Low Power Modes Application Note

AirPrime XM0110 Module

SIERRA WIRELESS

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Contact Information

Sales Desk:	Phone:	1-604-232-1488
	Hours:	8:00 AM to 5:00 PM Pacific Time
	E-mail:	sales@sierrawireless.com
Post:	Sierra Wireless 13811 Wireless Way Richmond, BC Canada V6V 3A4	
Fax:	1-604-231-1109	
Web:	www.sierrawireless.com	

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Document History

Version	Date	Updates
001	June 21, 2010	Creation
002	December 17, 2010	Details added on Low Power Navigation behavior
		Details added on Embedded Module Active/Sleep mode, and stack ON / stack OFF modes.
		Take into account sleep modes renaming (sleep mode becomes idle mode, deep sleep mode becomes hibernate mode)
		All power consumption figures and accuracy figures updated
		Details added on Host Wake-Up application
		Details added on External XM0110 Control application
		2 Use-case examples added in synthesis chapter
003	February 28, 2011	Acquisition power consumption updated
		Embedded Module Wake-Up Application description updated
		External XM0110 Control Application updated
004	October 24, 2011	Current consumption data updated with Open AT Framework 2.36 and 1.2.0.201108191103 Location Library values.
		AEE data added to the Power Modes Overview section.
		GPS Deep Sleep mode information added
		How to estimate criteria to select one low power mode (Off, Deep Sleep or Hibernate) added.
		Updated Total System Power Consumption according to latest data
5.0	June 15, 2012	Update document reference numbers and legal boilerplate.
		Sections 5.2.2, 5.2.3, and 5.2.4 updated based on the release update from 1.2 to 1.3.

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1. Introduction

1.1. Overview

This Application Note provides detailed information about the low power modes of operation available with the GPS solution based on AirPrime XM0110 GPS module combined with AirPrime Embedded Module.

This Application Note explains the benefits and impacts of the various low power modes, together with associated hardware and software requirements.

1.2. Related Documents

[1] Location Library AT Command Interface Guide

Reference: 4110991

[2] Location Library Development Guide

Reference: 4110990

[3] AT Commands Interface Guide for Firmware

Reference: 4111703; 4111843

[4] ADL User Guide for Open AT Framework

Reference: 4111704; 4111844

[5] AirPrime XM0110 Product Technical Specification and Customer Design Guidelines

Reference: 4111805

[6] AirPrime XM0110 Development Kit Daughter Board User Guide

Reference: 4112246

[7] GPS Aiding for AirPrime XM0110

Reference: WM_DEV_XM0110_APN_002

1.3. Glossary

Embedded Module or **AirPrime Embedded Module**: a Sierra Wireless AirPrime Embedded Module, capable of wireless connectivity, and acting as host processor of the AirPrime XM0110 GPS Module.

AirPrime XM0110 GPS Module: a Sierra Wireless' AirPrime GPS module, acting as a GPS receiver, and compatible with AirPrime Embedded Modules.

2. System Overview

2.1. System Presentation

The AirPrime XM0110 GPS Module, used in combination with an AirPrime Embedded Module, offers several low power options, offering choices for the best compromise between highest GPS performances and lowest total system power consumption.

A GPS solution based on XM0110 is composed of the AirPrime XM0110 GPS module (the GPS receiver) and the AirPrime Embedded Module (the host processor). The Embedded Module may directly run the customer OS application (“OS use case”) or, alternatively, an external application processor may drive the Embedded Module through Location AT commands extension set (“External host use case”).

In both cases, in the typical application (see Figure 1) the AirPrime Embedded Module drives the XM0110 GPS Module through a serial interface and few GPIOs. The XM0110 also requires a 32k clock input that can also be supplied by the Embedded Module.

For some low power modes, the application may differ, i.e. 32k and ON/OFF may have to be driven externally by the application, and/or an Embedded Module interrupt may be required.

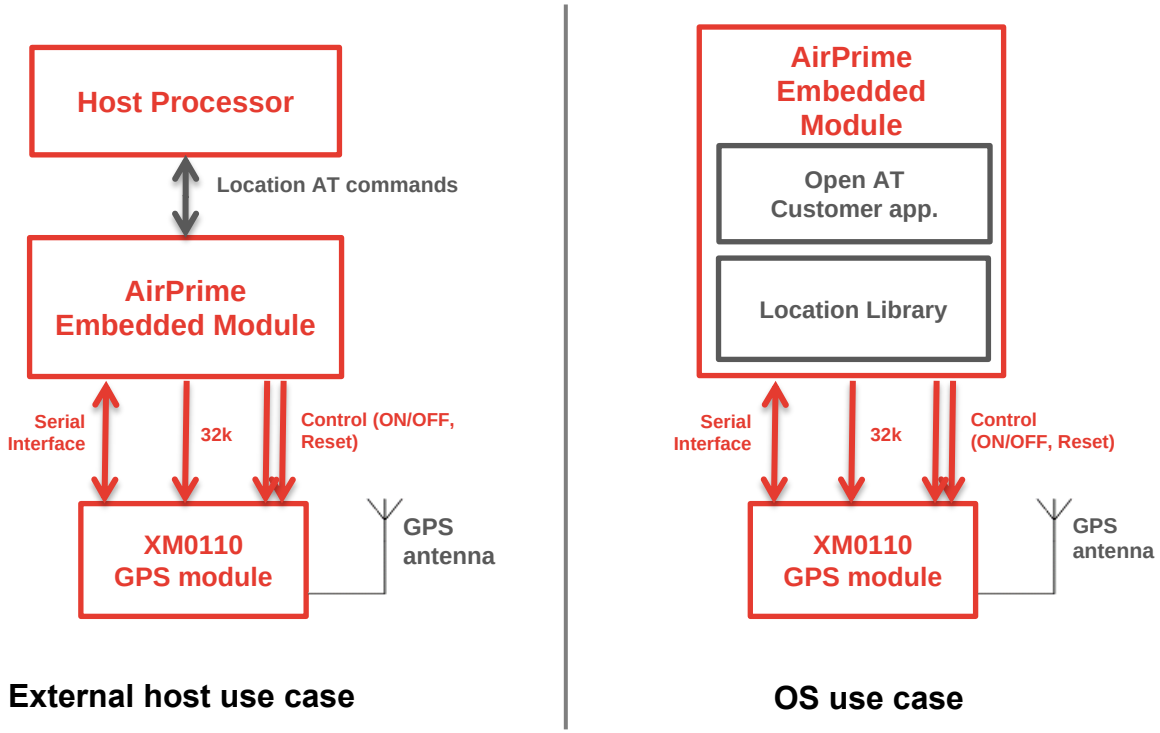

Figure 1. System Overview – Typical application

The AirPrime XM0110 GPS Module is based on SiRFstarIV GSD4t GPS receiver, which contains hardware and firmware to acquire GPS satellites signals and perform some pre-processing. XM0110 has limited autonomy; it requires the Embedded Module to run host GPS software to exploit GPS signals in ways like for decoding ephemeris or calculating a GPS position (see Figure 2).

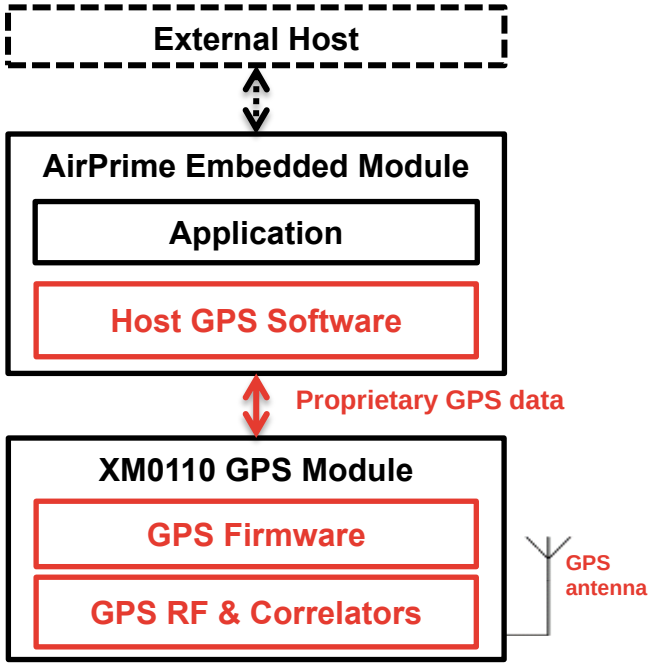

Figure 2. Functional Architecture

2.2. System Low Power Modes

The low power mode of operation of the GPS solution based on XM0110 is achieved using combinations of the Embedded Module low power modes (as described in section 4) and the AirPrime XM0110 GPS module low power modes (as described in section 5).

The selection of the low power modes to be used depends strongly of GPS target use cases, which are described in section 3.

Note that all low power modes are available in the 2 types of application: external host processor driver with Location AT command extension on Embedded Module, and OS application executed on Embedded Module.

However, the hardware application may vary according to the low power mode to be used. The main possible hardware applications are indicated through this document and summarized in section 6.

3. GPS Application Use Cases

Two main application use cases have to be considered to decide for the power mode to use:

- the navigation use case
- the push-to-fix use case

3.1. Navigation Use Case

In the navigation use case, the GPS solution is permanently running to calculate up-to-date GPS position information at a regular short period (typically 1 second up to several seconds). In this mode, up-to-date GPS information is available immediately to the application; it is automatically reported to the application at a pre-configured period.

Note that this does not mean that at each period a valid fix is available – for example no fix may be available if there is no GPS signal – but at least an up-to-date fix status will be available to the application.

In navigation use case, various levels of low power modes are available. Such low power mode may impact the GPS position accuracy, and require some minimum GPS reception quality to be effective.

3.2. Push-to-Fix Use Case

In the Push-to-Fix use case, the application stops (or pauses) the GPS solution for an undefined duration, and restarts (or resumes) operation when needed.

Note that in the periods in which the GPS solution is running, the solution is in fact in navigation use-case.

Some low power modes of operation are available in Push-to-Fix use case. The time required to restart the GPS operation and to obtain a first fix varies according to the low power mode. It depends also on the duration of the interruption, and if assisted GPS (for example Autonomous Extended Ephemeris) is used.

4. Embedded Module Power Modes of Operation

4.1. Power Modes Overview

The AirPrime Embedded Module may be in 3 main power modes of operation, characterized by different power consumption and feature availability:

- Active Mode
- Sleep Mode
- Alarm/OFF modes

In addition, while in Active Mode or in Sleep Mode, the application can control the Embedded Module GSM stack state to lower the power consumption:

- GSM Stack ON
- GSM Stack OFF

Finally, the Embedded Module CPU clock speed will also impact the power consumption.

Autonomous Extended Ephemeris (AEE) feature forces high speed usage (104MHz), increasing the Embedded Module power consumption during Extended Ephemeris computation.

The table below provides, as an example, AirPrime WMP100 Embedded Module power consumption in the various modes of operation.

Table 1: Example of Embedded Module power consumption measurements: AirPrime WMP100 and its 64/16 memory combo power consumption at 3V6 power supply

Mode of Operation	Conditions	Power consumption
Alarm/OFF Mode		20 uA
Sleep Mode, GSM stack OFF	No application processing.	0.9 mA
Sleep Mode, GSM stack ON	In GSM Idle, paging 4. No application processing	3.5 mA
Active Mode	With application permanent processing	40 mA
AEE computation period	Occurs for each new satellite during 2.5sec	70mA

Note: To get or measure your Embedded Module specific power consumption, please refer to your Embedded Module Product Technical Specification.

Note: Active mode power consumption data is provided for the module running in standard mode. Additional power consumption occurs when the module is switched to boost mode.

The following sub-sections will provide more information on the benefits and impacts of each mode on the GPS solution.

The compatibility of Embedded Module low power modes with each one of the AirPrime XM0110 GPS module low power modes is also indicated in each XM0110 power mode description and in section 6.

Autonomous Extended Ephemeris information (principle, benefits, implementation using AT commands or Location Library) are described in document [7].

4.2. Embedded Module Active Mode

4.2.1. Principle

Embedded Module Active Mode is the default operating mode. It is a full power mode with no feature restriction on the Embedded Module. All interfaces are available.

In Active Mode, the Embedded Module power consumption does NOT significantly vary according to the various GPS modes of operation.

4.2.2. Benefits & Impacts

Embedded Module Active Mode is fully compatible to all GPS modes, with the standard application (see 6.1).

This is the simplest configuration. It should be used if power consumption of the Embedded Module is not critical, or if the Embedded Module is active most of the time due to other running application tasks on the Embedded Module.

4.2.3. Implementation Using AT commands

By default, Active mode is used after Embedded Module reset.

In case the default starting mode was changed to Sleep Mode, AT+WBHV=1,0 (Active mode, GSM Stack ON) or AT+WBHV=1,1 (Active mode, GSM Stack OFF) commands can be used to revert the default mode after an Embedded Module reset to be the Active mode.

Alternatively, in case the Embedded Module is in Sleep Mode, AT+W32K=0 allows reverting back immediately to Active mode without requiring a reset. This command does not change the default starting mode, only the current Embedded Module mode: the Embedded Module starting mode (default starting mode, or starting mode set with AT+WBHV) will apply after reset.

Please refer to document [3] for more details about Embedded Module Firmware AT commands.

4.2.4. Implementation Using OS

There is no dedicated OS interface controlling of the Embedded Module mode of operation.

To configure the Embedded Module mode of operation, the Open AT Framework application must send the AT commands listed in the previous subsection using appropriate OS API (see document [4] for complete information).

4.3. Embedded Module Sleep Mode

4.3.1. Principle

Embedded Module Sleep Mode is a low power consumption mode with restricted access to peripheral interfaces. Power savings take place when the Embedded Modules is in sleep periods, i.e. its runs on its 32k clock. This requires, once Sleep Mode is activated, that the application and the GSM stack have no more pending processing.

The Embedded Module automatically wakes up (exits sleep period) on some unsolicited events like GSM paging (if stack is on), External Interruption, Key press, Strict Timer expiration, etc, and goes back to sleep once requested processing are completed.

The Embedded Module will not wake up automatically on any interface, and typically it will not wake up automatically when data are received on UART or I2C serial interface; such data will be lost. An external interrupt is required in such cases to wake up the Embedded Module at the start of UART or I2C incoming flow.

Note: Depending on software configuration, the UART1 DTR signal may be used to avoid the Embedded Module entering sleep periods or wake-up Embedded Module.

Note: When a device is connected on the Embedded Module USB port, and the USB port has been activated, Embedded Module does not enter into sleep periods.

Note: Sleep mode limitation until1.3 location library : only UART is available for this mode.

In Sleep Mode, the Embedded Module power consumption significantly varies according to the GPS mode of operation.

4.3.2. Benefits & Impacts

The Embedded Module Sleep Mode is not compatible to GPS Navigation and GPS Idle mode with the default application, as data sent by AirPrime XM0110 on the serial interface could be lost.

To be compatible with all GPS modes, including GPS Navigation and GPS Idle mode, a specific hardware application with Embedded Module wake-up through External Interrupt must be used. For more details on this application, see section 6.3. Note that this application remains compatible to Active Mode, in which case switching between Sleep Mode and Active Mode is allowed.

The power savings brought by the activation of Embedded Module Sleep Mode depends on observed Embedded Module sleep period duration versus running period duration. The sleeping time ratio depends on the GPS mode used, as the GPS mode impacts the traffic on the serial interface – Embedded Module is not sleeping while data are received from the AirPrime XM0110 – and the amount of GPS processing required on the Embedded Module. The sleep period ratios, and therefore the power savings, for each mode, are provided in section 5.

4.3.3. Implementation Using AT commands

By default, Active mode is used after Embedded Module reset.

You can change the Embedded Module starting mode after reset to be Sleep Mode with AT+WBHV=1,2 command. Note that with this command, GSM Stack is also turned OFF, and that a reset of the Embedded Module is required after the AT command for Sleep Mode to take effect.

Alternatively, AT+W32K=1 enables the mode to change from Active mode directly into Sleep Mode without the need for a reset. In this case, Sleep Mode may not be preserved after Embedded Module reset: the Embedded Module starting mode (default starting mode, or starting mode set with AT+WBHV) applies.

Note: AT+W32K=1,0 forces to ignore DTR signal in Sleep Mode, whereas with AT+W32K=1,1, the Embedded Module takes DTR state into account to enter/exit sleep periods.

Please refer to document [3] for more details on Embedded Module Firmware AT commands.

4.3.4. Implementation Using OS

There is no dedicated OS interface allowing the control of the Embedded Module mode of operation.

To configure the Embedded Module mode of operation, the Open AT Framework application must send the AT commands listed in previous sub-section using appropriate OS API (see document [4]).

4.4. Embedded Module Alarm/OFF Modes

4.4.1. Principle

In Embedded Module Alarm/OFF modes, the embedded application is no longer running. All interfaces are turned off (including 32K output). Only the RTC remains powered, allowing for waking up if an alarm was programmed.

4.4.2. Benefits & Impacts

This mode provides the lowest Embedded Module power consumption.

Embedded Module Alarm and OFF modes are not compatible to GPS Navigation and GPS Idle modes because no GPS processing can take place on Embedded Module in these modes.

GPS Off mode is of course compatible to Embedded Module Alarm/OFF modes.

GPS Hibernate mode can be made compatible to Embedded Module Alarm/OFF mode. But this requires a specific application to be used, in which AirPrime XM0110 32k and ON/OFF inputs are not driven by the Embedded Module but by the application itself, via an external controller and/or some hardware logic. For more details on this application, see section 6.4.

4.4.3. Implementation Using AT commands

AT+CALA must be used to program an alarm, and AT+CPOF (with Embedded Module ON/OFF switch low) to activate this mode. Alarm expiration or setting ON/OFF switch high will exit this mode.

Please refer to document [3] for more details on Embedded Module Firmware AT commands.

4.4.4. Implementation Using OS

There is no dedicated OS interface allowing the control of the Embedded Module mode of operation.

To configure the Embedded Module mode of operation, the Open AT Framework application must send the AT commands listed in previous sub-section using appropriate OS API (see document [4]).

4.5. Embedded Module Stack ON/Stack OFF

4.5.1. Principle

If GSM stack is turned off, SIM device and GSM/GPRS features are not available. It is also possible to turn off the GSM stack RF only while keeping the SIM active. In both cases, the embedded application behavior is not impacted.

At any time, stack RF and SIM can be re-activated.

4.5.2. Benefits & Impacts

Turning off the GSM stack will significantly reduce power consumption of the system.

Turning off the GSM stack has no impact to the GPS feature behavior. It is compatible to all GPS modes of operation. Therefore, when no GSM activity is necessary, it is recommended to turn off the GSM stack to save power.

4.5.3. Implementation Using AT commands

By default, GSM Stack is ON after Embedded Module reset.

You can change the Embedded Module starting mode after resetting to set the GSM Stack OFF with AT+WBHV=1,1 (Active mode and GSM Stack OFF) or AT+WBHV=1,2 (Sleep Mode and GSM Stack OFF) commands. Note that a first reset is required after AT command to turn GSM Stack OFF.

Alternatively, AT+CFUN=0 turns the GSM stack and SIM device off, and AT+CFUN=4 turns the GSM stack RF off while keeping SIM device on. AT+CFUN=1,0 re-activates the GSM stack and SIM device. None of these commands cause nor require Embedded Module reset, but the change is not preserved after Embedded Module reset.

Note: *In order to not impact the GPS, if running, GSM stack ON request must explicitly request to not reset the module, using the commands AT+CFUN=1,0. AT+CFUN=1 will instead reset the Embedded Module.*

Please refer to document [3] for more details on Embedded Module Firmware AT commands.

4.5.4. Implementation Using OS

There is no dedicated OS interface allowing the control of the Embedded Module mode of operation.

To configure the Embedded Module mode of operation, the Open AT Framework application must send the AT commands listed in previous sub-section using appropriate OS API (see document [4]).

5. AirPrime XM0110 GPS Module Low Power Modes

The AirPrime XM0110 uses different kinds of resources that can be turned on or off to save energy, in particular:

- Storage capabilities
- Radio Frequency receiver capabilities
- Processing capabilities
- Clock capabilities

The low power modes of XM0110 that are described in detail in this section are directly linked to the low power modes available with SIRFstarIV GSD4t.

The table below summarizes AirPrime XM0110 average current according to its various modes of operation, and the LNA settings. For more details, please refer to [4].

Table 2: AirPrime XM0110 averaged power consumption in the various operation mode at -130dBm

Operating Mode		I average (internal LNA)	I average (external LNA)	Unit
Push-to-Fix	GPS Off	<5		µA
	GPS Deep Sleep	9		µA
	GPS Hibernate	25		µA
	GPS Idle	<500		µA
1Hz Navigation	Very Low Power Navigation	7	6	mA
	Low Power Navigation	11	10	mA
	Medium Power Navigation	22	19	mA
	Full Power Navigation	33	28	mA
Acquisition		58	54	mA

The subsections in this chapter define the principle, benefits and impacts of each XM0110 power mode. This includes impacts on the Embedded Module power consumption.

5.1. Standard (1Hz) GPS Navigation

5.1.1. Principle

In full power navigation, the AirPrime XM0110 is continuously listening to satellite signal. This means that all operative parts remain permanently active. At the default GPS update rate (once per second), a position update is available.

In order to reduce power consumption, it is possible to receive satellite signals for a limited time but keeping standard 1Hz update rate. This Low Power Navigation mode is using GSD4t Trickle Power mode.

3 different Low Power Navigation profiles have been defined with different GPS signal reception window duration: Medium Power, Low Power, and Very Low Power.

It is important to note that:

- Until a 3D fix is accomplished, the XM0110 power consumption will be the GPS acquisition power consumption, whether the selected full power or low power navigation mode.
- Even if one of the 3 low power navigation profiles is activated, full power navigation will apply in following conditions:
  - If the 4 best satellites' signal strength is not strong enough, or
  - When specific data collection is required for the navigation, such as ephemeris, almanac, ionospheric or UTC data.

The navigation mode requires the Embedded Module to be running every second to process GPS data.

5.1.2. Benefits & Impacts

Listening only for a reduced time the satellite signal during the GPS update period significantly reduces AirPrime XM0110 power consumption, thanks to the RF part, TCXO and processor being turned off partly between two updates. The counterpoint is the degradation of the GPS position accuracy.

The table below gives typical XM0110 power consumption and GPS position accuracy figures obtained for each mode.

Table 3: XM0110 power consumption and GPS position accuracy according to GPS Navigation mode

	GPS RF window length	XM0110 average current(1)	GPS tracking accuracy @-130dBm (50%)
Full Power navigation	Continuous	28 mA	<2.5 m
1Hz Medium Power navigation	600 ms	19 mA	<3.5 m
1Hz Low Power navigation	200 ms	10 mA	<5 m
1Hz Very Low Power navigation	100 ms	6 mA	<7 m

(1) With external LNA settings

Obtaining the above mentioned power consumption is conditioned to the availability of a fix with some minimum satellite signal strength. If the fourth-best satellite level goes below 26dB-Hz (which corresponds to approximately -143dBm), XM0110 falls back to full power navigation. Once the fourth-best satellite level goes back to a value exceeding 30dB-Hz, the low power navigation mode is automatically resumed.

The compatibility of the full power and low power navigation modes with the Embedded Module modes of operation is as follows:

- Active mode: Compatible
- Sleep Mode: Not compatible with the default application. A specific software and hardware application with Embedded Module wake-up by XM0110 GPS module has to be used. See section 6.3 for more details.
- Alarm/OFF mode: Not compatible.

While Sleep Mode is activated, Embedded Module power consumption benefits depend on selected profile. The table below gives the Embedded Module effective sleep time and an example of power consumption depending on the navigation modes.

Table 4: Example of system power consumption in GPS Navigation in UART case

GPS mode	Active Mode GSM Stack ON(1)		Sleep Mode GSM Stack ON(1)	
	Embedded Module	**Embedded Module + XM0110(2)**	**Embedded Module**	**Embedded Module + XM0110(2)**
1Hz Very Low Power navigation	41 mA	**47 mA**	20 mA	**27 mA**
1Hz Low Power navigation	41 mA	**51 mA**	23 mA	**33 mA**
1Hz Medium Power navigation	41 mA	**60 mA**	22 mA	**41 mA**
Full Power navigation	41 mA	**69 mA**	22 mA	**50 mA**

(1) AirPrime WMP100 Embedded Module, in GSM Idle, Paging 4.
(2) With external LNA settings

Note that prior to GPS fix, the power consumption is the acquisition power consumption.

5.1.3. Implementation Using Location AT Commands

The typical AT command sequence to type, in order to activate the navigation low power mode is:

```
AT+GPSINIT=…
AT+GPSCONF=0,X
AT+GPSSTART
```

The specified navigation power mode is now activated. The parameter « X » defines the navigation power mode as follows:

```
0:   Full power navigation mode.
1:   Medium power navigation mode.
2:   Low power navigation mode.
3:   Very low power navigation mode.
```

The AT command AT+GPSCONF=0,*X* can be called at any time while application is in INITIALIZED, RUNNING or SLEEP states, to change the navigation power mode.

Tip: *In order to know at a given time if the low power navigation is effective, i.e. if the conditions have been reached to have shortened GPS RF window, EXT_LNA_EN signal can be monitored. If EXT_LNA_EN signal remains high permanently, low power navigation is not effective. If EXT_LNA_EN signal toggles every second, low power navigation is effective. Alternatively, GPS debug raw data also allow to check if low power was active or not at a given time.*

5.1.4. Implementation Using Location Library

The following function should be called in order to activate and configure the navigation power mode:

```
gps_init(…)
gps_coreSetOpts( GPS_OPT_CORE_RUNNING_POWER_MODE, X,  GPS_OPT_END);
gps_start(…)
```

The parameter « X » selects the navigation power mode:

```
0:   Full power navigation mode.
```

```
1:   Medium power navigation mode.
2:   Low power navigation mode.
3:   Very low power navigation mode.
```

The gps_coreSetOpts() function can be called at any time while Location library is in GPS_INITIALIZED, GPS_RUNNING or GPS_SLEEP states.

Tip: *In order to know at a given time if the low power navigation is effective, i.e. if the conditions have been reached to have shortened GPS RF window, EXT_LNA_EN signal can be monitored. If EXT_LNA_EN signal remains high permanently, that low power navigation is not effective. If EXT_LNA_EN signal toggles every second, low power navigation is effective. Alternatively, GPS debug raw data also allow to check if low power was active or not at a given time.*

5.2. Reduced Rate GPS Navigation (Available from 1.3 Release)

5.2.1. Principle

In addition to reducing the GPS signal reception period, it can be decided to increase the GPS update period from 1 second to 2 seconds (0.5Hz) or more. Up to 10 seconds update rate (0.1Hz navigation rate) is supported.

This is of course to be used only if the application does not require 1Hz navigation, but a slower rate is acceptable.

In full power navigation, reducing the navigation rate will have no significant effect as the GPS receiver will be continuously active. In low power navigation mode, reducing the navigation rate lowers power as GPS receiver inactivity periods will significantly increase.

5.2.2. Benefits & Impacts

Reduced rate navigation mode increases the power savings in a close to linear way compared to 1Hz low power navigation modes. In addition, impact on system power saving will be very significant when Embedded Module is in sleep mode (large period without any activities).

The compatibility of the reduced rate navigation with the Embedded Module modes of operation is same as for 1Hz navigation modes (see 5.1.2).

Note: As all low power modes, using update rate feature have an impact on signal to noise ratio and 2D accuracy error.

Table 5: AirPrime XM0110 current consumption for 1 period and 1 hour according to GPS update rate navigation mode

AirPrime XM0110 Current Consumption	Short Term Period(1)	1 Hour Average Example(2)
1Hz Full Power navigation	28.9 mA	28.9 mA
0.5Hz Update rate navigation	14.6 mA	15.9 mA
0.2Hz Update rate navigation	6.5 mA	8.3 mA
0.1Hz Update rate navigation	3.3 mA	4,7 mA

(1) These values provide short term measurement that show minimum current consumption limits. These measurements have been done on consecutive period with exact update rate limits (so, without maintenance period or update rate variation).

(2) These values are measured during 1 hour. Due to maintenance activity and update rate variation result could vary from 1 period limit to 1Hz Full Power navigation.

Table 6: Example of system power consumption in GPS Navigation, in UART mode, with several update rate

GPS mode	Active Mode GSM Stack ON(1)		Sleep Mode GSM Stack ON(1)	
	Embedded Module	**Embedded Module + XM0110(2)**	**Embedded Module**	**Embedded Module + XM0110(2)**
1Hz navigation	41 mA	**70 mA**	21 mA	**50 mA**
0.5Hz update rate navigation	41 mA	**57 mA**	14 mA	**28 mA**
0.2Hz update rate navigation	41 mA	**49 mA**	11 mA	**18 mA**
0.1Hz update rate navigation	41 mA	**46 mA**	6 mA	**11 mA**

(1) AirPrime WMP100 Embedded Module, in GSM Idle, Paging 4.

(2) With external LNA settings

5.2.3. Implementation using Location AT commands

The AT command to activate Reduced Rate GPS Navigation and modify directly Update Rate value in second is:

AT+GPSCONF=5,X

The specified update rate navigation is now activated. The parameter « X » defines the navigation power mode as follows:

1: 1 second update rate (default value)

2: 2 seconds update rate

…

10: 10 seconds update rate (maximum value)

During long time navigation, mean update rate will be greater than 1 second, that decrease mean current consumption value.

Update rate will be always lower than X seconds.

Note: The goal of this comment is to reduce current consumption without navigation degradation, the first priority. That's why, depending on reception condition and maintenance operations, update rate greater than 1 second could not be provided with accuracy.

5.2.4. Implementation Using Location Library

The following function should be called in order to activate and configure the navigation update rate:

```
gps_coreSetOpts(GPS_OPT_CORE_RUNNING_POWER_RATE, X);
gps_start(…)
```

The parameter « X » selects the navigation update rate:

```
GPS_PR_DEACTIVATED:     1 second update rate.
GPS_PR_MED_RATE:        Maximum update rate is 2 seconds.
```

```
GPS_PR_LOW_RATE:        Maximum update rate is 5 seconds.
GPS_PR_VERY_LOW_RATE:   Maximum update rate is 10 seconds.
```

The gps_coreSetOpts() function can be called at any time while Location library is in GPS_INITIALIZED, GPS_RUNNING or GPS_SLEEP states.

During long time navigation, mean update rate will be greater than 1 second, that decreases mean current consumption value.

Update rate will be always lower than seconds specified before.

5.3. GPS Idle mode

5.3.1. Principle

The GPS Idle mode is to be used in Push-to-Fix scenario. It corresponds to GSD4t Micro Power Mode, also known as SiRFaware™ mode.

The objective of the GPS Idle mode is to have an automatic, regular monitoring of the satellites in order to guaranty as far as possible a hot start condition when the application will resume GPS operation. In particular, the ephemeris will be decoded before becoming obsolete, and new satellites ephemeris will also be decoded.

The power consumption of the GPS Idle mode is then subject to the GPS conditions, but also variation of the temperature or other factors that will force to increase the activity period. In average, about half of the energy is consumed for ephemeris decode, while the other half is consumed for maintaining accurate clock calibration.

During GPS Idle mode, the AirPrime XM0110 regularly communicates with the host software. Therefore GPS Idle mode requires the Embedded Module to be running or regularly awaken to process GPS data.

Note that if no fix is available when GPS Idle mode is entered, the acquisition power consumption will apply. GPS Idle mode power consumption starts to apply only after a first valid fix has been obtained.

5.3.2. Benefits & Impacts

The main benefits of this mode are to provide to the application hot start TTFF, while having very limited power consumption.

In GPS Idle mode, AirPrime XM0110 power consumption is about 1mA in average over long periods, including the ephemeris decode updates that have to take place every 2 hours.

The compatibility of the GPS Idle mode with the Embedded Module modes of operation is same as for navigation modes (see 5.1.2).

Power consumption of the Embedded Module will be significantly reduced when using Embedded Module Sleep Mode. The table below gives in particular the Embedded Module effective sleep time and example of power consumption depending on the modes.

Table 7: Example of system power consumption in GPS Idle mode

GPS mode	Active Mode GSM Stack ON(1)		Sleep Mode GSM Stack ON(1)	
	Embedded Module	**Embedded Module + XM0110(2)**	**Embedded Module**	**Embedded Module + XM0110(2)**
GPS Idle	41 mA	**41 mA**	6.5 mA	**7 mA**

(1) AirPrime WMP100 Embedded Module, in GSM Idle, Paging 4.
(2) With external LNA settings

5.3.3. Implementation Using Location AT commands

The AT command to activate the GPS Idle mode while GPS is running (i.e. after AT+GPSSTART has been issued) is:

```
AT+GPSSLEEP=0
« Waiting the +GPSEVSLEEP event »
```

The AirPrime XM0110 solution is now in GPS Idle mode.

The GPS Idle mode is left when the +GPSSTART command is sent.

5.3.4. Implementation Using Location Library

The following function should be called in order to activate the GPS Idle mode while GPS is running (i.e. after gps_init() and gps_start() have been successfully called):

```
gps_sleep(GPS_IDLE_MODE)
« Waiting the GPS_SLEEP_STATE_EVENT event »
```

The Location Library is now in GPS Idle mode.

The GPS Idle mode is left when the gps_start() function is called by the OS application.

5.4. GPS Hibernate Mode

5.4.1. Principle

The GPS Hibernate mode is to be used in Push-to-Fix scenario. When entering in Hibernate mode, the GSD4t will stop any operation.

In this mode, AirPrime XM0110 firmware and clock calibration data are preserved. GPS Hibernate mode allows for fast restart if the interruption is limited to several minutes.

5.4.2. Benefits & Impacts

GPS Hibernate mode results in very low power consumption below 30uA (typical: 26uA).

Going to GPS Hibernate may increase TTFF compare to GPS Idle mode for example, but this will depend very much on the interruption time. For limited interruption periods, the restart time will remain very close to hot start time or aided start time.

The compatibility of the GPS Hibernate mode with the Embedded Module modes of operation is as follows:

- Active mode: Compatible
- Sleep Mode: Compatible.
- Alarm/OFF mode: Partially compatible. With default application, AirPrime XM0110 is turned off, reset, and 32k is not being supplied, i.e. exiting GPS Hibernate mode is similar to exiting GPS OFF mode. Compatibility is possible if the application manages externally the XM0110 ON/OFF, reset and 32K input signals. See 6.4 for more details.

Note that in GPS Hibernate mode, the Embedded Module has no GPS processing to perform. Its power consumption is therefore the power consumption of the module depending on its mode. Some examples are given in the table below.

Table 8: Example of system power consumption in GPS Hibernate mode

GPS mode	Active Mode GSM Stack ON(1)		Sleep Mode GSM Stack ON(1)		Alarm / OFF mode	
	Embedded Module	**Embedded Module + XM0110**	**Embedded Module**	**Embedded Module + XM0110**	**Embedded Module**	**Embedded Module + XM0110**
GPS Hibernate	41 mA	**41 mA**	3 mA	**3 mA**	20 uA	**45 uA**

(1) AirPrime WMP100 Embedded Module, in GSM Idle, Paging 4.

5.4.3. Implementation Using Location AT commands

The AT command to activate the GPS Hibernate mode while GPS is running (i.e. after AT+GPSSTART has been issued) is:

```
AT+GPSSLEEP=1
« Waiting the +GPSEVSLEEP event »
```

The AirPrime XM0110 solution is now in GPS Hibernate mode.

The GPS Hibernate mode is left when the AT+GPSSTART command is sent.

Note: In case AirPrime XM0110 ON/OFF signal is managed externally (see 6.4), GPS Hibernate can also be entered with AT+GPSSTOP. From XM0110 perspective, both commands will have same result. The only difference will reside in the state in which the Host software will be set.

5.4.4. Implementation Using Location Library

The following function should be called in order to activate the GPS Hibernate mode while GPS is running (i.e. after gps_init() and gps_start() have been successfully called):

```
gps_sleep(GPS_HIBERNATE_MODE)
« Waiting the GPS_SLEEP_STATE_EVENT event »
```

The Location Library is now in GPS Hibernate mode.

The GPS Hibernate mode is left when the gps_start() function is called by the OS application.

Note: In case AirPrime XM0110 ON/OFF signal is managed externally (see 6.4), GPS Hibernate can also be entered with gps_stop() API. From XM0110 perspective, both commands will have same result. The only difference will reside in the state in which the Host software will be set.

5.5. GPS OFF Mode

5.5.1. Principle

The GPS OFF mode is to be used in Push-to-Fix scenario.

In this mode, the AirPrime XM0110 simply shuts down with XM0110 ON/OFF signal. This results in the lowest power consumption. However, exiting GPS OFF mode forces a new firmware download, and forces a cold start, resulting in the highest Time-To-First-Fix.

5.5.2. Benefits & Impacts

In GPS OFF mode, the power consumption is below 5uA (typical: 2uA). Note that power supply may also be simply removed.

In order to restart from GPS OFF mode, AirPrime XM0110 Firmware will have to be reloaded. This operation takes approximately 7 seconds (with UART) or 12 seconds (with I2C) extra time compared to start without the firmware download and has to be added to the cold start TTFF that applies in this condition.

GPS OFF mode is compatible to all Embedded Module modes of operation.

Table 9: Example of system power consumption according to GPS OFF modes

GPS mode	Active Mode GSM Stack ON(1)		Sleep Mode GSM Stack ON(1)		Alarm / OFF mode	
	Embedded Module	**Embedded Module + XM0110**	**Embedded Module**	**Embedded Module + XM0110**	**Embedded Module**	**Embedded Module + XM0110**
GPS OFF	41 mA	**41 mA**	3 mA	**3 mA**	20 uA	**23 uA**

(1) AirPrime WMP100 Embedded Module, with GSM Stack ON in GSM Idle, Paging 4.

5.5.3. Implementation Using Location AT commands

The AT command to go into GPS OFF mode while GPS is running (i.e. after AT+GPSSTART has been issued) is:

```
AT+GPSSTOP
« Waiting the +GPSEVSTOP event »
```

The AirPrime XM0110 solution is now in GPS Off mode.

The GPS OFF mode is left when the AT+GPSSTART command is sent.

5.5.4. Implementation Using Location Library

The following function should be called in order to activate the GPS OFF mode while GPS is running (i.e. after gps_init() and gps_start() have been successfully called):

```
gps_stop()
« Waiting the GPS_SLEEP_STOP_EVENT event »
```

The Location Library is now in GPS OFF mode.

The GPS OFF mode is left when the gps_start() function is called by the OS application.

5.6. GPS Deep Sleep Mode

5.6.1. Principle

The GPS Deep Sleep mode is used in Push-to-Fix scenarios.

In this mode, the XM0110 is still powered on VBAT and ketp alive with the XM0110 ON/OFF signal.

Only XM0110 RTC domain is powered, so the RTC clock still should be provided to the module. See Figure 7 for hardware implementation details.

The result is a much lower power consumption for XM0110 and Embedded Module with the capacity to keep a hot start condition for low Time-To-First-Fix.

Note: Exiting GPS Deep Sleep mode forces a new firmware download.

5.6.2. Benefits & Impacts

In GPS Deep Sleep mode, the AirPrime XM0110 module power consumption is approximately 9µA.

The Embedded Module power supply may also be removed.

In order to restart from GPS Deep Sleep mode, the XM0110 firmware will have to be reloaded. This operation takes approximately 5 seconds (with UART) or 9 seconds (with I2C) extra to be added to hot start TTFF.

The external Host processor should provide the RTC clock and XM0110 ON/OFF signal control.

Table 10: Example of system power consumption according to GPS Deep Sleep mode

GPS mode	Active Mode GSM Stack ON(1)		Power OFF(2)		Alarm / OFF mode	
	Embedded Module	**Embedded Module + XM0110**	**Embedded Module**	**Embedded Module + XM0110**	**Embedded Module**	**Embedded Module + XM0110**
GPS DEEP SLEEP	41 mA	**41 mA**	0 µA	**9 µA**	20 µA	**29 µA**

(1) AirPrime WMP100 Embedded Module, with GSM Stack ON in GSM Idle, Paging 4.

(2) AirPrime WMP100 Embedded Module Power OFF, managed by External Host Processor

5.6.3. Implementation Using Location AT commands

The AT command to go into GPS Deep Sleep mode while GPS is running (i.e. after AT+GPSSTART has been issued) is:

```
AT+GPSSLEEP=2
« Waiting the +GPSEVSLEEP event »
```

The AirPrime XM0110 solution is now in GPS Deep Sleep mode.

The GPS Deep Sleep Mode is left when the AT+GPSSTART=0 command is sent.

5.6.4. Implementation Using Location Library

The following function should be called in order to activate the GPS Deep Sleep mode while GPS is running (i.e. after gps_init() and gps_start() have been successfully called):

```
gps_sleep(GPS_DEEP_MODE)
« Waiting the GPS_SLEEP_STATE_EVENT event »
```

The Location Library is now in GPS Deep Sleep mode.

The GPS Deep Sleep mode is left when the gps_start() function is called by the OS application.

6. Main Applications Examples

This section presents several hardware application options, to be selected depending on the targeted low power modes.

Note: Please refer also to AirPrime XM0110 Product Technical Specification [4] which contains several design recommendations that impact system power consumption, like XM0110 power supply design, or use of EXT_LNA_EN pin to control an external LNA.

6.1. How to Select GPS Module Low Power Mode for Push-to-Fix Use Cases

Four GPS Low Power Modes can be used in Push-to-Fix use cases. Refer to Table 2: for details (including power consumption) for each mode.

Selecting one mode over another to optimize the power consumption (especially in situations when the battery life time is crucial) must be carefully considered based upon the update rate and taking into account whether an AirPrime XM0110 firmware download is needed or not.

6.1.1. Push-to-Fix Timelines

6.1.1.1. With AirPrime XM0110 FW Download from the Embedded Module

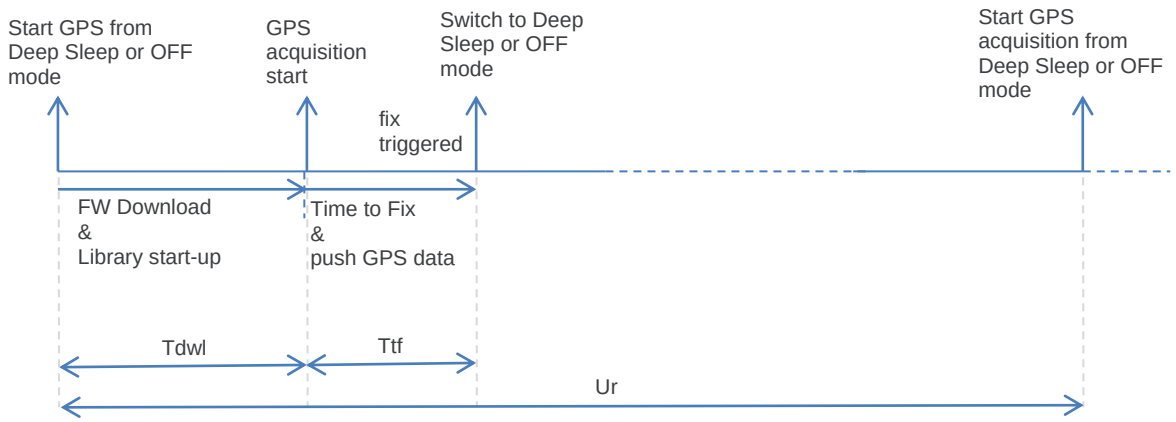

Figure 3. Push-to-Fix Timeline with XM0110 FW Download

Figure Notation	Definition
Tdwl	Firmware download duration
Ttf	Time to make GPS fix and send GPS data
Ur	Update rate

6.1.1.2. Without AirPrime XM0110 FW Download

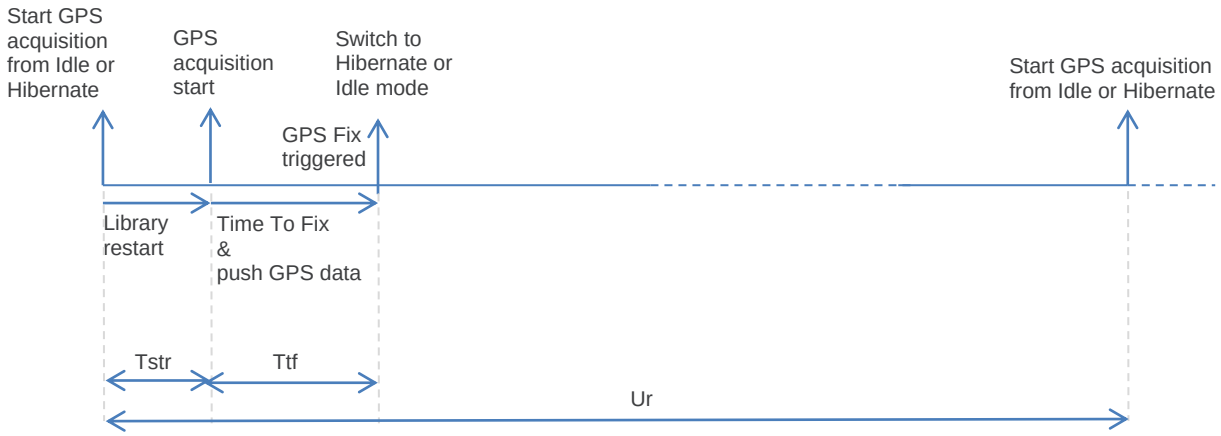

Figure 4. Push-to-Fix Timeline without AirPrime XM0110 FW Download

Figure Notation	Definition
Tstr	Time to start Location Library
Ttf	Time to make GPS fix and send GPS data
Ur	Update rate

6.1.2. Embedded Module and XM0110 Power Consumption Measured for the Different Push-to-Fix Phases

Figures referred to are instant current consumptions at the various Push-to-Fix phases, as defined in the table below.

Table 11: Push-to-Fix Phase Current Consumptions

Push-to-Fix Phase	Current Consumption
XM0110 current consumption during FW download	45 mA
Embedded Module current consumption during FW download	41 mA
XM0110 current consumption during Library re-start	45 mA
Embedded Module current consumption during Library re-start	41 mA
XM0110 current consumption while in GPS Hibernate	26 µA
XM0110 current consumption while in GPS Deep Sleep	9 µA

6.1.3. Calculate Low Power Mode Selection Criteria

The criteria are 100% focused on the power consumption and the battery life cycle.

6.1.3.1. Establish Criteria to Select between Hibernate (HIB) and Deep Sleep (DSL) Modes

Current consumption in Deep Sleep over a Push-to-Fix period with given update rate of Ur:

```
Pdsl = ((45000+41000)*Tdwl) /Ur + ((Ur-Tdwl)*9)/Ur
```

Current consumption in Hibernate over a Push-to-Fix period with given update rate of Ur:

```
Phib = ((45000+41000)*Tstr) /Ur + ((Ur-Tstr)*26)/Ur
```

Threshold to select between Deep Sleep or Hibernate:

```
Pdsl < Phib
Ur >= (77.10^3*Tdwl – 60.10^3*Tstr) / 17
```

6.1.3.2. Criteria in Case of AirPrime XM0110 Connecting thru UART

6.1.3.2.1. Timing

UART bus	From INITIALIZED state	From SLEEP state / IDLE mode	From SLEEP state / HIBERNATE mode
Location library initialization	< 1,6 sec	< 0,3 sec	< 1,6 sec
Firmware download time	< 3,6 sec	0	0
Startup time*	< 5,2 sec	< 0,3 sec	< 1,6 sec

* First GPS position information is received 1 second after.

6.1.3.2.2. Criteria Values

Ur = 6.2 hours. Reducing the firmware download duration and Core Library initialization by 1s will result in Ur = 4.9 hours.

6.2. Standard Application

The standard application (see Figure 5 for UART case) is the simplest application, recommended by default.

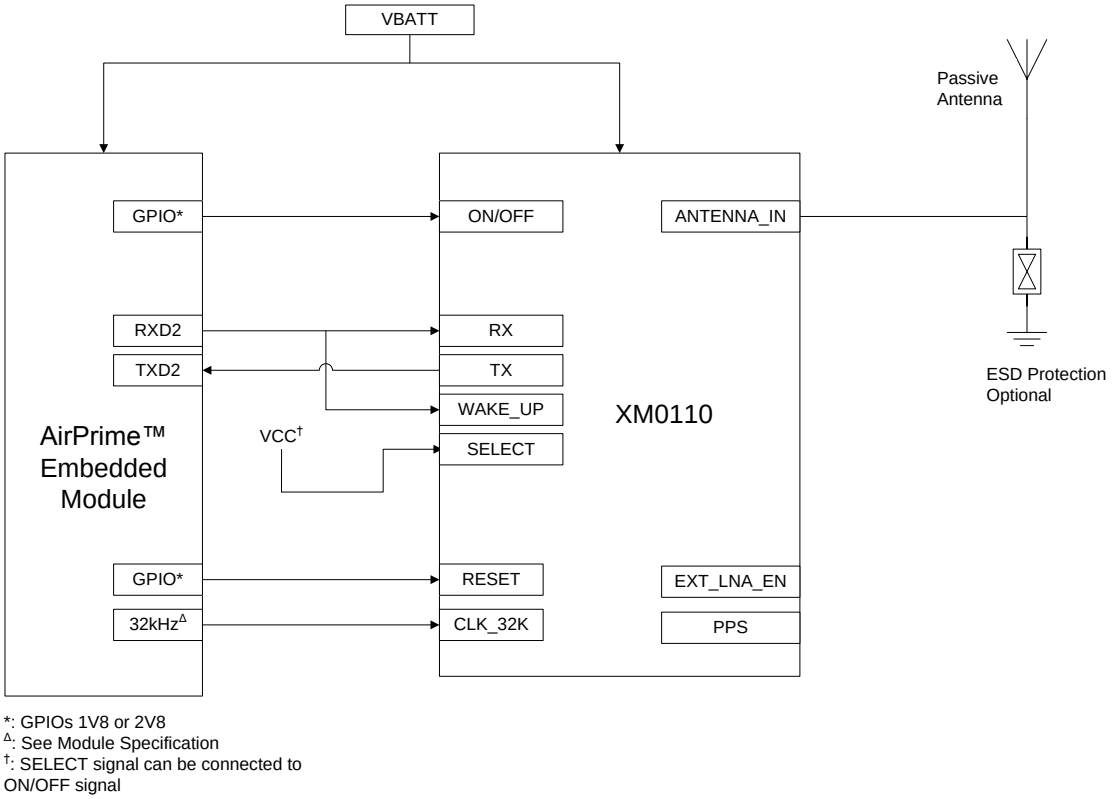

Figure 5. Standard application

With this application, the following low power modes combinations are supported:

Table 12: Standard Application Low Power Mode Combinations

		Embedded Module Mode of Operation		
		Active Mode	**Sleep Mode**	**Alarm / OFF mode**
XM0110 Low Power Modes	**GPS OFF**	Supported	Supported	Supported
	GPS Hibernate	Supported	Supported	Not supported
	GPS Idle	Supported	Not supported	Not supported
	GPS Navigation	Supported	Not supported	Not supported

6.3. Embedded Module Wake-Up Application (Available on UART only from 1.2 release)

The application with Embedded Module wake-up is proposed when the Embedded Module is to be put in Sleep Mode while AirPrime XM0110 is in GPS Navigation or GPS Idle mode. This application allows the XM0110 to wake-up the Embedded Module when GPS data are to be processed.

This application requires a wake-up mechanism which has both hardware and software impacts as described below.

With this application, the following low power modes combinations are supported:

Table 13: Embedded Module Wake-Up Low Power Mode Combinations

		Embedded Module Mode of Operation		
		Active Mode	**Sleep Mode**	**Alarm / OFF mode**
XM0110 Low Power Modes	**GPS OFF**	Supported	Supported	Supported
	GPS Hibernate	Supported	Supported	Not supported(1)
	GPS Idle	Supported	Supported	Not supported
	GPS Navigation	Supported	Supported	Not supported

(1) Supported if combined with External XM0110 Control application.

6.3.1. Hardware Impacts

In this application, an external interrupt of the Embedded Module (1V8 interrupt such as INT0 is recommended to avoid any level shifting) has to be connected to AirPrime XM0110 TX/SCL output pin.

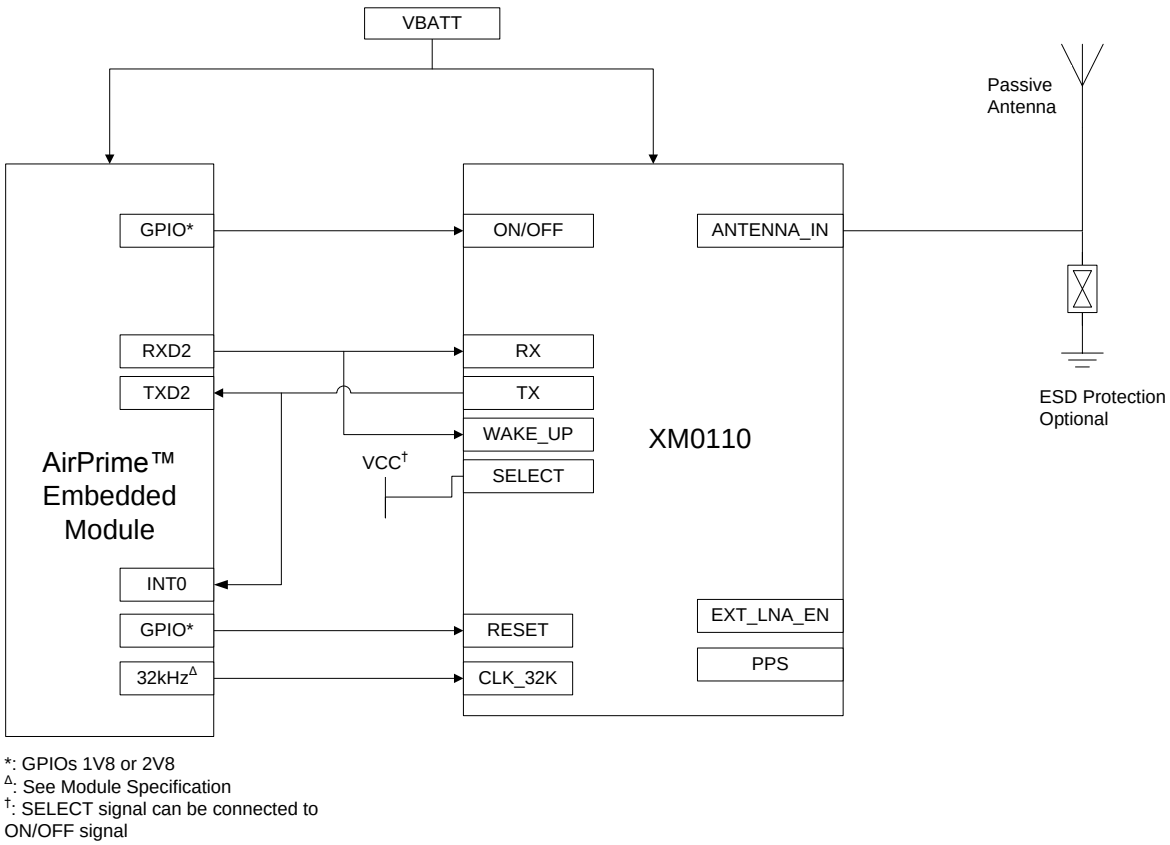

Figure 6. Application with Wake-Up Mechanism for UART case

6.3.2. Software Impacts

This application requires Location Library 1.1 release or later, and Open AT Framework 2.35 (OS + Firmware) or later.

This application is not available currently with I2C.

6.3.2.1. Implementation Using Location AT Commands

The use of this application requires setting the <host_wakeup> parameter of the +GPSINIT command to the external interrupt used (typically, '0' for INT0) for host wake-up (see [1] for more details on +GPSINIT). For example:

```
AT+GPSINIT=1,1,2,22,23,65535,0,1,65534
```

In addition, the wake-up feature must be activated through with AT command:

```
AT+GPSCONF=3,1
```

Optionally, this specific configuration can be saved in flash, and would then be automatically used for any subsequent Embedded Module power off/on or reset cycle:

```
AT+GPSSAVE=1
```

6.3.2.2. Implementation Using Location Library

The use of this application requires the hardware configuration in gps_init() API to specify the external interrupt used (typically, INT0). This must be done setting to the appropriate value the host wake-up parameter '*ptIoConfig->u16HostWakeupExtIntID*'.

In addition, the wake-up feature must be enabled through the following gps_setOpt API call:

```
gps_coreSetOpts( GPS_OPT_CORE_WAKEUP, GPS_WAKEUP_ENABLED );
```

6.4. External XM0110 Control Application

The application with external AirPrime XM0110 control is required when the Embedded Module is to be put in Alarm or OFF mode while the XM0110 remains in Hibernate mode or Deep Sleep mode. This application allows XM0110 to remain powered and supplied with 32k clock whatever the Embedded Module state, in order to ensure a faster restart (without firmware download in hibernate mode, or with firmware download in deep sleep mode).

With this application, the following low power modes combinations are supported:

Table 14: External XM1001 Control Application Low Power Mode Combinations

		Embedded Module Mode of Operation		
		Active Mode	**Sleep Mode**	**Alarm / OFF mode**
XM0110 Low Power Modes	**GPS OFF**	Supported	Supported	Supported
	GPS Hibernate	Supported	Supported	Supported
	GPS Idle	Supported	Supported (1)	Not supported
	GPS Navigation	Supported	Supported (1)	Not supported

(1) Supported if combined with Embedded Module Wake-Up application.

6.4.1. Hardware Impacts

In this application, the AirPrime XM0110 ON/OFF has to be controlled externally by the hardware of the application, typically a host processor. In addition, as 32K signal must be provided to XM0110 32K input. See Figure 7 for an example for UART case.

Application design must ensure that electrical and timing characteristics of ON/OFF and 32K comply with XM0110 specification [4].

Note: XM0110 RESET pin should be controlled by the Embedded Module when using Deep Sleep mode.

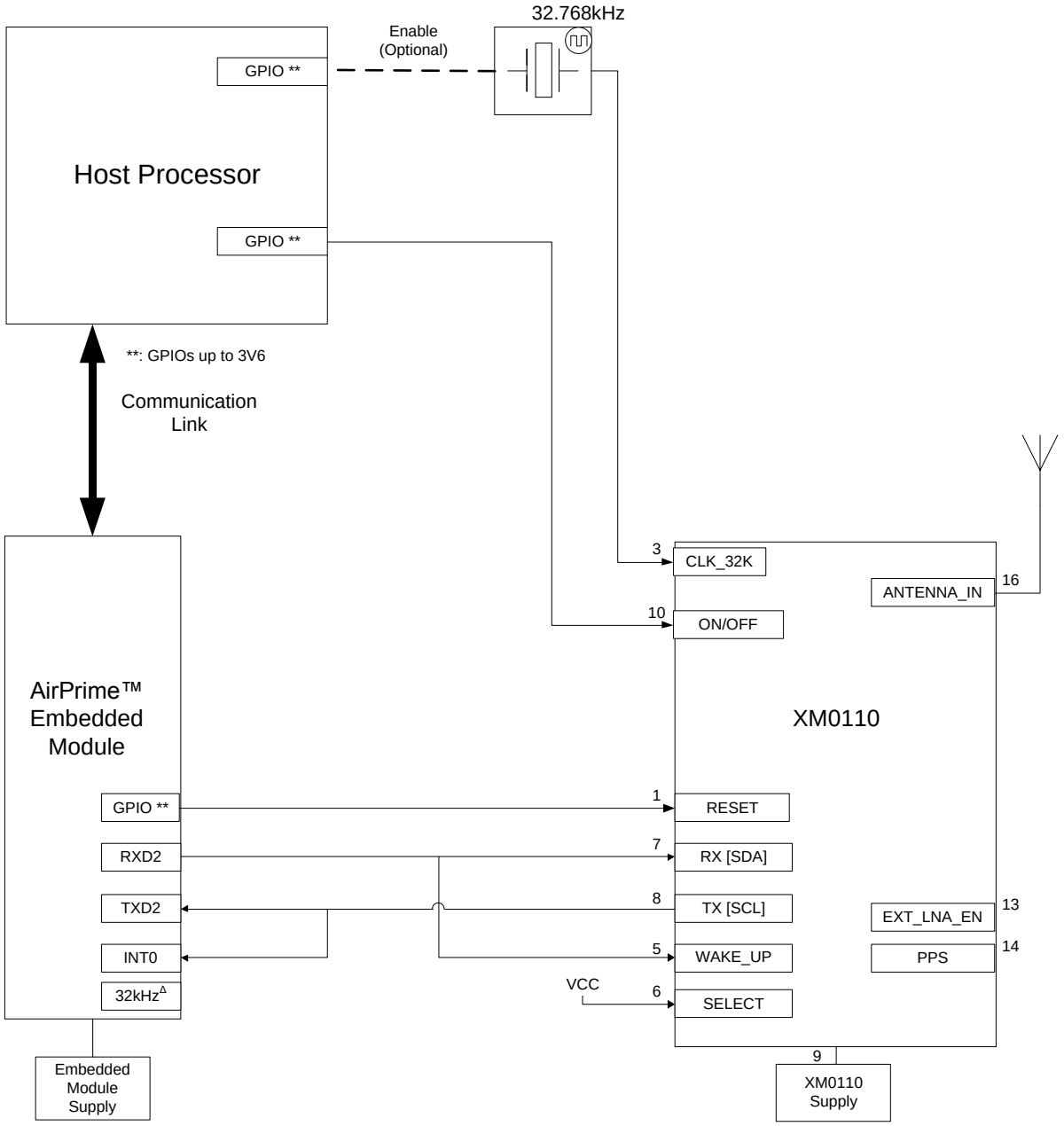

Figure 7. External AirPrime XM0110 Control application

6.4.2. Software Configuration

6.4.2.1. Implementation Using Location AT Commands

This application requires to set the AT+GPSINIT command parameters <on_off> and <clock32k> to specify respectively the use of external ON/OFF (value: 65535) and external 32K (value: 2) (see [1] for more details on +GPSINIT). For example:

```
AT+GPSINIT=1,1,2,65535,23,65535,0,2,65534
```

The external application must ensure that ON/OFF is high, reset is high (or unconnected), and 32K is available at least prior to +GPSSTART command, and at minimum until +GPSSTOP command. In

addition, these signals must be maintained as long as it is expected to have XM0110 in GPS Hibernate mode to take all benefits from this application.

On some specific error events (typically, +GPSEVABORT events), application must attempt to reset or power OFF / power ON AirPrime XM0110 and restart GPS.

6.4.2.2. Implementation Using Location Library

This application requires the hardware settings at gps_init() API to specify the use of external 32K and external ON/OFF (see [2] for more details on gps_init() API and hardware configuration options). Typically, the is done by following assignments:

```
ptIoConfig->u16OnOffCmdID = GPS_GPIO_NOT_MANAGED;
ptIoConfig->e32kMngt = GPS_32K_EXTERNAL;
```

The external application must ensure that ON/OFF is high, reset is high or unconnected, and 32K is available at least prior to gps_start() API call, and at minimum until gps_stop() API call. In addition, these signals must be maintained as long as it is expected to have AirPrime XM0110 in GPS Hibernate mode to take all benefits from this application.

On some specific error events (typically on GPS_ABORT_EVENT received on the GPS event callback, application must attempt to reset or power OFF / power ON XM0110 and restart GPS.

7. Examples and Additional Information

7.1. Total System Power Consumption

The table below provides summary of the total system power consumption for internal and external LNA cases.

Power consumption figures are based on the current measurement figures indicated in the document, and considering following power supply levels:

- 2V0 for AirPrime XM0110
- 3V6 for AirPrime WMP100

Table 15: Combined System power consumption example for AirPrime XM0110 GPS Module and AirPrime WMP100 Embedded Module for UART

XM0110 \ Embedded Module		Active Mode Stack ON(1) (148mW)	Sleep Mode Stack ON(1) (12mW to 107mW)	Sleep Mode Stack OFF (3mW to 104mW)	Alarm or OFF Modes (72 µW)
Push-to-Fix (internal or external LNA)	GPS Off (0 µW)	148 mW	12 mW	3 mW	90 µW
	GPS Hibernate (50uW)	148 mW	13 mW	3 mW	122 µW
	GPS Idle (0.8mW)	148 mW	24 mW	4 mW	
1Hz Navigation (external LNA)	Very Low Power (12mW)	160 mW	85 mW	82 mW	
	Low Power (19mW)	167 mW	102 mW	102 mW	
	Medium Power (39mW)	186 mW	116 mW	105 mW	
	Full Power (57mW)	204 mW	136 mW	125 mW	
1Hz Navigation (internal LNA)	Very Low Power (14mW)	162 mW	87 mW	83 mW	
	Low Power (22mW)	170 mW	105 mW	105 mW	
	Medium Power (44mW)	192 mW	121 mW	110 mW	
	Full Power (65mW)	213 mW	144 mW	133 mW	

(1) AirPrime WMP100 Embedded Module with GSM Stack ON in GSM Idle, Paging 4.

Pink colored boxes require ‘Host wake-up application’ to be implemented. Blue colored box requires ‘XM0110 external control application’ to be implemented.

Use of Embedded Module Sleep Mode benefits are:

- About 90% power savings in Push-to-Fix scenarios
- From 20% power savings in full power 1Hz navigation up to 40% in low power 1Hz navigation

7.2. Example of Use-Case: Medium Power Navigation with Embedded Module Sleep Mode

Below is an example of the sequence to be used to perform Standard GPS Navigation at Medium power, with Embedded Module Sleep Mode.

The example is provided for use of GPS AT commands with the AirPrime XM0110 Daughter Board for Development Kit. Similar result can be obtained with hardware application implementing the Embedded Module Wake-Up (see 6.3).

1. Setup your hardware
   a. Connect your XM0110 Daughter Board to your Embedded Module Development Kit
   b. Configure your XM0110 Daughter Board for UART interface, and with INT jumper set to 'NO' position to force wake-up through interrupt (see [6]).
   c. Power ON your Embedded Module Development Kit
2. Activate your GPS AT application (if not already activated):
   `AT+WOPEN=1`
3. Make sure your USB port is not in use (no USB device connected)
4. Set Embedded Module to Sleep Mode:
   `AT+W32K=1,0`

Note: As DTR will not wake-up the Embedded Module with this specific setting, it may be needed to enter a character prior to the following AT commands, to wake-up the module. Alternatively, you can use AT+W32K=1,1, and make sure DTR is low when no AT command is to be sent to have Embedded Module entering sleep mode)

5. Turn GSM Stack OFF (optional):
   `AT+CFUN=0`
6. Initialize the GPS with correct settings, in particular with host wake-up set to INT0:
   `AT+INIT=1,1,2,22,23,65535,0,1,65534`
7. Configure the GPS Navigation to Medium Power:
   `AT+GPSCONF=0,1`
8. Activate the host wake-up mechanism:
   `AT+GPSCONF=3,1`
9. Start GPS Navigation:
   `AT+GPSSTART`

You are now navigating, with 1Hz NMEA data output on the UART1 interface, at an average combined current of 39mA.

You can observe the Antenna Supply LED: as soon as medium power navigation is effective, i.e. non-permanent RF activity is used, this LED will be blinking: it is OFF in the RF off periods.

7.3. Example of Use-Case: Push-to-Fix scenario with Embedded Module Alarm mode

Below is an example of the sequence to be used to perform one GPS fix each hour, and no activity in between.

The example is provided for use of GPS AT commands with the AirPrime XM0110 Daughter Board for Development Kit. Similar result can be obtained with hardware application implementing the External XM0110 Control (see 6.4).

1. Setup your hardware
   a. Connect your XM0110 Daughter Board to your Embedded Module Development Kit
   b. Configure your XM0110 Daughter Board for UART interface, with ON/OFF jumper set to 'ON' position. Provide an appropriate 32k clock signal to 32K jumper pin (see [6]).
   c. Power ON your Embedded Module Development Kit
2. Activate your GPS AT application (if not already activated):
   `AT+WOPEN=1`
3. Initialize the GPS with correct settings, in particular with external ON/OFF, external 32K, external Reset:
   `AT+INIT=1,1,2,65535,65535,65535,65535,2,65534`
4. Start GPS Navigation
   `AT+GPSSTART`
5. Wait for a fix event: +GPSEVPOS:3
   a. Cold start TTFF conditions is observed
   b. You have your GPS position
6. Stop GPS Navigation
   `AT+GPSSTOP`
7. You can now power OFF the Embedded Module or program an Alarm with AT+CALA

Note: You are now in the very low current consumption mode of 46uA.

8. When required, you can restart Navigation:
   `AT+GPSSTART`
9. Wait for a fix event: +GPSEVPOS:3
   a. Fast start TTFF must be now be observed
   b. You have your new GPS position

In order to maintain fast start conditions, you must maintain, at least once every 2 hours, some navigation for several minutes, to ensure satellites ephemerides are collected.

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