
AT13485: SAM C System (SYSTEM) Driver

APPLICATION NOTE

Introduction

This driver for Atmel® | SMART ARM®-based microcontrollers provides an interface for the configuration and management of the device's system relation functionality, necessary for the basic device operation. This is not limited to a single peripheral, but extends across multiple hardware peripherals.

The following peripherals are used by this module:

- PM (Power Manager)
- RSTC (Reset Controller)
- SUPC (Supply Controller)

The following devices can use this module:

- Atmel | SMART SAM C20/C21

The outline of this documentation is as follows:

- [Prerequisites](#)
- [Module Overview](#)
- [Special Considerations](#)
- [Extra Information](#)
- [Examples](#)
- [API Overview](#)

Table of Contents

Introduction.....	1
1. Software License.....	3
2. Prerequisites.....	4
3. Module Overview.....	5
3.1. Voltage Regulator.....	5
3.2. Voltage References.....	5
3.3. System Reset Cause.....	5
3.4. Sleep Modes.....	5
4. Special Considerations.....	7
5. Extra Information.....	8
6. Examples.....	9
7. API Overview.....	10
7.1. Structure Definitions.....	10
7.1.1. Struct system_standby_config.....	10
7.1.2. Struct system_voltage_references_config.....	10
7.1.3. Struct system_voltage_regulator_config.....	10
7.2. Function Definitions.....	10
7.2.1. Voltage Regulator.....	10
7.2.2. Voltage References.....	11
7.2.3. Device Sleep Control.....	12
7.2.4. Standby Configuration.....	13
7.2.5. Reset Control.....	13
7.2.6. System Debugger.....	14
7.2.7. System Identification.....	14
7.2.8. System Initialization.....	14
7.3. Enumeration Definitions.....	15
7.3.1. Enum system_reset_cause.....	15
7.3.2. Enum system_sleepmode.....	15
7.3.3. Enum system_voltage_reference.....	15
7.3.4. Enum system_voltage_references_sel.....	16
7.3.5. Enum system_vreg_switch_mode.....	16
8. Extra Information for SYSTEM Driver.....	17
8.1. Acronyms.....	17
8.2. Dependencies.....	17
8.3. Errata.....	17
8.4. Module History.....	17
9. Document Revision History.....	18

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2. Prerequisites

There are no prerequisites for this module.

3. Module Overview

The System driver provides a collection of interfaces between the user application logic, and the core device functionality (such as clocks, reset cause determination, etc.) that is required for all applications. It contains a number of sub-modules that control one specific aspect of the device:

- System Core (this module)
- System Clock Control (sub-module)
- System Interrupt Control (sub-module)
- System Pin Multiplexer Control (sub-module)

3.1. Voltage Regulator

The SAM device controls the voltage regulators for the core (VDDCORE). It sets the voltage regulators according to the sleep modes.

There are a selectable reference voltage and voltage dependent on the temperature which can be used by analog modules like the ADC.

3.2. Voltage References

The various analog modules within the SAM devices (such as AC, ADC, and DAC) require a voltage reference to be configured to act as a reference point for comparisons and conversions.

The SAM devices contain multiple references, including an internal temperature sensor and a fixed band-gap voltage source. When enabled, the associated voltage reference can be selected within the desired peripheral where applicable.

3.3. System Reset Cause

In some applications there may be a need to execute a different program flow based on how the device was reset. For example, if the cause of reset was the Watchdog timer (WDT), this might indicate an error in the application, and a form of error handling or error logging might be needed.

For this reason, an API is provided to retrieve the cause of the last system reset, so that appropriate action can be taken.

3.4. Sleep Modes

The SAM devices have several sleep modes. The sleep mode controls which clock systems on the device will remain enabled or disabled when the device enters a low power sleep mode. [Table 3-1 SAM Device Sleep Modes](#) on page 6 lists the clock settings of the different sleep modes.

Table 3-1 SAM Device Sleep Modes

Sleep mode	CPU clock	AHB clock	APB clocks	Clock sources	System clock	32KHz	Reg mode	RAM mode
Idle 0	Stop	Run	Run	Run	Run	Run	Normal	Normal
Idle 1	Stop	Stop	Run	Run	Run	Run	Normal	Normal
Idle 2	Stop	Stop	Stop	Run	Run	Run	Normal	Normal
Standby	Stop	Stop	Stop	Stop	Stop	Stop	Low Power	Source/ Drain biasing

Before entering device sleep, one of the available sleep modes must be set. The device will automatically wake up in response to an interrupt being generated or upon any other sleep mode exit condition.

Some peripheral clocks will remain enabled during sleep, depending on their configuration. If desired, the modules can remain clocked during sleep to allow them continue to operate while other parts of the system are powered down to save power.

4. Special Considerations

Most of the functions in this driver have device specific restrictions and caveats; refer to your device datasheet.

5. Extra Information

For extra information, see [Extra Information for SYSTEM Driver](#). This includes:

- [Acronyms](#)
- [Dependencies](#)
- [Errata](#)
- [Module History](#)

6. Examples

For SYSTEM module related examples, refer to the sub-modules listed in the [Module Overview](#).

7. API Overview

7.1. Structure Definitions

7.1.1. Struct `system_standby_config`

Configuration structure for standby mode.

Table 7-1 Members

Type	Name	Description
bool	hmcramchs_back_bias	Back bias for HMCramCHS (false: no, true: standby)
enum system_vreg_switch_mode	vreg_switch_mode	Regulator switch mode in standby

7.1.2. Struct `system_voltage_references_config`

Configuration structure for VREF.

Table 7-2 Members

Type	Name	Description
bool	on_demand	On demand control
bool	run_in_standby	Run in standby
enum system_voltage_references_sel	sel	Voltage references selection

7.1.3. Struct `system_voltage_regulator_config`

Configuration structure for VREG.

Table 7-3 Members

Type	Name	Description
bool	run_in_standby	Run in standby in standby sleep mode

7.2. Function Definitions

7.2.1. Voltage Regulator

7.2.1.1. Function `system_voltage_regulator_get_config_defaults()`

Retrieve the default configuration for voltage regulator.

```
void system_voltage_regulator_get_config_defaults(  
    struct system_voltage_regulator_config *const config)
```

Fills a configuration structure with the default configuration:

- The voltage regulator is in low power mode in Standby sleep mode

Table 7-4 Parameters

Data direction	Parameter name	Description
[out]	config	Configuration structure to fill with default values

7.2.1.2. Function `system_voltage_regulator_set_config()`

Configure voltage regulator.

```
void system_voltage_regulator_set_config(
    struct system_voltage_regulator_config *const config)
```

Configures voltage regulator with the given configuration.

Table 7-5 Parameters

Data direction	Parameter name	Description
[in]	config	Voltage regulator configuration structure containing the new config

7.2.1.3. Function `system_voltage_regulator_enable()`

Enable the selected voltage regulator.

```
void system_voltage_regulator_enable( void )
```

Enables the selected voltage regulator source.

7.2.1.4. Function `system_voltage_regulator_disable()`

Disable the selected voltage regulator.

```
void system_voltage_regulator_disable( void )
```

Disables the selected voltage regulator.

7.2.2. Voltage References

7.2.2.1. Function `system_voltage_reference_get_config_defaults()`

Retrieve the default configuration for voltage reference.

```
void system_voltage_reference_get_config_defaults(
    struct system_voltage_references_config *const config)
```

Fill a configuration structure with the default configuration:

- 1.024V voltage reference typical value
- On demand control:disabled
- The voltage reference and the temperature sensor are halted during standby sleep mode

Table 7-6 Parameters

Data direction	Parameter name	Description
[out]	config	Configuration structure to fill with default values

7.2.2.2. Function `system_voltage_reference_set_config()`

Configure voltage reference.

```
void system_voltage_reference_set_config(  
    struct system_voltage_references_config *const config)
```

Configures voltage reference with the given configuration.

Table 7-7 Parameters

Data direction	Parameter name	Description
[in]	config	Voltage reference configuration structure containing the new config

7.2.2.3. Function `system_voltage_reference_enable()`

Enable the selected voltage reference.

```
void system_voltage_reference_enable(  
    const enum system_voltage_reference vref)
```

Enables the selected voltage reference source, making the voltage reference available on a pin as well as an input source to the analog peripherals.

Table 7-8 Parameters

Data direction	Parameter name	Description
[in]	vref	Voltage reference to enable

7.2.2.4. Function `system_voltage_reference_disable()`

Disable the selected voltage reference.

```
void system_voltage_reference_disable(  
    const enum system_voltage_reference vref)
```

Disables the selected voltage reference source.

Table 7-9 Parameters

Data direction	Parameter name	Description
[in]	vref	Voltage reference to disable

7.2.3. Device Sleep Control

7.2.3.1. Function `system_set_sleepmode()`

Set the sleep mode of the device.

```
void system_set_sleepmode(  
    const enum system_sleepmode sleep_mode)
```

Sets the sleep mode of the device; the configured sleep mode will be entered upon the next call of the `system_sleep()` function.

For an overview of which systems are disabled in sleep for the different sleep modes, see [Sleep Modes](#).

Table 7-10 Parameters

Data direction	Parameter name	Description
[in]	sleep_mode	Sleep mode to configure for the next sleep operation

7.2.3.2. Function `system_sleep()`

Put the system to sleep waiting for interrupt.

```
void system_sleep( void )
```

Executes a device DSB (Data Synchronization Barrier) instruction to ensure all ongoing memory accesses have completed, then a WFI (Wait For Interrupt) instruction to place the device into the sleep mode specified by `system_set_sleepmode` until woken by an interrupt.

7.2.4. Standby Configuration

7.2.4.1. Function `system_standby_get_config_defaults()`

Retrieve the default configuration for standby.

```
void system_standby_get_config_defaults(
    struct system_standby_config *const config)
```

Fills a configuration structure with the default configuration for standby:

- Automatic VREG switching is used
- Retention back biasing mode for HMCRAMCHS

Table 7-11 Parameters

Data direction	Parameter name	Description
[out]	config	Configuration structure to fill with default values

7.2.4.2. Function `system_standby_set_config()`

Configure standby mode.

```
void system_standby_set_config(
    struct system_standby_config *const config)
```

Configures standby with the given configuration.

Table 7-12 Parameters

Data direction	Parameter name	Description
[in]	config	Standby configuration structure containing the new config

7.2.5. Reset Control

7.2.5.1. Function `system_reset()`

Reset the MCU.

```
void system_reset( void )
```

Resets the MCU and all associated peripherals and registers, except RTC, OSC32KCTRL, RSTC, GCLK(if WRTLOCK is set) and I/O retention state of PM.

7.2.5.2. Function `system_get_reset_cause()`

Get the reset cause.

```
enum system_reset_cause system_get_reset_cause( void )
```

Retrieves the cause of the last system reset.

Returns

An enum value indicating the cause of the last system reset.

7.2.6. System Debugger

7.2.6.1. Function `system_is_debugger_present()`

Check if debugger is present.

```
bool system_is_debugger_present( void )
```

Check if debugger is connected to the onboard debug system (DAP).

Returns

A bool identifying if a debugger is present.

Table 7-13 Return Values

Return value	Description
true	Debugger is connected to the system
false	Debugger is not connected to the system

7.2.7. System Identification

7.2.7.1. Function `system_get_device_id()`

Retrieve the device identification signature.

```
uint32_t system_get_device_id( void )
```

Retrieves the signature of the current device.

Returns

Device ID signature as a 32-bit integer.

7.2.8. System Initialization

7.2.8.1. Function `system_init()`

Initialize system.

```
void system_init( void )
```

This function will call the various initialization functions within the system namespace. If a given optional system module is not available, the associated call will effectively be a NOP (No Operation).

Currently the following initialization functions are supported:

- System clock initialization (via the SYSTEM CLOCK sub-module)
- Board hardware initialization (via the Board module)
- Event system driver initialization (via the EVSYS module)
- External Interrupt driver initialization (via the EXTINT module)

7.3. Enumeration Definitions

7.3.1. Enum `system_reset_cause`

List of possible reset causes of the system.

Table 7-14 Members

Enum value	Description
SYSTEM_RESET_CAUSE_SOFTWARE	The system was last reset by a software reset
SYSTEM_RESET_CAUSE_WDT	The system was last reset by the watchdog timer
SYSTEM_RESET_CAUSE_EXTERNAL_RESET	The system was last reset because the external reset line was pulled low
SYSTEM_RESET_CAUSE_BODVDD	The system was last reset by VDD brown out detector
SYSTEM_RESET_CAUSE_BODCORE	The system was last reset by VDDCORE brown out detector
SYSTEM_RESET_CAUSE_POR	The system was last reset by the POR (Power on reset)

7.3.2. Enum `system_sleepmode`

List of available sleep modes in the device. A table of clocks available in different sleep modes can be found in [Sleep Modes](#).

Table 7-15 Members

Enum value	Description
SYSTEM_SLEEPMODE_IDLE_0	IDLE 0 sleep mode
SYSTEM_SLEEPMODE_IDLE_1	IDLE 1 sleep mode
SYSTEM_SLEEPMODE_IDLE_2	IDLE 2 sleep mode
SYSTEM_SLEEPMODE_STANDBY	Standby sleep mode

7.3.3. Enum `system_voltage_reference`

List of available voltage references (VREF) that may be used within the device.

Table 7-16 Members

Enum value	Description
SYSTEM_VOLTAGE_REFERENCE_TEMPSENSE	Temperature sensor voltage reference
SYSTEM_VOLTAGE_REFERENCE_OUTPUT	Voltage reference output for ADC/DAC

7.3.4. Enum `system_voltage_references_sel`

Voltage references selection for ADC/DAC.

Table 7-17 Members

Enum value	Description
SYSTEM_VOLTAGE_REFERENCE_1V024	1.024V voltage reference typical value
SYSTEM_VOLTAGE_REFERENCE_2V048	2.048V voltage reference typical value
SYSTEM_VOLTAGE_REFERENCE_4V096	4.096V voltage reference typical value

7.3.5. Enum `system_vreg_switch_mode`

Table 7-18 Members

Enum value	Description
SYSTEM_VREG_SWITCH_AUTO	Automatic mode
SYSTEM_VREG_SWITCH_PERFORMANCE	Performance oriented
SYSTEM_VREG_SWITCH_LP	Low Power consumption oriented

8. Extra Information for SYSTEM Driver

8.1. Acronyms

Below is a table listing the acronyms used in this module, along with their intended meanings.

Acronym	Definition
PM	Power Manager
SUPC	Supply Controller
RSTC	Reset Controller

8.2. Dependencies

This driver has the following dependencies:

- None

8.3. Errata

There are no errata related to this driver.

8.4. Module History

An overview of the module history is presented in the table below, with details on the enhancements and fixes made to the module since its first release. The current version of this corresponds to the newest version in the table.

Changelog
Initial Release

9. Document Revision History

Doc. Rev.	Date	Comments
42484A	12/2015	Initial document release.



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