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Applied products	Description	Version
SC-1513, RSC-2024	Application note: Power management considerations	1.0

1 Introduction

This application note describes the power management considerations of SC-1513 based on SiRFstarIII single chip. Two power saving modes are described with timing diagram and estimated power consumption.

In general, the power management scheme goes as follows:

The receiver starts in the full power mode until the user's position is fixed and relevant information is gathered. In a cold start (autonomous operation), it will take about 30 to 40 seconds on average to compute the first position fix and extract other information. The time will be shorter in other cases, such as aided or hot starts.

Once the receiver is ready for normal processing, different portions of hardware can be turned off or un-clocked, depending on the receiver state. After all the processing is completed, the receiver will program the Real Time Clock (RTC) wakeup register to wake up at some time in the future, and then go to sleep by turning off most of the circuitry except the RTC. When the wakeup interrupt occurs, the receiver starts up the system and resumes GPS tasks.

2 Power Management Modes Overview

Two kinds of power saving modes are offered to meet demanding applications that have different requirements in position report interval and power consumption. These modes perform similarly in principle but provide different output rates and reliability. They are Adaptive Trickle Power and Push to Fix.

Key characteristics of power management modes are as follows:

- Adaptive Trickle Power is intended to save power by cycling between full power, a reduced power setting using just the CPU, and a low-power setting in a fixed-rate cycle. Cycle times range between 1 and 10 seconds. When signal levels are strong enough, it provides a fixed power savings and provides a constant output rate. But when signal levels drop, it returns to full power so that message output rates remain constant even in difficult environments. This results in variable power savings but much more reliable performance for a fixed output rate. Applications using this mode should give performance very similar to full power, but with significant power savings in strong-signal conditions.
- Push to Fix mode is designed for the application that requires infrequent position reporting. The receiver generally stays in a low-power mode, up to 2 hours, but wakes up periodically to refresh position, time, ephemeris data and RTC calibration. A position request acts a wakeup to the receiver, which is then able to supply a position within the hot-start time specification.

2.1 Power Management System States

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Depending on different states of the power management, the receiver belongs to one of four system states.

1. **Full power state**

   This is the initial state of the receiver where all RF circuitry and the baseband are fully powered. The receiver stays in this state until a position solution is made and estimated to be reliable. Even in this state, there is a difference in power consumption during acquisition mode and tracking mode. During the acquisition mode, processing is more intense, thus consuming more power.

2. **CPU only state**

   This state is entered when the satellite measurements have been collected but the navigation solution still needs to be computed. The RF and DSP processing are no longer needed and can be turned off.

3. **Stand by state**

   In this state, the RF section is completely powered off and the clock to the baseband is stopped. About 1 mA of current is drawn in this state for the internal core regulator, RTC and battery-backed RAM.

   The receiver enters this state when a position fix has been computed and reported. Typically, before shutting down the RTC wakeup register is programmed to wake up the system sometime in the future. In some cases, programming the wakeup register is kipped when an external host wakes up the receiver.

4. **Hibernate state**

   This is a new feature that is introduced in SiRFstarIII. It is intended for ultra-low power consuming applications. Both the RF and the baseband are turned off, leaving only the RTC and battery-backed RAM running. In this state, less than 50 μA of current is drawn. This state is available in Push to Fix mode only.

Table 1. Pin levels of system states

	RFPWRUP	VOUT
Full power	H	Enable
CPU only	H	Enable
Stand by	L	Enable
Hibernate	L	Disable

2.2 Adaptive Trickle Power Mode

When Adaptive Trickle Power is enabled the receiver will maximize the navigation performance. Under normal tracking conditions, Adaptive Trickle Power performs a fixed power savings, but in harsh tracking environments the receiver automatically switches to full power state to improve navigation performance. When the satellites are sorted according their signal strength, the

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fourth satellite determines if the transition will occur or not. Currently, the threshold is 26 dB-Hz.

When tracking, conditions return to normal (four or more satellites with C/No of 30 dB-Hz or higher), the receiver switches back to a fixed power savings. Consequently, navigation results can then be improved in harsh GPS environments at the cost of using more power.

Adaptive Trickle Power is best suited for applications that require solutions at a fixed rate as well as low power consumption and still maintain the ability to track weak signals. For this purpose SiRF recommends the use of 300 ms, 1 second or 400 ms, 2 seconds duty cycles for optimum performance.

Adaptive Trickle Power is best suited for applications where regular updates are required, and where stronger signal levels are expected. The receiver is set for a specific update period, and a specific sampling time during each period (range from 200 to 900 ms). The receiver turns to full power state for the sampling time to collect data, and then operates in stand-by state for the remainder of the update period. The next full-power state is initiated by an RTC wakeup.

Adaptive Trickle Power mode cycles through full power and stand by state. However, there are some situations where the receiver stays in full-power mode. They are:

- To collect periodic ephemeris data,
- To collect periodic ionospheric data,
- To perform RTC convergence, and
- To improve navigation result.

Timing diagrams is shown in Figure 1 based on the Trickle Power parameters of 1 second interval and 300 ms on-time. Those figures are simplified for ease of understanding and may not represent true timing.

After tracking is completed, it takes approximately 160ms to compute the navigation solution and drain the UART before going to the stand by state.

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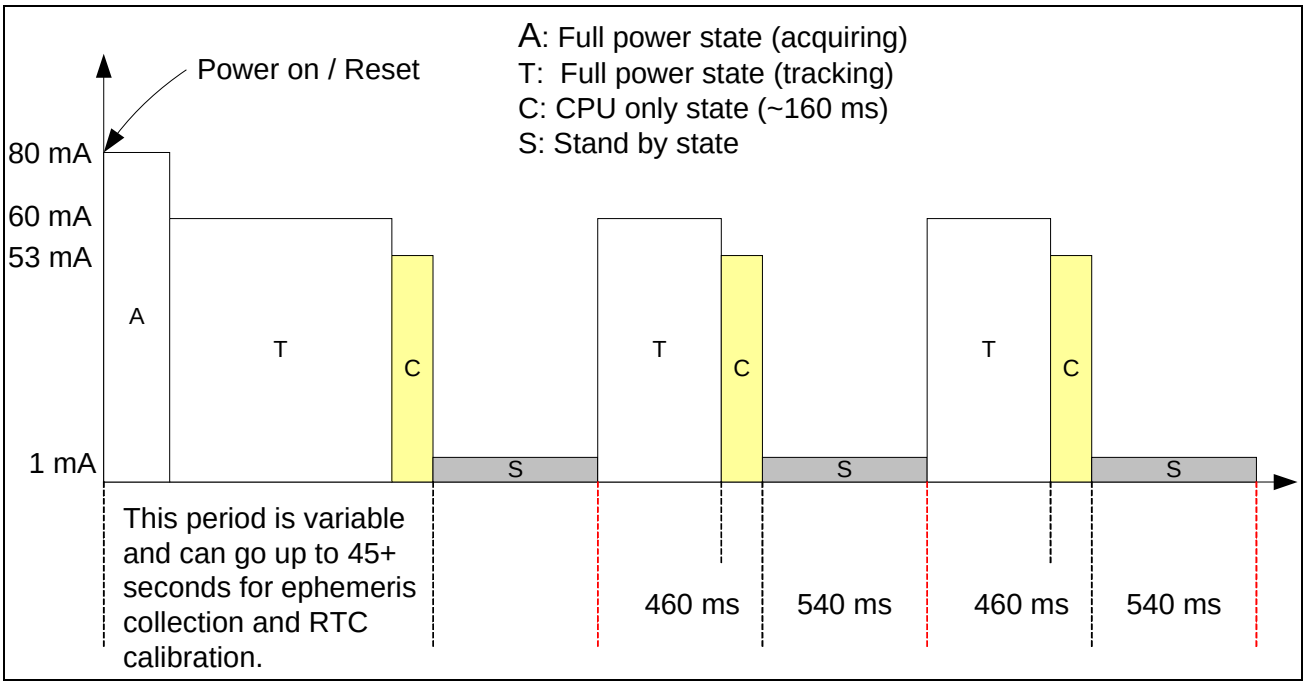

Figure 1. Timing diagram for the Adaptive Trickle Power mode (1 second interval and 300ms on-time).

2.3 Push To Fix Mode

The Push to Fix mode puts the receiver into a background duty cycle mode that provides a periodic refresh of position, GPS time, ephemeris, and RTC calibration every 10 minutes to 2 hours. Typical Push To Fix operation is illustrated in Figure 2.

The Push To Fix period is 30 minutes by default but can be anywhere between 10 seconds and 2 hours. When the Push To Fix mode is enabled, upon power on or a new Push To Fix cycle, the receiver will stay on full power until the good navigation solution is computed. The hibernate state will follow for the remainder of the period. If it took 36 seconds to fix position and refresh ephemeris on the default period of 30 minutes, the receiver will sleep for the 29 minutes and 24 seconds. When the application needs a position report, it can toggle the ON_OFF pin to wake up the receiver. Please note that it should be done only when the receiver is in hibernate state. When the receiver wakes up because of the ON_OFF pin, a new Push To Fix cycle begins resetting all variables related to handling the wakeup and sleep time (See Figure 2).

Whenever the receiver wakes up, it stays up in order to collect pertinent GPS data, such as ephemeris and almanac before going back to sleep. Its purpose is to compute a position in the normal hot-start time.

Note: This mode is not implemented in SC-1513. If very low power consumption is desired, please use a power switch to turn on/off the receiver. There is an example circuit in the figure 3.

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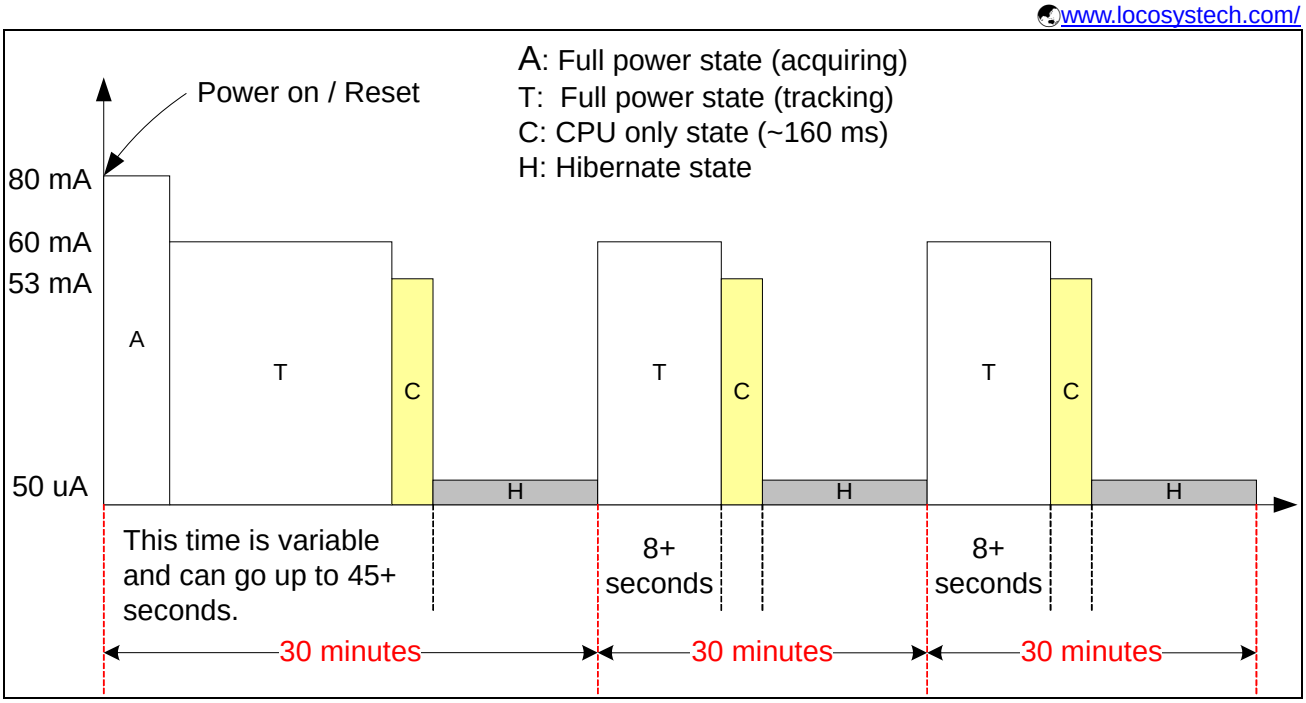

Figure 2. Timing diagram for the Push To Fix mode (period of 30 minutes).

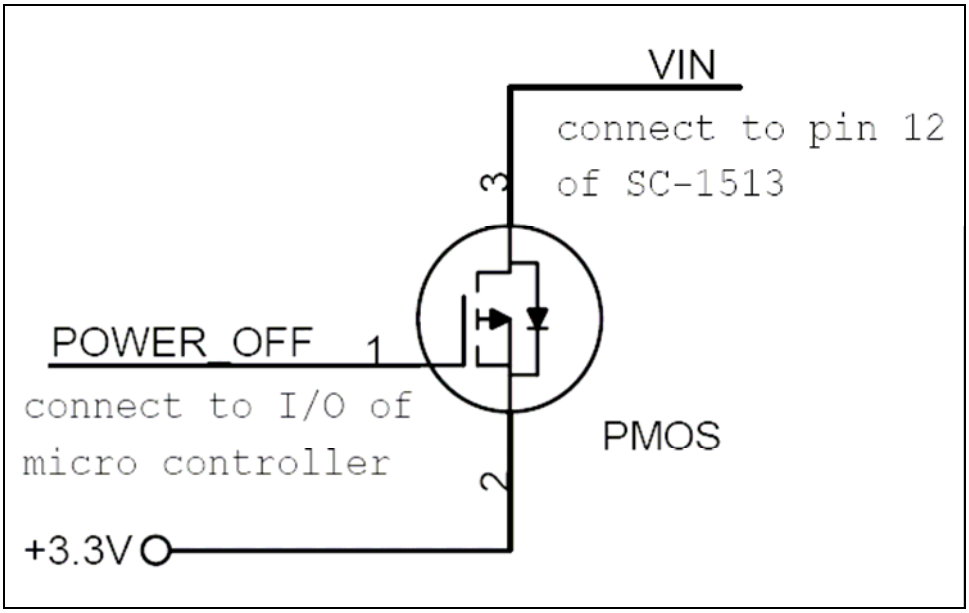

Figure 3. Example circuit: actually turn off the power of receiver, SC-1513.

3 Software interface

Power saving mode is disabled by default. In order to enable it, there are two methods, one is to use SiRF binary protocol and another is to use LOCOSYS proprietary ASCII command. For SiRF binary protocol, please refer to the document, SiRF Binary Protocol Reference Manual.

3.1 LOCOSYS proprietary ASCII command

All the commands follow the syntax as below:

Command:

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$PLSC,MID,Parameter…*<CKSUM>\r\n

Response:

$PLSR,MID,Valid,Parameter…*<CKSUM>\r\n

For more and latest LOCOSYS proprietary ASCII command, please refer to the document, "LOCOSYS proprietary ASCII command".

Table 3.1-1 LOCOSYS proprietary message

MID	Description
200	Power management
201	Poll software version

- 200 --- PowerManagement

This command is used to setup the state of Power Mode or to check.

Table 3.1-2 <200> Command data format

Name	**Value**	**Unit**	**Description**
MID	200		Message ID
Mode	0..3		See Table3.1-3
OnTime	200..900	ms	Must be a multiple of 100 (if not, it is rounded up to the nearest multiple of 100). OnTime must be greater than or equal to 200 ms. Set to 0 when mode = 3.
LPInterval	1000.. 2147483000	ms	Must be an integer value greater than or equal to 1000 (i.e., 1 second). LPInterval does not need to be a multiple of 100. Set to 0 when mode = 3.
MaxAcqTime	1000.. 2147483000	ms	When Adaptive Trickle Power is enabled, MaxAcqTime (in ms) is the maximum allowable interval from the start of an Adaptive Trickle Power cycle to the time a valid position fix is obtained from navigation. If this time elapses and no fix is obtained, the receiver is deactivated for up to MaxOffTime, and when the receiver reactivates, a hot start is commanded. The integer must be in multiples of 1000 ms. The smallest allowable value is 1000 ms. The largest value is 2147483000 ms.
MaxOffTime	1000.. 1800000	ms	The longest period (in ms) for which the receiver deactivates due to the MaxAcqTime timeout. The actual deactivated period may be less if the

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			user-specified duty cycle (OnTime / LpInterval) can be maintained. It must be a positive number. The smallest allowable value is 1000 ms. The largest allowable value is 1800000 ms (i.e., 1800 seconds, or 30 minutes.)
PushToFixPeriod	10..7200	sec	10~7200 seconds
Checksum			
<CR><LF>			End of message termination

Table 3.1-3 Power management modes

Value	Description
0	Ask receiver to send current power mode
1	Set receiver to Full power mode
2	Set receiver to Adaptive Trickle Power mode
3	Set receiver to Push To Fix mode

Table 3.1-4 <200> Response data format

Name	**Value**	**Unit**	**Description**
MID	200		Message ID
Valid	0..1		0: command invalid, 1: command valid
Mode	1..3		See Table3.1-3
OnTime	200..900	ms	Display when mode = 2
LPInterval	1000.. 2147483000	ms	Display when mode = 2
MaxAcqTime	1000.. 2147483000	ms	Display when mode = 2 or 3
MaxoffTime	1000.. 1800000	ms	Display when mode = 2 or 3
PushToFixPeriod	10..7200	sec	Display when mode = 3
Checksum			
<CR><LF>			End of message termination

Example:

1. Query the power management mode
   Input command: $PLSC,200,0*0E
   Output response: $PLSR,200,1,1*03
2. Set to Full power mode
   Input command: $PLSC,200,1*0F
   Output response: $PLSR,200,1,1*03
3. Set to Adaptive Trickle Power mode

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Input command: $PLSC,200,2,300,1000,300000,30000*0E

Output response: $PLSR,200,1,2,300,1000,300000,30000*02

4. Set to Push To Fix mode

Input command: $PLSC,200,3,0,0,300000,30000,10*10

Output response: $PLSR,200,1,3,300000,30000,10*1C

- 201 --- PollSoftwareVersion

This command is used to query the software version of SiRF and Manufacturer.

Table 3.1-5 <201> Command data format

Name	Value	Unit	Description
MID	201		Message ID
Checksum			
<CR><LF>			End of message termination

Table 3.1-6 <201> Response data format

Name	Value	Unit	Description
MID	201		Message ID
Valid	0..1		0: command invalid, 1: command valid
SiRF	String		SiRF software version
Mfer	String		Manufacturer software version
Checksum			
<CR><LF>			End of message termination

Example:

Input command: $PLSC,201*13

Output response: $PLSR,201,1,GSW3.1.1_3.1.00.07-C23P1.00,B20060517-4800bps*3E

3.2 Flow chart of how to use Advanced Trickle Power mode

Example to set the receiver to Advanced Trickle power mode with 1-second interval and 300 ms On-Time is as below.

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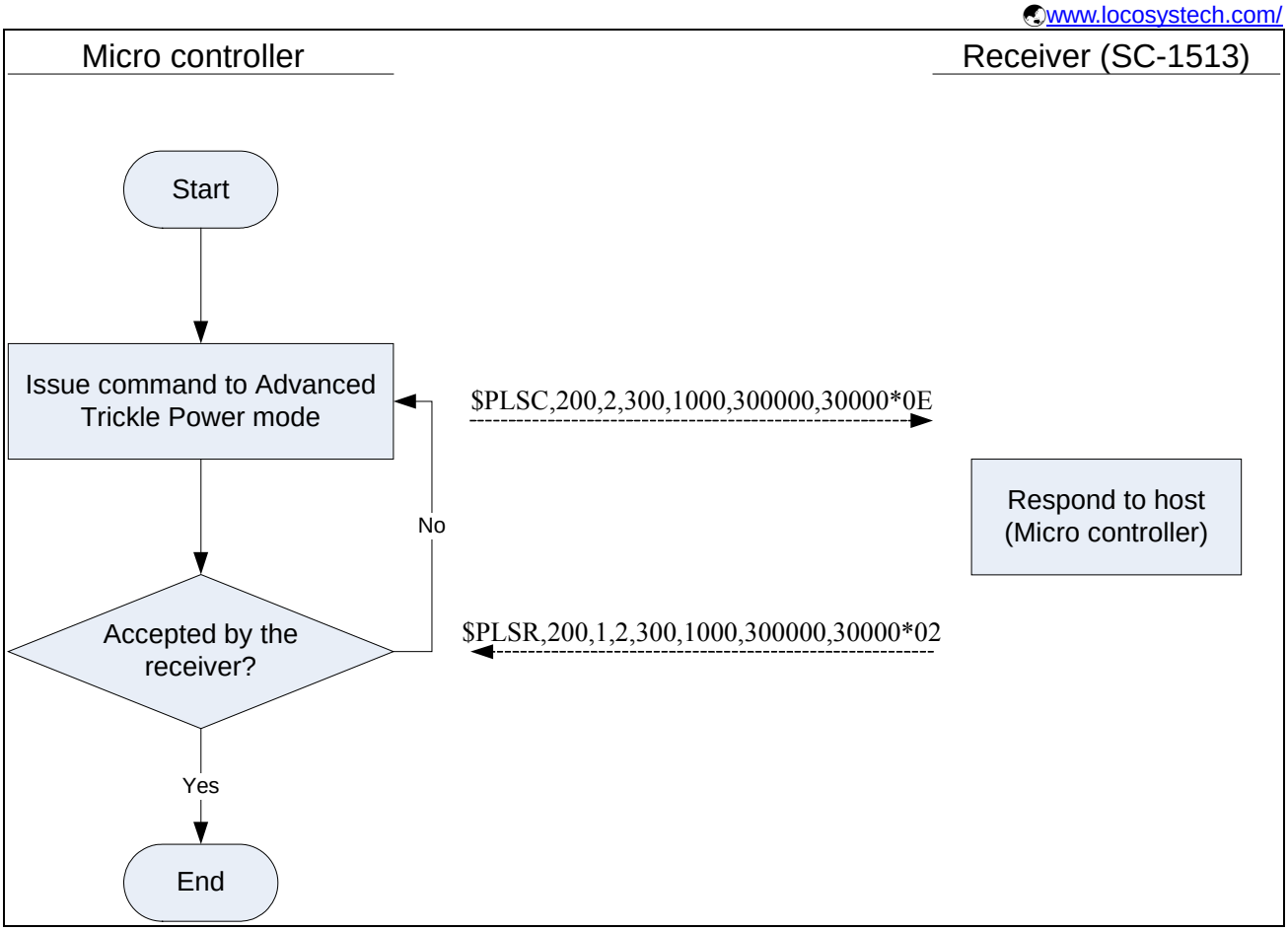

Figure 4. Set receiver to Advanced Trickle Power mode with 1-second interval and 300 ms On-Time

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Document change list

Revision 1.0

- First release.