

**AC437**  
**Application Note**  
**Implementing PCIe Reset Sequence in SmartFusion2**  
**and IGLOO2 Devices**



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# 1 Revision History

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

## 1.1 Revision 5.0

The following is a summary of the changes made in this revision.

- Updated the document for Libero SoC v12.6.
- Removed the references to Libero version numbers.

## 1.2 Revision 4.0

The following is a summary of the changes made in revision 4.0 of this document.

- Information about L2 state was updated. Refer [Special Consideration for L2](#), page 2.
- Information about SERDES\_IF\_2\_L2P2\_ACTIVE signal was added. Refer [M2S060 / M2S090 / M2GL060 / M2GL090 Devices without PERSTn](#), page 22 and [M2S/M2GL 060/090 Device Dual PCIe without PERSTn](#), page 30.
- Information about [M2S060 / M2S090 / M2GL060 / M2GL090 Devices with PERSTn](#), page 15 and [M2S/M2GL 060/090 Device Dual PCIe with PERSTn](#), page 23 was updated.
- Updated the document for Libero SoC v11.8 SP3 software release.

## 1.3 Revision 3.0

Updated the document for Libero SoC v11.7 software release.

## 1.4 Revision 2.0

Updated the document for Libero SoC v11.6 software release.

## 1.5 Revision 1.0

Revision 1.0 is the first publication of this document.

## 2 Implementing PCIe Reset Sequence in SmartFusion2 and IGLOO2 Devices

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### 2.1 Purpose

This application note describes how to implement the Peripheral Component Interconnect express (PCIe) reset sequence for the SmartFusion<sup>®</sup>2 System-on-Chip (SoC) Field Programmable Gate Array (FPGA) and IGLOO<sup>®</sup>2 FPGA devices using the CoreABC standalone peripheral initialization flow.

### 2.2 Introduction

The SmartFusion2 and IGLOO2 devices integrate a fourth-generation flash-based FPGA fabric and high-performance communication interfaces on a single chip. The high-speed serial interface (SERDESIF) provides a fully hardened PCIe endpoint implementation and is compliant to the PCIe base specification revision 2.0 and 1.1. For more information about SERDESIF, refer to the *UG0447: SmartFusion2 and IGLOO2 High Speed Serial Interfaces User Guide*.

The PCIe specification describes two reset generation mechanisms:

- **Fundamental reset:** Signaled through an auxiliary side-band signal PERSTn (PCIe reset, active low).
- **In-band reset:** Initiated by the host by setting a specific bit in the training sequence (hot-reset, link enabled or disabled).

PCIe reset causes endpoint device state machines, hardware logic, port states, and configuration registers (except for the sticky registers) to initialize the default conditions.

During a host initiated PCIe reset process, SERDES PCIe endpoint reset must be generated in a proper sequence, and the endpoint device must be reinitialized correctly. If the PCIe endpoint is not reset properly, this may cause corrupt data to be passed through the PCIe link.

#### 2.2.1 Special Consideration for L2

This section describes the following scenarios important for a PCIe endpoint to reset:

- PCIe endpoint connects to the PERSTn
- PCIe endpoint does not connect to the PERSTn

When the PERSTn signal is connected to the endpoint, the root port uses this signal for an endpoint to exit from L2 state. Some of the applications do not use PERSTn signal (when PCIe is used over distances through long cable or fiber lengths). In such applications, the L2 state before the root port access of an endpoint must release itself from L2 without the PERSTn connection. This self reset requirement and implementation is discussed in this application note.

This application note also describes the recommended reset sequence for the SmartFusion2 and IGLOO2 PCIe designs. The existing PCIe control plane demo reference design is modified and used to implement and describe the recommended PCIe reset sequence.

## 2.3 References

The following reference documents complement and help in understanding the relevant Microsemi SmartFusion2 and IGLOO2 FPGA devices flows and features:

- UG0447: SmartFusion2 and IGLOO2 High Speed Serial Interfaces User Guide
- SmartFusion2 Standalone Peripheral Initialization User Guide
- UG0456: SmartFusion2 SoC FPGA PCIe Control Plane Demo User Guide
- IGLOO2 Standalone Peripheral Initialization User Guide
- TU0509: Implementing PCIe Control Plane Design in IGLOO2 FPGA Tutorial

## 2.4 PCIe Control Plane Demo Design Requirements

The following table lists the hardware and software required for this application.

**Table 1 • Design Requirements**

Requirement	Version
Operating System	64 bit Windows 7 and 10
<b>Hardware</b>	
SmartFusion2 Security Evaluation Kit and IGLOO2 Rev D or later Evaluation Kit:	
<ul style="list-style-type: none"> <li>• 12 V adapter (provided along with the kit)               <ul style="list-style-type: none"> <li>- FlashPro4 programmer (provided along with the kit)</li> </ul> </li> </ul>	
<b>Software</b>	
FlashPro Express	Refer to the <code>readme.txt</code> file provided in the design files for the software versions used with this reference design.
Libero® System-on-Chip (SoC)	
SoftConsole	
Host PC Drivers	Refer <i>TU0456: SmartFusion2 SoC FPGA PCIe Control Plane Tutorial</i>
GUI executable	The GUI executable is available at GUI folder of <i>TU0456: SmartFusion2 SoC FPGA PCIe Control Plane Tutorial</i> design file.

**Note:** Libero SmartDesign and configuration screen shots shown in this guide are for illustration purpose only. Open the Libero design to see the latest updates.



## 2.5 Prerequisites

Before you begin:

1. Download and install Libero SoC (as indicated in the website for this design) on the host PC from the following location.

<https://www.microsemi.com/product-directory/design-resources/1750-libero-soc>

2. For demo design files download link:

[http://soc.microsemi.com/download/rsc/?f=m2s\\_m2gl\\_ac437\\_df](http://soc.microsemi.com/download/rsc/?f=m2s_m2gl_ac437_df)

The design file consists of the Libero SoC Verilog project, SoftConsole software project, and programming files (\*.job) for the SmartFusion2 Security Evaluation Kit board and IGLOO2 Evaluation Kit board. Refer to the `Readme.txt` file included in the design file for the directory structure and description.

## 2.6 Design Description

The implementation of a PCIe reset sequence, which supports the host reset involves detection of PCIe reset using the FPGA fabric logic and generating the reset for endpoint block.

PCIe reset sequence is device dependent and based on whether PERSTn is used in the design. As a result, the reference designs are categorized into the following four use models:

- [M2S010 / M2S025 / M2S050 / M2S150 / M2GL010 / M2GL025 / M2GL050 / M2GL150 Devices with PERSTn, page 5](#)
- [M2S010 / M2S025 / M2S050 / M2S150 / M2GL010 / M2GL025 / M2GL050 / M2GL150 Devices without PERSTn, page 12](#)
- [M2S060 / M2S090 / M2GL060 / M2GL090 Devices with PERSTn, page 15](#)
- [M2S060 / M2S090 / M2GL060 / M2GL090 Devices without PERSTn, page 22](#)
- [M2S/M2GL 060/090 Device Dual PCIe with PERSTn, page 23](#)
- [M2S/M2GL 060/090 Device Dual PCIe without PERSTn, page 30](#)

**Note:** The System Builder flow does not implement the PCIe/SERDES reset sequence automatically as described in this application note. To implement the PCIe reset sequence, the SERDES standalone peripheral initialization methodology must be followed. For more information about peripheral initialization methodology, refer the following documents:

- [SmartFusion2 Standalone Peripheral Initialization User Guide](#)
- [IGLOO2 Standalone Peripheral Initialization User Guide](#)

## 2.7 Implementation

The implementation details for each of the above four scenarios are described as follows:

This application note uses M2GL010 Evaluation Kit and the M2S090 Security Evaluation Kit to implement the PCIe reset sequence. These two examples provide both the methods for implementing the PCIe reset sequence.

**Note:** This application note uses customized M2S090 Kit to implement the PCIe reset sequence for dual PCIe controller.

**Note:** For the PCIe reset sequence implementation, the CoreABC clock must be more than 1 MHz.

**Note:** The PCIe reset sequence described in this application note requires the following register bit settings, which are default settings in Libero:

- `cfgr_l2_p2_enable = 1'b1`
- `enable_perstn_support = 1'b0`

## 2.7.1 M2S010 / M2S025 / M2S050 / M2S150 / M2GL010 / M2GL025 / M2GL050 / M2GL150 Devices with PERSTn

Figure 1, page 6 shows the implementation of PCIe reset sequence for M2S010 / M2S025 / M2S050 / M2S150 / M2GL010 / M2GL025 / M2GL050 / M2GL150 devices with PERSTn. The PCIe reset detection logic detects the PCIe reset and resets the SERDES and CoreABC through the CoreResetP. CoreABC is used to initialize the SERDES (PCIe) through the APB interface. In addition, the APB\_MUX logic is implemented to support access to the Microcontroller Subsystem (MSS) or High-Performance Memory Subsystem (HPMS). By using the APB MUX logic, the user can retain access through SmartFusion2 ARM Cortex-M3 or utilizing the SmartDebug SERDES utility, which is available for both SmartFusion2 and IGLOO2 devices.

**Note:** The method to reset the PCIe controller resets the entire controller including the configuration space. This clears any of the “sticky” bits contained in these registers. If any of these sticky bits are important for the application software on the host, the information must be gathered before the HotReset event is initiated.

The PCIe reset detection logic and SERDES reset generation is explained as follows:

### 2.7.1.1 PCIe Reset Detection

Detect the entry of the PCIe endpoint to the HOT\_RESET state by monitoring the LTSSM[4:0] bits and then call the signal as hot\_reset\_n\_ltssm. The Link Training and Status State Machine (LTSSM) bits are available as CoreConfigP output signal PRDATA[30:26].

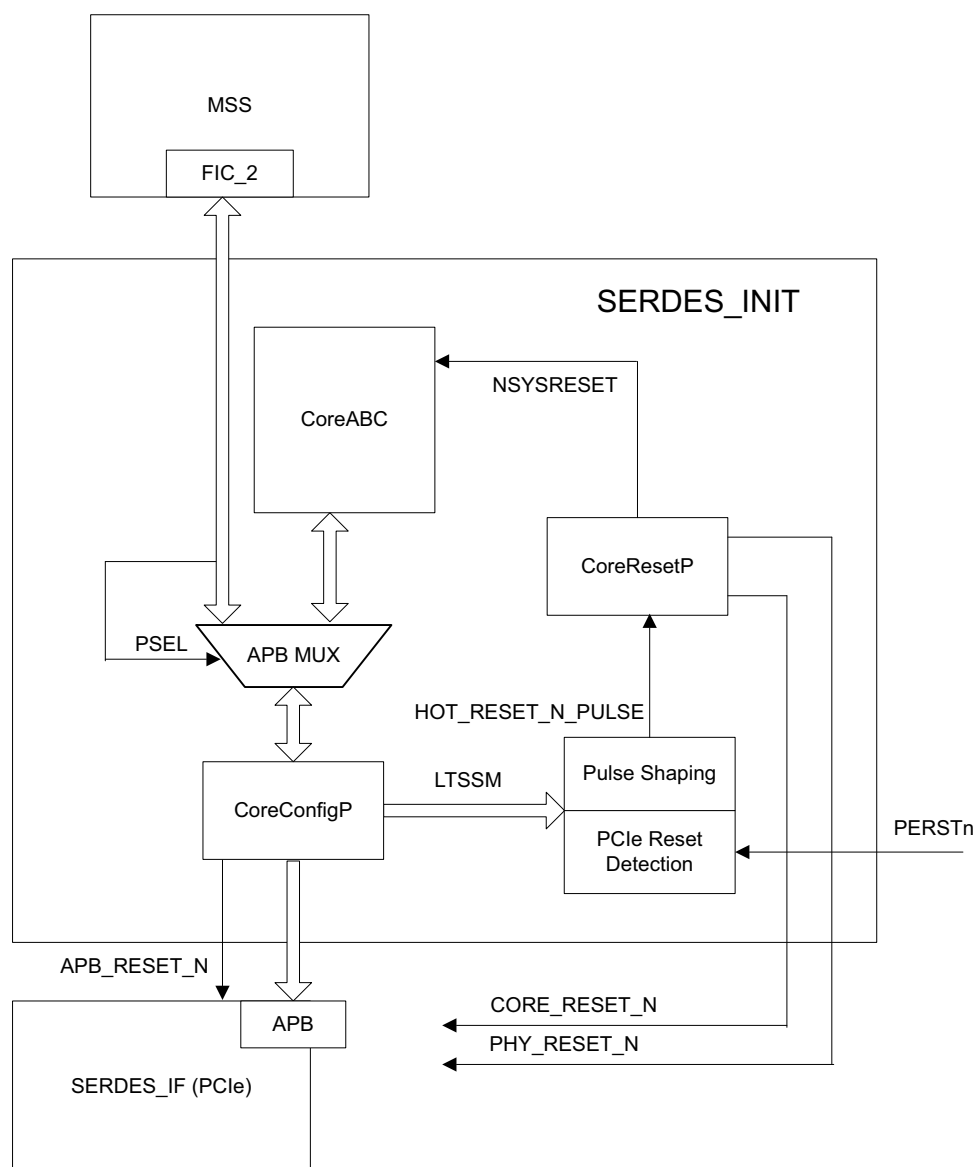
Generate hot\_reset\_n as the following: hot\_reset\_n = PERSTn and hot\_reset\_n\_ltssm.

Connect the PERST\_N of SERDES\_INIT directly to PERSTn on board.

### 2.7.1.2 SERDES (PCIe) Reset Generation

Use the pulse shaping logic to generate the reset pulse from the hot\_reset\_n and connect it to the CoreResetP asynchronous reset input to reset the SERDES core (PMA reset, PCIE controller reset, and APB reset). Release the SERDES resets and reinitialize the SERDES using CoreABC.

The following figure shows the M2S010 / M2S025 / M2S050 / M2S150 / M2GL010 / M2GL025 / M2GL050 / M2GL150 devices PCIe reset generation with PERSTn.

**Figure 1 • M2S/M2GL010/025/050/150 Device PCIe Reset Generation with PERSTn**


The PCIe control plane demo design for the M2GL010 Evaluation Kit is created using the CoreABC standalone peripheral initialization method, and the HOTRESET logic is implemented to detect the PCIe reset. The top-level SmartDesign with the SERDES\_INIT and SERDES\_IF blocks are shown in the following figure. The SERDES\_INIT is a SmartDesign block to initialize the SERDES and to generate the SERDES (PCIe) resets.

The following figure shows the SERDES INIT SmartDesign.

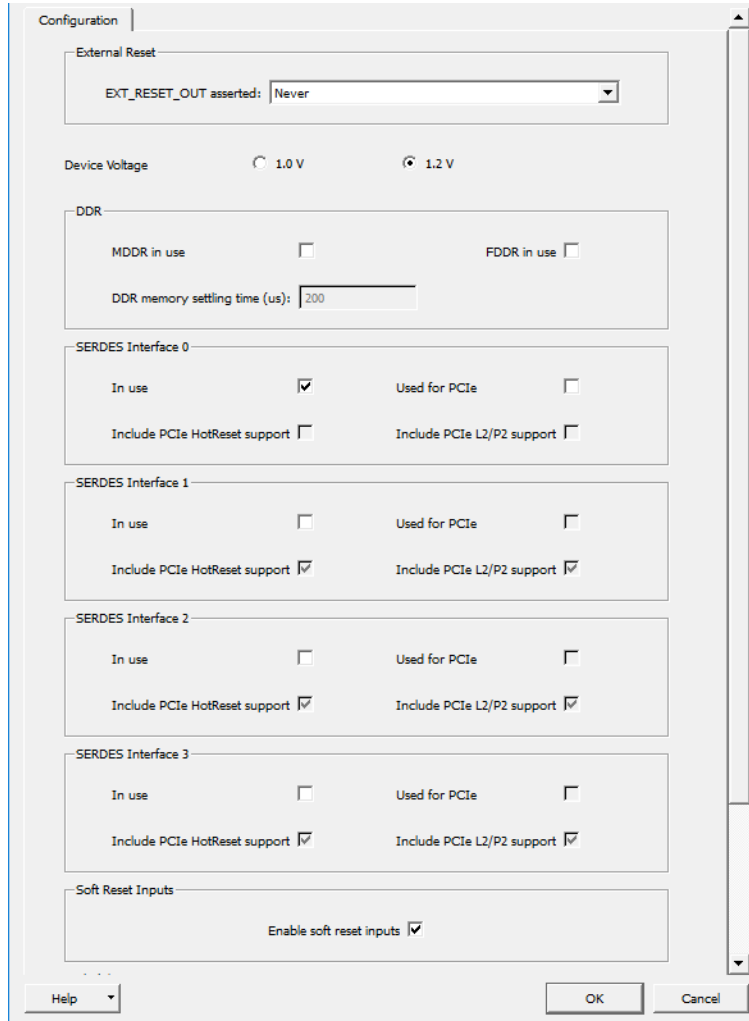
The diagram illustrates the reset logic for the i.MX6Q. It shows the following components and their connections:

- HOTRESET\_0**: Receives inputs from `CLK_BASE`, `CLK_L1TSSM`, `RSEL`, `PWRITE`, `POWER_ON_RESET_N`, `RESET_N`, `SOPF_CORE_RESET_N`, and `PRDATA[10]`. It outputs `HOT_RESET_N_PULSE`.
- CoreResetP\_0**: Receives `HOT_RESET_N_PULSE` and outputs multiple reset signals: `RESET_N_MZF`, `FC2_APB_M_PRESET_N`, `FC2_APB_M_PCLK`, `POWER_ON_RESET_N`, `PAB_RESET_N`, `WDOG2_24_10MHz`, `SOPF_CORE_RESET_N`, `SOPF_PHY_RESET_N`, `CLK_BASE`, `SOPF_SALL_LOCK`, `CONFIG1_DONE`, `SOFT_EXT_RESET_OUT`, `SOFT_RESET_P2M`, `SOFT_M0_RESET`, `SOFT_SOPF_PHY_RESET`, and `SOFT_SOPF_CORE_RESET`.
- COREABC\_0**: Receives `NSV3RESET` and `POLK_O_IN[0]`. It outputs `PRESETN_O_OUT[0]`.
- APB\_MUX\_0**: Receives `APB_M` and outputs `APB_S_PCLK`, `APB_S_PRESET_N`, `CONF1_DONE`, `SOFT_EXT_RESET_OUT`, `SOFT_RESET_P2M`, `SOFT_SOPF_PHY_RESET`, and `SOFT_SOPF_CORE_RESET`.
- CoreConfigP\_0**: Receives `FC2_APB_M_PRESET_N`, `FC2_APB_M_PCLK`, `SWF_RELEASED_INT_DONE`, `CONF1_DONE`, `SOFT_EXT_RESET_OUT`, `SOFT_RESET_P2M`, `SOFT_SOPF_PHY_RESET`, `SOFT_SOPF_CORE_RESET`, `R_SOPF_PSEL`, `R_SOPF_WRITE`, and `R_SOPF_MAXCAP[0]`. It outputs `YAC_S_DONE`, `YAC_S_RESET_N`, and `SWF_AFFINITY`.

Additional signals shown include `SOPF_READY`, `SOPF_CORE_RESET_N`, `SOPF_PHY_RESET_N`, `YAC_S_DONE`, `YAC_S_RESET_N`, and `SWF_AFFINITY`.

The following figure shows the CoreResetP configured for SERDES\_IF\_0 block.

**Figure 4 • CoreResetP Configuration**



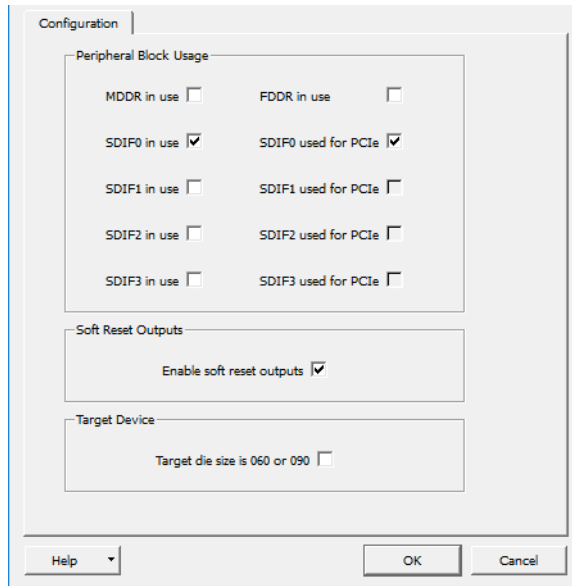
The image shows a 'Configuration' dialog box for the CoreResetP block. It contains several sections for configuring reset behavior:

- External Reset:** A dropdown menu for 'EXT\_RESET\_OUT asserted:' is set to 'Never'.
- Device Voltage:** Radio buttons for '1.0 V' and '1.2 V'. '1.2 V' is selected.
- DDR:** Checkboxes for 'MDDR in use' and 'FDDR in use' are both unchecked. A text field for 'DDR memory settling time (us):' is set to '200'.
- SERDES Interface 0:** 'In use' is checked. 'Used for PCIe' is unchecked. 'Include PCIe HotReset support' and 'Include PCIe L2/P2 support' are both unchecked.
- SERDES Interface 1:** 'In use' is unchecked. 'Used for PCIe' is unchecked. 'Include PCIe HotReset support' and 'Include PCIe L2/P2 support' are both checked.
- SERDES Interface 2:** 'In use' is unchecked. 'Used for PCIe' is unchecked. 'Include PCIe HotReset support' and 'Include PCIe L2/P2 support' are both checked.
- SERDES Interface 3:** 'In use' is unchecked. 'Used for PCIe' is unchecked. 'Include PCIe HotReset support' and 'Include PCIe L2/P2 support' are both checked.
- Soft Reset Inputs:** 'Enable soft reset inputs' is checked.

At the bottom, there are 'Help', 'OK', and 'Cancel' buttons.

The following figure shows the CoreConfigP configured for SERDES\_IF\_0 block.

**Figure 5 • CoreConfigP Configuration**



The image shows a 'Configuration' dialog box for CoreConfigP. It has a title bar 'Configuration' and a 'Help' dropdown button. The main content area is divided into three sections: 'Peripheral Block Usage', 'Soft Reset Outputs', and 'Target Device'. The 'Peripheral Block Usage' section contains a table of checkboxes for MDDR, FDDR, and four SDIF blocks, with 'SDIF0 in use' and 'SDIF0 used for PCIe' checked. The 'Soft Reset Outputs' section has 'Enable soft reset outputs' checked. The 'Target Device' section has 'Target die size is 060 or 090' unchecked. At the bottom are 'OK' and 'Cancel' buttons.

Peripheral Block Usage	
MDDR in use <input type="checkbox"/>	FDDR in use <input type="checkbox"/>
SDIF0 in use <input checked="" type="checkbox"/>	SDIF0 used for PCIe <input checked="" type="checkbox"/>
SDIF1 in use <input type="checkbox"/>	SDIF1 used for PCIe <input type="checkbox"/>
SDIF2 in use <input type="checkbox"/>	SDIF2 used for PCIe <input type="checkbox"/>
SDIF3 in use <input type="checkbox"/>	SDIF3 used for PCIe <input type="checkbox"/>

Soft Reset Outputs

Enable soft reset outputs ☒

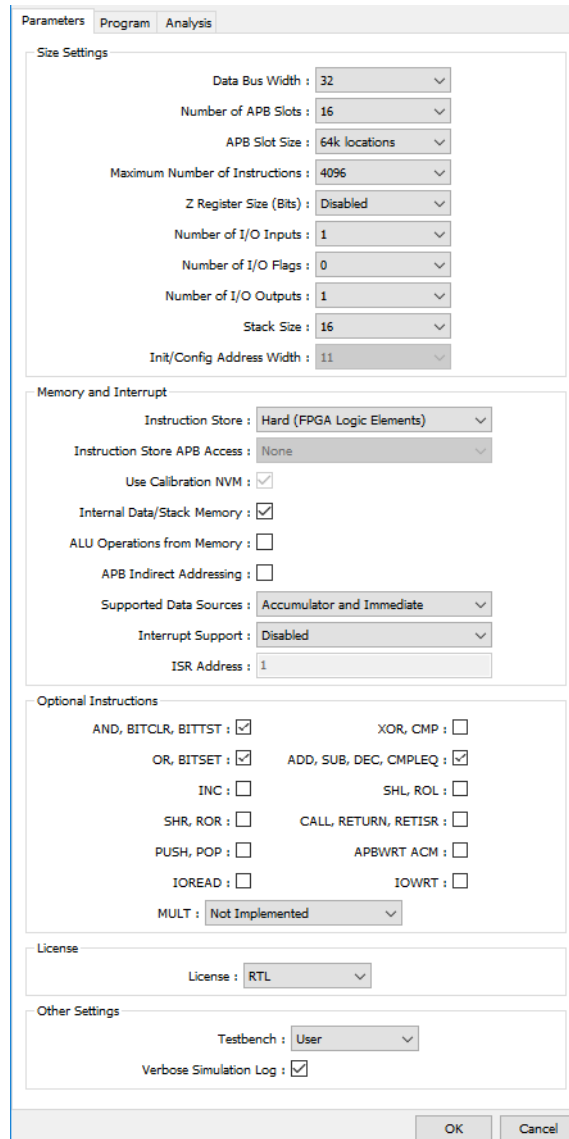
Target Device

Target die size is 060 or 090 ☐

Help OK Cancel

CoreABC is configured, as shown in the following figure.

**Figure 6 • CoreABC Configuration**



The figure shows the CoreABC Configuration dialog box with the following settings:

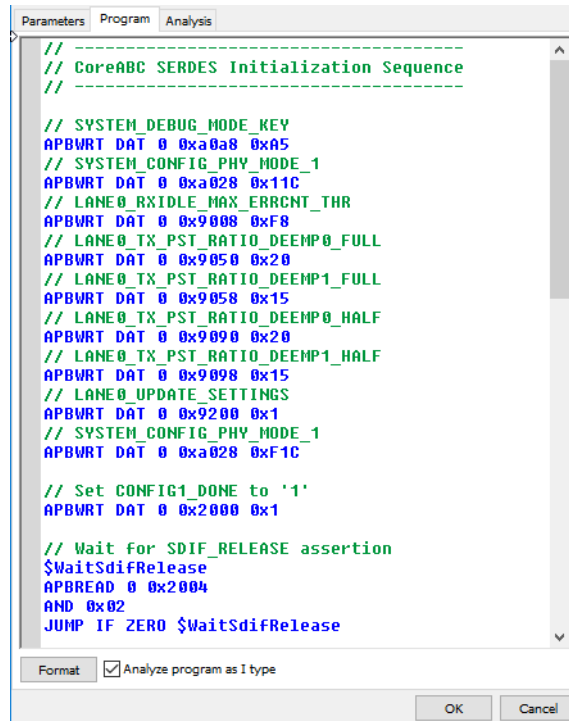
- Parameters** tab is selected.
- Size Settings:**
  - Data Bus Width: 32
  - Number of APB Slots: 16
  - APB Slot Size: 64k locations
  - Maximum Number of Instructions: 4096
  - Z Register Size (Bits): Disabled
  - Number of I/O Inputs: 1
  - Number of I/O Flags: 0
  - Number of I/O Outputs: 1
  - Stack Size: 16
  - Init/Config Address Width: 11
- Memory and Interrupt:**
  - Instruction Store: Hard (FPGA Logic Elements)
  - Instruction Store APB Access: None
  - Use Calibration NVM: ☒
  - Internal Data/Stack Memory: ☒
  - ALU Operations from Memory: ☐
  - APB Indirect Addressing: ☐
  - Supported Data Sources: Accumulator and Immediate
  - Interrupt Support: Disabled
  - ISR Address: 1
- Optional Instructions:**
  - AND, BITCLR, BITTST: ☒
  - XOR, CMP: ☐
  - OR, BITSET: ☒
  - ADD, SUB, DEC, CMPLAQ: ☒
  - INC: ☐
  - SHL, ROL: ☐
  - SHR, ROR: ☐
  - CALL, RETURN, RETISR: ☐
  - PUSH, POP: ☐
  - APBWRT ACM: ☐
  - IOREAD: ☐
  - IOWRT: ☐
  - MULT: Not Implemented
- License:**
  - License: RTL
- Other Settings:**
  - Testbench: User
  - Verbose Simulation Log: ☒

Buttons: OK, Cancel



The Libero generates the `SERDESIF_O_init_abc.txt` file at `<prt_location>\Libero_Project\component\work\top\SERDES_IF_0` with CoreABC code to initialize the SERDES (PCIe). This code is used for CoreABC program as shown in the following figure.

**Figure 7 • CoreABC Code**



```
// -----
// CoreABC SERDES Initialization Sequence
// -----

// SYSTEM_DEBUG_MODE_KEY
APBVRT DAT 0 0xa0a8 0xa5
// SYSTEM_CONFIG_PHY_MODE_1
APBVRT DAT 0 0xa028 0x11c
// LANE0_RXIDLE_MAX_ERRCNT_THR
APBVRT DAT 0 0x9008 0xf8
// LANE0_TX_PST_RATIO_DEEMP0_FULL
APBVRT DAT 0 0x9050 0x20
// LANE0_TX_PST_RATIO_DEEMP1_FULL
APBVRT DAT 0 0x9058 0x15
// LANE0_TX_PST_RATIO_DEEMP0_HALF
APBVRT DAT 0 0x9090 0x20
// LANE0_TX_PST_RATIO_DEEMP1_HALF
APBVRT DAT 0 0x9098 0x15
// LANE0_UPDATE_SETTINGS
APBVRT DAT 0 0x9200 0x1
// SYSTEM_CONFIG_PHY_MODE_1
APBVRT DAT 0 0xa028 0xf1c

// Set CONFIG1_DONE to '1'
APBVRT DAT 0 0x2000 0x1

// Wait for SDIF_RELEASE assertion
$WaitSdifRelease
APBREAD 0 0x2004
AND 0x02
JUMP IF ZERO $WaitSdifRelease
```

## 2.7.2 M2S010 / M2S025 / M2S050 / M2S150 / M2GL010 / M2GL025 / M2GL050 / M2GL150 Devices without PERSTn

The following figure shows the implementation of PCIe reset sequence for M2S010 / M2S025 / M2S050 / M2S150 / M2GL010 / M2GL025 / M2GL050 / M2GL150 devices without PERSTn.

### 2.7.2.1 PCIe Reset Detection

Detect the entry of the PCIe endpoint to the HOT\_RESET and L2 state by monitoring the LTSSM[4:0] bits and call the signals as `hot_reset_n_ltssm` and `l2_detected_n`. The LTSSM bits are available as APB signal `PRDATA[30:26]`.

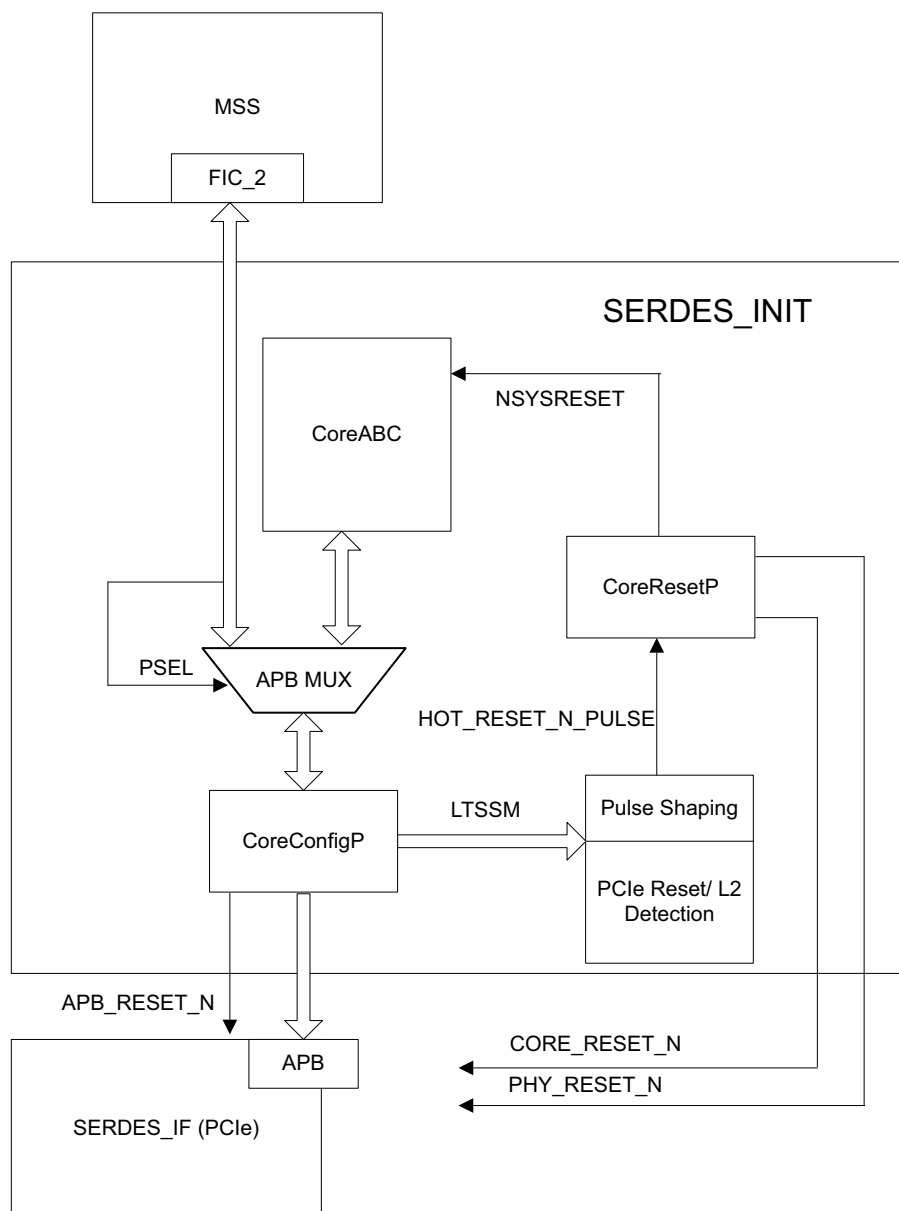
Generate `hot_reset_n` as the following: `hot_reset_n = l2_detected_n & hot_reset_n_ltssm`.

### 2.7.2.2 SERDES (PCIe) Reset Generation

Use pulse shaping logic to generate the reset pulse from the `hot_reset_n` and connect it to the CoreResetP asynchronous reset input to reset the SERDES core (PMA reset, PCIE controller reset, and APB reset). Release the SERDES resets and reinitialize the SERDES using CoreABC.

**Note:** The method to reset the PCIe controller resets the entire controller including the configuration space. This clears any of the “sticky” bits contained in these registers. If any of these sticky bits are important for the application software on the host, the information should be gathered before the HotReset event is initiated.

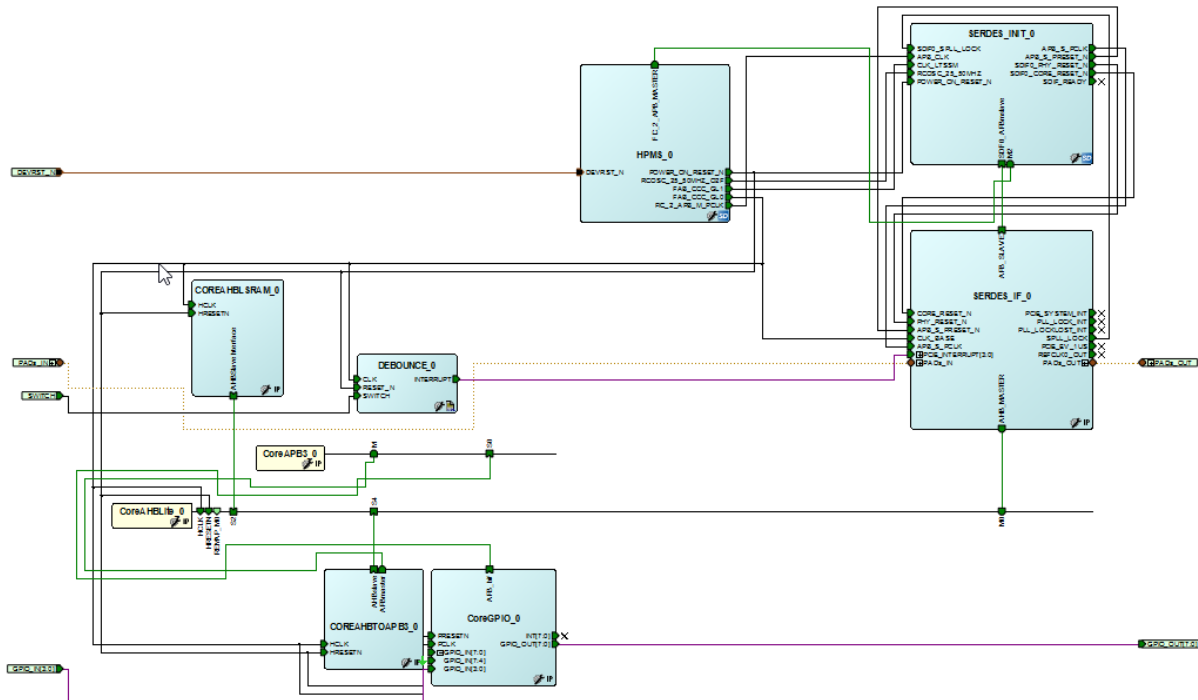
**Figure 8 • M2S010 / M2S025 / M2S050 / M2S150 / M2GL010 / M2GL025 / M2GL050 / M2GL150  
Devices PCIe Reset Generation without PERSTn**



### 2.7.2.3 Implementation using M2GL010 Evaluation Kit

The PCIe control plane demo design for the M2GL010 Evaluation Kit is created using the CoreABC standalone peripheral initialization method, and the HOTRESET logic is implemented to detect the PCIe reset. The top-level SmartDesign with the SERDES\_INIT and SERDES\_IF blocks are shown in the following figure. The SERDES\_INIT is implemented to detect the PCIe reset without monitoring the PERSTn and to generate the SERDES (PCIe) resets.

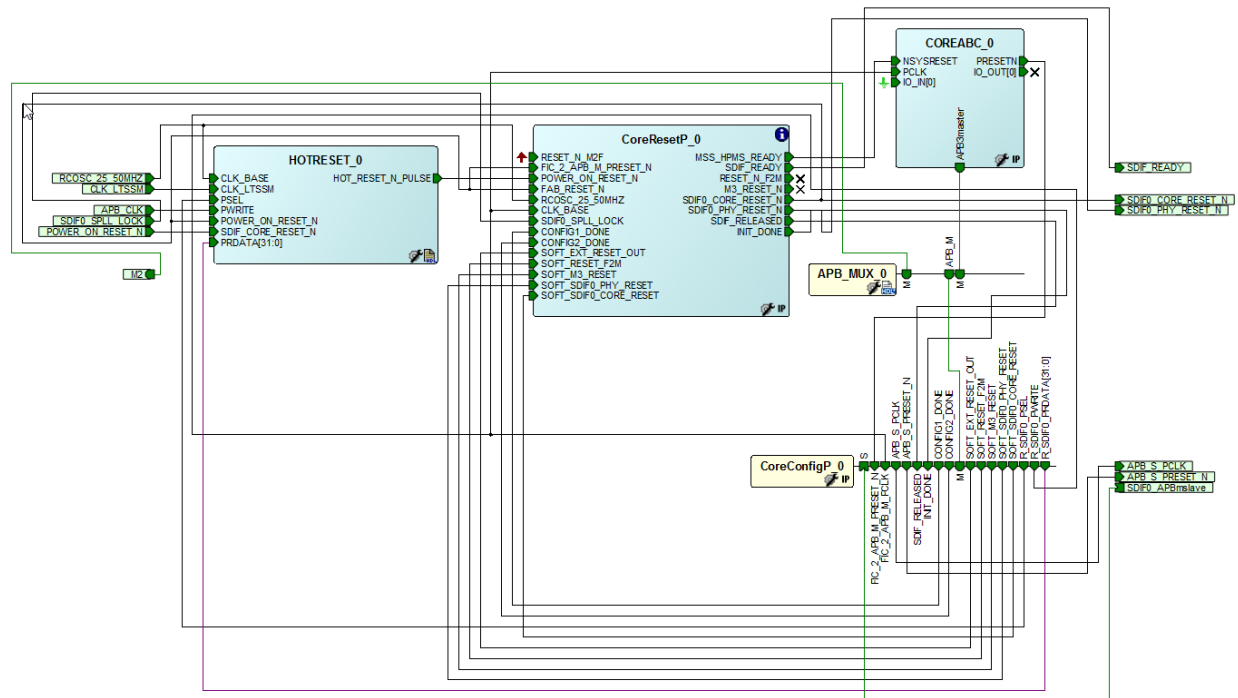
### Figure 9 • Top-Level Design



The SERDES\_INIT has CoreABC, CoreResetP, CoreConfigP, and HOTRESET blocks, as shown in the following figure. The HOTRESET logic monitors the LTSSM (PRDATA [30:26]) signals for hot reset state and L2 state and generates the HOT\_RESET\_N\_PULSE signal. It is connected to the CoreResetP (FAB\_RESET\_N), which generates resets to SERDES (PCIe) and performs re-initialization of SERDES through CoreABC and CoreConfigP. The configuration of CoreResetP, CoreConfigP, and CoreABC is same as described in [M2S010 / M2S025 / M2S050 / M2S150 / M2GL010 / M2GL025 / M2GL050 / M2GL150 Devices with PERSTn](#), page 5.

The following figure shows the SERDES INIT SmartDesign.

**Figure 10 • SERDES INIT SmartDesign**



## 2.7.3 M2S060 / M2S090 / M2GL060 / M2GL090 Devices with PERSTn

The following figure shows the implementation of the PCIe reset sequence for M2S060 / M2S090 / M2GL060 / M2GL090 devices with PERSTn. The PCIe reset detection logic detects the PCIe reset and triggers the CoreABC to reset the SERDES Core and AXI using the soft reset. Also, the APB\_MUX logic is implemented to support access to the MSS/HPMS. By using the APB MUX, the user can retain access through the SmartFusion2 Cortex-M3 or utilizing the SmartDebug SERDES utility, which is available for both SmartFusion2 and IGLOO2 devices.

The CoreABC takes few APB cycles to reset the SERDES Core and AXI IF. During these cycles, the SERDES AXI master initiates buffered AXI/AHB transactions and the fabric AXI/AHB slave logic should indicate the busy state to AXI master. In this application note, an AXI\_AHB reset is generated to AHB\_to\_AHB.v logic (which asserts the HREADY to '0' during reset) during the reset operation of SERDES Core/AXI IF.

### 2.7.3.1 PCIe Reset Detection

The SERDES\_IF2 (PCIe) has LTSSM[5] and L2P2\_ACTIVE signals. The LTSSM[5] indicates hot-reset, data link up or L2 exit. The L2P2\_ACTIVE indicates that PCIe is in L2 state.

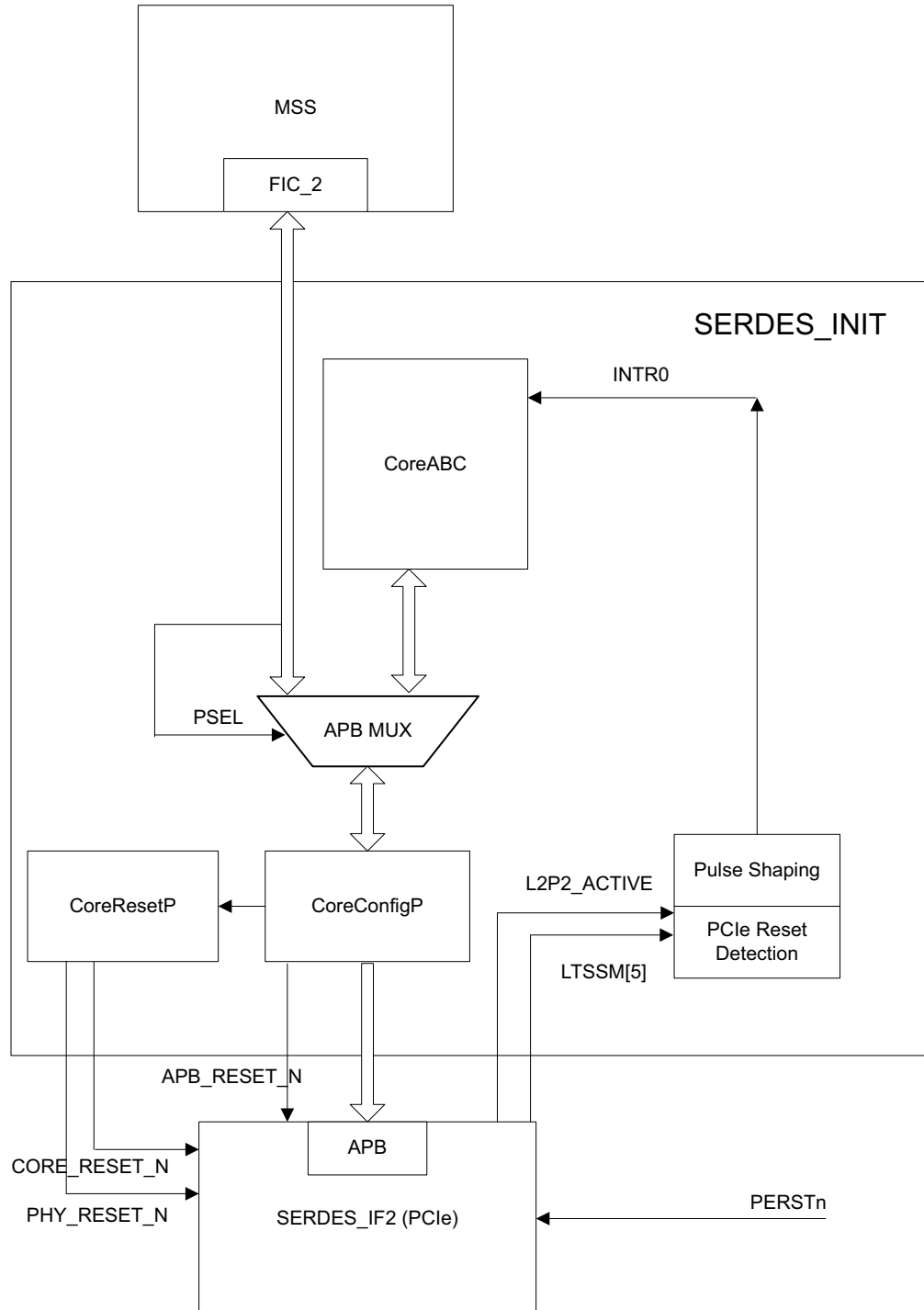
Generate the hot\_reset\_n as the following:  $\text{hot\_reset\_n} = (! \text{L2P2\_ACTIVE}) \& (! \text{LTSSM}[5])$ .

Connect the SERDES PCIe PERST\_N directly to PERSTn on board.

### 2.7.3.2 SERDES (PCIe) Reset Generation

Use `hot_reset_n` to generate interrupt `INTR0` to CoreABC. The pulse shaping logic generates `INTR0` synchronized to the CoreABC clock domain. The CoreABC interrupt routine resets the SERDES PCIE controller reset, and AXI reset using the soft reset register.

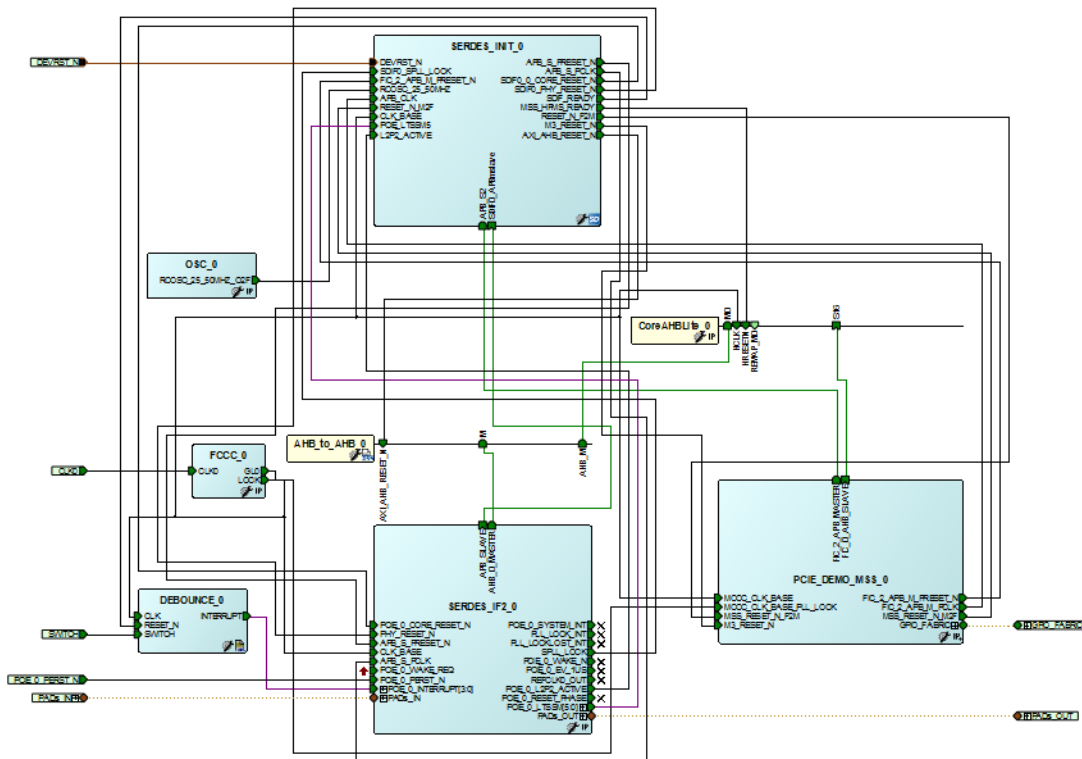
**Figure 11 • M2S060 / M2S090 / M2GL060 / M2GL090 Devices PCIe Reset Generation with PERSTn**



### 2.7.3.3 Implementation using M2S090 Security Evaluation Kit

The PCIe control plane demo design for the M2S090 Security Evaluation Kit is created using CoreABC standalone peripheral initialization method and the HOTRESET logic is implemented to detect the PCIe reset. The top-level SmartDesign with the SERDES\_INIT and SERDES\_IF blocks are shown in the following figure. The SERDES\_INIT is a SmartDesign block to initialize the SERDES and to generate the SERDES (PCIe) resets. The SERDES\_IF\_2 PERST\_N signal is directly connected to the PERSTn on the board.

**Figure 12 • Top Level Design**

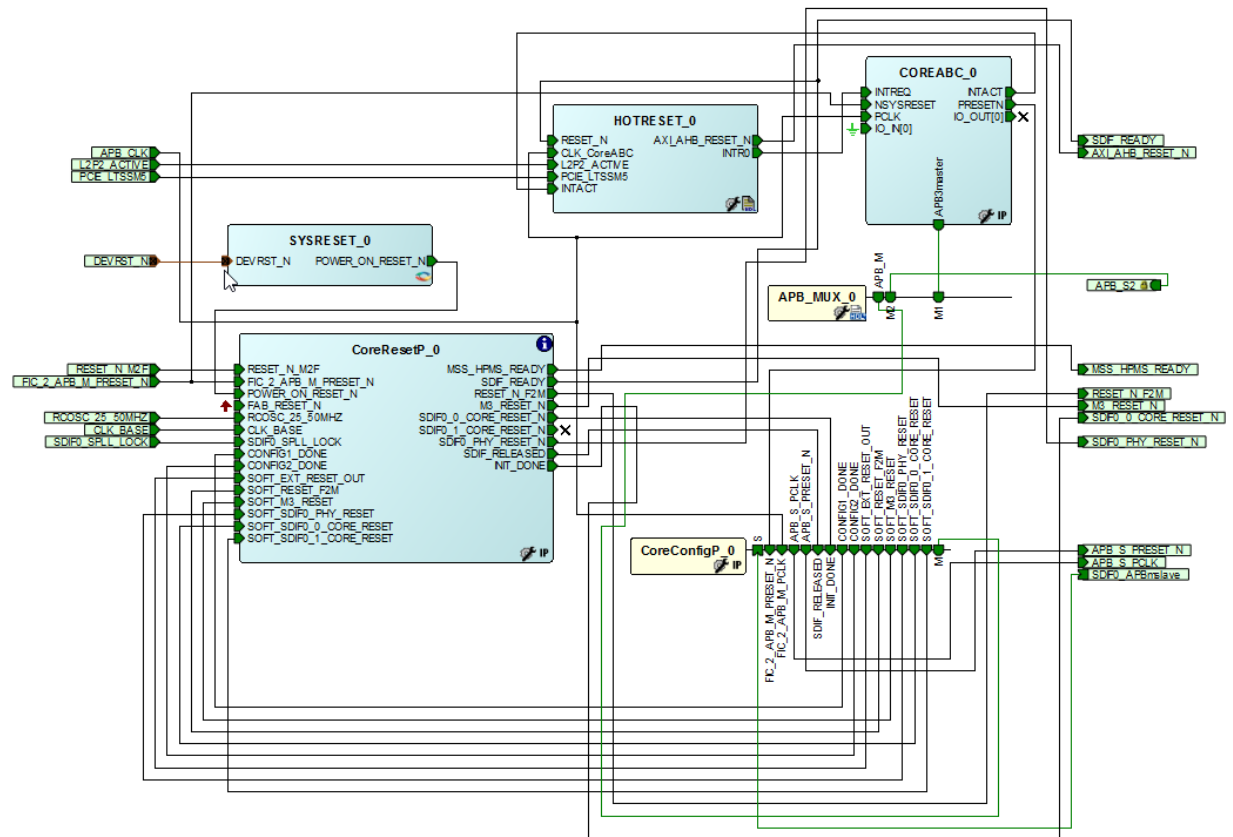


The SERDES\_INIT SmartDesign has CoreABC, CoreResetP, CoreConfigP, APB\_MUX, and HOTRESET blocks, as shown in the following figure. The HOTRESET logic monitors the LTSSM[5], L2P2\_ACTIVE signals and generates the INTR0 signal. It is connected to the INTREQ of CoreABC and CoreABC interrupt routine issues SERDES (PCIe) Core and the AXI soft resets, when INTREQ goes low.

**Note:** The HOTRESET logic uses INTACT signal from CoreABC to de-assert the INTR0 interrupt, which is synchronous to CoreABC/HOTRESET logic clock. The INTACT - interrupt acknowledge signals needs to be synchronized to HOTRESET logic if any other processor is used for implementing PCIe reset sequence.

The following figure shows the SERDES INIT SmartDesign.

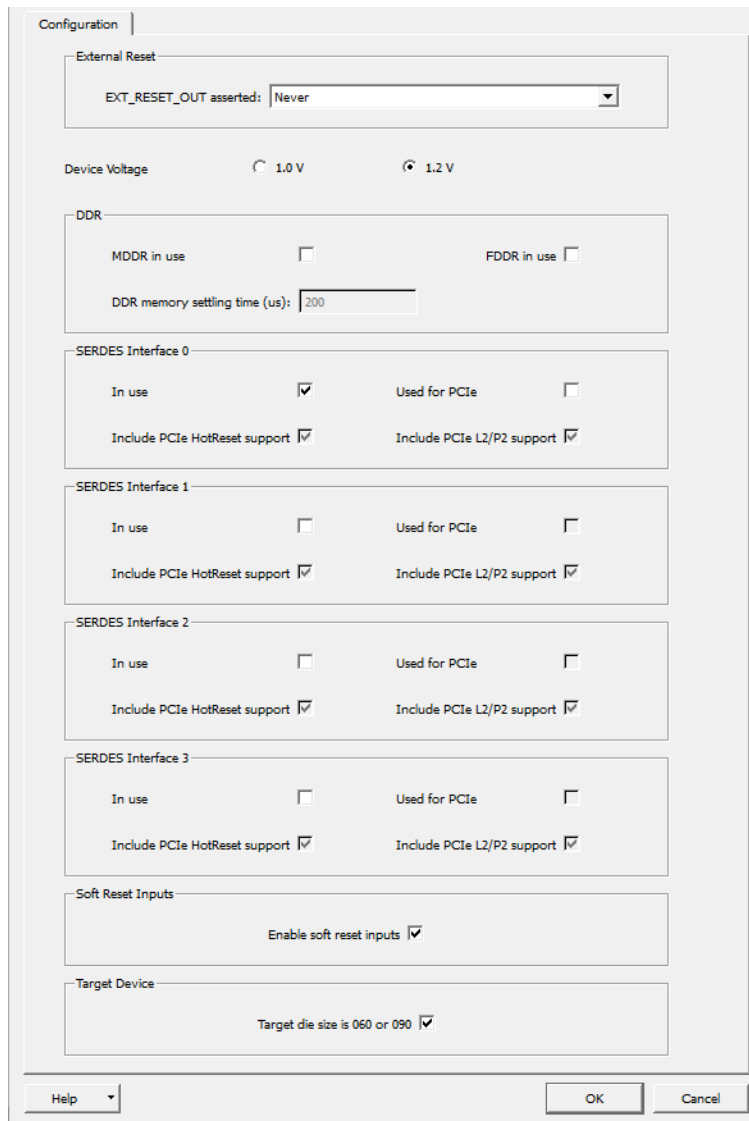
**Figure 13 • SERDES INIT SmartDesign**



CoreResetP is configured to generate resets for SERDES\_IF2\_0, as shown in the following figure.

Select only the SERDES interface check box. Do not select the other PCIe check boxes as those functionalities are already implemented in the HOTRESET block.

**Figure 14 • CoreResetP Configuration**



The figure shows the CoreResetP Configuration dialog box. The configuration is as follows:

- External Reset:** EXT\_RESET\_OUT asserted: Never
- Device Voltage:** 1.0 V (radio button), 1.2 V (radio button, selected)
- DDR:**
  - MDDR in use: ☐
  - FDDR in use: ☐
  - DDR memory settling time (us): 200
- SERDES Interface 0:**
  - In use: ☒
  - Used for PCIe: ☐
  - Include PCIe HotReset support: ☒
  - Include PCIe L2/P2 support: ☒
- SERDES Interface 1:**
  - In use: ☐
  - Used for PCIe: ☐
  - Include PCIe HotReset support: ☒
  - Include PCIe L2/P2 support: ☒
- SERDES Interface 2:**
  - In use: ☐
  - Used for PCIe: ☐
  - Include PCIe HotReset support: ☒
  - Include PCIe L2/P2 support: ☒
- SERDES Interface 3:**
  - In use: ☐
  - Used for PCIe: ☐
  - Include PCIe HotReset support: ☒
  - Include PCIe L2/P2 support: ☒
- Soft Reset Inputs:**
  - Enable soft reset inputs: ☒
- Target Device:**
  - Target die size is 060 or 090: ☒

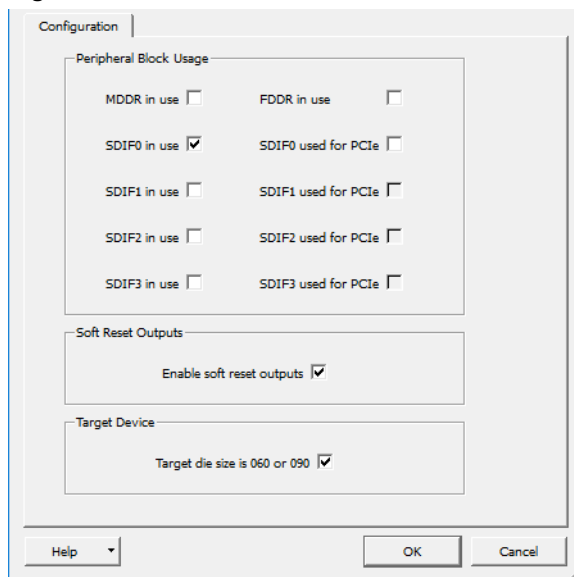
Buttons: Help, OK, Cancel



CoreConfigP is configured for the SERDES\_IF\_0 block, as shown in the following figure.

Select only the SERDES interface checkbox. Do not select the other PCIe checkboxes as those functionalities are already implemented in the HOTRESET block.

**Figure 15 • CoreConfigP Configuration**



The image shows a 'Configuration' dialog box for CoreConfigP. It has three main sections: 'Peripheral Block Usage', 'Soft Reset Outputs', and 'Target Device'. The 'Peripheral Block Usage' section contains two columns of checkboxes. The first column has 'MDDR in use' (unchecked), 'SD1F0 in use' (checked), 'SD1F1 in use' (unchecked), 'SD1F2 in use' (unchecked), and 'SD1F3 in use' (unchecked). The second column has 'FDDR in use' (unchecked), 'SD1F0 used for PCIe' (unchecked), 'SD1F1 used for PCIe' (unchecked), 'SD1F2 used for PCIe' (unchecked), and 'SD1F3 used for PCIe' (unchecked). The 'Soft Reset Outputs' section has a single checkbox 'Enable soft reset outputs' which is checked. The 'Target Device' section has a single checkbox 'Target die size is 060 or 090' which is checked. At the bottom, there is a 'Help' button with a dropdown arrow, and 'OK' and 'Cancel' buttons.

Peripheral Block Usage	
MDDR in use <input type="checkbox"/>	FDDR in use <input type="checkbox"/>
SD1F0 in use <input checked="" type="checkbox"/>	SD1F0 used for PCIe <input type="checkbox"/>
SD1F1 in use <input type="checkbox"/>	SD1F1 used for PCIe <input type="checkbox"/>
SD1F2 in use <input type="checkbox"/>	SD1F2 used for PCIe <input type="checkbox"/>
SD1F3 in use <input type="checkbox"/>	SD1F3 used for PCIe <input type="checkbox"/>

Soft Reset Outputs

Enable soft reset outputs ☒

Target Device

Target die size is 060 or 090 ☒

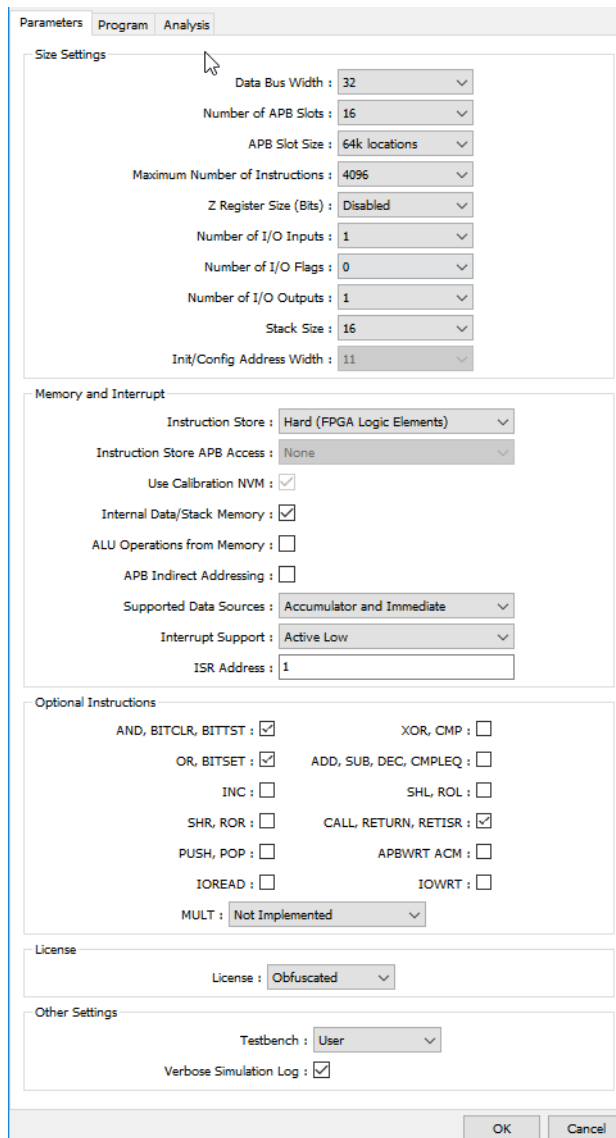
Help OK Cancel

The CoreABC configuration, is as shown in the following figure. Libero generates SERDESIF\_0\_init\_abc.txt file at

<proj\_location>\Libero\_Project\component\work\top\SERDES\_IF2\_0 with CoreABC code to initialize the SERDES (PCIe). This code is modified to reset the SERDES core and AXI, using the SERDES soft reset register on the CoreABC active low interrupt.

The following figure shows the CoreABC Configuration.

**Figure 16 • CoreABC Configuration**



The figure shows the CoreABC Configuration dialog box with the following settings:

- Parameters** tab is selected.
- Size Settings:**
  - Data Bus Width: 32
  - Number of APB Slots: 16
  - APB Slot Size: 64k locations
  - Maximum Number of Instructions: 4096
  - Z Register Size (Bits): Disabled
  - Number of I/O Inputs: 1
  - Number of I/O Flags: 0
  - Number of I/O Outputs: 1
  - Stack Size: 16
  - Init/Config Address Width: 11
- Memory and Interrupt:**
  - Instruction Store: Hard (FPGA Logic Elements)
  - Instruction Store APB Access: None
  - Use Calibration NVM: ☒
  - Internal Data/Stack Memory: ☒
  - ALU Operations from Memory: ☐
  - APB Indirect Addressing: ☐
  - Supported Data Sources: Accumulator and Immediate
  - Interrupt Support: Active Low
  - ISR Address: 1
- Optional Instructions:**
  - AND, BITCLR, BITTST: ☒
  - XOR, CMP: ☐
  - OR, BITSET: ☒
  - ADD, SUB, DEC, CMPEQ: ☐
  - INC: ☐
  - SHL, ROL: ☐
  - SHR, ROR: ☐
  - CALL, RETURN, RETISR: ☒
  - PUSH, POP: ☐
  - APBWRT ACM: ☐
  - IOREAD: ☐
  - IOWRT: ☐
  - MULT: Not Implemented
- License:**
  - License: Obfuscated
- Other Settings:**
  - Testbench: User
  - Verbose Simulation Log: ☒

Buttons: OK, Cancel

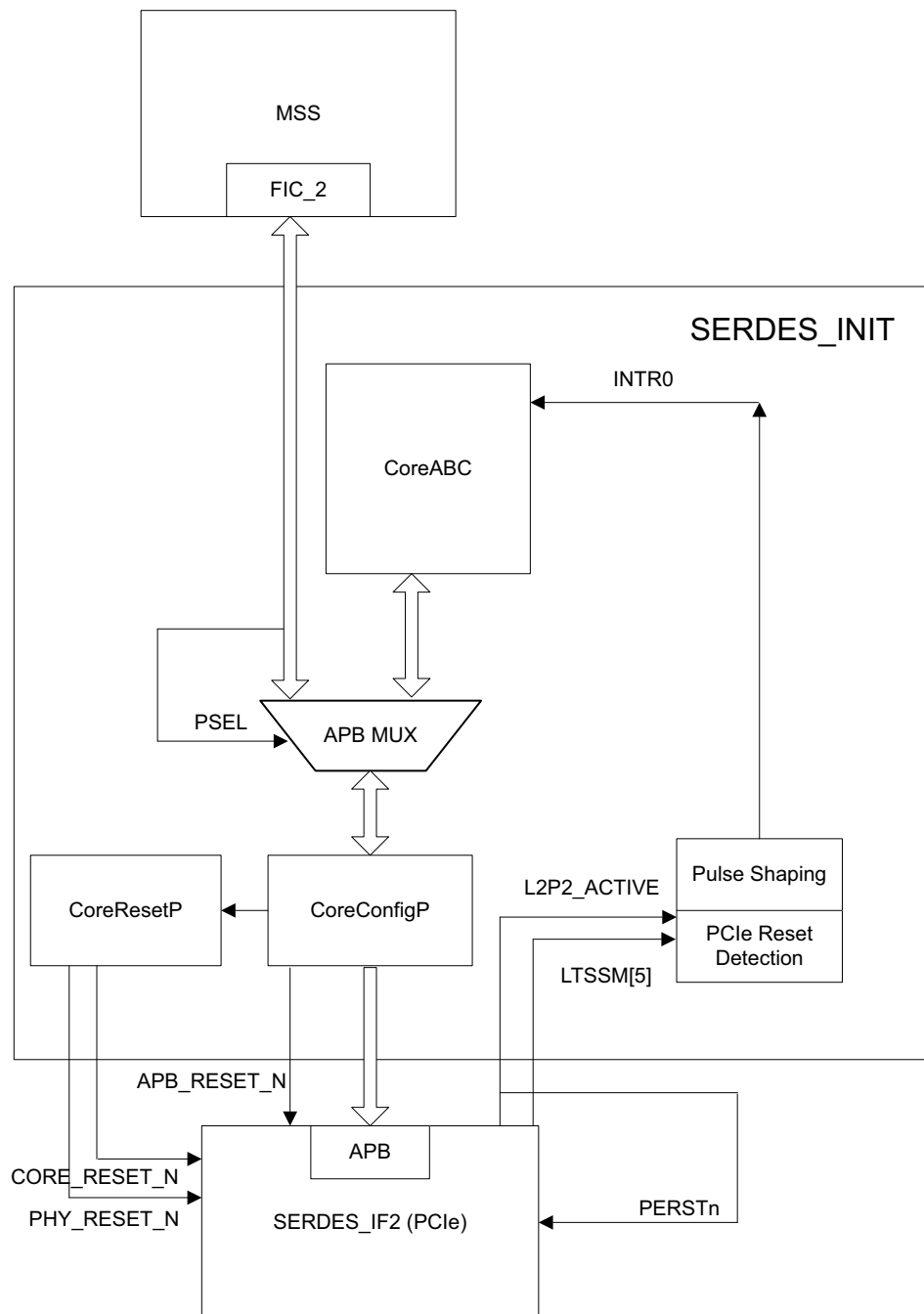
## 2.7.4 M2S060 / M2S090 / M2GL060 / M2GL090 Devices without PERSTn

The following figure shows the implementation of the PCIe reset sequence for M2S060 / M2S090 / M2GL060 / M2GL090 devices without PERSTn.

**Note:** This implementation is similar to the PCIe reset sequence implementation for M2S060 / M2S090 / M2GL060 / M2GL090 Devices with PERSTn, page 15 except that the SERDES\_IF\_2 PERST\_N signal is directly connected to the SERDES\_IF\_2 L2P2\_ACTIVE signal instead of PERSTn.

The SERDES\_IF\_2\_L2P2\_ACTIVE signal gets asserted to '1' when host/root port initiates L2 state. This assertion causes the EndPoint reset through PERST\_N to exit from L2 state.

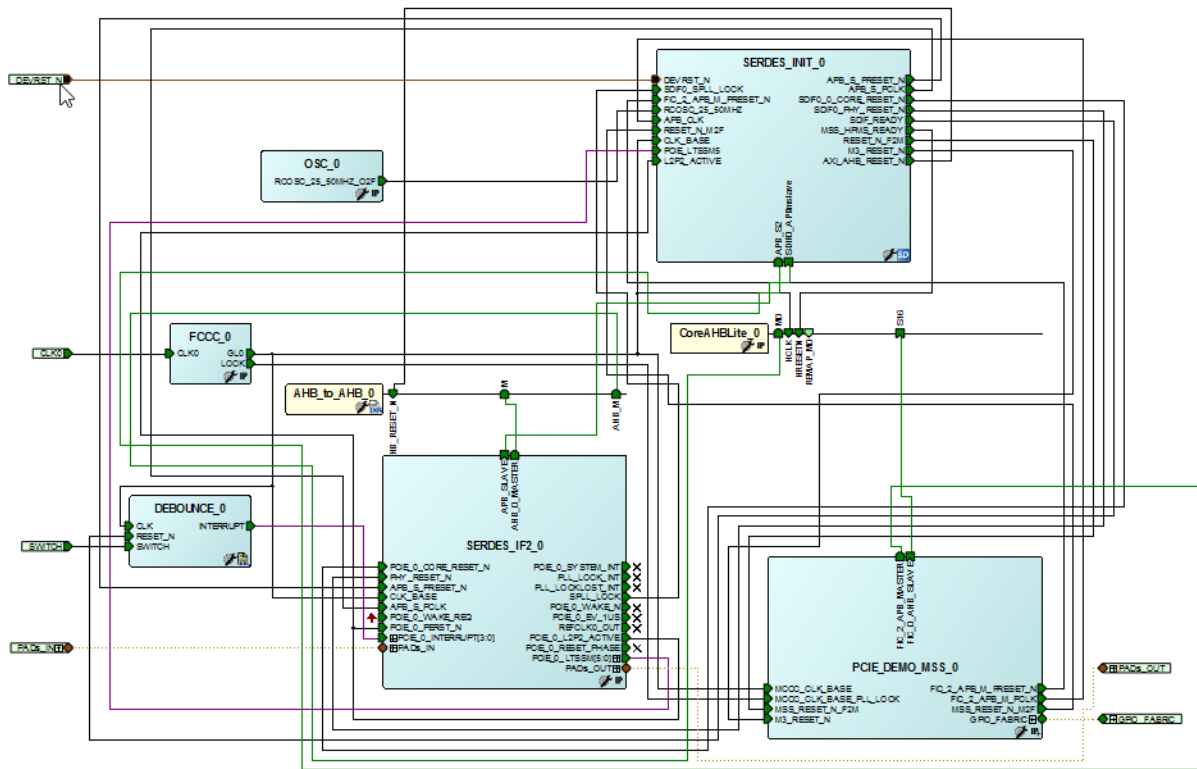
**Figure 17 • M2S060 / M2S090 / M2GL060 / M2GL090 Devices PCIe Reset Generation without PERSTn**



### 2.7.4.1 Implementation using M2S090 Security Evaluation Kit

The PCIe control plane demo design for the M2S090 Security Evaluation Kit is created using the CoreABC standalone peripheral initialization method, and the HOTRESET logic is implemented to detect the PCIe reset. The top-level SmartDesign with the SERDES\_INIT and SERDES\_IF blocks are shown in the following figure.

**Figure 18 • Top-Level Design**



### 2.7.5 M2S/M2GL 060/090 Device Dual PCIe with PERSTn

The following figure shows the implementation of the PCIe reset sequence for M2S/M2GL 060/090 devices dual PCIe with PERSTn. The PCIe reset detection logic detects the PCIe reset and triggers the CoreABC to reset the SERDES PCIE controller0/controller1 and AXI interface using a soft reset. Also, the APB\_MUX logic is implemented to support the SERDES APB register access from the MSS/HPMS as well. Using the APB\_MUX the user can retain access through SmartFusion2 Cortex-M3 or utilizing the SmartDebug SERDES utility available for both SmartFusion2 and IGLOO2 devices.

The CoreABC takes few APB cycles to reset the SERDES core and AXI IF. During these cycles, the SERDES AXI master initiates buffered AXI/AHB transactions and the fabric AXI/AHB slave logic should indicate the busy state to AXI master. In this application note, an AXI\_AHB reset is generated to AHB\_to\_AHB.v logic (which asserts the HREADY to '0' during reset) during the reset operation of SERDES Core/AXI IF.

#### 2.7.5.1 PCIe Reset Detection

SERDES\_IF2 (PCIe) has PCIE\_0\_LTSSM[5] and PCIE\_0\_L2P2\_ACTIVE signals for PCIE\_0 core and PCIE\_1\_LTSSM[5] and PCIE\_1\_L2P2\_ACTIVE signals for PCIE\_1 core. LTSSM[5] indicates hot-reset, data link up, or L2 exit. L2P2\_ACTIVE indicates that PCIe is in L2 state.

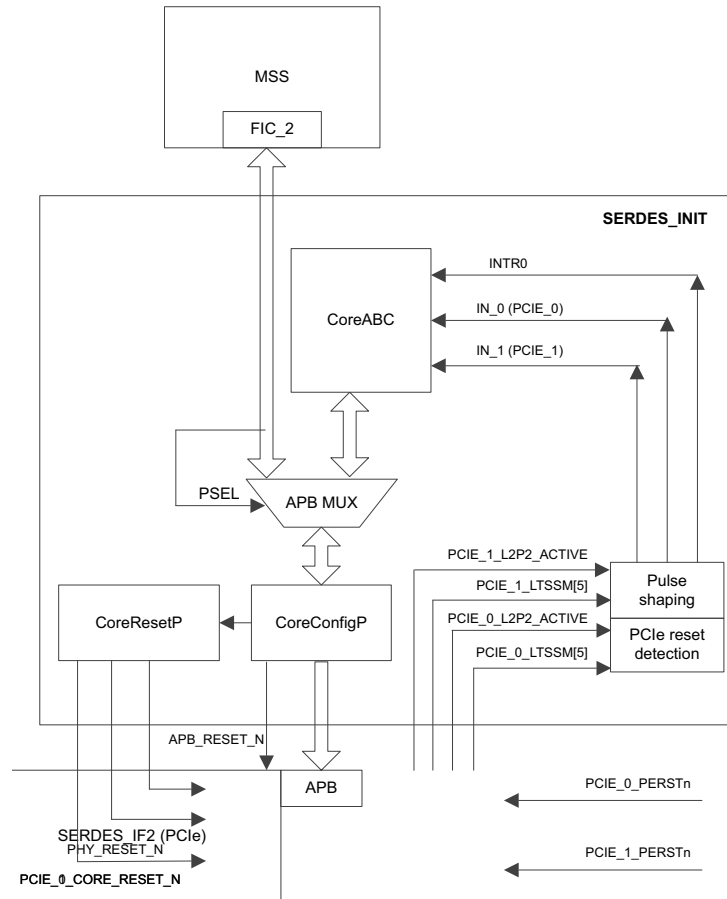
Generate hot\_reset\_n as:  $\text{hot\_reset\_n} = (!\text{PCIE\_x\_L2P2\_ACTIVE}) \& (!\text{PCIE\_x\_LTSSM}[5])$ .

Connect the SERDES PCIe PERST\_N to PERSTn on the board.

### 2.7.5.2 SERDES (PCIe) Reset Generation

Use `hot_reset_n` to generate interrupt INTR0 to CoreABC. The pulse shaping logic generates INTR0 synchronized to the CoreABC clock domain. The CoreABC interrupt routine resets the SERDES PCIE controller0/controller1 reset, and AXI interface reset using the soft reset register.

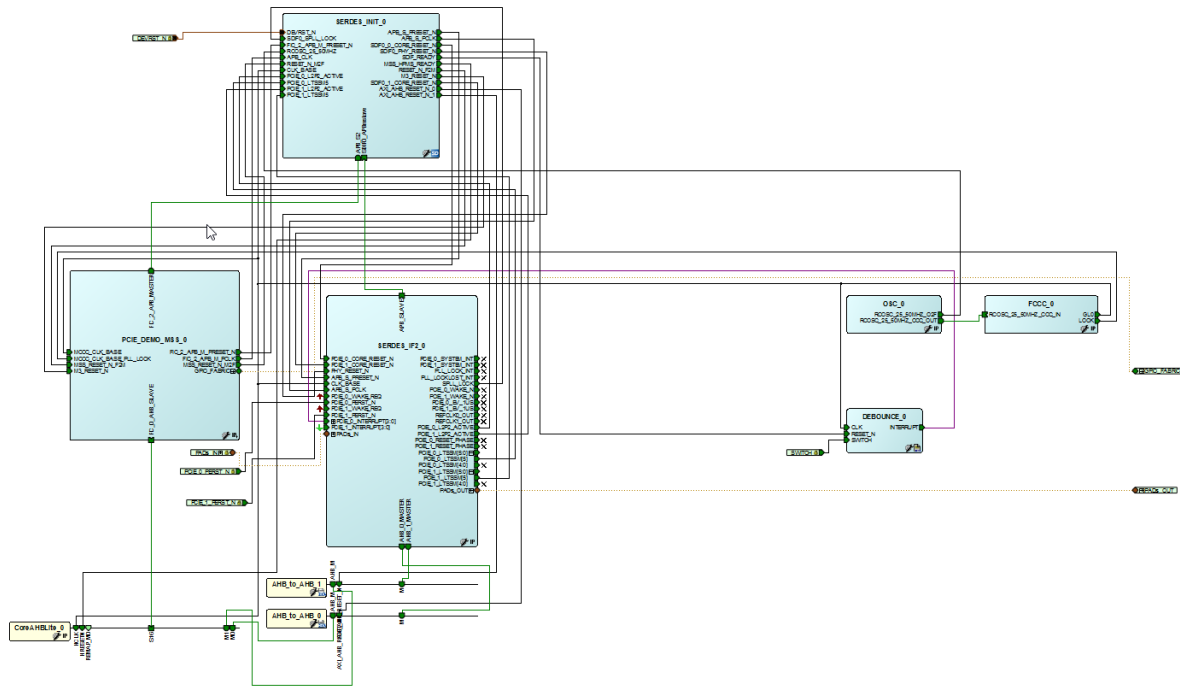
**Figure 19 • M2S/M2GL 060/090 Device PCIe Reset Generation with PERSTn**



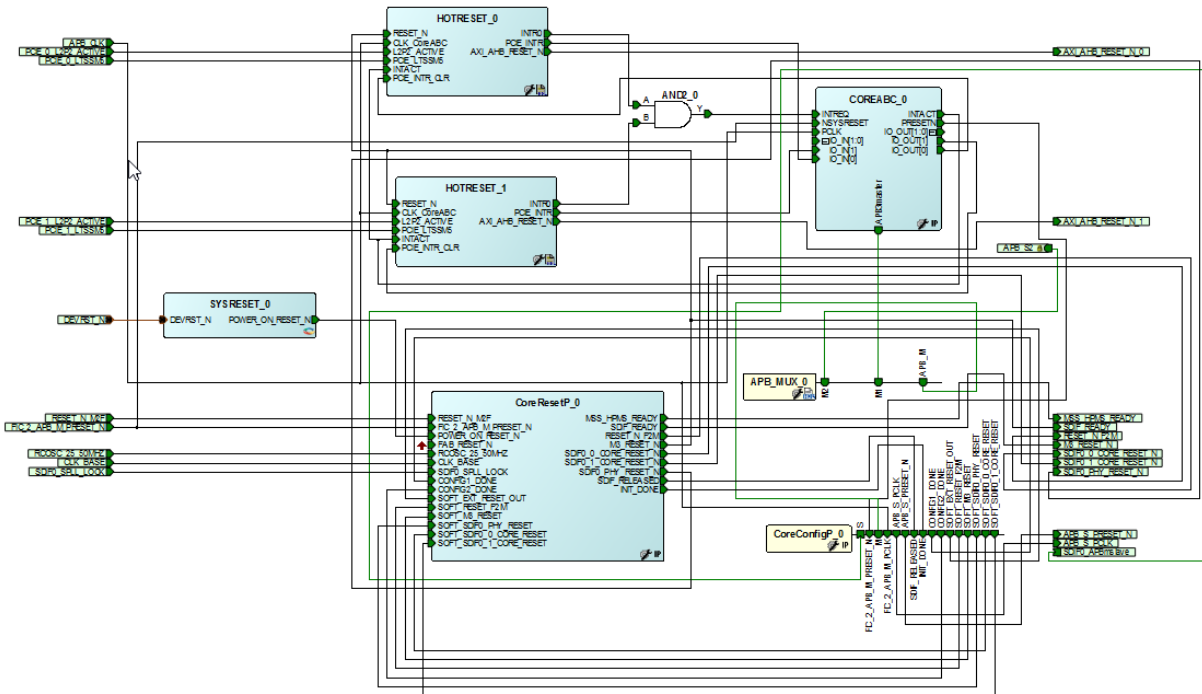
### 2.7.5.3 Implementation Using M2S090 FG676 Device

The PCIe control plane demo design for M2S090 is created using CoreABC standalone peripheral initialization method, and HOTRESET logic is implemented to detect the PCIe reset. The top-level SmartDesign with the SERDES\_INIT and SERDES\_IF blocks are shown in the following figure. SERDES\_INIT is a SmartDesign block used to initialize the SERDES and to generate the SERDES (PCIe) resets. The SERDES\_IF\_2 PERST\_N signals are connected to the PCIe PERSTn signals on the board.

**Figure 20 • Top-Level Design**



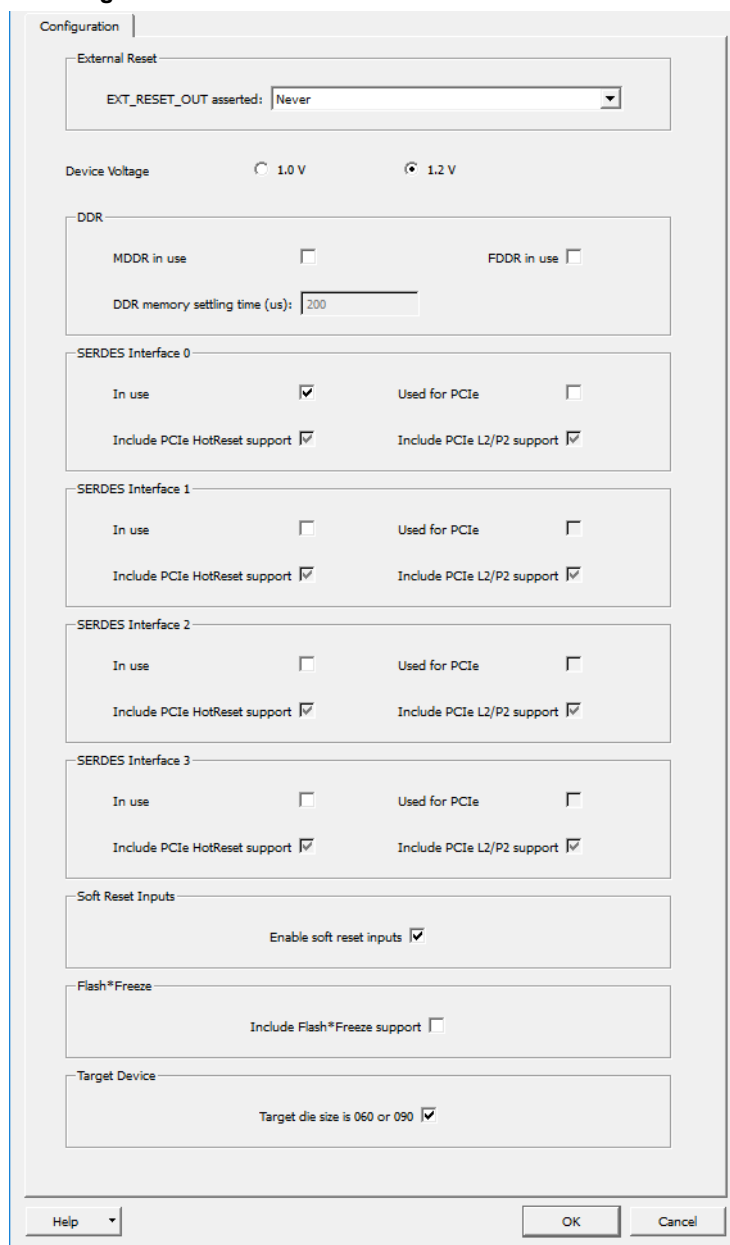
**Figure 21 • SERDES\_INIT SmartDesign**



CoreResetP is configured to generate resets for SERDES\_IF2\_0, as shown in the following figure.

Select only the SERDES interface check box. Do not select the other PCIe check boxes as those functionalities are already implemented in the HOTRESET block.

**Figure 22 • CoreResetP Configuration**



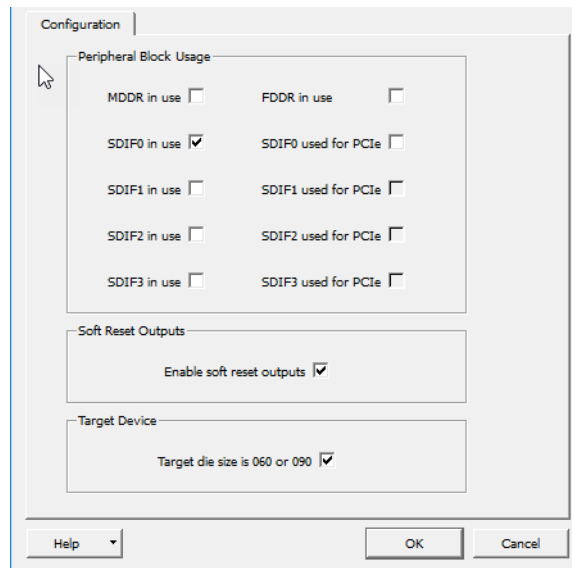
The figure shows the CoreResetP Configuration dialog box. The 'Configuration' tab is selected. The 'External Reset' section has a dropdown for 'EXT\_RESET\_OUT asserted:' set to 'Never'. The 'Device Voltage' section has radio buttons for '1.0 V' and '1.2 V', with '1.2 V' selected. The 'DDR' section has checkboxes for 'MDDR in use' and 'FDDR in use', both unchecked, and a text field for 'DDR memory settling time (us):' set to '200'. There are four sections for 'SERDES Interface' (0, 1, 2, and 3). For each interface, there are checkboxes for 'In use', 'Used for PCIe', 'Include PCIe HotReset support', and 'Include PCIe L2/P2 support'. For Interface 0, 'In use' and 'Include PCIe HotReset support' are checked. For Interfaces 1, 2, and 3, 'Include PCIe HotReset support' is checked, but 'In use' and 'Used for PCIe' are unchecked. The 'Soft Reset Inputs' section has a checkbox for 'Enable soft reset inputs' which is checked. The 'Flash\*Freeze' section has a checkbox for 'Include Flash\*Freeze support' which is unchecked. The 'Target Device' section has a checkbox for 'Target die size is 060 or 090' which is checked. At the bottom, there are 'Help', 'OK', and 'Cancel' buttons.



CoreConfigP is configured for SERDES\_IF\_0 block, as shown in the following figure.

Select only the SERDES interface check box. Do not select the other PCIe check boxes as those functionalities are already implemented in the HOTRESET block.

**Figure 23 • CoreConfigP Configuration**



The image shows a 'Configuration' dialog box for CoreConfigP. It has a 'Peripheral Block Usage' section with a table of checkboxes. The 'SDIF0 in use' checkbox is checked. Below this is a 'Soft Reset Outputs' section with 'Enable soft reset outputs' checked. At the bottom is a 'Target Device' section with 'Target die size is 060 or 090' checked. The dialog has 'Help', 'OK', and 'Cancel' buttons at the bottom.

Peripheral Block Usage	
MDDR in use <input type="checkbox"/>	FDDR in use <input type="checkbox"/>
SDIF0 in use <input checked="" type="checkbox"/>	SDIF0 used for PCIe <input type="checkbox"/>
SDIF1 in use <input type="checkbox"/>	SDIF1 used for PCIe <input type="checkbox"/>
SDIF2 in use <input type="checkbox"/>	SDIF2 used for PCIe <input type="checkbox"/>
SDIF3 in use <input type="checkbox"/>	SDIF3 used for PCIe <input type="checkbox"/>

Soft Reset Outputs

Enable soft reset outputs ☒

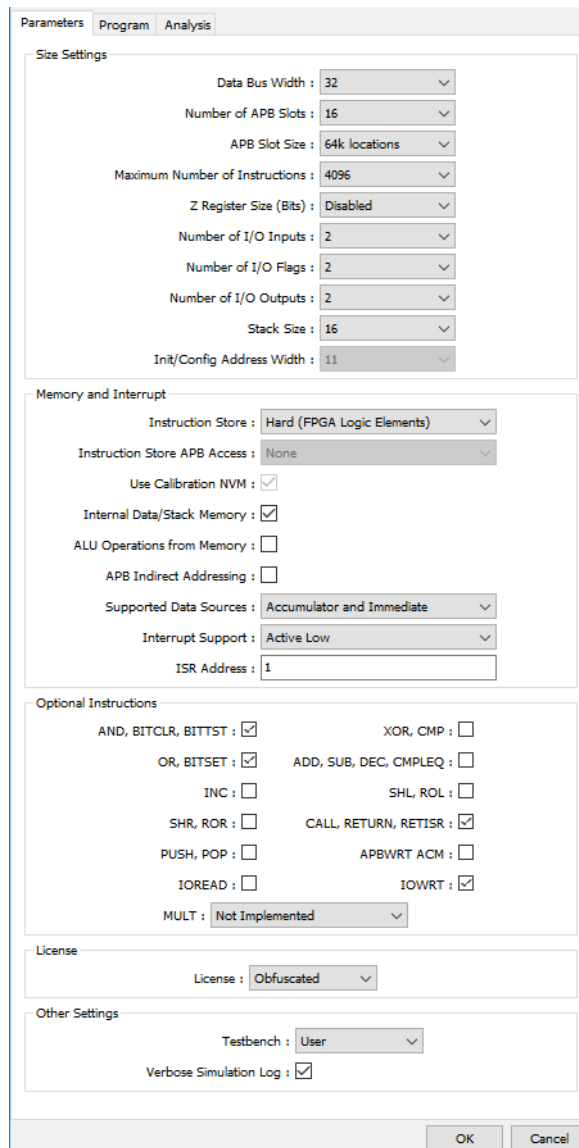
Target Device

Target die size is 060 or 090 ☒

Help OK Cancel

CoreABC configuration is shown in the following figure. Libero generates the `SERDESIF_0_init_abc.txt` file at `<proj_location>\Libero_Project\component\work\top\SERDES_IF2_0` with CoreABC code to initialize the SERDES (PCIe). The code is modified to reset the SERDES core0/core1 and AXI, using the SERDES soft reset register on CoreABC active low interrupt.

**Figure 24 • CoreABC Configuration**



The image shows the CoreABC Configuration dialog box with the following settings:

- Parameters** tab is selected.
- Size Settings:**
  - Data Bus Width: 32
  - Number of APB Slots: 16
  - APB Slot Size: 64k locations
  - Maximum Number of Instructions: 4096
  - Z Register Size (Bits): Disabled
  - Number of I/O Inputs: 2
  - Number of I/O Flags: 2
  - Number of I/O Outputs: 2
  - Stack Size: 16
  - Init/Config Address Width: 11
- Memory and Interrupt:**
  - Instruction Store: Hard (FPGA Logic Elements)
  - Instruction Store APB Access: None
  - Use Calibration NVM: ☒
  - Internal Data/Stack Memory: ☒
  - ALU Operations from Memory: ☐
  - APB Indirect Addressing: ☐
  - Supported Data Sources: Accumulator and Immediate
  - Interrupt Support: Active Low
  - ISR Address: 1
- Optional Instructions:**
  - AND, BITCLR, BITTST: ☒
  - XOR, CMP: ☐
  - OR, BITSET: ☒
  - ADD, SUB, DEC, CMPEQ: ☐
  - INC: ☐
  - SHL, ROL: ☐
  - SHR, ROR: ☐
  - CALL, RETURN, RETISR: ☒
  - PUSH, POP: ☐
  - APBWRT ACM: ☐
  - IOREAD: ☐
  - IOWRT: ☒
  - MULT: Not Implemented
- License:**
  - License: Obfuscated
- Other Settings:**
  - Testbench: User
  - Verbose Simulation Log: ☒

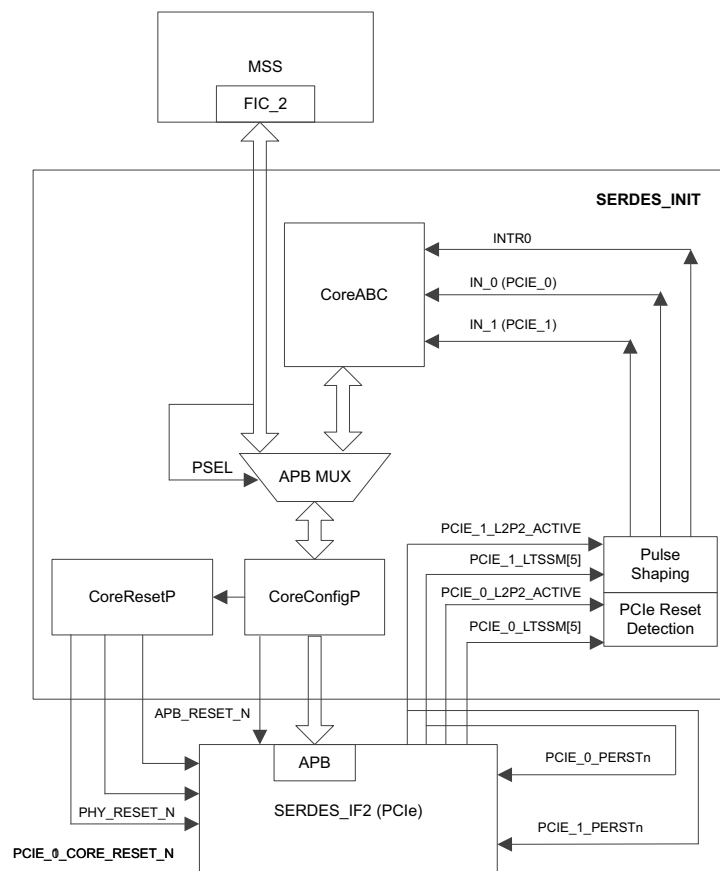
Buttons: OK, Cancel

## 2.7.6 M2S/M2GL 060/090 Device Dual PCIe without PERSTn

The following figure shows the implementation of the PCIe reset sequence for the M2S/M2GL 060/090 device dual PCIe without PERSTn. This implementation is similar to the PCIe reset sequence implementation for [M2S/M2GL 060/090 Device Dual PCIe with PERSTn](#), page 23 except that the SERDES\_IF\_2 PERST\_N signal is connected to the SERDES\_IF\_2 L2P2\_ACTIVE instead of the PERSTn signal.

The SERDES\_IF\_2\_L2P2\_ACTIVE signal gets asserted to '1' when the host/root port initiates L2 state. This assertion causes the EndPoint reset through PERST\_N to exit from L2 state.

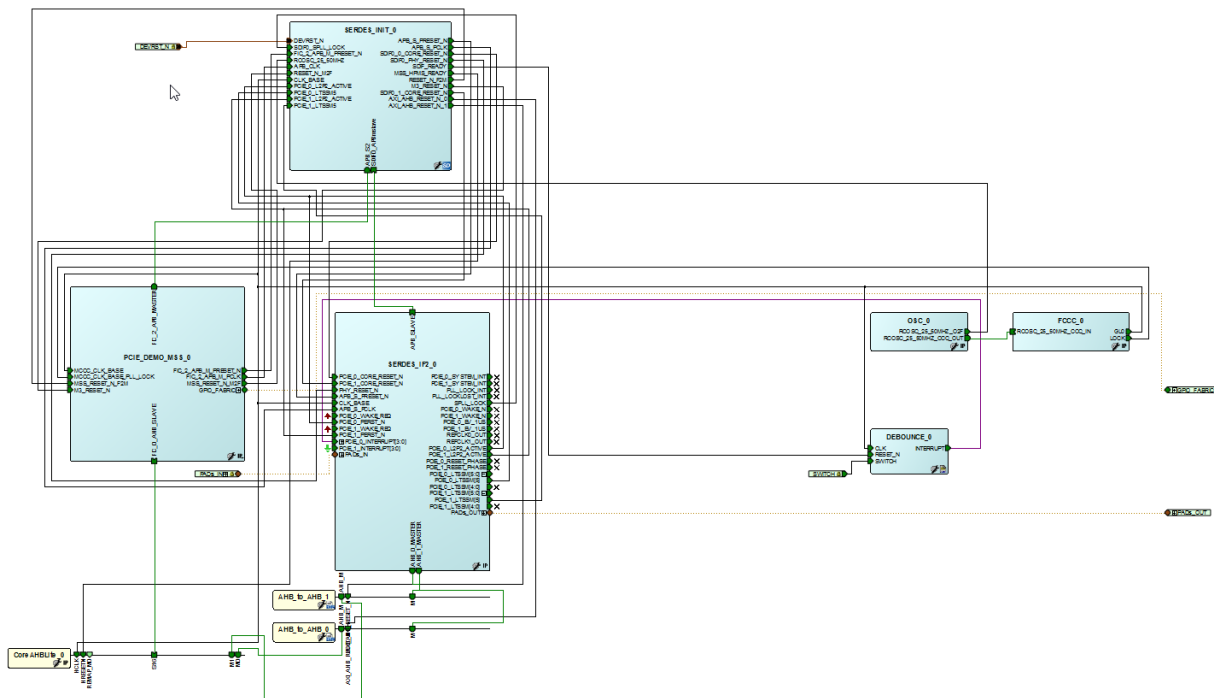
**Figure 25 • M2S/M2GL 060/090 Device Dual PCIe without PERSTn**



### 2.7.6.1 Implementation using M2S090 FG676 Device

The PCIe control plane demo design for M2S090 is created using CoreABC standalone peripheral initialization method, and HOTRESET logic is implemented to detect the PCIe reset. The top-level SmartDesign with the SERDES\_INIT and SERDES\_IF blocks are shown in the following figure.

**Figure 26 • Top-Level Design**



M2S060/M2S090/M2GL060/M2GL090 devices also support configuring the SERDES in triple mode (two PCIe endpoint controllers and one EPCS controller).

The possible configurations are:

1. 1. PCIeX1 on L0 + PCIeX1 on L1 + EPCSX2 on L2 and L3
2. 2. PCIeX1 on L0 + PCIeX1 on L1 + EPCSX1 on L2
3. 3. PCIeX1 on L0 + PCIeX1 on L1 + EPCSX1 on L3

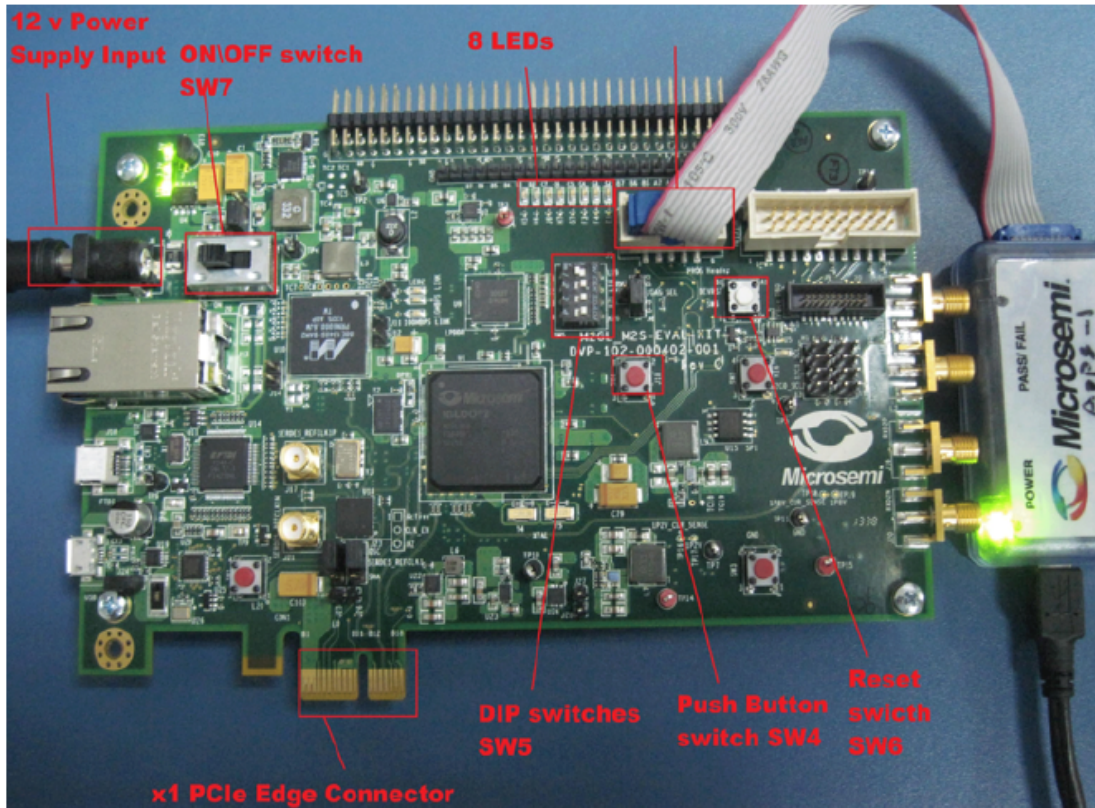
The PCIe reset sequence for the third configuration is similar to the PCIe reset sequence implementation for M2S/M2GL 060/090 device dual PCIe with/without PERSTn. It is not possible to implement the PCIe reset sequence for the first and second configurations as the `pcie_1_l2p2_active` signal is overlaid by the `epcs_rxclk_2` signal.

## 2.8 Running the Design

Program the SmartFusion2 Security Evaluation kit board or IGLOO2 Evaluation kit board with the job file provided as part of the design files using FlashPro Express software, refer to [Appendix: Programming the Device Using FlashPro Express](#), page 34.

The IGLOO2 Evaluation kit board is shown in the following figure.

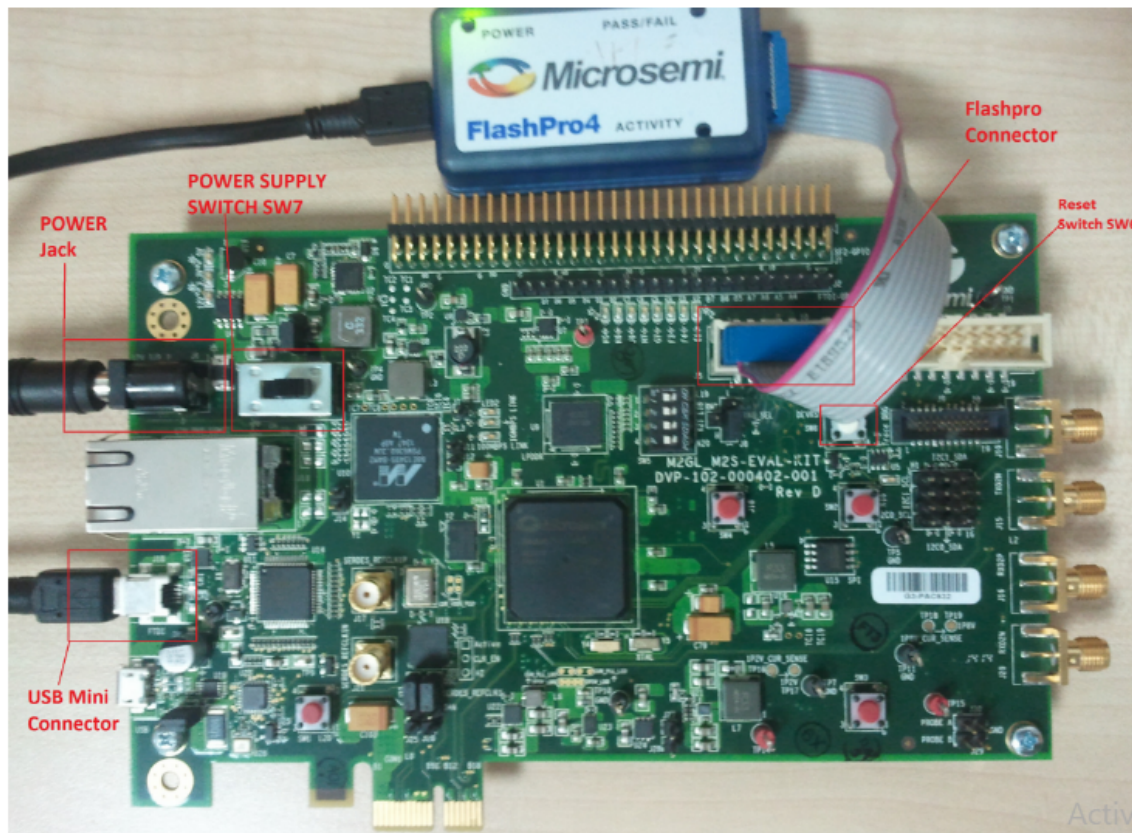
**Figure 27 • IGLOO2 Evaluation Kit Board**





The SmartFusion2 Security Evaluation kit board is shown in the following figure.

**Figure 28 • SmartFusion2 Security Evaluation Kit Board**



## 2.8.1 Testing the PCIe Reset

The reference designs provided with this application note implements a PCIe Control Plane demo. Use the PI flow and CoreABC using the recommended PCIe reset methodology. To validate the PCIe reset flow, the following test is performed by the user on their host system.

The following steps describe how to test the PCIe reset feature:

1. Click **Exit** to quit the PCIe Demo application.
2. Restart (do not shut down) the host PC or put the host PC in Hibernate/Sleep mode (this issues PERSTn to the PCIe endpoint).
3. After the host PC restarts or comes out of the sleep mode, check the Device Manager and ensure that the endpoint device is detected correctly.
4. Run the PCIe Demo application by following steps 2 through 13. The reference design must run for any number of restarts or coming out of Hibernate or Sleep mode without causing any system hang.

**Note:** Laptop PCIe adapter cards do not have PERSTn signal.

**Note:** In some cases, while exiting from the sleep mode, the host PC may not recognize the device. This may be due to L0S and L1 entry and exit latencies of the host PC not matching with SmartFusion2 and IGLOO2 PCIe device latencies. This is dependent on a specific motherboard configuration. If this occurs, the device needs to be reset to be detected.

## 2.9 Conclusion

This application note describes the recommended implementation of the PCIe reset sequence for the SmartFusion2 and IGLOO2 devices using the standalone peripheral initialization flow. The existing PCIe control plane demo design has been used to illustrate the PCIe reset sequence for the SmartFusion2 Security Evaluation Kit and IGLOO2 Evaluation Kit.

## 3 Appendix: Programming the Device Using FlashPro Express

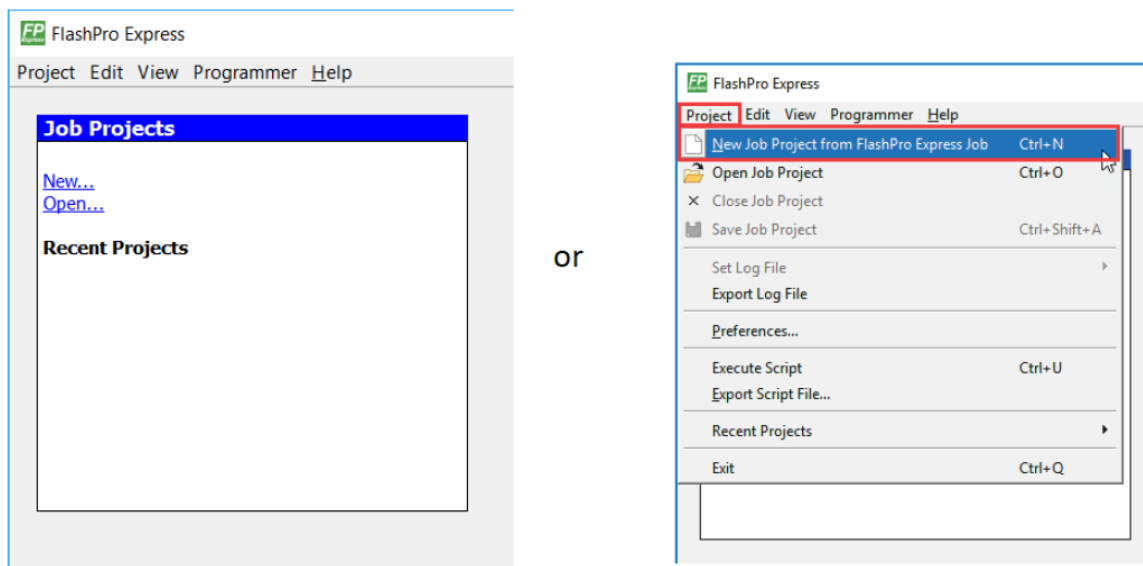
This section describes how to program the SmartFusion2 and IGLOO2 devices with the programming job file using FlashPro Express.

The following steps describe how to program the FlashPro Express:

1. Switch **ON** the power supply switch **SW7**.
2. Launch the FlashPro Express software.
3. Click **New Project**.
4. In the **New Project** window, type the project name as:
  - IGLOO2: IGL2\_MDDR\_Demo
  - SmartFusion2: SF2\_MDDR\_Demo
5. Click **Browse** and navigate to the location where you want to save the project.
6. Select **Single device** as the **Programming mode**.
7. Click **OK**.

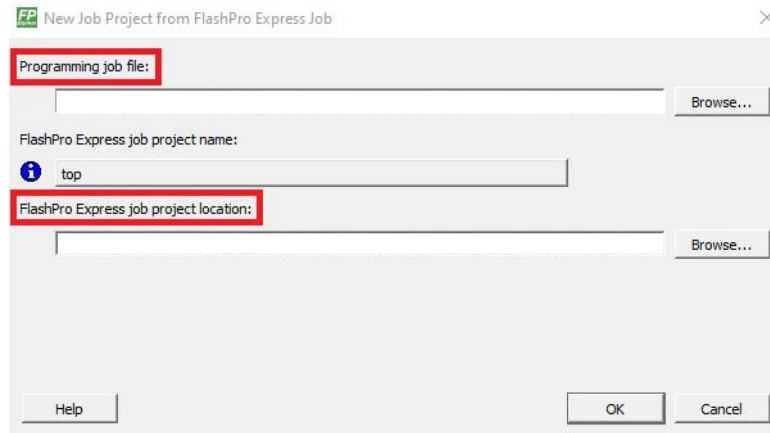
The FlashPro new project is shown in the following figure.

**Figure 29 • FlashPro Express Job Project**



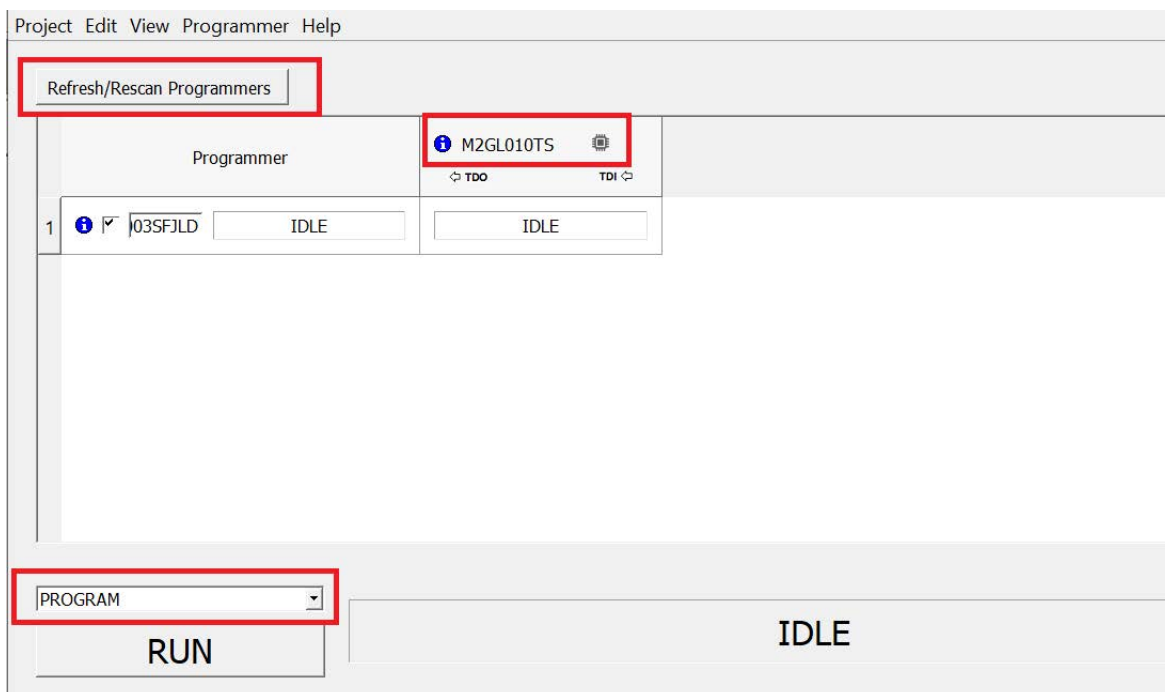
8. Enter the following in the **New Job Project from FlashPro Express Job** dialog box:
  - **Programming job file:** Click **Browse**, and navigate to the location where the .job file is located and select the file. The default location is:  
`<download_folder>\m2s_m2gl_ac437_df\Programming_Job`
  - **FlashPro Express job project name:** Click **Browse** and navigate to the location where you want to save the project.

**Figure 30 • New Job Project from FlashPro Express Job**



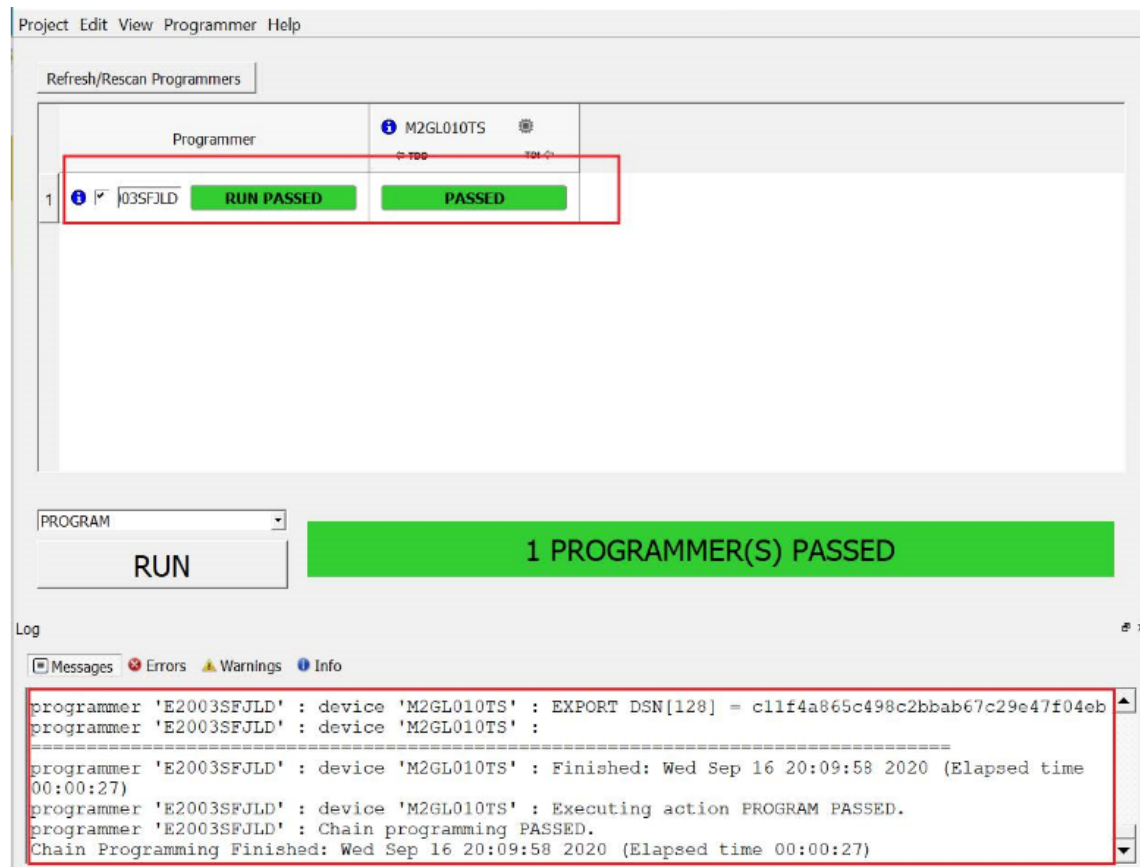
9. Click **OK**. The required programming job is selected and ready to be programmed in the device.
10. The FlashPro Express window appears as shown in the following figure. Confirm that a programmer number appears in the Programmer field. If it does not, confirm the board connections and click **Refresh/Rescan** Programmers.

**Figure 31 • Programming the Device**



11. Click **RUN**. When the device is programmed successfully, a **RUN PASSED** status is displayed as shown in the following figure.



**Figure 32 • FlashPro Express—RUN PASSED**

12. Close **FlashPro Express** or in the Project tab, click **Exit**.