

TU0456
Tutorial
SmartFusion2 SoC FPGA PCIe Control Plane -
Libero SoC v11.8 SP1



Power Matters.™

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1 Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision 9.0

Updated the document for Libero v11.8 SP1 software release.

1.2 Revision 8.0

Updated the broken design files link.

1.3 Revision 7.0

Updated push button description from SW3 to SW4 in (SAR 78370).

1.4 Revision 6.0

Updated the document for Libero v11.7 software release (SAR 76664).

1.5 Revision 5.0

Updated the document for Libero v11.6 software release (SAR 73139).

1.6 Revision 4.0

Updated the document for Libero v11.5 software release (SAR 64184).

1.7 Revision 3.0

Updated the document for Libero v11.4 software release (SAR 59644).

1.8 Revision 2.0

Updated the document for Libero v11.3 software release (SAR 56081).

1.9 Revision 1.0

Updated the document for Libero v11.2 software release (SAR 52109) (SAR 52909) and (SAR 50779).

1.10 Revision 0

Revision 0 was the first publication of this document.

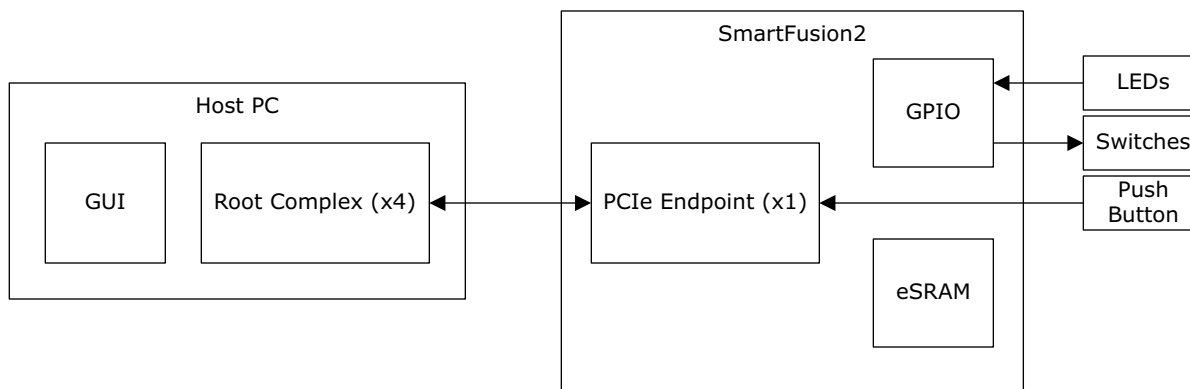
2 SmartFusion2 SoC FPGA - PCIe Control Plane Tutorial

SmartFusion[®]2 SoC FPGA devices integrate a fourth generation flash-based FPGA fabric and an ARM Cortex-M3 processor, along with high performance communication interfaces on a single chip. The SmartFusion2 high-speed serial interface (SERDESIF) provides a fully hardened PCIe endpoint implementation and is compliant with PCIe Base Specification Revision 2.0, 1.1 and 1.0. For more information, see the [UG0447: IGLOO2 and SmartFusion2 High Speed Serial Interfaces User Guide](#).

The tutorial explains the SmartFusion2 embedded PCI Express feature and how this can be used as a low bandwidth control plane interface using the SmartFusion2 Security Evaluation Kit. The tutorial provides a simple design to access the SmartFusion2 PCIe endpoint from a host PC. A GUI is provided for read and write access to the SmartFusion2 PCIe configuration space and memory space of BAR0 and BAR1. The tutorial also provides host PC device drivers for the SmartFusion2 PCIe endpoint. This tutorial can run on both windows and Red Hat Linux operating system.

The following figure shows the top-level block diagram for the PCIe control plane tutorial. The tutorial design uses a SmartFusion2 PCIe interface with a link width of ×1 to interface with a host PC PCIe Gen2 slot. The SmartFusion2 microcontroller subsystem (MSS) General Purpose I/Os (GPIOs) control the LEDs and switches on the SmartFusion2 Security Evaluation Kit through the PCIe interface. The host PC can also read memory and writes to the SmartFusion2 eSRAM through the GUI. The host PC can also be interrupted by using the push button on the SmartFusion2 Security Evaluation Kit.

Figure 1 • PCIe Control Plane Tutorial Top-Level Block Diagram



The design performs the following tasks:

- Displays the PCIe link enable or disable, negotiated link width, and the link speed.
- Controls the status of LEDs on the SmartFusion2 Security Evaluation Kit according to the command from the GUI.
- Displays the position of DIP Switches on SmartFusion2 Security Evaluation Kit.
- Enables read and write to eSRAM.
- Interrupts the host PC, when the push button is pressed. The GUI displays the count value of the number of interrupts sent from the SmartFusion2 Security Evaluation Kit.
- Displays the SmartFusion2 PCIe Configuration Space.

2.1 Design Requirements

The following figure the hardware and software required to run the tutorial.

Table 1 • Hardware and Software Requirements

Hardware	Version
SmartFusion2 Security Evaluation Kit: – 12 V adapter (provided along with the kit) – FlashPro4 programmer (provided along with the kit)	Rev E or later
Host PC with an available PCIe 2.0 Gen1 or Gen2 compliant slot	Operating system: Windows XP SP2: 64-bit Windows 7: 64-bit or Red Hat Linux Kernel Version: 2.6.18-308
Software	
Liberio® SoC Design Suite	v11.8 SP1
SoftConsole	v4.0
Host PC Drivers (provided along with the design files)	–
GUI executable (provided along with the design files)	–

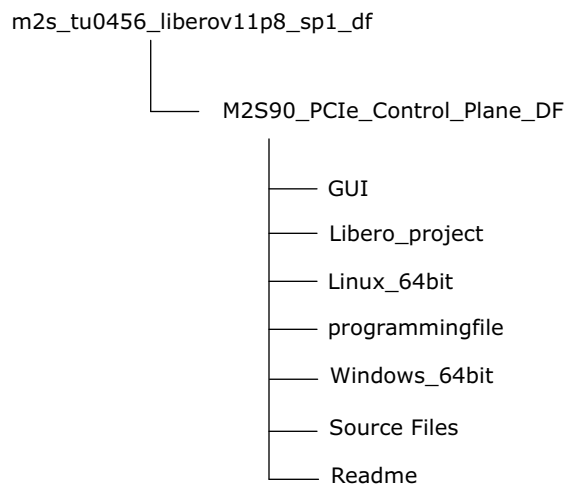
2.2 Design Files

The design files for this tutorial can be downloaded from the Microsemi website:

http://soc.microsemi.com/download/rsc/?f=m2s_tu0456_liberov11p8_sp1_df

The following figure shows the top-level structure of the design files. For further details, see the `Readme.txt` file.

Figure 2 • Design Files Top-Level Structure



2.3 Design Description

This design implements the SmartFusion2 embedded PCI Express interface as a low bandwidth control plane interface. This design provides host PC drivers and a host PC interface over PCIe to control the SmartFusion2 device. The following figure shows a detailed block diagram of the design implementation. The PCIe endpoint device receives commands from the host PC through the GUI and does corresponding memory writes to the SmartFusion2 MSS address space. The MSS address space provides a GPIO block and eSRAM memory block, which is accessed through a fabric interface controller (FIC_0).

The SERDES_IF2_0 is configured for a PCIe 2.0, x1 link width with GEN2 speed. The PCIe interface to the fabric uses an AMBA High-speed Bus (AHB). The AHB master interface of SERDESIF is enabled and connected to the AHB slave interface of FIC_0 to access the MSS peripherals. The SmartFusion2 PCIe BAR0 and BAR1 are configured in 32-bit memory mapped memory mode.

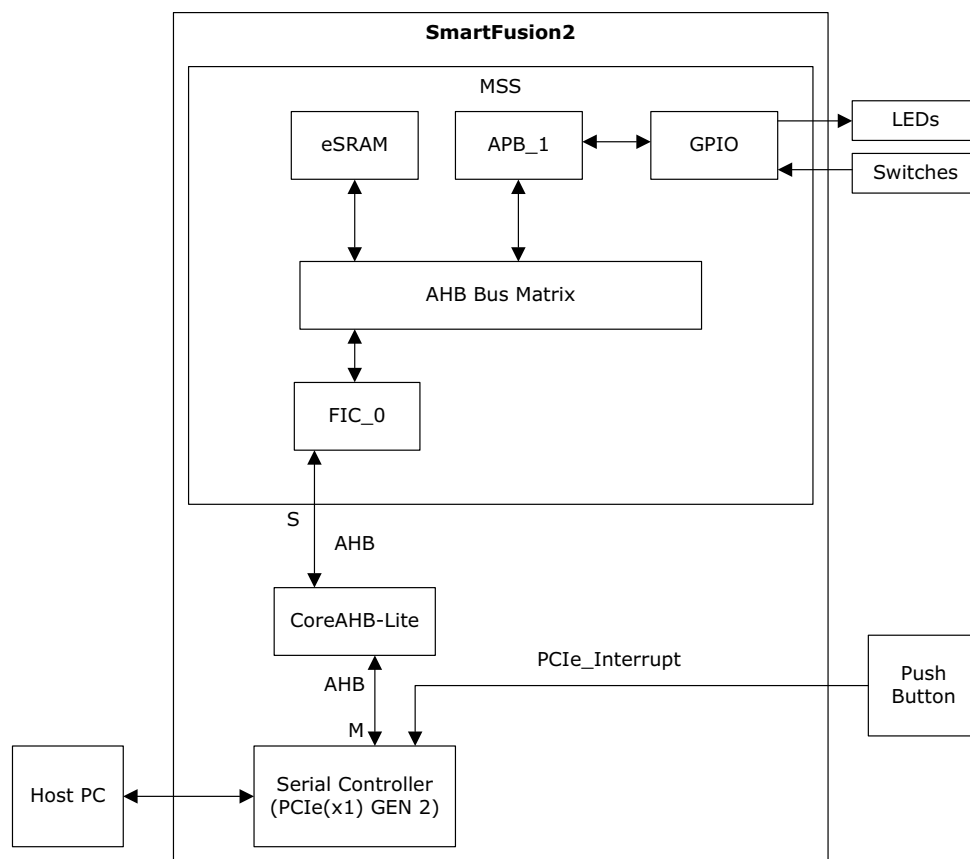
The AXI master windows of the SERDESIF PCIe provide address translation for accessing one address space from another address space as the PCIe address is different from SmartFusion2 AHB bus matrix address space. The AXI master window 0 is enabled and configured to translate the BAR0 memory address space to the MSS GPIO address space to control the MSS GPIOs. The AXI master window 1 is enabled and configured to translate the BAR1 memory address space to the eSRAM address space to perform read and writes from PCIe.

MSS GPIO block is enabled and configured as below:

- GPIO_0 to GPIO_7 as outputs and connected to LEDs
- GPIO_8 to GPIO_11 as inputs and connected to DIP switches

The PCIe interrupt line is connected to the SW4 push button on the SmartFusion2 Security Evaluation Kit. The FPGA clocks are configured to run the FPGA fabric and MSS at 90 MHz.

Figure 3 • PCIe Control Plane Block Diagram



2.4 Building the Design

This section provides a complete design flow starting from a new project to a working design on the SmartFusion2 Security Evaluation Kit. This process includes usage of the tools in the Libero SoC design suite to program the SmartFusion2 device.

Building the design involves the following steps:

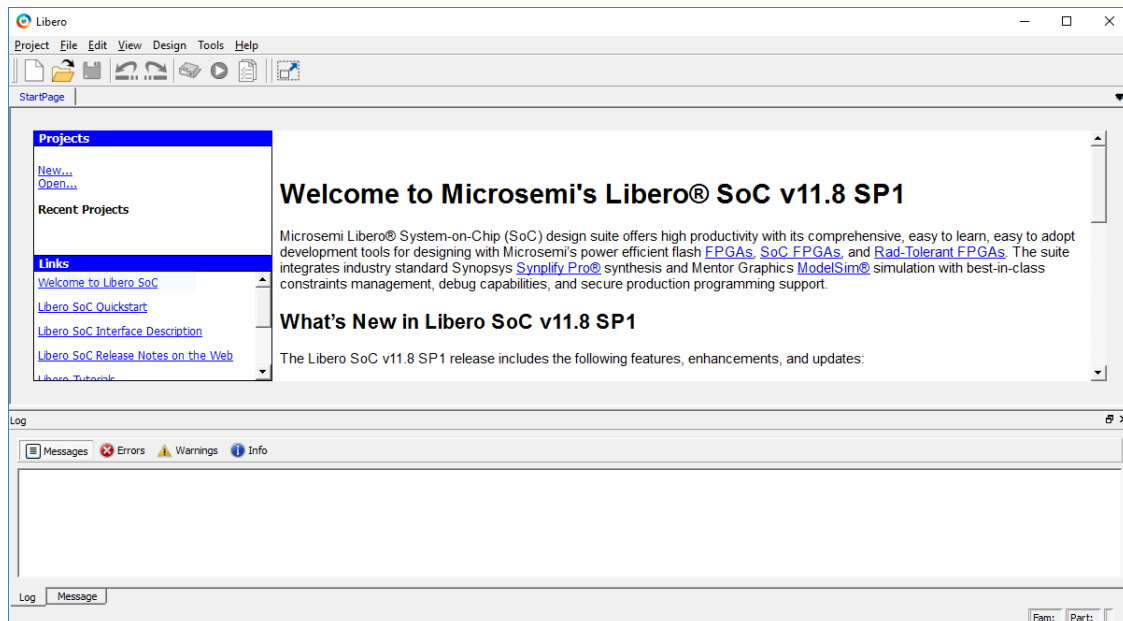
- **Step 1: Creating a Libero SoC Project**
- **Step 2: Creating an eNVM Client**
- **Step 3: Developing the Simulation Stimulus**
- **Step 4: Simulating the Design**
- **Step 5: Generating the Program File**

2.5 Step 1: Creating a Libero SoC Project

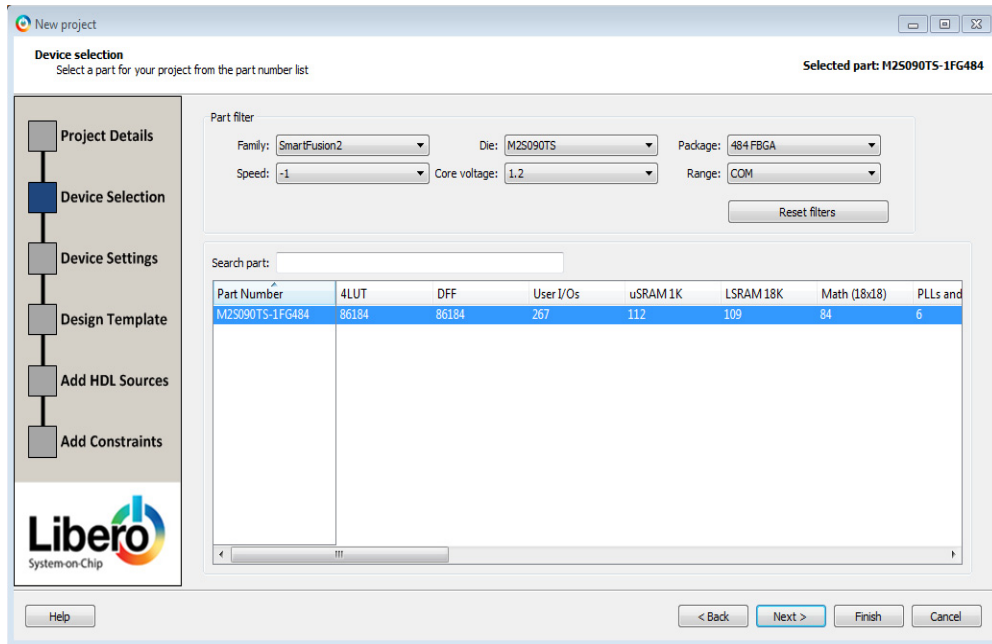
The following steps describe how to create a Libero SoC project:

1. Click **Start > Programs > Microsemi Libero SoC v11.8 SP1 > Libero SoC v11.8 SP1**, or click desktop shortcut. The Libero SoC v11.8 SP1 Project Manager is displayed, as shown in the following figure.

Figure 4 • Libero SoC v 11.8 SP1 Project Manager



2. Create a new project using one of the following options:
 - Select **New** on the Start Page tab as highlighted in the preceding figure.
 - Click **Project > New Project** from the Libero SoC menu.
3. Enter the following information in the **New Project-Project Details** tab, as shown in the following figure.
 - **Project Name:** PCIE_Demo
 - **Project Location:** Select an appropriate location (for example, D:/Microsemi_proj)
 - **Preferred HDL Type:** Verilog or VHDL
4. Select the information for **Device Selection** and click **Next**, as shown in the following figure.
 - **Family:** SmartFusion2
 - **Die:** M2S090TS
 - **Package:** 484 FBGA
 - **Speed:** -1
 - **Core voltage:** 1.2
 - **Range:** COM

Figure 5 • Device Selection Tab


Device selection
Select a part for your project from the part number list

Selected part: M2S090TS-1FG484

Part filter

Family: SmartFusion2 Die: M2S090TS Package: 484 FBGA
 Speed: -1 Core voltage: 1.2 Range: COM

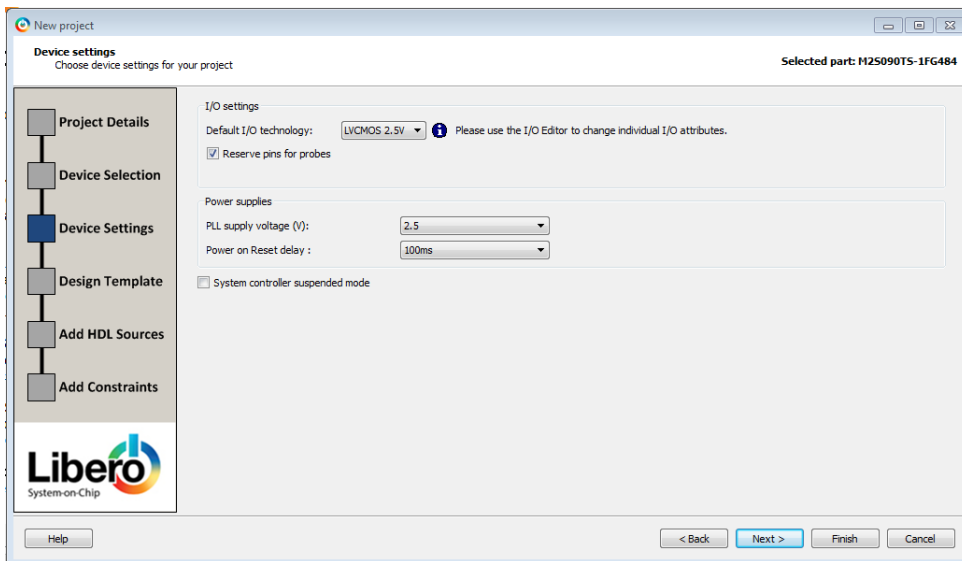
Reset filters

Search part:

Part Number	4LUT	DFF	User I/Os	uSRAM 1K	LSRAM 18K	Math (18x18)	PLLs and
M2S090TS-1FG484	86184	86184	267	112	109	84	6

Help < Back Next > Finish Cancel

5. Select the information for **Device Settings** and click **Next**, as shown in the following figure.

Figure 6 • Device Settings Tab


Device settings
Choose device settings for your project

Selected part: M2S090TS-1FG484

I/O settings

Default I/O technology: LVCMOS 2.5V Please use the I/O Editor to change individual I/O attributes.

☒ Reserve pins for probes

Power supplies

PLL supply voltage (V): 2.5

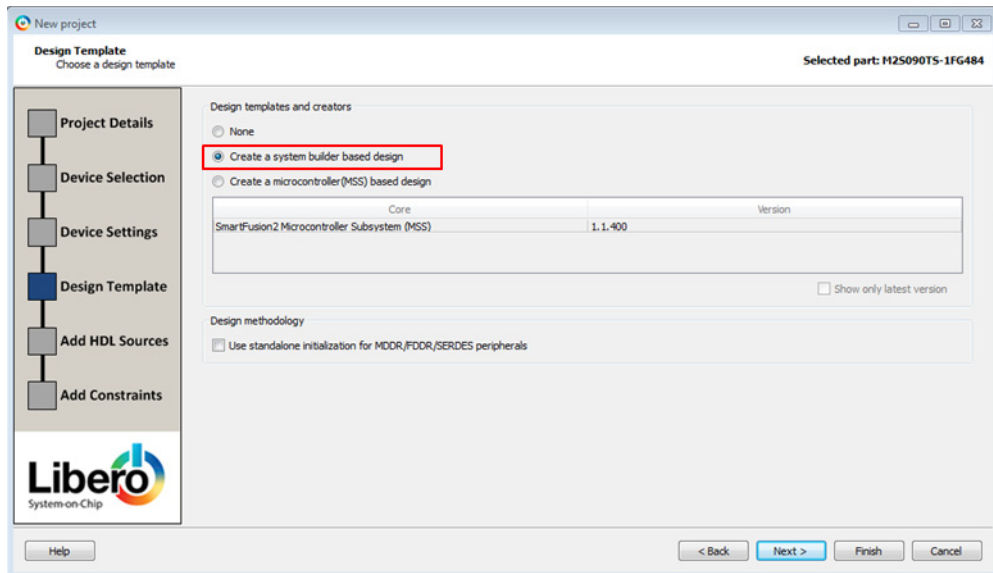
Power on Reset delay : 100ms

☐ System controller suspended mode

Help < Back Next > Finish Cancel

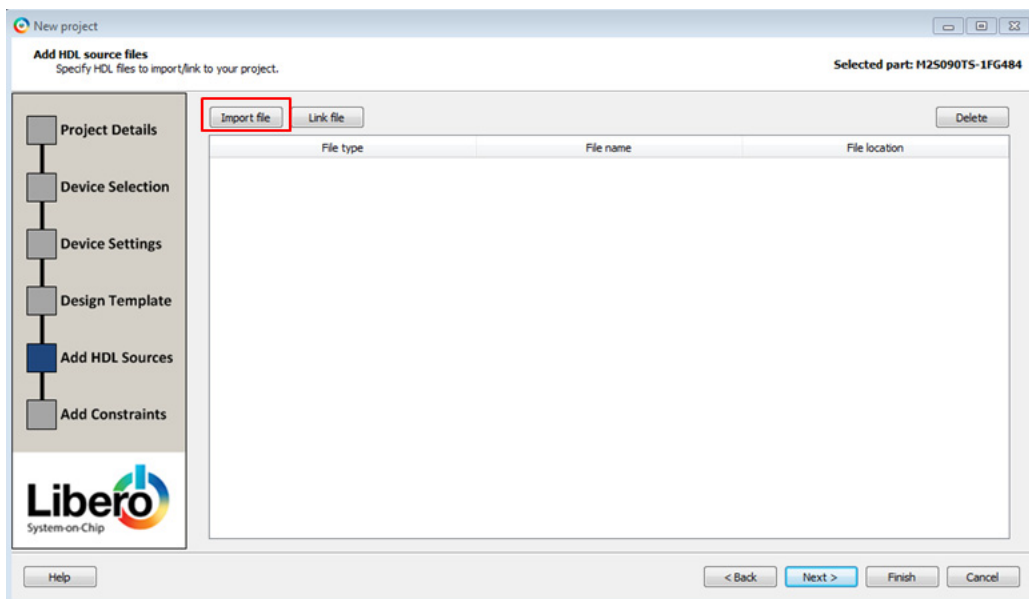
6. **Design Template** tab is displayed, as shown in the following figure. Select **Create a System Builder based design** under **Design Templates and Creators** and click **Next**.

Figure 7 • Design Template Tab



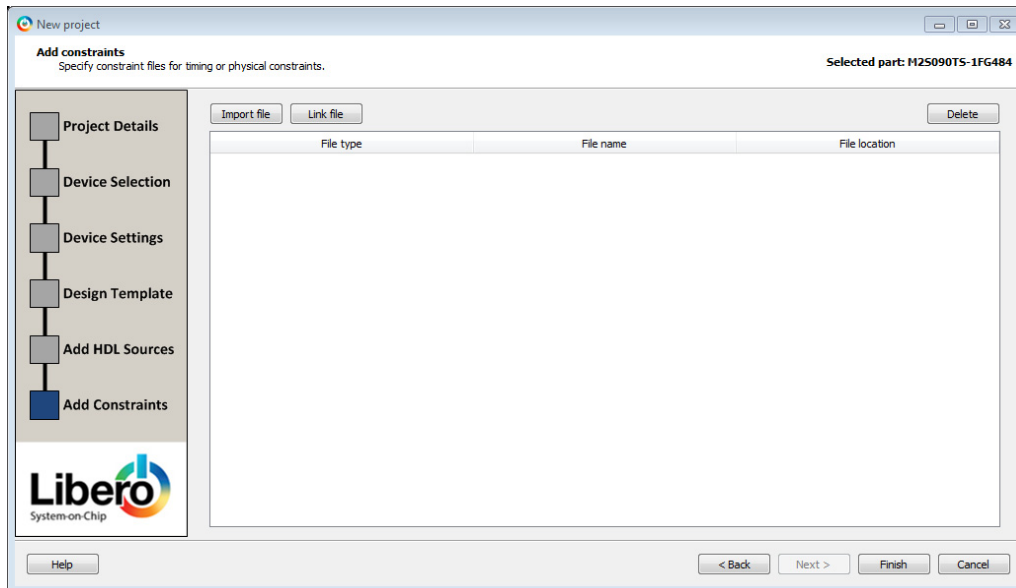
7. **Add HDL Sources** tab is displayed, as shown in the following figure. **Verilog/VHDL Source Files** can be added here.

Figure 8 • Add HDL Source Files Tab



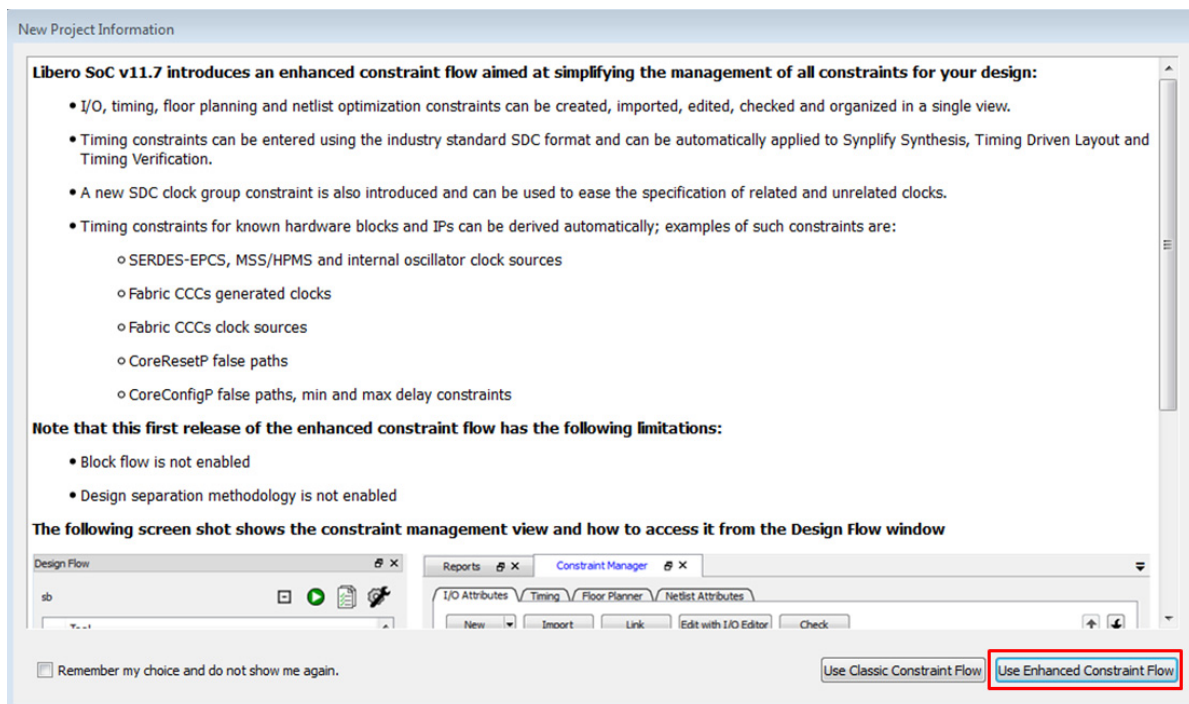
8. **Add Constraints** tab is displayed, as shown in the following figure. **Constraints** file can be added using Import option.

Figure 9 • Add Constraints Tab



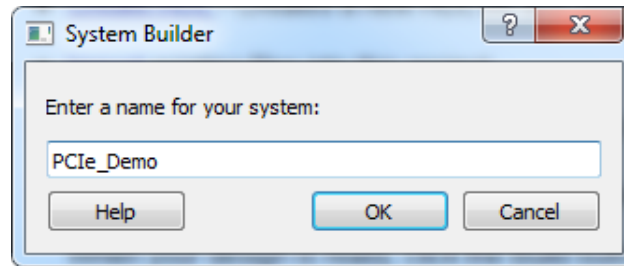
9. Click **Finish**. This displays the **New project information** window. Select **Use Enhanced Constraint Flow** to use the new constraint flow as part of Libero v11.8 SP1 SoC, as shown in the following figure.

Figure 10 • New Project Information



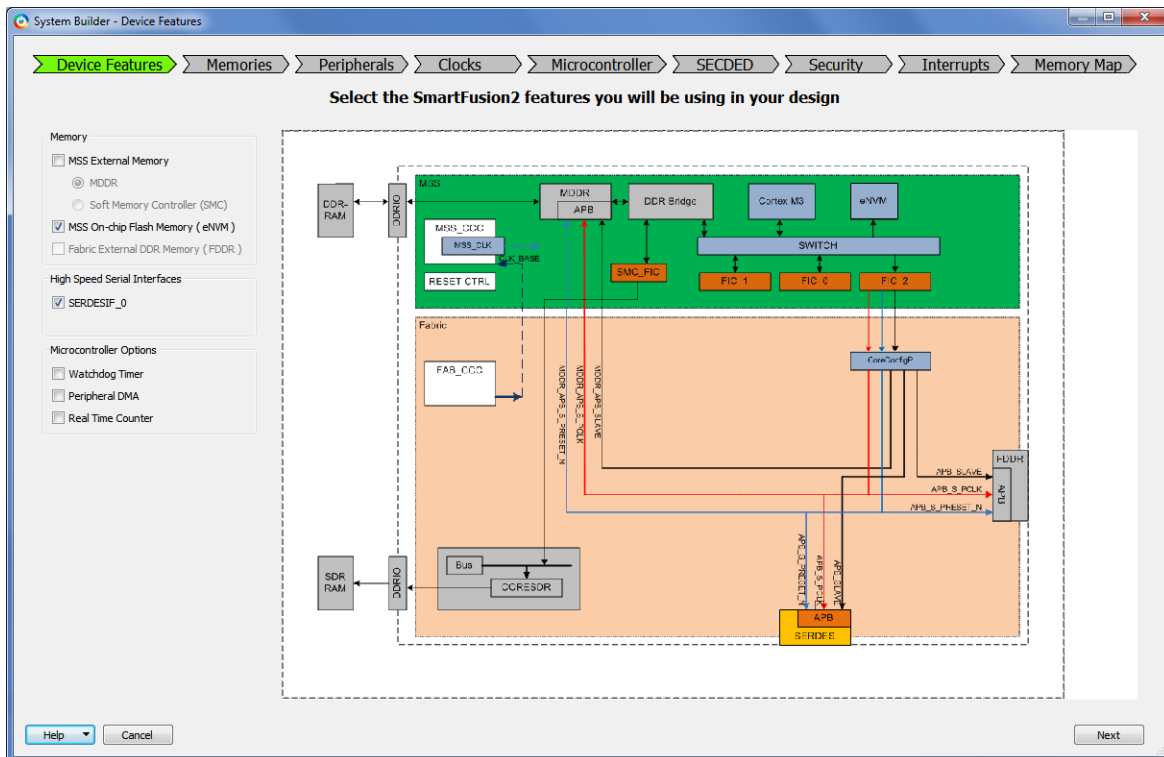
10. Enter **PCIe_Demo** as the name of the system in the **System Builder** dialog box, as shown in the following figure.

Figure 11 • System Builder Dialog Box



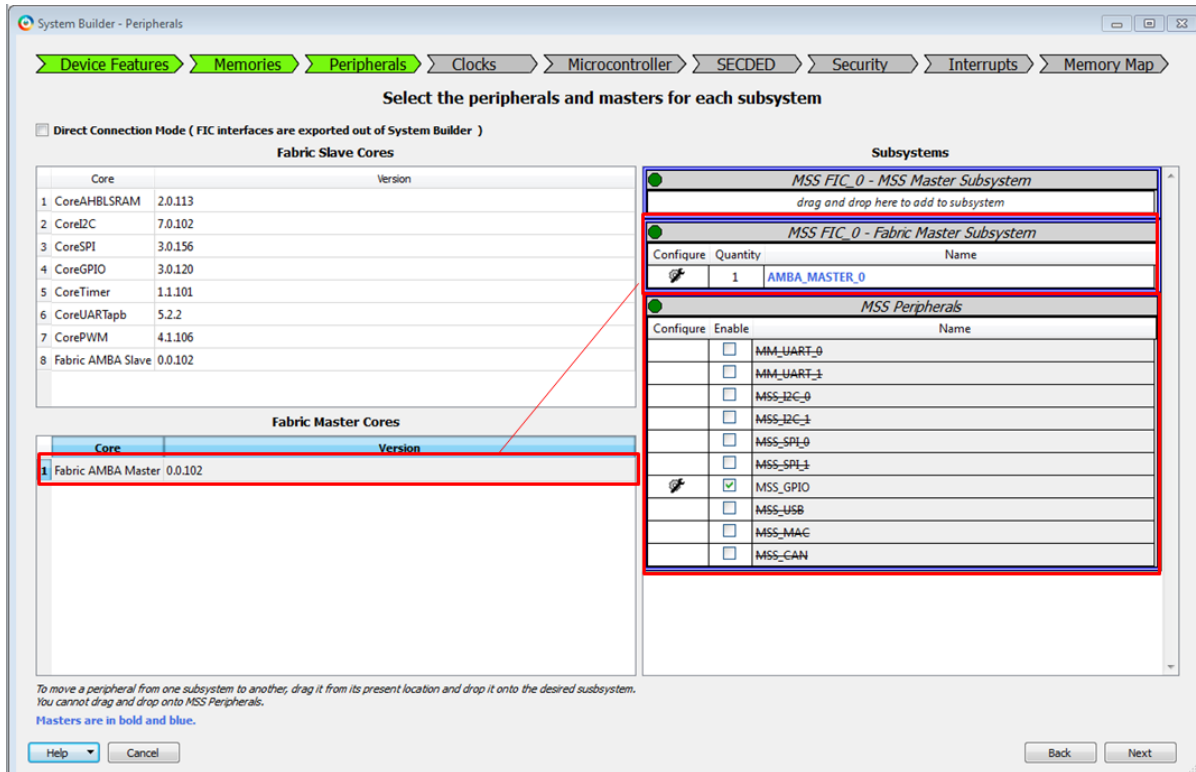
11. Click **OK**. The System Builder dialog box is displayed with the Device Features page open by default.
12. Enter the following information in the **System Builder – Device Features** page, as shown in the following figure:
- **Memory:** Clear all except MSS On-chip Flash Memory (eNVM)
 - **High-speed serial interfaces:** Check SERDESIF_0
 - **Microcontroller Options:** Clear All

Figure 12 • SmartFusion2 System Builder Configurator



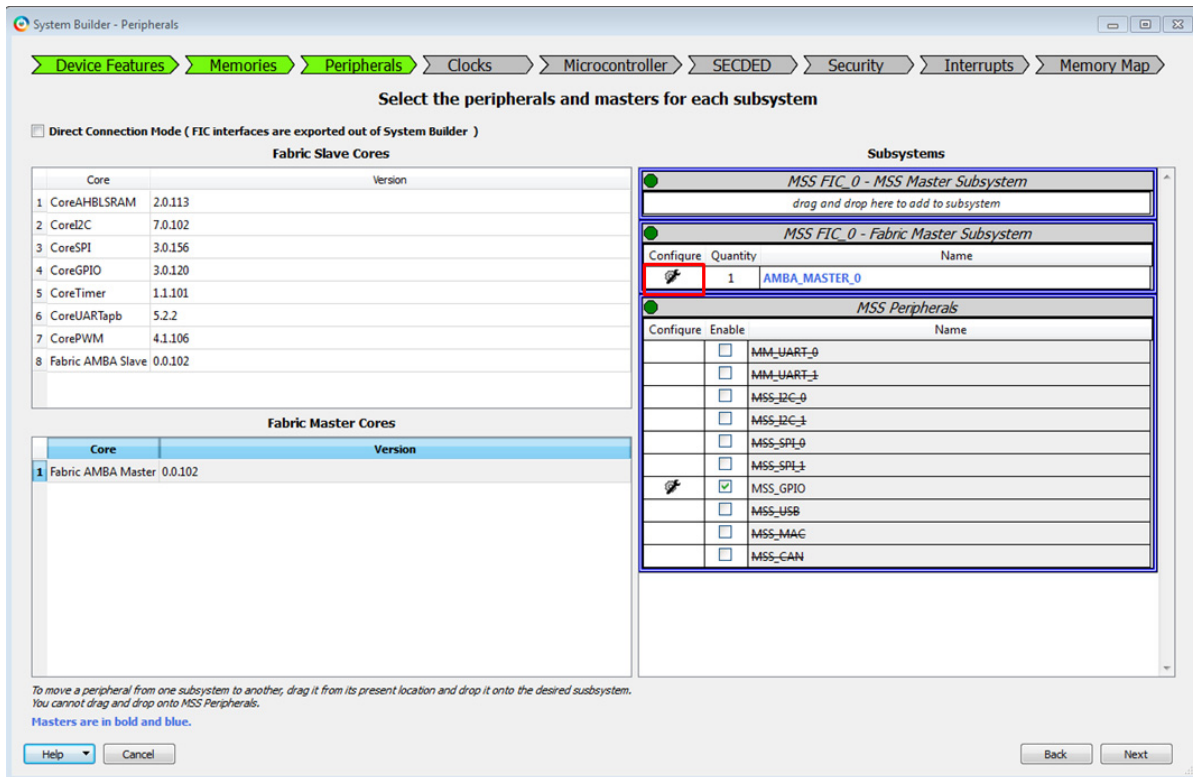
13. Click **Next**. The **System Builder – Memories** page is displayed.
14. Click **Next**. The **System Builder – Peripherals** page is displayed. Drag the **Fabric AMBA Master** to **MSS_FIC_0 – Fabric Master Subsystem**, as shown in the following figure. It enables the MSS FIC_0 slave interface.

Figure 13 • System Builder—Peripherals Page



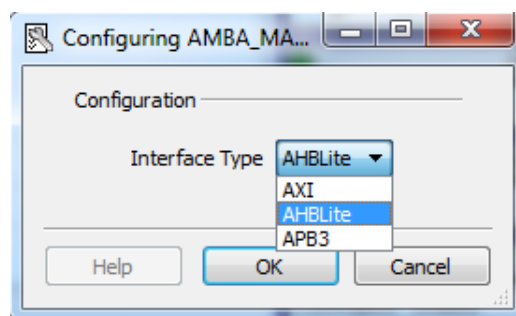
15. Disable the MSS Peripherals except MSS_GPIO. The **System Builder – Peripherals** page is displayed. Configure **MSS_FIC_0 – Fabric Master Subsystem** for AHB-Lite by clicking **AMBA_MASTER_0** configurator highlighted in the following figure. This displays a drop-down list, as shown in [Figure 15](#), page 11.

Figure 14 • System Builder—Peripherals Page



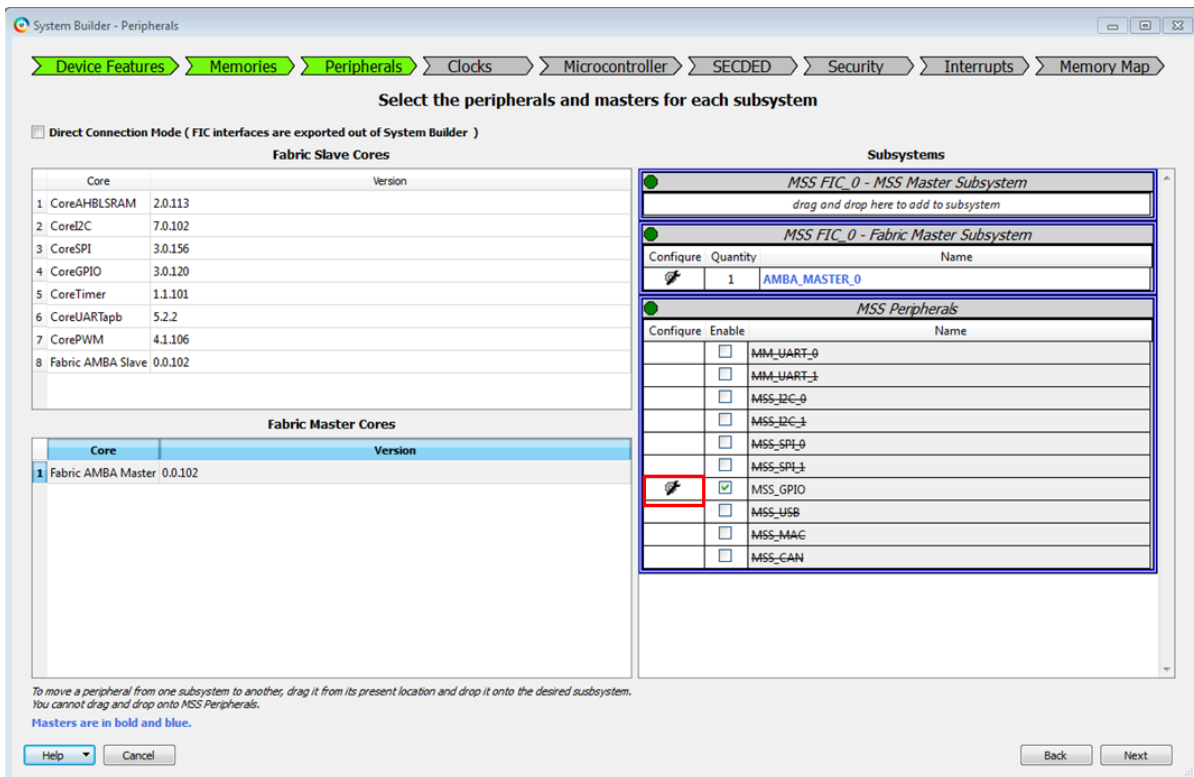
16. Select **AHBLite** from the drop-down list, as shown in the following figure.

Figure 15 • Configuring AMBA Master



17. Configure MSS_GPIO by clicking **MSS_GPIO Configure**, as shown in the following figure.

Figure 16 • System Builder—Peripherals Page



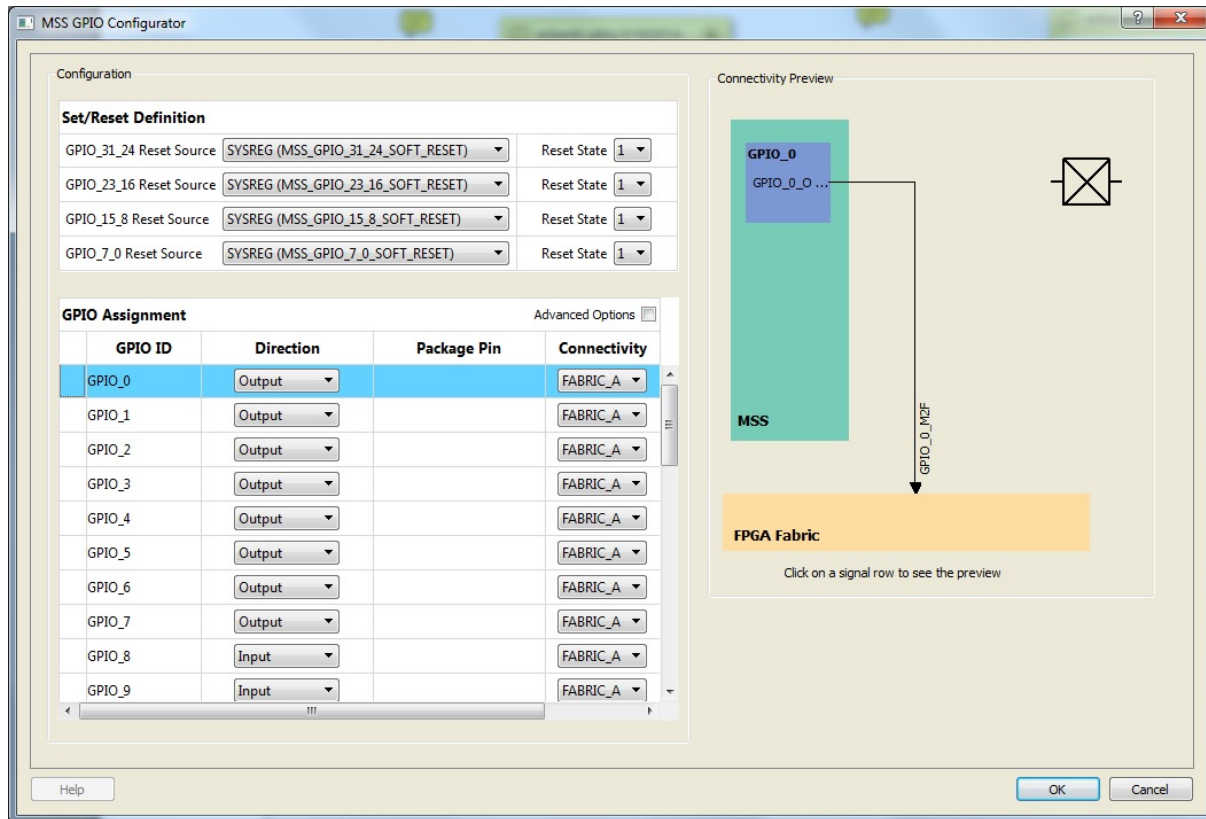
18. Double-click **MSS_GPIO** configuration, as shown in the following figure and configure:

- GPIO_0 to GPIO_7 as outputs and their connectivity to FABRIC_A to connect with LEDs.
- GPIO_8 to GPIO_11 as inputs and their connectivity to FABRIC_A, to connect with DIP switches.

This design requires configuring GPIO_0 to GPIO_7 to drive LED_1 to LED_8 on the SmartFusion2 Security Evaluation Kit, and GPIO_8 to GPIO_11 to connect DIP1 to DIP4. These signals are routed through the fabric to the I/O pins.

The following figure shows the MSS GPIO Configurator.

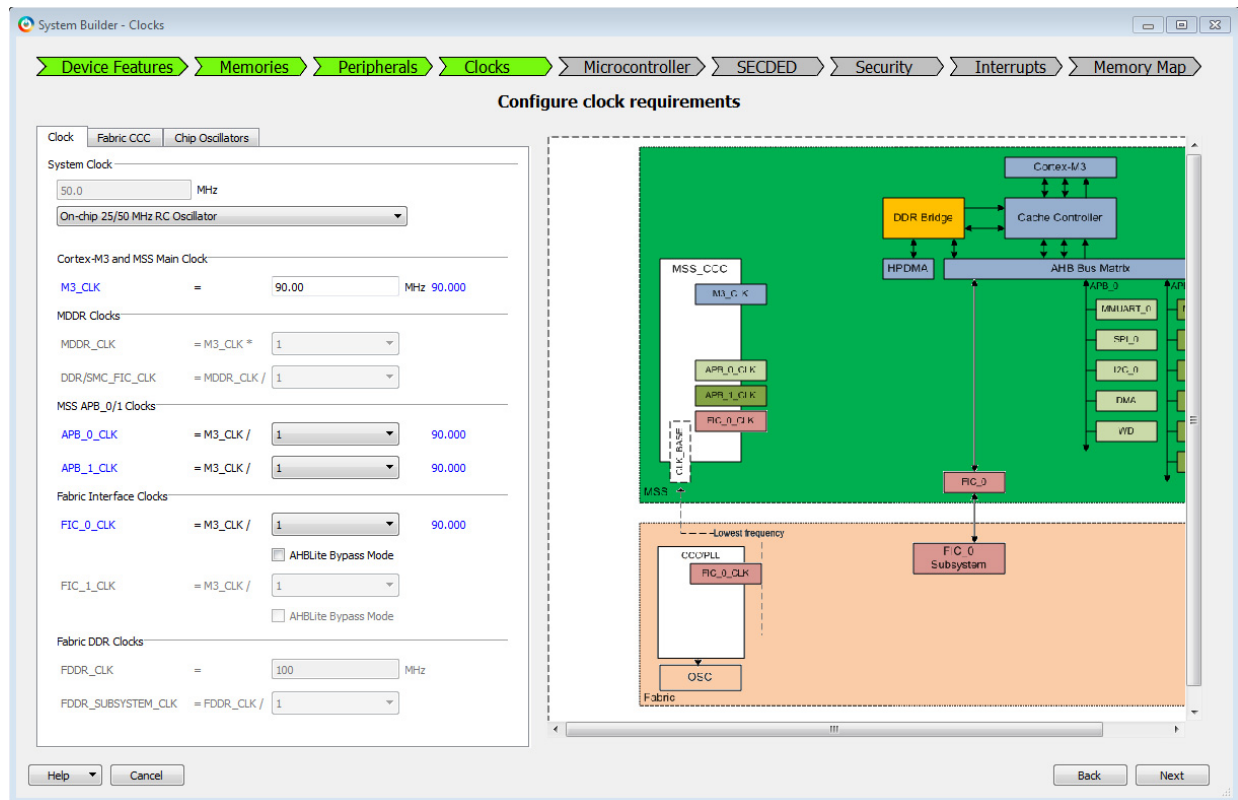
Figure 17 • GPIO Configuration



19. Click **OK** on MSS GPIO Configurator.

20. Click **Next**. The **System Builder – Clock** page is displayed, as shown in the following figure. Change the configuration of **System Clock** from 100 MHz to 50 MHz. The dedicated input pad is connected to on board 50 MHz oscillator. The M3_CLK is configured to 90 MHz by default.

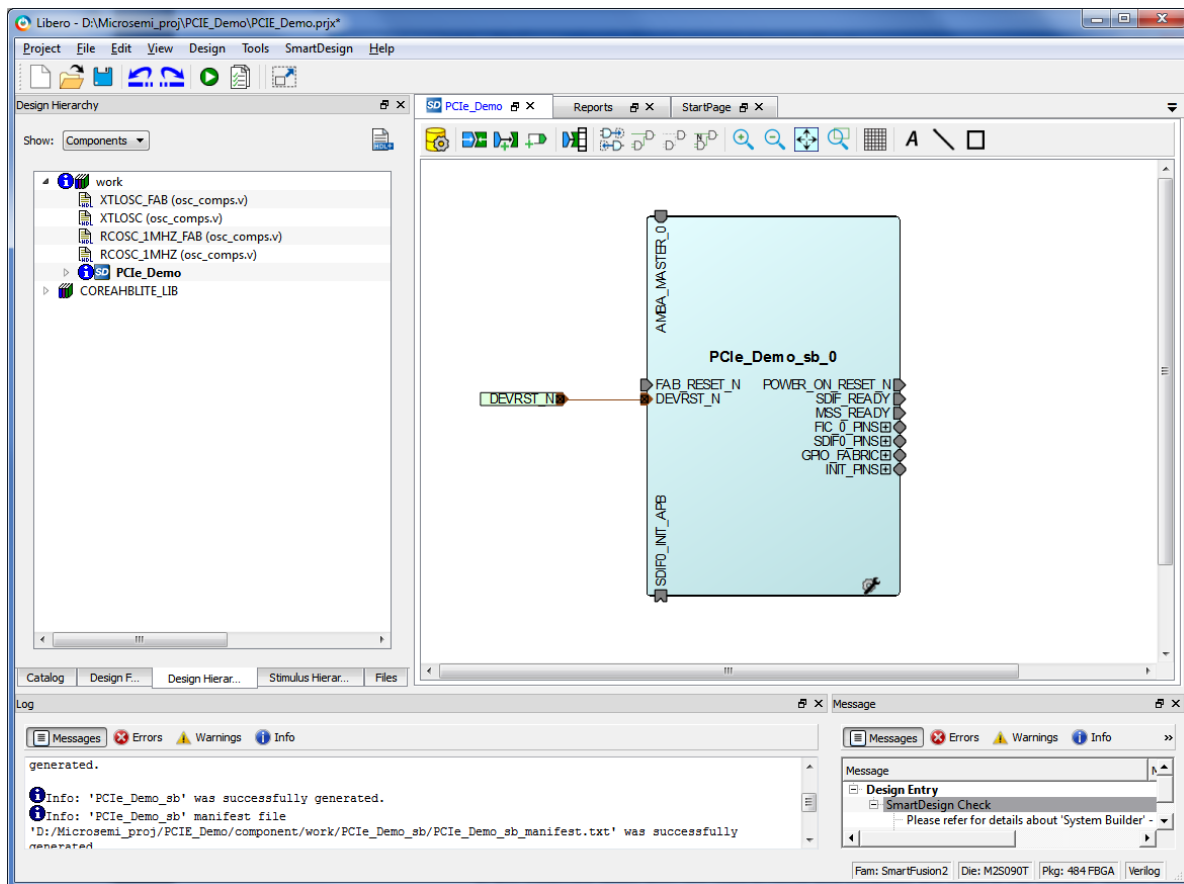
Figure 18 • System Builder—Clock Page



21. Click **Next**. The **System Builder - Microcontroller** page is displayed. Leave all the default selections.
22. Click **Next**. The **System Builder - SECEDED** page is displayed. Do not change the default selections.
23. Click **Next**. The **System Builder - Security** page is displayed. Do not change the default selections.
24. Click **Next**. The **System Builder - Interrupts** page is displayed. Do not change the default selections.
25. Click **Next**. The **System Builder - Memory Map** page is displayed. Do not change the default selections.
26. Click **Finish**. The **System Builder** generates the system based on the selected options.

The System Builder block is created and added to Libero SoC project automatically, as shown in the following figure.

Figure 19 • SmartFusion2 System Builder Generated System



The two soft cores (CoreResetP and CoreConfigP) are automatically instantiated and connected by the System Builder. The block connections can be seen by opening the System Builder component in the SmartDesign canvas.

Note: CoreResetP and CoreConfigP are responsible for the reset and configuration of ASIC peripherals. In this particular design, they are used to reset and configure the SERDESIF module. These modules are included in the System Builder generated component when an ASIC peripheral is selected.

2.5.1 Instantiating SERDESIF Component in PCIe_Demo SmartDesign

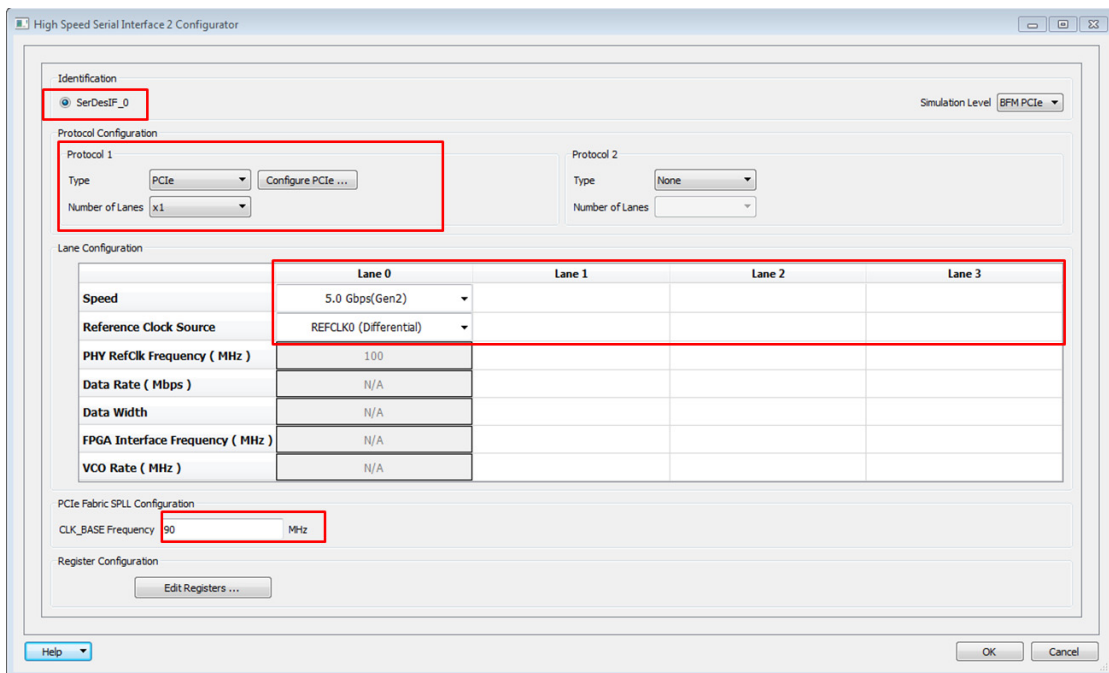
The Libero SoC Catalog provides IP cores that can be easily dragged-and-dropped into the SmartDesign Canvas workspace. Many of these IPs are free to use while several require a license agreement. The SERDESIF module that supports the PCIe embedded interface is included in the catalog. To instantiate the SERDESIF component in the **PCIe_Demo** SmartDesign, expand the **Peripherals** category in the Libero SoC Catalog.

Figure 20 • IP Catalog

CoreSDLC	3.0.121
CoreSDR	4.1.111
CoreSDR_AHB	4.3.100
CoreSDR_AXI	2.0.116
CoreSF2Config	3.0.100
CoreSF2Reset	3.0.100
CoreSGMII	2.0.101
CoreSPI	5.0.100
CoreSysServices	3.1.101
CoreTSE	2.0.307
CoreTSE_AHB	2.1.105
CoreTimer	2.0.103
CoreUART	5.5.101
CoreUARTapb	5.5.101
CoreWatchdog	1.1.101
High Speed Serial Interface 2	1.2.212
High Speed Serial Interface 3	1.2.211

1. Drag the **High Speed Serial Interface2** onto the **PCIe_Demo SmartDesign** canvas. If the component appears shadowed in the Vault, right-click the name and select **Download**.
2. Double-click the **SERDES_IF2_0** component in the SmartDesign canvas to open the **SERDES** configurator. Configure the SERDES with the following settings, as shown in the following figure:
 - Select **SERDESIF_0**
 - Simulation Level: **BFM PCIe**
 - Protocol1: Number of Lanes: **x1**
 - Protocol1: Type: **PCIe**
 - CLK_BASE Frequency (MHz): **90**
 - Lane Configuration: Speed: **5.0 Gbps(Gen2)**
 - Reference Clock Source: **REFCLK0 (Differential)**

Figure 21 • SERDES Configurator



High Speed Serial Interface 2 Configurator

Identification: **SerDesIF_0** Simulation Level: **BFM PCIe**

Protocol Configuration

Protocol 1: Type: **PCIe** Number of Lanes: **x1**

Protocol 2: Type: **None** Number of Lanes:

Lane Configuration

	Lane 0	Lane 1	Lane 2	Lane 3
Speed	5.0 Gbps(Gen2)			
Reference Clock Source	REFCLK0 (Differential)			
PHY RefClk Frequency (MHz)	100			
Data Rate (Mbps)	N/A			
Data Width	N/A			
FPGA Interface Frequency (MHz)	N/A			
VCO Rate (MHz)	N/A			

PCIe Fabric SPLL Configuration

CLK_BASE Frequency: **90** MHz

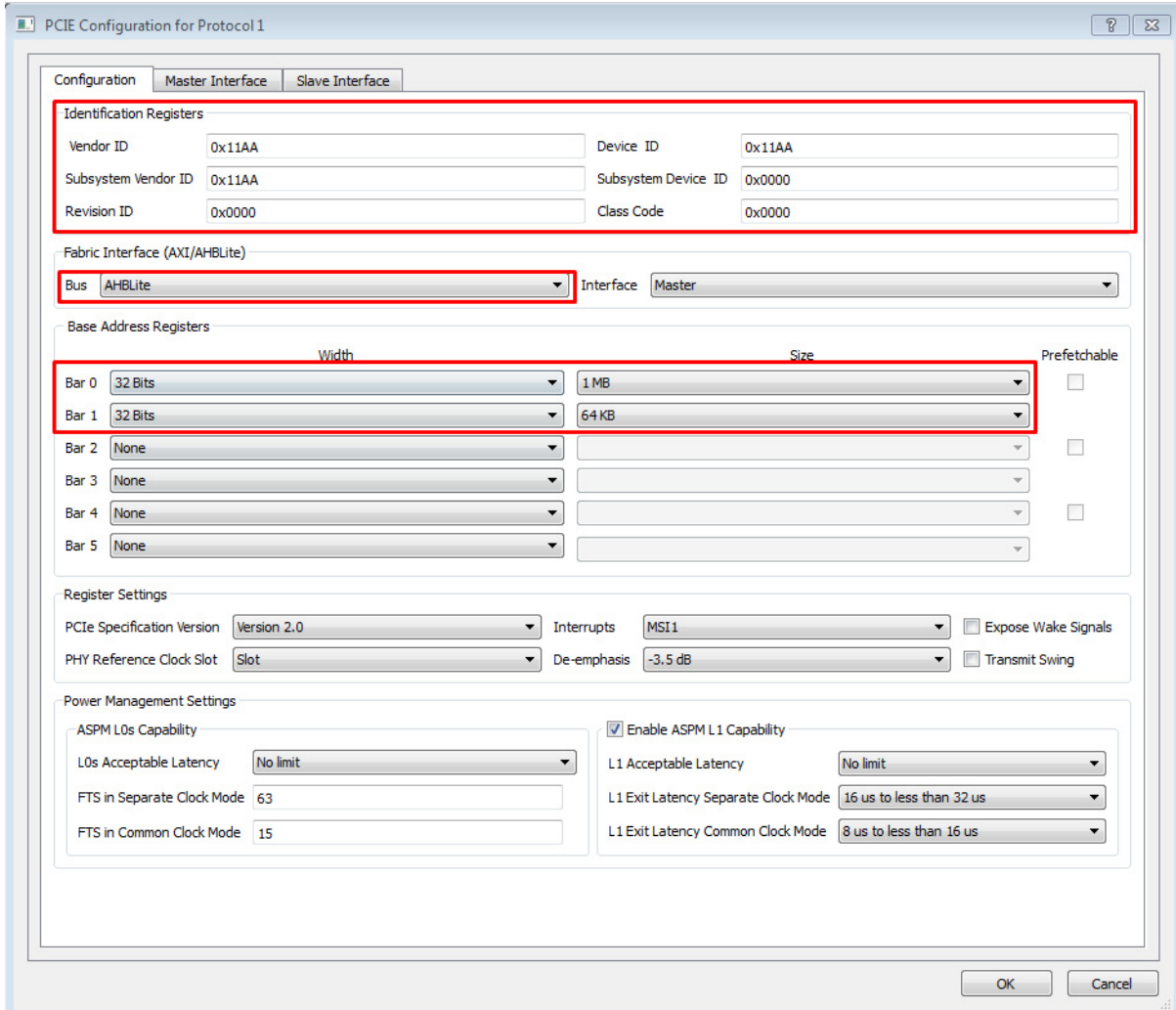
Register Configuration

Edit Registers ...

Help OK Cancel

3. Click **Configure PCIe** in Protocol1, as shown in [Figure 21](#), page 16. The following settings are made in the Configuration tab, as shown in the following figure.
 - Fabric Interface (AXI/AHBLite)
 - Bus: select as AHBLite from the drop-down list
 - Base Address Registers
 - BAR 0 Width: 32-bit, Size: 1 MB (to access MSS Peripheral address space)
 - BAR 1 Width: 32-bit, Size: 64 KB (to access eSRAM memory)
 - Identification Registers
 - Device ID: 0x11AA (MicroSemi ID)
 - Subsystem Vendor ID: 0x11AA (MicroSemi ID)

Figure 22 • PCIe Configuration for Protocol 1



PCIe Configuration for Protocol 1

Configuration Master Interface Slave Interface

Identification Registers

Vendor ID	0x11AA	Device ID	0x11AA
Subsystem Vendor ID	0x11AA	Subsystem Device ID	0x0000
Revision ID	0x0000	Class Code	0x0000

Fabric Interface (AXI/AHBLite)

Bus: AHBLite Interface: Master

Base Address Registers

	Width	Size	Prefetchable
Bar 0	32 Bits	1 MB	☐
Bar 1	32 Bits	64 KB	☐
Bar 2	None		☐
Bar 3	None		☐
Bar 4	None		☐
Bar 5	None		☐

Register Settings

PCIe Specification Version: Version 2.0 Interrupts: MSI1 ☐ Expose Wake Signals

PHY Reference Clock Slot: Slot De-emphasis: -3.5 dB ☐ Transmit Swing

Power Management Settings

ASPM L0s Capability: L0s Acceptable Latency: No limit

FTS in Separate Clock Mode: 63

FTS in Common Clock Mode: 15

☒ Enable ASPM L1 Capability

L1 Acceptable Latency: No limit

L1 Exit Latency Separate Clock Mode: 16 us to less than 32 us

L1 Exit Latency Common Clock Mode: 8 us to less than 16 us

OK Cancel

4. Click the **Master Interface** tab to configure the PCIe master windows. The PCIe AXI master windows are used to translate the PCIe address domain to the local device address domain. In this design the PCIe AXI master windows are used to translate the address of BAR0 and BAR1 to CoreGPIO address and COREAHBLSRAM address. Make settings, as shown in the following figure.

– Select Window 0 and configure following settings:

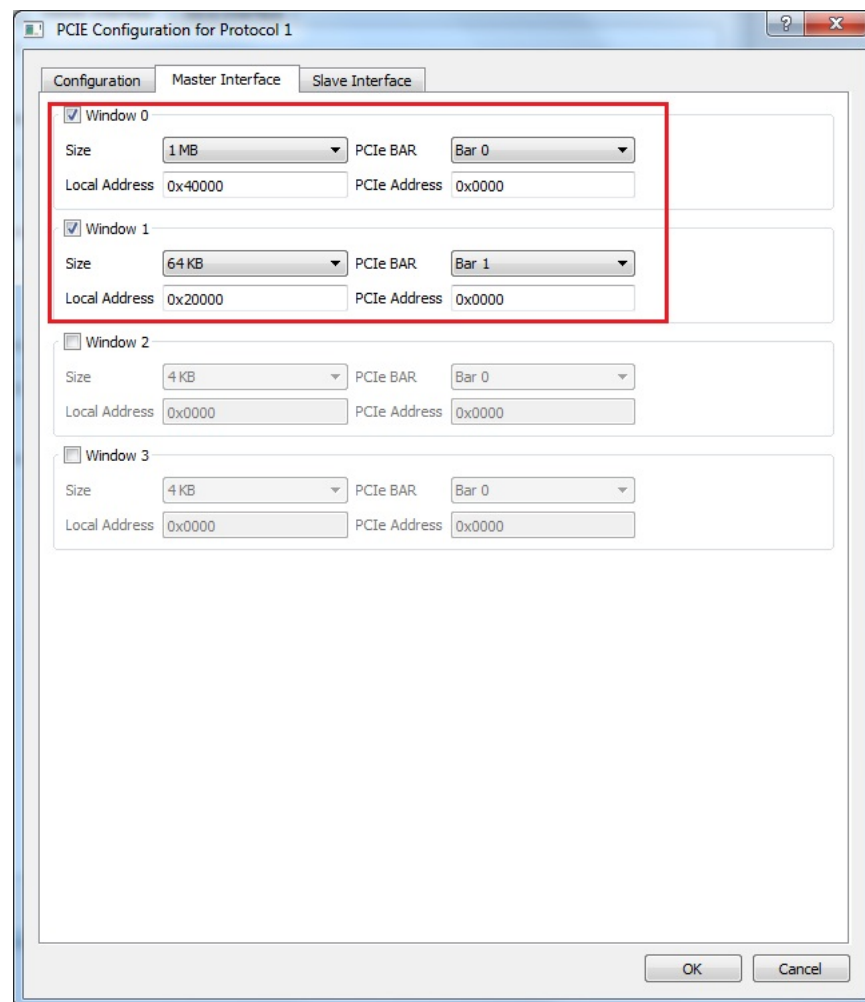
- Size: Select as 1 MB from the drop-down list
- PCIe BAR: Select as Bar0 from the drop-down list
- Local Address: Enter values as 0x40000 to translate the BAR0 address space to CoreGPIO address (0x4000_0000)

– Select Window 1 and configure following settings:

- Size: Select as 64 KB from the drop-down list
- PCIe BAR: Select as Bar1 from the drop-down list
- Local Address: Enter values as 0x20000 to translate the BAR1 address space to COREAHBLSRAM address (0x2000_0000)

For more information on PCIe address translation, refer to the **Address Translation on the AXI Master Interface** section of the [UG0447: IGL002 and SmartFusion2 High Speed Serial Interfaces User Guide](#).

Figure 23 • PCIe Configuration Memory

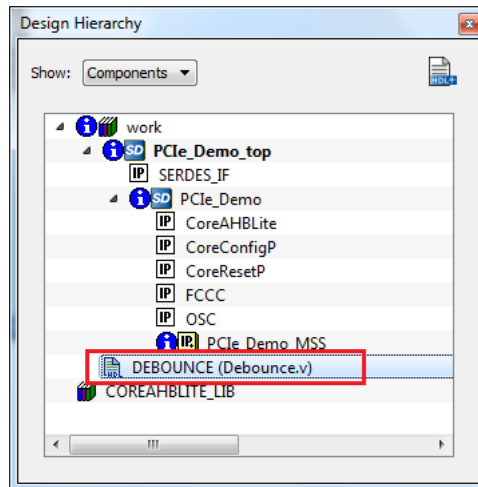


5. Click **OK** to close PCIe Configuration window.
6. Click **OK** to save and close the High Speed Serial Interface Configurator.

2.5.2 Instantiating Debounce Logic in PCIe_Demo SmartDesign

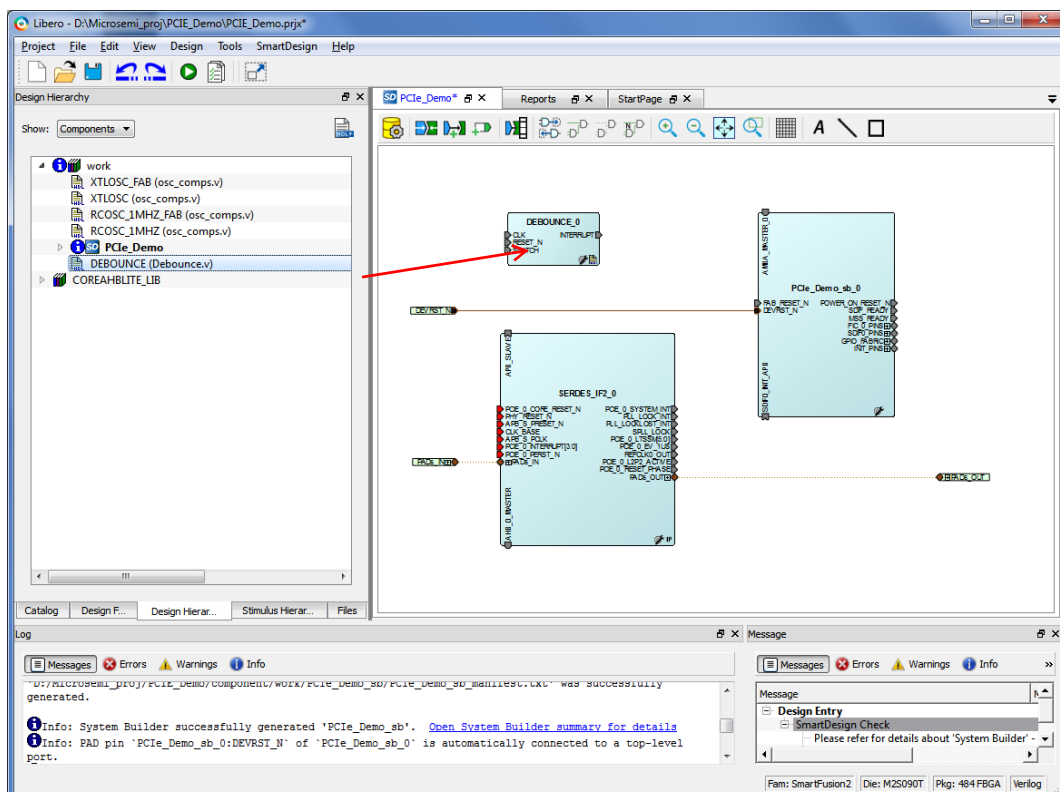
1. The design provides a push button on the SmartFusion2 Security Evaluation Kit to send an interrupt to the host PC. This push button generates switch bounce that causes multiple interrupts to PCIe. Debounce logic is required to avoid the switch bounce.
2. To add the debounce logic to the PCIe design, click **File > Import > HDL Source files**.
3. Browse to the Debounce.v or Debounce.vhd file location in the design files folder: *M2S90_PCIE_Control_DEMO_DF/Source Files*. The following figure shows the DEBOUNCE component in the Design Hierarchy window.

Figure 24 • DEBOUNCE Component in Design Hierarchy Window



4. Click the **PCie_Demo** tab and drag the **DEBOUNCE** component from the **Design Hierarchy** into the **PCie_Demo SmartDesign** canvas, as shown in the following figure. A SmartDesign symbol for the Verilog HDL file is automatically generated.

Figure 25 • DEBOUNCE Component in Design Hierarchy



The PCIe_Demo is displayed, as shown in Figure 27, page 21. Connect the pins of all the blocks as described in the following section.

2.5.3 Connecting Components in PCIe_Demo SmartDesign

There are three methods for connecting components in PCIe_Demo SmartDesign.

The first method is by using the **Connection Mode** option. To use this method, change the SmartDesign to connection mode by clicking **Connection Mode** on the SmartDesign window, as shown in Figure 27, page 21. The cursor changes from the normal arrow shape to the connection mode icon shape. To make a connection in this mode, click on the first pin and drag-drop to the second pin that you want to connect.

The second method is by selecting the pins to be connected together and selecting **Connect** from the context menu. To select multiple pins to be connected together, press down the **CTRL** key while selecting the pins. Right-click the input source signal and select **Connect** to connect all the signals together. Similarly, select the input source signal, right-click it, and select **Disconnect** to disconnect the signals already connected.

The third method is by using the **Quick Connect** option. To use this method, change the SmartDesign to quick connect mode by clicking **Quick Connect** mode on the SmartDesign window, as shown in the following figure. **Quick Connect** window opens. Find the Instance Pin that needs to be connected and click to select it. In Pins to Connect, find the pin that needs to be connected, right-click and choose **Connect**, as shown in the following figure.

Figure 26 • Quick Connect Window

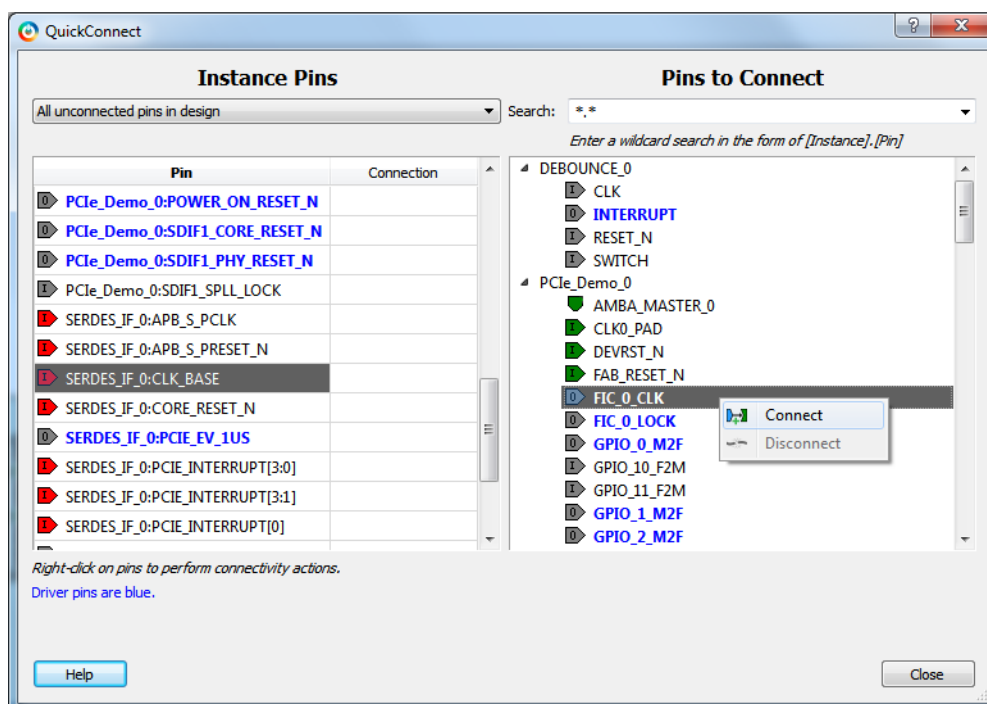
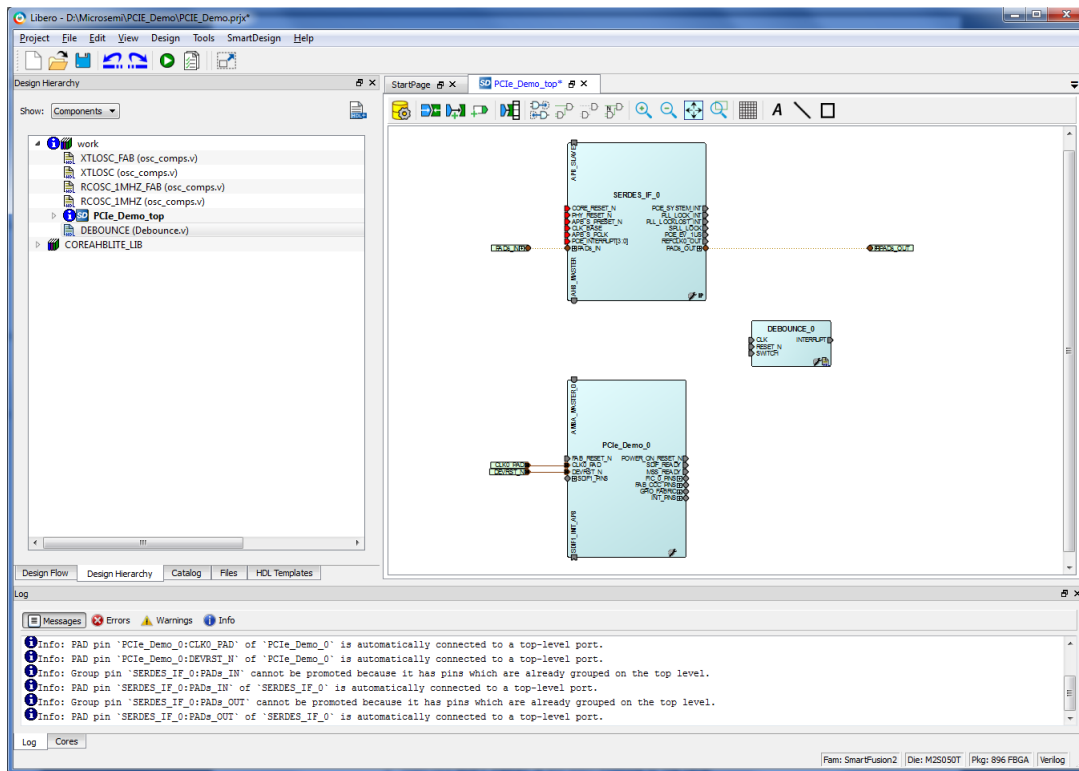


Figure 27 • PCIe Demo Top in SmartDesign



Use one of the three options and make the following connections:

1. Expand FIC_0_PINS of PCIe_Demo_sb_0 and make connections, as listed in the following table.
2. Right-click **FIC_0_LOCK** and select **Mark Unused**.

Table 2 • FIC_0_PINS

From PCIe_Demo_sb_0	To
FIC_0_CLK	CLK_BASE of SERDES_IF2_0
	CLK of DEBOUNCE_0

3. Expand SDIF0_PINS of PCIe_Demo_sb_0 and make connections, as listed in the following table.

Table 3 • SDIF0_PINS

From PCIe_Demo_sb_0	To SERDES_IF2_0
SDIF0_PHY_RESET_N	PHY_RESET_N
SDIF0_0_CORE_RESET_N	PCIE_0_CORE_RESET_N
SDIF0_SPLL_LOCK	SPLL_LOCK

4. Right-click **SDIF0_1_CORE_RESET_N** and select **Mark Unused**.
5. Right-click **PCIE_0_PERST_N** and select **Promote to Top Level**.

6. Expand **INIT_PINS** of **PCle_Demo_sb_0** and make connections, as listed in the following table.

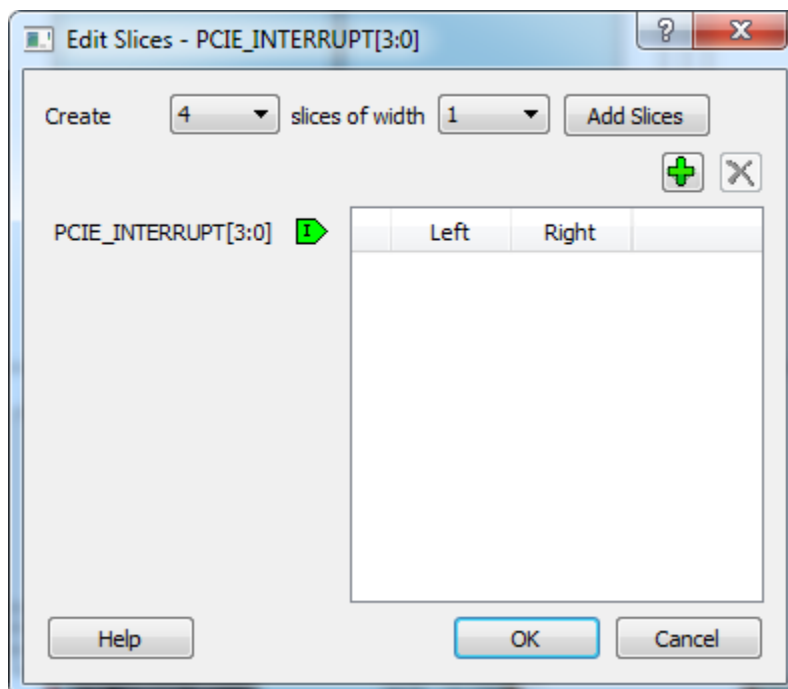
Table 4 • INIT_PINS

From PCle_Demo_sb_0	To SERDES_IF2_0
INIT_APB_S_PCLK	APB_S_PCLK
INIT_APB_S_PRESET_N	APB_S_PRESET_N

7. Right-click **INIT_DONE** and select **Mark Unused**.
8. Connect **MSS_READY** of **PCle_Demo_sb_0** and **RESET_N** of **DEBOUNCE_0**.
9. Right-click **FAB_RESET_N** of **PCle_Demo_sb_0** and select **Tie High**.
10. Right-click **GPIO_FABRIC** of **PCle_Demo_sb_0** and select **Promote to Top Level**.
11. Right-click **POWER_ON_RESET_N** of **PCle_Demo_sb_0** and select **Mark Unused**.
12. Right-click **SDIF_READY** of **PCle_Demo_sb_0** and select **Mark Unused**.
13. Connect **AMBA_MASTER_0** of **PCle_Demo_sb_0** and **AHB_MASTER** of **SERDES_IF2_0**.
14. Expand **FAB_CCC_PINS**, right-click **FAB_CCC_GL3** and select **Mark Unused**.
15. Connect **SDIF1_INIT_APB** of **PCle_Demo_sb_0** and **APB_SLAVE** of **SERDES_IF2_0**.
16. Right-click the **SWITCH** of **DEBOUNCE_0** and select **Promote to Top Level**.
17. Select the following ports of **SERDES_IF2_0** by pressing down the **CTRL** key, right-click, and select **Mark Unused**.
 - **PCIE_SYSTEM_INT**
 - **PLL_LOCK_INT**
 - **PLL_LOCKLOST_INT**
 - **PCIE_EV_1US**
 - **REFCLK0_OUT**
 - **PCIE_0_LTSSM[5:0]**
 - **PCIE_0_L2P2_ACTIVE**
 - **PCIE_0_RESET_PHASE**

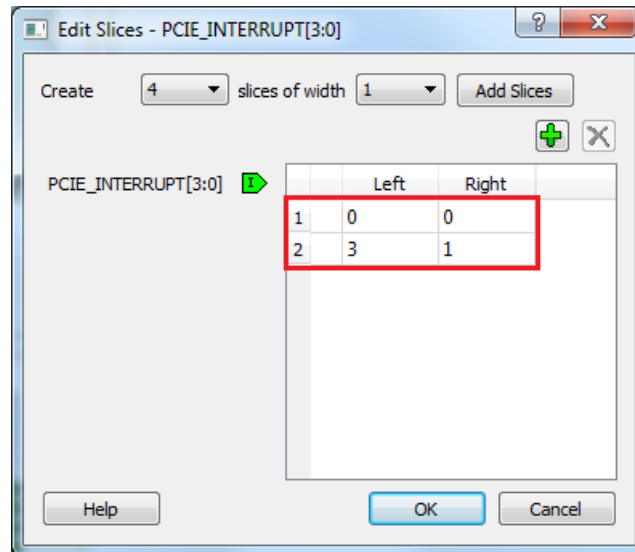
The PCIe supports four interrupts. This design uses only one interrupt out of four by connecting the unused interrupts to logic 0. To connect unused interrupt pins to logic 0 split the interrupt pins to two groups. Right-click the **PCIE_INTERRUPT[3:0]** of **SERDES_IF2_0** and select **Edit Slices** to split. The **Edit Slices** window is displayed, as shown in the following figure.

Figure 28 • Edit Slices



18. Click the + sign and create a slice with the Left index 0 and the Right index 0. Click + again to create a second slice with Left index 3 and Right index 1, as shown in the following figure.

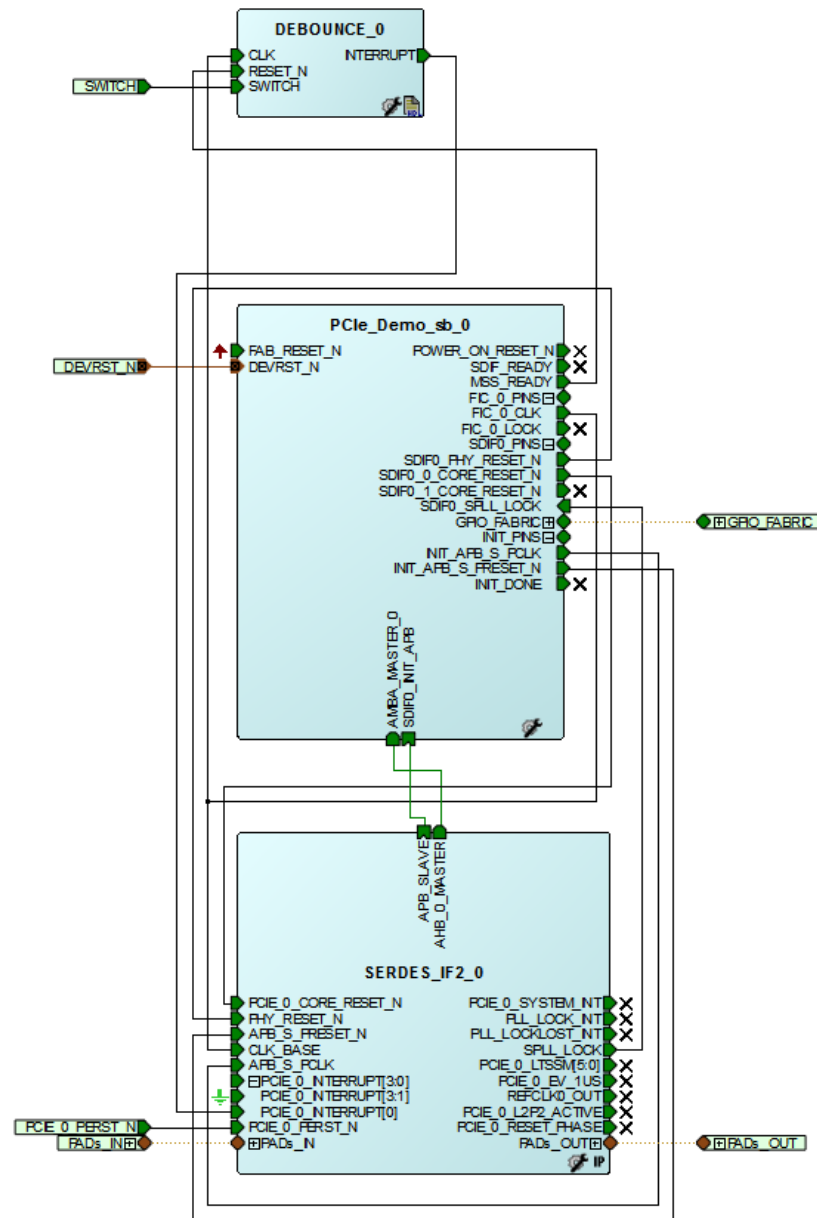
Figure 29 • Edit Slices



19. Expand **PCIE_INTERRUPT[3:0]**, right-click the **PCIE_INTERRUPT[3:1]**, and select **Tie low**.
20. Connect **INTERRUPT** of **DEBOUNCE_0** to the **PCIE_INTERRUPT[0]** of **SERDES_IF2_0**.

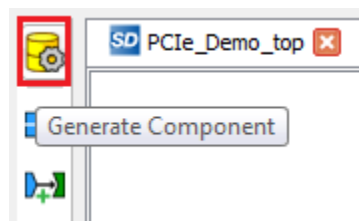
21. Click **Auto arrange instances** to arrange the instances and click **File > Save**. The PCIe_Demo is displayed, as shown in the following figure.

Figure 30 • PCIe_Demo Top Design



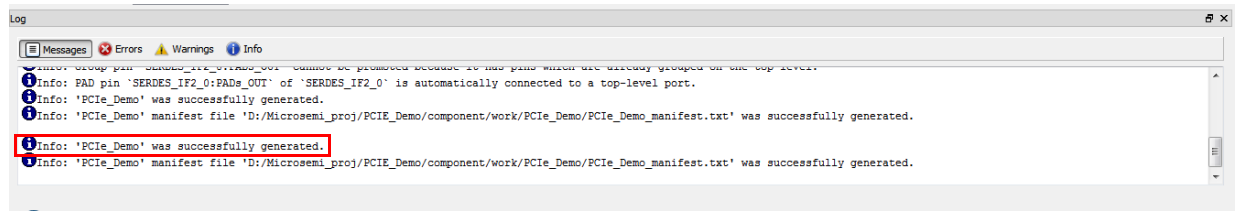
22. Click the **PCIe_Demo** tab and click **Generate Component**, as shown in the following figure.

Figure 31 • Generate Component



The message “PCIe_Demo” was successfully generated is displayed in the Libero SoC log window, if the design is generated without any error. On a successful component generation, the log window is displayed, as shown in the following figure.

Figure 32 • Log Window

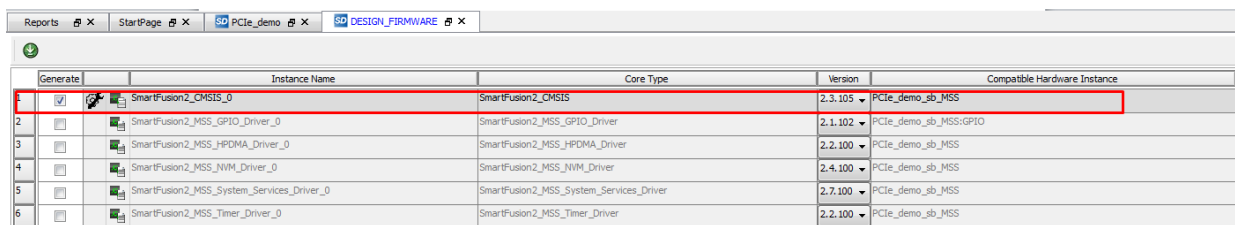


2.5.4 Configuring and Generating Firmware

The following steps describe how to configure and generate firmware.

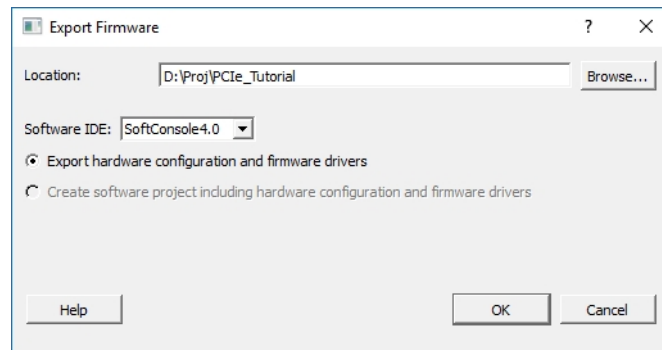
1. Double-click **Configure Firmware Cores** under **Handoff Design for Firmware Development** in Design Flow and clear all drivers except CMSIS, as shown in the following figure.

Figure 33 • Configuring Firmware



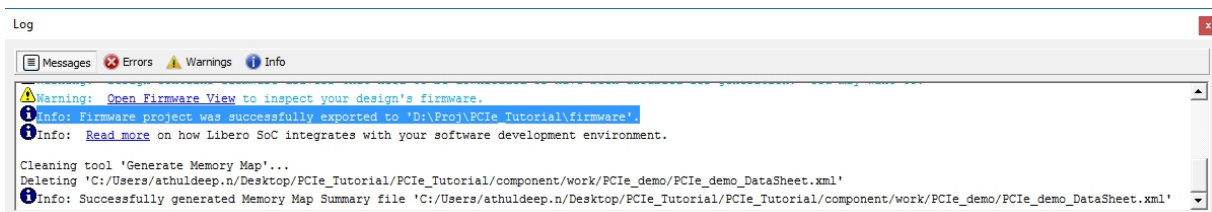
2. Click **Export Firmware**. The **Export Firmware** dialog box is displayed, as shown in the following figure.

Figure 34 • Export Firmware Dialog Box



3. Browse the **Location** to export the firmware.
4. Select the **Create firmware project for check box**.
5. Select **SoftConsole4.0** from the drop-down list.
6. Click **OK**. The successful firmware generation window is displayed.
7. Click **OK**. The log window is displayed, as shown in the following figure.

Figure 35 • Log Window



2.6 Step 2: Creating an eNVM Client

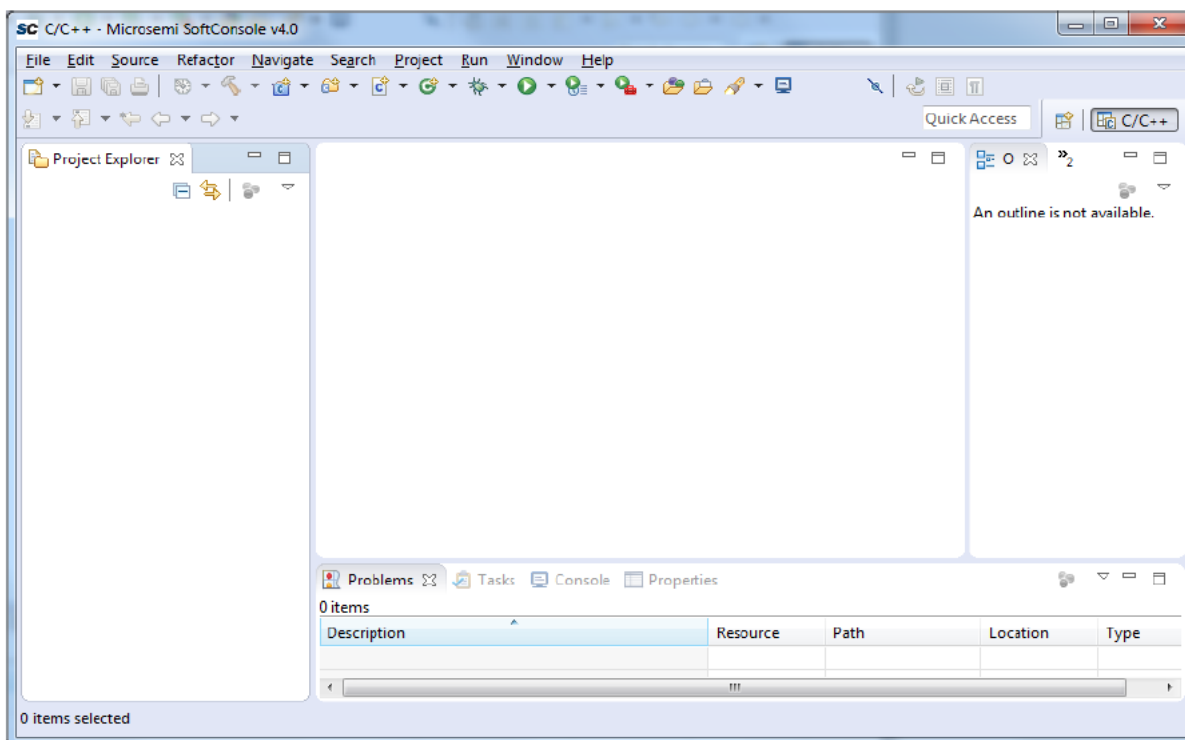
The HDL and logical design portion of the design is now complete. The following sections describe the creation of the Cortex-M3 firmware used to initialize the MSS and SERDESIF.

The eNVM client has to be uploaded with the firmware application to initialize the SERDESIF through **CoreConfigP**. The Cortex-M3 processor executes the code in the eNVM after the SmartFusion2 device has been reset. In this design the eNVM client is created with the firmware application code to initialize the SERDESIF.

The following steps describe how to create an eNVM Client:

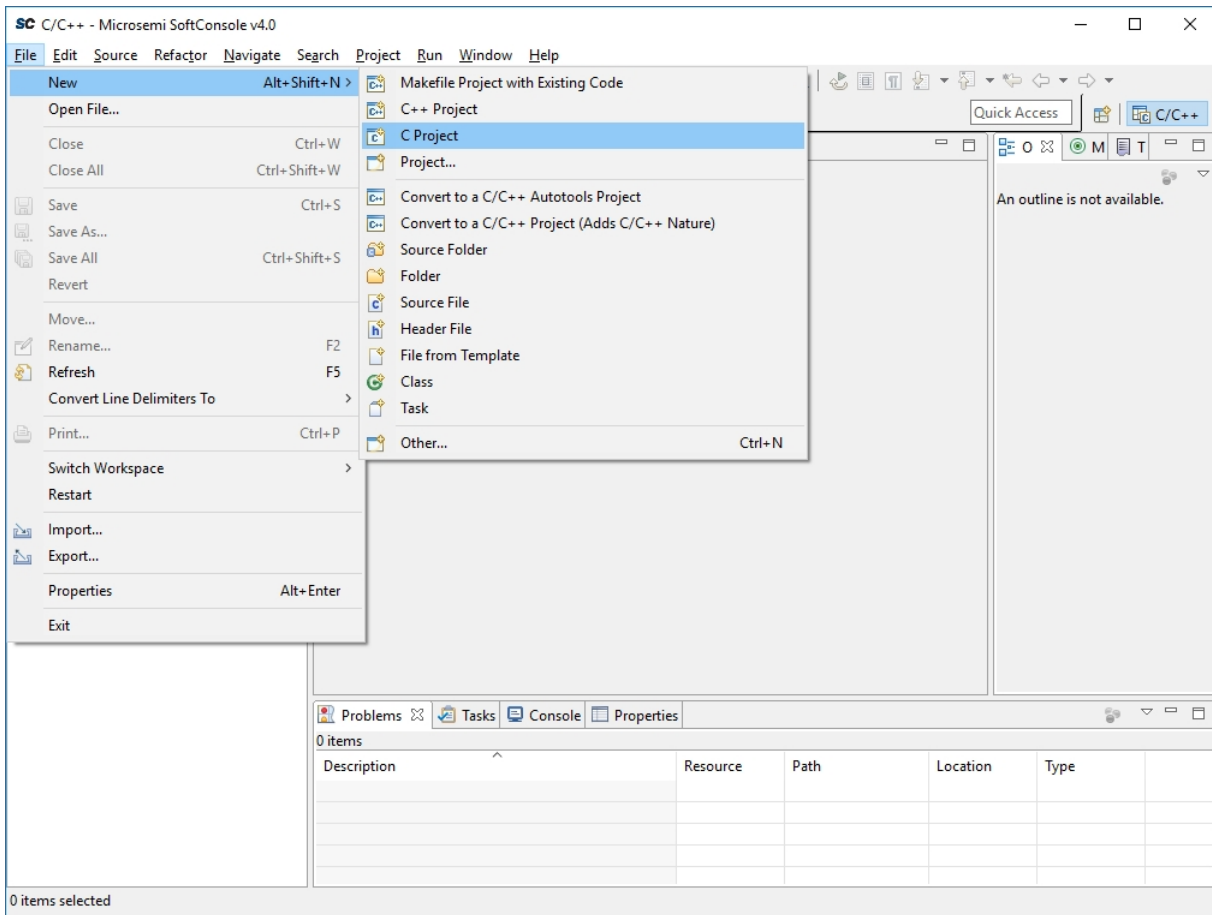
1. To build the firmware eNVM client, invoke the standalone SoftConsole4.0 IDE. The **SoftConsole4.0 IDE Project Workspace** window is displayed, as shown in the following figure.

Figure 36 • SoftConsole IDE Project Workspace



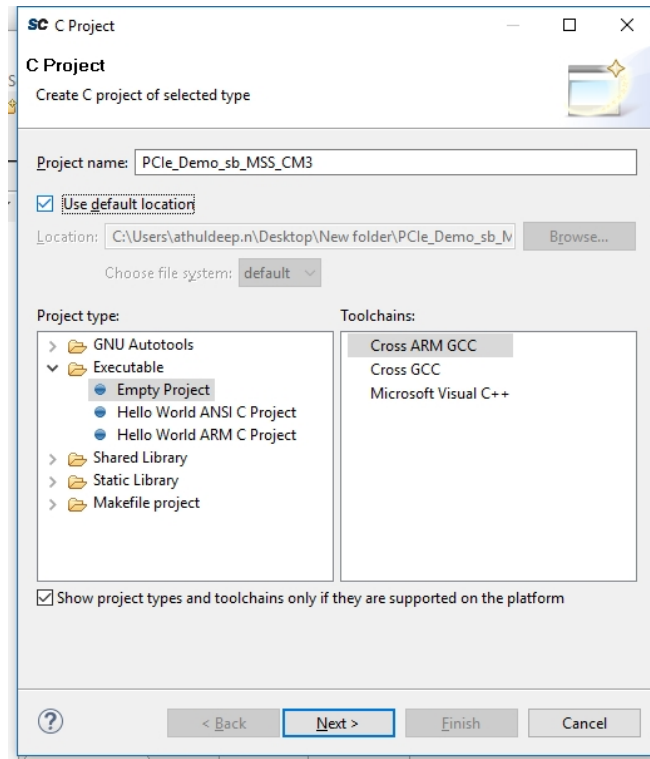
2. Click **File > New > C project** as shown in the following figure.

Figure 37 • Creating New C Project



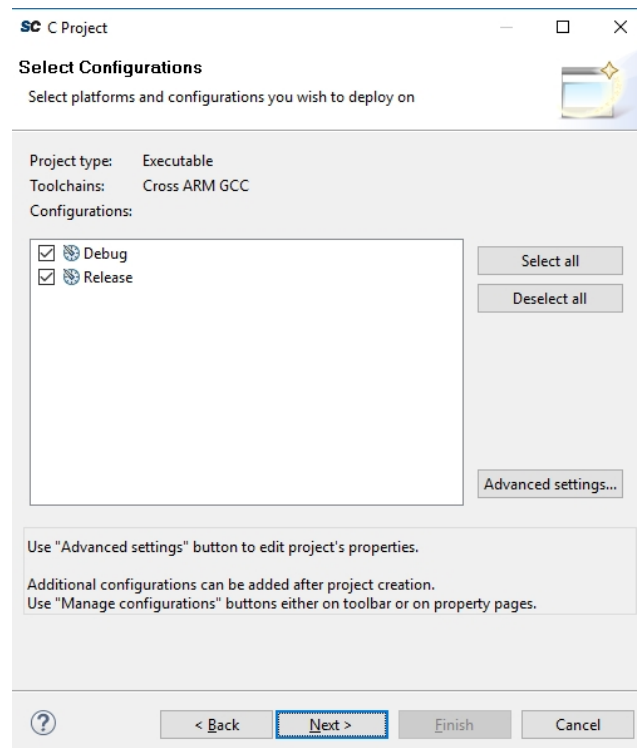
- Enter Project name as **PCle_Demo_sb_MSS_CM3**, and click **Next**, as shown in the following figure.

Figure 38 • C Project Window



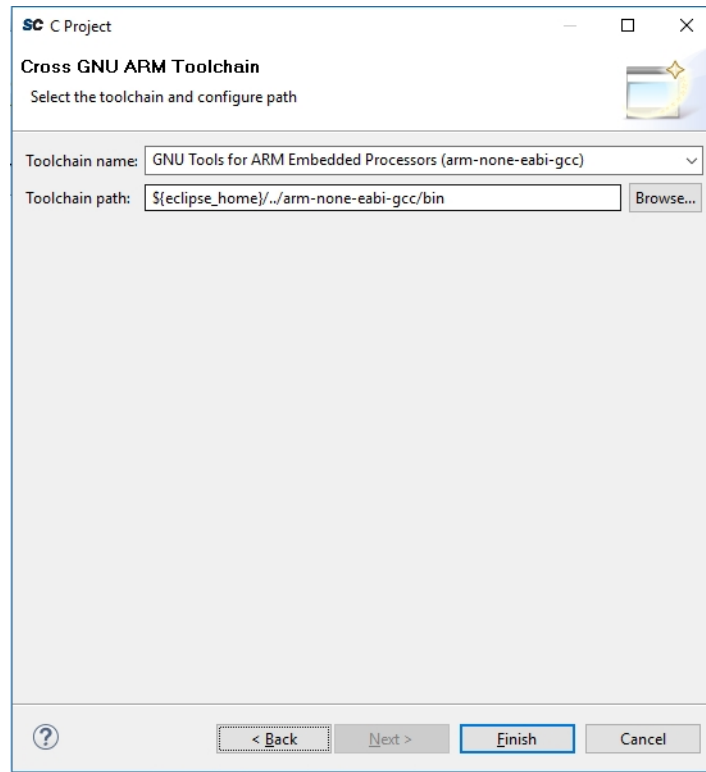
Select Configurations window is displayed, as shown in the following figure.

Figure 39 • C Project—Select Configuration



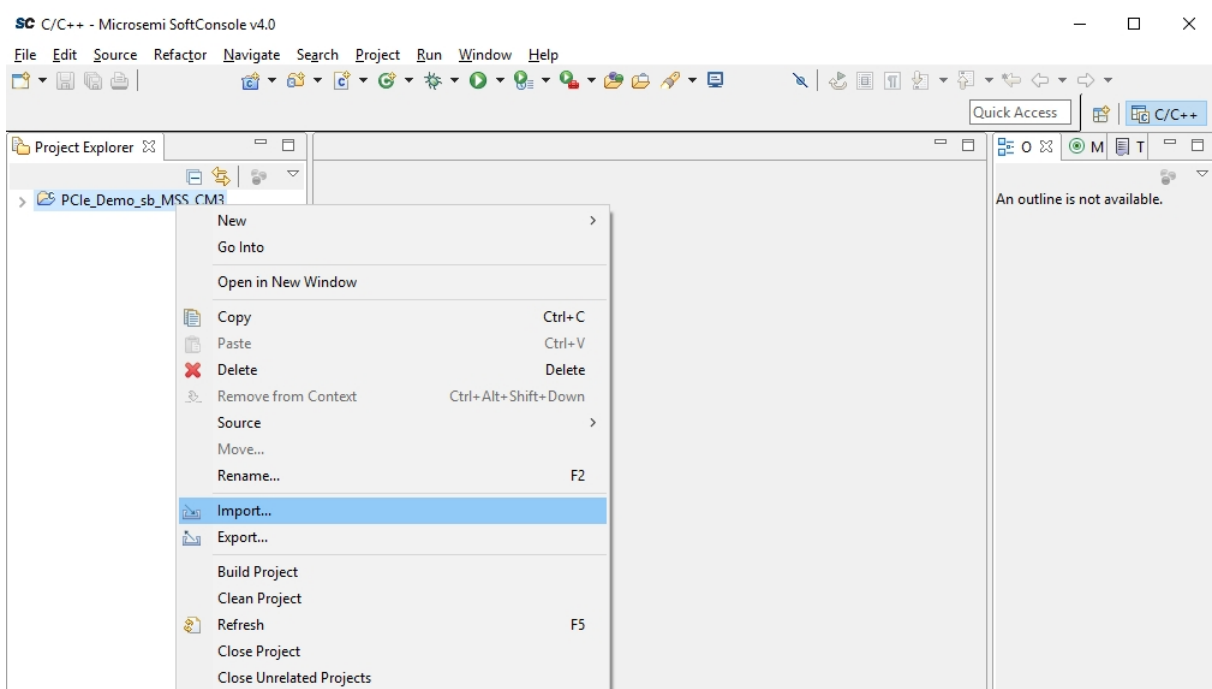
4. Do not change default settings. Click **Next**.
5. **Cross GNU ARM Tool chain** window is displayed, as shown in the following figure.

Figure 40 • C Project—Cross GNU ARM Tool Chain



6. Click **Finish**.
7. Right-click **PCle_Demo_sb_MSS_CM3** and click **Import** as shown in the following figure.

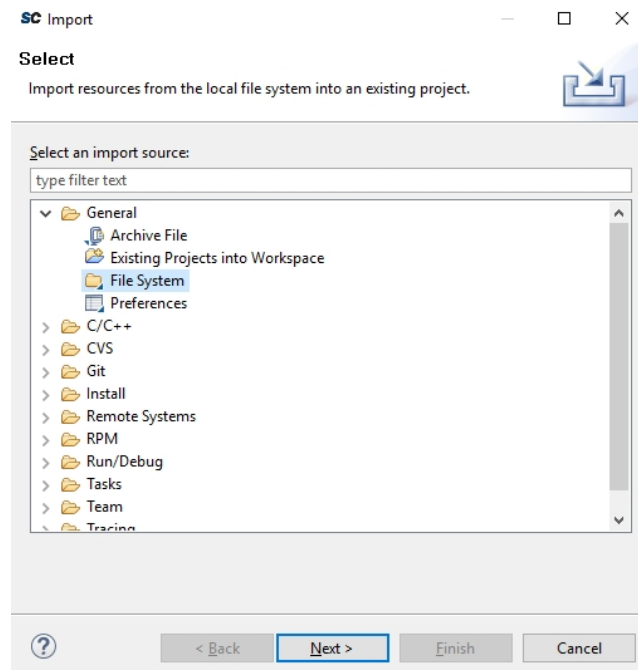
Figure 41 • Project Explorer—Import



Import window is displayed, as shown the following figure.

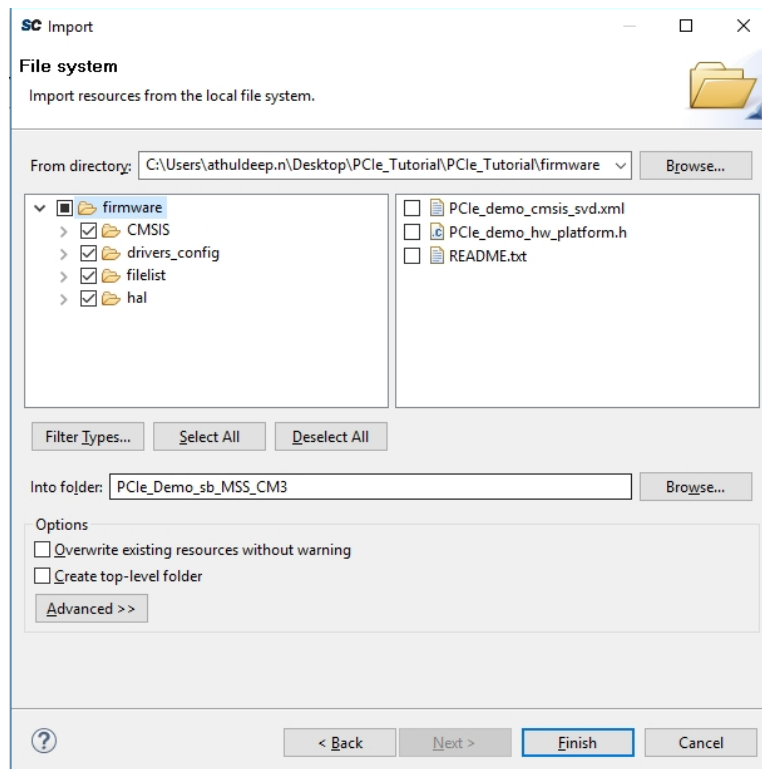
8. Click **File System** and then click **Next**.

Figure 42 • Import Window



9. Browse to the exported firmware location in your system and check **firmware** check box, as shown in the following figure.

Figure 43 • Import—File System

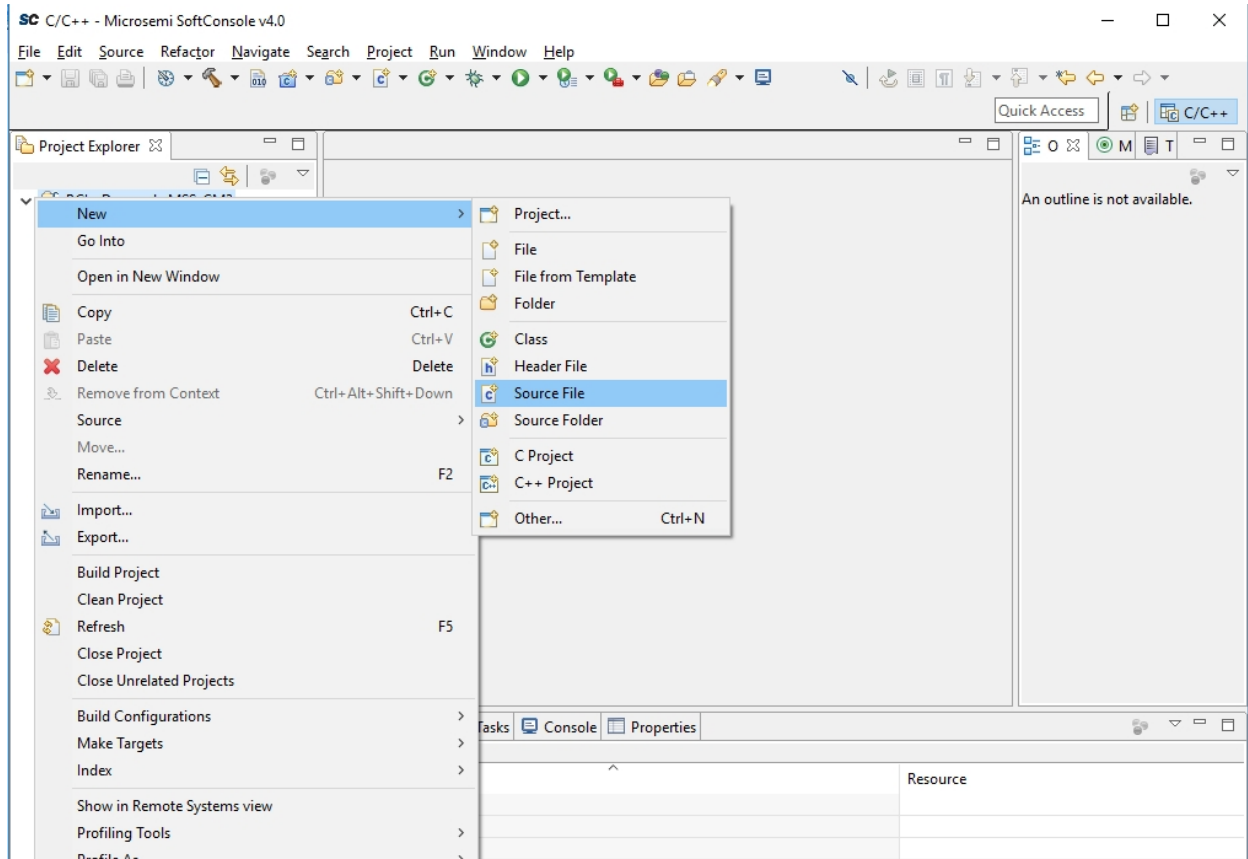


10. Click **Finish**.

Note: If any changes are made to the Libero SoC project, firmware needs to be exported from Libero and new firmware must be imported to **PCle_Demo_sb_MSS_CM3**.

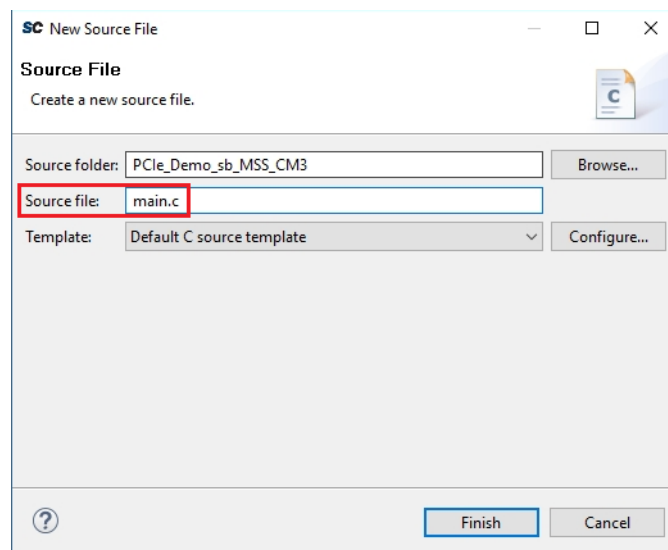
11. Right-click **PCle_Demo_sb_MSS_CM3**, and select **New > Source File**, as shown in the following figure.

Figure 44 • Project Explorer—Source File



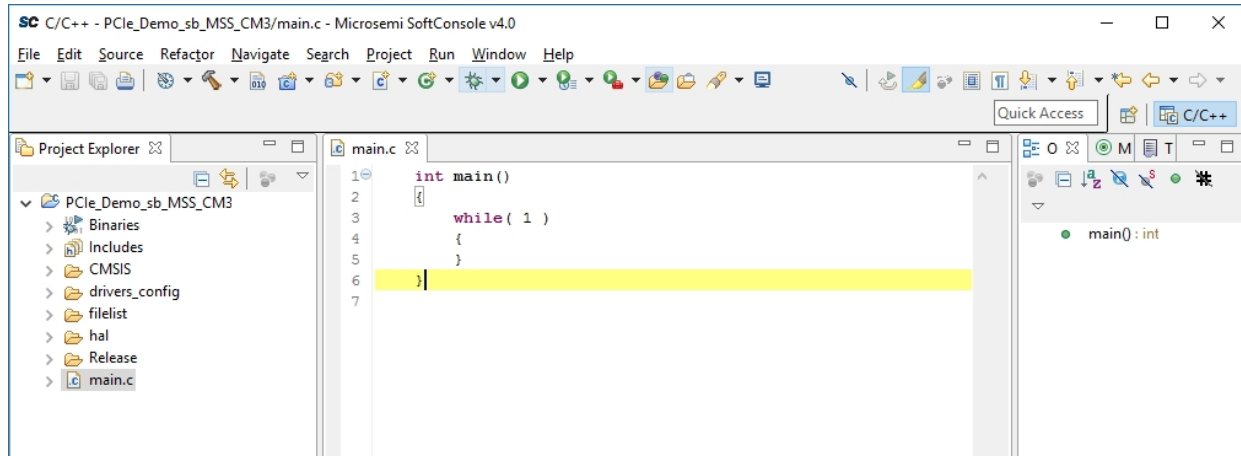
12. In the **New Source File** dialog, enter **main.c** in the **Source file** field and click **Finish** as shown in the following figure.

Figure 45 • Creating the main.c File



The main.c file is created inside the project, as shown in the following figure.

Figure 46 • The main.c File



13. Copy the following code in the main.c file of the SoftConsole project.

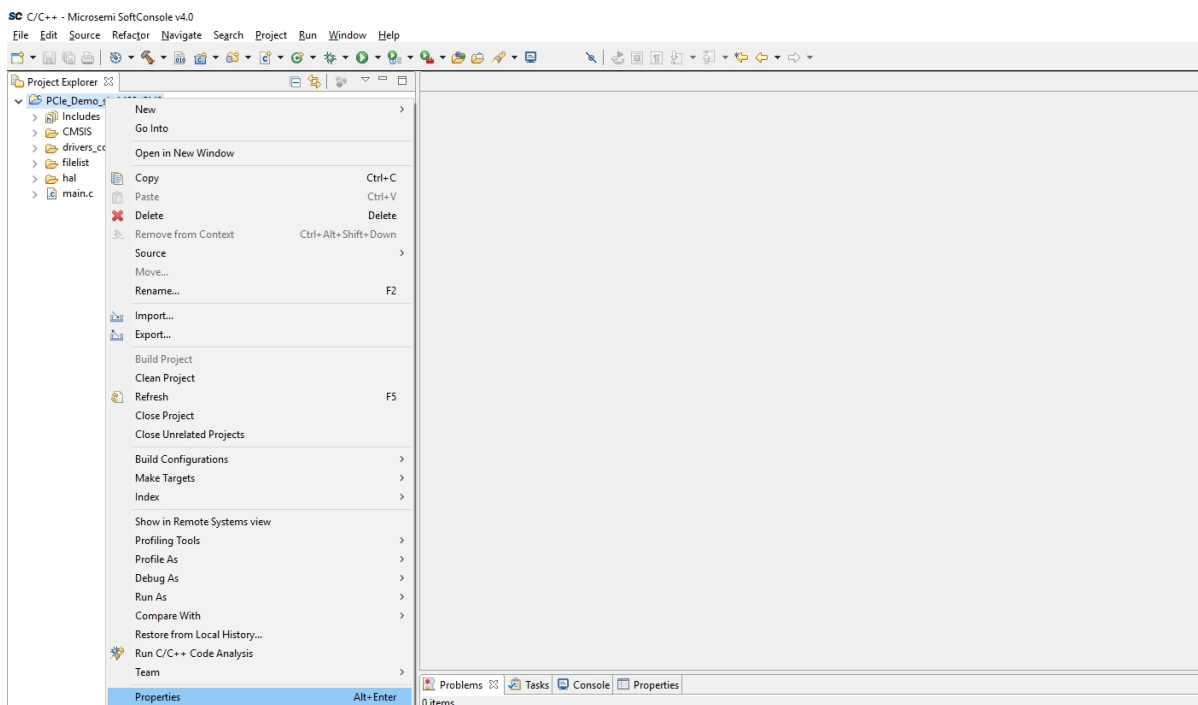
```
int main()
{
    while( 1 )
    {
    }
}
```

14. Save the main.c file.

This updates the main.c file.

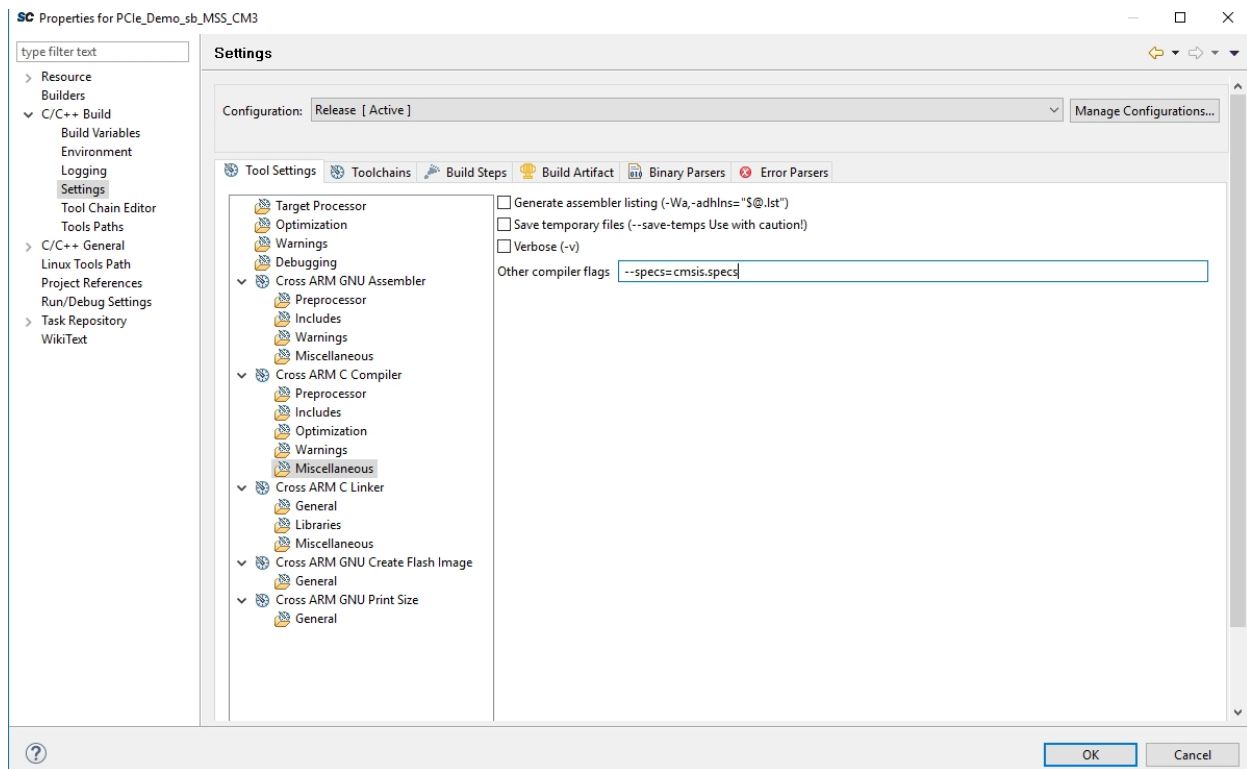
15. Right-click **PCle_Demo_sb_MSS_CM3** and click **Properties**, as shown in the following figure.

Figure 47 • Project Explorer window—Properties



16. Click **Settings** under the **C/C++ Build** tab, as shown in the following figure.
17. Under **Cross ARM C compiler**, click **Miscellaneous** and enter `--specs=cmsis.specs`, in **Other compiler flags** text box, as shown in the following figure.

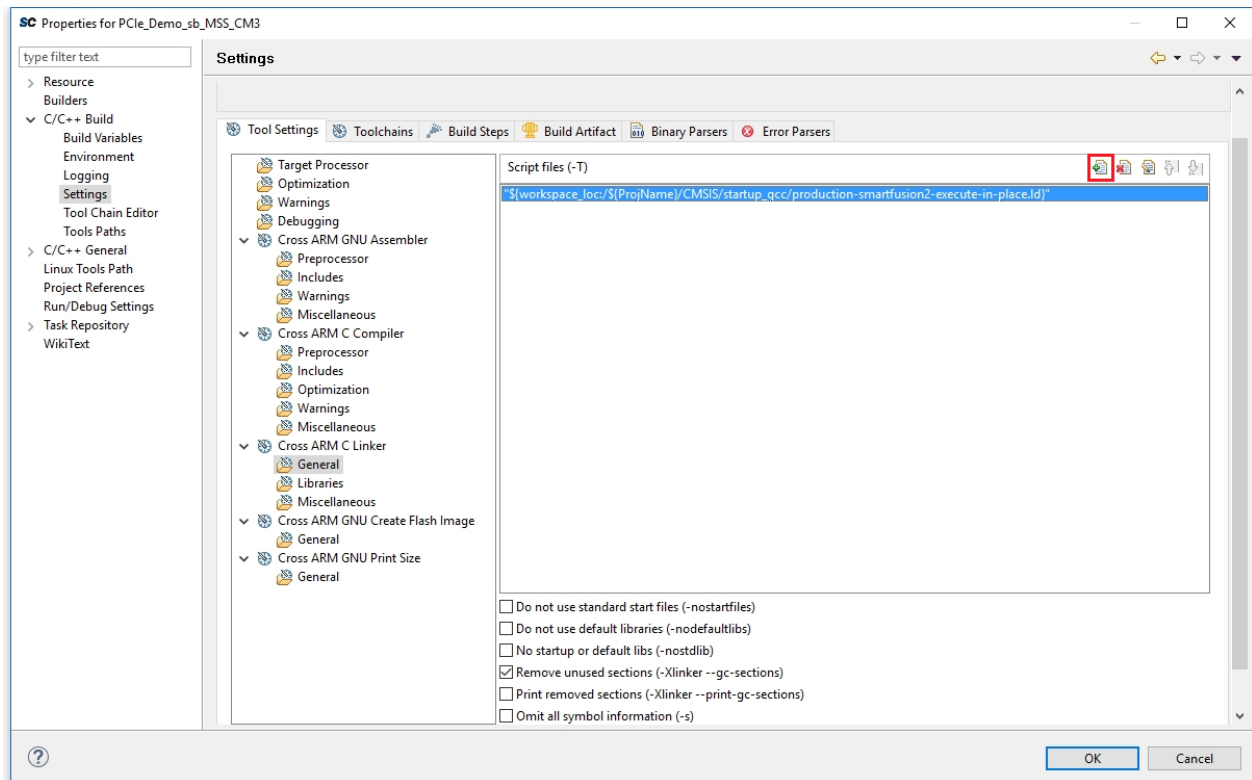
Figure 48 • Properties for PCIe_Demo_sb_MSS_CM3



18. Under **Cross ARM C Linker**, click **General** as shown in the following figure.
19. Click **add** (highlighted) and add following linker Script path:
"\${workspace_loc}/\${ProjName}/CMSIS/startup_gcc/production-smartfusion2-execute-in-place.ld"

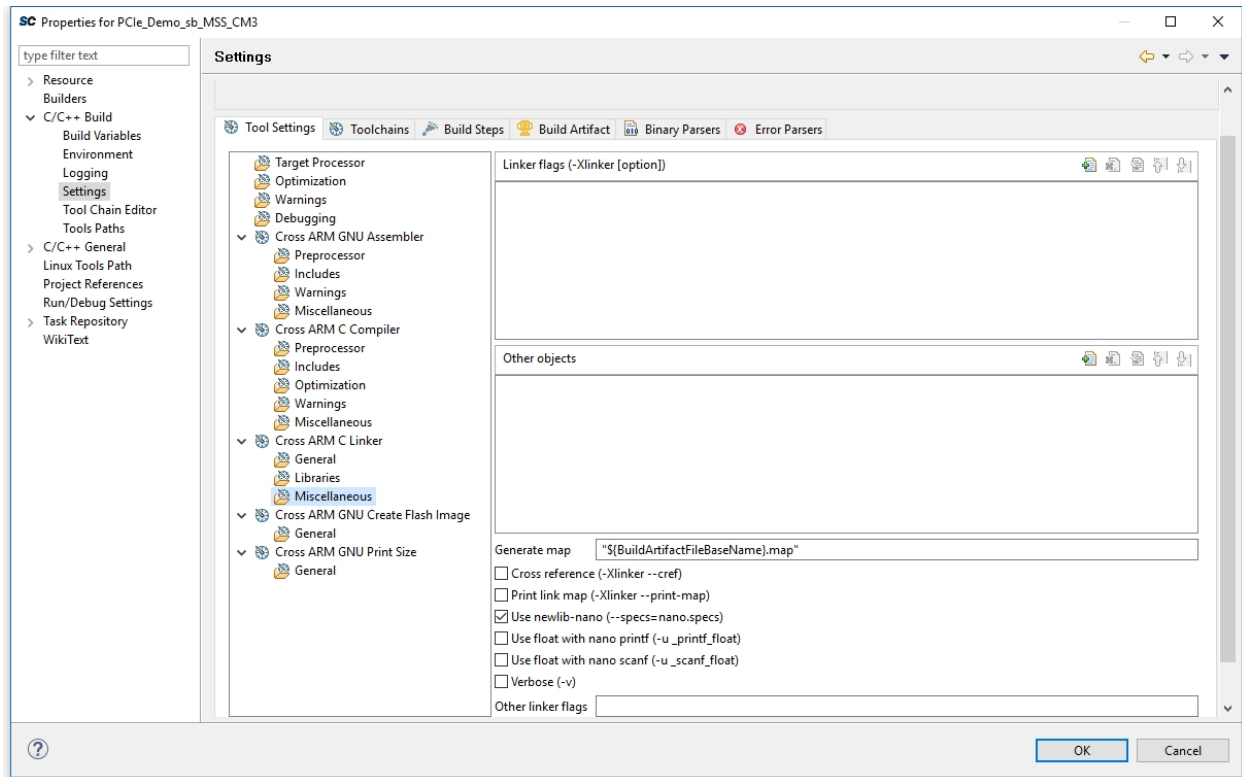
After adding Linker Script, **Properties for PCIe_Demo_sb_MSS_CM3** window is displayed, as shown in the following figure.

Figure 49 • Properties for PCIe_Demo_sb_MSS_CM3—General



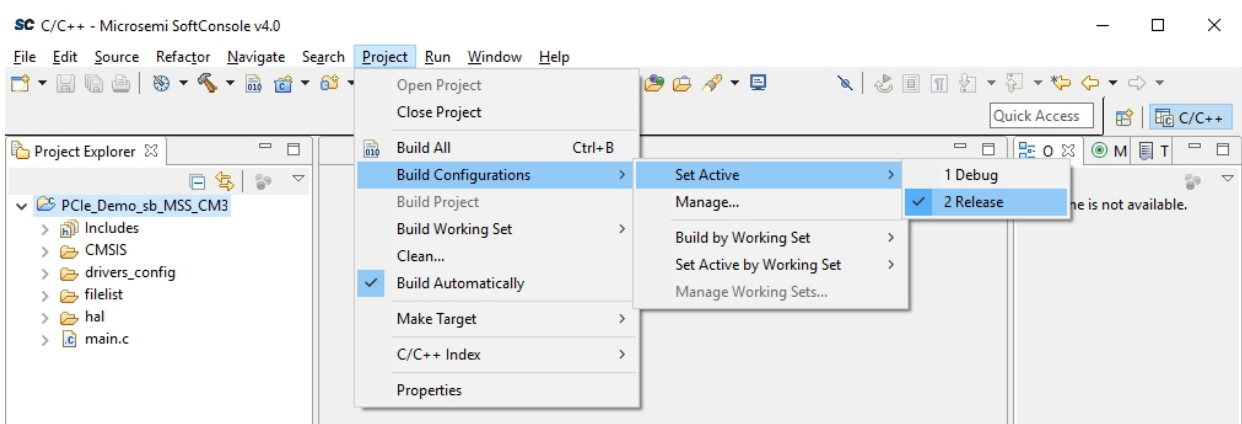
20. Under **Cross ARM C Linker**, click **Miscellaneous**.
21. Check **Use newlib-nano(--specs=nano.specs)** option, as shown in the following figure.

Figure 50 • Properties for PCIe_Demo_sb_MSS_CM3—Miscellaneous



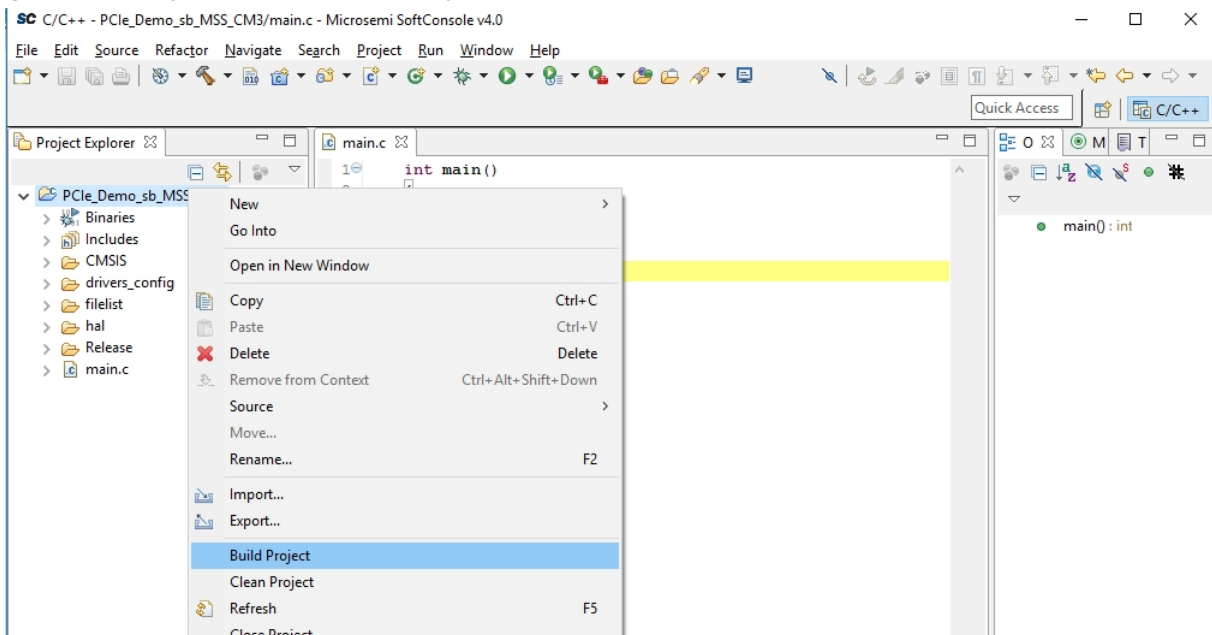
22. Click **Ok**.
23. Click the **Project** tab and select **Build Configurations > Set Active > 2 Release**, as shown in the following figure.

Figure 51 • Project Window—Release Mode



24. Click **Project** and click **Build All**, as shown in the following figure.

Figure 52 • Project Explorer—Build Project



The SoftConsole creates a .hex file in the **Release** folder under the **PCle_Demo_sb_MSS_CM3**.

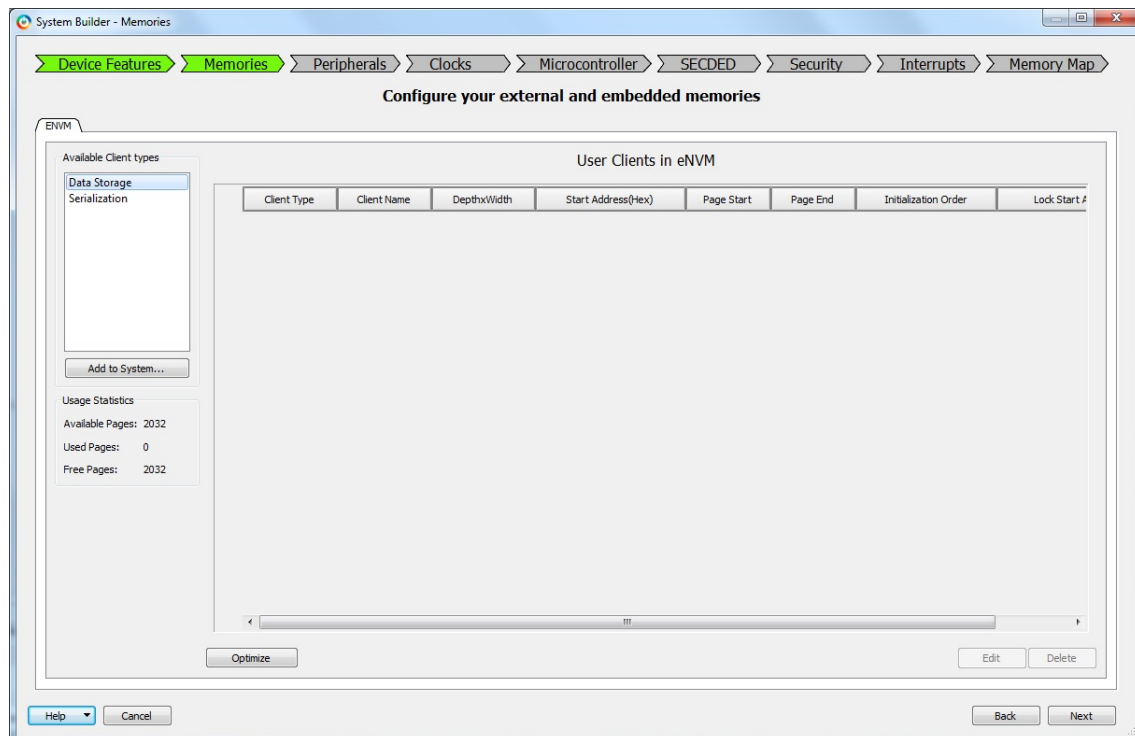
25. Close the **SoftConsole** project window.

26. Open the **Libero** project and **PCle_Demo** tab.

27. Double-click **PCle_Demo_sb_0** and go to **System Builder - Memories** tab to add the eNVM data storage client.

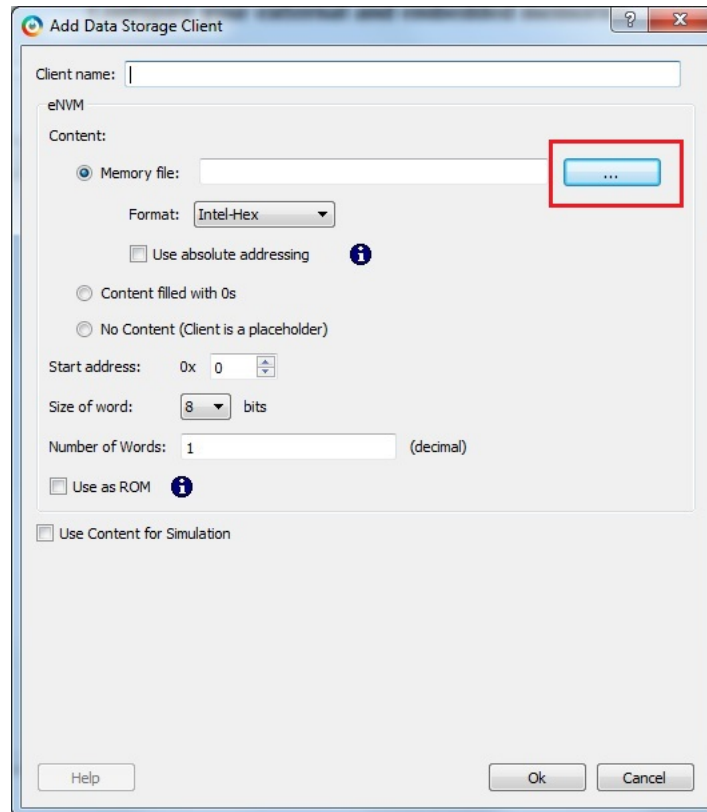
The eNVM configurator window is displayed, as shown in the following figure.

Figure 53 • System Builder—Memory eNVM



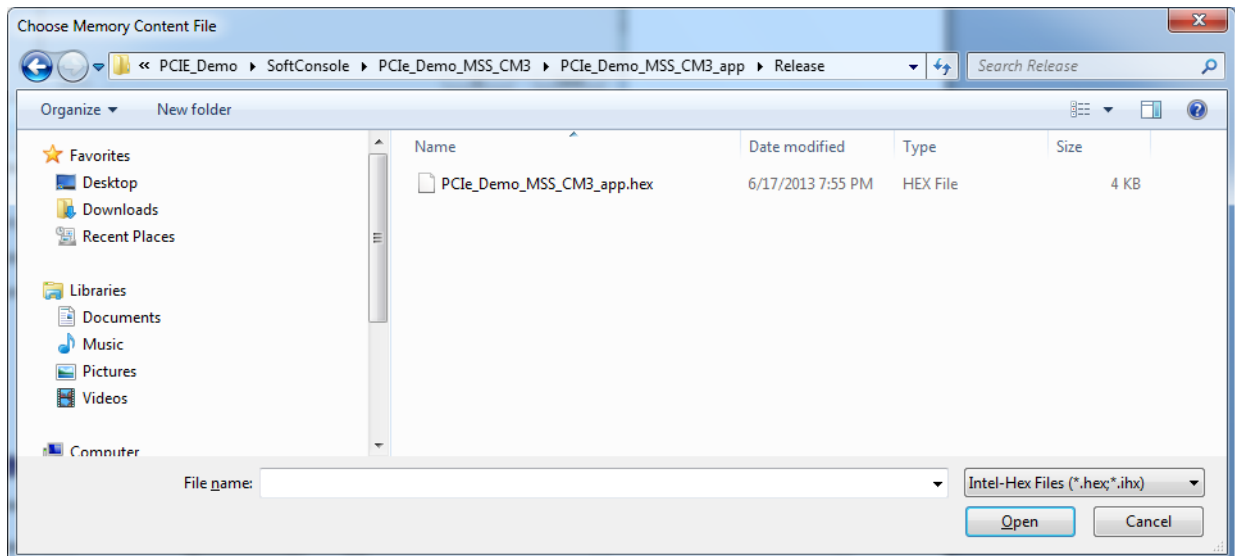
28. Select **Data Storage** under the **Available Client types** tab and click **Add to System**. The **Add Data Storage Client** window is displayed, as shown in the following figure.

Figure 54 • Add Data Storage Client



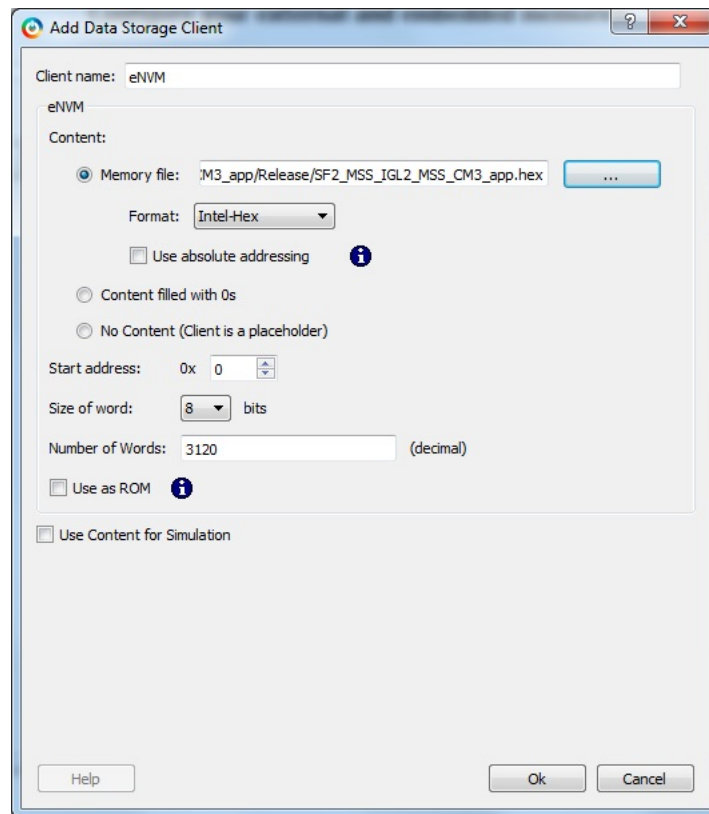
29. Enter **Client Name** as eNVM in the **Add Data Storage Client** window.
30. Browse for the .hex file generated, as shown in the following figure. The generated executable image can be found in the **Release** folder under the SoftConsole project workspace, as shown in the following figure.

Figure 55 • Browsing for .hex File



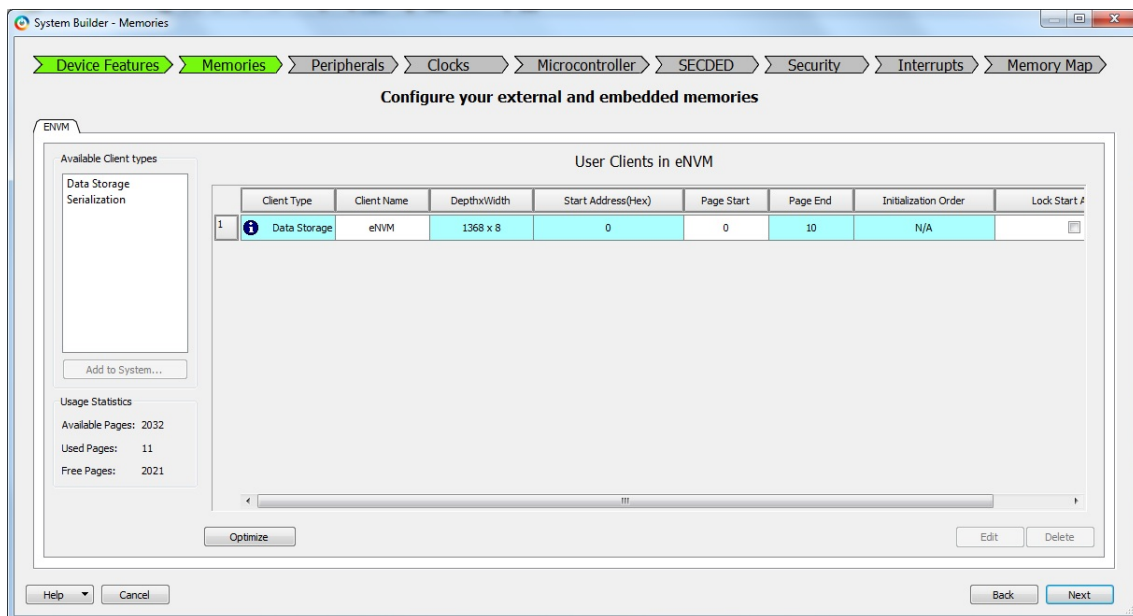
31. Click **OK** in the **Add Data Storage Client** window, as shown in the following figure.

Figure 56 • Add Data Storage Client



32. Click **Next** and keep the rest of the **System Builder** tabs as default.

Figure 57 • Modify Core—eNVM



33. Save **PCle_Demo** and regenerate the **PCle_Demo** component by clicking **Generate Component** in SmartDesign.

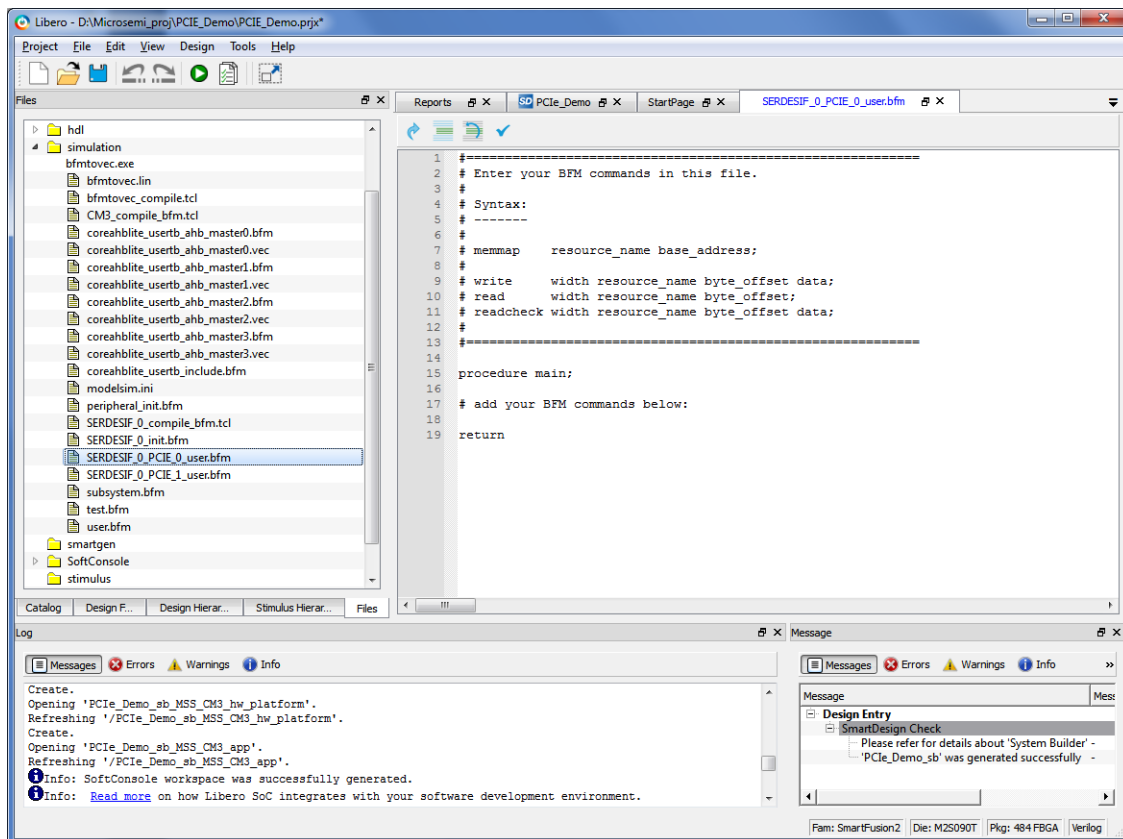
2.7 Step 3: Developing the Simulation Stimulus

During the design process, SERDESIF is configured for the BFM simulation model. The BFM simulation model replaces the entire PCIe interface with a simple BFM that can send write transactions and read transactions over the AHB-Lite interface. These transactions are driven by a file and allow easy simulation of the FPGA design connected to a PCIe interface. This simulation methodology has the benefit of focusing on the FPGA design since the SmartFusion2 PCIe interface is a fully hardened and verified interface.

This section describes how to modify the BFM script (`user.bfm`) file that is generated by SmartDesign. The BFM script file simulates PCIe writing or reading to or from the MSS through the FIC_0.

1. Open the `SERDESIF_0_PCIE_0_user.bfm` file. To open the `SERDESIF_0_PCIE_0_user.bfm`, go to the **Files** tab > **Simulation** folder, and double-click the `SERDESIF_0_PCIE_0_user.bfm`. The `SERDESIF_0_PCIE_0_user.bfm` file is displayed, as shown in the following figure.

Figure 58 • SmartDesign Generated `SERDESIF_0_PCIE_0_user.bfm` File



2. **Modify the `SERDESIF_0_PCIE_0_user.bfm` to add the following bfm commands of writing and reading:**

```
memmap GPIO 0x40013000;
memmap eSRAM 0x20000000;
procedure main;

# add your BFM commands below:
wait 500us;
wait 500us;
write w GPIO 0x00 0x5;
write w GPIO 0x04 0x5;
write w GPIO 0x08 0x5;
write w GPIO 0x0C 0x5;
write w GPIO 0x10 0x5;
write w GPIO 0x14 0x5;
write w GPIO 0x18 0x5;
write w GPIO 0x1C 0x5;

write w GPIO 0x88 0x00;
write w GPIO 0x88 0x01;
write w GPIO 0x88 0x02;
write w GPIO 0x88 0x04;
write w GPIO 0x88 0x08;
write w GPIO 0x88 0x10;
write w GPIO 0x88 0x20;
write w GPIO 0x88 0x40;
write w GPIO 0x88 0x80;

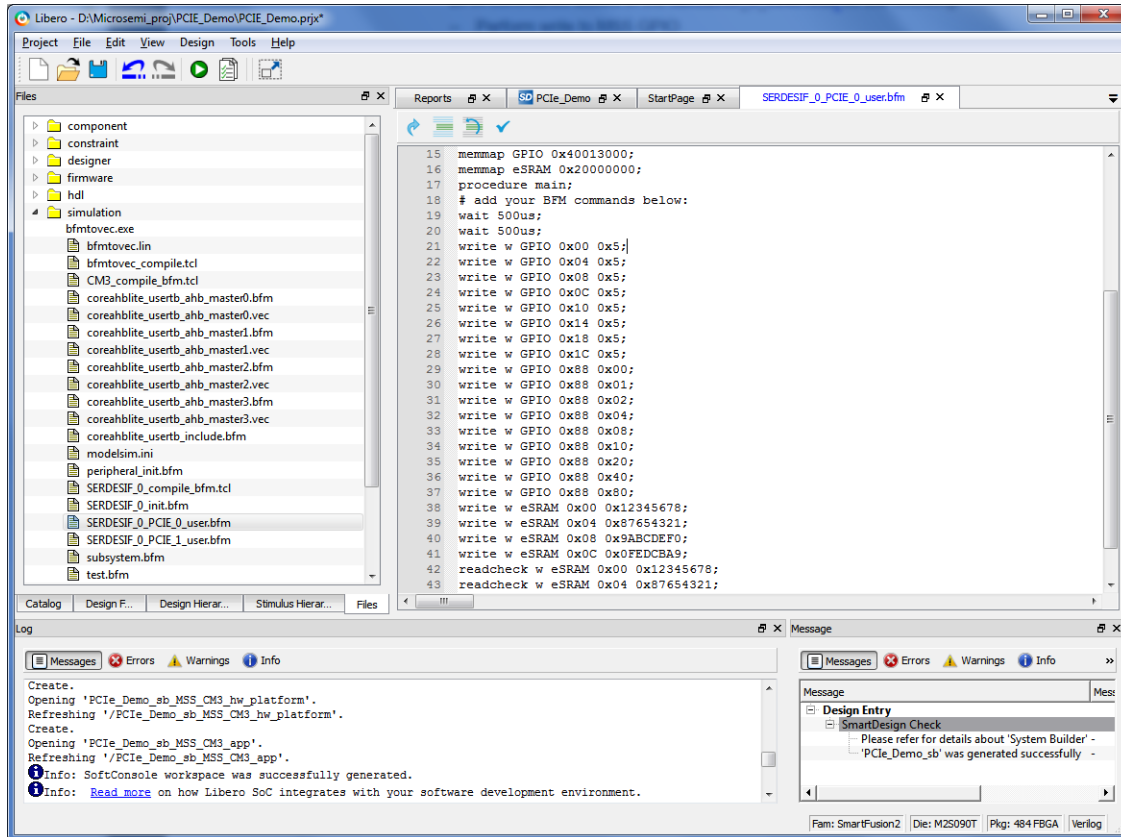
write w eSRAM 0x00 0x12345678;
write w eSRAM 0x04 0x87654321;
write w eSRAM 0x08 0x9ABCDEF0;
write w eSRAM 0x0C 0x0FEDCBA9;

readcheck w eSRAM 0x00 0x12345678;
readcheck w eSRAM 0x04 0x87654321;
readcheck w eSRAM 0x08 0x9ABCDEF0;
readcheck w eSRAM 0x0C 0x0FEDCBA9;

return
```

3. The modified BFM file appears similar to the file, as shown in the following figure.
 - a. Write to MSS GPIO
 - b. Write to eSRAM
 - c. Read-check from eSRAM

Figure 59 • Modified SERDES User BFM



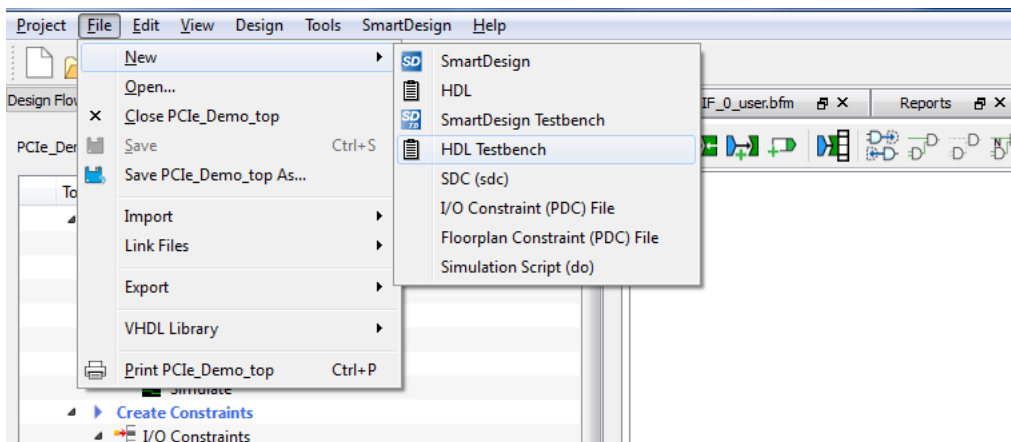
2.8 Step 4: Simulating the Design

The design supports the BFM_PClE simulation level to communicate with the high-speed serial interface block through the master AXI bus interface. Although, no serial communication actually goes through the High Speed Serial Interface block, this scenario allows validating the fabric interface connections. The SERDESIF_0_PCIE_0_user.bfm file under the <Libero project>/simulation folder contains the BFM commands to verify the read or write access to MSS GPIOs and eSRAM.

The following steps describe how to use the SmartDesign testbench and BFM script file to simulate the design.

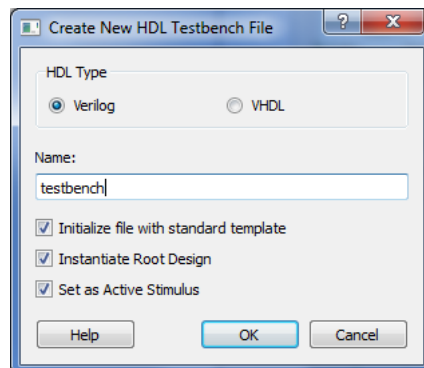
1. To generate the HDL testbench file follow the below instructions,
 - a. From the **File** menu, choose **New > HDL Testbench**, as shown in the following figure.

Figure 60 • HDL Testbench



Create New HDL Testbench File dialog box is displayed, as shown in the following figure.

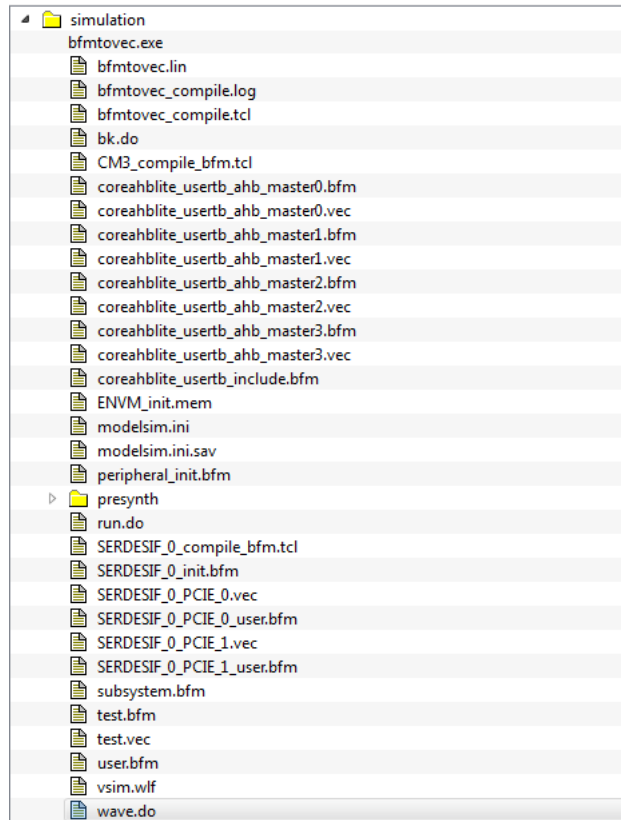
Figure 61 • Create New HDL Testbench File



- b. Select **Verilog** or **VHDL** under **HDL Type**.
 - c. Enter **testbench** as a name of the new HDL testbench file and click **OK**.
2. Add the wave do file to the PCIe design simulation folder by clicking **File > Import > Others**.

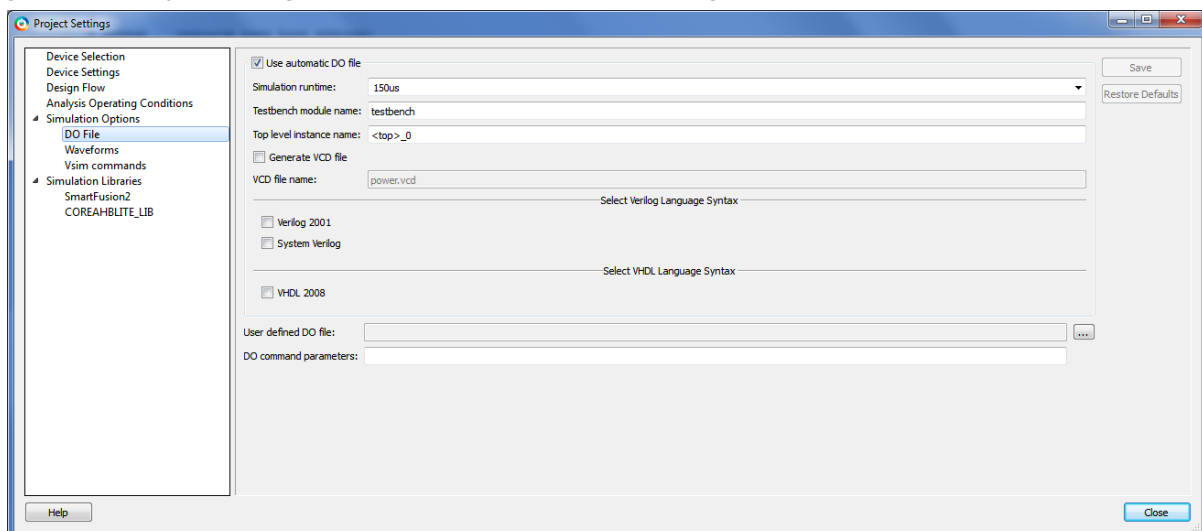
- Browse to the `wave.do` file location in the design files folder: `M2S90_PCIE_Control_Demo_DF/Source Files`. The following figure shows the `wave.do` file under simulation folder in the **Files** window.

Figure 62 • Wave.do File under Simulation Folder



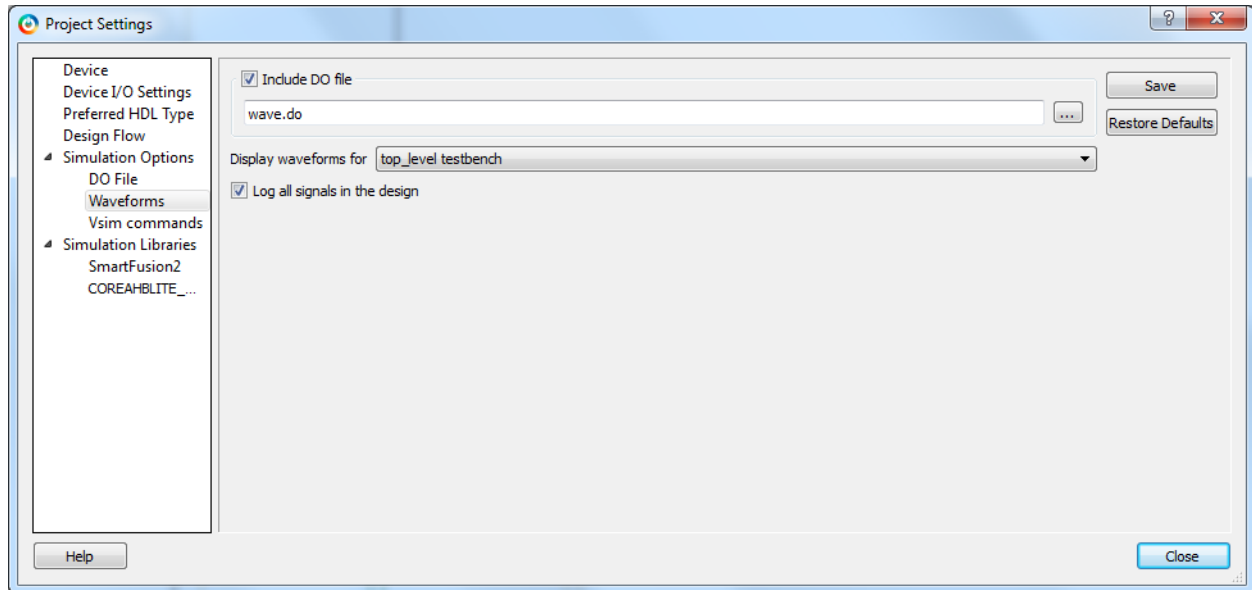
- Open the Libero SoC project settings (**Project > Project Settings**).
- Select **Do File** under **Simulation Options** in the Project Settings window. Change the **Simulation runtime** to **150 us**, as shown in the following figure.
- Click **Save**.

Figure 63 • Project Setting—Do File Simulation Runtime Setting



7. Select **Waveforms** under **Simulation Options**, as shown in the following figure:
 - Select **Include Do file**.
 - Select **Log all signals in the design**.
 - Click **Close** to close the Project settings dialog box.
 - Select **Save** when prompted to save the changes.

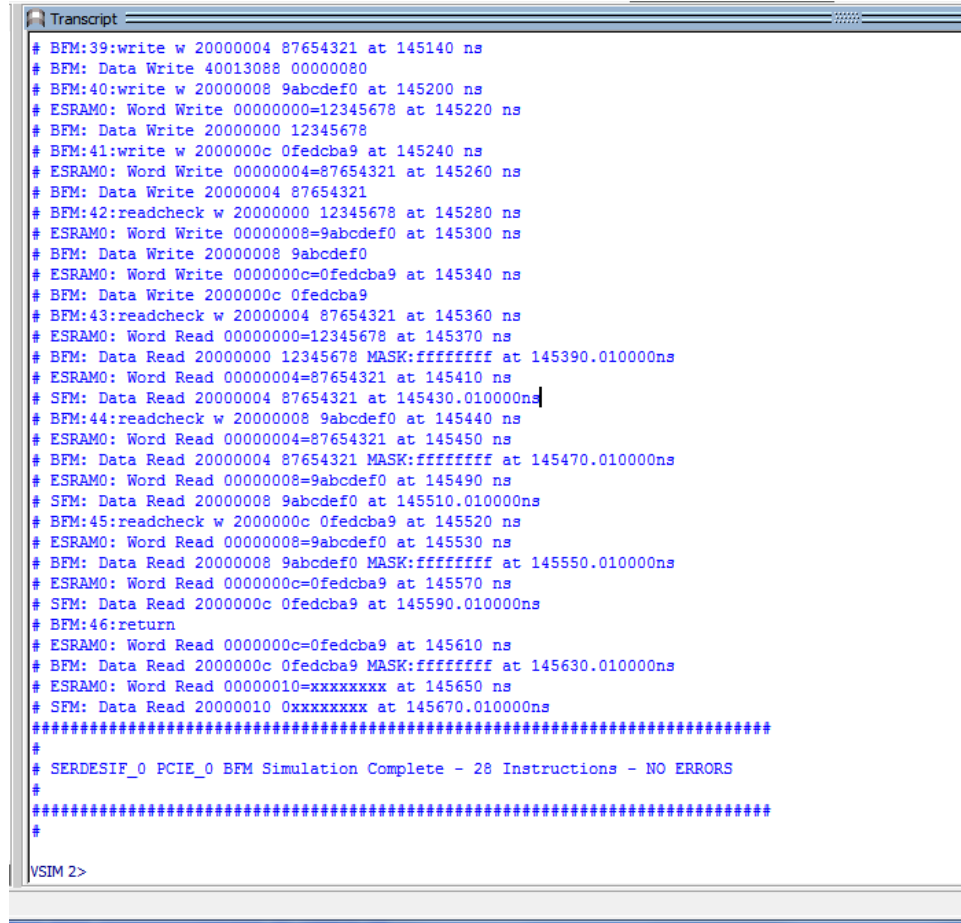
Figure 64 • Project Setting—Waveform



8. To run the simulation, double-click **Simulate** under **Verify Pre-Synthesized Design** in the **Design Flow** window.

ModelSim runs the design for approximately 150 us. The ModelSim transcript window displays the BFM commands and the BFM simulation completed with no errors, as shown in the following figure.

Figure 65 • SERDES BFM Simulation



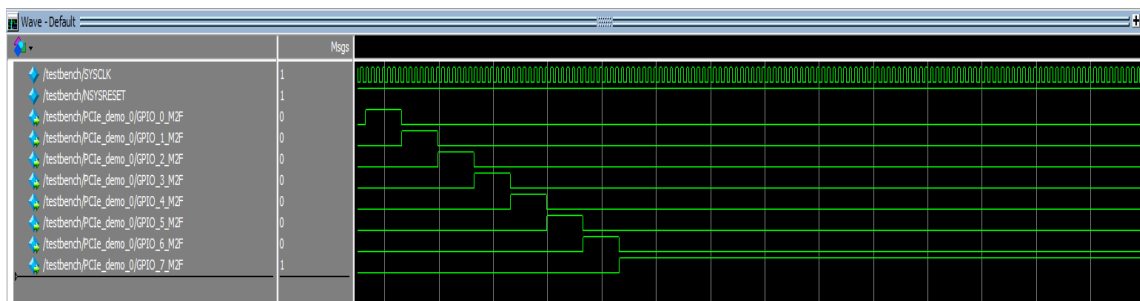
```

Transcript
# BFM:39:write w 20000004 87654321 at 145140 ns
# BFM: Data Write 40013088 00000080
# BFM:40:write w 20000008 9abcdef0 at 145200 ns
# ESRAM0: Word Write 00000000=12345678 at 145220 ns
# BFM: Data Write 20000000 12345678
# BFM:41:write w 2000000c 0fedcba9 at 145240 ns
# ESRAM0: Word Write 00000004=87654321 at 145260 ns
# BFM: Data Write 20000004 87654321
# BFM:42:readcheck w 20000000 12345678 at 145280 ns
# ESRAM0: Word Write 00000008=9abcdef0 at 145300 ns
# BFM: Data Write 20000008 9abcdef0
# ESRAM0: Word Write 0000000c=0fedcba9 at 145340 ns
# BFM: Data Write 2000000c 0fedcba9
# BFM:43:readcheck w 20000004 87654321 at 145360 ns
# ESRAM0: Word Read 00000000=12345678 at 145370 ns
# BFM: Data Read 20000000 12345678 MASK:ffffffff at 145390.010000ns
# ESRAM0: Word Read 00000004=87654321 at 145410 ns
# SFM: Data Read 20000004 87654321 at 145430.010000ns
# BFM:44:readcheck w 20000008 9abcdef0 at 145440 ns
# ESRAM0: Word Read 00000004=87654321 at 145450 ns
# BFM: Data Read 20000004 87654321 MASK:ffffffff at 145470.010000ns
# ESRAM0: Word Read 00000008=9abcdef0 at 145490 ns
# SFM: Data Read 20000008 9abcdef0 at 145510.010000ns
# BFM:45:readcheck w 2000000c 0fedcba9 at 145520 ns
# ESRAM0: Word Read 00000008=9abcdef0 at 145530 ns
# BFM: Data Read 20000008 9abcdef0 MASK:ffffffff at 145550.010000ns
# ESRAM0: Word Read 0000000c=0fedcba9 at 145570 ns
# SFM: Data Read 2000000c 0fedcba9 at 145590.010000ns
# BFM:46:return
# ESRAM0: Word Read 0000000c=0fedcba9 at 145610 ns
# BFM: Data Read 2000000c 0fedcba9 MASK:ffffffff at 145630.010000ns
# ESRAM0: Word Read 00000010=xxxxxxxx at 145650 ns
# SFM: Data Read 20000010 0xxxxxxxxx at 145670.010000ns
#####
#
# SERDESIF_0 PCIe_0 BFM Simulation Complete - 28 Instructions - NO ERRORS
#
#####
#
VSIM 2>

```

The following figure shows the waveform window with MSS GPIO output signals.

Figure 66 • Simulation Result with MSS GPIO Signals



2.9 Step 5: Generating the Program File

The following steps describe how to generate the program file.

1. Double-click **Manage Constraints** and click **Derive Constraints** option under **Timing** tab to generate SDC file for root module. Click **Yes** to associate SDC file to synthesis, place-and-route and timing verification stages, as shown in the following figures.

Figure 67 • Manage Constraints

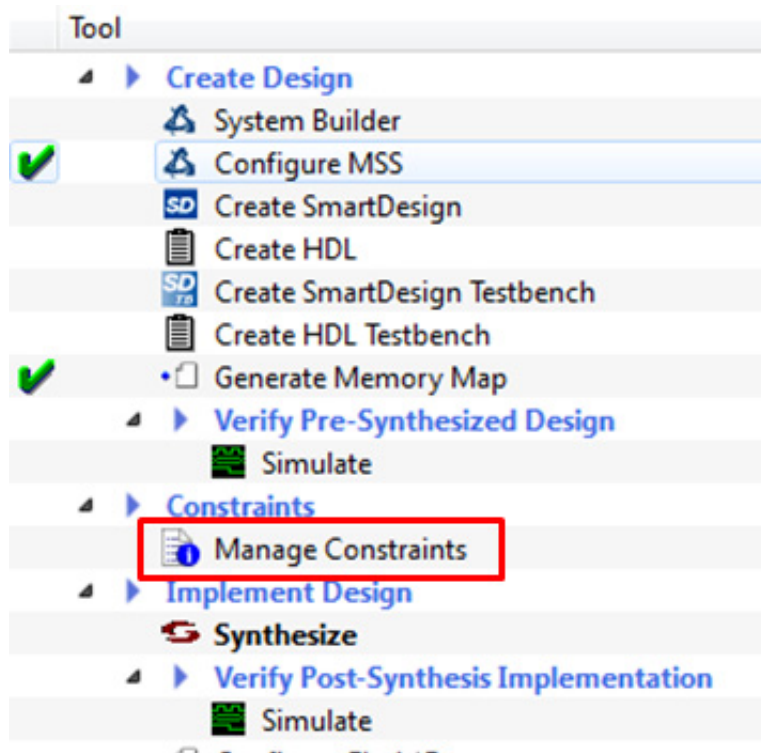


Figure 68 • Derive Constraints

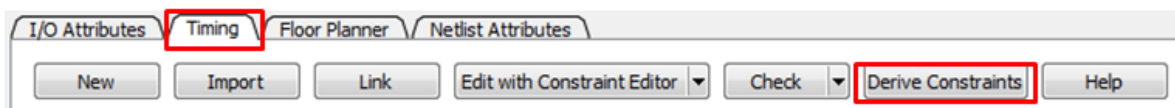
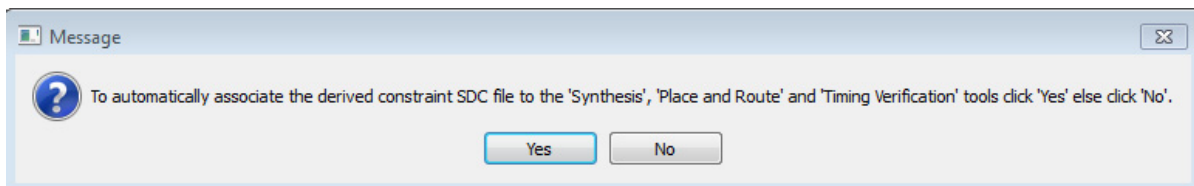


Figure 69 • Associate SDC File

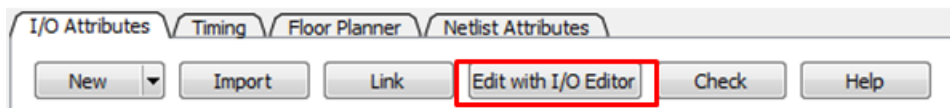


2. Click **Edit with I/O Editor** in constraint manager after completing synthesis, as shown in [Figure 70](#), page 47. The **I/O Editor** is displayed, make the pin assignments, as shown in the following table. After the pins are assigned, the **I/O Editor** is displayed, as shown in [Figure 71](#), page 48.

Table 5 • Port to Pin Mapping

Port Name	Pin Number
GPIO_0_M2F	E1
GPIO_1_M2F	F4
GPIO_2_M2F	F3
GPIO_3_M2F	G7
GPIO_4_M2F	H7
GPIO_5_M2F	J6
GPIO_6_M2F	H6
GPIO_7_M2F	H5
GPIO_8_M2F	L19
GPIO_9_M2F	L18
GPIO_10_M2F	K21
GPIO_11_M2F	K20
SWITCH	J18
PCIE0_PERST_N	P18

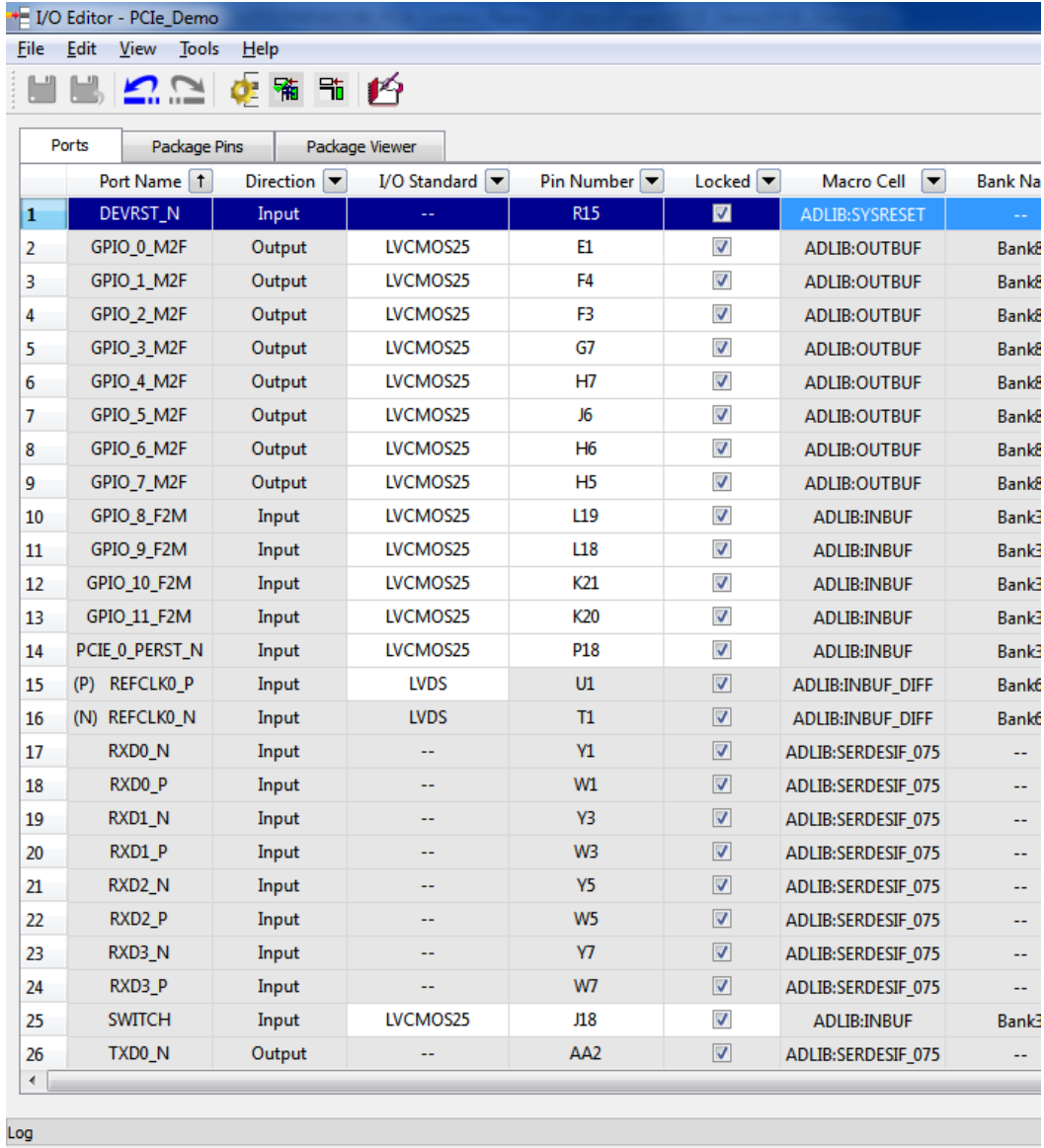
Figure 70 • Edit with I/O Editor



These pin assignments are for connecting below pins on the SmartFusion2 Security Evaluation Kit.

- GPIO_0 to GPIO_8 for LEDs
- GPIO_8 to GPIO_11 for DIP switches
- SWITCH for SW4
- PCIE_0_PERST_N to PERST of PCIe Edge connector

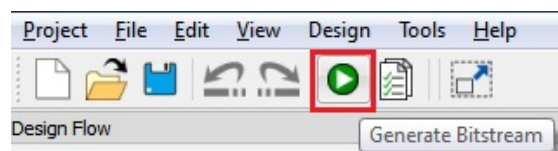
Figure 71 • I/O Editor



	Port Name	Direction	I/O Standard	Pin Number	Locked	Macro Cell	Bank Name
1	DEVIRST_N	Input	--	R15	☒	ADLIB:SYSRESET	--
2	GPIO_0_M2F	Output	LVC MOS25	E1	☒	ADLIB:OUTBUF	Bank0
3	GPIO_1_M2F	Output	LVC MOS25	F4	☒	ADLIB:OUTBUF	Bank0
4	GPIO_2_M2F	Output	LVC MOS25	F3	☒	ADLIB:OUTBUF	Bank0
5	GPIO_3_M2F	Output	LVC MOS25	G7	☒	ADLIB:OUTBUF	Bank0
6	GPIO_4_M2F	Output	LVC MOS25	H7	☒	ADLIB:OUTBUF	Bank0
7	GPIO_5_M2F	Output	LVC MOS25	J6	☒	ADLIB:OUTBUF	Bank0
8	GPIO_6_M2F	Output	LVC MOS25	H6	☒	ADLIB:OUTBUF	Bank0
9	GPIO_7_M2F	Output	LVC MOS25	H5	☒	ADLIB:OUTBUF	Bank0
10	GPIO_8_F2M	Input	LVC MOS25	L19	☒	ADLIB:INBUF	Bank0
11	GPIO_9_F2M	Input	LVC MOS25	L18	☒	ADLIB:INBUF	Bank0
12	GPIO_10_F2M	Input	LVC MOS25	K21	☒	ADLIB:INBUF	Bank0
13	GPIO_11_F2M	Input	LVC MOS25	K20	☒	ADLIB:INBUF	Bank0
14	PCIE_0_PERST_N	Input	LVC MOS25	P18	☒	ADLIB:INBUF	Bank0
15	(P) REFCLK0_P	Input	LVDS	U1	☒	ADLIB:INBUF_DIFF	Bank0
16	(N) REFCLK0_N	Input	LVDS	T1	☒	ADLIB:INBUF_DIFF	Bank0
17	RXD0_N	Input	--	Y1	☒	ADLIB:SERDESIF_075	--
18	RXD0_P	Input	--	W1	☒	ADLIB:SERDESIF_075	--
19	RXD1_N	Input	--	Y3	☒	ADLIB:SERDESIF_075	--
20	RXD1_P	Input	--	W3	☒	ADLIB:SERDESIF_075	--
21	RXD2_N	Input	--	Y5	☒	ADLIB:SERDESIF_075	--
22	RXD2_P	Input	--	W5	☒	ADLIB:SERDESIF_075	--
23	RXD3_N	Input	--	Y7	☒	ADLIB:SERDESIF_075	--
24	RXD3_P	Input	--	W7	☒	ADLIB:SERDESIF_075	--
25	SWITCH	Input	LVC MOS25	J18	☒	ADLIB:INBUF	Bank0
26	TXD0_N	Output	--	AA2	☒	ADLIB:SERDESIF_075	--

3. After updating I/O editor, click **Commit and Check**.
4. Close the **I/O Editor**.
5. Click **Generate Bitstream**, as shown in the following figure to complete place and route, verify timing, and generate the programming file.

Figure 72 • Generate Bitstream



2.10 Design Setup

Following steps describe how to program Smartfusion2 Security Evaluation Kit board using Flashpro and how to do design setup:

1. Connect the FlashPro4 programmer to the J5 connector of the SmartFusion2 Security Evaluation Kit board.
2. Connect the jumpers on the SmartFusion2 Security Evaluation Kit board, as shown in the following table.

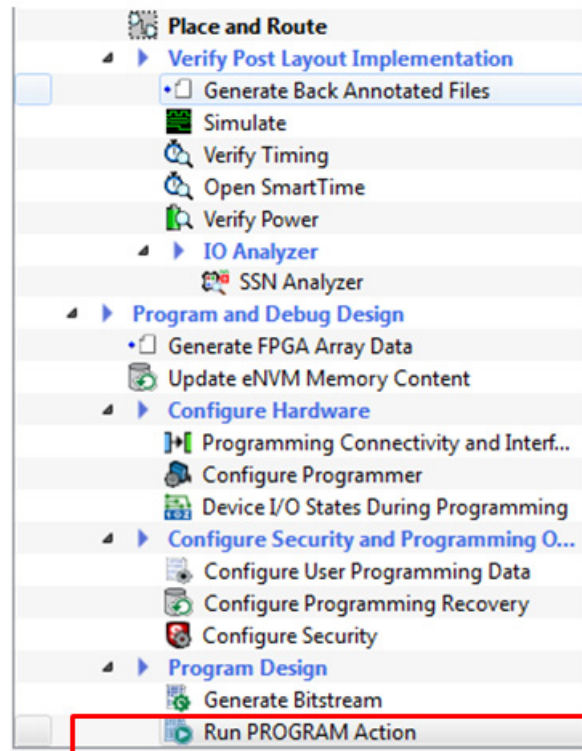
CAUTION: The power supply switch SW7 on the board should be in OFF position, while making the jumper connections.

Table 6 • SmartFusion2 FPGA Security Evaluation Kit Jumper Settings

Jumper	Pin (From)	Pin (To)	Comments
J22, J23, J24, J8, J3	1	2	These are the default jumper settings of the SmartFusion2 Security Evaluation Kit board. Ensure, these jumpers are set accordingly.

3. Connect the power supply to the **J6** connector.
4. Switch ON the power supply switch, SW7.
5. To program the SmartFusion2 device, double-click **Run PROGRAM Action** in the **Design Flow** tab, as shown in the following figure.

Figure 73 • Run PROGRAM Action



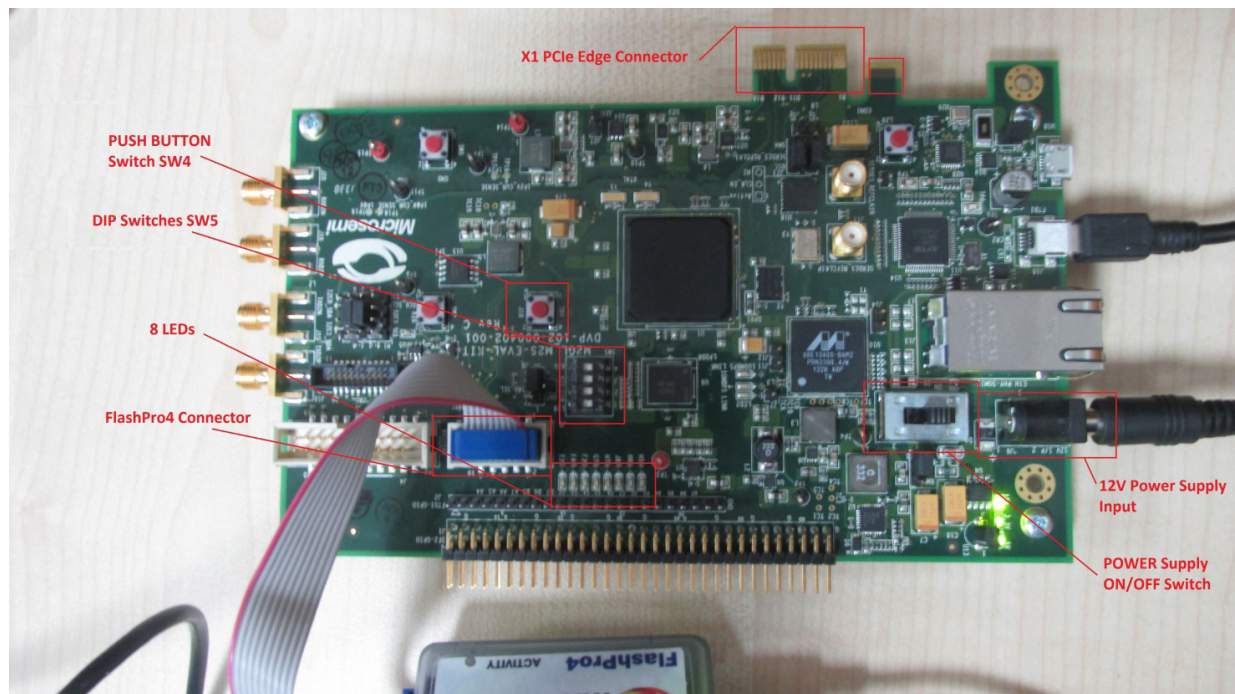
6. After Successful programming, power OFF the SmartFusion2 Security Evaluation Kit and shut down the host PC.
7. Following are the steps to connect the **CON1-PCIe Edge Connector** either to host PC or laptop:
 - a. Connect the CON1-PCIe Edge Connector to host PC PCIe Gen 2 slot or Gen 1 slot, as applicable. If the host PC does not support the Gen 2 compliant slot, the design switches to the Gen 1 slot.

b. Connect the CON1-PCIe Edge Connector to the laptop PCIe slot using the express card adapter. If you are using a laptop, the express card adapters typically support only Gen 1 and the design works on Gen 1 slot.

CAUTION: Host PC or laptop should be powered OFF while inserting the PCIe Edge Connector. If the system is not powered OFF, the PCIe device detection and selection of Gen 1 or Gen 2 does not occur properly. Microsemi recommends that the host PC or laptop should be powered OFF during the PCIe card insertion.

The board setup is as shown in the following figure.

Figure 74 • SmartFusion2 Security Evaluation Kit Setup



8. Switch ON the power supply switch, **SW7**.

2.11 Running the Design

This tutorial can run on both windows and Red Hat Linux operating system.

To run the tutorial on Windows operating system GUI, Microsemi PCIe drivers are provided. Refer to [Running the Design on Windows](#), page 51.

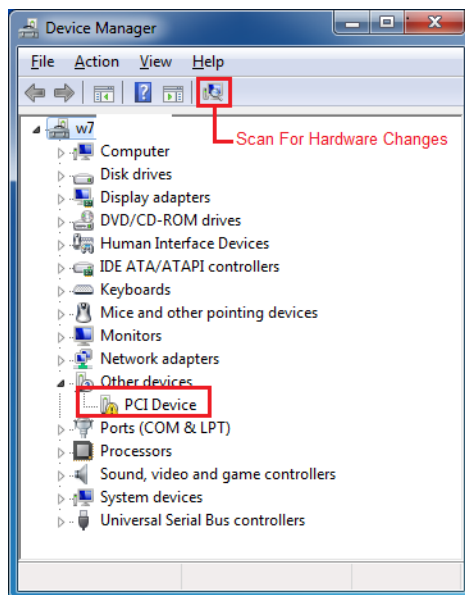
To run the tutorial on Linux operating system native Red Hat Linux drivers and command line scripts are provided. Refer to [Running the Design on Linux](#), page 59.

2.11.1 Running the Design on Windows

The following steps describe how to run the demo design on Windows:

1. Switch **ON** the power supply switch, **SW7**.
2. Power on the host PC and open the host PC **Device Manager** for PCIe device, as shown in the following figure. If the PCIe device is not detected, power cycle the SmartFusion2 Security Evaluation Kit board.
3. Right-click **PCI Device** > **scan for hardware changes** in Device Manager.

Figure 75 • Device Manager—PCIe Device Detection



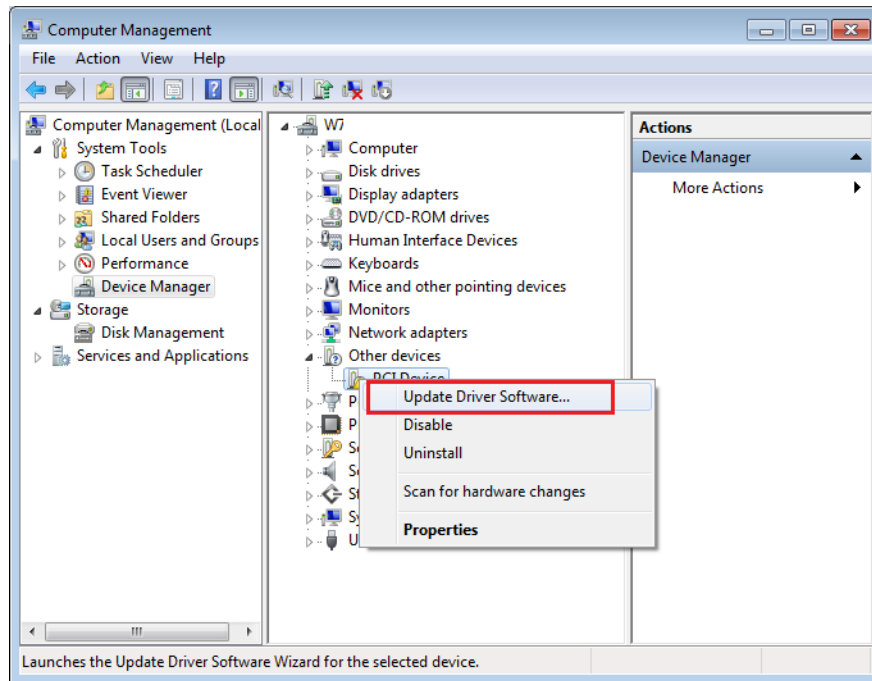
Note: If the device is still not detected, check if the BIOS in host PC is the latest version, and if PCI is enabled in the host PC BIOS.

2.11.1.1 Drivers Installation

Perform the following steps to install the PCIe drivers on the host PC:

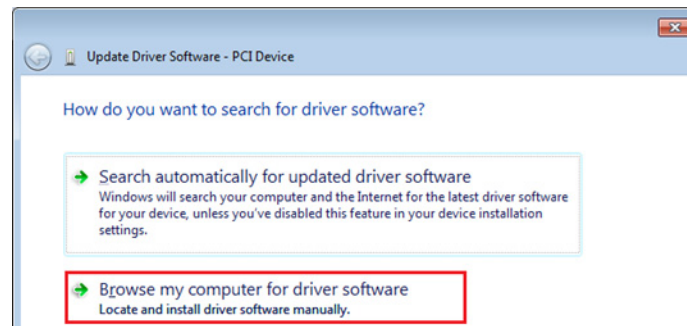
1. Right-click **PCI Device** in Device Manager and select **Update Driver Software...**, as shown in the following figure. To install the drivers, administrative rights are required.

Figure 76 • Update Driver Software



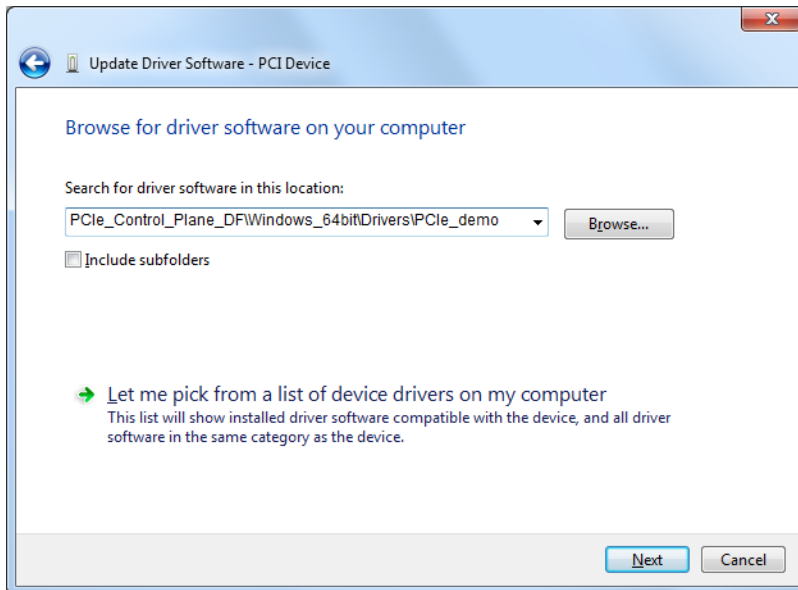
2. In the **Update Driver Software - PCI Device** window, select the **Browse my computer for driver software** option as shown in the following figure.

Figure 77 • Browse for Driver Software



3. Browse the drivers folder: M2S90_PCl_e_Control_Plane_DF\Windows_64bit\Drivers\PCl_e_Demo and click **Next**, as shown in the following figure.

Figure 78 • Browse for Driver Software Continued



4. The **Windows Security** dialog box is displayed. Click **Install** as shown in the following figure. After successful driver installation, a message appears. See Figure 80, page 53.

Figure 79 • Windows Security

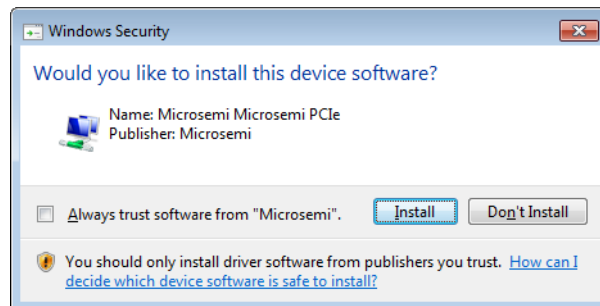
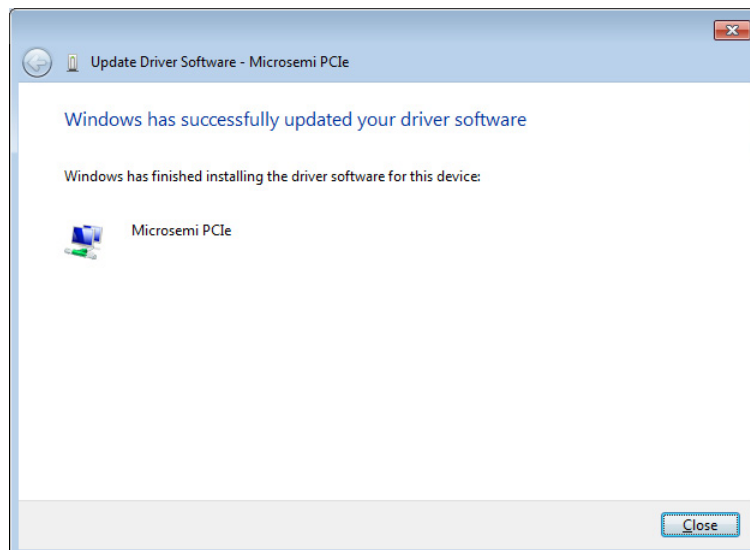


Figure 80 • Successful Driver Installation



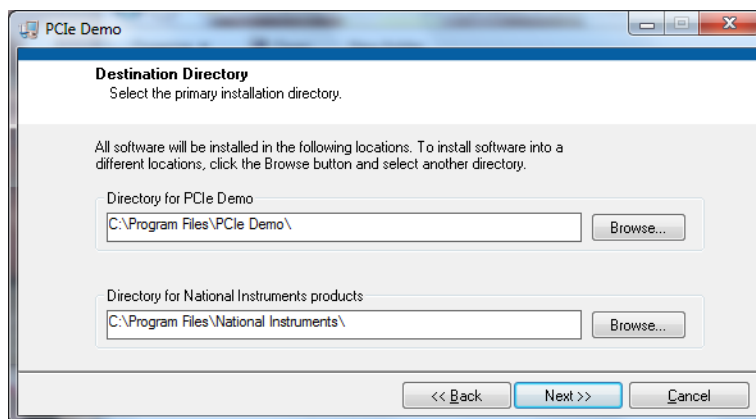
2.11.1.2 PCIe Demo GUI Installation

SmartFusion2 PCIe GUI is a simple graphic user interface that runs on the host PC to communicate with the SmartFusion2 PCIe endpoint device. The GUI provides the PCIe link status, driver information, and demo controls. The GUI invokes the PCIe driver installed on the host PC and provides commands to the driver according to the user selection.

To install the GUI:

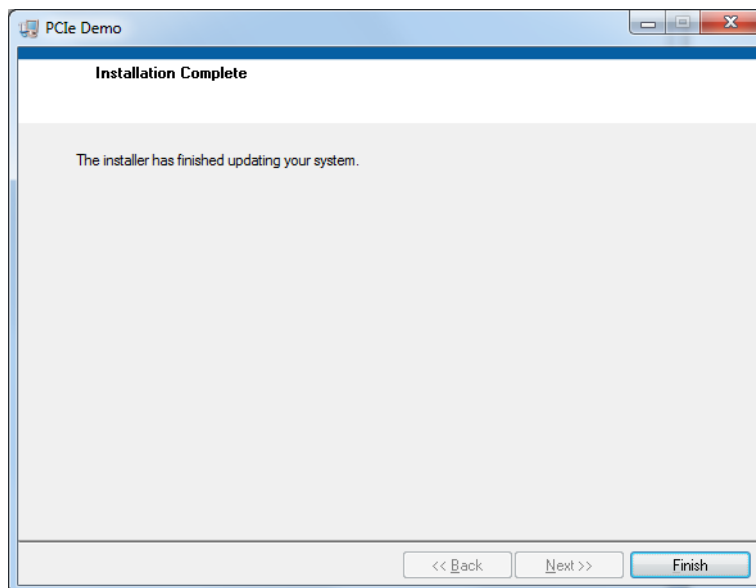
1. Extract the `PCIe_Demo_GUI_Installer.rar` and locate the files at **M2S90_PCl_e_Control_Plane_DF\GUI**
2. Double-click `setup.exe` in the provided GUI installation (`PCIe_Control_Plane_Demo_GUI_Installer\setup.exe`). Apply default options, as shown in the following figure.
3. To start the installation, click **Next**.

Figure 81 • GUI Installation



4. Click **Finish** to complete the installation.

Figure 82 • Successful GUI Installation



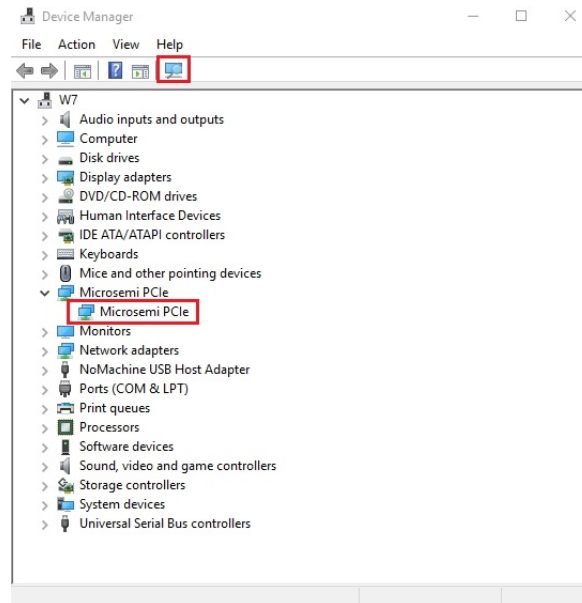
5. Restart the host PC.

2.11.1.3 Running the PCIe GUI

The following steps describe how to run the PCIe GUI:

1. Check the host PC **Device Manager** for the drivers. If the device is not detected, power cycle the SmartFusion2 Security Evaluation Kit board.
2. Click **scan for hardware changes** in Device Manager window. Ensure that the board is switched on.

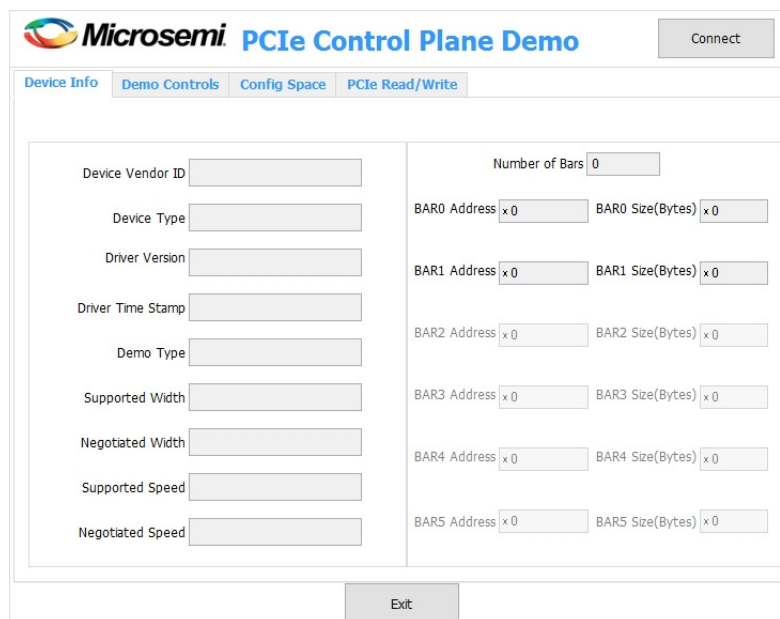
Figure 83 • Device Manager—PCIe Device Detection



Note: If a warning symbol is displayed on the **Microsemi PCIe** in the **Device Manager**, uninstall them and start from step1 of [Drivers Installation](#), page 59.

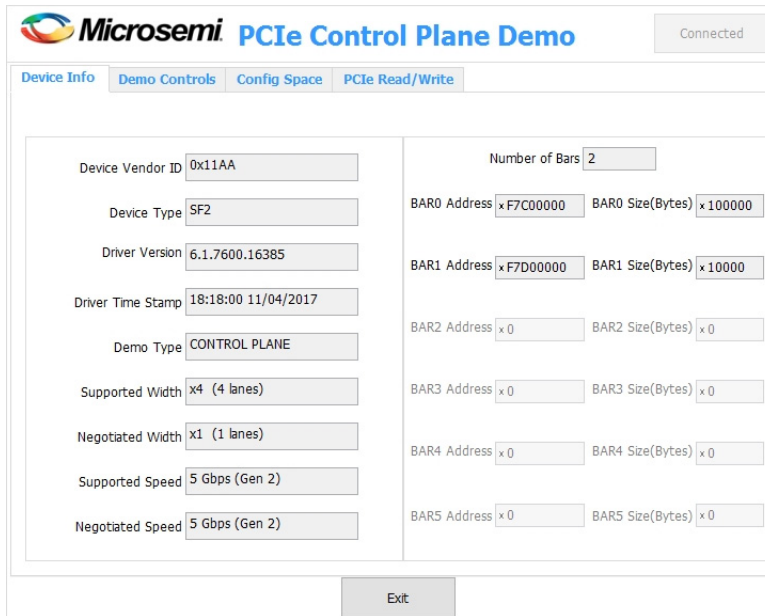
3. Invoke the GUI from **ALL Programs > PCIe Control Plane Demo**. The GUI is displayed, as shown in the following figure.

Figure 84 • PCIe Demo GUI



- Click **Connect**. The application detects and displays the information related to the connected kit such as Device Vendor ID, Device Type, Driver Version, Driver Time Stamp, Demo Type, Supported Width, Negotiated Width, Supported Speed, Negotiated Speed, Number of Bars, and BAR Address as shown in the following figure.

Figure 85 • Device Info



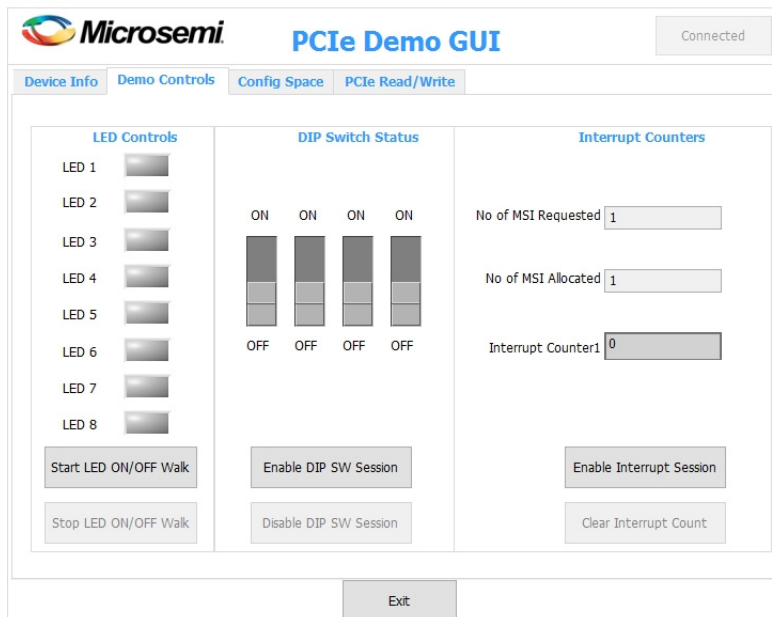
The screenshot shows the 'Device Info' tab of the 'Microsemi PCIe Control Plane Demo' application. The interface includes a 'Connected' status indicator and a navigation bar with tabs: 'Device Info', 'Demo Controls', 'Config Space', and 'PCIe Read/Write'. The main content area displays various device parameters in a two-column layout:

- Left Column:**
 - Device Vendor ID: 0x11AA
 - Device Type: SF2
 - Driver Version: 6.1.7600.16385
 - Driver Time Stamp: 18:18:00 11/04/2017
 - Demo Type: CONTROL PLANE
 - Supported Width: x4 (4 lanes)
 - Negotiated Width: x1 (1 lanes)
 - Supported Speed: 5 Gbps (Gen 2)
 - Negotiated Speed: 5 Gbps (Gen 2)
- Right Column:**
 - Number of Bars: 2
 - BAR0 Address: xF7C00000, BAR0 Size(Bytes): x100000
 - BAR1 Address: xF7D00000, BAR1 Size(Bytes): x10000
 - BAR2 Address: x0, BAR2 Size(Bytes): x0
 - BAR3 Address: x0, BAR3 Size(Bytes): x0
 - BAR4 Address: x0, BAR4 Size(Bytes): x0
 - BAR5 Address: x0, BAR5 Size(Bytes): x0

An 'Exit' button is located at the bottom center of the form.

- Click the **Demo Controls** tab to display the **LED Controls**, **DIP Switch Status**, and **Interrupt Counters** as shown in the following figure.

Figure 86 • Demo Controls



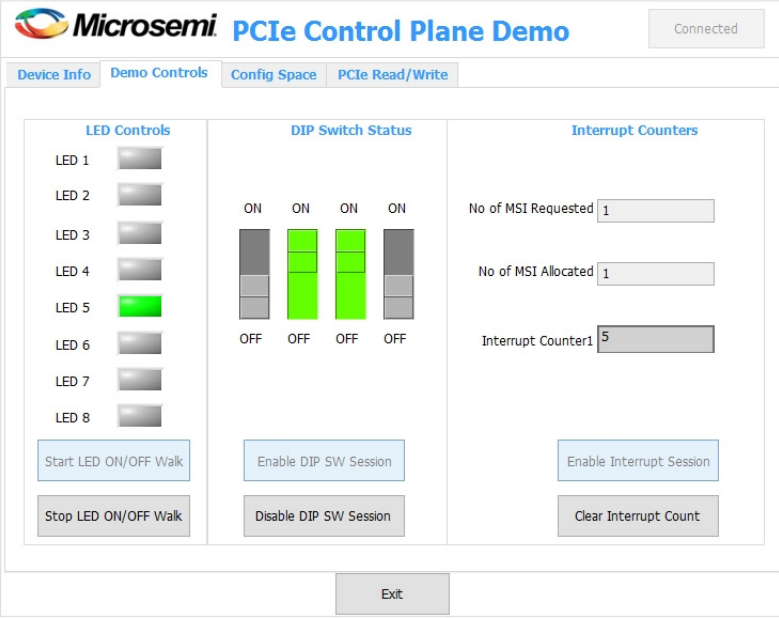
The screenshot shows the 'Demo Controls' tab of the 'Microsemi PCIe Demo GUI' application. The interface includes a 'Connected' status indicator and a navigation bar with tabs: 'Device Info', 'Demo Controls', 'Config Space', and 'PCIe Read/Write'. The main content area is divided into three columns:

- LED Controls:**
 - Eight LED indicators (LED 1 to LED 8) are shown, each with a corresponding button.
 - Buttons: 'Start LED ON/OFF Walk' and 'Stop LED ON/OFF Walk'.
- DIP Switch Status:**
 - Four DIP switches are shown, each with an 'ON' label and a corresponding button.
 - Buttons: 'Enable DIP SW Session' and 'Disable DIP SW Session'.
- Interrupt Counters:**
 - Fields for 'No of MSI Requested' (1) and 'No of MSI Allocated' (1).
 - 'Interrupt Counter1' field (0).
 - Buttons: 'Enable Interrupt Session' and 'Clear Interrupt Count'.

An 'Exit' button is located at the bottom center of the form.

6. Click **Start LED ON/OFF Walk**, **Enable DIP SW Session**, and **Enable Interrupt Session** to view controlling LEDs, getting the DIP switch status, and monitoring the interrupts simultaneously as shown in the following figure.

Figure 87 • Demo Controls—Continued



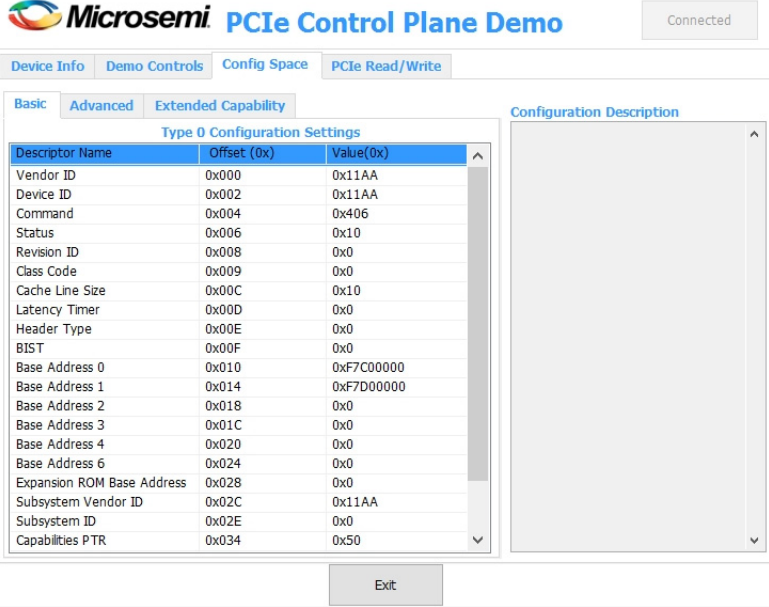
The screenshot shows the 'Demo Controls' tab of the Microsemi PCIe Control Plane Demo application. It is divided into three main sections: LED Controls, DIP Switch Status, and Interrupt Counters. Each section has a set of controls and a corresponding status display.

LED Controls	DIP Switch Status	Interrupt Counters
LED 1: ☐	ON: ☒	No of MSI Requested: 1
LED 2: ☐	ON: ☒	No of MSI Allocated: 1
LED 3: ☐	ON: ☒	Interrupt Counter1: 5
LED 4: ☐	ON: ☒	
LED 5: ☒	OFF: ☐	
LED 6: ☐	OFF: ☐	
LED 7: ☐	OFF: ☐	
LED 8: ☐	OFF: ☐	
Start LED ON/OFF Walk	Enable DIP SW Session	Enable Interrupt Session
Stop LED ON/OFF Walk	Disable DIP SW Session	Clear Interrupt Count

Buttons at the bottom: Exit

7. Click **Config Space** to view details about the PCIe configuration space. The following figure shows the PCIe configuration space.

Figure 88 • Configuration Space



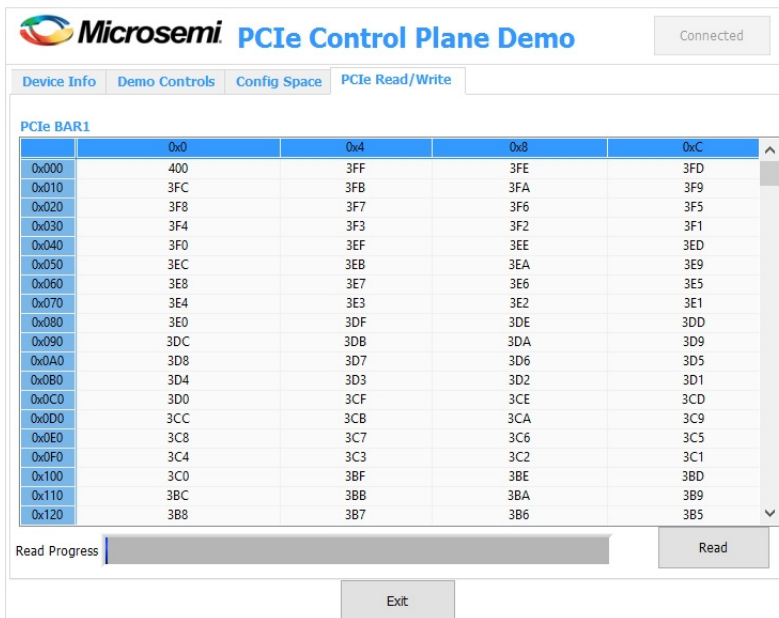
The screenshot shows the 'Config Space' tab of the Microsemi PCIe Control Plane Demo application. It displays the 'Type 0 Configuration Settings' table and a 'Configuration Description' area.

Descriptor Name	Offset (0x)	Value(0x)
Vendor ID	0x000	0x11AA
Device ID	0x002	0x11AA
Command	0x004	0x406
Status	0x006	0x10
Revision ID	0x008	0x0
Class Code	0x009	0x0
Cache Line Size	0x00C	0x10
Latency Timer	0x00D	0x0
Header Type	0x00E	0x0
BIST	0x00F	0x0
Base Address 0	0x010	0xF7C00000
Base Address 1	0x014	0xF7D00000
Base Address 2	0x018	0x0
Base Address 3	0x01C	0x0
Base Address 4	0x020	0x0
Base Address 6	0x024	0x0
Expansion ROM Base Address	0x028	0x0
Subsystem Vendor ID	0x02C	0x11AA
Subsystem ID	0x02E	0x0
Capabilities PTR	0x034	0x50

Buttons at the bottom: Exit

8. Click the **PCIe Read/Write** tab to perform read and writes to LSRAM memory through **BAR1** space. Click **Read** to read the 4 KB memory mapped to BAR1 space as shown in the following figure.

Figure 89 • PCIe BAR1 Memory Access



The screenshot shows the Microsemi PCIe Control Plane Demo application. The 'PCIe Read/Write' tab is selected. Below the tabs, a table displays the memory contents of BAR1. The table has five columns: Address (0x000 to 0x120), 0x0, 0x4, 0x8, and 0xC. The data is as follows:

Address	0x0	0x4	0x8	0xC
0x000	400	3FF	3FE	3FD
0x010	3FC	3FB	3FA	3F9
0x020	3F8	3F7	3F6	3F5
0x030	3F4	3F3	3F2	3F1
0x040	3F0	3EF	3EE	3ED
0x050	3EC	3EB	3EA	3E9
0x060	3E8	3E7	3E6	3E5
0x070	3E4	3E3	3E2	3E1
0x080	3E0	3DF	3DE	3DD
0x090	3DC	3DB	3DA	3D9
0x0A0	3D8	3D7	3D6	3D5
0x0B0	3D4	3D3	3D2	3D1
0x0C0	3D0	3CF	3CE	3CD
0x0D0	3CC	3CB	3CA	3C9
0x0E0	3C8	3C7	3C6	3C5
0x0F0	3C4	3C3	3C2	3C1
0x100	3C0	3BF	3BE	3BD
0x110	3BC	3BB	3BA	3B9
0x120	3B8	3B7	3B6	3B5

Below the table, there is a 'Read Progress' bar and a 'Read' button. At the bottom center, there is an 'Exit' button.

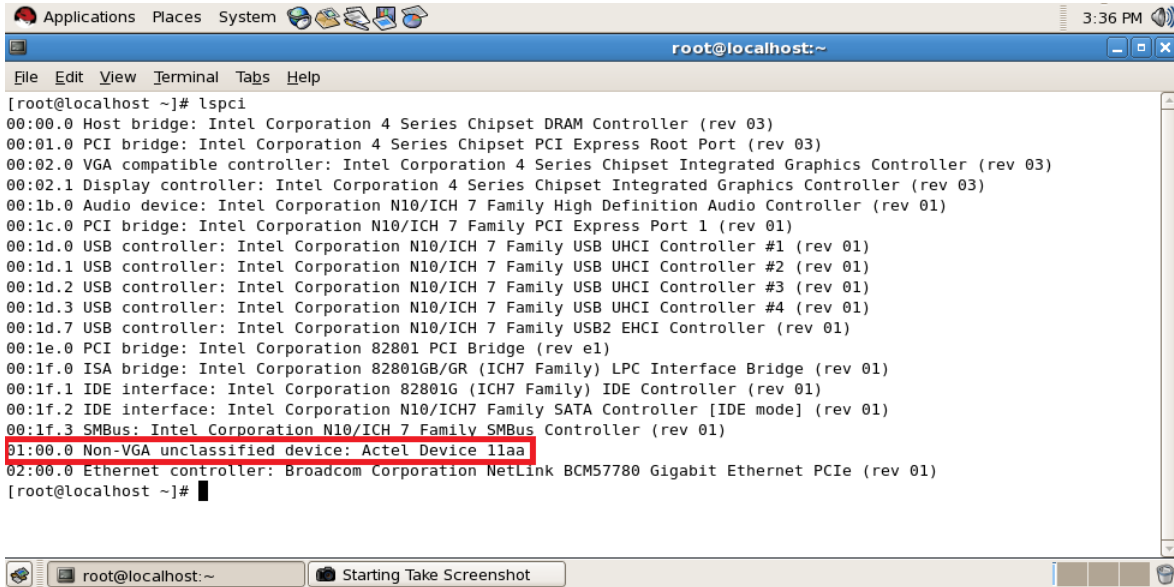
9. Click **Exit** to quit the demo.

2.11.2 Running the Design on Linux

The following steps describe how to run the Design on Linux.

1. Switch **ON** the Red Hat Linux host PC.
2. Red Hat Linux Kernel detects the SmartFusion2 PCIe endpoint as Actel Device.
3. On Linux Command Prompt Use `lspci` command to display the PCIe info.
`lspci`

Figure 90 • PCIe Device Detection



```

[root@localhost ~]# lspci
00:00.0 Host bridge: Intel Corporation 4 Series Chipset DRAM Controller (rev 03)
00:01.0 PCI bridge: Intel Corporation 4 Series Chipset PCI Express Root Port (rev 03)
00:02.0 VGA compatible controller: Intel Corporation 4 Series Chipset Integrated Graphics Controller (rev 03)
00:02.1 Display controller: Intel Corporation 4 Series Chipset Integrated Graphics Controller (rev 03)
00:1b.0 Audio device: Intel Corporation N10/ICH 7 Family High Definition Audio Controller (rev 01)
00:1c.0 PCI bridge: Intel Corporation N10/ICH 7 Family PCI Express Port 1 (rev 01)
00:1d.0 USB controller: Intel Corporation N10/ICH 7 Family USB UHCI Controller #1 (rev 01)
00:1d.1 USB controller: Intel Corporation N10/ICH 7 Family USB UHCI Controller #2 (rev 01)
00:1d.2 USB controller: Intel Corporation N10/ICH 7 Family USB UHCI Controller #3 (rev 01)
00:1d.3 USB controller: Intel Corporation N10/ICH 7 Family USB UHCI Controller #4 (rev 01)
00:1d.7 USB controller: Intel Corporation N10/ICH 7 Family USB2 EHCI Controller (rev 01)
00:1e.0 PCI bridge: Intel Corporation 82801 PCI Bridge (rev e1)
00:1f.0 ISA bridge: Intel Corporation 82801GB/GR (ICH7 Family) LPC Interface Bridge (rev 01)
00:1f.1 IDE interface: Intel Corporation 82801G (ICH7 Family) IDE Controller (rev 01)
00:1f.2 IDE interface: Intel Corporation N10/ICH7 Family SATA Controller [IDE mode] (rev 01)
00:1f.3 SMBus: Intel Corporation N10/ICH 7 Family SMBus Controller (rev 01)
01:00.0 Non-VGA unclassified device: Actel Device 11aa
02:00.0 Ethernet controller: Broadcom Corporation NetLink BCM57780 Gigabit Ethernet PCIe (rev 01)
[root@localhost ~]#

```

2.11.2.1 Drivers Installation

Enter the following commands in the Linux command prompt to install the PCIe drivers:

1. Create the **sf2** directory under the **home/** directory using the following command:
`mkdir /home/sf2`
2. Copy the M2S90_PCl_e_Control_Plane_DF design files folder under **/home/sf2** directory, which contains the Linux PCIe device driver files and Linux PCIe application utility files.
3. Copy the Linux PCIe Device Driver file (PCIe_Driver.rar) from M2S90_PCl_e_Control_Plane_DF/design files folder.
`cp -rf /home/sf2/M2S90_PCl_e_Control_Plane_DF/Linux_64bit/Drivers/PCIe_Driver.rar /home/sf2`
`unrar -e PCIe_Driver.rar`
4. Execute `ls` command to display the contents of **/home/sf2** directory.
`ls`
5. Change to **inc/** directory by using the following command:
`cd /home/sf2/inc`

6. Edit the `board.h` file for SmartFusion2 Security Evaluation Kit, as shown in the following figure.

```
#vi board.h

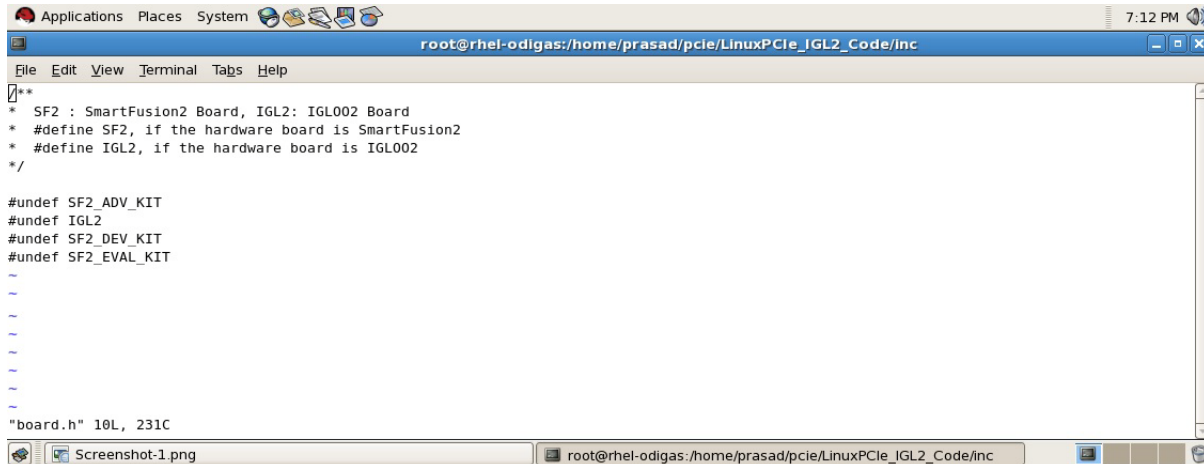
#undef SF2_ADV_KIT

#undef IGL2

#undef SF2_DEV_KIT

#define SF2_EVAL_KIT
```

Figure 91 • Edit board.h File



7. To save the selected file, execute the `:wq` command
8. Change to `PCIe_Driver/` directory using the `cd` command:

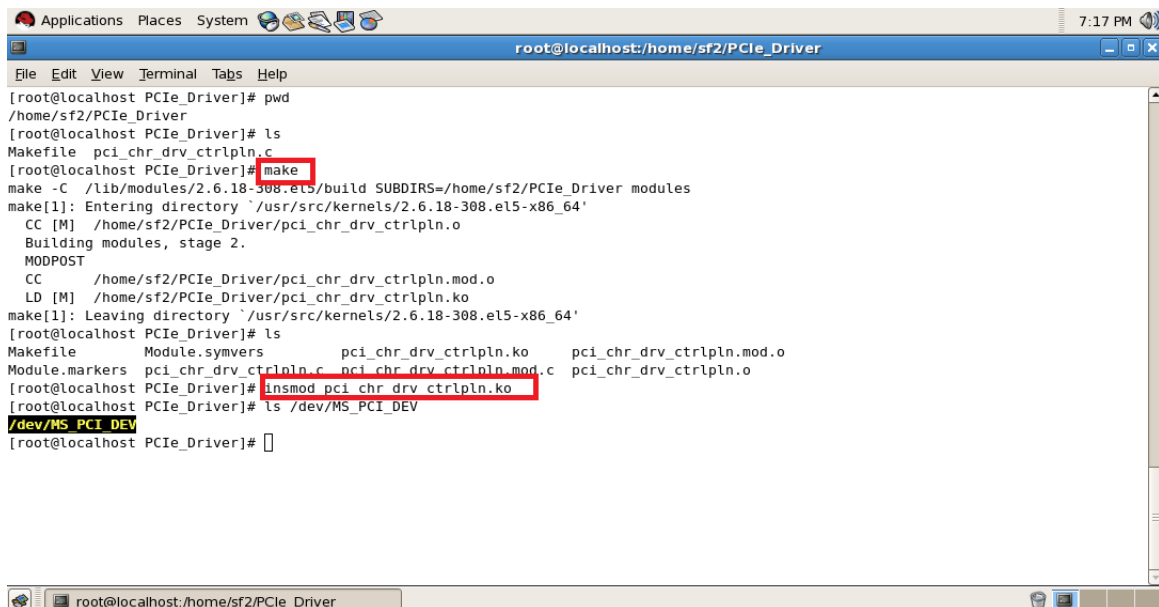
```
#cd /home/sf2/PCIe_Driver
```
9. To compile the Linux PCIe device driver code, execute `make` command.

```
#make clean [To clean any *.o, *.ko files]
#make
```
10. The kernel module, `pci_chr_drv_ctrlpln.ko` creates in the same directory.
11. To insert the Linux PCIe device driver as a module, execute `insmod` command.

```
#insmod pci_chr_drv_ctrlpln.ko
```

Note: Root privileges are required to execute this command.

Figure 92 • PCIe Device Driver Installation



12. After successful Linux PCIe device driver installation, check `/dev/MS_PCI_DEV` got created by using the following Linux command:

```
#ls /dev/MS_PCI_DEV
```

Note: `/dev/MS_PCI_DEV` interface is used to access the SmartFusion2 PCIe end point from Linux user space.

2.11.2.2 Linux PCIe Application Compilation and PCIe Control Plane Utility Creation

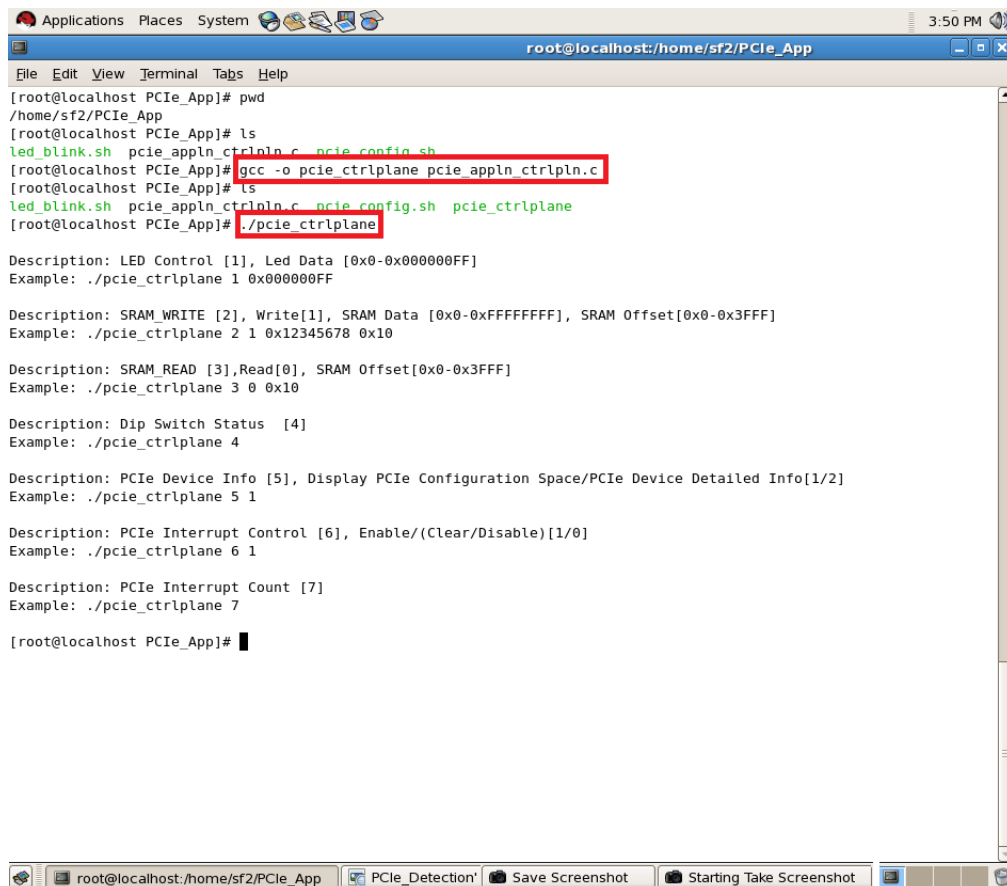
1. Change to the `/home/sf2/` directory using the following command:

```
#cd /home/sf2
```
2. Copy the `M2S90_PCIE_Control_DEMO_DFLinux_64bit\Util\PCie_App` folder from the Windows host PC and place it into the `/home/sf2` directory of RedHat Linux host PC.
3. Change to the `/home/sf2/PCie_App` directory using the following command:

```
#cd /home/sf2/PCie_App
```
4. Compile the Linux user space application `pcie_appln_ctrlpln.c` by using `gcc` command.

```
#gcc -o pcie_ctrlplane pcie_appln_ctrlpln.c
```

Figure 93 • Linux PCIe Application Utility



```

root@localhost: /home/sf2/PCie_App
File Edit View Terminal Tabs Help
[root@localhost PCie_App]# pwd
/home/sf2/PCie_App
[root@localhost PCie_App]# ls
led_blink.sh  pcie_appln_ctrlpln.c  pcie_config.sh
[root@localhost PCie_App]# gcc -o pcie_ctrlplane pcie_appln_ctrlpln.c
[root@localhost PCie_App]# ls
led_blink.sh  pcie_appln_ctrlpln.c  pcie_config.sh  pcie_ctrlplane
[root@localhost PCie_App]# ./pcie_ctrlplane

Description: LED Control [1], Led Data [0x0-0x000000FF]
Example: ./pcie_ctrlplane 1 0x000000FF

Description: SRAM_WRITE [2], Write[1], SRAM Data [0x0-0xFFFFFFFF], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 2 1 0x12345678 0x10

Description: SRAM_READ [3], Read[0], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 3 0 0x10

Description: Dip Switch Status [4]
Example: ./pcie_ctrlplane 4

Description: PCIe Device Info [5], Display PCIe Configuration Space/PCIe Device Detailed Info[1/2]
Example: ./pcie_ctrlplane 5 1

Description: PCIe Interrupt Control [6], Enable/(Clear/Disable)[1/0]
Example: ./pcie_ctrlplane 6 1

Description: PCIe Interrupt Count [7]
Example: ./pcie_ctrlplane 7

[root@localhost PCie_App]#
  
```

5. After successful compilation, Linux PCIe application utility `pcie_ctrlplane` creates in the same directory.
6. On Linux Command Prompt run the `pcie_ctrlplane` utility as:

```
#./pcie_ctrlplane
```

 Help menu displays, as shown in the preceding figure.

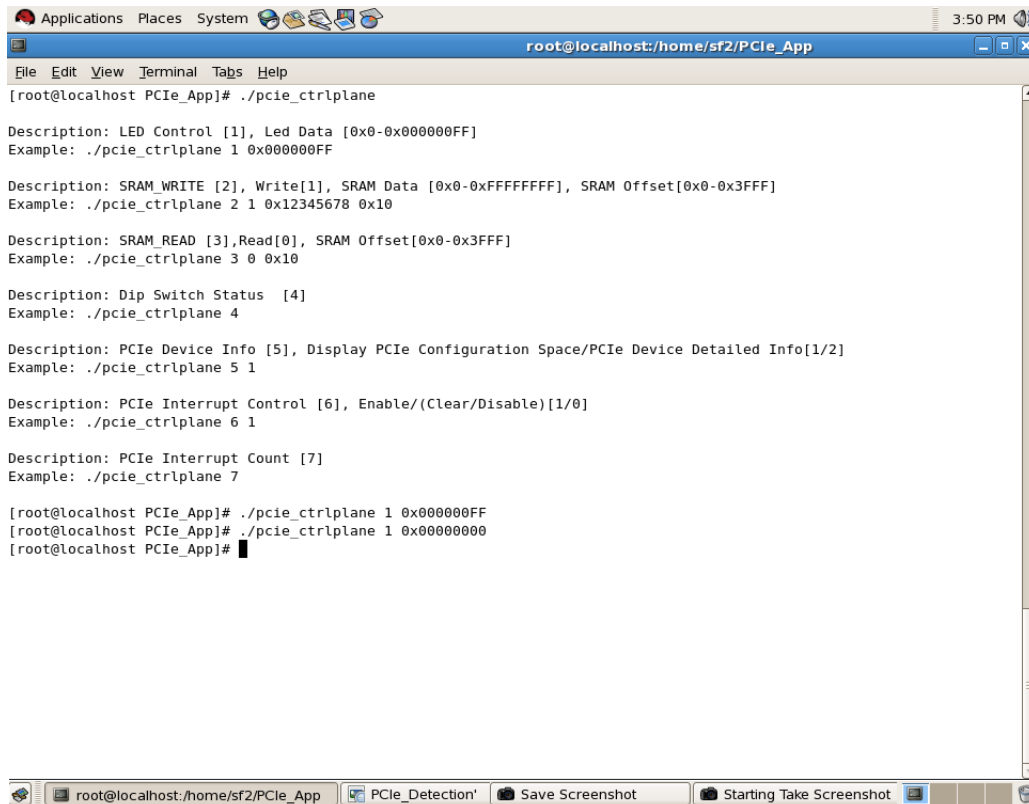
2.11.2.3 Execution of Linux PCIe Control Plane Features

2.11.2.3.1 LED Control

LED1 to LED8 is controlled by writing data to SmartFusion2 LED Control Registers.

```
#./pcie_ctrlplane 1 0x000000FF [LED OFF]
#./pcie_ctrlplane 1 0x00000000 [LED ON]
```

Figure 94 • Linux Command—LED Control



led_blink.sh, contains the shell script code to perform LED Walk ON where as Ctrl C exits the shell script and LED Walk turns OFF.

Run the led_blink.sh shell script using sh command.

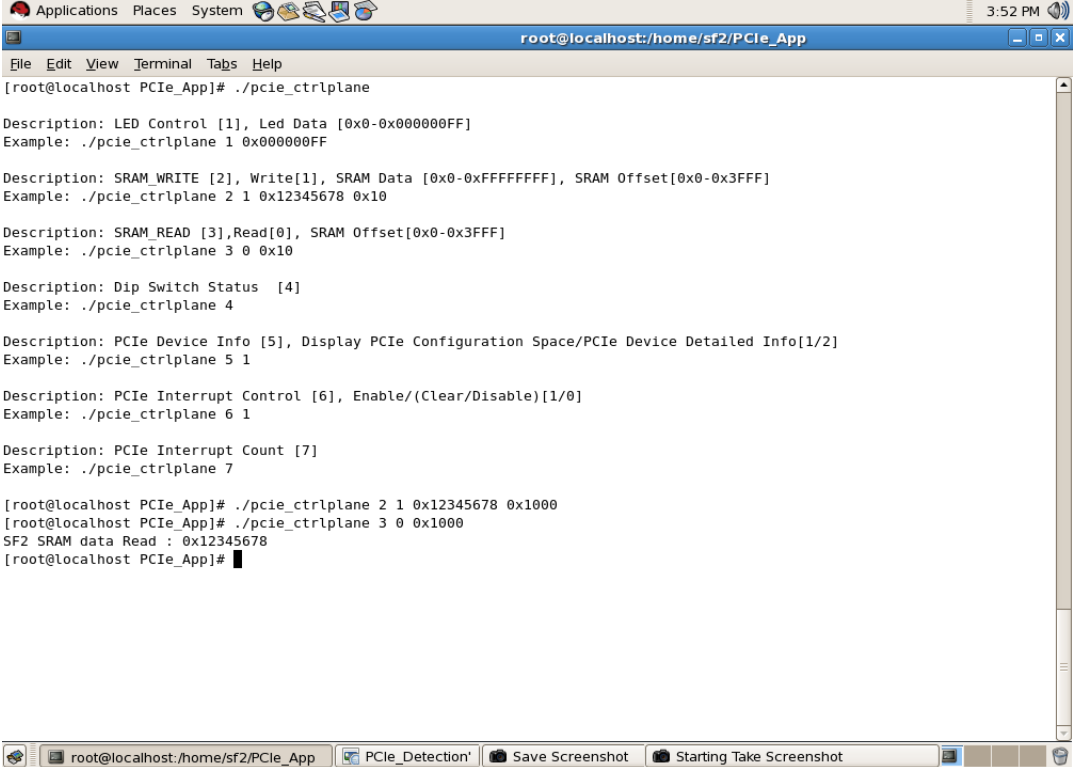
```
#sh led_blink.sh
```

2.11.2.3.2 SRAM Read/Write

64 KB SRAM is accessible for SmartFusion2 Security Evaluation Kit.

```
#./pcie_ctrlplane 2 1 0xFF00FF00 0x1000 [SRAM WRITE]
#./pcie_ctrlplane 3 0 0x1000 [SRAM READ]
```

Figure 95 • Linux Command—SRAM Read/Write



```

Applications  Places  System  3:52 PM
root@localhost:/home/sf2/PCie_App

File Edit View Terminal Tabs Help
[root@localhost PCie_App]# ./pcie_ctrlplane

Description: LED Control [1], Led Data [0x0-0x000000FF]
Example: ./pcie_ctrlplane 1 0x000000FF

Description: SRAM_WRITE [2], Write[1], SRAM Data [0x0-0xFFFFFFFF], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 2 1 0x12345678 0x10

Description: SRAM_READ [3],Read[0], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 3 0 0x10

Description: Dip Switch Status [4]
Example: ./pcie_ctrlplane 4

Description: PCIe Device Info [5], Display PCIe Configuration Space/PCIe Device Detailed Info[1/2]
Example: ./pcie_ctrlplane 5 1

Description: PCIe Interrupt Control [6], Enable/(Clear/Disable)[1/0]
Example: ./pcie_ctrlplane 6 1

Description: PCIe Interrupt Count [7]
Example: ./pcie_ctrlplane 7

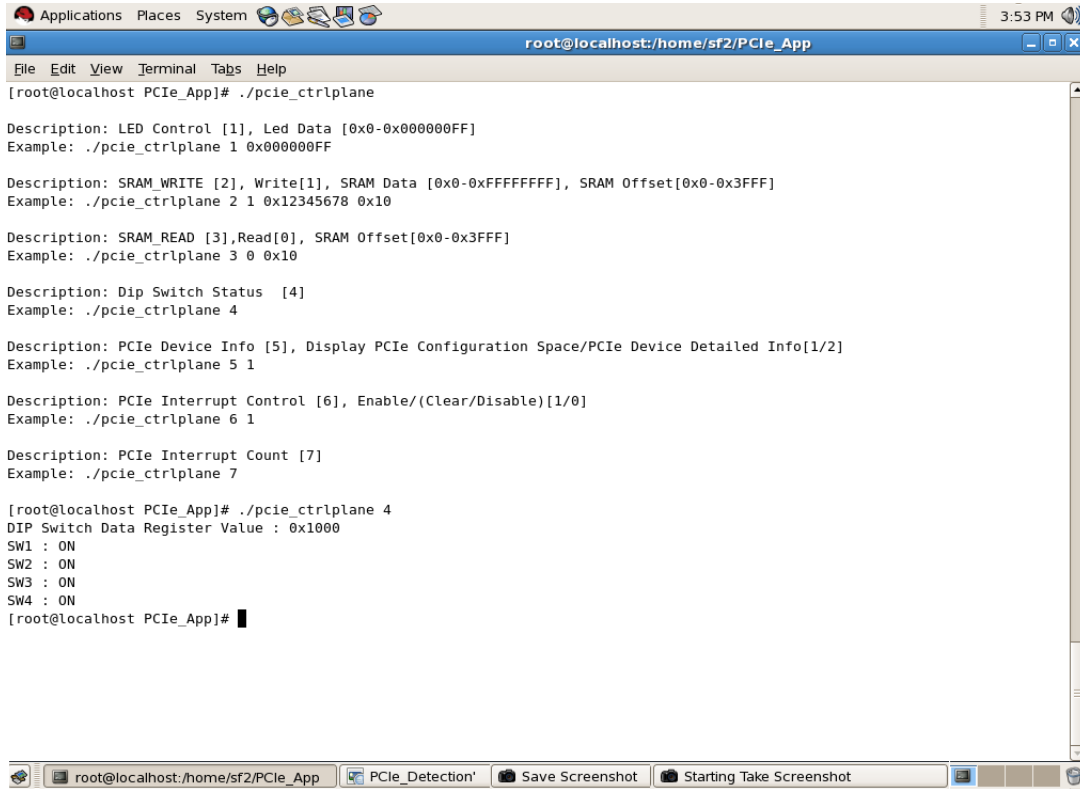
[root@localhost PCie_App]# ./pcie_ctrlplane 2 1 0x12345678 0x1000
[root@localhost PCie_App]# ./pcie_ctrlplane 3 0 0x1000
SF2 SRAM data Read : 0x12345678
[root@localhost PCie_App]#
  
```

2.11.2.3.3 DIP Switch Status

Dip Switch on SmartFusion2 Security Evaluation Kit consists of four electric switches to hold the device configurations. Linux PCIe utility reads the corresponding switches (ON/OFF) state.

```
#./pcie_ctrlplane 4 [DIP Switch Status]
```

Figure 96 • Linux Command—DIP Switch



```

root@localhost:~/home/sf2/PCie_App
File Edit View Terminal Tabs Help
[root@localhost PCie_App]# ./pcie_ctrlplane

Description: LED Control [1], Led Data [0x0-0x000000FF]
Example: ./pcie_ctrlplane 1 0x000000FF

Description: SRAM WRITE [2], Write[1], SRAM Data [0x0-0xFFFFFFFF], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 2 1 0x12345678 0x10

Description: SRAM READ [3], Read[0], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 3 0 0x10

Description: Dip Switch Status [4]
Example: ./pcie_ctrlplane 4

Description: PCIe Device Info [5], Display PCIe Configuration Space/PCIe Device Detailed Info[1/2]
Example: ./pcie_ctrlplane 5 1

Description: PCIe Interrupt Control [6], Enable/(Clear/Disable)[1/0]
Example: ./pcie_ctrlplane 6 1

Description: PCIe Interrupt Count [7]
Example: ./pcie_ctrlplane 7

[root@localhost PCie_App]# ./pcie_ctrlplane 4
DIP Switch Data Register Value : 0x1000
SW1 : ON
SW2 : ON
SW3 : ON
SW4 : ON
[root@localhost PCie_App]#
  
```

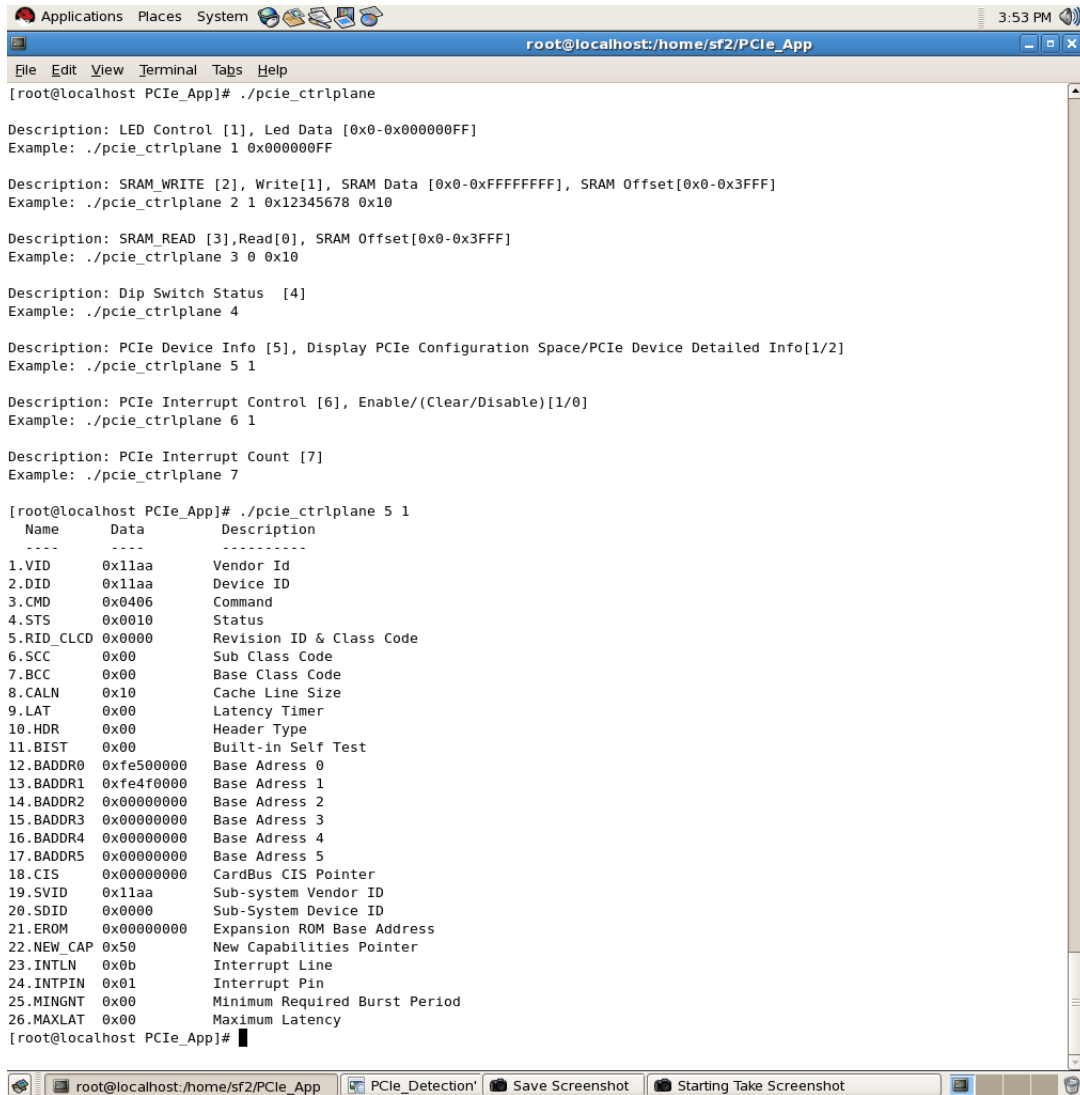
2.11.2.3.4 PCIe Configuration Space Display

PCIe Configuration Space contains the PCIe device data, such as Vendor ID, Device ID, and Base Address 0.

Note: Root Privileges are required to execute this command.

```
#./pcie_ctrlplane 5 1 [Read PCIe Configuration Space]
```

Figure 97 • Linux Command—PCIe Configuration Space Display



```

Applications Places System root@localhost:~ 3:53 PM
root@localhost:~/home/sf2/PCie_App
File Edit View Terminal Tabs Help
[root@localhost PCie_App]# ./pcie_ctrlplane

Description: LED Control [1], Led Data [0x0-0x000000FF]
Example: ./pcie_ctrlplane 1 0x000000FF

Description: SRAM_WRITE [2], Write[1], SRAM Data [0x0-0xFFFFFFFF], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 2 1 0x12345678 0x10

Description: SRAM_READ [3], Read[0], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 3 0 0x10

Description: Dip Switch Status [4]
Example: ./pcie_ctrlplane 4

Description: PCIe Device Info [5], Display PCIe Configuration Space/PCIe Device Detailed Info[1/2]
Example: ./pcie_ctrlplane 5 1

Description: PCIe Interrupt Control [6], Enable/(Clear/Disable)[1/0]
Example: ./pcie_ctrlplane 6 1

Description: PCIe Interrupt Count [7]
Example: ./pcie_ctrlplane 7

[root@localhost PCie_App]# ./pcie_ctrlplane 5 1
Name      Data      Description
-----
1.VID     0x11aa    Vendor Id
2.DID     0x11aa    Device ID
3.CMD     0x0406    Command
4.STS     0x0010    Status
5.RID_CLCD 0x0000    Revision ID & Class Code
6.SCC     0x00      Sub Class Code
7.BCC     0x00      Base Class Code
8.CALN    0x10      Cache Line Size
9.LAT     0x00      Latency Timer
10.HDR     0x00      Header Type
11.BIST    0x00      Built-in Self Test
12.BADDR0 0xfe500000 Base Address 0
13.BADDR1 0xfe4f0000 Base Address 1
14.BADDR2 0x00000000 Base Address 2
15.BADDR3 0x00000000 Base Address 3
16.BADDR4 0x00000000 Base Address 4
17.BADDR5 0x00000000 Base Address 5
18.CIS     0x00000000 CardBus CIS Pointer
19.SVID    0x11aa    Sub-system Vendor ID
20.SDID    0x0000    Sub-System Device ID
21.EROM    0x00000000 Expansion ROM Base Address
22.NEW_CAP 0x50      New Capabilities Pointer
23.INTLN   0x0b      Interrupt Line
24.INTPIN  0x01      Interrupt Pin
25.MINGNT  0x00      Minimum Required Burst Period
26.MAXLAT  0x00      Maximum Latency
[root@localhost PCie_App]#

```

2.11.2.4 PCIe Link Speed and Width

Note: Root Privileges are required to execute this command.

```
#./pcie_ctrlplane 5 2 [Read PCIe Link Speed and Link Width]
```

Figure 98 • Linux Command—PCIe Link Speed and Width

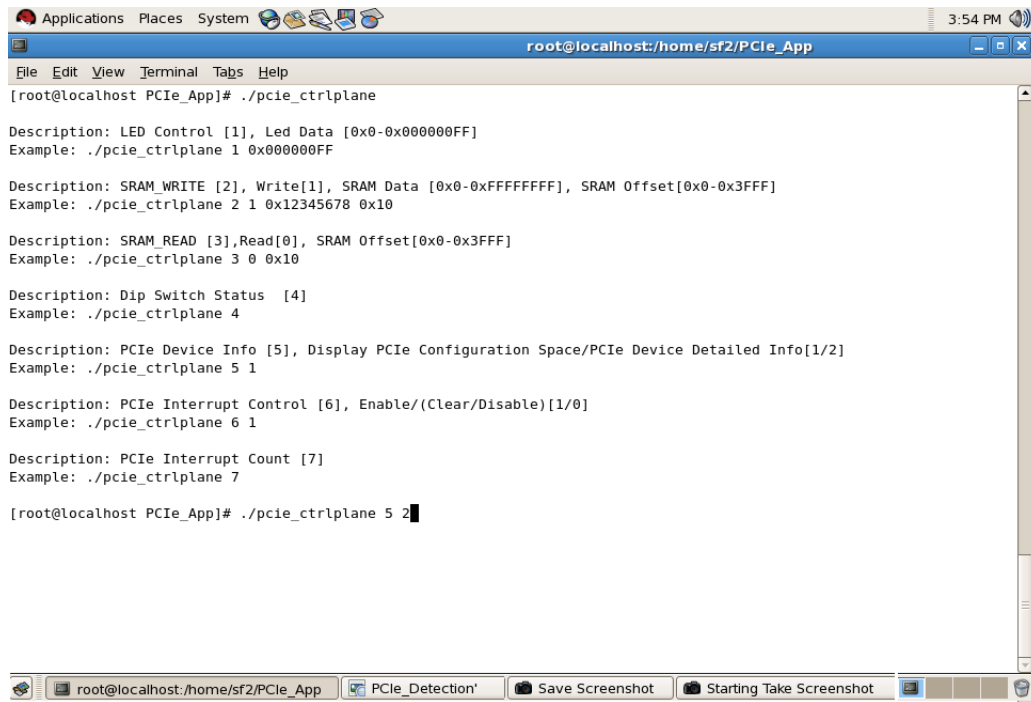
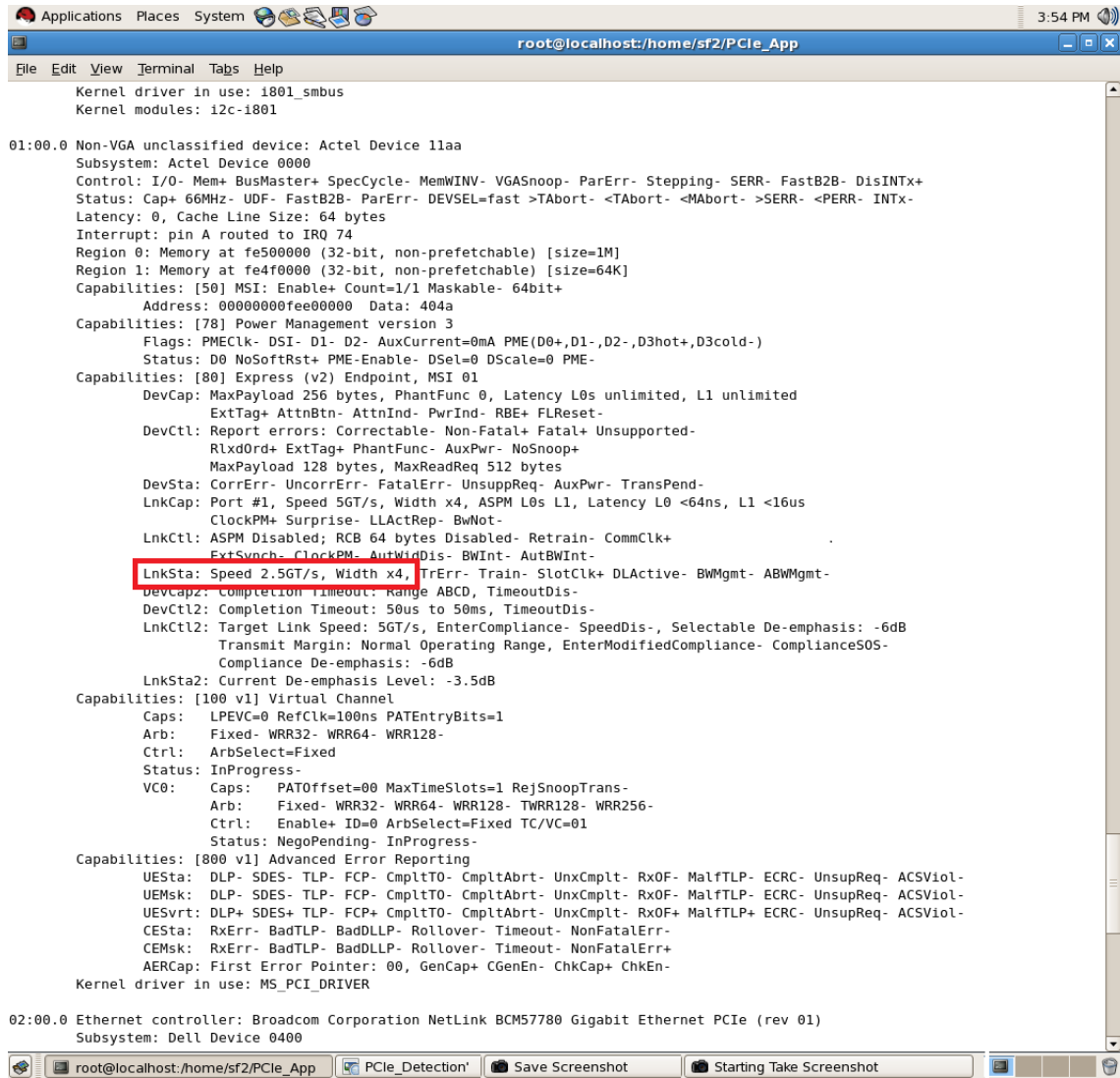


Figure 99 • Linux Command—PCIe Link Speed and Width


```

Applications Places System 3:54 PM
root@localhost:/home/sf2/PCIE_App
File Edit View Terminal Tabs Help
Kernel driver in use: i801_smbus
Kernel modules: i2c-i801

01:00.0 Non-VGA unclassified device: Actel Device 11aa
Subsystem: Actel Device 0000
Control: I/O- Mem+ BusMaster+ SpecCycle- MemWINV- VGASnoop- ParErr- Stepping- SERR- FastB2B- DisINTx+
Status: Cap+ 66MHz- UDF- FastB2B- ParErr- DEVSEL=fast >TAbort- <TAbort- <MAbort- >SERR- <PERR- INTx-
Latency: 0, Cache Line Size: 64 bytes
Interrupt: pin A routed to IRQ 74
Region 0: Memory at fe500000 (32-bit, non-prefetchable) [size=1M]
Region 1: Memory at fe4f0000 (32-bit, non-prefetchable) [size=64K]
Capabilities: [50] MSI: Enable+ Count=1/1 Maskable- 64bit+
Address: 00000000fee00000 Data: 404a
Capabilities: [78] Power Management version 3
Flags: PMEClk- DSI- D1- D2- AuxCurrent=0mA PME(D0+,D1-,D2-,D3hot+,D3cold-)
Status: D0 NoSoftRst+ PME-Enable- DSel=0 DScale=0 PME-
Capabilities: [80] Express (v2) Endpoint, MSI 01
DevCap: MaxPayload 256 bytes, PhantFunc 0, Latency L0s unlimited, L1 unlimited
ExtTag+ AttnBtn- AttnInd- PwrInd- RBE+ FLReset-
DevCtl: Report errors: Correctable- Non-Fatal+ Fatal+ Unsupported-
RlxdOrd+ ExtTag+ PhantFunc- AuxPwr- NoSnoop+
MaxPayload 128 bytes, MaxReadReq 512 bytes
DevSta: CorrErr- UncorrErr- FatalErr- UnsuppReq- AuxPwr- TransPend-
LnkCap: Port #1, Speed 5GT/s, Width x4, ASPM L0s L1, Latency L0 <64ns, L1 <16us
ClockPM+ Surprise- LLActRep- BwNot-
LnkCtl: ASPM Disabled; RCB 64 bytes Disabled- Retrain- CommClk+
ExtSynch- ClockPM- AutWidDis- BWInt- AutBWInt-
LnkSta: Speed 2.5GT/s, Width x4, TrErr- Train- SlotClk+ DLActive- BWMgmt- ABWMgmt-
DevCap2: Completion Timeout: Range ABCD, TimeoutDis-
DevCtl2: Completion Timeout: 50us to 50ms, TimeoutDis-
LnkCtl2: Target Link Speed: 5GT/s, EnterCompliance- SpeedDis-, Selectable De-emphasis: -6dB
Transmit Margin: Normal Operating Range, EnterModifiedCompliance- ComplianceS0S-
Compliance De-emphasis: -6dB
LnkSta2: Current De-emphasis Level: -3.5dB
Capabilities: [100 v1] Virtual Channel
Caps: LPEVC=0 RefClk=100ns PATEntryBits=1
Arb: Fixed- WRR32- WRR64- WRR128-
Ctrl: ArbSelect=Fixed
Status: InProgress-
VC0: Caps: PATOffset=00 MaxTimeSlots=1 RejSnoopTrans-
Arb: Fixed- WRR32- WRR64- WRR128- TWRR128- WRR256-
Ctrl: Enable+ ID=0 ArbSelect=Fixed TC/VC=01
Status: NegoPending- InProgress-
Capabilities: [800 v1] Advanced Error Reporting
UESta: DLP- SDES- TLP- FCP- CmpltTO- CmpltAbrt- UnxCmplt- RxOF- MalfTLP- ECRC- UnsupReq- ACSViol-
UEmsk: DLP- SDES- TLP- FCP- CmpltTO- CmpltAbrt- UnxCmplt- RxOF- MalfTLP- ECRC- UnsupReq- ACSViol-
UESvrt: DLP+ SDES+ TLP- FCP+ CmpltTO- CmpltAbrt- UnxCmplt- RxOF+ MalfTLP+ ECRC- UnsupReq- ACSViol-
CESSta: RxErr- BadTLP- BadDLLP- Rollover- Timeout- NonFatalErr-
CEmsk: RxErr- BadTLP- BadDLLP- Rollover- Timeout- NonFatalErr+
AERCap: First Error Pointer: 00, GenCap+ CGenEn- ChkCap+ ChkEn-
Kernel driver in use: MS_PCI_DRIVER

02:00.0 Ethernet controller: Broadcom Corporation NetLink BCM57780 Gigabit Ethernet PCIe (rev 01)
Subsystem: Dell Device 0400
PCIE_Detection' Save Screenshot Starting Take Screenshot

```

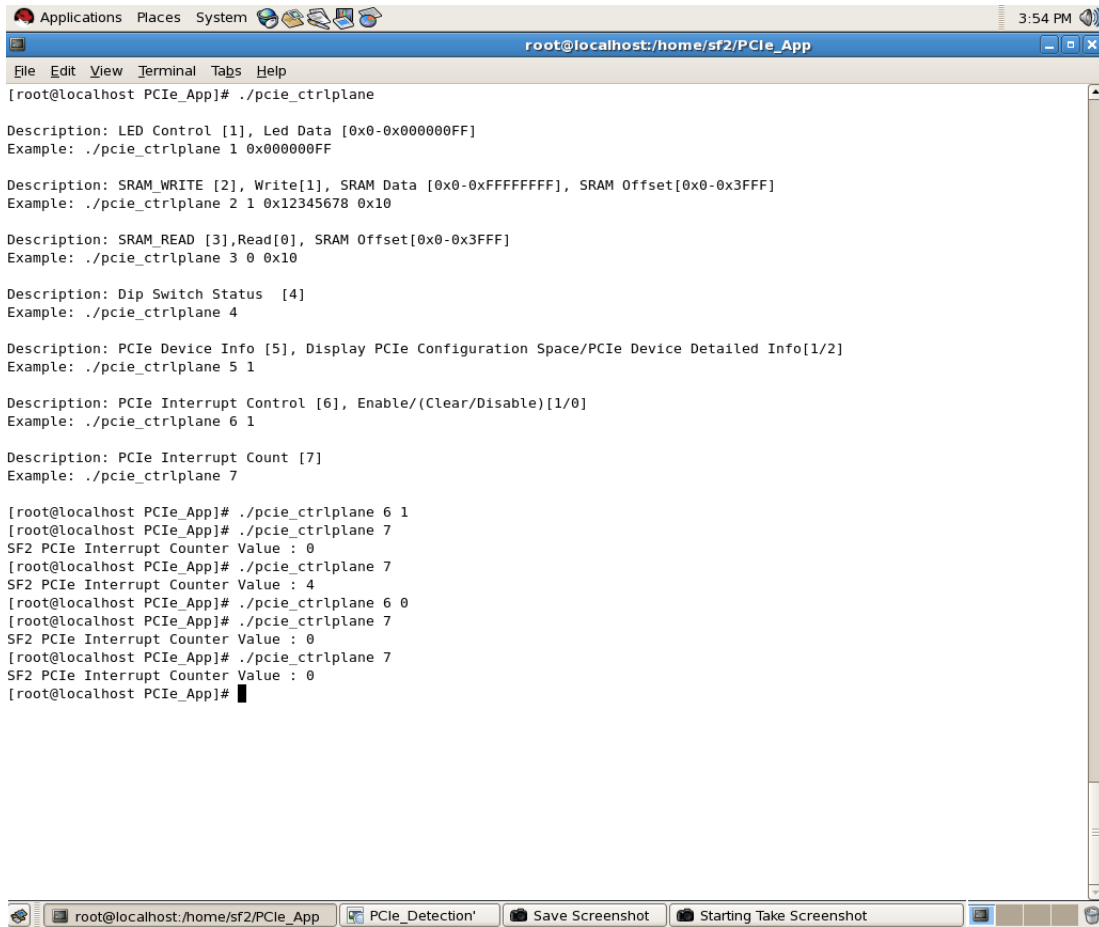
2.11.2.4.1 PCIe Interrupt Control (Enable/Disable) and Interrupt Counter

SmartFusion2 Security Evaluation Kit enable or disable the MSI interrupts by writing data to its PCIe configuration space.

Interrupt Counter holds the number of MSI interrupts got triggered by pressing the SW4 Push button.

```
#. /pcie_ctrlplane 6 0 [Disable Interrupts]
#. /pcie_ctrlplane 6 1 [Enable Interrupts]
#. /pcie_ctrlplane 7 [Interrupt Counter Value]
```

Figure 100 • Linux Command—PCIe Interrupt Control



```

root@localhost: /home/sf2/PCie_App
File Edit View Terminal Tabs Help
[root@localhost PCie_App]# ./pcie_ctrlplane

Description: LED Control [1], Led Data [0x0-0x000000FF]
Example: ./pcie_ctrlplane 1 0x000000FF

Description: SRAM_WRITE [2], Write[1], SRAM Data [0x0-0xFFFFFFFF], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 2 1 0x12345678 0x10

Description: SRAM_READ [3], Read[0], SRAM Offset[0x0-0x3FFF]
Example: ./pcie_ctrlplane 3 0 0x10

Description: Dip Switch Status [4]
Example: ./pcie_ctrlplane 4

Description: PCIe Device Info [5], Display PCIe Configuration Space/PCIe Device Detailed Info[1/2]
Example: ./pcie_ctrlplane 5 1

Description: PCIe Interrupt Control [6], Enable/(Clear/Disable)[1/0]
Example: ./pcie_ctrlplane 6 1

Description: PCIe Interrupt Count [7]
Example: ./pcie_ctrlplane 7

[root@localhost PCie_App]# ./pcie_ctrlplane 6 1
[root@localhost PCie_App]# ./pcie_ctrlplane 7
SF2 PCIe Interrupt Counter Value : 0
[root@localhost PCie_App]# ./pcie_ctrlplane 7
SF2 PCIe Interrupt Counter Value : 4
[root@localhost PCie_App]# ./pcie_ctrlplane 6 0
[root@localhost PCie_App]# ./pcie_ctrlplane 7
SF2 PCIe Interrupt Counter Value : 0
[root@localhost PCie_App]# ./pcie_ctrlplane 7
SF2 PCIe Interrupt Counter Value : 0
[root@localhost PCie_App]#

```

2.12 Conclusion

This tutorial describes how to access the PCIe endpoint features of SmartFusion2, create a simple design, and verify the design using BFM simulation. This tutorial demonstrates that the host PC can easily communicate with the SmartFusion2 Security Evaluation Kit through the provided GUI and Drivers. This tutorial also provides a Linux PCIe application for accessing PCIe endpoint device through Linux PCIe Device Driver.