RTC Backup Application Note

80000NT10005A Rev. 2 - 07/09/07

Making machines talk.

APPLICABILITY TABLE

PRODUCT	PART NUMBER	APPLICABILITY
EZ10-QUAD-PY	3990150467	
GT863-PY	3990150466	
GT864-QUAD	4990150069	
GT864-PY	4990150070	
GM862-GPRS	3990250631	
GM862-QUAD	3990250655	
GM862-QUAD-PY	3990250656	
GM862-GPS	3990250657	
GM862-GPS	3990250689	
GM862-QUAD-PY	3990250658	
GM862-QUAD	3990250659	
GC864-QUAD	3990250675	√
GC864-PY	3990250676	√
GC864-QUAD-C2	3990250681	√
GC864-PY-C2	3990250686	√
GE863-QUAD	3990250653	√
GE863-PY	3990250654	√
GE863-GPS	3990250660	√
GE863-GPS	3990250690	√
GE863-PY	3990250661	√
GE863-QUAD	3990250662	√
GE864-PY	3990250650	√
GE864-QUAD	3990250648	√

Contents

1 Overview

This application note describes how to implement in a customer's application a backup battery / capacitor on the Telit modules.
The backup battery is necessary if is needed to maintain active the RTC (real time clock) settings if the main power supply of the module (VBATT) is switched off.
In case of a GE863-GPS module this backup battery is also keeping supplied the RTC and memory of the GPS receiver in order to keep stored the data acquired form the satellites (ephemeredes, almanac etc.)

1.1 Pinout

The pin for the RTC backup is present on the following products; below the electrical characteristics.

1.1.1 GE864

On GE864 products (GE864-QUAD and GE864-PY) the signal is present on the BGA BALL called **E2**.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.95	2.05	2.15	V	
Output current	IRTC	130			µA	VBAT > 3.0 V; VRTC=2.1V
Reverse Current	Irev		1.6		µA	VBAT = 0V
Minimum RTC voltage	IRTCmin		1.1		V	

1.1.2 GC864

On GC864 products (GC864-QUAD and GC864-PY) the signal is present on the Pin n° **55** of board to board connector.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.95	2.05	2.15	V	
Output current	IRTC	130			µA	VBAT > 3.0 V; VRTC=2.1V
Reverse Current	Irev		1.6		µA	VBAT = 0V
Minimum RTC voltage	IRTCmin		1.1		V	

1.1.3 GC864-QUAD-C2 and GC864-PY-C2

On GC864 C2 products (GC864-QUAD-C2 and GC864-PY-C2) the signal is present on the Pin n° **25** of board to board connector.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.95	2.05	2.15	V	
Output current	IRTC	130			µA	VBAT > 3.0 V; VRTC=2.1V
Reverse Current	Irev		1.6		µA	VBAT = 0V
Minimum RTC voltage	IRTCmin		1.1		V	

1.1.4 GE863-QUAD and PY (p.n. 3990250662 & 3990250661)

On GE863 products the signal is present on the BGA BALL number **24**.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.95	2.05	2.15	V	
Output current	IRTC	130			µA	VBAT > 3.0 V; VRTC=2.1V
Reverse Current	Irev		1.6		µA	VBAT = 0V
Minimum RTC voltage	IRTCmin		1.1		V	

1.1.5 GE863-GPS

On GE863-GPS product the signal is present on the BGA BALL number **24**.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.95	2.05	2.15	V	
Output current	IRTC	100			µA	VBAT > 3.0 V; VRTC=2.1V
Reverse Current	Irev		31		µA	VBAT = 0V
Minimum RTC voltage	IRTCmin		1.6		V	

1.1.6 GE863-QUAD and PY (p.n. 3990250653 & 3990250654)

On GE863 products the signal is present on the BGA BALL number **24**.

Parameter	Symbol	Limit Values			Unit	Remark
		min.	typ.	max.		
Output Voltage	VRTC	1.95	2.05	2.15	V	
Output current	IRTC	130			µA	VBAT > 3.0 V; VRTC=2.1V
Reverse Current	Irev		2		µA	VBAT = 0V
Minimum RTC voltage	IRTCmin		1.1		V	

1.2 Backup Capacitor

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

1.2.1 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)
- IRTC (Ampere) – The current consumption of the RTC circuitery 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:

$$C = \frac{B\_Time * IRTC}{VRTC - VRTC\_min} * 3600$$

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

$$B\_Time = \frac{C*(VRTC - VRTC\_min)}{IRTC * 3600}$$

For example if we have the following data :

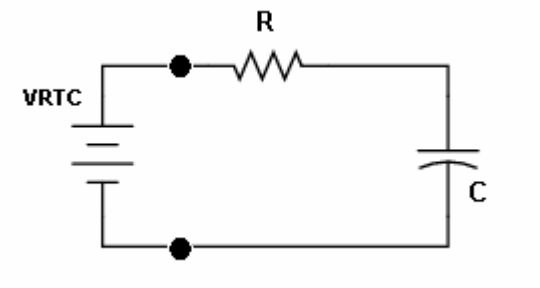
- VRTC = 1.95 V
- VRTC_min = 1.1V
- IRTC = 2uA
- B_Time = 23 hours

The necessary capacitor will be: 0.2F

1.2.2 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 (ie 0.2F)
- Capacitor Starting Voltage (i.e. 0V)
- Series Resistor (i.e. 10K ohm)



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

The series resistor has to determine a drop voltage not lower than 1.1V in order to mantain the RTC alive. If we consider a current of 130uA and a minimum voltage of 1.1V the minimum value is 10KOhm.

Starting with a voltage on capacitor=0 the voltage for the RTC circuit is :

Vrtc = 130uA *10KOhm = 1.31V.

This voltage permits to supply the RTC part.

When the RTC is supplied by the capacitor only the voltage drop on the 10K resistor is :

Vr= 10Kohm * (2uA) = 20mV.

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

Considering the above considerations the charging time will be 5 * 10000 * 0.2 = 10000 sec (2.5 hours)

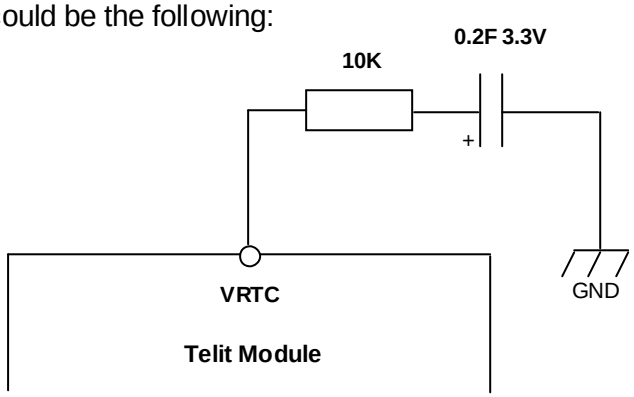
NOTE: the above considerations are done considering the module switched on.

1.2.3 QUAD and PY TELIT MODULES (GE863, GE864, GC864 and GC864 C2)

The example is considering the use of a capacitor with the following characteristics:

Example: Korchip Starcap SCDMR 3R3 224
RATED VOLTAGE : 3.3 VDC
CAPACITANCE : 0.20 F

A typical schematic could be the following:



1.2.3.1 RTC AUTONOMY

If we consider the modem's characteristics:
VRTC min = 1.95 V
IRTC = 130uA
Irev = 1.6uA
Minimum voltage for RTC functionality during backup: 1.1 V

The application for the RTC backup is shown in the above schematic.
The series resistor is 10K.

At T=0 with the capacitor fully discharged the voltage due to the series resistor is 1.3V that doesn't affect the RTC functionality.
The voltage drop during backup is 16mV and it is also acceptable.

Considering the modem characteristics, the charging time for this solution is 166 min and the backup time is 23 hours.

NOTE: With RESET line activated and with VBATT=0 the consumption will rise to 200uA; Please consider this for a backup time calculation.

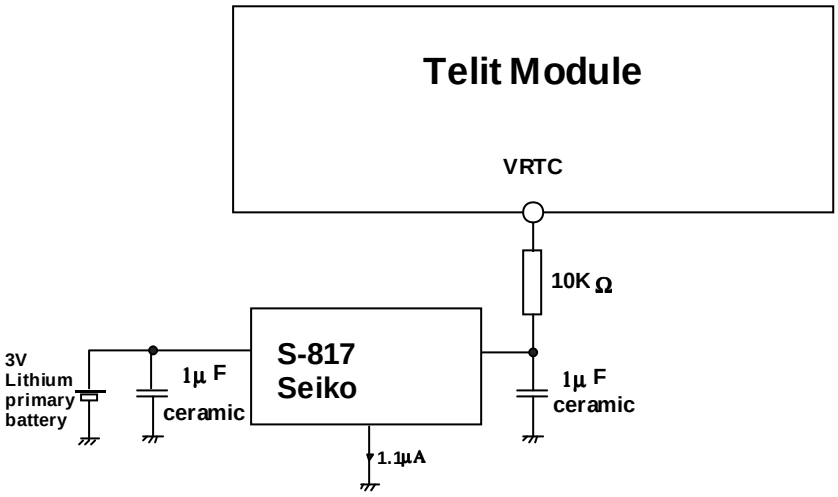
1.3 Backup Battery

The second solution for the RTC backup is using a lithium primary battery.
This solution is suggested on the GPS products where the RTC current is higher than the other products due to the fact we are also supplying the GPS memory.

1.3.1 QUAD and PY TELIT MODULES (GE863, GE864, GC864 and GC864 C2)

To obtain several working years for the Real Time Clock without VBATT power supply voltage, it is necessary to make use of a lithium primary battery to supply the RTC circuits in the Telit Module.

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:



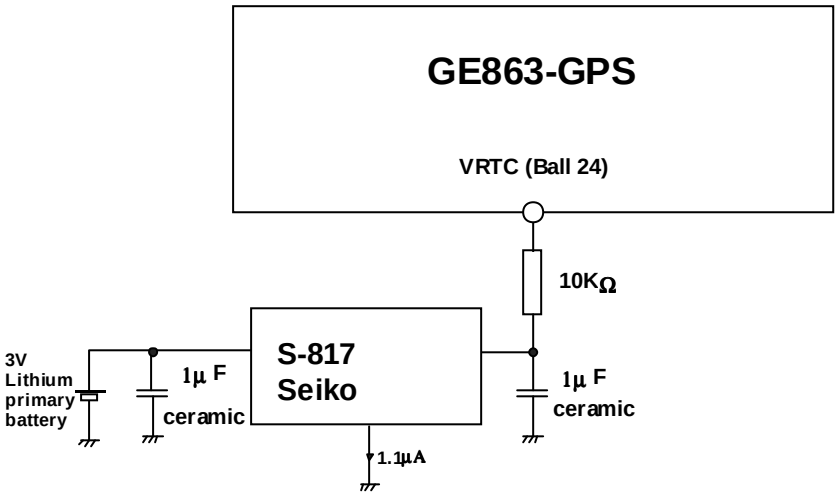
The quoted current intensity are without Vbatt power supply for the module.
The S-817 Seiko Instruments Inc. LDO has **1.2µA Typ** for the quiescent current. Without Vbatt power supply voltage, the VRTC Reverse Current is **2µA Typ**.
At ambient temperature 20°C, the BR2032 coin type (Panasonic 190 mAh) should be sufficient for 5 years with **typical current intensity**. The CR2032 coin type Panasonic 220 mAh) has an improved behaviour at low and high temperatures.
When the Vbatt voltage is present, the VRTC voltage exceeds the S-817 output voltage, so the current for the Lithium Primary Battery is only **1.2µA Typ (or less)**.

NOTE: the 5 years are given considering the worst case (VBATT always off)

1.3.2 GE863-GPS module

On the GE863-GPS we have to consider the consumption related to the GSM RTC, the GPS RTC and its internal memory. To develop a backup circuit for the VRTC when we are without VBATT power supply voltage, it is necessary to make use of lithium primary.

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:



The quoted current intensity is considering the condition when VBATT=0.
The S-817 Seiko Instruments Inc. LDO has **1.2µA Typ** for the quiescent current.
Without VBATT power supply voltage, the VRTC Reverse Current is **31µA Typ**.

At ambient temperature 20°C, the BR2032 coin type (Panasonic 190 mAh) should be sufficient for 6 months with **typical current intensity**.
The CR2032 coin type Panasonic 220 mAh) has an improved behaviour at low and high temperatures.

When the Vbatt voltage is present, the VRTC voltage exceeds the S-817 output voltage, so the current for the Lithium Primary Battery is only **1.2µA Typ (or less)**.

NOTE: the 6 months are given considering the worst case (VBATT always off)

NOTE: With RESET line activated and with VBATT=0 the consumption will rise to 200uA; Please consider this for a backup time calculation.

2 Document Change Log

Revision	Date	Changes
ISSUE#0	10/01/07	Release First ISSUE# 0
ISSUE#1	21/08/07	Updated components used for application note
ISSUE#2	07/09/07	Added GT864-QUAD and GT864-PY into applicability table