APPLICATION NOTE

Atmel AT03304: SAM D20 I²C Slave Bootloader

SAM D20

Description

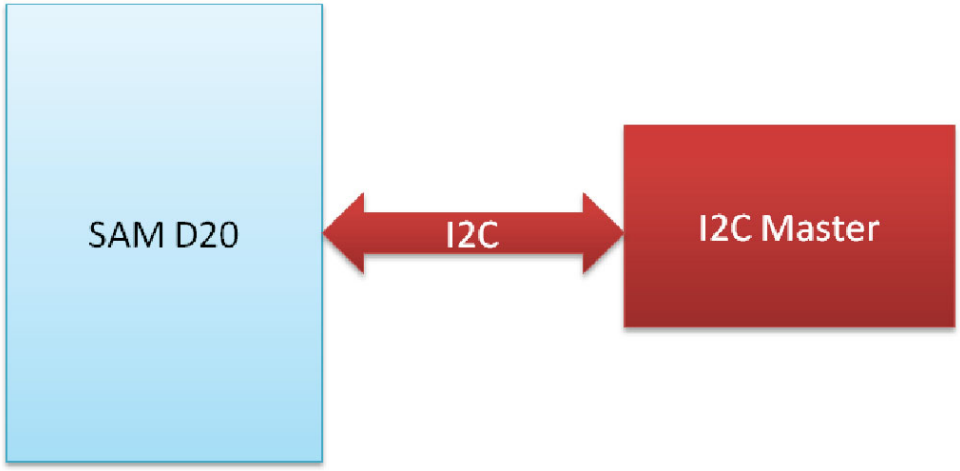
As many electronic designs evolve rapidly there is a growing need for being able to update products, which have already been shipped or sold. Microcontrollers that support boot loader functionalities facilitates updating of the application flash section without the need of an external programmer, are of great use in situations where the application has to be updated on the field. The boot loader may use various interfaces like SPI, UART, I²C, Ethernet etc.

This application note describes how to make use of the In-System programming capability of the Atmel® SAM D20 series devices using an I²C slave interface.

Features

- Application for self programming
- Uses I²C Slave interface
- I²C master sends the data to be programmed over I²C bus
- Resets the device after programming and starts executing application

Figure 1. SAM D20 I²C Slave Bootloader



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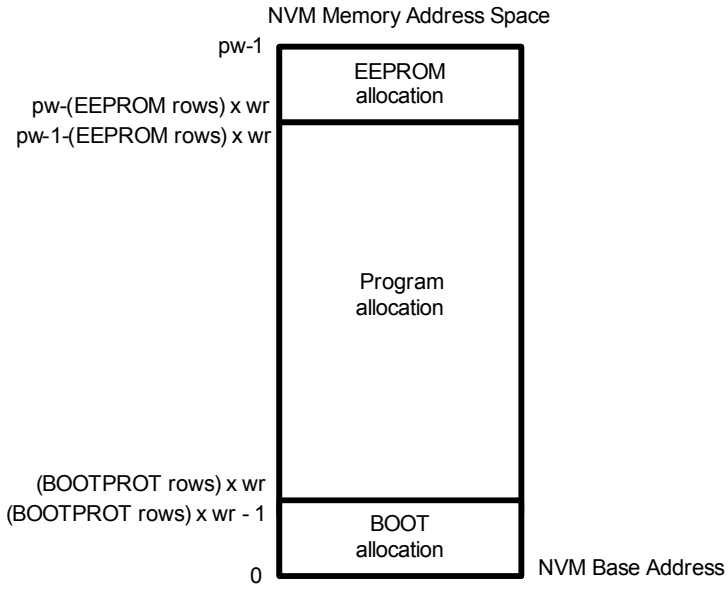
1. Program Memory Organization

The lower rows in the NVM main address space can be allocated as a boot section by using the BOOTPROT fuses of the device. The BOOT memory section is protected both by the lock bit(s) corresponding to this address space, and the BOOTPROT[2:0] fuse.

Figure 1-1. EEPROM and BOOT Allocation



This bootloader implementation consumes approximately 8KB of Flash memory, which are 32 rows of Program Memory space starting from address 0x00000000. BOOTPROT fuses on the device can be set to protect first 32 rows of the program memory, which are allocated for the BOOT section. So, the end user application should be generated with a starting address of 0x00002000.

2. Prerequisites

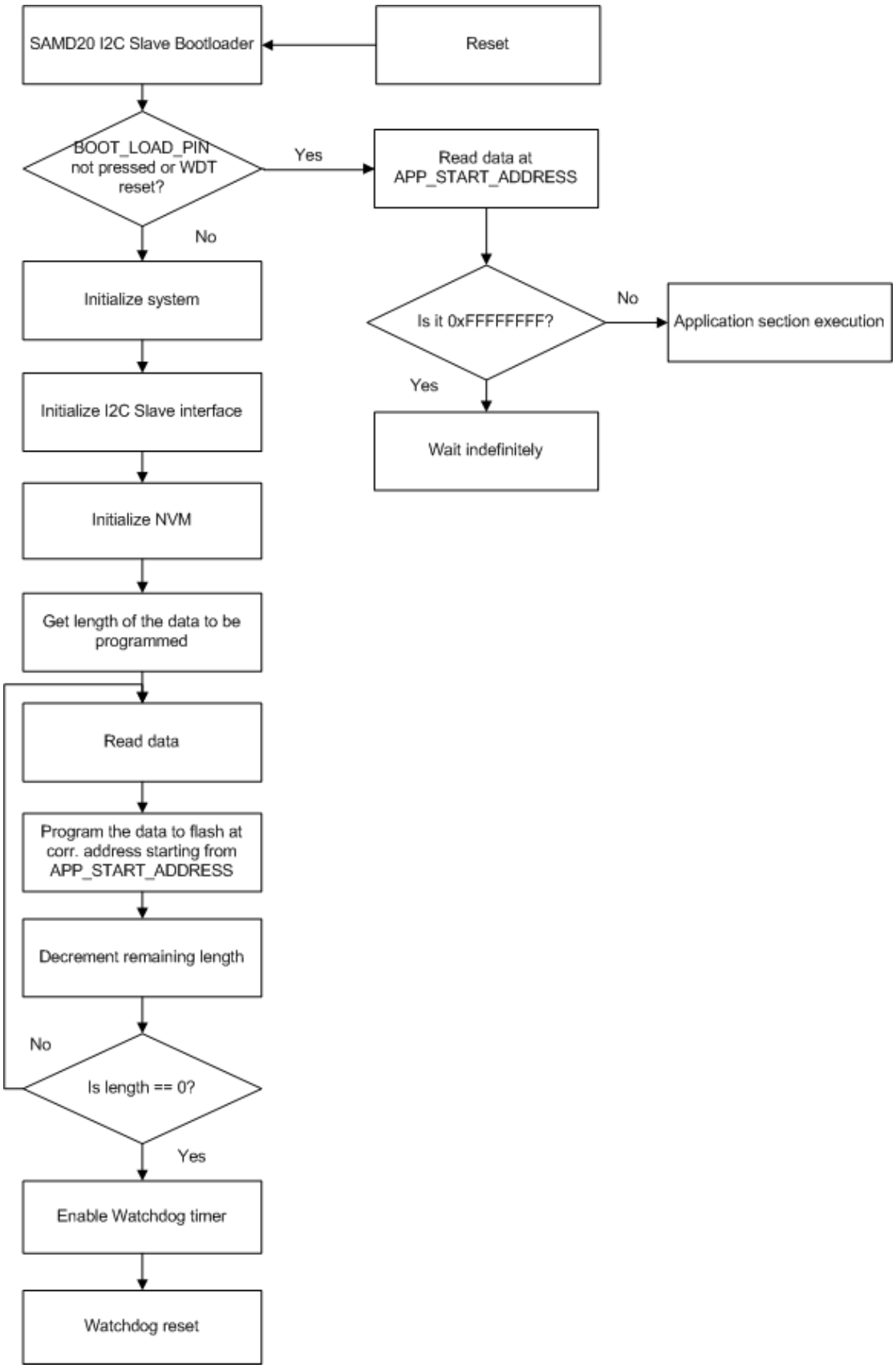
The end user application to be programmed into the program memory of the SAM D20 using the bootloader should be generated with starting address offset of 0x2000.

3. Bootloader Process

3.1 Boot Check

The bootloader is located at the start of the program memory and it is executed at each reset/power-on sequence. The bootloader first checks the status of a user configurable BOOT_LOAD_PIN. If the pin is pulled low it continues execution in bootloader mode, otherwise it reads the first location of the application section (0x00002000), which contains the stack pointer address and checks whether it is set to 0xFFFFFFFF. If this is true, the application section is assumed to be empty and it enters an infinite loop. If not, it jumps to the application section and starts execution normally from the start of the loaded application. Configuration of the BOOT_LOAD_PIN and disabling of the Watchdog module in this boot mode check routine are made with direct peripheral register access to enable a quick decision to be made on the execution of the loaded application or bootloader.

Figure 3-1. Bootloader Process



3.2 Bootloader Process

The NVM module, board hardware and system clocks are initialized according to the configurations in the conf_clocks.h and conf_board.h header files. Consequently, the I^2C slave module is initialized with the configurations specified in the conf_bootloader.h header file. The bootloader then waits for the reception of four bytes of data from I^2C master, which represent the length of the data to be programmed. After transferring the length value, the I^2C master continues sending the data to be programmed in blocks of NVMCTRL_PAGE_SIZE. Data is received in the bootloader and programmed to Program memory starting from APP_START_ADDRESS. An acknowledgment byte 's' is transferred from I^2C slave bootloader to I^2C master to indicate it has received the data and finished programming it. This is repeated until the entire length of data is programmed to Program memory.

3.3 Start Application

Once the programming is completed, the bootloader enables the Watchdog Timer with a timeout period of 256 clock cyles and waits in a loop for Watchdog to reset the device.

4. Hardware Setup

4.1 I^2C Slave Lines

The SAM D20 mounted on the SAM D20 Xplained Pro kit is used as the I^2C slave. The I^2C master should be connected to PIN11 and PIN12 on External header 2 (EXT2) of the SAM D20 Xplained Pro board.

4.2 Bootloader Enable Pin

The SW0 on this kit will be configured as BOOT_LOAD_PIN and LED0 will be used to display the bootloader status. LED0 will be ON when the device is in bootloader mode.

5. Application Specific Configurations

5.1 Clock Configuration

The SAM D20 Internal 8MHz Oscillator (OSC8M) is used as the system clock in this implementation, without any prescaling. The APBA and APBB bus also run at 8MHz without any prescaling.

The Internal 32kHz Oscillator (OSC32K) is enabled and configured as clock source for the Generic Clock Generator 4 channel. The Watchdog timer is configured with Generic Clock Generator 4 as the clock source.

These configurations should be made in the conf_clocks.h header file.

5.2 Bootloader Configuration

The application starting address to program the user application is configured to 0x00002000, because the bootloader only uses first 32 rows of the program memory. The BOOT_LOAD_PIN and BOOT_LED are set to SW0 and LED0 on the kit.

These configurations should be made in the conf_bootloader.h header file.

In addition to the above configurations, I^2C slave configurations are made in the conf_bootloader.h header file. SERCOM2 is to be used for I^2C slave interface with slave address of 0x15. PIN11 and PIN12 on external header 2 (EXT2) are configured as SDA and SCL respectively.

6. Doxygen Documentation

All source code is prepared for automatic documentation generation using Doxygen. Doxygen is a tool for generating documentation from source code by analyzing the source code and using special keywords. For more details about Doxygen, visit http://www.doxygen.org.

7. Revision History

Doc. Rev.	Date	Comments
42205A	10/2013	Initial document release

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