RTC Backup Application Note

80000NT10054A Rev.1 – 2014-04-24

Making machines talk.

APPLICABILITY TABLE

PRODUCT
GC864-QUAD V2
GC864-DUAL V2
GE864-QUAD AUTOMOTIVE V2
GE864-QUAD ATEX
GE864-QUAD V2
GE864-GPS
GE865-QUAD
GL865-DUAL
GL868-DUAL
GL865-DUAL V3
GL865-QUAD V3
GL868-DUAL V3
GE866-QUAD

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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 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 (sample):

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

"Chapter 2 "RTC backup implementation" provides the electrical characteristics of the respective RTC sections, and describes some hardware solutions useful to implement an RTC Backup solution

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

- GE865-QUAD Hardware User Guide, 1vv0300799
- GE/GC864 and GE864-GPS Hardware User Guide, 1vv0300915
- GE864-QUAD Automotive V2 Hardware User Guide, 1vv0300840
- GE864 QUAD ATEX Hardware User Guide, 1vv0300879
- GL865 Hardware User Guide, 1vv0300910
- GL868 DUAL Hardware User Guide, 1vv0300896
- GL865-DUAL/QUAD V3 Hardware User Guide, 1vv0301018
- GL868-DUAL V3 Hardware User Guide, 1vv0301061
- GE866-QUAD Hardware User Guide, 1vv0301051

2. RTC Backup implementation

In applications where it is needed to keep the Real Time Clock settings even when the main power supply of the module, VBATT, is switched off, a backup solution is required.
The aim of this application note is to describe some hardware solutions useful to implement an RTC backup battery/capacitor for the modules listed on the Applicability Table at the beginning of the document.

2.1. Pin out

In order to identify the VRTC pin on each of the applicable modules, please consult the relative Hardware User Guide (see 1.6).

2.2. RTC section electrical characteristics

The following paragraphs will list the main electrical characteristics for the RTC sections on each of the modules on the Applicability Table at the beginning of this document.

2.2.1. GE865

The signal is present on the BGA BALL reported on the relative Telit Hardware User Guide.

Parameter	**Symbol**	**Limit Values**			**Unit**	**Remark**
		min.	**typ.**	**max.**		
Output Voltage	VRTC	1.86	2.05	2.14	V	
Output current	IRTC	2			mA	VBATT > 3.0 V; VRTC=2.1V
Reverse Current(*)	IRev		10		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.1		V	

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

2.2.2. GL865-QUAD/GL865-DUAL

The signal is present on the PAD reported on the relative Telit Hardware User Guide.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.86	2.05	2.14	V	
Output current	IRTC	2			mA	VBATT > 3.0 V; VRTC=2.1V
Reverse Current(*)	IRev		20		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.1		V	

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

2.2.3. GE864-QUAD/GE864-QUAD-V2/GE864-QUAD AUTOMOTIVE V2/GE864-QUAD ATEX/GE864-GPS/GC864-QUAD/GC864-QUAD-V2

The signal is present on the BGA BALL/PIN reported on the relative Telit Hardware User Guide.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.86	2.05	2.14	V	
Output current	IRTC	2			mA	VBATT > 3.0 V; VRTC=2.1V
Reverse Current(*)	IRev		40		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.1		V	

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

2.2.4. GL865-DUAL V3/GL865-QUAD V3/GL868-DUAL V3/GE866-QUAD

The signal is present on the pin reported on the relative Telit Hardware User Guide.

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 > 3.1 V; VRTC=2.3V
Reverse Current(*)	IRev		68		µA	VBATT = 0V
Minimum RTC voltage	VRTC min		1.1		V	

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

2.3. Backup Capacitor

The first solution for the RTC backup is adding a capacitor to the VRTC pin.

2.3.1. 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)
- I_{rev} (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:

$$C = \frac{B_{Time} \times I_{rev}}{VRTC - VRTC_{\min}} \times 3600$$

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

$$B_{Time} = \frac{C \times \left(VRTC - VRTC_{\min}\right)}{I_{rev} \times 3600}$$

Numerical example for GE865. From 2.2.1, we have the following data:

- VRTC = 2.05 V
- $VRTC_{MIN}$ = 1.1V
- IRev = 10 µA

If we require a B_{Time} of 23 hours, the necessary capacitor will be around 0.9F.

Numerical example for GL865-DUAL V3. From 2.2.4, we have the following data:

- VRTC = 2.3 V
- $VRTC_{MIN}$ = 1.1V
- IRev = 68 µA

Using the same capacitor as the previous example, the backup time would be 4.9 hours.

On Figure 1 is reported a simple example of Backup Capacitor connection; for both examples, a Cooper/Bussmann KR-5R5H105-R capacitor can be used.

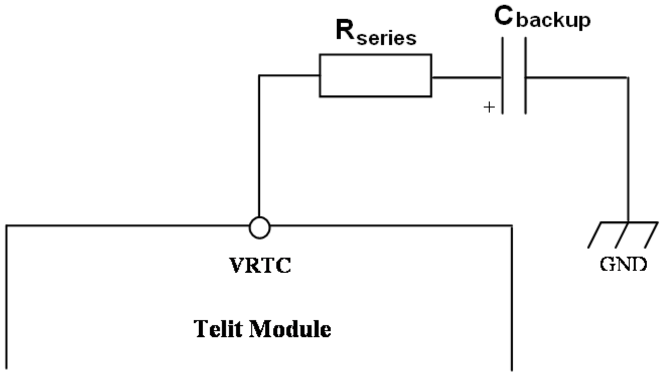


Figure 1. RTC backup capacitor

NOTE:

For modules where an ON/OFF line is available, connecting it to GND will increase the IRev to around 110µA. Please consider this for the backup time calculation.

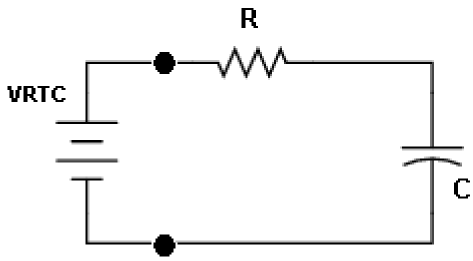
NOTE:

For GL865-DUAL/QUAD V3, GL868-DUAL V3 and GE866-QUAD modules: VRTC is 2.3V and the reverse current is 68µA. Please consider this for the backup time calculation.

2.3.2. 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:
For all applicable modules except GL865-DUAL/QUAD V3, GL868-DUAL V3 and GE866-QUAD: in order to guarantee the correct module start-up, the current drawn by VRTC pin must not exceed 2mA. For this reason, the minimum required series resistor is **1kΩ**. This guarantees the correct module start-up even if the backup capacitor is completely discharged (voltage on capacitor=0V).

WARNING:
For GL865-DUAL/QUAD V3, GL868-DUAL V3 and GE866-QUAD modules: in order to guarantee the correct module start-up, the current drawn by VRTC pin must not exceed 1mA. For this reason, the minimum required series resistor is **2.3kΩ**. This guarantees the correct module start-up even if the backup capacitor is completely discharged (voltage on capacitor=0V).

Numerical example for GE865. Following the previous example, and assuming a completely discharged capacitor as a starting condition, the voltage drop for the RTC circuit is:

$$VRTC = 2mA \times 1k\Omega = 2V \ .$$

This voltage allows supplying the RTC part.
When the RTC is supplied only by the capacitor, the voltage drop over the 1K resistor is:

$$V_r = 1k\Omega \times (10\mu A) = 10mV \ .$$

This voltage drop is negligible and doesn't affect the circuit functionality.
Using the above considerations, the charging time will be: 5 × 1kΩ ×1F = 5000 s (1.38 hours)

Numerical example for GL865-DUAL V3. Following the previous example, and supposing a completely discharged capacitor as a starting condition, the voltage drop for the RTC circuit is:

$$VRTC = 1mA \times 2.3k\Omega = 2.3V \ ,$$

which is the nominal VRTC value.
When the RTC is supplied only by the capacitor, the voltage drop over the 2.3K resistor is:

$$V_r = 2.3k\Omega \times (68\mu A) = 156.4mV \ ,$$

which is low enough not to affect the circuit functionality.
Using the above considerations, the charging time will be: 5 × 2.3kΩ ×1F = 11500s (3.19 hours)

2.4. Backup Battery

The second solution for the RTC backup is using a lithium primary battery. Since 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. The suggested circuit is reported on Figure 2.

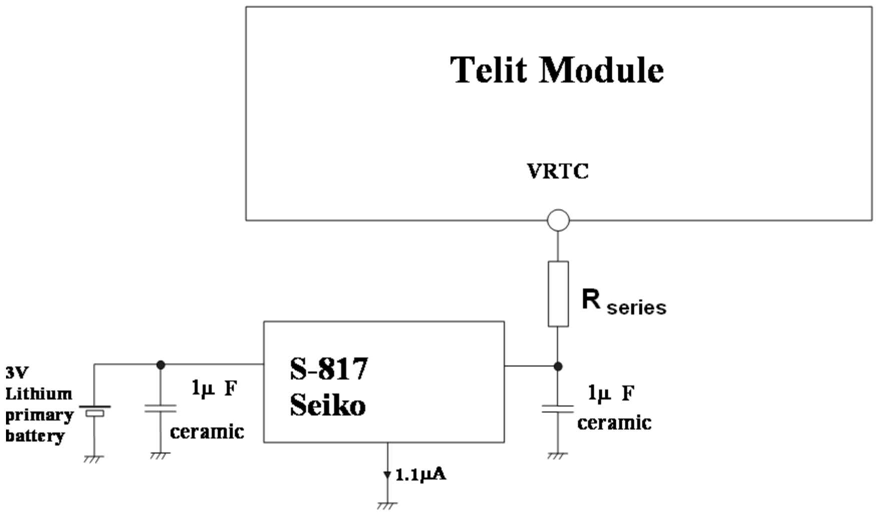


Figure 2. RTC backup battery

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

Numerical example for GE865. When VBATT is not applied, the VRTC Reverse Current (IRev) is 10µA (see 2.2.1). Considering a typical capacity of 220 mAh for a Lithium Primary Battery, we can calculate briefly the life time of the battery when VBATT is not applied:

$$\frac{220000\,\mu Ah}{(1.1+10)\,\mu A} = 19820h \rightarrow \text{ more than 2 years.}$$

Numerical example for GL865-DUAL V3. When VBATT is not applied, the VRTC Reverse Current (IRev) is 68µA (see 2.2.4). Using the same battery, the expected life time will be

$$\frac{220000\,\mu Ah}{(1.1+68)\,\mu A} = 3184h \rightarrow \text{ more than 4 months.}$$

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

NOTES:

For modules where an ON/OFF line is available, connecting it to GND will increase the IRev to around 110µA. Please consider this for the backup time calculation.

WARNING:

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

3. Document History

Revision	Date	Changes
ISSUE#0	2011-08-09	First ISSUE
ISSUE#1	2014-04-24	Added GL865-DUAL/QUAD V3, GL868-DUAL V3 and GE866-QUAD