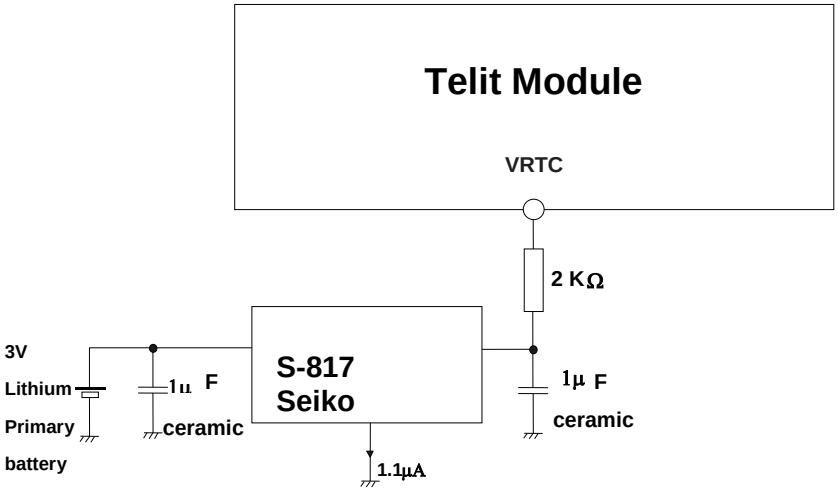

Figure 3-3 Battery

The S-817 Seiko Instruments Inc. LDO has a typical quiescent current value of 1.1 □A. 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.

4. 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
ISSUE#6	201-02-10	2017 Template applied

SUPPORT INQUIRIES

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

www.telit.com

Telit Communications S.p.A.
Via Stazione di Prosecco, 5/B
I-34010 Sgonico (Trieste), Italy

Telit IoT Platforms LLC
5300 Broken Sound Blvd, Suite 150
Boca Raton, FL 33487, USA

Telit Wireless Solutions Inc.
3131 RDU Center Drive, Suite 135
Morrisville, NC 27560, USA

Telit Wireless Solutions Co., Ltd.
8th Fl., Shinyoung Securities Bld.
6, Gukjegeumyung-ro8-gil, Yeongdeungpo-gu
Seoul, 150-884, Korea

Telit Wireless Solutions Ltd.
10 Habarzel St.
Tel Aviv 69710, Israel

Telit Wireless Solutions
Technologia e Servicos Ltda
Avenida Paulista, 1776, Room 10.C
01310-921 São Paulo, Brazil

Mod. 0809 2017-01 Rev.8

[01.2017]