JF2/JN3 Low Power Modes Application Note

80000NT10062A Rev.6 – 2013-01-29

Making machines talk.

APPLICABILITY TABLE

PRODUCT
JF2
JN3

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Contents

1. Introduction

1.1. Scope

This document is intended to give an overview of the low power operating modes available in the JF2 and JN3 GPS modules based upon SiRFStarIV™ ROM 2.2 and firmware 4.1.2

1.2. Audience

This document is intended for customers who are about to develop an application based on the Telit JF2 or JN3 GPS module.

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

http://www.telit.com

To register for product news and announcements or for product questions contact Telit Technical Support Center (TTSC).

Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates feedback from the users of our information.

1.4. Document Organization

This document contains the following chapters (sample):

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

"Chapter 2: "Overview" gives an overview of the low power features of the product.

"Chapter 3: "System Power States" describes in detail the characteristics of the different power states.

"Chapter 4: "Power Management Modes" describes in detail the power management operating modes.

"Chapter 5: "Antenna Performance Considerations" summarizes the impact of antenna performance on power management.

"Chapter 6: "Low Power Mode Messages" gives an overview about messages concerning power management.

"Chapter 7: "Document History" provides history of the present document.

1.5. Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.6. Related Documents

- JF2 Datasheet
- JN3 Datasheet
- JF2 Product Description, 80403ST10103A
- JN3 Product Description, 80403ST10104A
- JF2 Hardware User Guide, 1vv0300985

- JN3 Hardware User Guide, 1vv0300984
- JF2 EVK User Guide, 1vv0300987
- JN3 EVK User Guide, 1vv0300986

2. Overview

As GPS continues to gain popularity with consumers, it has found its way into more battery-powered devices for which saving power is critical. The SiRFStarIV chipset offers three low power operating modes used by Telit Jupiter GPS modules to provide flexibility in the power versus performance trade-off, which OEMs involved in battery-powered applications must address. These operating modes are controlled using SiRF Binary messages.

Important Note:

All data values provided in this document are approximate and provided for example and illustration only. These are not meant to be specifications or performance guarantee.

2.1. Background

The baseband processor within SiRFStarIV performs GPS tasks such as satellite signal acquisition, tracking and navigation, while the RF front-end provides signal down conversion and clock generation. During the course of GPS operations, not all of these functions need to be fully powered and operating. By controlling the power and clock carefully, power consumption can be managed more efficiently. For this purpose, SiRFStarIV provides power management schemes, three of which are used by Telit Jupiter modules: TricklePower™, Push-To-Fix™, and Micro Power/SiRFAware™.

2.2. Overview

The power management process can be summarized as follows. The SiRFStarIV receiver starts up in a hibernation state and remains there until an ON_OFF signal is sent to it. This signal is an external input to the JF2. However, the JN3 manages the signal internally. The receiver stays in Full Power mode until it obtains an initial user position fix and all relevant information from the satellites is gathered. In good RF signal environments it takes about 30 to 40 seconds on average for the receiver to compute the first position fix and extract the information. The time is shorter when the receiver is undergoing a hot start or is aided (using Extended Ephemeris or ephemeris push). When the receiver is ready to carry out normal processing, different sections of hardware can be turned off or un-clocked, depending upon the receiver state. After processing is completed, the receiver programs the RTC (Real Time Clock) to wake up at a specified time and then go to sleep by turning off most of the circuitry except the RTC. When the wakeup interrupt occurs, the receiver re-starts the system and resumes GPS tasks.

TricklePower, Push-To- Fix, and Micro Power low power modes are designed to meet the demands of applications that have different requirements for the interval between position updates and for power consumption. All of these modes perform similarly in principle but provide different output rates and reliability. TricklePower is a duty cycling mode with a user-selectable position update interval, providing high quality GPS accuracy and dynamic motion response at a reduced average current draw. Push-to- Fix mode provides infrequent periodic position updates and also allows on-demand user position requests with short TTFF

(Time-To-First-Fix). Micro Power mode is a sophisticated power management mode that keeps the receiver in Hot Start conditions while maximizing the time spent in a very low power state.

Note:

All three of the low power modes are available for the JF2 module, but Micro Power mode is not supported for the JN3. Additionally, there is only partial support for Push-To-Fix mode on the JN3 module, and therefore there are some restrictions on its use. These restrictions are discussed later in this Application Note.

3. System Power States

There are three basic system power states (other than OFF) of the SiRFStarIV receiver that are used by JF2 and JN3 GPS modules for power management. Low power operating modes transition the receiver between these states.

3.1. Full-Power State

This is the state of the SiRFStarIV receiver where both the RF front-end section and the baseband processor are fully powered. This is the operating state of the receiver whenever it performs satellite acquisition and tracking activities. While in this state clocks and bias currents are under software control, and therefore there is a difference in power consumption between satellite signal acquisition and signal tracking. During initial acquisition, processing is more intensive, thus consuming more power. Current consumption for the Full-power state while tracking signals is specified in the GPS receiver module datasheets.

After power is applied, the JF2 module enters the full-power state after a pulse on the ON_OFF input line is provided. The JN3 module does not have an ON_OFF input – the pulse is generated internally and therefore the JN3 enters this state after the main supply voltage is applied.

Regardless of the selected low power operating mode, the receiver stays in this state during initial acquisition, until an initial position is calculated and is estimated to be reliable, before transitioning to a low power state. Afterwards, the receiver re-enters the full-power state whenever it must perform satellite search and acquisition, satellite tracking, navigation updates, or data collection.

3.2. Stand-By (Trickle) State

In this state the RF front-end is completely powered off and thus there is no clock signal to the baseband processor. The Keep-alive (KA) device section, which includes the RTC, Battery-Backed RAM (BBRAM) and the Power Control Finite State Machine (FSM), is powered and clocked by the RTC. Additionally the baseband processor is powered, though un-clocked, as are the ARM CPU instruction, data and patch RAM areas. Thus the processor state and volatile data is preserved. Therefore when leaving this state, the system is able to resume operations from the point at which the Stand-By state was entered.

3.3. Hibernate State

This state is an ultra-low power state that is intended for use in very low power consuming applications. Both the RF and baseband power regulators are turned off in this state. Only the Keep-Alive (KA) section is powered. The ARM instruction and patch RAMs located within the KA section are powered although they are not clocked by the RTC. This avoids reloading instruction and patch code at the next start-up. These memories are supplied by a reduced voltage to reduce leakage. When operation resumes upon leaving this state, the ARM processor powers up and restarts from the program beginning.

Current consumption for the Hibernate state is specified in the GPS receiver module datasheets.

4. Power Management Modes

There are four power management operating modes available for the JF2. These modes are:

- Full-Power
- TricklePower™
- Push-to-Fix™
- Micro Power/SiRFAware™

The fourth mode, Micro Power, is not available for the JN3. These power management modes are available to meet different applications requirements in terms of navigation quality, position reporting interval, and power consumption. They are sophisticated power management schemes that attempt to avoid the occurrence of cold and warm starts by managing enough ON time to attempt to refresh ephemeris information and recalibrate internal frequency references and clocks. In principle, these modes operate similarly but provide different output rates and reliability.

The fundamental assumption for the three low power modes is that power is maintained continuously to the SiRFStarIV receiver’s Keep-Alive (KA) section, which contains the RTC, BBRAM, and Power Control Finite State Machine (FSM). The RTC provides a clock signal, the BBRAM retains critical navigation data, and the FSM sequences the internal system power and reset signals. If supply voltages (VDD_18 on the JF2, VBATT on the JN3) are not maintained, power to the KA section will be lost, and the receiver will revert back to its original factory settings, which can result in a very long start-up Time-To-First-Fix (TTFF).

4.1. Full-Power Mode (Continuous Navigation)

Full-power mode is also known as Continuous Navigation mode. This is the most accurate navigation mode and supports the most dynamic motion scenarios. The RF block produces continuous RF samples that are continuously processed by the acquisition and tracking processes. Measurements and demodulated GPS data are continuously sent to the navigation engine for the highest quality and dynamic mode of GPS navigation.

The SiRFStarIV receiver remains in the initial full-power state until all required satellite ephemeris data are collected, a navigation solution is obtained, and the RTC is calibrated. The amount of time spent in the initial full-power state depends upon the type of start conditions that apply, which in turn affects TTFF as shown in the table below.

Mode	TTFF @ -130dBm	
	Typical	90%
cold start	33s	35s
warm start	31s	35s
hot start	500ms	<1s

Table 1. Jupiter-F2/N3 TTFF values

4.2. TricklePower™

TricklePower mode is a duty cycled mode in which the system selects a minimum rate of navigation solution updates and minimizes average current. This mode also balances the solution update rate with navigation solution quality. To accomplish this, the SiRFStarIV receiver software will transition to Full-Power mode for a limited period when conditions are difficult or when satellite navigation data must be demodulated. This results in variable power savings, but much more reliable performance as compared against fixed-rate duty cycling with a fixed message output rate. Applications using TricklePower should achieve results very similar to full power, but with significant power savings in strong signal conditions.

4.2.1. TricklePower State Cycling

In TP mode the receiver transitions between the Full-Power and Stand-By states. There are also transitional power states of short duration between the Full-Power and Stand-By states in which RF sub-sections are switched off but the CPU is still running.

The duty cycle used by TP mode is user-selectable and is expressed as the ratio of receiver measurement sampling ON-time (effectively the time in Full-Power) to the position update interval. The sampling ON-time is user-selectable from 200 to 900 milliseconds. The selection of duty cycle and sampling ON-time sets the position update interval and also sets up the overall timing for transitioning between the power states. The position update interval can be set within the range of one to ten seconds.

While in TP mode, the time in full power within a given cycle is governed by the user-selected sampling ON-time and is used by the receiver to track satellites and collect range measurements. The actual ON-time may be slightly greater than the user-specified ON-time due to set-up and processing overhead required to configure the hardware.

After tracking is completed, the receiver enters a lower power transitional state in which the RF section is powered down while the baseband processor continues to run. The receiver remains in this baseband-only transitional state while it computes position from the range measurements and then outputs the resulting data. Thus the time spent in this baseband-only state depends upon the time taken to complete the transmission of any messages over the serial host interface.

Note:

The duration of the transitional state depends upon the number of messages to be output and the data-rate/line-speed of the interface. Slow SPI, I2C, or UART line speeds will extend the duration of the transitional power state and thus increase the average power used in TP mode.

When all processing is complete the firmware performs maintenance checks on the GPS data to determine whether the receiver is in a situation in which it should stay in the Full-Power state rather than entering the Stand-By state. These situations are:

- Collecting periodic ephemeris data
- Collecting periodic almanac data
- Collecting periodic ionosphere and UTC data

- Performing RTC calibration
- Improving the navigation solution

If the maintenance checks pass, the receiver enters the Stand-By state and remains there for the remainder of the solution update period. The firmware programs the RTC to generate an interrupt which will wake up the receiver from the Stand-By state at the appropriate time and initiate the next Full-Power state.

4.2.2. Adaptive Behavior

When TricklePower mode is enabled, the receiver firmware initiates mode transitions between TricklePower mode and Full-Power mode in order to maximize navigation performance. Under good tracking conditions the receiver remains in TricklePower mode. But in harsh tracking environments, the receiver automatically switches to Full-Power mode to improve navigation performance. When the satellites are sorted according to their signal strength, the fourth satellite determines if the transition occurs or not. Currently the thresholds are

- 30dB-Hz to enter TricklePower mode cycling
- 26dB-Hz to return to Full-Power mode

Thus the receiver switches from Full-Power back to TricklePower mode when tracking conditions improve such that there are four or more satellites with C/N0 of 30dB-Hz or higher in use. Consequently, navigation results are improved in harsh GPS environments but at the cost of using more power.

4.2.3. Recommended Usage

TP Mode is best suited for applications that require:

- Navigation solutions at a fixed rate
- Low-power consumption
- Maintaining the ability to track weak signals

CSR/SiRF recommends the use of 300ms with a 30% duty cycle (full power for 300ms with a one-second update interval), or 400ms with a 20% duty cycle (full power for 400ms with a two-second update interval) for optimum performance.

4.2.4. Cycle Timing Diagrams

A typical timing diagram for 300ms full-power ON time and 30% duty cycle is shown in the figure below for illustrative purposes.

Note:

The CPU-only state shown in the timing diagrams shown in this Note represents the transitional state described in the previous section regarding state cycling. The duration of the CPU-only state can therefore vary.

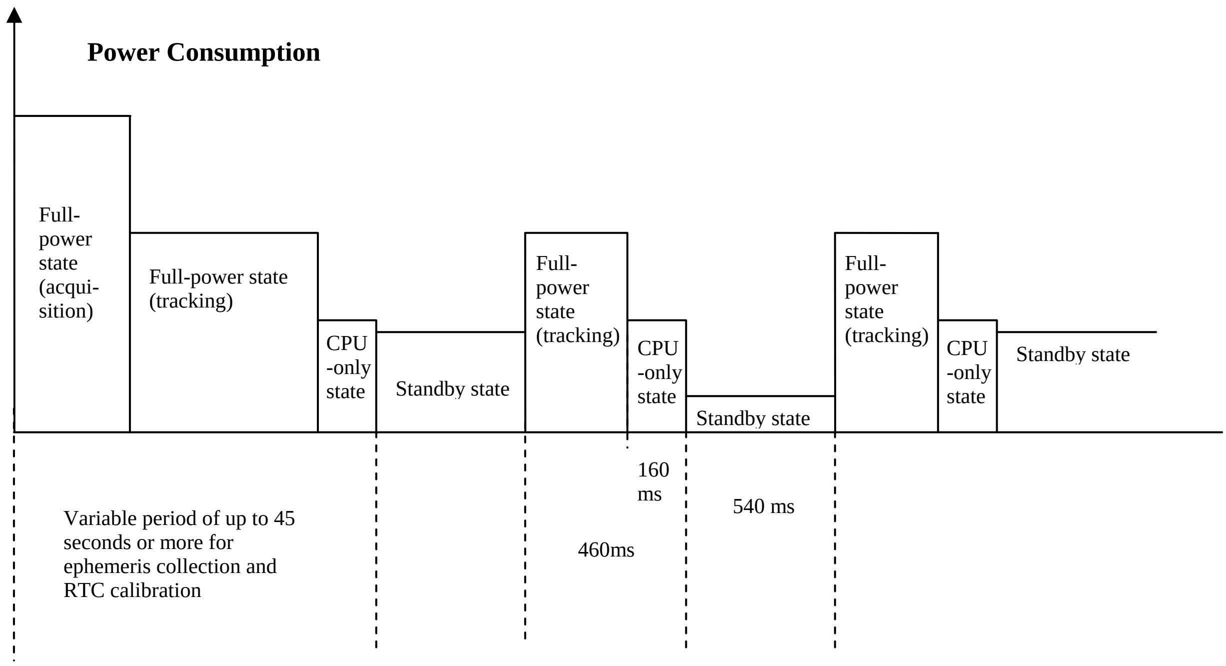

Figure 4-1. Timing Diagram for TricklePower™ mode

A typical timing diagram for 400ms full-power ON and 20% duty cycle is shown in the figure below for illustrative purposes.

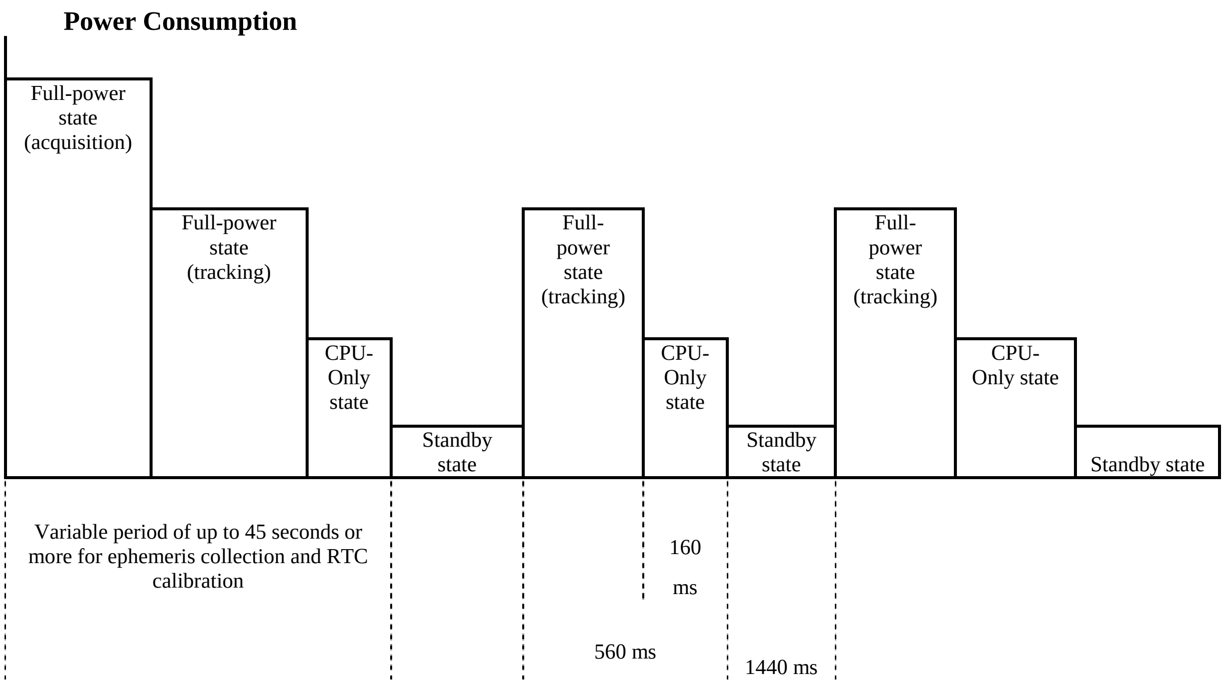

Figure 4-2. Timing Diagram TricklePower: 400ms, 20% Duty Cycle.

4.3. Push-To-Fix™

Push-to-Fix™ mode (PTF) is designed for applications that require infrequent position reporting. The SiRFStarIV receiver generally stays in the Hibernate system power state but wakes up periodically to refresh position, time, ephemeris data and RTC calibration.

On the JF2, a pulse on the external ON_OFF line to the receiver acts as a position update request. The request wakes up the receiver, which is then able to supply a position within the Hot Start TTFF specification. This particular feature of PTF mode is not available on the JN3 because it does not have an ON_OFF input.

Average current levels are proportionally lower relative to TP Mode duty-cycling because in PTF mode the receiver stays longer in a reduced power state. Additionally, the reduced power state used in PTF mode is the Hibernate state, which consumes less power than does the Standby state used by TP mode. However, because the system comes up from the Hibernate state, it must initialize the CPU state and data RAM. This requires a longer time spent in the Full Power state.

4.3.1. State Transitions

When the receiver is powered up in PTF mode or is awakened to start a new PTF Mode cycle, it remains in the initial Full Power state until a good navigation solution is computed and RTC calibration is completed. The firmware then programs the RTC to generate an interrupt which will wake up the receiver at the end of the current refresh cycle period to start a new PTF mode cycle. The Hibernate state then follows for the remainder of the refresh cycle period. For example, if it takes 36 seconds to compute position and to refresh ephemeris, and the refresh period is 30 minutes (the default), the receiver sleeps/hibernates for 29 minutes and 24 seconds if there is no pulse on the ON_OFF line.

4.3.2. Refresh Cycle

PTF mode puts the receiver into a background duty cycling mode in which the receiver repeatedly wakes from the Hibernate state and transitions to the Full-Power state. This background cycling is governed by the refresh cycle period, which is user-selectable from 10 seconds to 2 hours, with the default value being 30 minutes.

When the receiver wakes up after a refresh cycle period has elapsed, an internal reset is generated and a hot start acquisition is performed. After the receiver verifies position and time, it updates ephemeris data and calibrates the RTC as needed to maintain hot start conditions at the next scheduled refresh cycle.

4.3.3. Use of ON_OFF Signal

For JF2 modules, the user application can apply a pulse to the ON_OFF line to initiate a PTF cycle when it needs a position report. The pulse is positive-going and must have a duration of at least 100 milliseconds. The ON_OFF line can be pulsed at any time except within 1 second of a previous pulse. When the receiver awakes from the ON_OFF pulse, it behaves the same as when it awakes due to the background refresh cycle period. Additionally, a new background cycle period begins.

Important Note:

The ON_OFF line is not available on the JN3 as a means to request a position report. Rather, the position is only updated when the background refresh cycle period elapses. If Push-To-Fix mode is to be used on the JN3, care should be taken to select a refresh cycle period that is appropriate for the required frequency of position updates.

4.3.4. Timing Diagram

A typical timing diagram for the default 30-minute background refresh cycle is shown in the figure below. As with TricklePower mode, the receiver passes through a transitional baseband-only power state (shown in the diagram as CPU-Only) before entering the Hibernate state. While in this state the processor computes the final position and outputs the last set of serial data messages.

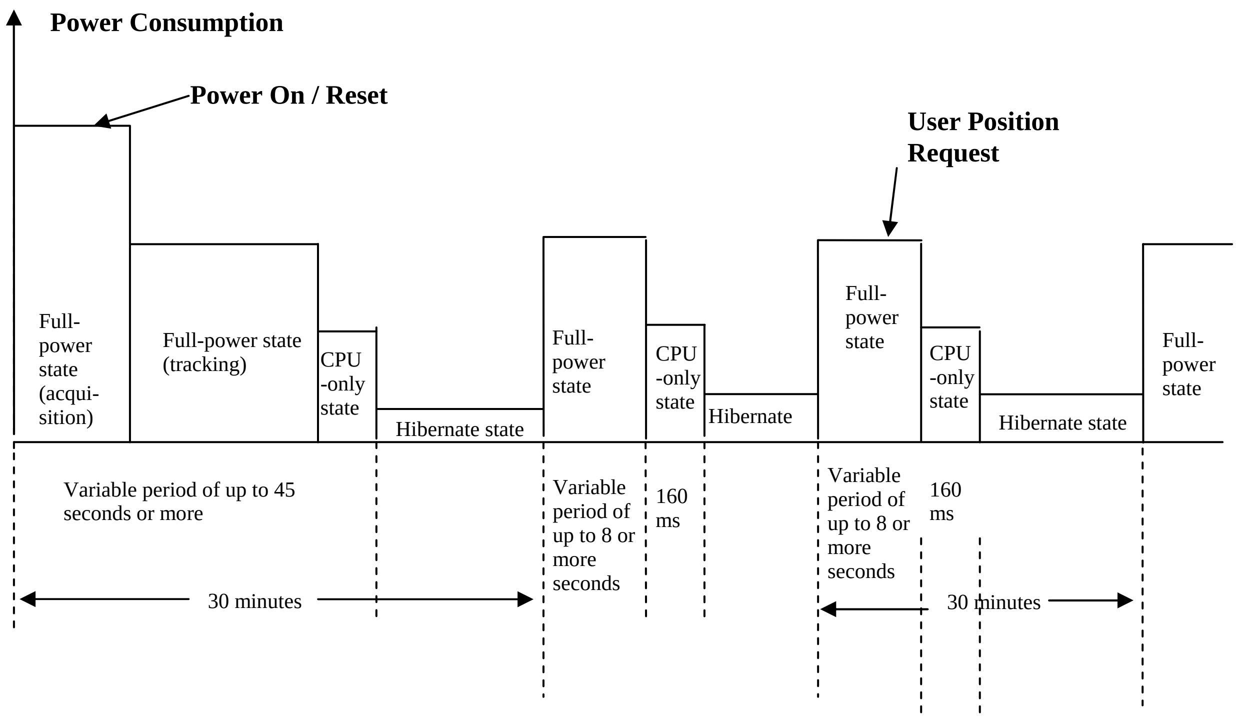

Figure 4-3. Timing Diagram for Push-to-Fix™ mode

4.4. Micro Power/SiRFAware™ Mode

Micro Power mode (MPM) is a very low power maintenance mode that delivers continuous availability of the navigation solution. It is intended for low dynamics applications. It continuously maintains ephemeris data as well as a low level of uncertainty in the estimates of position, time, and receiver clock error. It achieves this by keeping the SiRFStarIV receiver in the Hibernate power state and leaving Hibernate only as needed to maintain these conditions.

Micro Power mode does not provide periodic position updates. Position is reported on demand only when a pulse is input on the ON_OFF line, and it can be provided very quickly, typically within two seconds.

Important Note:

Micro Power mode is not supported on the JN3 because the ON_OFF line is not brought out as part of the module I/O. Section 4 of this document is only applicable to the JF2.

Micro Power mode is not available as a default low power operating mode. The module must be commanded into this mode by sending an MPM request message into the serial host port. Before MPM can be entered, the receiver must have calculated an initial position at near zero user velocity and must have calibrated time for the RTC and frequency error for the TCXO. It must also gather ephemeris for satellites in track, whether demodulated from satellite signals or provided by ephemeris aiding (InstantFix, for example).

4.4.1. Capture/Update Cycles

While in Micro Power mode, the receiver transitions from Hibernate to Full Power and captures a buffer of GPS samples at infrequent intervals and analyses the data to update its time, frequency and position estimates. The interval between these update cycles can vary from one to ten minutes, depending upon whether the receiver is operating at temperature extremes or rapidly varying temperatures. The internal temperature sensor is used to characterize the RTC and predict the drift rate, and if a temperature change is sensed, the receiver leaves Hibernate and uses the TCXO to calibrate the RTC clock frequency and correct the RTC clock estimate of time. Each update cycle on average requires about 150 to 250ms, depending upon how long the receiver has been operating and developing the oscillator database.

4.4.2. Maintenance Cycles

For satellites needing updated ephemeris data, a data collection is scheduled whenever strong signals are detected. During the data collection phase, time and frequency calibration operations are also carried out. Data collection in MPM is managed to limit power consumption. When data collection is required, it is timed in order to collect just the required data. If the receiver determines that the signal is not strong enough to collect new ephemeris, then it will return to the Hibernate state and try again later.

Note that Client-Generated synthetic ephemeris (Extended Ephemeris) calculations are performed by the receiver software during MPM, subject to overall power consumption constraints. If the receiver has valid synthetic ephemeris modeled for the current set of visible satellites, whether calculated locally (CGEE) or downloaded previously from an EE Server (SGEE), ephemeris data collection is not required. Thus data collection is only scheduled as needed in order to maintain CGEE. If however CGEE is disabled, maintenance cycles occur more frequently, about every two hours.

In good signal conditions MPM will typically take 18 to 24 seconds to perform data collection during a maintenance cycle, plus additional time in order to calculate CGEE. But note that the additional time for CGEE calculation is spent in a transitional state in which only the baseband processor is running.

4.4.3. Timing Diagram

A diagram illustrating the timing of maintenance and capture/update cycles during MP Mode with CGEE enabled is presented below.

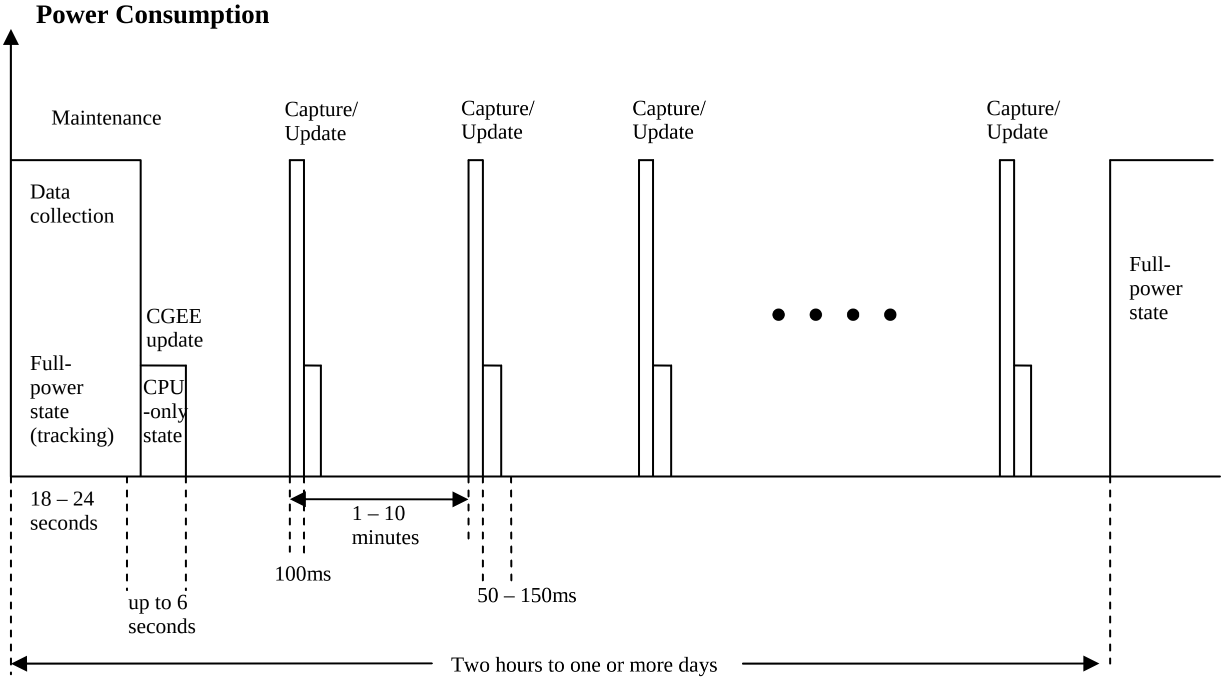

Figure 4-4. Timing Diagram for Micro Power Mode

4.4.4. State Transitions

The transition to Micro Power mode is always made from Full Power mode. When MPM is requested while the receiver is in Full Power mode, a direct transition to MPM is made as soon as conditions allow. If MPM is requested when the receiver is in any other low power mode, the receiver will first transition to Full-Power mode, then transition to MPM when conditions allow.

The MPM request includes a timeout value which can be selected from zero to 255 seconds. If the conditions for the transition to MPM are not met within the timeout, the receiver transitions to a permanent Hibernate state. This prevents the receiver from staying in Full Power mode in weak or blocked signal environments and shortening device battery life.

4.4.5. Use of ON_OFF Signal

When the receiver is in Micro Power mode, pulsing the ON_OFF signal will send the receiver into Full-Power mode. The pulse requirements are the same as with Push-To-Fix mode. If MPM has been successful in maintaining ephemeris and position and clock estimates, a position will be provided within two seconds. Another MPM request must be sent to the receiver in order for it to re-enter MPM.

Time

5. Antenna Performance Considerations

Antenna performance is critical for effective operation of low power modes. If the antenna performance is not sufficient, the GPS receiver will not reliably enter and remain in low system power states. In the case of TricklePower and Push-To-Fix modes, the receiver will spend an increased amount of time in the Full Power state, as it will take longer to acquire new satellites and collect ephemeris data if the average C/N_0 levels are not sufficient. Thus low signal levels will result in an increase of power consumption as compared to what would be obtained with good GPS antenna performance. Position accuracy will also be affected. In the case of Micro Power mode, the receiver will not be able to maintain conditions for providing a fast response to a position request.

Average C/N_0 levels for all satellites in open sky conditions must be between 36 and 40 dB-Hz for good low power mode operation. Higher C/N_0 levels would offer even better operation and reduced power consumption overall.

6. Low Power Mode Messages

Messages used for configuring low power operating modes are described in this section.

6.1. Mode Request Command

Specific low power modes can be commanded using OSP binary Message ID 218, which is defined in the *GSD4e OSP Manual*. This command consists of several Sub IDs, each of which is used to request a transition to a particular power mode:

- Sub ID 0 is used to command Full Power mode.
- Sub ID 2 is used to command Micro Power mode (JF2 only)
- Sub ID 3 is used to command TricklePower mode
- Sub ID 4 is used to command Push-To-Fix mode

The receiver module responds to Message ID 218 with a Power Mode Response message, which is Message ID 90 and is described in Section 6.2 below. By using the command and response mechanism afforded by Message ID 218 and Message ID 90, the user application can request power mode transitions and verify whether the requests were successful.

6.1.1. Full Power Request

There are no parameters required for the Full Power Mode Request command.

Name	Bytes	Binary (Hex)	Units	ASCII (Decimal)
Message ID	1U	DA	n/a	218
Sub ID	1U	00	n/a	0

Table 2. Full Power Request

The complete byte sequence for this command is therefore:

```
A0 A2 00 02 DA 00 00 DA B0 B3
```

6.1.2. Micro Power Mode Request

The Micro Power Mode (MPM) Request command has several parameters, but only one of which is allowed to be changed by the user.

Name	Bytes	Binary (Hex) Example	Unit	ASCII (Decimal) Example
Message ID	1U	DA	n/a	218
Sub ID	1U	02	n/a	2
Timeout	1U	1E	Seconds	30
Control	1U	00	Bitmap	00
Reserved	2	-	n/a	-

Table 3. Micro Power Mode Request

Timeout Parameter

The MPM timeout is the maximum time limit, in seconds, in which MPM pre-conditions must be met from the time the MPM Request message arrives. If the pre-conditions are not met within the time limit, the receiver module goes into a permanent hibernate state.

A timeout value of 0 indicates that a “hard” MPM transition is being requested and that the pre-conditions for transitioning must be met immediately. The receiver module responds with a success or failure status message (Message ID 90, Sub ID 2) depending on whether it enters MP Mode or the hibernate state, respectively.

If a transition timeout value is provided, this is considered a “soft” MPM request, and the receiver module initially responds with pending status message. A success or failure status message is sent subsequently by the receiver module depending upon whether or not MP Mode could be reached within the timeout limit.

Control Parameter

This field is used to specify control values for MPM. It should be treated as a reserved field and should be set to 0 (default values).

Command Example

This example shows the complete byte stream for a request to enter MPM mode within 30 seconds or else go to permanent Hibernation.

```
A0 A2 00 06 DA 02 1E 00 00 00 00 FA B0 B3
```

6.1.3. TricklePower Mode Request

The TricklePower Mode Request Command is shown in the table below:

Name	**Bytes**	**Binary (Hex) Example**	**Unit**	**ASCII (Decimal) Example**
Message ID	1U	DA	n/a	218
Sub ID	1U	03	n/a	3
Duty Cycle	2U	012C	0.1%	30.0%
ON-time	4U	0000012C	msec	300
Max Off Time	4U	00007530	msec	30,000
Max Search Time	4U	0001D4C0	msec	120,000

Table 4. Trickle Power Request

Duty Cycle

The duty cycle, which represents the percentage of time spent in full power mode during TricklePower operation, can be specified from 0 to 100% (0 to 1000). Specifying 0% however is a special case that is also interpreted as 100% duty cycle. The duty cycle is modified by the Jupiter module if necessary in order to produce a valid update interval that is an integer value in seconds. Update intervals can be from 1 to 10 seconds. If the input duty cycle is too low and causes the update interval to exceed 10 seconds, the low power parameters are not updated.

ON-Time

The TricklePower ON-time is the amount of time that the receiver spends in full power during each position update period. It can be specified between 100 and 900ms. However, for one second update rates, the maximum ON-time value is 600ms. If the commanded ON-time exceeds the allowed maximum value, the low power parameters are not updated.

Maximum Off Time

When the Jupiter module is unable to acquire satellites while in TricklePower mode, it will drop into a low power system state for a period of time before re-attempting acquisition. The Maximum Off Time specifies this low power period of time. The default value is 30000 (30 seconds). Although the module will accept values from 1ms to the maximum 32-bit value, the recommended range limits are 1000 to 1800000 (1 second to 30 minutes).

The Maximum Off Time should be set to fit the predominant dynamics of the signal environment. If received signal power is relatively static and changes infrequently, longer times, perhaps 3 to 5 minutes, are more appropriate. If signal power changes more rapidly due to intermittent blockages, as for example in a vehicle going into and out of tunnels, shorter times should be used so that a position fix can be obtained more readily in changing conditions.

Maximum Search Time

This is the maximum amount of time that the Jupiter module attempts to acquire satellites and obtain a navigation solution while in TricklePower mode. If unsuccessful the module drops into a low power system state as described above. The default value is 120000 (2 minutes). The module will accept values from 1ms to the maximum 32-bit value, although the recommended minimum limit is 1000 (1 second).

Note that the Maximum Search Time also applies to initial acquisition if the module is in a low power operating mode at start-up or when it is reset. For these situations, it should be set to a value that can accommodate the average TTFF for the initial acquisition conditions, e.g. warm start or cold start, plus an additional 15 to 30 seconds for margin. Otherwise, the Maximum Search Time can be set to a value from 15 to 30 seconds for most open-sky situations during normal operation. For receiver modules that experience frequent blockages or weak signal conditions, as for example a receiver frequently used in-doors, larger values should be used in order to accommodate the longer times needed to acquire and track satellites.

Command Example

The duty cycle is determined by the ratio of ON-time to the desired position update interval. As an example, for an ON-time of 300 milliseconds and a one second update rate, the duty cycle is 300ms/1000ms, or 30%. To enable TricklePower mode with 30% duty cycle, a Maximum Off Time of 30 seconds and a Maximum Search Time of 120 seconds, the complete command byte stream would be:

`A0 A2 00 10 DA 03 01 2C 00 00 01 2C 00 00 75 30 00 01 D4 C0 03 71 B0 B3`

6.1.4. Push-To-Fix Mode Request

The Push-To-Fix Mode Request Command is shown in the table below:

Name	Bytes	Binary (Hex) Example	Unit	ASCII (Decimal) Example
Message ID	1U	DA	n/a	218
Sub ID	1U	03	n/a	3
Refresh Period	4U	0000003C	seconds	60
Max Search Time	4U	0001D4C0	msec	120,000
Max Sleep Time	4U	00007530	msec	30,000

Refresh Period

This is the background refresh cycle period used by Push-To-Fix mode to wake up the receiver module in order to update ephemeris data and maintain hot start acquisition conditions. The module will also output a position update during the refresh cycle. It will accept values from 10 to 7200 seconds.

Maximum Search Time

This is the maximum amount of time that the Jupiter module attempts to acquire satellites and obtain a navigation solution after it is awakened from sleep mode, either by a scheduled refresh cycle or a position request. It is used the same as with TricklePower mode.

Maximum Sleep Time

This parameter is used the same as the Maximum Off Time with TricklePower mode.

Command Example

Below is the complete byte stream for a Push-To-Fix Request with a 60 seconds Refresh period, 120 seconds Maximum Search Time and 30 seconds Maximum Sleep Time.

```
A0 A2 00 0E DA 04 00 00 00 3C 00 01 D4 C0 00 00 75 30 03 54 B0 B3
```

6.2. Power Mode Response

The Power Mode Response from the receiver module is Message ID 90 and is also defined in the *GSD4e OSP Manual*. If the requested power mode transition is successful, the response message contains the Sub ID of the new power mode. Otherwise the response contains the Sub ID of the current power mode. The exception to this behavior is in the response to a Micro Power Mode request (Message ID 218, Sub ID 2), which is described below.

6.2.1. Micro Power Mode Response

The Micro Power Mode Response message is shown in the following table. The example data indicates a pending status response.

Name	Bytes	Binary (Hex) Example	Unit	ASCII (Decimal) Example
Message ID	1U	5A	n/a	90
Sub ID	1U	02	n/a	2
Status	2U	0100	Bitmap	256
Reserved	2U	-	n/a	-

Table 5. Micro Power Mode Response

The *Status* is a bit field indicating the progress of the transition to MPM. It has assigned bits that indicate the following conditions if the bit is set:

- Bit 4 indicates a successful transition
- Bit 5 indicates that a navigation solution was not reached
- Bit 6 indicates that the real-time clock was not calibrated
- Bit 7 indicates that the estimated horizontal position was more than 100 meters

- Bit 8 indicates that MPM is pending.

For soft MPM requests (non-zero timeout parameter), the receiver first issues a response with Bit 8 set, indicating a pending transition. If the pre-conditions for MPM are not met when the timeout expires, the receiver issues another response where the bit field indicates the failed condition. Otherwise, once pre-conditions are met, the receiver issues a response with Bit 4 set.

6.2.2. Other Power Mode Responses

The response to requests for power modes other than Micro Power is shown in the table below. The example data shown is for a successful transition to TricklePower mode.

Name	Bytes	Binary (Hex) Example	Unit	ASCII (Decimal) Example
Message ID	1U	5A	n/a	90
Sub ID	1U	03	n/a	3
Error Code	1U	00	n/a	0

Table 6. TricklePower Mode Response

The *Sub ID* reflects the new power mode if the requested transition was successful, in which case the *Error Code* has a value of 0. If the transition was unsuccessful the *Sub ID* reflects the current power mode, and the *Error Code* has a value of 1. See Section 6.1 regarding Sub ID mode assignments.

6.3. Legacy Low Power Commands

The JF2 and JN3 modules support the configuration of TricklePower and Push-To-Fix modes using Message ID 151 (Set TricklePower Parameters) and Message ID 167 (Set Low Power Acquisition Parameters) commands. These messages are described in the *GSD4e OSP Manual* and are legacy SiRF Binary commands that were used in SiRFStarIII receivers. The parameters for the Power Mode requests are the same as those used in these legacy commands.

7. Document History

Revision	Date	Changes
1	28-Mar-11	Preliminary Release
2	30-Jun-11	Update MPM section to MPM2.0
3	7-Jul-11	Minor formatting edits
4	20-Jul-11	Add Figure 3-2 Tricklepower Timing Diagram
5	19-Mar-12	Incorporate JN3 details. Update MPM information from latest CSR note. Technical and grammatical corrections.
6	29-Jan-13	Updated for ROM 2.2 / Firmware 4.1.2 MPM operation, including additional information on MPM timeouts. Added detailed description of power mode command and response messages. Removed MEMS wake-up section (not supported).