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Flash Programmer Drivers for ADSP-BF51xF16 Blackfin® Processors

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Introduction

Analog Devices Inc. released a product discontinuance notification (PD13_0091[2]) for ADSP-BF51xF Blackfin® processors describing SPI flash memory die changes. Specifically, ADSP-BF51xF4 devices containing an embedded SST25WF040[4] SPI flash memory die were discontinued and replaced by ADSP-BF51xF16[1] devices containing an embedded S25FL116K[5] SPI flash memory die. This change requires adjustments to existing drivers that were developed to communicate with the on-chip SPI flash memory.

This EE-Note describes the modifications required for the existing VisualDSP++® flash programmer utility to work with the new ADSP-BF51xF16 devices, which can be used as a guideline for any custom-developed drivers. In addition, for CrossCore® Embedded Studio (CCES) users, a new driver for use with the CCES Command Line Device Programmer (CLDP) is introduced, which can also serve as a boilerplate for any custom SPI memory device drivers under CCES.

While the CCES driver provided with this EE-Note will only support ADSP-BF51xF16 devices, VisualDSP++ driver supports both ADSP-BF51xF16 and ADSP-BF51xF4 devices.

VisualDSP++ Flash Programmer Utility Modifications

VisualDSP++ flash programmer utility is an embedded program that runs on ADSP-BF51x Blackfin processor core to configure the SPI port and properly communicate with the on-chip SPI flash memory device. This includes sector program/fill/erase commands, as well as functions like chip erase. Inclusive of these commands is the ability to program the SPI flash memory with the application boot loader image (`.LDR` file) so that the processor can boot from the internal flash.

VisualDSP++ flash programmer utility (release 5.1.1 or later) uses the device driver for the SST25WF040 memory, which only supports the ADSP-BF51xF4 devices. This driver, however, can be modified to also work with the new S25FL116K memory die present in the ADSP-BF51xF16 devices.

The associated `.ZIP` file includes a VisualDSP++ project for the flash programmer utility in the `VDSPInternalSPI` folder.

To open the driver from the VisualDSP++ tools, select **File->Open->Project** and navigate to this folder. Then select the project file `BF518FEzFlashDriver_SST25WF040.dpj`.

Support for the S25FL116K memory was added in the detection portion of the code such that the S25FL116K flash device can be recognized and communicated with properly. The two files that required modification are the `VDSPInternalSPI\sst25wf040.h` and `VDSPInternalSPI\sst25wf040.c`.

Modifying sst25wf040.h

This file defines the manufacturer/capacity JEDEC ID codes and the number of physical sectors for the memory device, which were added for the S25FL116K flash device from the memory data sheet[5], as shown in Listing 1:

```
/* ids for S25FL116K SPI Flash */
/* Spansion, Inc. */
#define MAN_CODE_SPANSION    0x01

/* S25FL116K (16Mbit SPI flash) */
#define DEV_CODE_S25         0x15

/* num sectors */
#define NUM_SECTORS_S25      512
```

Listing 1. JEDEC ID Modifications

These `#defines` supporting the S25FL116K flash memory were added after the `#defines` for the original SST25WF040 flash memory.

Modifying sst25wf040.c

The `sst25wf040.c` file contains the main functions for opening, closing, writing and reading the flash device. In this file, support was added for:

- Start and end addressing
- Detecting the S25FL116K SPI flash ID

Start and End Addresses

The VisualDSP++ driver requires mapping of the beginning and end of the available storage space. As such, the following `#defines` were added at `line 26`, as shown in Listing 2:

```
/* Spansion S25FL116K Start and End
Address - 16Mbit SPI Flash*/
#define START_ADDRESS_S25    0x0
#define END_ADDRESS_S25      0x001fffff
/* 2 Mbyte */
```

Listing 2. S25FL116K Memory Address Range

Detecting the S25FL116K SPI Flash ID

When the driver first opens, it reads the device ID from the SPI memory. Support to recognize the S25FL116K flash during this operation was added at `line 190` via an additional `if` statement, as shown in Listing 3.

Once the S25FL116K is detected, the number of sectors, description, and company name are setup so the proper configuration appears in the flash programmer utility. Also, the SPI0 baud rate is increased to speed up writing to and erasing the much larger S25FL116K flash device.

Due to the larger capacity of the S25FL116K versus the previous flash memory device, VisualDSP++ tools may appear to lock up during erase/programming operations. It may take several minutes depending on the emulation device.

```
// Check if device is S25FL116K
else if(DEV_CODE_S25 == g_DevId)
{
    // 512 4KB sectors
    gNumSectors = 512;
    // Change Flash description
    pFlashDesc = "S25FL116K";
    // Change flash company name
    pDeviceCompany = "Spansion, Inc.";
    // Increase SPI0 baud
    *pSPI0_BAUD = 0x2;
}
```

Listing 3. S25FL116K Device Detection/Configuration

Booting from SPI Flash Memory

To build the flash programmer utility driver, select **Project->Build Project** in your VisualDSP++ session. The executable file (`.DXE`) will be located in the `VDSPinternalSPI` folder.

As the flash programmer utility GUI makes use of embedded debug information, make sure that the driver is built in Debug mode (default), and not in Release mode.

Once the new driver is built, the flash programmer utility GUI must be directed to it. Make sure a powered target board is connected via a VisualDSP++ emulator session and select **Tools->Flash Programmer**, which opens the GUI. On the **Driver** tab, click the `[…]` browse button next to the **Driver file** dialog box, navigate to the `VDSPInternalSPI` folder, and select the new driver that was just built, `BF518FEzFlashDriver_SST25WF040.dxe`.

When **Load Driver** is clicked, the **Flash Information** from Listing 1 and Listing 3 should appear, and the new ADSP-BF51xF16 device is now supported by the same tools used with the previous ADSP-BF51xF4 devices. If the target board were swapped with a board featuring the ADSP-BF51xF4 device, this same driver when loaded would reflect the **Flash Information** for the SST25WF040 SPI flash die and function identically.

CCES Considerations

The flash programmer utility present in the VisualDSP++ tools is not currently supported in the CCES development tools. Rather, there is a Command Line Device Programmer (CLDP) that is used to program memory devices.

Similar to the VisualDSP++ flash programmer utility, the CCES CLDP tool also requires a memory device driver to properly communicate with the connected SPI memory. However, because the device driver API was significantly changed from VisualDSP++ to CCES, the driver had to be created from scratch for the S25FL116K memory embedded in ADSP-BF51xF16 devices.

This driver can be used as the baseline for similar SPI flash memory drivers required by customer applications.

Importing and Building the Driver in CCES

The `.ZIP` file associated with this EE-Note includes a CCES project for the flash memory device driver in the `CCESInternalSPI` folder. To import the project in the CCES tools:

- Select **File->Import.**
- Select **Existing Projects into Workspace** and click **Next.**
- Ensure **Select root directory** is selected, and click the associated **Browse…** button.
- The **Browse For Folder** window opens. Navigate to the `CCESInternalSPI` folder and click **OK**.

Once the project is imported, the driver executable (`.DXE` file) can be built by using the **Project->Build Project** pull-down, and the output `.DXE` file will be located in the `CCESInternalSPI\serial\Debug` folder. This is what the CLDP will use to program the boot image into the on-chip flash. However, the driver code itself can be modified to support other SPI flash memory devices, as described next.

S25FL116K Driver Files

In the *Project Explorer* view, click the arrow next to the `bf518f_s25fl116k_dpia` project name to list the source files. The relevant files for the CCES S25FL116K SPI flash memory driver code are included in the `CCESInternalSPI\serial\src` directory:

`bf518f_s25fl116k_dpia.c`

`\s25fl116k\s25fl116k.c`

Supported JEDEC Commands

The S25FL116K flash supports the same basic JEDEC flash memory command structure as the SST25WF040 featured on the ADSP-BF51xF4 devices, namely those depicted in Table 1.

Command Name	Instruction
READ_DATA	0x03
FAST_READ	0x0B
SECTOR_ERASE	0xD8
BULK_ERASE	0xC7
PAGE_PROGRAM	0x02
READ_STATUS_REGISTER	0x05
WRITE_STATUS_REGISTER	0x01
WRITE_ENABLE	0x06
WRITE_DISABLE	0x04
JEDEC_ID	0x9F
READ_SIGNATURE	0xAB

Table 1. Supported Flash Commands

The `#defines` for the instructions are located in the `s25fl116k.c` file starting at `line 5`, and additional commands can be added as needed to support other memories.

JEDEC ID

Unlike the VisualDSP++ device driver, this device driver uses three parts of the JEDEC ID to identify the connected flash device - the Manufacturer's ID, the Memory Type ID, and the Capacity ID. These three IDs help identify various flash devices and allow the driver to select the correct sector map table and command structure. The JEDEC ID for the S25FL116K flash memory is shown in Table 2:

JEDEC ID	Value
Manufacture ID	0x01
Memory Type ID	0x40
Capacity ID	0x15

Table 2. JEDEC ID Information for S25FL116K

The JEDEC ID can be changed in the `s25fl116k.c` file starting at `line 320`, as shown in Listing 4.

```
struct flash_info s25fl116k_info =
"s25fl116k", /* name */
 "Spansion", /* name */
  0x01,      /* manufacturer ID */
  0xff,      /* 0xff */
  0x40,      /* memory type */
  0x15,      /* capacity ID */
  STANDARD,  /* supported modes */
```

Listing 4. JEDEC ID Code

SPI Slave-Select Pin

On ADSP-BF51xFy devices, the SPI Slave-Select pin (`PH8`) is internally routed as a dedicated chip-select for the internal SPI flash memory. In the `bf518f_s25fl116k_dpia.c` source file, `line 44` configures the SPI Slave-Select pin along with the SPI pins for SCK, MISO and MOSI. Make sure that the Slave-Select is set for `PH8` for the internal SPI select to operate.

Flash Sector Map

Each flash memory device has a unique sector map, which is based on the memory size and memory block configuration. The sector map is required for the programmer driver to determine which blocks of memory require erasing prior to a new write operation.

The S25FL116K is configured into 512 sectors, each containing 4 kB (0x1000 bytes). The sector map can be configured in the `s25fl116k.c` file in the following `#defines` starting at `line 26` (Listing 5):

```
#define NUM_SECTORS 512
#define SECTOR_SIZE 0x1000
```

Listing 5. Sector Map Code

Using the CLDP to Program ADSP-BF51xF16 Processors

The CLDP utility for CCES (`cldp.exe`) is located in the root installation folder (default):

```
\Analog Devices\CrossCore Embedded Studio CCES_version_number\
```

To program the ADSP-BF51xF16 device with the loader image for an application called `app.ldr`, make sure a powered target board is connected via emulator, and open a Windows command prompt (`cmd.exe`). Navigate to the root path for the CCES installation and use the following command:

```
cldp.exe -proc ADSP-BF518 -emu HPUSB -driver
"C:\CCESInternalSPI\serial\Debug\bf518f_s25fl116k_dpia.dxe" -cmd prog -erase affected -format hex -file "app.ldr"
```

This command line assumes the connected target is the ADSP-BF518 EZ-KIT board via the HPUSB-ICE emulator and that the associated `.ZIP` archive was extracted to the C:\ root directory. The processor, emulator, driver pathname, and/or `.ldr` file name may need to be modified.

More information on the CLDP can be found in CCES On-Line Help.

References

[1] *ADSP-BF512/ADSP-BF514/ADSP-BF514F16/ADSP-BF516/ADSP-BF518/ADSP-BF518F16 Blackfin Embedded Processor Data Sheet*. Rev D, April 2014. Analog Devices, Inc.

[2] *Obsolescence and Replacement Options for ADSP-BF512F, BF514F, BF516F and BF518F Processors with Flash Memory (http://www.analog.com/static/imported-files/PCN/ADI_PDN_13_0091_Rev_-_Form.pdf)*. November 2014. Analog Devices Inc.

[3] *ADSP-BF51x Blackfin Processor Hardware Reference*. Rev 1.2, February 2013. Analog Devices, Inc.

[4] *SST25WF040 Microchip 4 Mbit Serial Flash Data Sheet*. Rev B. December 2012. Microchip Technology Inc.

[5] *S25FL116K Spansion 16 Mbit Serial Flash Data Sheet*. Rev 1. April 14, 2014. Spansion Inc.

Document History

Revision	Description
Rev 1 – July 8, 2014 *by D. Harrington*	Initial release.