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Getting Started with SAM9X7 Early Samples on SAM9X75-DDRx-EB

Introduction

This document describes how to set up the SAM9X7 Series device and boot on external memories using the SAM9X75-DDRx-EB evaluation board. The command lines provided as examples refer to SAM-BA v3.7.

This application note should be read in conjunction with the SAM9X7 Series data sheet:

- We recommend to read the Boot Strategies section before reading this application note.
- For further details about the OTP controller and OTP features, refer to the OTP Memory Controller (OTPC) section.

Notes:

- The SAM9X75-DDRx-EB ROM code uses the 24 MHz external crystal oscillator only for the SAM-BA Monitor USB connection.
- The ROM code version is v1.0 p1.
- SAM9X7 Series chips use Physical Unclonable Function (PUF) features to protect keying materials.
- JTAG is disabled out of reset. When Standard Boot mode is enabled, the chip boots on a program from an external Flash memory or runs the SAM-BA Monitor, and JTAG is automatically enabled by the ROM code.

1. SAM9X7 Series Device Startup

The 12 MHz internal RC oscillator is used as the main clock source.

The processor clock is set to 600 MHz and the main system bus clock for peripherals is set to 200 MHz.

The external 24 MHz crystal oscillator is only used to provide an accurate clock for the USB device while running one of the two SAM-BA Monitors (standard or secure).

The DBGU port is initialized to run at 115 200 bauds, 8 bits of data, no parity and 1 stop bit, and the "RomBOOT" string is sent to the DBGU port when the ROM code starts.

1.1 Connecting the Device to a Host Computer

When the SAM9X7 Series device does not boot on a program stored in an external Flash memory, the communication with the SAM-BA Monitor can be established through the USB or DBGU (UART) ports.

The ROM code initializes both interfaces before running the SAM-BA Monitor, but only one of them can be selected by the user. The user can choose the USB link by plugging a cable between the USB connector on the EB board and the host computer, or continue to use the DBGU (UART) port for the next commands by sending a character via the host computer console.

To get the ROM code version displayed on the console, send the "V#" command.

1.2 Boot Sequence

The ROM code uses a Boot Configuration Packet stored in the OTP user area for various configurations, for example:

- Disable the Monitor
- Enable boot on selected memories
- Configure external boot memories pin
- Configure the FLEXCOM UART pins or DBGU port used as a console

Out of factory, the ROM code uses a default boot configuration and tries to boot from the following external memories:
- SD Card/e.MMC (SDMMC 0)
- SD Card/e.MMC (SDMMC 1)
- QSPI NOR Flash (QSPI)
- NAND Flash (SMC)
- SPI (FLEXCOM 5)

If no bootable file is found in any of these memories, the ROM code runs the SAM-BA Monitor and waits for user's commands.

1.2.1 Enabling/Disabling OTP Emulation Mode

Before using the OTPC Emulation mode, the internal SRAM1 must be cleared using the following command:

- Reset the internal SRAM1 used by the OTPC in Emulation mode

```
sam-ba -p serial -b sam9x75-ddr3-eb -a bootconfig -c resetemul
```

The OTPC holds sensitive settings. Loading it with incorrect data can impact ROM code behavior and even damage the chip. It is recommended to use the OTPC Emulation Mode feature to load settings and test boot behavior before programming the real OTP matrix.

To enable OTPC Emulation mode, send the following command:

- Request the ROM code to enable OTPC Emulation mode at next reboot

```
sam-ba -p serial -b sam9x75-ddr3-eb -a bootconfig -c writecfg:bscr:EMULATION_ENABLED
```

To disable OTPC Emulation mode, send the following command:

- Request the ROM code not to enable OTPC Emulation mode at next reboot

```
sam-ba -p serial -b sam9x75-ddr3-eb -a bootconfig -c writecfg:bscr:EMULATION_DISABLED
```

To check if the OTPC Emulation mode is correctly enabled/disabled, send the following command:

- Read OTPC Emulation mode status

```
sam-ba -p serial -b sam9x75-ddr3-eb -a bootconfig -c readcfg:bscr
```

1.2.2 Booting from External Flash Memories

Booting from an external Flash memory can be performed using the default boot scheme or by writing a custom Boot Configuration Packet in the OTP.

The default boot scheme is used when the OTP memory does not hold a valid Boot Configuration Packet. In this case, the user can load the boot file to the targeted external memory and ensure that no other connected memory holds a bootable file, otherwise the ROM code will not boot as expected on the required memory.

To enable a custom boot sequence, the user's Boot Configuration Packet must be valid, and the correct options set. In this case, the ROM code boots only on the chosen memories, even if another connected memory contains a bootable file.

The following sections provide examples of SAM-BA command lines to load a specific Boot Configuration Packet in OTP in Emulation mode (then no real OTP is written) and to load a boot file into the targeted memory.

To program the real OTP matrix, disable Emulation mode and change "bcp-emul" to "bcp-otp" in all SAM-BA commands.

> ⚠️ **WARNING** Never perform a software or hardware reset after writing, invalidating or locking a packet into the OTP matrix. Instead, perform a power-off/power-on cycle.

1.2.2.1 Booting from an SDMMC Memory

To boot from an SD Card, the following conditions must be satisfied:

- The sdcard.img file must be an SD Card disk image that holds a MS-DOS/Bios/Legacy (non UEFI) partition table with a Master Boot Record (MBR).
- The first partition type must be FAT12, FAT16 or FAT32.
- The bootstrap must be named `boot.bin` in the root directory of the FAT partition.
- The `boot.bin` file size must not exceed 32 Kbytes.

To configure and enable a boot from an SDMMC memory, send the following commands through the SAM-BA tool:

- Enable boot from SDMMC memory in the Boot Configuration Packet

```
sam-ba -p serial -b sam9x75-ddr3-eb -a bootconfig -c writecfg:bcp-emul:DBGU,SDMMC0_IOSET1
```

- Write the boot file

```
sam-ba -p serial -b sam9x75-ddr3-eb -a sdmmc -c write:sdcard.img -c verify:sdcard.img
```

- Reset to boot from SDMMC memory

```
sam-ba -p serial -b sam9x75-ddr3-eb -a reset
```

1.2.2.2 Booting from a QSPI Memory

To configure and enable a boot from a QSPI memory, send the following commands:

- Enable boot from QSPI memory in the Boot Configuration Packet
  ```
  sam-ba -p serial -b sam9x75-ddr3-eb -a bootconfig -c writecfg:bcp-emul:DBGU,QSPI0_IOSET1
  ```
- Write the boot file

```
sam-ba -p serial -b sam9x75-ddr3-eb -a qspiflash -c writeboot:bootstrap.bin -c
verifyboot: bootstrap.bin
```

- Reset to boot from QSPI memory
```
sam-ba -p serial -b sam9x75-ddr3-eb -a reset
```

1.2.2.3 Booting from a NAND Flash Memory

To configure and enable a boot from a NAND Flash memory, send the following commands:

- Enable boot from NAND Flash memory in the Boot Configuration Packet

```
sam-ba -p serial -b sam9x75-ddr3-eb -a bootconfig -c writecfg:bcp-emul:DBGU,NFC_IOSET1
```

- Write the boot file

```
sam-ba -p serial -b sam9x75-ddr3-eb -a nandflash -c writeboot:bootstrap.bin -c
verifyboot:bootstrap.bin
```

- Reset to boot from NAND Flash memory

```
sam-ba -p serial -b sam9x75-ddr3-eb -a reset
```

1.2.2.4 Booting from an SPI Flash Memory

SPI memories can be connected to one of the SAM9X7x FLEXCOM ports.

To configure and enable a boot from an SPI memory, send the following commands:

- Enable boot from an SPI memory connected to FLEXCOM 0 pins in the Boot Configuration Packet

```
sam-ba -p serial -b sam9x75-ddr3-eb -a bootconfig -c writecfg:bcp-
emul:DBGU,FLEXCOM5_SPI_IOSET1
```

- Write the boot file

```
sam-ba -p serial -b sam9x75-ddr3-eb -a serialflash -c writeboot:bootstrap.bin -c
verifyboot:bootstrap.bin
```

- Reset to boot from SPI memory

```
sam-ba -p serial -b sam9x75-ddr3-eb -a reset
```

2.   Revision History

2.1   Rev. A - 06/2022

First issue.