GPS

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Power Management

Considerations with u-blox 6 GPS receivers

Application Note

Abstract

This document describes the power management considerations for u-blox 6 module or chipset designs. Low power modes are described with diagrams showing acquisition time vs. estimated power consumption. Where appropriate, differences in performance due to the selection of modes are illustrated.

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Contents

1 Introduction

This application note describes ways of configuring u-blox 6 GPS receivers to reduce power consumption while maintaining a high level of performance. These are important design goals for portable systems.

2 Power saving options

u-blox 6 receivers offer various hardware and software options for applications with different power requirements by means of its flexible supply voltage and operating mode configuration.

2.1 Hardware options

2.1.1 u-blox 6 modules

u-blox 6 modules support three kinds of power supply models:

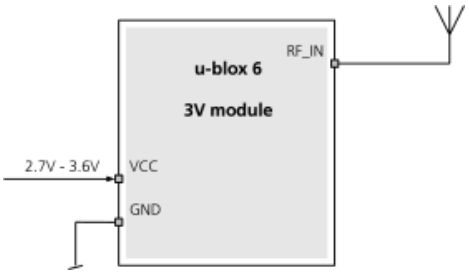

Figure 1 : u-blox 6 modules with supply voltage of 3 V nominal (2.7 … 3.6 V)

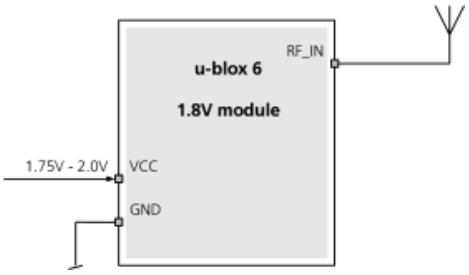

Figure 2: u-blox 6 modules with supply voltage of 1.8 V nominal (1.75 … 2.0 V).

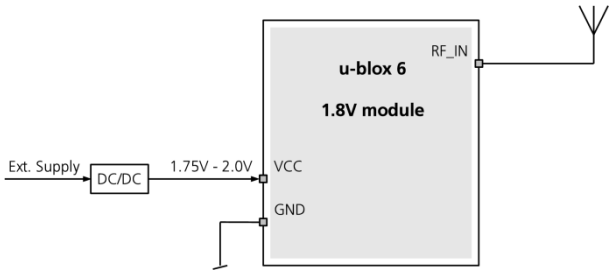

Figure 3: u-blox 6 modules supplied by DC/DC converter.

☞ For more information including detailed schematics, consult the applicable Hardware Integration Manuals (see Related documents).

2.1.2 u-blox 6 ICs

Depending on the application, u-blox 6 ICs support different kinds of power supply models. Some examples are:

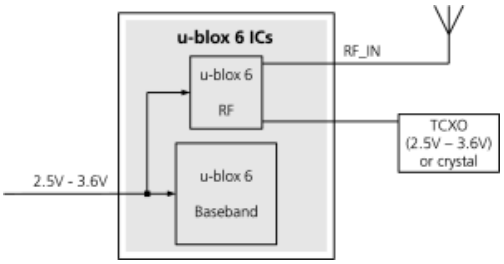

Figure 4: Single supply voltage from 2.5 … 3.6 V

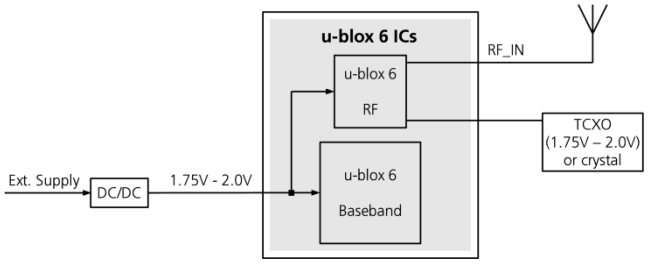

Figure 5: Single supply voltage of 1.8 V nominal (1.75 … 2.0 V)

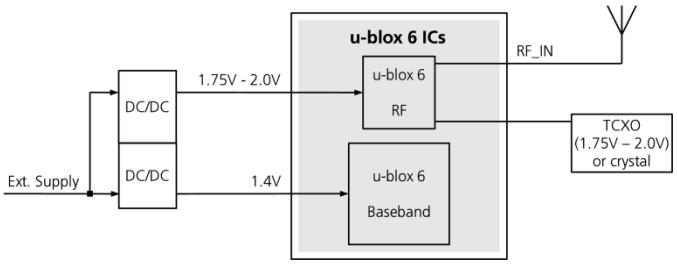

Figure 6: Separate supply of 1.8 V nominal (1.75 … 2.0 V) and 1.4 V (1.4…3.6 V)

☞ For more information including detailed schematics, consult the applicable Hardware Integration Manuals (see Related documents).

2.2 Software options

u-blox 6 technology provides a power-optimized architecture with built-in autonomous power saving functions that minimize power consumption at any given time. u-blox 6 can be run in three different operating modes: Maximum Performance, Eco and Power Save Mode. The difference lies in how the acquisition and tracking engine are used to get optimum GPS performance and power consumption for a given scenario. Actual reduction in power consumption results in some degradation of GPS performance, but can be sufficient for the specific application.

☞ The operating modes can be selected by using the message UBX-CFG-RXM.

2.2.1 Maximum Performance Mode

In Maximum Performance Mode, u-blox 6 receivers use the acquisition engine at full performance to search for all possible satellites even if a position fix still exists. Lower tracking current consumption is only achieved when: a valid GPS position is fixed; the Almanac is entirely downloaded and the Ephemeris for all possible satellites in view is valid. In real life scenarios these ideal conditions rarely exist.

2.2.2 Eco Mode

In Eco Mode, the u-blox 6 receiver uses the acquisition engine to search for new satellites ***only when needed*** for navigation and deactivates it as soon as a position is fixed and a sufficient number (at least 4) of satellites are being tracked. The tracking engine continues tracking the minimum number of satellites and searches for new ones if necessary:

- During cold starts, the receiver searches for enough satellites to navigate and optimizes use of the acquisition engine to download their ephemeris.
- During warm and hot starts, the receiver focuses on searching for visible satellites whose orbits are known from the Almanac.

In Eco Mode, the acquisition engine limits its use of searching resources to minimize power consumption. As a consequence the current consumption drops much faster in comparison to Max Performance Mode (see Figure 7). On the other hand the time to find satellites at a weaker signal level might be slightly increased.

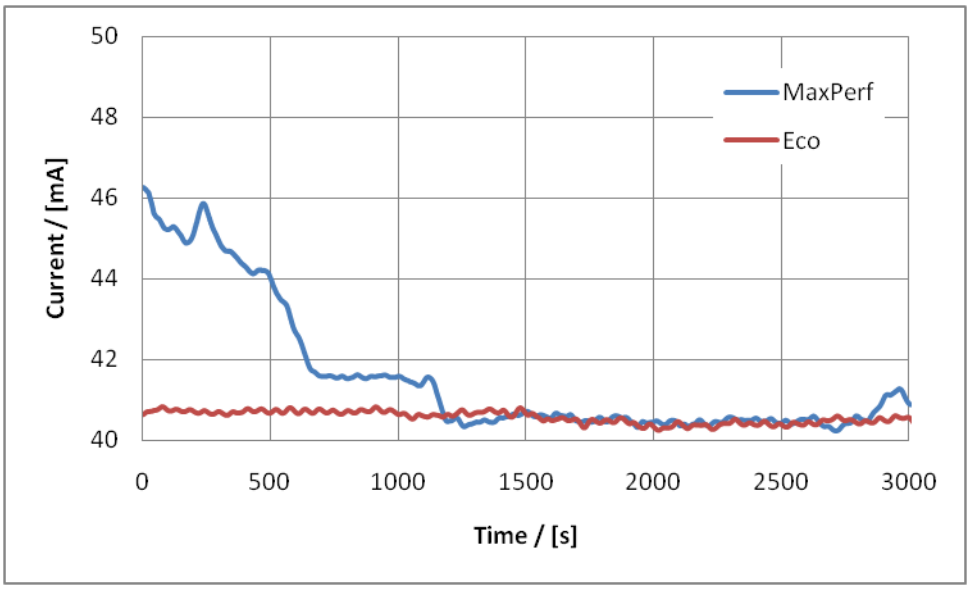

Figure 7: Current consumption during cold start with good sky visibility (acquisition: 0s…1200s, tracking: 1200s…2700s)

When tracking and with all satellites in view, Max Performance Mode performs like Eco Mode (see also Figure 7). However, as mentioned, shadowing or multipath effects cause the receiver to frequently search for new satellites. Thus in a dynamic scenario Eco Mode shows superior performance in terms of power consumption.

2.2.3 Power Save Mode

Power Save Mode (PSM) allows a reduction in system power consumption depending on signal strength and PSM settings. Power Save Mode can be configured to either ON/OFF or Cyclic tracking operation. These are optimized for different update periods, with the update period length causing the main difference in how the receiver performs. In conjunction with other settings PSM can be configured to optimally match a given scenario. Power Save Mode is described in detail in Chapter 3.

☞ Power Save Mode can be configured by using the message UBX-CFG-PM with FW6.02 and UBX-CFG-PM2 with FW7.03.

3 Power Save Mode

ON/OFF operation is available for update periods of 5 s and longer whereas cyclic tracking operation is used for update periods between 1 s and 5 s with FW6.02 and between 1 s and 10 s with FW7.03.

☞ The update period in ON/OFF operation does not depend on firmware versions.

3.1 ON/OFF operation for long update periods

When the receiver is switched on, it enters acquisition state to get a position fix within a given time, which is called acquisition timeout. When there is a position fix before timeout, it switches to tracking state. It remains in this state until the on time is over. In this case the receiver enters the inactive for update state. Once the update period is over the sequence starts again. If signal is lost, while in tracking state, the receiver enters acquisition state. If there are no position fixes before acquisition timeout, the receiver switches to inactive for search state. This sequence will repeat according to the search period until the receiver again gets a position fix.

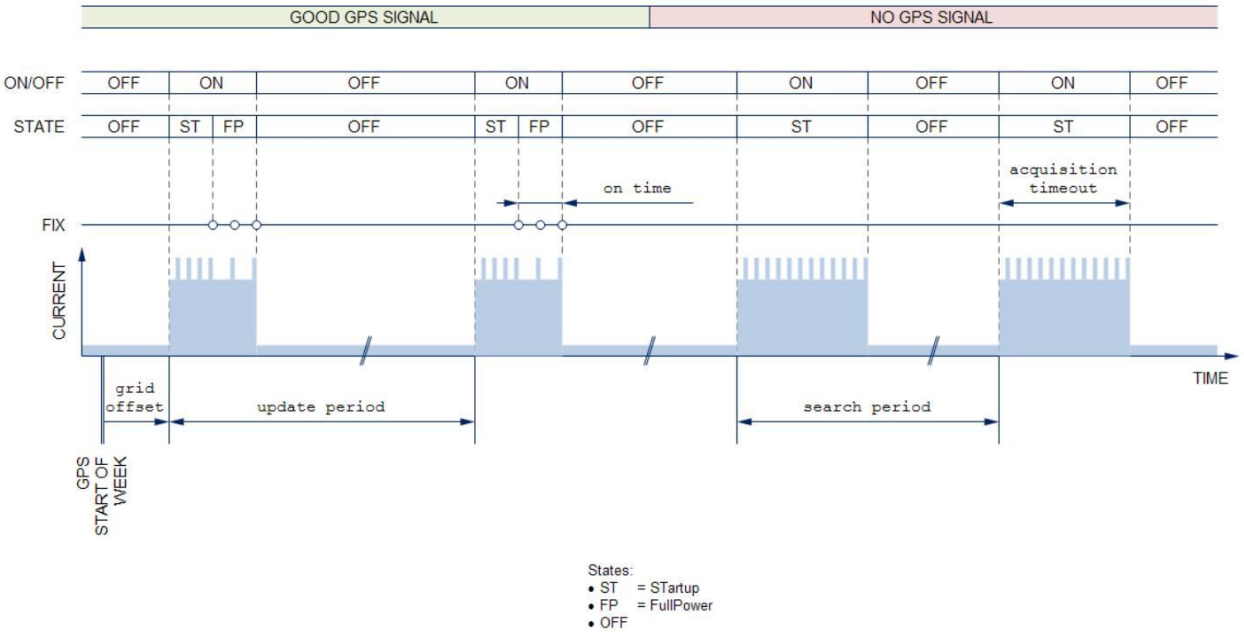

Figure 8: ON/OFF operation of the PSM

3.2 Cyclic tracking operation for short update periods

When the receiver is switched on, it enters acquisition state. If it gets a position fix before acquisition timeout, the receiver enters tracking state until on time is over. Now the receiver enters the power optimized tracking state, which is designed to reduce power consumption while continuously calculating position fixes. The receiver stays in power optimized tracking state as long as the GPS signal is strong enough. If it is not, the receiver returns to tracking state or even to acquisition state.

If the receiver has lost the position fix or cannot get a position fix before acquisition timeout, it will behave like in ON/OFF operation with no GPS signal.

☞ For more information, consult the u-blox 6 Receiver Description including Protocol Specification [8]

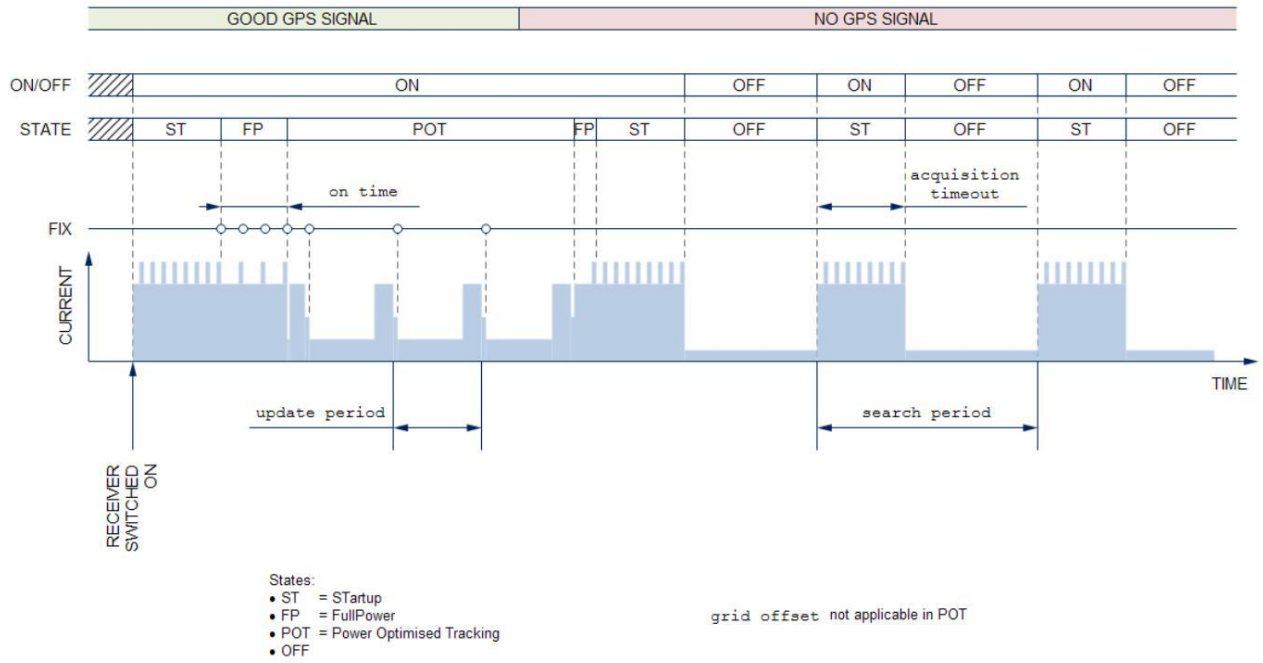

Figure 9: Cyclic tracking operation of the PSM

3.3 Limitations with FW7.03

Use of Power Save Mode with FW7.03 can result in performance limitations. In PSM use Cyclic tracking operation only, since ON/OFF operation is not supported. For module and IC designs with a TCXO the update periods can be configured from 1 s to 10 s as described in chapter 3. For crystal based modules the update period is limited to 1 s to 3 s. For IC designs with crystal the update period should be fixed to 1 s. Any operation beyond these limits can result in false position fixes. Table 1 summarizes PSM configuration with FW7.03.

Type	XTO	Firmware version	PSM operation	Min. update period	Max. update period	Remarks
Module	Crystal	7.03	ON/OFF	-	-	not available
Module	TCXO	7.03	ON/OFF	-	-	not available
Module	Crystal	7.03	Cyclic tracking	1 s	3 s	limited use
Module	TCXO	7.03	Cyclic tracking	1 s	10 s	
IC	Crystal	7.03	ON/OFF	-	-	not available
IC	TCXO	7.03	ON/OFF	-	-	not available
IC	Crystal	7.03	Cyclic tracking	1 s	1 s	limited use
iC	TCXO	7.03	Cyclic tracking	1 s	10 s	

Table 1: Configurations with FW7.03

☞ Power Save Mode with FW6.02 is not affected by any limitations described in this section.

4 Considerations for low power designs

This chapter describes how to reduce power consumption from a practical point of view. Recommendations are given and examples are shown when low power consumption is a critical design goal.

4.1 Selecting a supply voltage

4.1.1 Considerations regarding the supply voltage

Good performance requires a clean and stable power supply with minimal ripple. Be careful when selecting a strategy to achieve this. Placing a resistor at VCC can negatively impact performance. For better performance, use an LDO to provide a clean supply at VCC and consider the following:

- Wide power lines or even power planes are preferred.
- Place LDO near the module.
- Avoid resistive components in the power line (e.g. narrow power lines, coils, resistors, etc.).

Placing a filter or other source of resistance at VCC may result in significantly longer acquisition times.

Applicable Datasheets and Hardware Integration Manuals provide power supply specifications with u-blox 6 modules and IC designs (see Related documents).

4.1.2 Recommendations

For low power applications, 1.8V solutions are best as current will remain lower than in 3 V solutions. For u-blox 6 GPS ICs, using a separate supply of 1.4 V for the IC Base band part and 1.8 V for RF parts provides the least power consumption (see 2.1.2).

For more information, consult the applicable Datasheets and Hardware Integration Manuals (see Related documents).

4.2 Configuring the Power Save Mode

4.2.1 Considerations using the PSM

Receivers operating in Power Save Mode calculate position fixes at given periods of time. If a GPS signal exists the period is called update period. If no GPS signal is available the receiver will only search for a signal as defined by the search period. The Power Save Mode can perform in two operations, which make use of different techniques how to use the acquisition and the tracking engine.

Depending on the application one should first decide if ON/OFF operation or cyclic tracking operation is more suitable. A rule of thumb is that cyclic tracking provides nearly as good performance as Max Performance Mode with a reduction of 60% of power consumption. ON/OFF operation is capable of saving even more power for update periods greater than 30 s, but much fewer position fixes are calculated.

☞ For update periods smaller than 30 s ON/OFF operation shows no advantage compared to cyclic tracking operation.

Keep in mind that the average signal strength affects both the overall power consumption (see Figure 10) and GPS performance. Poor signal conditions can degrade the performance of PSM and lead to power consumption comparable to Max Performance Mode with worse GPS performance. In this case it is recommended to use Max Performance Mode only.

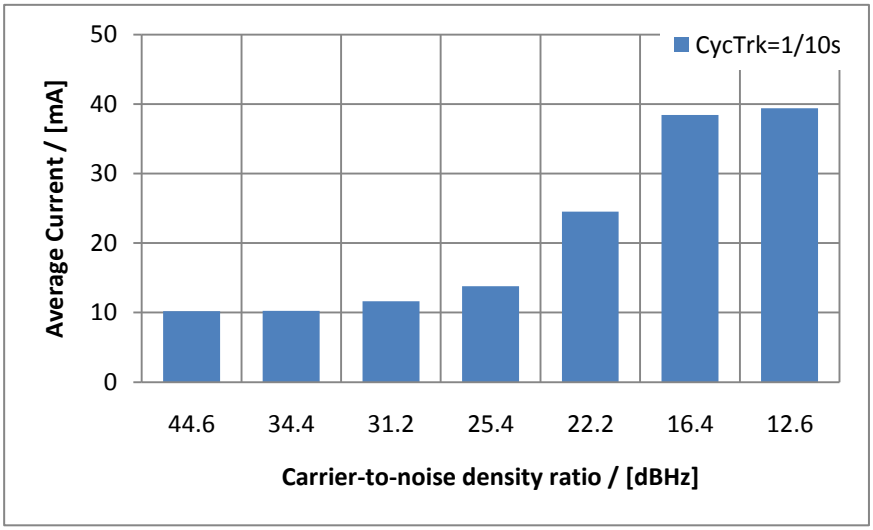

Figure 10: Average current at different carrier-to-noise density ratios for PSM in cyclic tracking operation (update period: 1 s, search period: 10 s)

4.2.2 Example: Power Save Mode with long update period

To demonstrate ON/OFF operation an update period of 30 s and a search period of 100 s were chosen. Figure 11 shows a typical current profile switching from active to inactive state. Figure 12 shows that only a few position fixes are calculated. The average current consumption was about 8 mA in this demonstration. A red colored point means that no position fix has been calculated. A green point indicates a valid position fix and a blue point represents a position fix with limited accuracy.

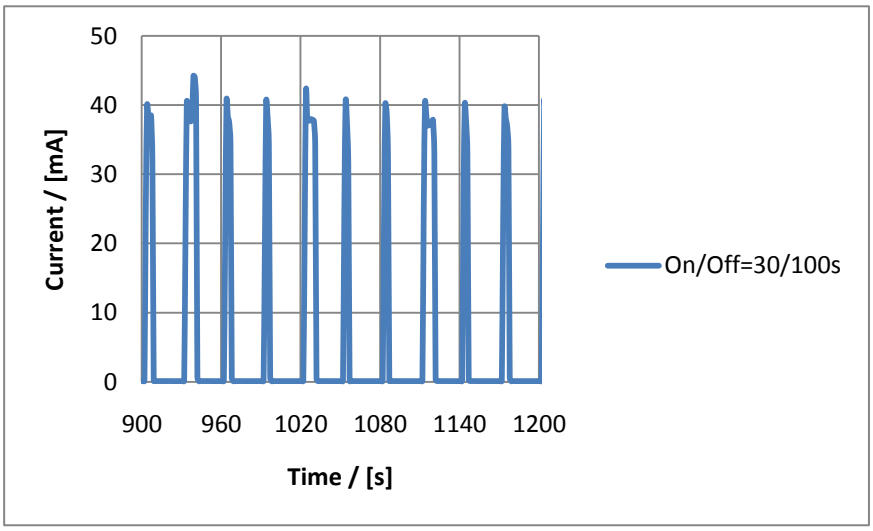

Figure 11: Current consumption in ON/OFF operation with good sky visibility (update period: 30 s, search period=100 s)

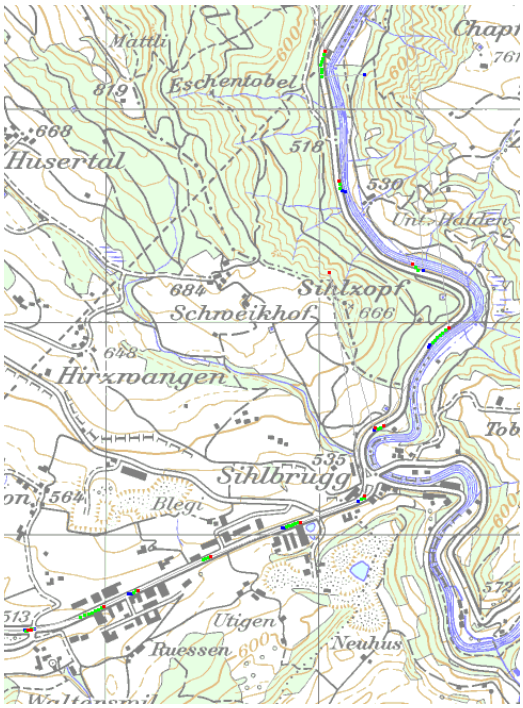

Figure 12: Position fixes in ON/OFF operation with good sky visibility (update period: 30 s, search period=100 s)

4.2.3 Example: Power Save Mode with short update period

As an example of Cyclic Tracking operation an update period of 1 s and a search period of 10 s were chosen. Figure 13 shows the current profile during power optimized tracking state. In contrast to ON/OFF operation the receiver calculates more position fixes, which is shown in Figure 14. The average current consumption was about 12 mA in this scenario.

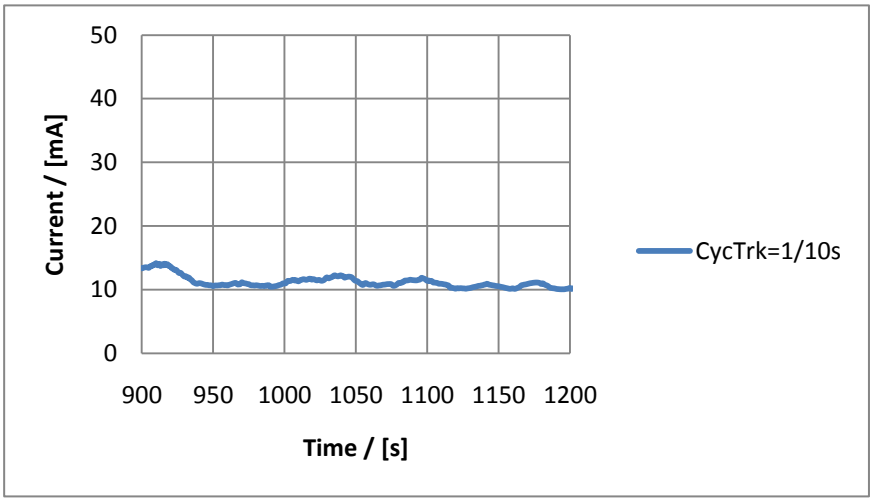

Figure 13: Current consumption in Cyclic Tracking operation with good sky visibility (update period: 1 s, search period: 10 s)

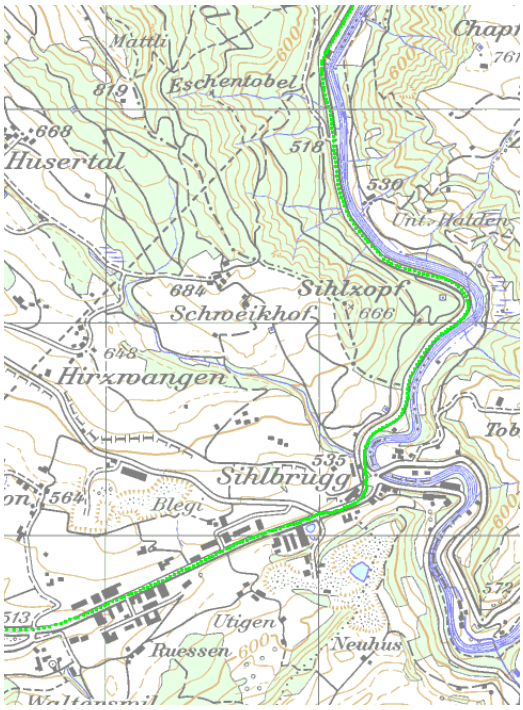

Figure 14: Position fixes in Cyclic Tracking operation with good sky visibility (update period: 1 s, search period: 10 s)

5 Settings related to Power Save Mode

5.1 Hardware settings

5.1.1 Pin assignment

u-blox 6 ICs, NEO-6 and AMY-6M modules include a **CFG_GPS0** pin, which enables boot-time configuration of the operating mode. Note that Power Save Mode cannot be configured by hardware default, but can later be changed using software. If the **CFG_GPS0** pin is set to high, Max Performance Mode is selected. With this pin set to low, Eco Mode is used as hardware default (see Table 1). With LEA-6 modules the **CFG_GPS0** pin is internally set high.

CFG_GPS0	Power Mode
0	Eco Mode
1	Maximum Performance Mode

Table 2: Supported CFG_GPS0 settings

☞ The CFG_GPS0 pin is shared with the SPI Clock pin. When using Eco Mode and SPI, pull CFG_GPS0 low during startup and then release it.

5.1.2 Default settings

Table 2 shows the recommended hardware default settings for all u-blox modules. It is recommended to select Eco Mode for AMY-6M as default operating mode. All u-blox 6 ICs and NEO-6 modules should operate in Max Performance Mode by default. As previously mentioned, Max Performance Mode is already selected for LEA-6 modules.

Operating mode	Default settings
Eco Mode	AMY-6M
Maximum Performance Mode	LEA-6A, LEA-6S, LEA-6T, LEA-6H, LEA-6P and LEA-6R NEO-6Q, NEO-6M and NEO-6G
Peak current reduction	Disabled (with firmware 6.02 and above)
Maintain fast start-up	Disabled (with firmware 6.02 and above)
Power Save Mode	Disabled (with firmware 6.02 and above)

Table 3: Default operating modes on u-blox 6 modules

5.2 Software settings

5.2.1 Recommended operating mode settings

u-blox 6 offers the option to change the operating modes via software. The following operating modes can be chosen by using the message UBX-CFG-RXM:

- Maximum Performance Mode enables the full capability of u-blox 6 positioning. This should be used if GPS performance is the most important consideration.
- Eco Mode provides slightly reduced current consumption with nearly the same GPS performance as Max Performance Mode.
- Power Save Mode allows significant reduction in system power consumption with reasonable GPS performance. Cyclic tracking operation is recommended with moderate to good signal conditions where position fixes are often needed. ON/OFF operation is recommended with strong signals and when position fixes are infrequently needed.

☞ For more information, consult the Receiver Description including Protocol Specification [8] and the applicable Firmware Release Note.

Related documents

[1] LEA-6 Data Sheet, Docu. No GPS.G6-HW-09004
[2] NEO-6 Data Sheet, Docu. No GPS.G6-HW-09005
[3] AMY-5M Data Sheet, Docu. No GPS.G5-MS-08196
[4] UBX-G60x0 Data Sheet, Docu No GPS.G6-HW-12001
[5] UBX-G6010-NT Data Sheet, Docu No GPS.G6- HW-12002
[6] LEA-6 / NEO-6 Hardware Integration Manual, Docu. No GPS.G6-X-09007
[7] UBX-G6010, UBX-G6000/UBX-G0010 Hardware Integration Manual, Docu. No GPS.G6-X-09006
[8] u-blox 6 Receiver Description including Protocol Specification, Docu. No GPS.G6-SW-10018
[9] FW 7.03 Release Note, Docu. No GPS.G6-SW-11013
[10] FW 6.02 Release Note, Docu. No GPS.G6-SW-10003

For regular updates to u-blox documentation and to receive product change notifications please register on our homepage (www.u-blox.com):

Revision history

Revision	Date	Name	Status / Comments
A	10/22/2010	ffel	Initial release
A1	12/14/2010	ffel	Update for FW7.01
A2	01/10/2011	ffel	Errata corrections
B	02/02/2012	ffel	Update for FW7.03

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