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Using and Creating Flash Files for the MicroBlaze Development Kit - Spartan-3E Edition

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Abstract

This application note describes the files for programming the StrataFlash memory for the MicroBlaze™ Development Kit - Spartan™-3E 1600E Edition. The development kit includes a BlueCat Linux reference system. The development kit also includes two systems that are pre-loaded into the Intel StrataFlash on the SP3E1600E board that is included with the development kit. In the pre-loaded systems, the μClinux system is programmed to run in BPI Up configuration mode and the Web server system is programmed to run in BPI Down configuration mode. All files needed to run the BlueCat Linux reference system from the StrataFlash memory are provided for the user. This application note describes how to use the provided files, as well as create new files, to run the BlueCat Linux reference system from the StrataFlash memory.

Introduction

The SP3E1600E board supports a variety of FPGA configuration options. One of the options is to program the on-board Intel StrataFlash parallel NOR Flash PROM, then configure the FPGA from the image stored in the Flash PROM using either BPI Up or BPI Down configuration modes. For BPI Up mode, the FPGA configuration image source is stored in the StrataFlash parallel Flash PROM, starting at address `0x00000000` and incrementing through address space. For BPI Down mode, the FPGA configuration image source is stored in the StrataFlash parallel Flash PROM, starting at address `0x00FFFFFF` and decrementing through address space. For the SP3E1600E board shipped with the MicroBlaze Development Kit - Spartan-3E 1600E Edition, two reference system configurations are pre-loaded into the StrataFlash PROM to show both BPI Up and BPI Down configuration modes.

Warning: If the user downloads and updates the FLASH with the BlueCat Linux image, the μClinux image will be overwritten. Send email to sp3e1600@xilinx to get access to the μClinux Flash files.

Hardware and Software Requirements

The hardware and software requirements are:

- SP3E1600E development board
- USB download cable
- RS232 null modem serial cable and serial communications utility (HyperTerminal)
- Xilinx Platform Studio 9.2.01i
- Xilinx Integrated Software Environment (ISE™) 9.2.03i

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Creating and Programming New Flash Files for the BlueCat Linux Demonstration

Steps to program the BlueCat Linux demonstration into Strata Flash

Following are the steps to program the BlueCat Linux demonstration into the Strata Flash in BPI Up mode configuration.

1. Erase the Strata Flash contents using the PicoBlaze Flash Programmer.
2. Download reference system bitstream, program the FLASH with KDI image, and create bootloader files.
3. Create MCS file for BPI Up Configuration Mode.
4. Load the MCS file into FLASH using PicoBlaze Flash programmer.

Each of these steps are explained in detail in the following sections.

Erasing the StrataFlash contents

The Xilinx PicoBlaze™ NOR Flash Programmer is used to program the StrataFlash. The Xilinx PicoBlaze NOR Flash Programmer design is implemented using a single PicoBlaze processor and UART macros and is used as a configuration bit file for immediate programming of the Spartan XC3S1600E on the Spartan-3E MicroBlaze Development kit.

To erase or program the Strata Flash, user must download the Flash Programmer configuration bitstream into the Spartan-3E FPGA and then communicate to it through the RS232 serial link using the Hyper Terminal. The Xilinx PicoBlaze NOR Flash Programmer design files are provided in the Spartan-3E development kit website.

To download the files for the PicoBlaze NOR Flash Programmer for the SP3E1600E board, go to the following link:

- http://www.xilinx.com/sp3e1600e

Select the Product Info tab, then click on Spartan-3E MicroBlaze Development Kit Design Examples under the Documentation section. Download the PicoBlaze RS-232 StrataFlash Programmer (zip file) from the webpage.

After downloading the PicoBlaze RS-232 StrataFlash Programmer zip file, follow these steps to load the MCS file into the Strata Flash:

1. Unzip all the files into a directory.
2. Check you have the USB cable connected and the SP3E1600E development board is turned on.
3. Double click on the `PicoBlaze_NOR_Flash_programmer.ht` Hyper Terminal file. This will open the Hyper Terminal with the following settings: Baud Rate of **115200**, Data Bits to **8**, Parity to **None**, and Flow Control to **Xon/Xoff.** The Hyper Terminal utility is used to talk to PicoBlaze StrataFlash Programmer.
4. Double click on the file `install_SP3E1600E_parallel_flash_uart_prog.bat`. This will open a DOS window and run iMPACT in batch mode to configure the Spartan device.
5. Erase the contents of the Flash by typing **`E`** (Erase All) command in the Hyperterminal. Make sure that all the contents of Flash is completely erased.

Note: Warning: The **`E`** (Erase All) command will erase the factory pre-loaded flash designs.

Programming the BlueCat Linux Image KDI File Into StrataFlash and Creating New Bootloader Files

Instead of using the existing bootloader file from the `/ready_for_download/Flash_files` folder under the root directory, new bootloader files can be created using the EDK tools.

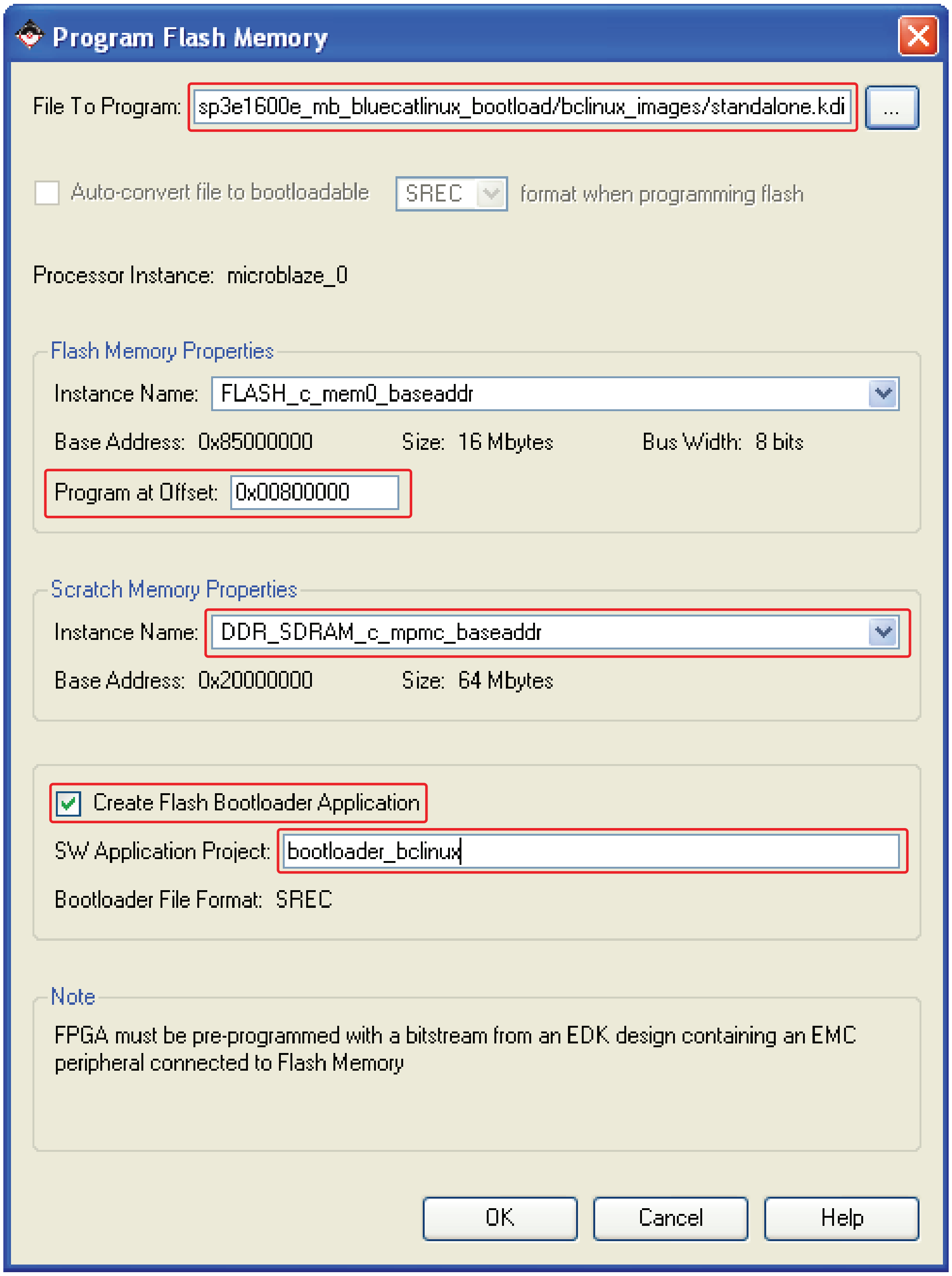
To load a new BlueCat Linux image KDI file into the StrataFlash and to create new bootloader files, follow these steps:

1. Open the reference system project in XPS.
2. Connect the USB programming cable, the serial cable, and the power supply to the SP3E1600E development board. Power on the board.
3. The target board must be configured with the project bitstream before XPS can program the SREC file into the flash memory. Select **Device Configuration** → **Download Bitstream** in XPS.

Note: The Jumper (J30) settings does not affect the bitstream download operation.

4. In XPS, select **Device Configuration** → **Program Flash Memory.**
5. In the Program Flash Memory dialog box, choose the file to program to be `/bclinux_images/standalone.kdi` under the project root directory. Change the program offset to the desired value, allowing enough room for the MCS file, which will be programmed at `0x00000000`. The provided example files use an offset of `0x00800000`. The external DDR memory is set as the Scratch Memory. A bootloader is created by clicking the **Create Flash Bootloader Application** check box in the Program Flash Memory dialog box.

The Program Flash Memory settings are shown in Figure 1.



Program Flash Memory

File To Program: sp3e1600e_mb_bluecatlinux_bootload/bclinux_images/standalone.kdi

□ Auto-convert file to bootloadable SREC format when programming flash

Processor Instance: microblaze_0

Flash Memory Properties

Instance Name: FLASH_c_mem0_baseaddr

Base Address: 0x85000000 Size: 16 Mbytes Bus Width: 8 bits

Program at Offset: 0x00800000

Scratch Memory Properties

Instance Name: DDR_SDRAM_c_mpmc_baseaddr

Base Address: 0x20000000 Size: 64 Mbytes

☑ Create Flash Bootloader Application

SW Application Project: bootloader_bclinux

Bootloader File Format: SREC

Note

FPGA must be pre-programmed with a bitstream from an EDK design containing an EMC peripheral connected to Flash Memory

Figure 1: **Program Flash Memory Dialog Box for the BlueCat Linux ELF**

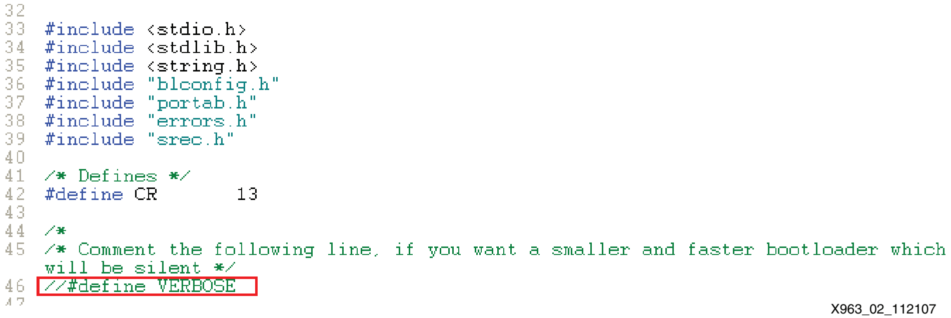
6. Click the *OK* button. This will program the flash memory with the BlueCat Linux image and will create a bootloader software application project.

Note: The Program Flash Memory application will take a long time as the application must program the image of size approximately 6 MB.

7. After creating the bootloader files, it is strongly suggested to disable the bootloader from displaying its progress. This is done by commenting out the following line in the `bootloader.c` generated file:

```
#define VERBOSE
```

The line to comment out to allow non-verbose bootloading is shown in Figure 2.



```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "blconfig.h"
#include "portab.h"
#include "errors.h"
#include "srec.h"

/* Defines */
#define CR       13

/*
/* Comment the following line, if you want a smaller and faster bootloader which
will be silent */
//#define VERBOSE
```

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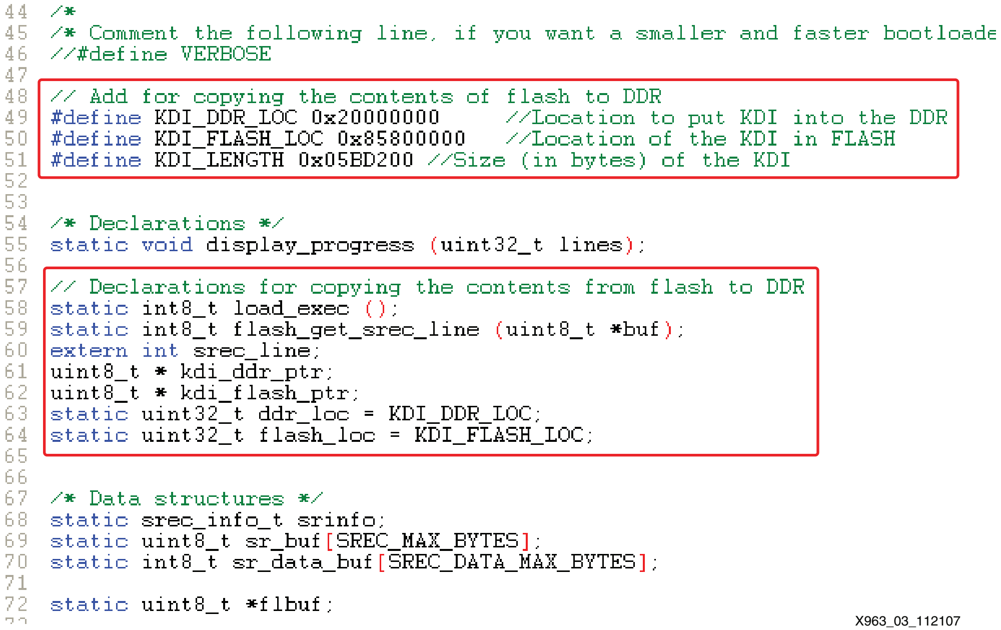
Figure 2: **Code to Select Non-Verbose Bootloading**

8. The bootloader must be modified to copy the KDI image from flash into DDR for the BlueCat Linux demonstration to fully operate. This is done by adding lines of code to the `bootloader.c` file that the EDK generates. To modify the newly created bootloader, add the following pieces of code:

   a. Code is required to define the location in flash where the KDI image resides and the location in DDR to put the KDI image. This code is shown in Figure 3. The KDI_FLASH_LOC parameter should be set to the location in flash memory of where the KDI image will be placed.The KDI_DDR_LOC parameter should be set to the location in DDR memory where the KDI image is to be copied. The KDI_LENGTH parameter should be set to the length of the KDI image in bytes.



```
/*
/* Comment the following line, if you want a smaller and faster bootloade
//#define VERBOSE

// Add for copying the contents of flash to DDR
#define KDI_DDR_LOC 0x20000000     //Location to put KDI into the DDR
#define KDI_FLASH_LOC 0x85800000   //Location of the KDI in FLASH
#define KDI_LENGTH 0x05BD200 //Size (in bytes) of the KDI


/* Declarations */
static void display_progress (uint32_t lines);

// Declarations for copying the contents from flash to DDR
static int8_t load_exec ();
static int8_t flash_get_srec_line (uint8_t *buf);
extern int srec_line;
uint8_t * kdi_ddr_ptr;
uint8_t * kdi_flash_ptr;
static uint32_t ddr_loc = KDI_DDR_LOC;
static uint32_t flash_loc = KDI_FLASH_LOC;


/* Data structures */
static srec_info_t srinfo;
static uint8_t sr_buf[SREC_MAX_BYTES];
static int8_t sr_data_buf[SREC_DATA_MAX_BYTES];

static uint8_t *flbuf;
```

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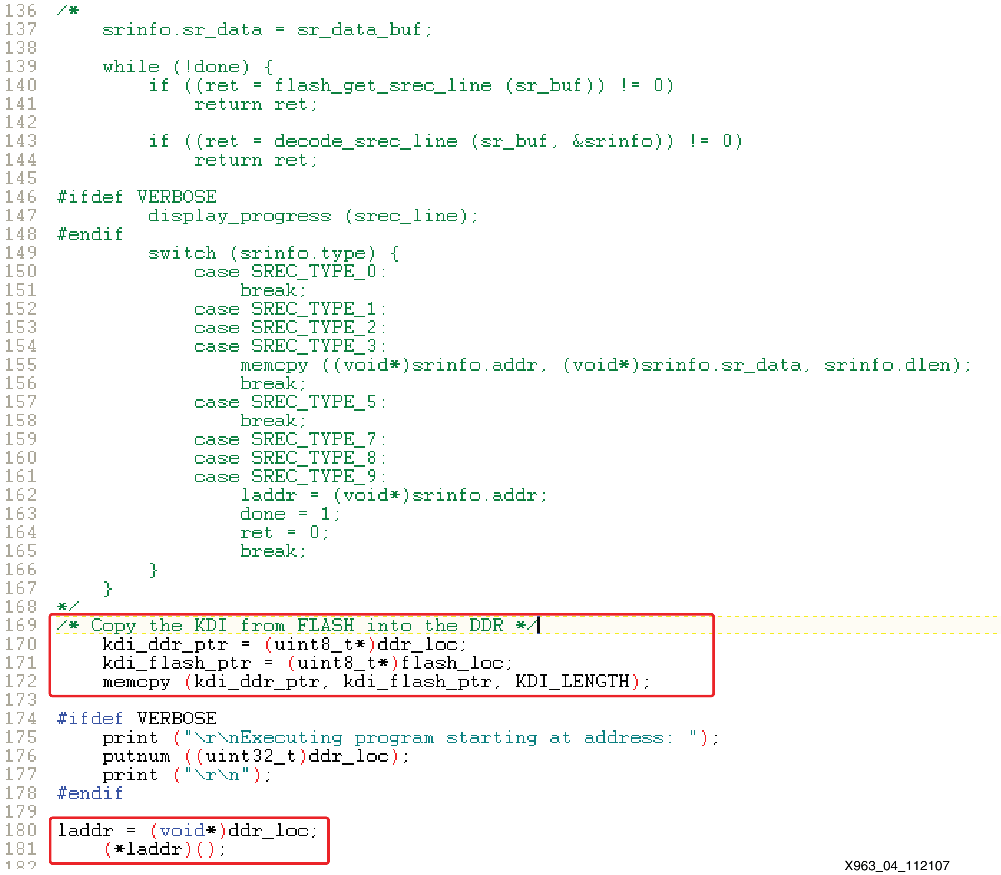
Figure 3: **BlueCat Linux Bootloader Code Definitions and Declarations**

b. Comment the SREC function **load_exec** in the source file as the KDI image is loaded as it is to the FLASH memory and so these functions are not required. Code is also required for the bootloader to copy the KDI image from flash into DDR when the bootloader runs. This code is shown in Figure 4. After modifying the C file, be sure to recompile the software application.



```
/*
    srinfo.sr_data = sr_data_buf;

    while (!done) {
        if ((ret = flash_get_srec_line (sr_buf)) != 0)
            return ret;

        if ((ret = decode_srec_line (sr_buf, &srinfo)) != 0)
            return ret;

#ifdef VERBOSE
        display_progress (srec_line);
#endif
        switch (srinfo.type) {
            case SREC_TYPE_0:
                break;
            case SREC_TYPE_1:
            case SREC_TYPE_2:
            case SREC_TYPE_3:
                memcpy ((void*)srinfo.addr, (void*)srinfo.sr_data, srinfo.dlen);
                break;
            case SREC_TYPE_5:
                break;
            case SREC_TYPE_7:
            case SREC_TYPE_8:
            case SREC_TYPE_9:
                laddr = (void*)srinfo.addr;
                done = 1;
                ret = 0;
                break;
        }
    }
*/
/* Copy the KDI from FLASH into the DDR */
    kdi_ddr_ptr = (uint8_t*)ddr_loc;
    kdi_flash_ptr = (uint8_t*)flash_loc;
    memcpy (kdi_ddr_ptr, kdi_flash_ptr, KDI_LENGTH);

#ifdef VERBOSE
    print ("\r\nExecuting program starting at address: ");
    putnum ((uint32_t)ddr_loc);
    print ("\r\n");
#endif

laddr = (void*)ddr_loc;
    (*laddr)();
```

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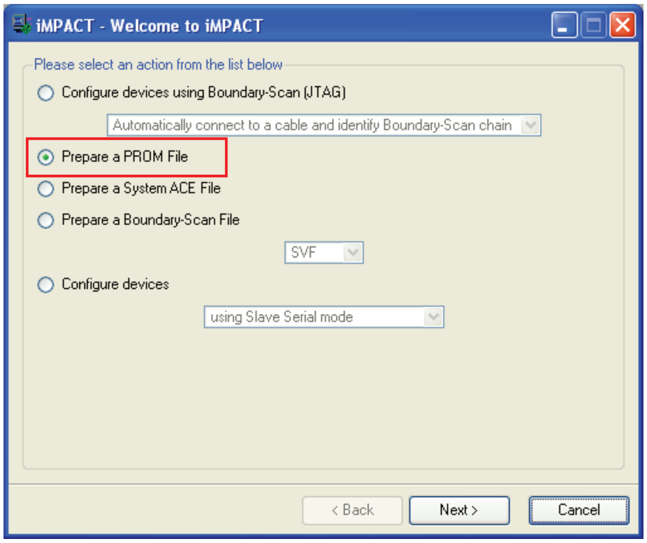
Figure 4: **BlueCat Linux Bootloader Code to Copy the KDI Image**

Generating a MCS File for BPI Up Configuration Mode

Once the bootloader application is created, the next step is to create a MCS file for the BlueCat Linux reference system using the iMPACT tool. A MCS file is used to program the StrataFlash with the system bitstream and bootloader loaded in the bitstream. For BPI Up configuration mode, the BlueCat Linux MCS file is loaded at address `0x00000000`, incrementing in address space. To generate a new MCS file for BPI up configuration mode, follow these steps:

1. In XPS, compile a bitstream, `download.bit`, that includes the system configuration and the bootloader application. This is done by marking the bootloader application to Initialize BRAM's and then by selecting **Device Configuration** → **Update Bitstream** in XPS.
2. Launch the iMPACT GUI and create a new project.

3. In the iMPACT - Welcome to iMPACT dialog box, select the *Prepare a PROM file* option, as shown in Figure 5. Click the Next button.



iMPACT - Welcome to iMPACT

Please select an action from the list below

○ Configure devices using Boundary-Scan (JTAG)

Automatically connect to a cable and identify Boundary-Scan chain

● Prepare a PROM File

○ Prepare a System ACE File

○ Prepare a Boundary-Scan File

SVF

○ Configure devices

using Slave Serial mode

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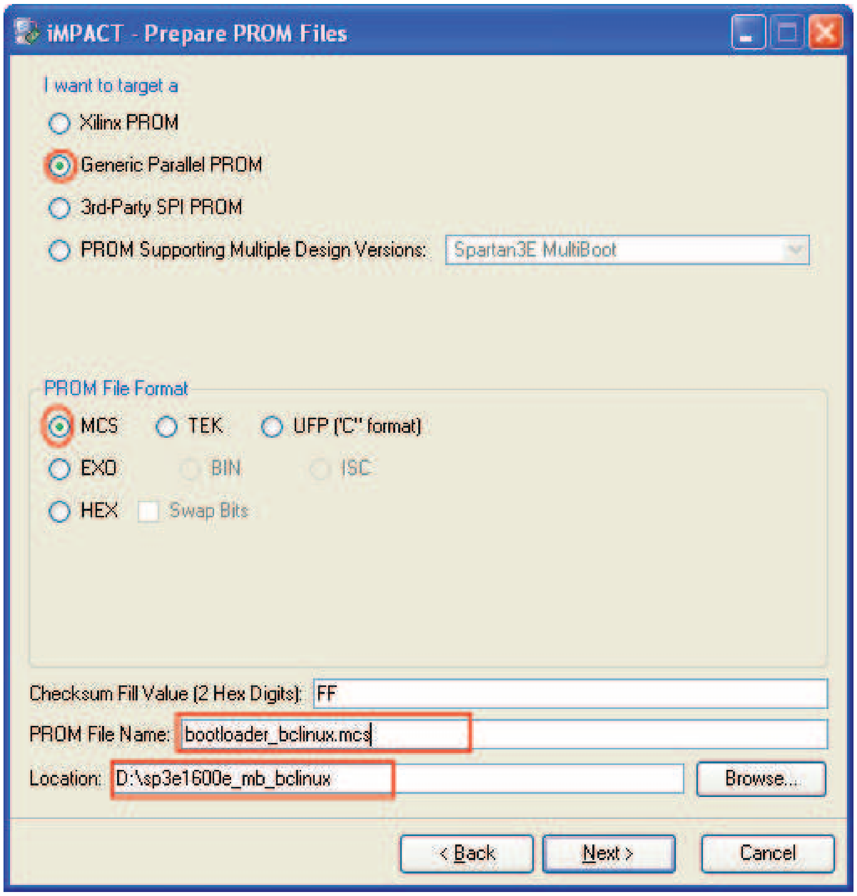
Figure 5: **Welcome to iMPACT Screen**

4. In the iMPACT - Prepare PROM Files dialog box, select the target to be a Generic Parallel PROM. Ensure that the file format is selected to be MCS. Enter an appropriate PROM file name and location. The dialog box is shown in Figure 6. Click Next.



iMPACT - Prepare PROM Files

I want to target a

○ Xilinx PROM

● Generic Parallel PROM

○ 3rd-Party SPI PROM

○ PROM Supporting Multiple Design Versions: Spartan3E MultiBoot

PROM File Format

● MCS ○ TEK ○ UFP ("C" format)

○ EXO ○ BIN ○ ISC

○ HEX □ Swap Bits

Checksum Fill Value (2 Hex Digits): FF

PROM File Name: bootloader_bclinux.mcs

Location: D:\sp3e1600e_mb_bclinux

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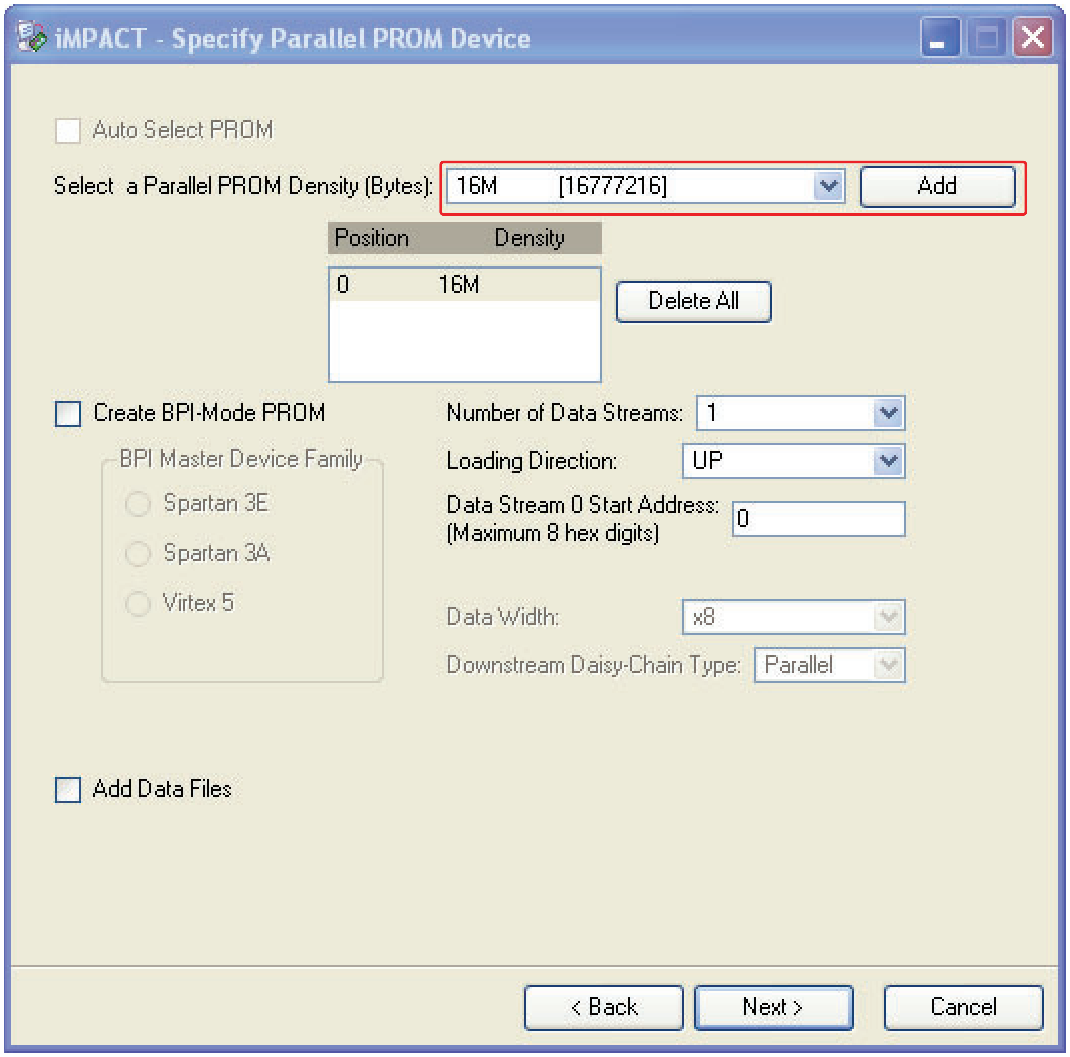
Figure 6: **Prepare PROM Files Dialog Box**

5. In the iMPACT - Specify Parallel PROM Device dialog box, shown in Figure 7, select a parallel PROM density of 16M and click Add. Ensure the Number of Data Streams is set to 1, the Loading Direction is set to UP, and the Data Stream 0 Start Address is set to 0. Click Next.



iMPACT - Specify Parallel PROM Device

□ Auto Select PROM

Select a Parallel PROM Density (Bytes): 16M [16777216] Add

Position	Density
0	16M

Delete All

□ Create BPI-Mode PROM

BPI Master Device Family

○ Spartan 3E

○ Spartan 3A

○ Virtex 5

Number of Data Streams: 1

Loading Direction: UP

Data Stream 0 Start Address: (Maximum 8 hex digits) 0

Data Width: x8

Downstream Daisy-Chain Type: Parallel

□ Add Data Files

< Back Next > Cancel

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Figure 7: **Specify Parallel PROM Device Dialog Box**

6. In the File Generation Summary dialog box, click Finish.
7. The iMPACT screen will prompt for a device file to be added to Data Stream: 0. Select the `download.bit` file in the BlueCat Linux reference system project. When asked to add another design file to Data Stream: 0, click No. Click OK.
8. Select **Operations** → **Generate File...** in iMPACT to generate the MCS file.

Loading the MCS File into StrataFlash

The PicoBlaze NOR Flash programmer must be used again to load the Flash with the generated MCS file

1. Double click on the Hyper Terminal file '`PicoBlaze_NOR_Flash_programmer.ht`'. This will open the Hyper Terminal with the following settings Baud Rate of **115200**, Data Bits to **8**, Parity to **None**, and Flow Control to **Xon/Xoff.** The Hyper Terminal utility is used to talk to PicoBlaze StrataFlash Programmer.
2. Configure the Spartan device with the PicoBlaze NOR Flash programmer again by double clicking on the file `install_SP3E1600E_parallel_flash_uart_prog.bat`. This will open a DOS window and run iMPACT in batch mode and configure the Spartan device.
3. Program the flash by using **`P`** (Program) command in the Hyperterminal.
4. In the HyperTerminal, select the **Transfer** → **Send Text File..**. and Navigate to the appropriate directory and select the generated `bootloader_bclinux.mcs` file for programming.

Note: Do not use the **Transfer** → **Send File...** option in step 4.

For further details, refer to the PicoBlaze StrataFlash Programmer document.

After following those steps, the MCS file will be loaded into the StrataFlash memory and the BlueCat Linux demonstration is ready to be run in BPI Up mode. Proceed to the section, "Running the Demonstrations out of Flash", to run the demonstration.

Using the Provided Flash Files

This section includes details on how to use the flash files provided in the reference system to boot the BlueCat Linux demonstration out of the StrataFlash.

The files required to run the BlueCat Linux demonstration out of the StrataFlash memory are provided at the following link:

http://www.xilinx.com/sp3e1600e

Select the Product Info tab and then click on Spartan-3E MicroBlaze Development Kit Design Examples under the Documentation section and download the Getting Started and Linux Reference System.

Loading the BlueCat Linux KDI Image into Flash

To run the BlueCat Linux demonstration properly, the KDI image must be loaded into the StrataFlash. To load the KDI image into the StrataFlash memory, follow these steps:

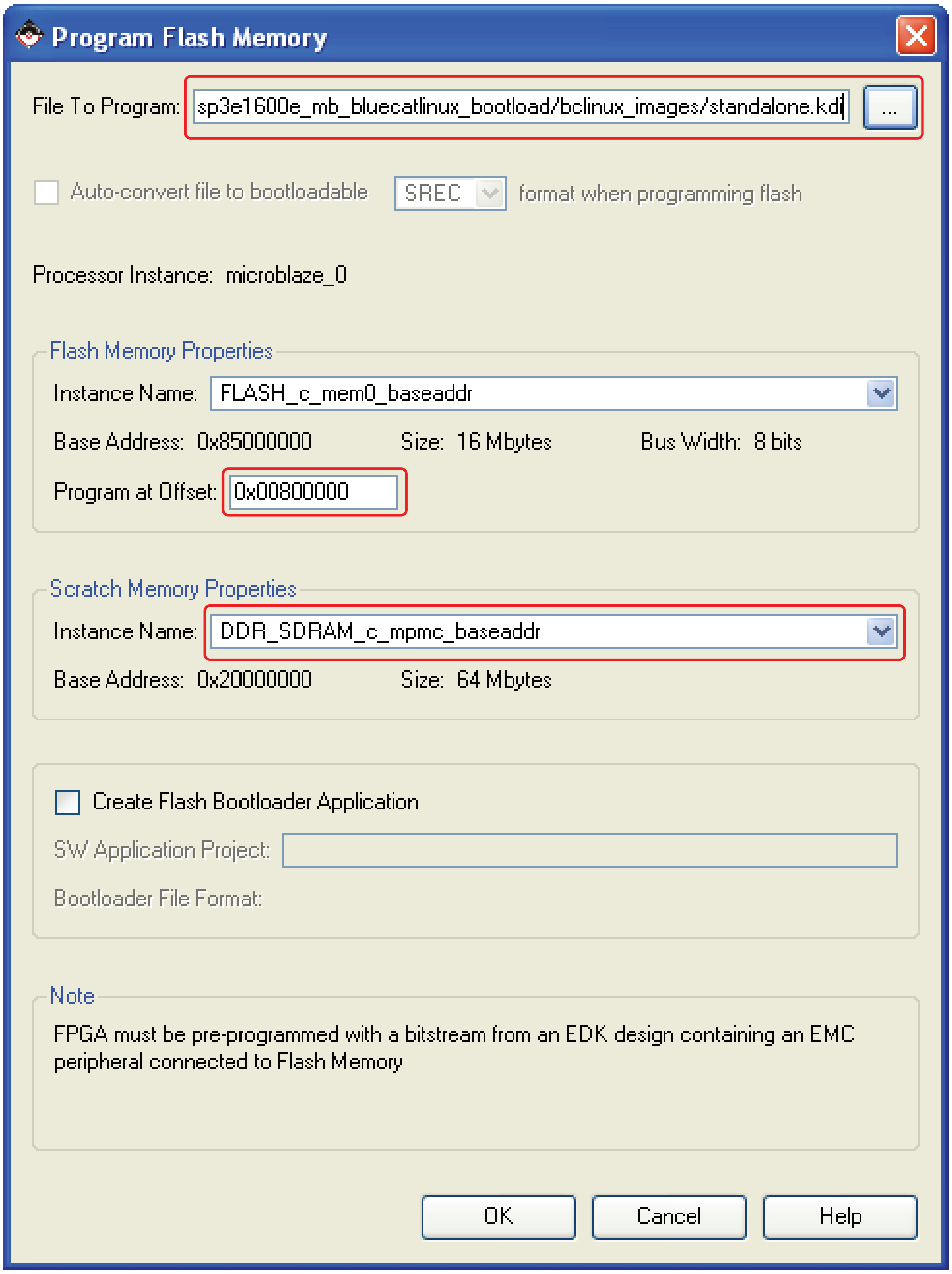
1. Erase the pre-loaded Strata Flash contents first as mentioned in "Erasing the StrataFlash contents" section.

1. Unzip the contents of the reference system into a directory.
2. Change directories to the `ready_for_download` directory under the unzipped directory.
3. Use iMPACT to download the bitstream by using the following:

```
impact -batch sp3an_isf.cmd
```

4. Open the reference system project `system.xmp` in the root directory using XPS.
5. In XPS, select **Device Configuration** → **Program Flash Memory.**

6. In the Program Flash Memory dialog box, choose the file to program to be the provided KDI image file, `sp3e1600e_mb_bclinux\bclinux_images\standalone.kdi`. Change the program offset to `0x00800000`. This program offset is the address where the provided BlueCat Linux bootloader is programmed to find the KDI image. The Program Flash Memory settings for the KDI image are shown in Figure 8.



Program Flash Memory

File To Program: sp3e1600e_mb_bluecatlinux_bootload/bclinux_images/standalone.kdi

□ Auto-convert file to bootloadable SREC format when programming flash

Processor Instance: microblaze_0

Flash Memory Properties

Instance Name: FLASH_c_mem0_baseaddr

Base Address: 0x85000000 Size: 16 Mbytes Bus Width: 8 bits

Program at Offset: 0x00800000

Scratch Memory Properties

Instance Name: DDR_SDRAM_c_mpmc_baseaddr

Base Address: 0x20000000 Size: 64 Mbytes

□ Create Flash Bootloader Application

SW Application Project:

Bootloader File Format:

Note

FPGA must be pre-programmed with a bitstream from an EDK design containing an EMC peripheral connected to Flash Memory

Figure 8: **Program Flash Memory Dialog Box for the BlueCat Linux KDI Image**

7. Click the **OK** button.

Note: The Program Flash Memory application will take a long time as the application must erase the flash contents and program the image of size approximately 6 MB.

This will program the flash memory with the BlueCat Linux image.

Loading the provided MCS File into StrataFlash

To load the MCS file provided with the BlueCat Linux Reference system:

1. Download the PicoBlaze NOR Flash programmer again to configure the Spartan device.
2. Program the flash with the MCS file by using `P` (Program) command in the Hyperterminal.
3. In the HyperTerminal, select the **Transfer** → **Send Text File...** and select the provided `bootloader_bclinux.mcs` file from the `sp3e1600e_mb_bclinux\ready_for_download\Flash_files` directory for programming.

Note: Do not use the **Transfer** → **Send File...** option step 3.

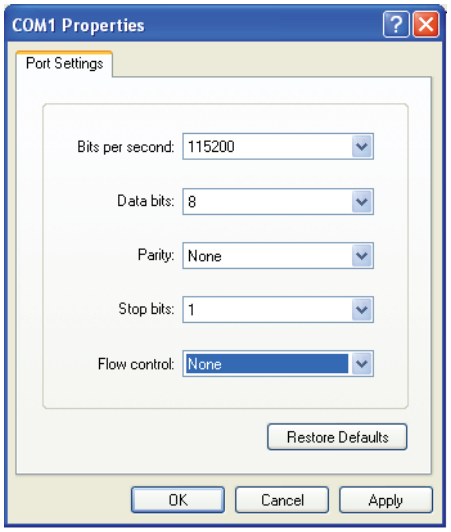
After following these steps, the MCS file will be loaded into the StrataFlash memory and the BlueCat Linux demonstration is ready to be run in BPI Up mode. Proceed to the section, "Running the Demonstrations out of Flash", to run the demonstration.

Running the Demonstrations out of Flash

Once all the files are loaded into the StrataFlash memory as detailed in the previous sections, the BlueCat Linux demonstration can be run out of flash. The following section details how to run the BlueCat Linux demonstration out of the StrataFlash.

Preparing to Run the Demonstrations out of Flash

To run the demonstration, ensure that the SP3E1600E development board is set up properly with the serial cable and power supply connected. A serial terminal program, such as HyperTerminal must be set up to view the output of the demonstrations. The serial terminal program should be set to Baud Rate of **115200**, Data Bits to **8**, Parity to **None**, and Flow Control to **None**, as shown in Figure 9.



Bits per second: 115200

Data bits: 8

Parity: None

Stop bits: 1

Flow control: None

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Figure 9: **HyperTerminal Settings for the Demonstrations**

Running the BlueCat Linux Demonstration in BPI Up Mode

To run the files out of the StrataFlash in BPI Up mode, set the J30 configuration jumpers as shown in Figure 10. Once the configuration jumpers are set properly, power cycle the development board or press the PROG button to start the BlueCat Linux demonstration.

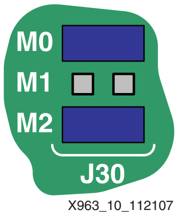
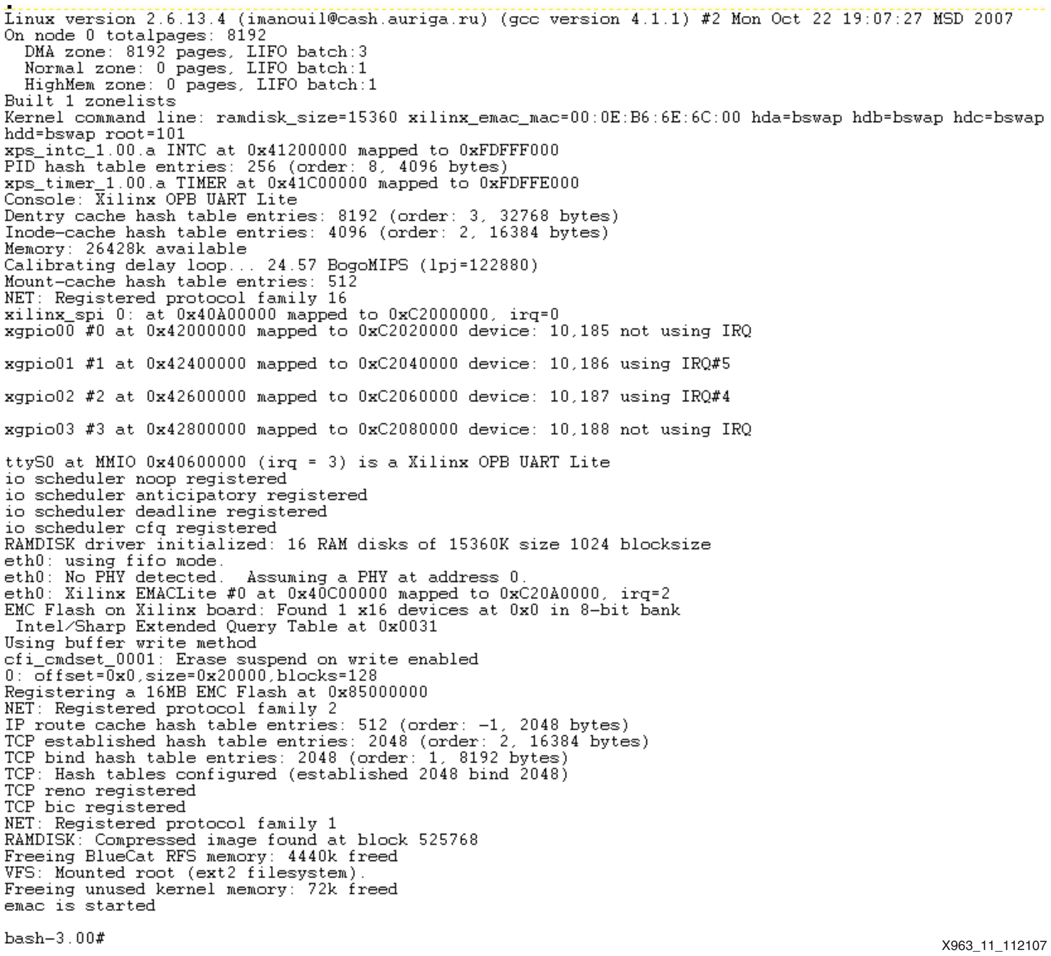


Figure 10: **Configuration Jumper Settings for BPI Up Mode**

Once the BlueCat Linux kernel boots up, the output on the HyperTerminal will be as shown in Figure 11.



```
.
Linux version 2.6.13.4 (imanouil@cash.auriga.ru) (gcc version 4.1.1) #2 Mon Oct 22 19:07:27 MSD 2007
On node 0 totalpages: 8192
  DMA zone: 8192 pages, LIFO batch:3
  Normal zone: 0 pages, LIFO batch:1
  HighMem zone: 0 pages, LIFO batch:1
Built 1 zonelists
Kernel command line: ramdisk_size=15360 xilinx_emac_mac=00:0E:B6:6E:6C:00 hda=bswap hdb=bswap hdc=bswap
hdd=bswap root=101
xps_intc_1.00.a INTC at 0x41200000 mapped to 0xFDFFF000
PID hash table entries: 256 (order: 8, 4096 bytes)
xps_timer_1.00.a TIMER at 0x41C00000 mapped to 0xFDFFE000
Console: Xilinx OPB UART Lite
Dentry cache hash table entries: 8192 (order: 3, 32768 bytes)
Inode-cache hash table entries: 4096 (order: 2, 16384 bytes)
Memory: 26428k available
Calibrating delay loop... 24.57 BogoMIPS (lpj=122880)
Mount-cache hash table entries: 512
NET: Registered protocol family 16
xilinx_spi 0: at 0x40A00000 mapped to 0xC2000000, irq=0
xgpio00 #0 at 0x42000000 mapped to 0xC2020000 device: 10,185 not using IRQ

xgpio01 #1 at 0x42400000 mapped to 0xC2040000 device: 10,186 using IRQ#5

xgpio02 #2 at 0x42600000 mapped to 0xC2060000 device: 10,187 using IRQ#4

xgpio03 #3 at 0x42800000 mapped to 0xC2080000 device: 10,188 not using IRQ

ttyS0 at MMIO 0x40600000 (irq = 3) is a Xilinx OPB UART Lite
io scheduler noop registered
io scheduler anticipatory registered
io scheduler deadline registered
io scheduler cfq registered
RAMDISK driver initialized: 16 RAM disks of 15360K size 1024 blocksize
eth0: using fifo mode.
eth0: No PHY detected.  Assuming a PHY at address 0.
eth0: Xilinx EMACLite #0 at 0x40C00000 mapped to 0xC20A0000, irq=2
EMC Flash on Xilinx board: Found 1 x16 devices at 0x0 in 8-bit bank
 Intel/Sharp Extended Query Table at 0x0031
Using buffer write method
cfi_cmdset_0001: Erase suspend on write enabled
0: offset=0x0,size=0x20000,blocks=128
Registering a 16MB EMC Flash at 0x85000000
NET: Registered protocol family 2
IP route cache hash table entries: 512 (order: -1, 2048 bytes)
TCP established hash table entries: 2048 (order: 2, 16384 bytes)
TCP bind hash table entries: 2048 (order: 1, 8192 bytes)
TCP: Hash tables configured (established 2048 bind 2048)
TCP reno registered
TCP bic registered
NET: Registered protocol family 1
RAMDISK: Compressed image found at block 525768
Freeing BlueCat RFS memory: 4440k freed
VFS: Mounted root (ext2 filesystem).
Freeing unused kernel memory: 72k freed
emac is started

bash-3.00#
```

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Figure 11: **BlueCat Linux Boot-Up Screen**

References

UG257, MicroBlaze Development Kit Spartan-3E 1600E Edition User Guide

UG258, Getting Started with the MicroBlaze Development Kit - Spartan-3E 1600E Edition

Conclusion

The BlueCat Linux reference system is provided with the MicroBlaze Development Kit - Spartan-3E Edition. This application note describes how to use the files provided and create new files for programming the Intel StrataFlash PROM with the BlueCat Linux demonstrations in the BPI UP mode configuration.

Revision History

The following table shows the revision history for this document.

Date	Version	Revision
11/15/06	1.0	Initial Xilinx release.
11/28/07	1.1	Updated for BlueCat Linux Demo in BPI UP configuration