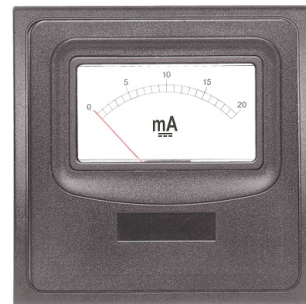


Power Management Considerations with u-blox 6 GPS receivers

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

2 Power management options

2.1 Hardware options

2.1.1 u-blox 6 modules

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

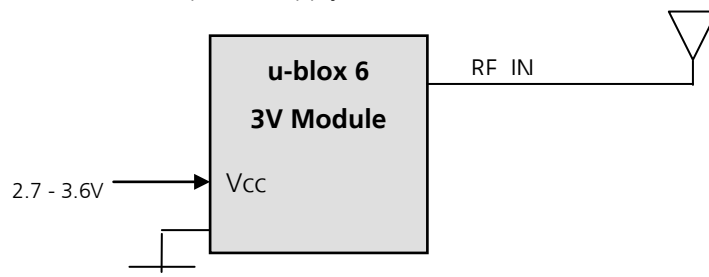


Figure 1: u-blox 6 modules with supply voltage of 3V nominal (2.7 ... 3.6 V)

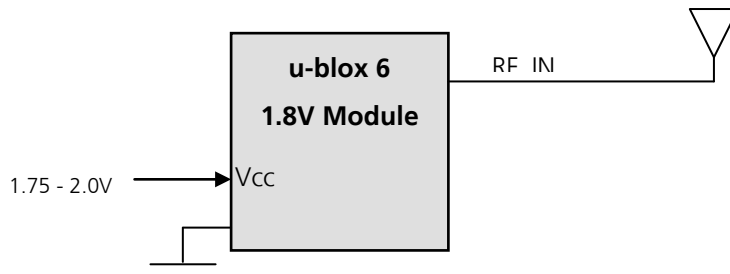


Figure 2: u-blox 6 modules with supply voltage of 1.8V nominal (1.75 ... 2.0 V).

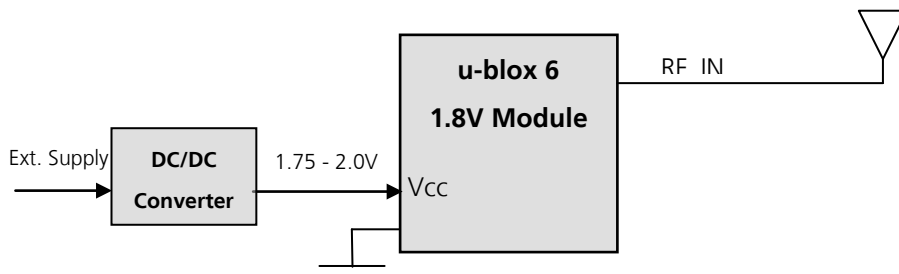


Figure 3: u-blox 6 modules supplied by DC/DC converter.



For more information, 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:

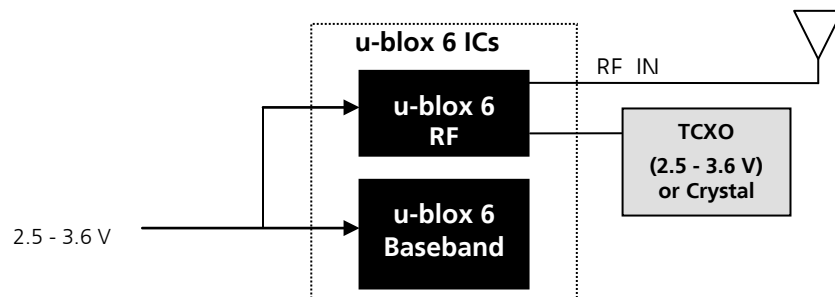


Figure 4: Single supply voltage from 2.5 ... 3.6 V

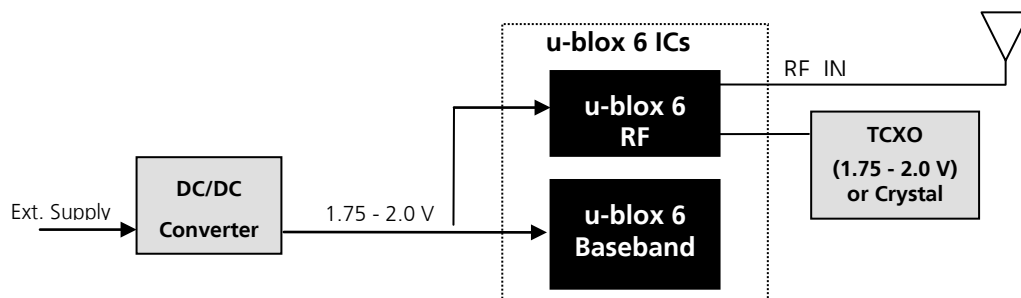


Figure 5: Single supply voltage of 1.8 V nominal (1.75 ... 2.0 V)

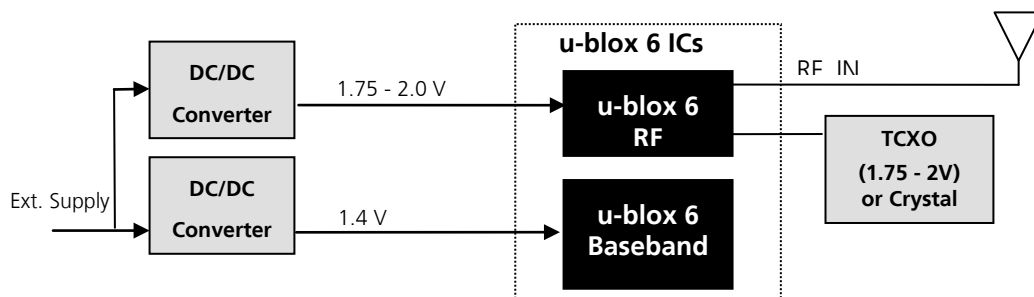


Figure 6: Separate supply of 1.8 V nominal (1.75 ... 2.0 V) and 1.4 V (1.4...3.6 V)



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

2.2 Software options

2.2.1 Operating modes

u-blox 6 technology offers 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 an optimum of GPS performance and power consumption for a given scenario. Actually reduction in power consumption will result in some degradation of GPS performance, but might be well sufficient for the specific application.



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

2.2.1.1 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. As a consequence, lower tracking current consumption level will only be achieved when: a valid GPS position is fixed; Almanac is entirely downloaded and Ephemeris for all possible satellites in view are valid. In a true life scenario this ideal conditions will rarely exist.

2.2.1.2 Eco Mode

In Eco Mode, u-blox 6 receivers use the acquisition engine to search for new satellites **only when needed** for navigation and deactivate 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 searching for new satellites if necessary:

- During cold starts, it searches for enough satellites to navigate and optimizes use of the acquisition engine to download their ephemeris.
- During warm and hot starts, it 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.

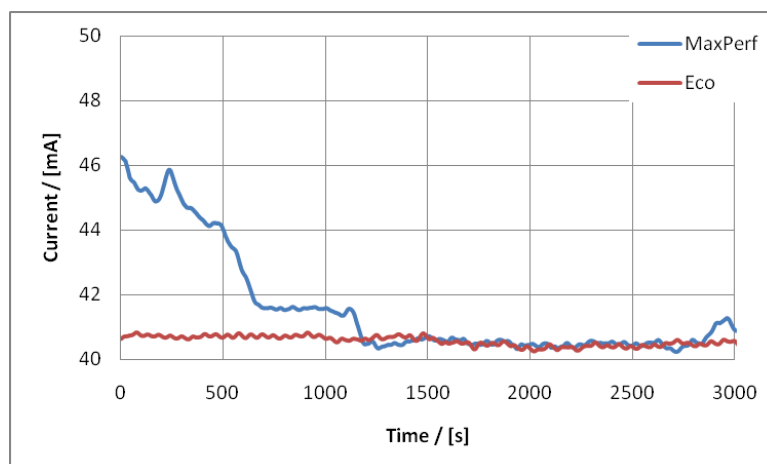


Figure 7: Current consumption during cold start with good sky visibility (acquisition: 0s...1200s, tracking: 1200s...2700s)

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 reducing power consumption.

2.2.1.3 Power Save Mode

Power Save Mode (PSM) allows a reduction in system power consumption depending on signal strength and PSM settings. Mainly the update period length causes the receiver to perform differently, which is called ON/OFF operation and cyclic tracking operation. In conjunction with other settings PSM can be configured to match optimally with a given scenario.

Power Save Mode will be described in detail in the next section.



Power Save Mode can be configured by using the message CFG-PM with FW6.02 and CFG-PM2 with FW7.01 and above.

2.2.2 Power Save Mode: detailed description

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

2.2.2.1 Long update period – ON/OFF operation

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.

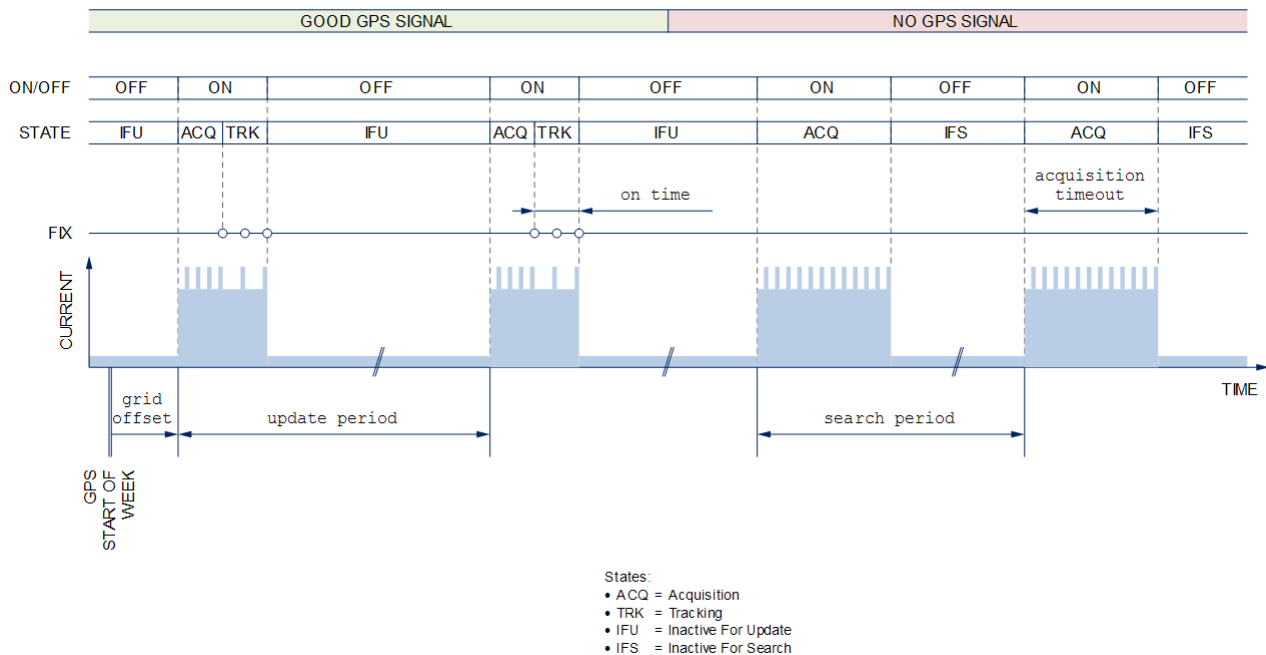


Figure 8: ON/OFF operation of the PSM

2.2.2.2 Short update period – cyclic tracking operation

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* [7] (see Related documents).

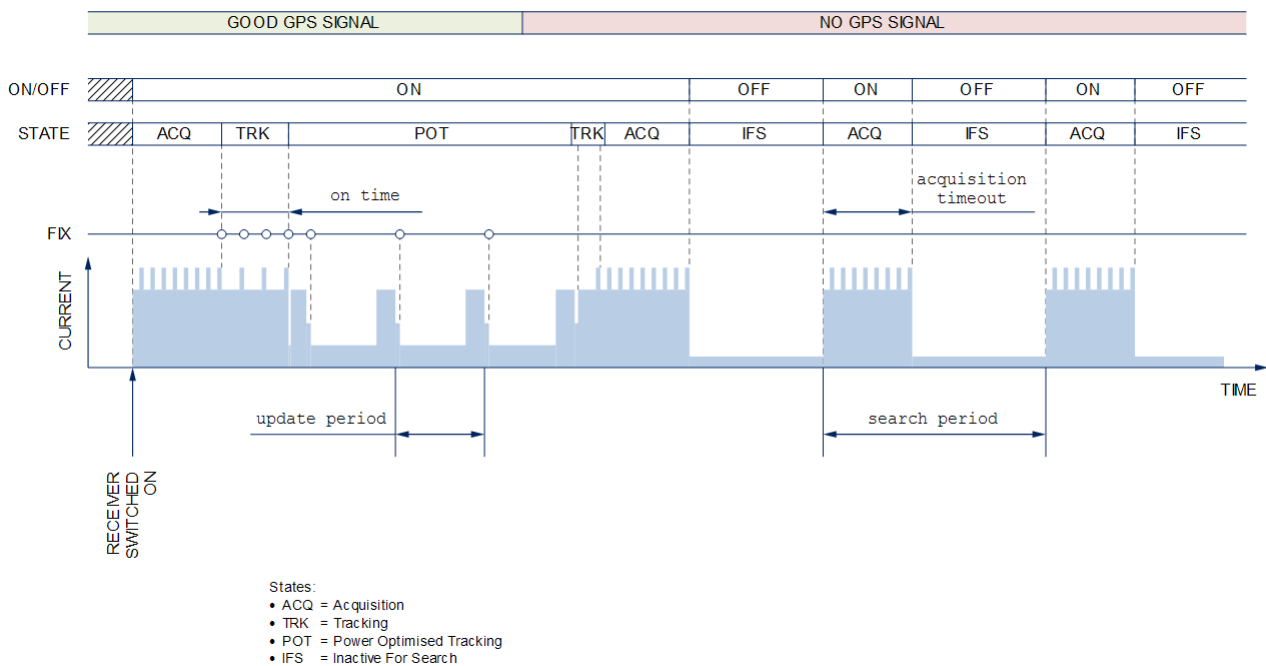


Figure 9: Cyclic tracking operation of the PSM

3 Performance

3.1 Supply voltage option

3.1.1 Recommendation

Good performance requires a clean and stable power supply with minimal ripple. Care needs to be exercised in selecting a strategy to achieve this. Placing a resistor at V_{cc} can negatively impact performance. For better performance, use an LDO to provide a clean supply at V_{cc} 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 V_{cc} can create 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).

3.1.2 Optimization

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

3.2 Operating modes option

3.2.1 General considerations using the PSM

As mentioned before, the receiver calculates position fixes at a given period. This period is called *update period*. ON/OFF operation is available for update periods greater than 5s and cyclic tracking operation is available from 1s to 5s with FW6.02 and from 1s to 10s with FW7.01.

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 30s, but obviously much fewer position fixes are calculated.



For update periods smaller than 30 s ON/OFF operation shows no advantage compared to cyclic traffic 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 the Max Performance Mode with worse GPS performance. In this case it is recommended to use Max Performance Mode only.

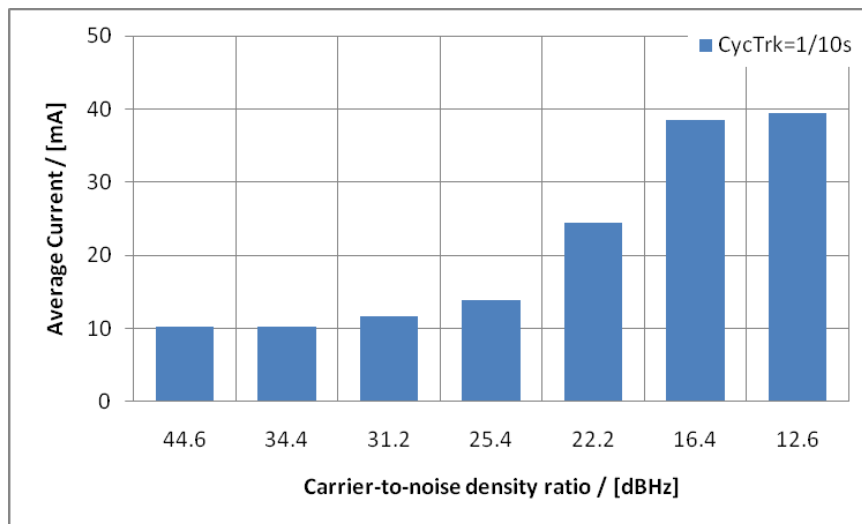


Figure 10: Average current at different carrier-to-noise density ratios for PSM in cyclic tracking operation (update period: 1s, search period: 10s)

3.2.2 Example: Power Save Mode with long update period

As an example of ON/OFF operation an update period of 30s was chosen. Figure 11 shows a typical current profile switching from active to inactive state. However, figure 12 shows that only a few position fixes are calculated. The average current consumption was about 8mA in this scenario. 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.

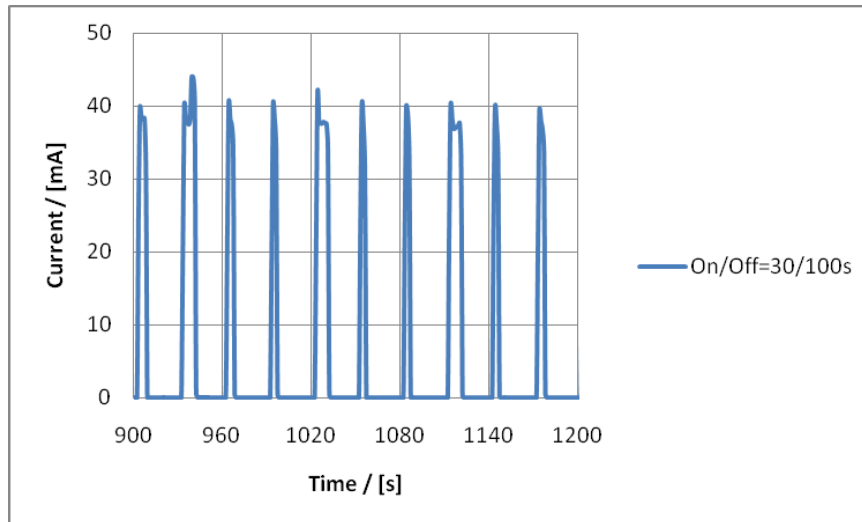


Figure 11: Current consumption in ON/OFF operation with good sky visibility (update period: 30s, search period=100s)

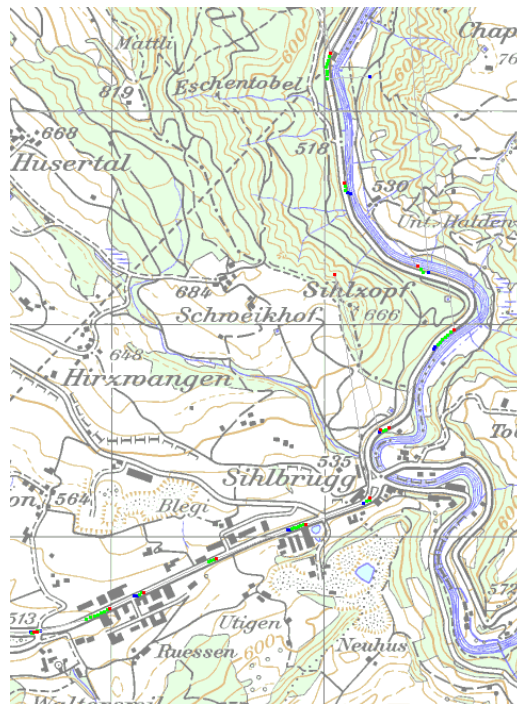


Figure 12: Position fixes in ON/OFF operation with good sky visibility (update period: 30s, search period=100s)

3.2.3 Example: Power Save Mode with short update period

As an example of cyclic tracking operation an update period of 1s was 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 12mA in this scenario.

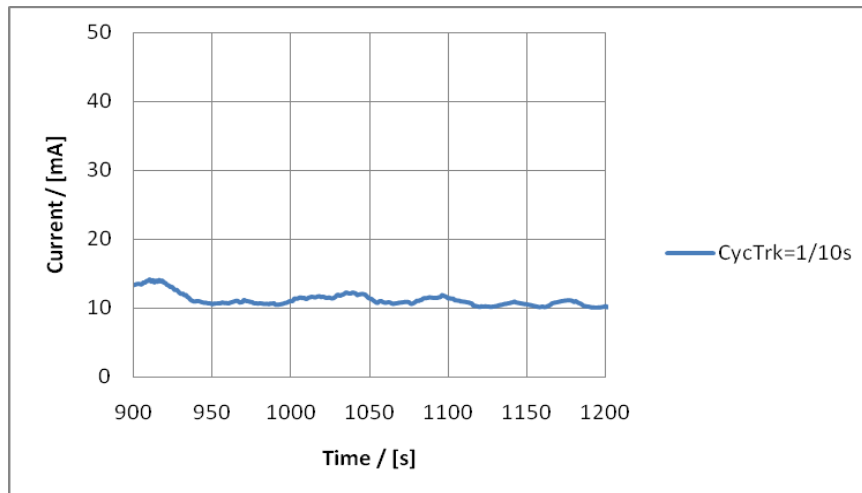


Figure 13: Current consumption in cyclic tracking operation with good sky visibility (update period: 1s, search period: 10s)

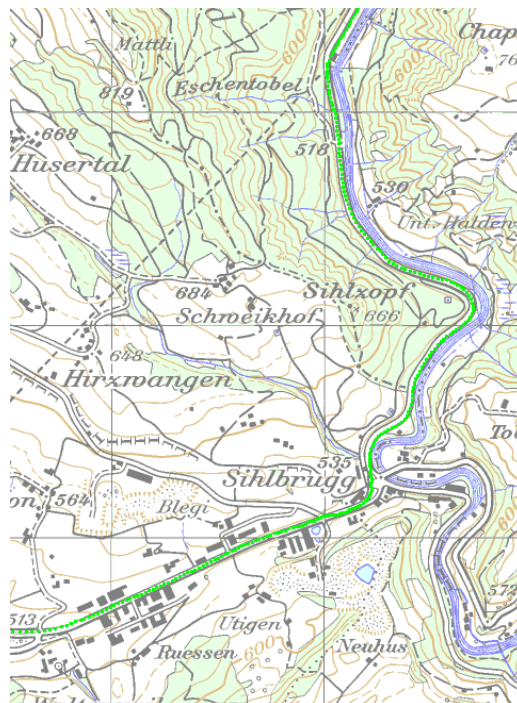


Figure 14: Position fixes in cyclic tracking operation with good sky visibility (update period: 1s, search period: 10s)

4 Settings and configuration

4.1 Hardware settings

4.1.1 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. Please note that Power Save Mode cannot be configured by hardware default, but can be changed later on by 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 1: 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.

4.1.2 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 2: Default operating modes on u-blox 6 modules

4.2 Software settings

4.2.1 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 CFG-RXM:

- Maximum Performance Mode enables the full capability of u-blox 6 positioning. Thus it should be used if GPS performance is most important.
- Eco Mode can be selected for slightly reduced current consumption with nearly the same GPS performance.
- Power Save Mode allows significant reduction in system power consumption with reasonable GPS performance. Cyclic tracking operation is recommended for scenarios with moderate to good signals

where position fixes are frequently needed. And ON/OFF operation is recommended for scenarios with strong signals and where position fixes are rarely needed.



For more information, consult the Receiver Description including Protocol Specification and Firmware Release Note (see Related documents).

5 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-G6010, UBX-G6000/UBX-G0010 Data Sheet, Docu No GPS.G6-X-09004
- [5] LEA-6 / NEO-6 Hardware Integration Manual, Docu. No GPS.G6-X-09007
- [6] UBX-G6010, UBX-G6000/UBX-G0010 Hardware Integration Manual, Docu. No GPS.G6-X-09006
- [7] u-blox 6 Receiver Description including Protocol Specification, Docu. No GPS.G6-SW-10018



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	22/10/2010	ffel	Initial release
A1	14/12/2010	ffel	Update for FW7.01
A2	10/01/2011	ffel	Errata corrections

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