Accessing Serial Flash Memory Using SPI Interface

Libero SoC v11.5 and IAR Embedded Workbench Flow Tutorial for SmartFusion2 TU0547 Tutorial

Microsemi®

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Accessing Serial Flash Memory using SPI Interface - Libero SoC v11.5 and IAR Embedded Workbench Flow Tutorial for SmartFusion2

Introduction

The Libero® System-on-Chip (SoC) software generates firmware projects using IAR, Keil, and SoftConsole tools. This tutorial describes the process to build an IAR application that can be implemented and validated using the SmartFusion®2 system-on-chip (SoC) field programmable gate array (FPGA) Security Evaluation Kit.

The same firmware project can be built using SoftConsole and Keil tools. Refer to the respective tutorials:

- *Accessing Serial Flash Memory using SPI Interface - Libero SoC and SoftConsole Flow Tutorial for SmartFusion2 SoC FPGA*
- *Accessing Serial Flash Memory Using SPI Interface - Libero SoC and Keil uVision Flow Tutorial for SmartFusion2 SoC FPGA*

The tutorial describes the following:

- Creating a Libero SoC project using System Builder
- Generating the programming file to program the SmartFusion2 device
- Opening the project in IAR Embedded Workbench from Libero SoC
- Compiling application code
- Debugging and run code using IAR Embedded Workbench

Design Requirements

Table 1 • **Design Requirements**

Design Requirements	**Description**
Hardware Requirements	
SmartFusion2 Security Evaluation Kit • FlashPro4 programmer • J-Link programmer • USB A to Mini-B cable • 12 V Adapter	Rev D or later
Host PC or Laptop	Any 64-bit Windows Operating System
Software Requirements	
Libero SoC	v11.5
FlashPro programming software	v11.5
IAR Embedded Workbench for ARM	6.4
Host PC Drivers	USB to UART drivers
Any one of the following serial terminal emulation programs: • HyperTerminal • TeraTerm • PuTTY	-

Project Files

The design files for this tutorial can be downloaded from the Microsemi® website:
http://soc.microsemi.com/download/rsc/?f=m2s_tu0547_liberov11p5_df

The design files include:

- Libero project
- Programming files
- Source files
- SPI_Flash_Drivers
- Readme files

Refer to the Readme.txt file provided in the design files for the complete directory structure.

Target Board

SmartFusion2 Security Evaluation Kit Board, Rev D or later.

Design Overview

This design example demonstrates the execution of basic read and write operations on the SPI flash present on the SmartFusion2 Security Evaluation Kit board. This kit has a built-in winbond SPI flash memory W25Q64FVSSIG, which is connected to the SmartFusion2 microcontroller subsystem (MSS) through dedicated MSS SPI_0 interface.

Read and write data information is displayed using HyperTerminal, which communicates to the SmartFusion2 MSS using the MMUART_1 interface.

For more information on SPI, refer to the *SmartFusion2 Microcontroller Subsystem User Guide*.

Figure 1 shows interfacing the external SPI flash to MSS SPI_0.

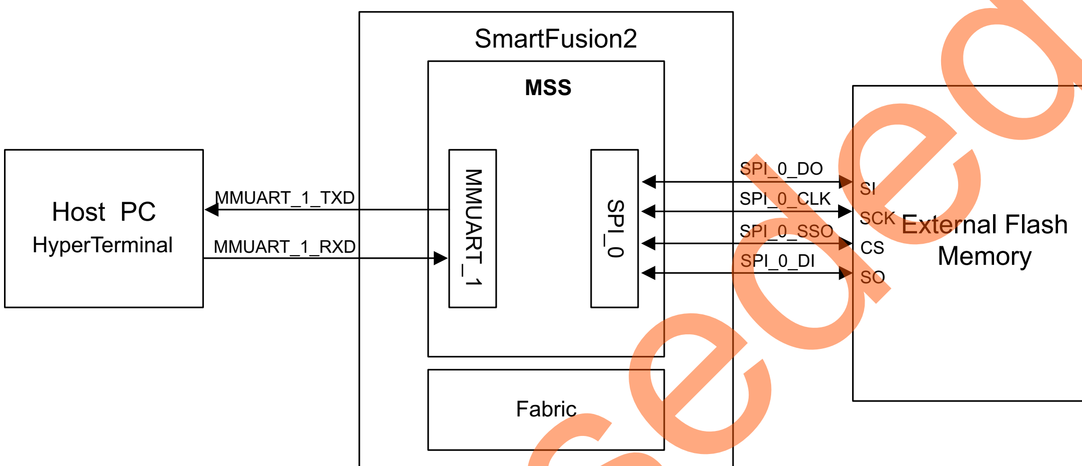

***Figure 1* • SPI Flash Interfacing Block Diagram**

Step 1: Creating a Libero SoC Project

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

Launching Libero SoC

The following steps describe how to launch Libero SoC:

1. Click **Start > Programs > Microsemi Libero SoC v11.5 > Libero SoC v11.5**, or click the shortcut on desktop to open the Libero SoC v11.5 Project Manager.
2. Create a new project using one of the following options:
   – Select **New** on the **Start Page** tab as shown in Figure 2.
   – Click **Project > New Project** from the Libero SoC menu.

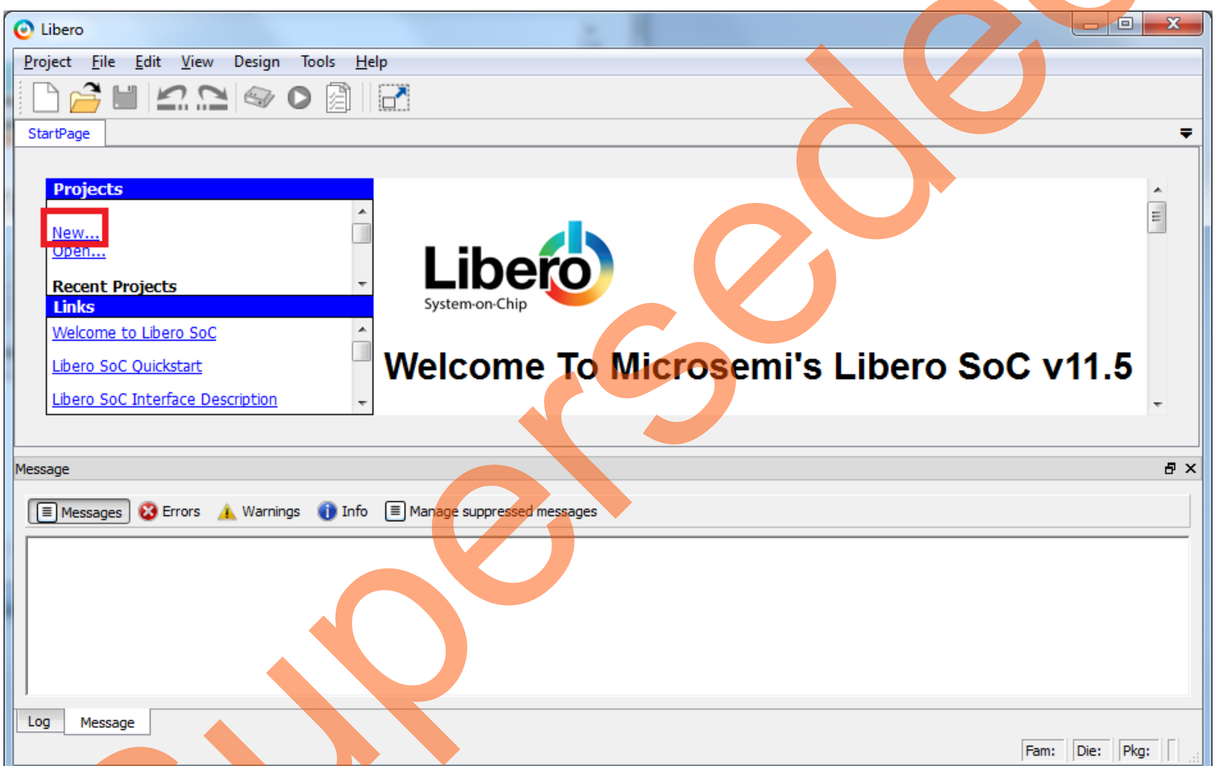

Figure 2 **• Libero SoC Project Manager**

3. Enter the following information in the **Project Details** page, as shown in Figure 3.
   – **Project Name**: SPI_Flash
   – **Project Location**: Select an appropriate location (for example, D:/Microsemi_prj)
   – **Preferred HDL Type**: Verilog
   – **Enable Block Creation**: Unchecked

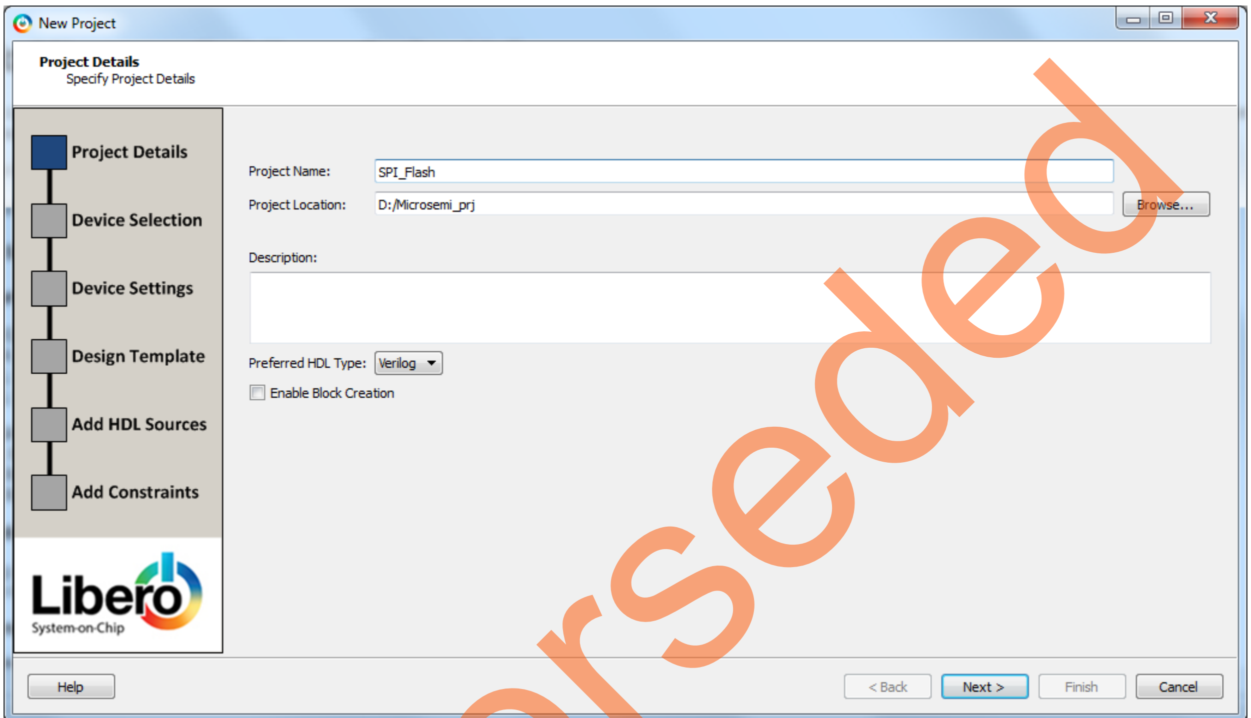

***Figure 3* • Project Details Page**

4. Click **Next.** This opens **Device Selection** page as shown in Figure 4.

Select the following values from the drop down list:

– **Family**: SmartFusion2
– **Die**: M2S090TS
– **Package**: 484 FBGA
– **Speed**: -1
– **Core Voltage**: 1.2
– **Range**: COM

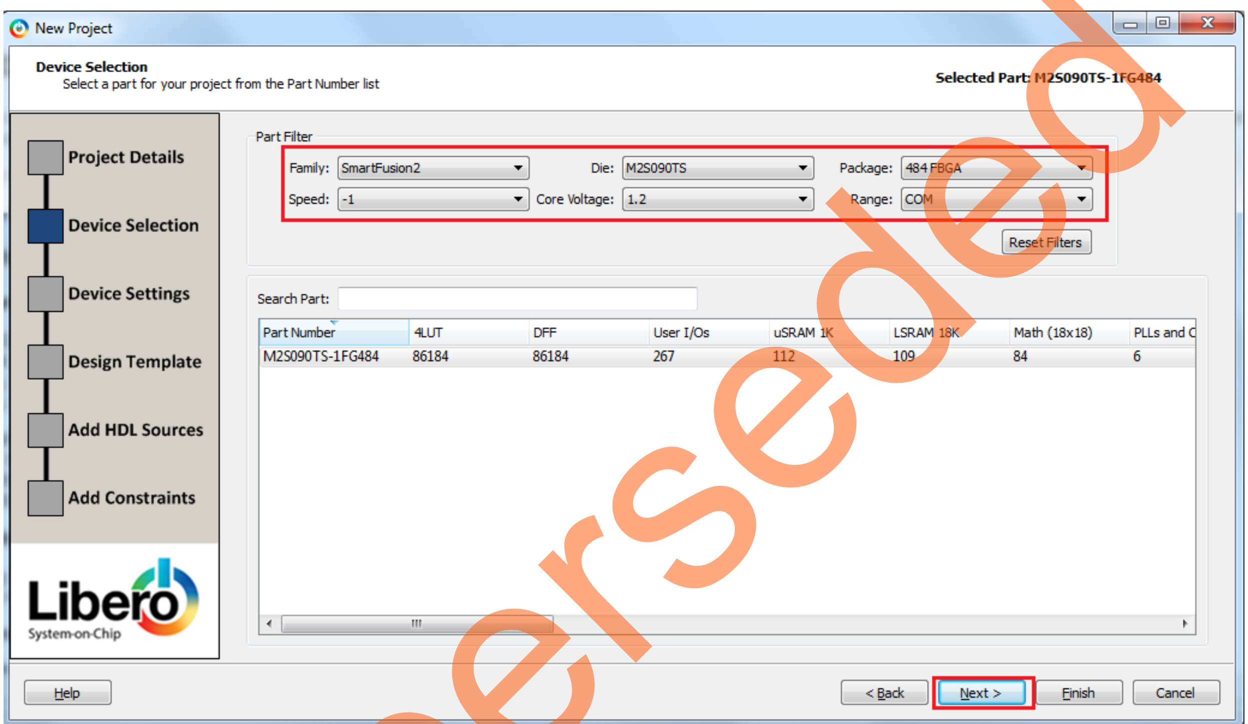

***Figure 4* • Device Selection Page**

5. Click **Next.** This opens **Device Settings** page. Do not change the default settings.
6. Click **Next.** This opens **Design Template** page as shown in Figure 5, Under Design Templates and Creators, select **Create a System Builder based design.**

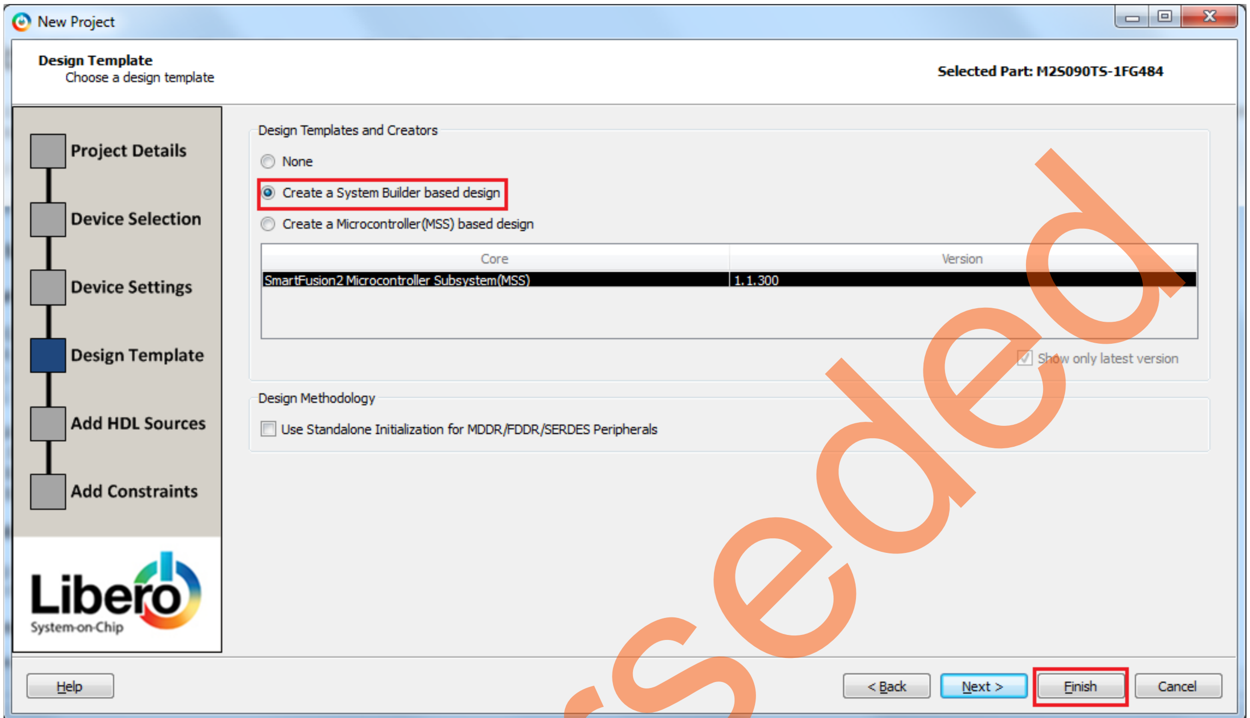

Figure 5 **• Device Template Page**

7. Click **Finish.** This opens **System Builder** window.

Note: System Builder is a graphical design wizard. It creates a design based on high-level design specifications by taking the user through a set of high-level questions that will define the intended system.

8. Enter the name of the system as **SPI_Flash** and click **OK**, as shown in Figure 6.

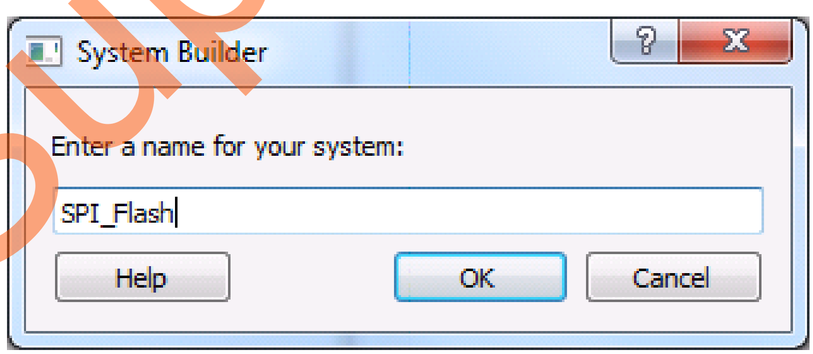

Figure 6 **• System Builder Window**

Figure 7 shows the **System Builder – Device Features** page.

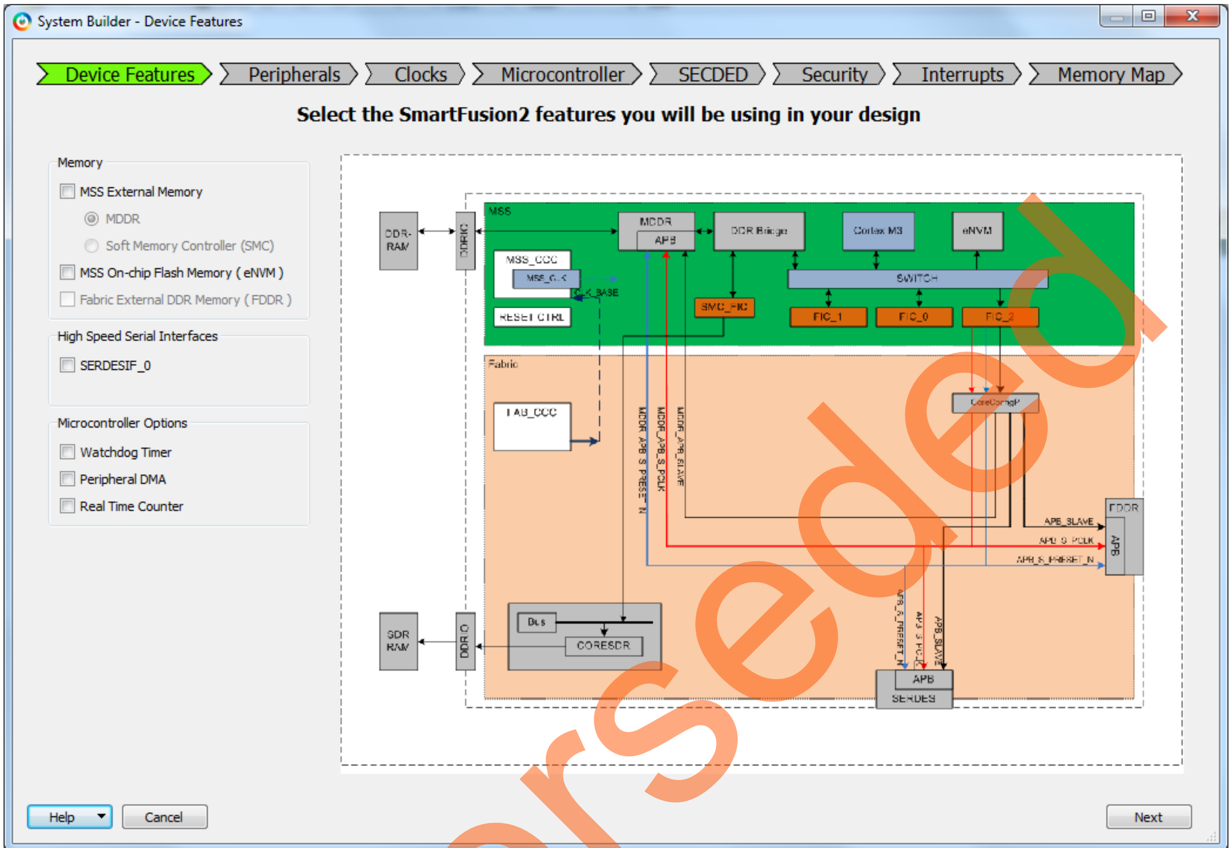

***Figure 7* • System Builder – Device Features Page**

9. Click **Next**. This opens **System Builder - Peripherals** page as shown in Figure 8.
10. Under the MSS Peripherals section, clear all the check boxes except **MM_UART_1** and **MSS_SPI_0**, as shown in Figure 8.

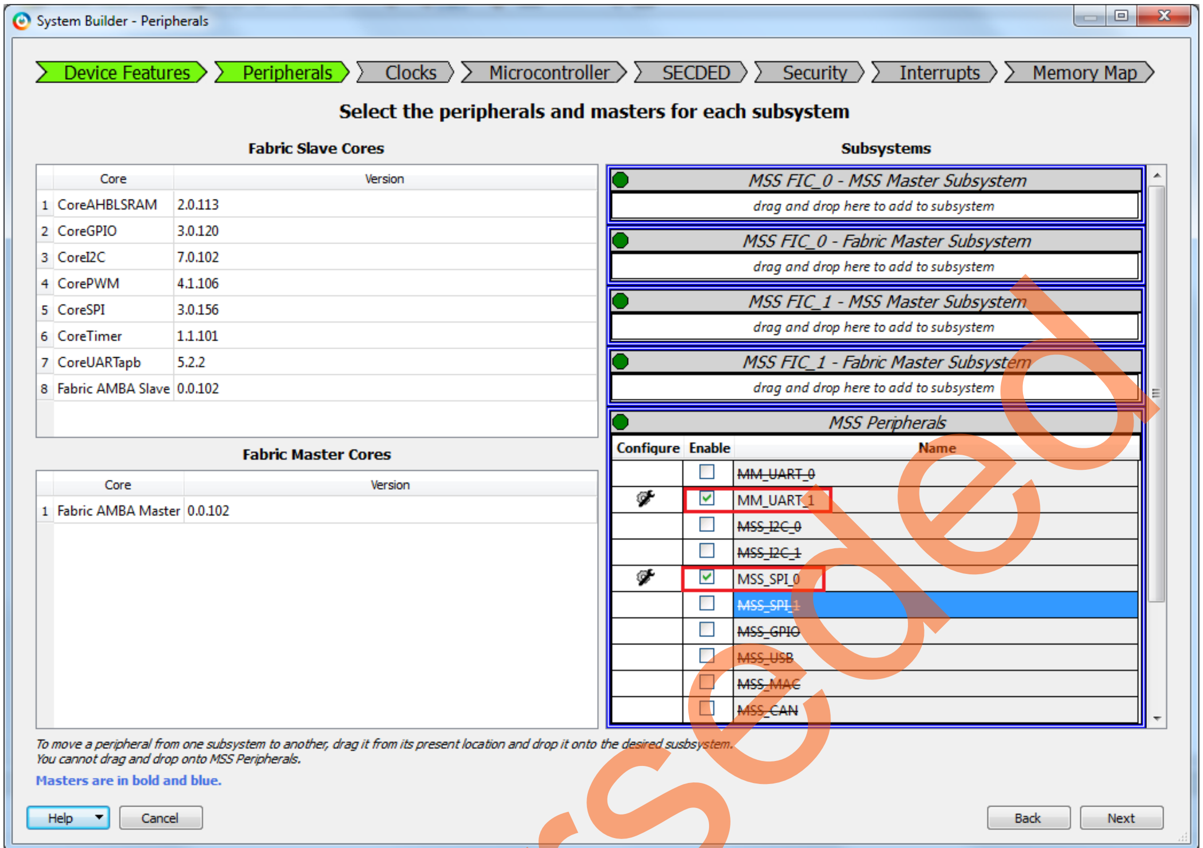

Figure 8 • **System Builder – Peripherals Page**

11. Click **Next**. This opens **System Builder - Clocks** page as shown in Figure 9.
12. In the **System Builder - Clocks** page (see Figure 9):
    – Select **System Clock** frequency as **50 MHz** and clock source as **On-chip 25/50 MHz RC Oscillator**
    – Select **M3_CLK** as **100 MHz**
    – Select **APB_0_CLK** and **APB_1_CLK** frequency as **M3_CLK/1**
    – Do not change the default settings of remaining parameters.

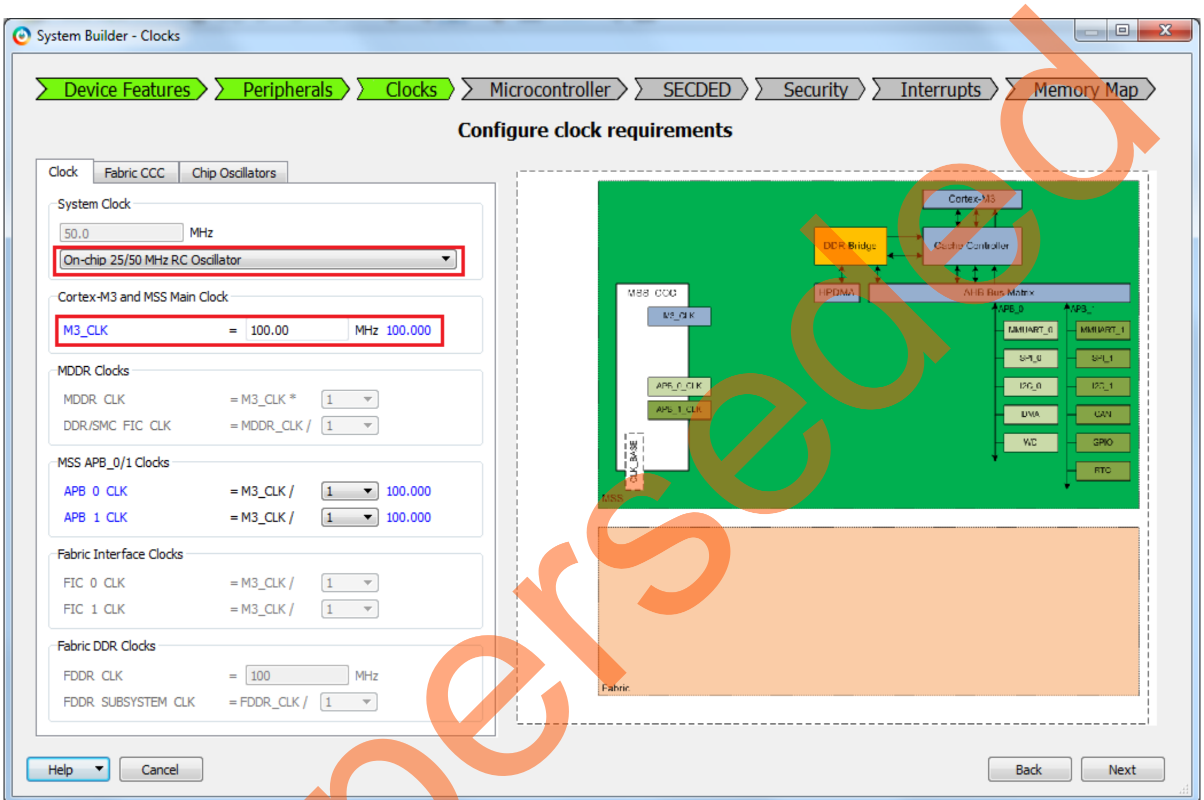

Figure 9 **• System Builder – Clock Page**

13. Click **Next**. This opens **System Builder - Microcontroller** page. Do not change the default selections.
14. Click **Next**. This opens **System Builder - SECDED** page. Do not change the default selections.
15. Click **Next**. This opens **System Builder - Security** page. Do not change the default selections.
16. Click **Next**. This opens **System Builder - Interrupts** page. Do not change the default selections.
17. Click **Next**. This opens **System Builder - Memory Map** page. Do not change the default selections.
18. Click **Finish**.

19. Select **File > Save** to save **SPI_Flash**. Select the **SPI_Flash** tab on the Smart Design canvas, as shown in Figure 10.

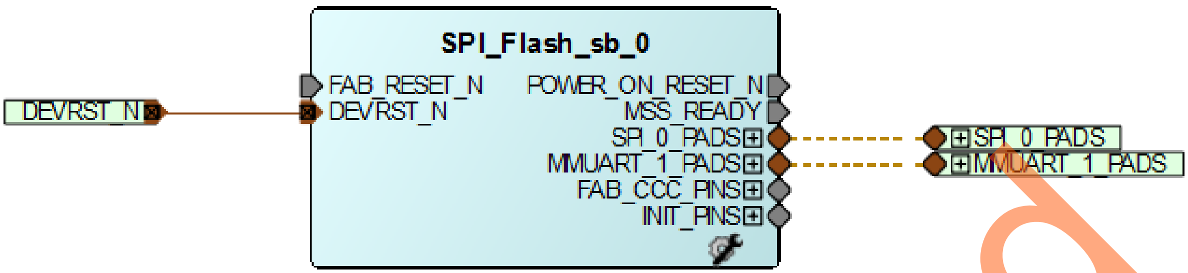

Figure 10 • **SPI_Flash Smart Design**

Connecting Components in SPI_Flash SmartDesign

The following steps describe how to connect the components in the **SPI_Flash** SmartDesign:

1. Right-click **POWER_ON_RESET_N** and select **Mark Unused**.
2. Right-click **MSS_READY** and select **Mark Unused**.
3. Expand **INIT_PINS**, right-click **INIT_DONE** and select **Mark Unused**.
4. Expand **FAB_CCC_PINS**, right-click **FAB_CCC_GL0** and select **Mark Unused**.
5. Right-click **FAB_CCC_LOCK** and select **Mark Unused**.
6. Right-click **FAB_RESET_N** and select **Tie High**.
7. Click **File > Save**.

The SPI_Flash design is displayed as shown in Figure 11.

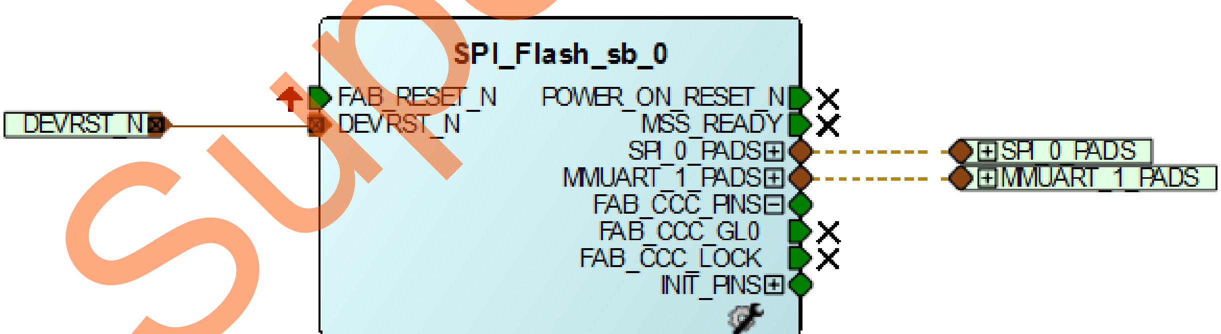

Figure 11 • **SPI_Flash Smart Design**

8. Generate the SPI_Flash Smart Design by clicking **SmartDesign > Generate Component** or by clicking **Generate Component** on the SmartDesign toolbar as shown in Figure 12

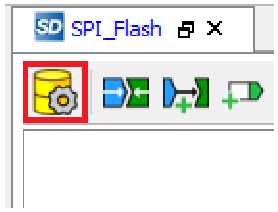

***Figure 12* • Generate Component**

After successful generation of all the components, the following message is displayed on the log window, as shown in Figure 13.

```
Info: 'SPI_Flash' was successfully generated.
```

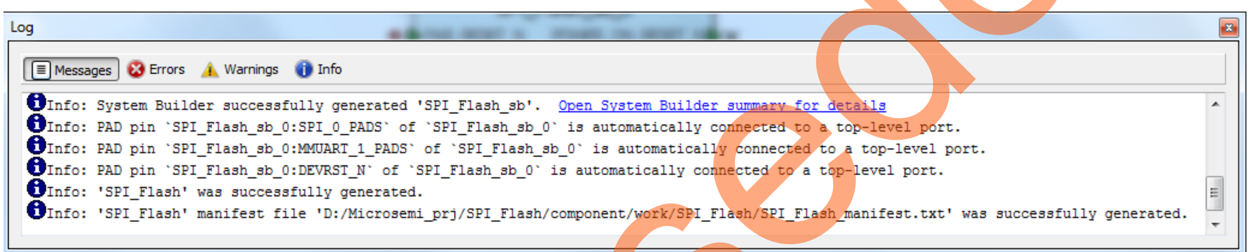

***Figure 13* • Log Window**

Step 2: Generating the Program File

The following step describe how to generate the program file:

Click **Generate Bitstream** as shown in Figure 14 to complete place and route, and generate the programming file.

***Figure 14* • Generate Bitstream**

Step 3: Programming SmartFusion2 Security Evaluation Board Using FlashPro

The following steps describe how to program the SmartFusion2 Security Evaluation Board using FlashPro:

1. Connect the FlashPro4 programmer to the J5 connector of the SmartFusion2 Security Evaluation Kit.
2. Connect the jumpers on the SmartFusion2 Security Evaluation Kit board as per Table 2. For more information on jumper locations, refer to Appendix C - SmartFusion2 Security Evaluation Kit Board Jumper Locations.

   CAUTION: Ensure that the power supply switch, **SW7** is switched OFF while connecting the jumpers on the SmartFusion 2 Security Evaluation Kit.

Table 2 • **SmartFusion2 Security Evaluation Kit Jumper Settings**

Jumper Number	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 that these jumpers are set accordingly.

3. Connect the power supply to the J6 connector.
4. Switch **ON** the power supply switch, SW7. Refer to Appendix A - Board Setup for Programming the Tutorial for information on the board setup for running the tutorial.
5. To program the SmartFusion2 device, double-click **Run PROGRAM Action** in the **Design Flow** tab as shown in Figure 15.

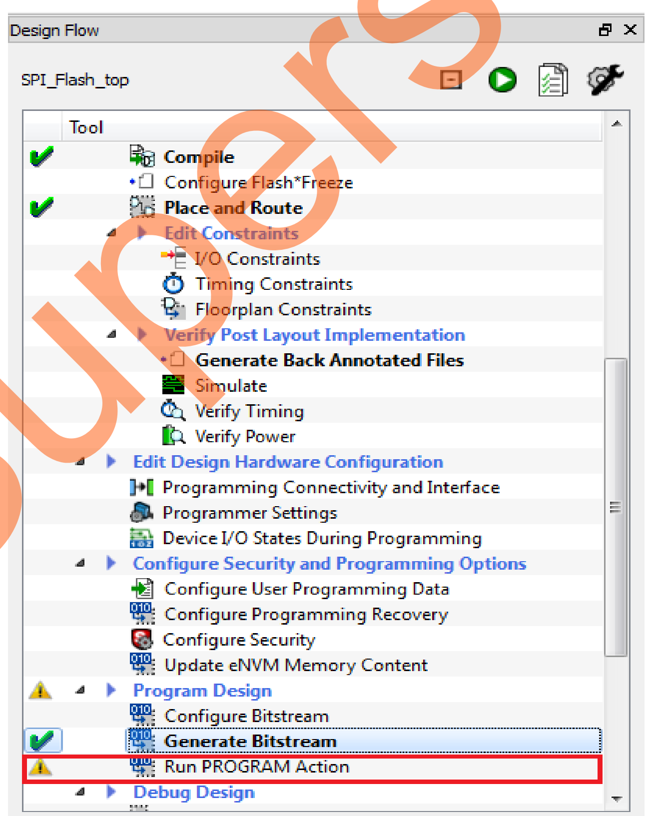

Figure 15 • **Run Program Action**

Step 4: Configuring and Generating Firmware

The Design Firmware window displays compatible firmware drivers based on peripherals configured in the design. Following drivers are used in this tutorial:

- CMSIS
- MMUART
- SPI

To generate the required drivers:

1. Double-click on **Configure Firmware Cores** in **Handoff design for Firmware Development** in **Design Flow** window.
2. Clear all the drivers check boxes, except CMSIS, MMUART, and SPI as shown in Figure 16.

Note: Select the latest version of the drivers.

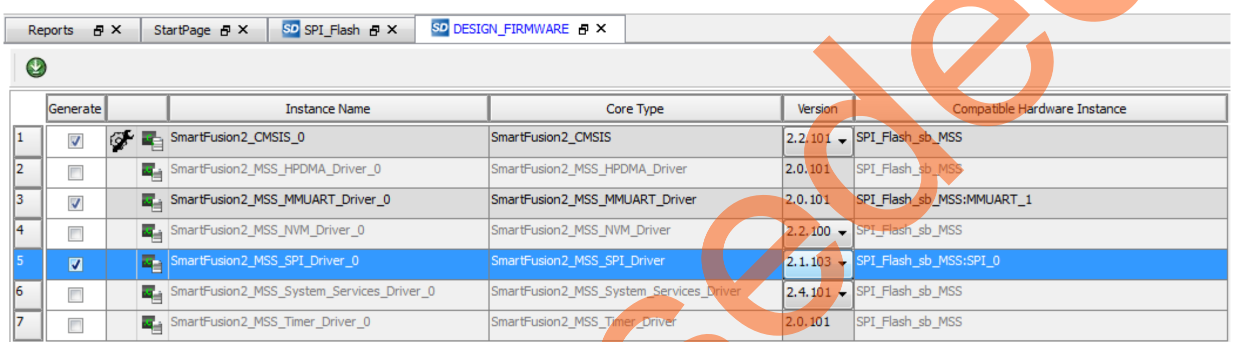

Figure 16 • **Configuring Firmware**

3. Double-click on **Export Firmware** in **Handoff design for Firmware Development** in **Design Flow** window.

   Export Firmware dialog box is displayed as shown in Figure 17.

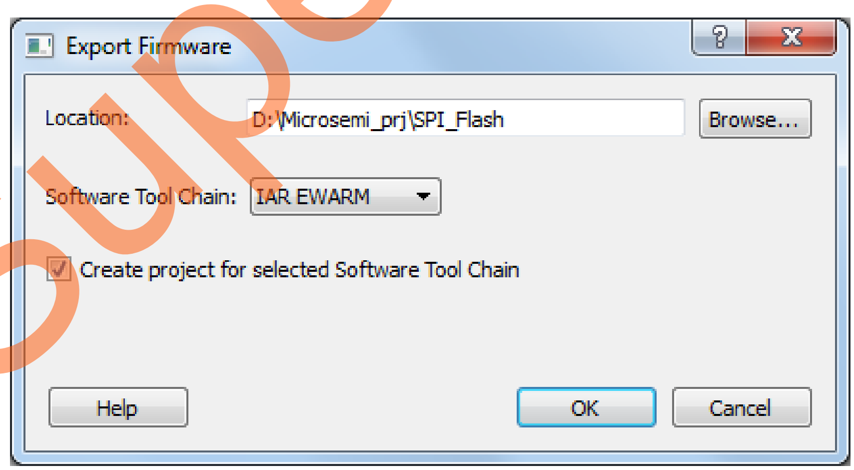

Figure 17 • **Export Firmware Dialog Box**

4. In the **Export Firmware** dialog box:
   – Select **Create project for selected Software Tool Chain**.
   – Select **IAR EWARM** from the drop down list.

5. Click **OK**. The successful firmware generation window is displayed as shown in Figure 18.

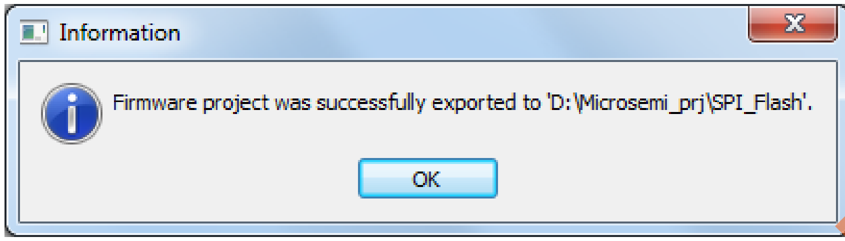

***Figure 18* • Firmware Successfully Exported Message**

6. Click **OK**.

The SmartFusion2 Security Evaluation Kit is ready for running and debugging the IAR Embedded Workbench application through J-Link Debugger.

Step 5: Building Software Application using IAR Embedded Workbench

The following steps describe how to build a software application using IAR embedded workbench:

1. Connect the J-Link programmer to **J4 connector** of SmartFusion2 Security Evaluation Kit.

   Refer to "Appendix B - Board Setup for Running the IAR Tutorial" on page 43 for information on the board setup for running and debugging the IAR software application.

   Ensure that the SmartFusion2 Security Evaluation Kit Jumper **J8** is in **2-3 closed** position for IAR Embedded Workbench and J-Link communication.

2. Open the IAR project by double-clicking **SPI_Flash_sb_MSS_CM3 IAR** project as shown in Figure 19.

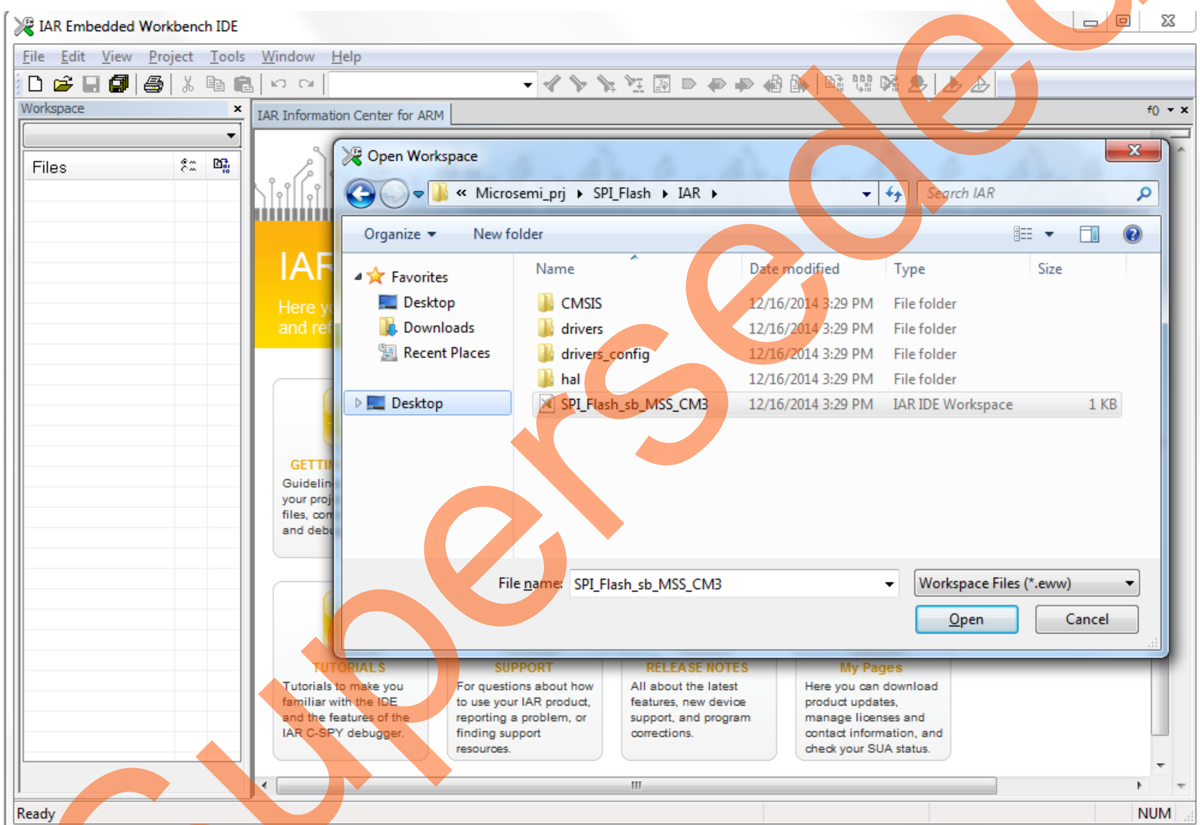

***Figure 19* • Invoking IAR Embedded Workbench from Libero SoC Software**

The IAR workspace is displayed, as shown in Figure 20.

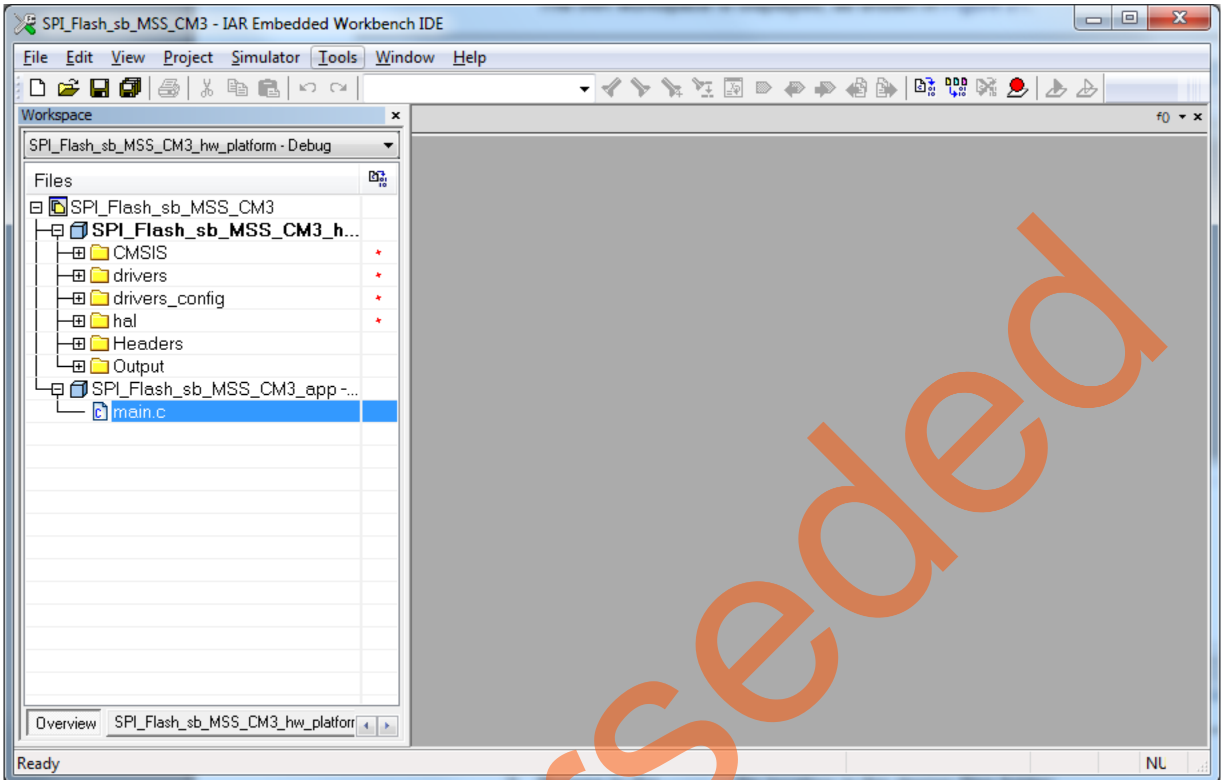

Figure 20 **• IAR Workspace**

3. Browse to the `main.c` file location in the design files folder: *<download folder>\SF2_SPI_Flash_IAR_Tutorial_DF\SourceFiles*.
4. Copy the `main.c` file and replace the existing `main.c` file under SPI_Flash_sb_MSS_CM3_app project in the IAR workspace.

The IAR window displays the `main.c` file, as shown in Figure 21.

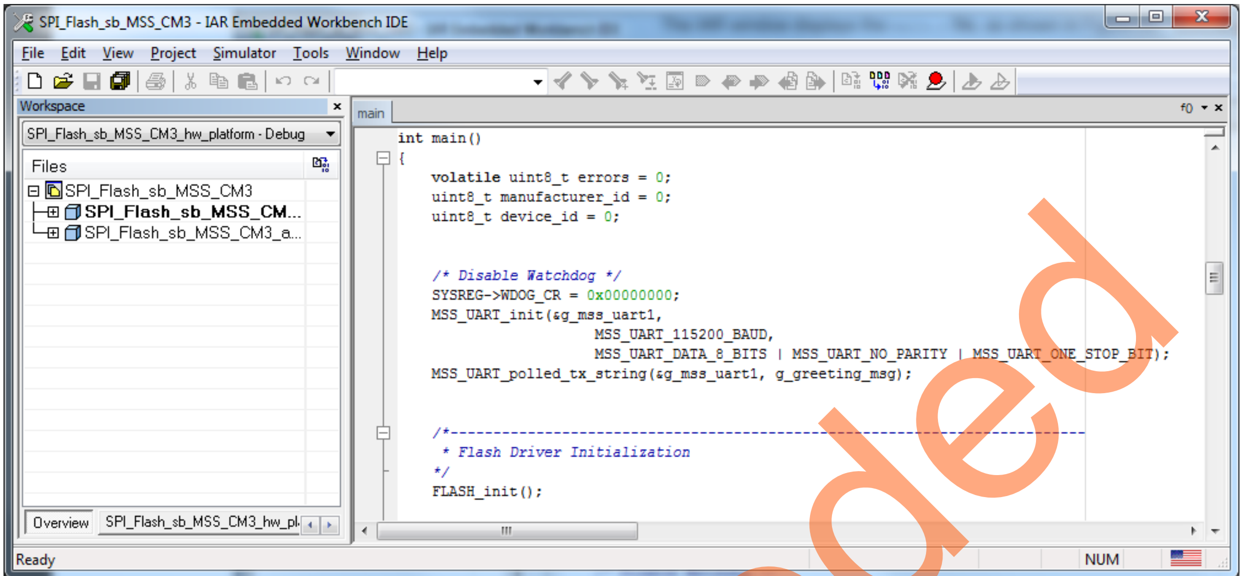

Figure 21 **• IAR Workspace main.c file**

5. winbondflash SPI flash drivers are not included in the Libero generated IAR workspace. To include the drivers in the IAR workspace, browse to the location of the winbondflash drivers in the design files folder: *<download_folder>\SF2_SPI_Flash_IAR_Tutorial_DF\SPI_Flash_Drivers*.
6. Copy the **winbondflash** folder to the drivers folder of SPI_Flash_sb_MSS_CM3_hw_platform project in the IAR workspace: *projectdirectory\IAR\drivers*.

7. Right-click and add the driver files (winbondflash.c & winbondflash.h) to the SPI_Flash_sb_MSS_CM3_hw_platform project in the IAR workspace as shown in Figure 22.

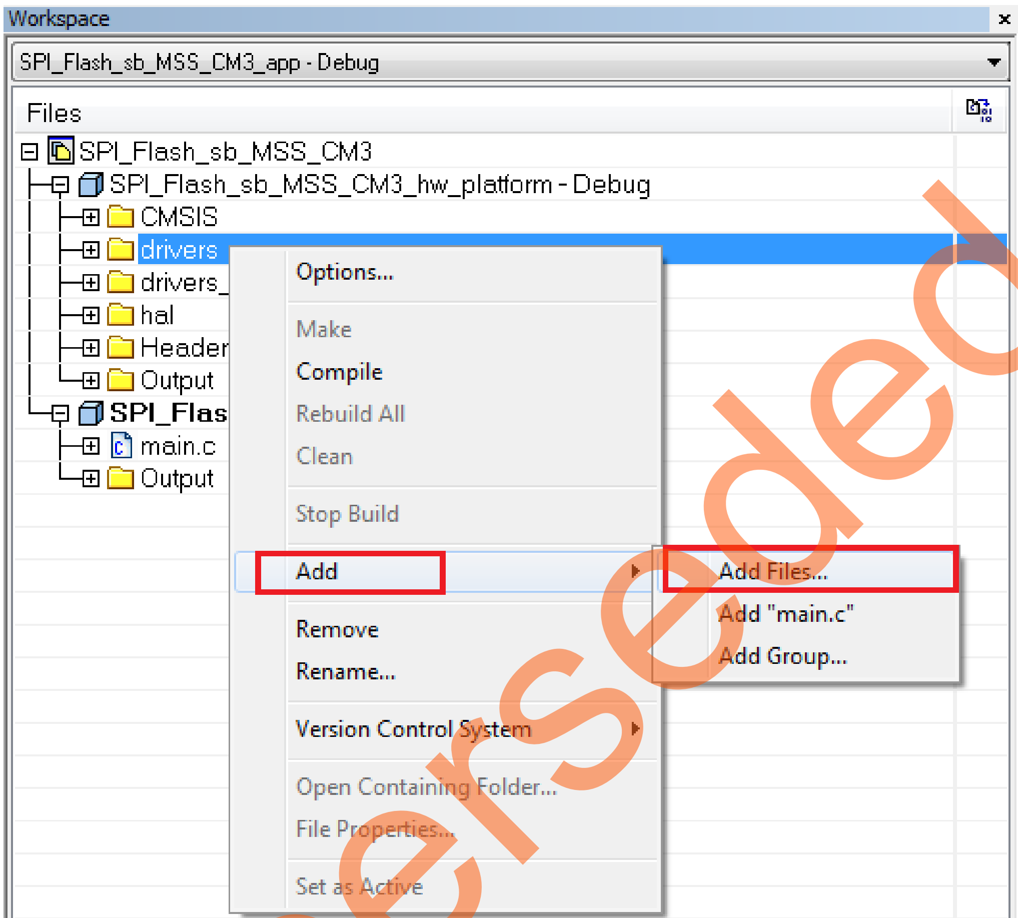

Figure 22 **• IAR Workspace Window - Add winbondflash SPI Driver Files**

Figure 23 shows the IAR workspace window displaying winbondflash SPI Driver Files.

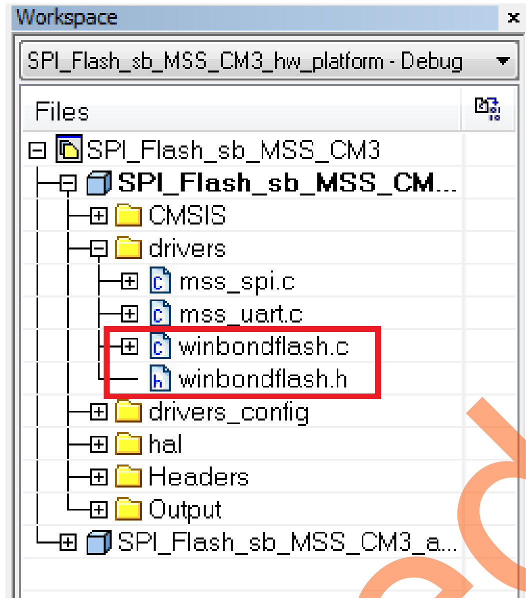

Figure 23 **• IAR Workspace Window - Display winbondflash SPI Driver Files**

8. To configure the project, right-click the project name (SPI_Flash_sb_MSS_CM3_hw_platform) and click **Options** as shown in Figure 24.

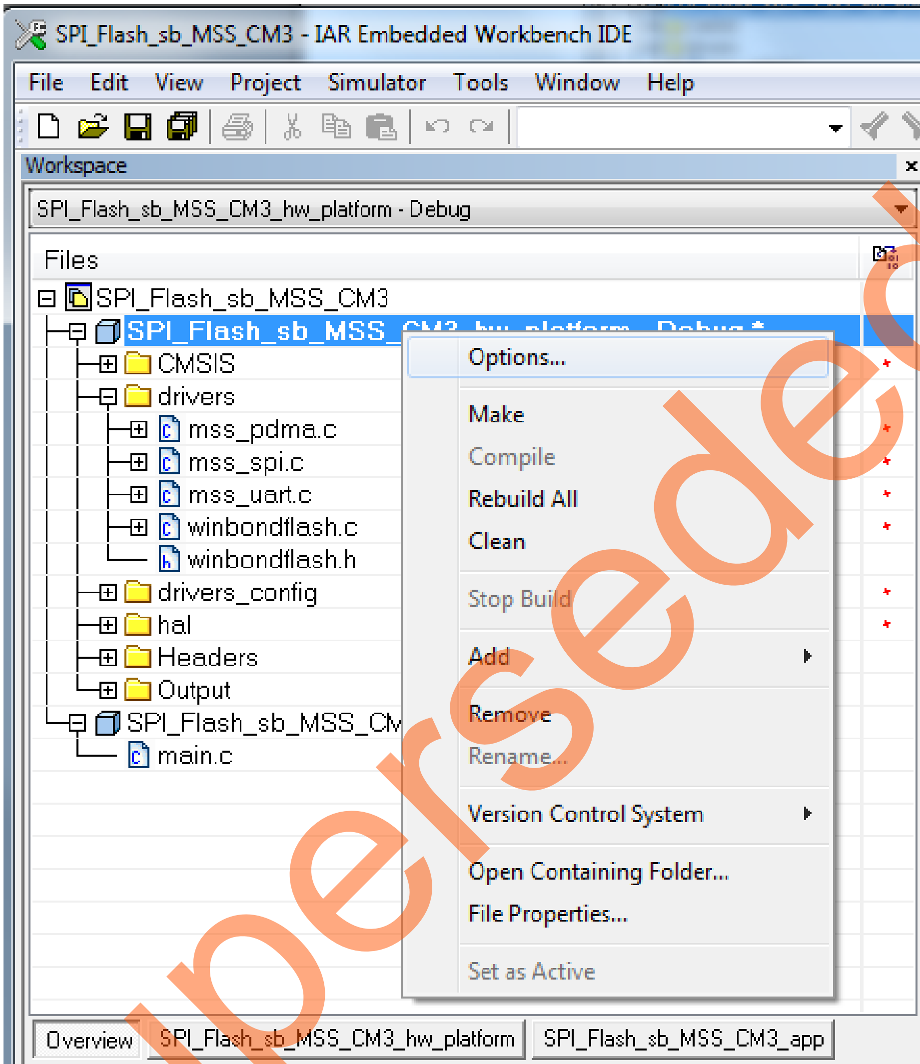

Figure 24 • **IAR Workspace Window - Choose Options**

This tutorial uses `printf` statements to display memory read data. Redirection of the output of `printf()` to a UART is enabled by adding the **MICROSEMI_STDIO_THRU_UART** symbol.

9. In Options window, click **C/C ++ Compiler**.
10. Click **Preprocessor** tab.

11. Under **Defined symbols** enter MICROSEMI_STDIO_THRU_UART and click **OK**, as shown in Figure 25.

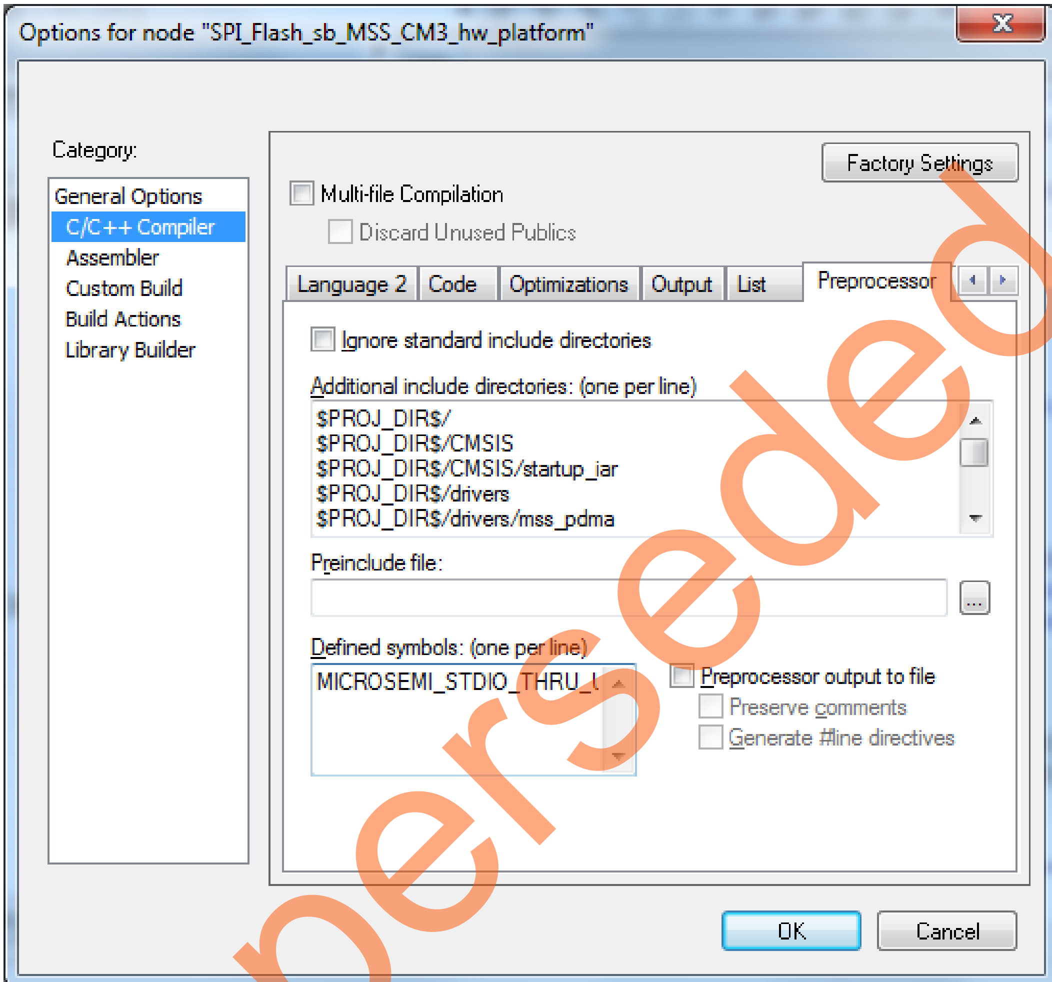

***Figure 25* • IAR Workspace Window - Adding Symbol**

12. To configure the project, right-click the project name (SPI_Flash_sb_MSS_CM3_app) and click **Options** as shown in Figure 26.

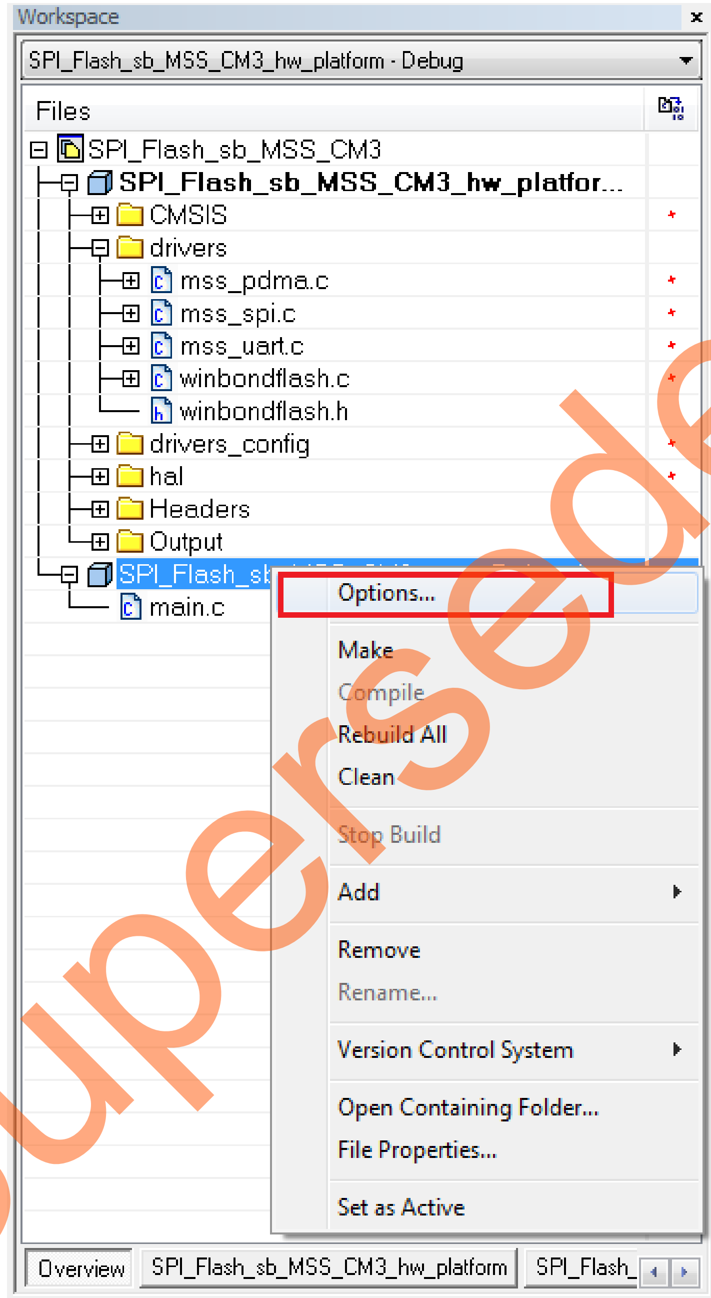

Figure 26 • **IAR Workspace Window - Choose Options**

The **Options for node SPI_Flash_sb_MSS_CM3_app** window is displayed as shown in Figure 27.

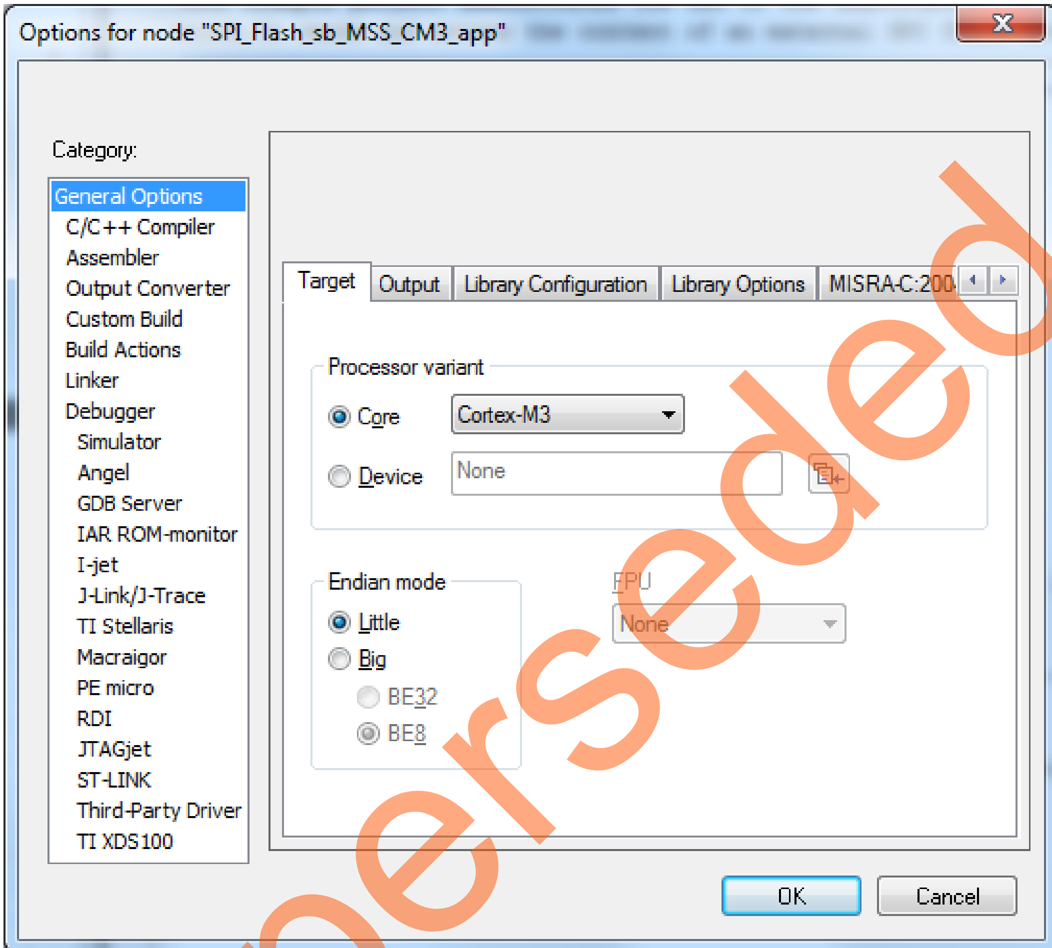

***Figure 27* • IAR Node Options**

13. Click **Debugger**. Under the **Setup** tab, select **J-Link/J-Trace** from the Driver the drop-down list (refer to Figure 28).

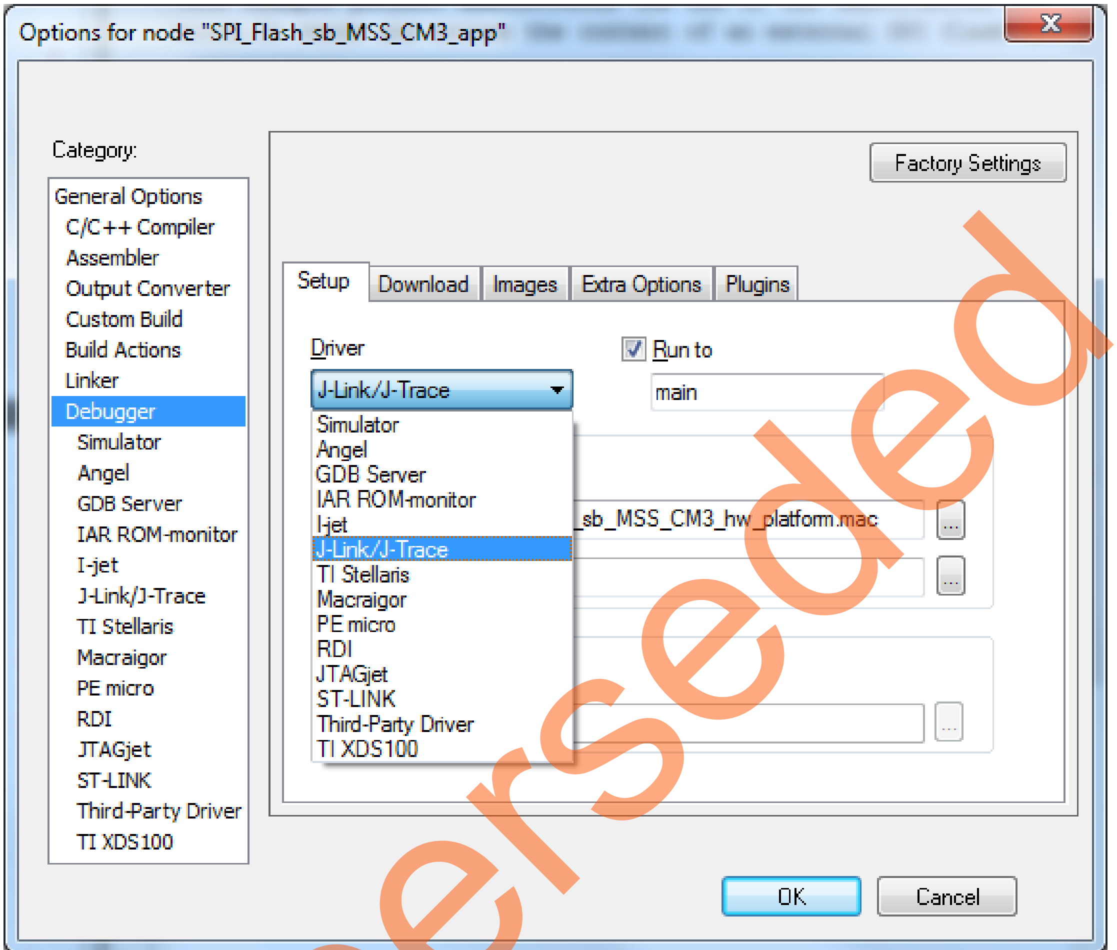

***Figure 28* • IAR Debugger Options - Selecting Driver**

14. Click **Download** tab and select the **Verify download** check box as shown in Figure 29.

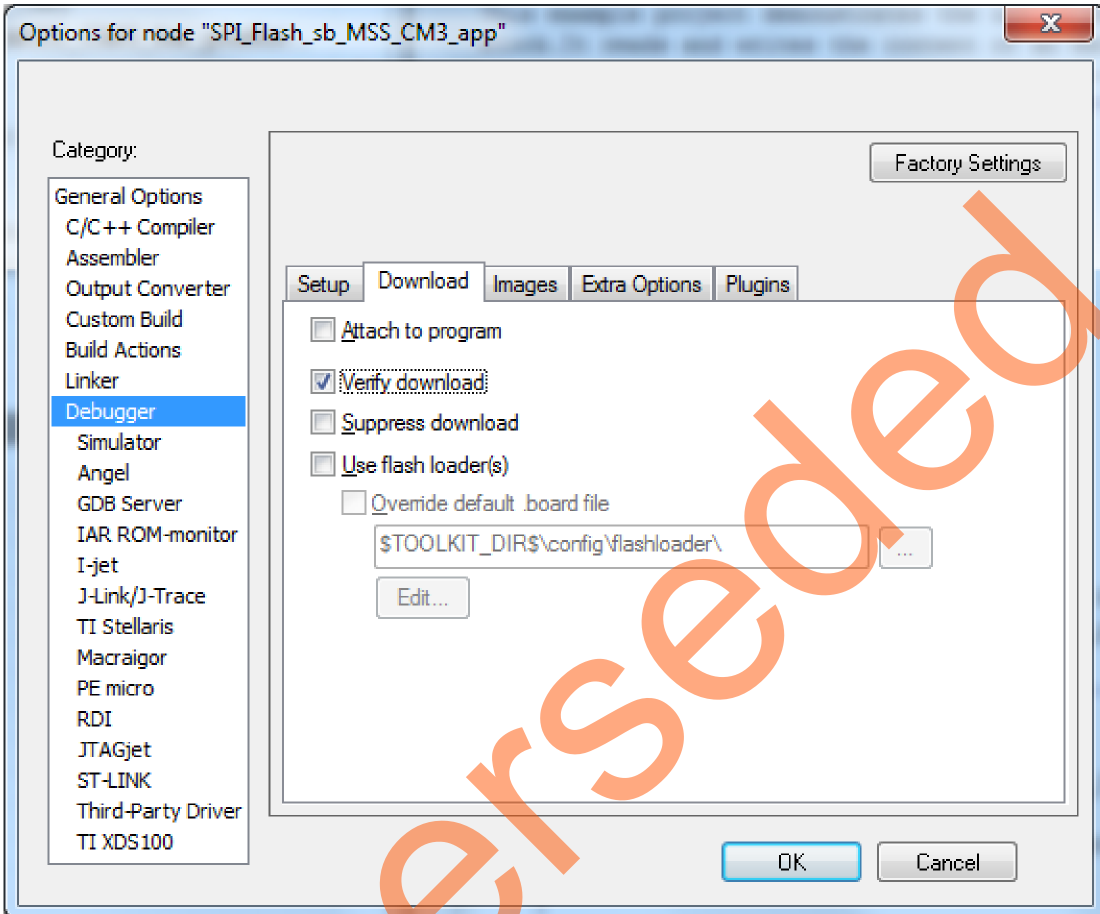

***Figure 29* • IAR Debugger Options - Download**

15. Click **OK** to close the **Options** window and build the project.

16. Right-click **SPI_Flash_sb_MSS_CM3_hw_platform - Debug** and select **Make** as shown in (Figure 30 and Figure 31).

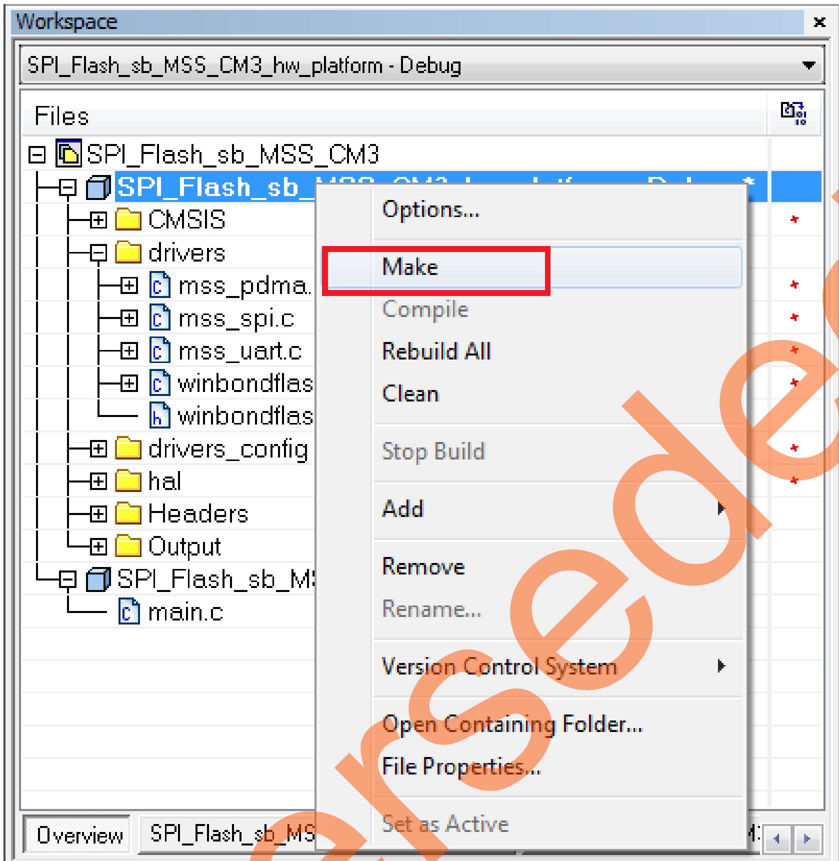

Figure 30 • **IAR Workspace - Hardware Platform Code Compilation using Make**

Successful Hardware Platform Code Compilation page is displayed as shown in Figure 31.

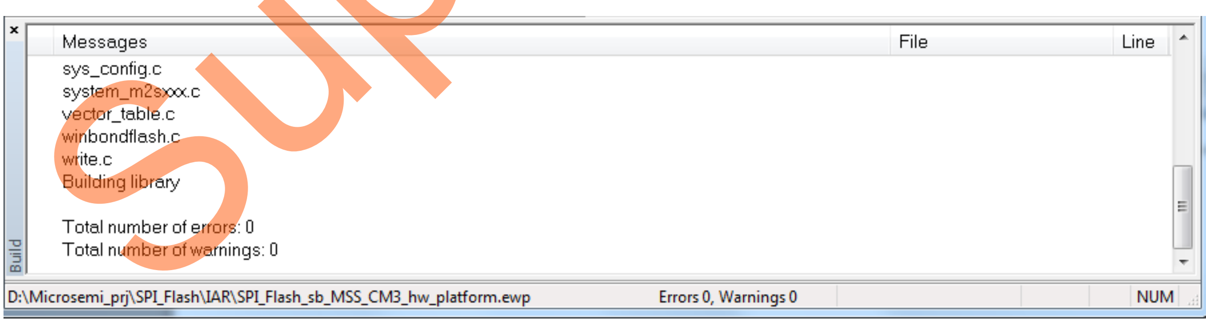

Figure 31 • **IAR Workspace - Successful Hardware Platform Code Compilation using Make**

17. Right-click **SPI_Flash_sb_MSS_CM3_app - Debug** project name and select **Set as Active** as shown in Figure 32.

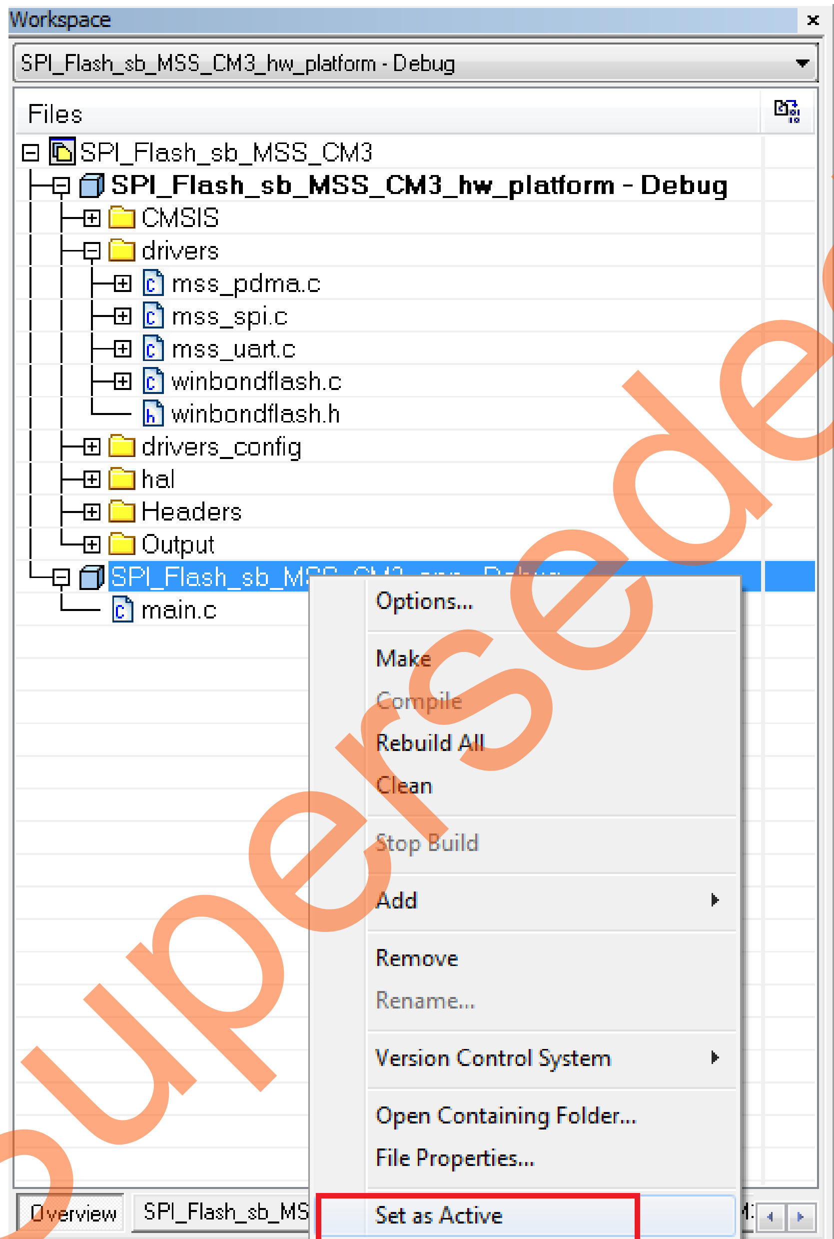

***Figure 32* • IAR Workspace - SPI_Flash_sb_MSS_CM3_app Set as Active**

18. Right-click **SPI_Flash_sb_MSS_CM3_app - Debug** project name and select **Clean** as shown in Figure 33.

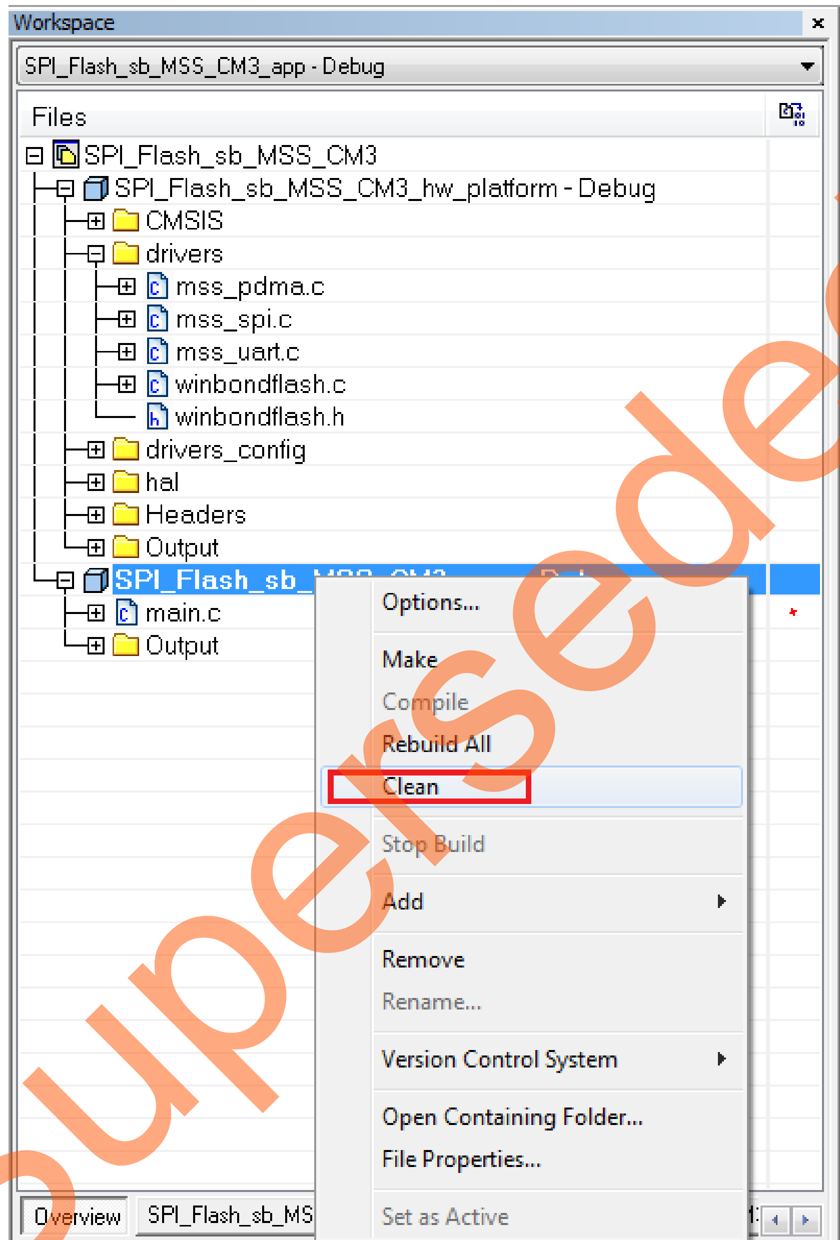

***Figure 33* • IAR Workspace - Execute Clean on SPI_Flash_sb_MSS_CM3_app Project**

19. After cleaning the project, the **Messages** log section shows that some files are deleted as shown in Figure 34.

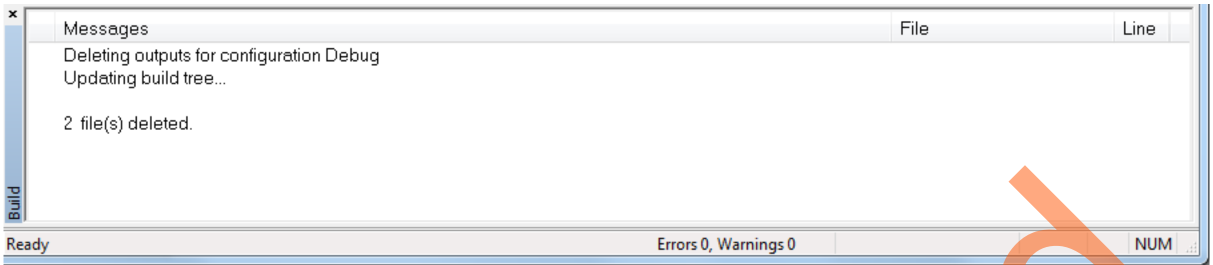

Figure 34 **• IAR Workspace - Deleted Files**

20. Right-click **SPI_Flash_sb_MSS_CM3_app - Debug** project name and click **Rebuild All** as shown in Figure 35.

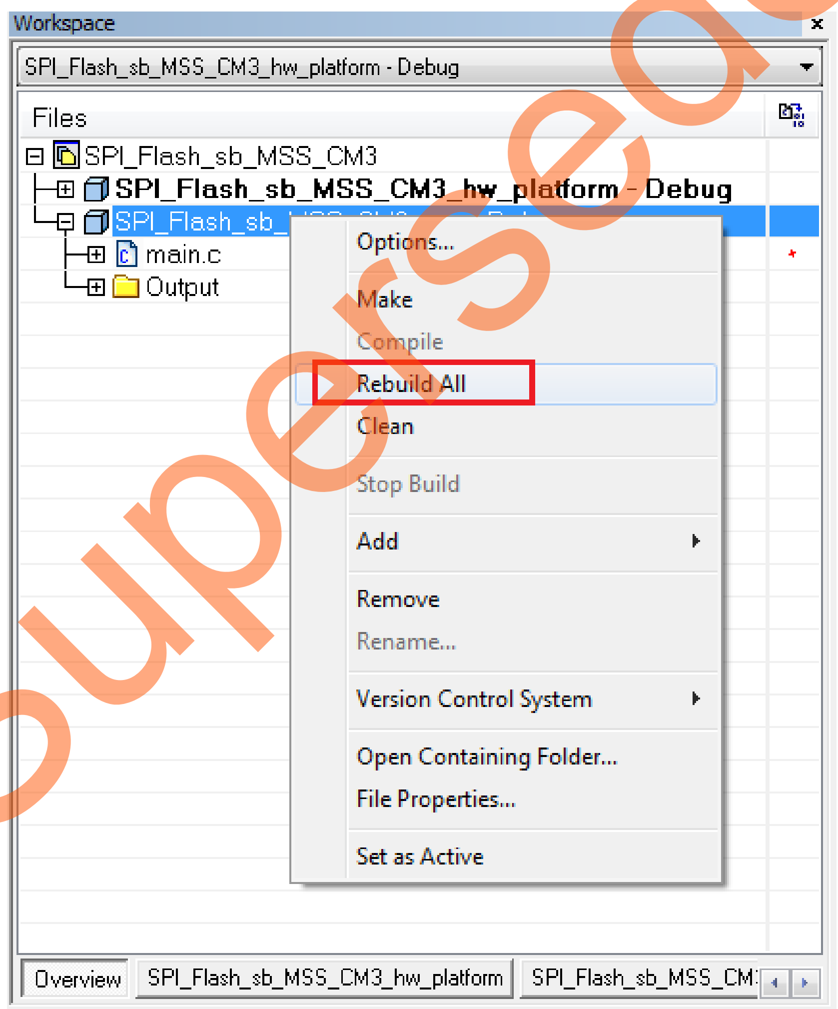

Figure 35 **• IAR Workspace - Select Rebuild All**

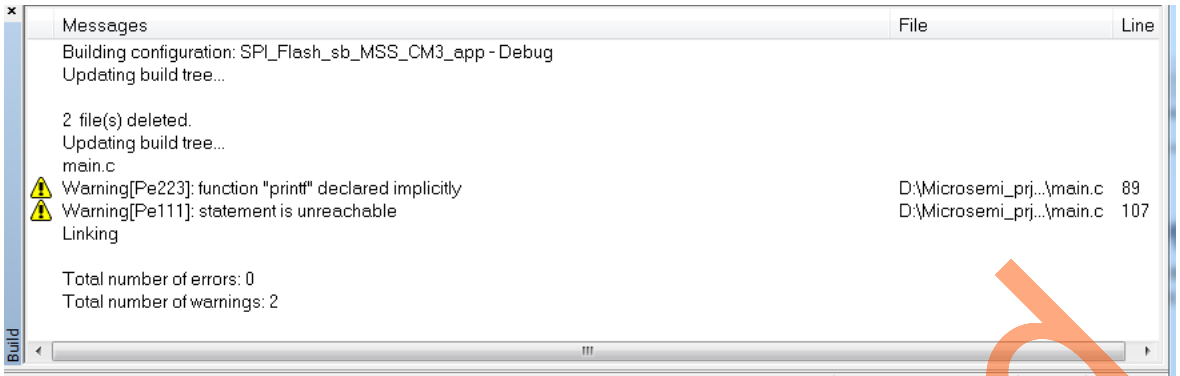

***Figure 36* • IAR Workspace - Rebuild All**

Step 6: Configuring Serial Terminal Emulation Program

The following steps describe how to configure serial terminal emulation program:

1. Install the USB driver. For serial terminal communication through the FTDI mini USB cable, install the FTDI D2XX driver. Download the drivers and the installation guide from: www.microsemi.com/soc/documents/CDM_2.08.24_WHQL_Certified.zip.
2. Connect the host PC to the J18 connector using the USB Mini-B cable. The USB to UART bridge drivers are automatically detected. Of the four COM ports, select the one with Location as **on USB Serial Converter D**. Figure 37 shows an example Device Manager window.

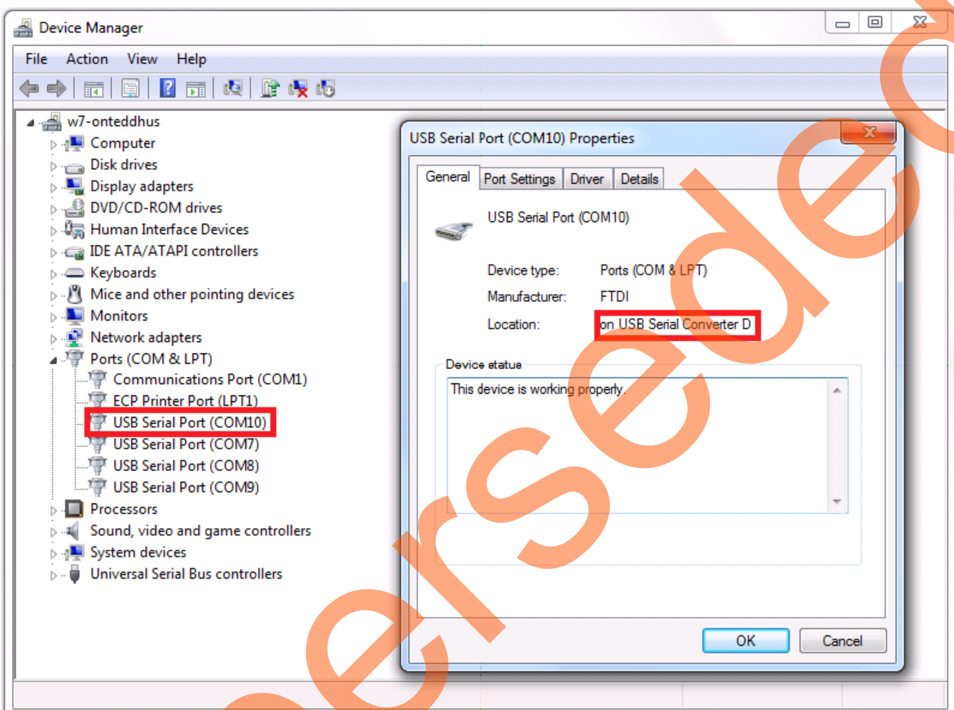

***Figure 37* • Device Manager Window**

3. Start the HyperTerminal session. If the HyperTerminal program is not available in the computer, any free serial terminal emulation program such as PuTTY or TeraTerm can be used. Refer to the *Configuring Serial Terminal Emulation Programs Tutorial* for configuring the HyperTerminal, TeraTerm, or PuTTY.

   The HyperTerminal settings are as follows:
   – 115200 baud rate
   – 8 data bits
   – 1 stop bit
   – No parity
   – No flow control

Step 7: Debugging the Application Project using IAR Workbench

The following steps describe how to debug the application project using IAR Workbench:

1. Switch to **SPI_Flash_sb_MSS_CM3_app - Debug** tab from Overview tab as shown in Figure 38.

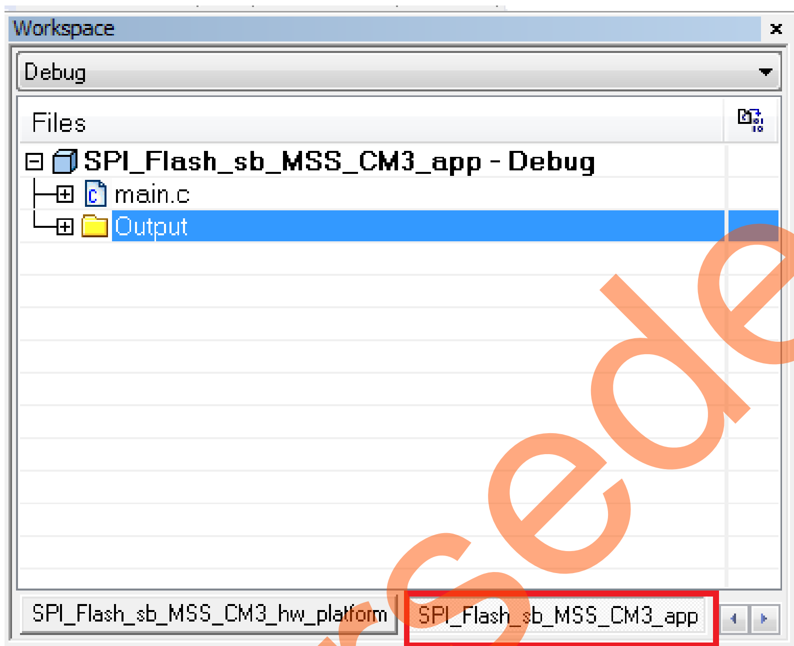

***Figure 38* • Debug Window**

2. In the IAR Workbench, click **Download and Debug** as shown in Figure 39.

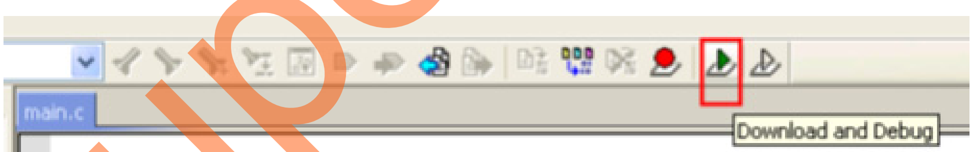

***Figure 39* • IAR Workbench - Download and Debug Option**

IAR Debugger Perspective window is opened, as shown in Figure 40.

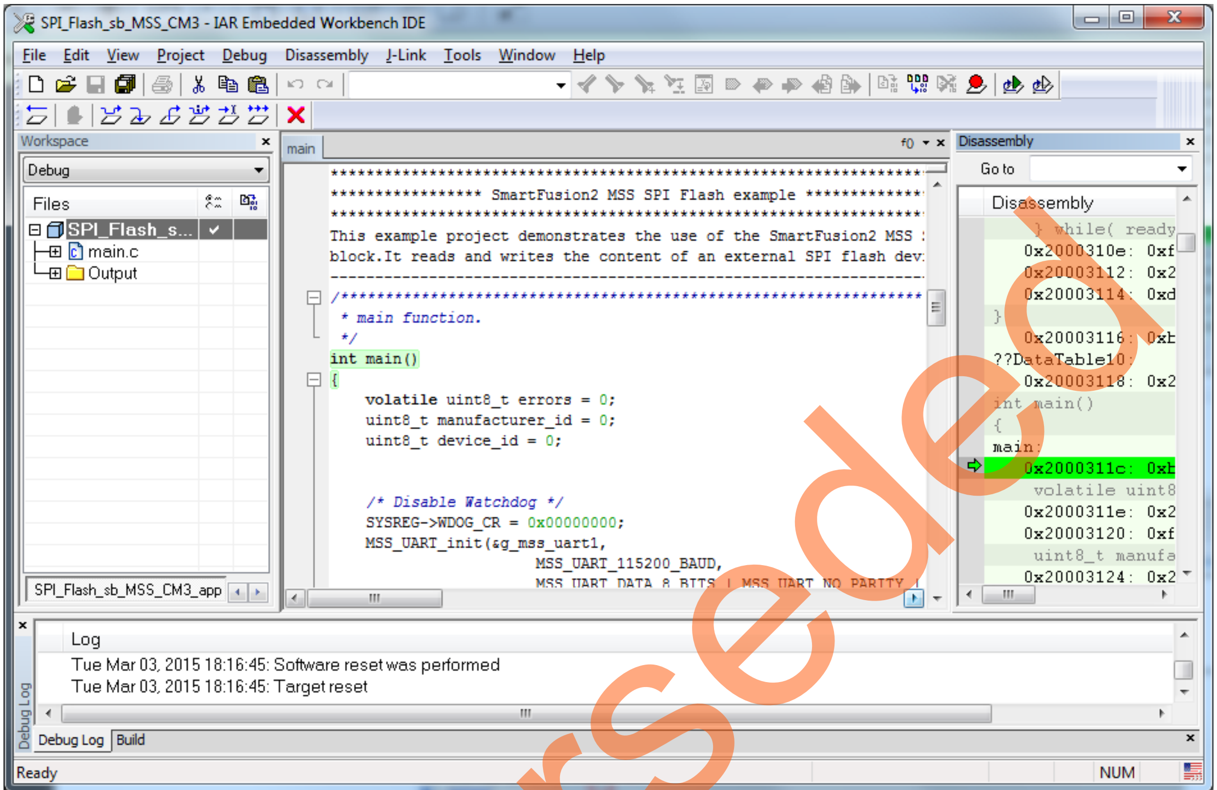

Figure 40 • **IAR Workbench - Debugger Perspective**

3. Click **Go** on IAR workbench to run the application as shown in Figure 41.

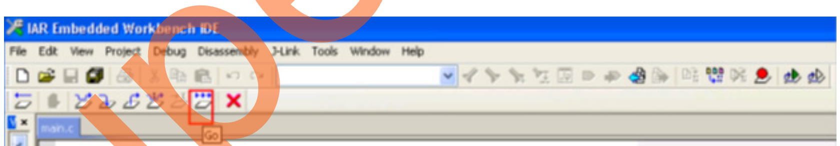

Figure 41 • **IAR Workbench - Go Option**

4. On successful operation, the HyperTerminal window displays a message as shown in Figure 42.

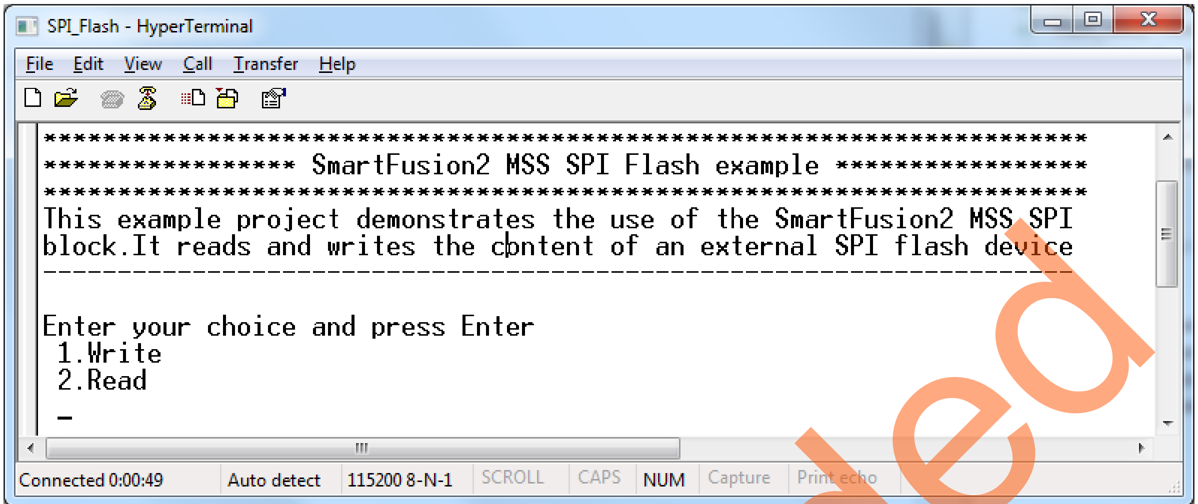

Figure 42 • **HyperTerminal Window**

5. Select option 1 and enter values to write to the SPI Flash Memory as shown in Figure 43.

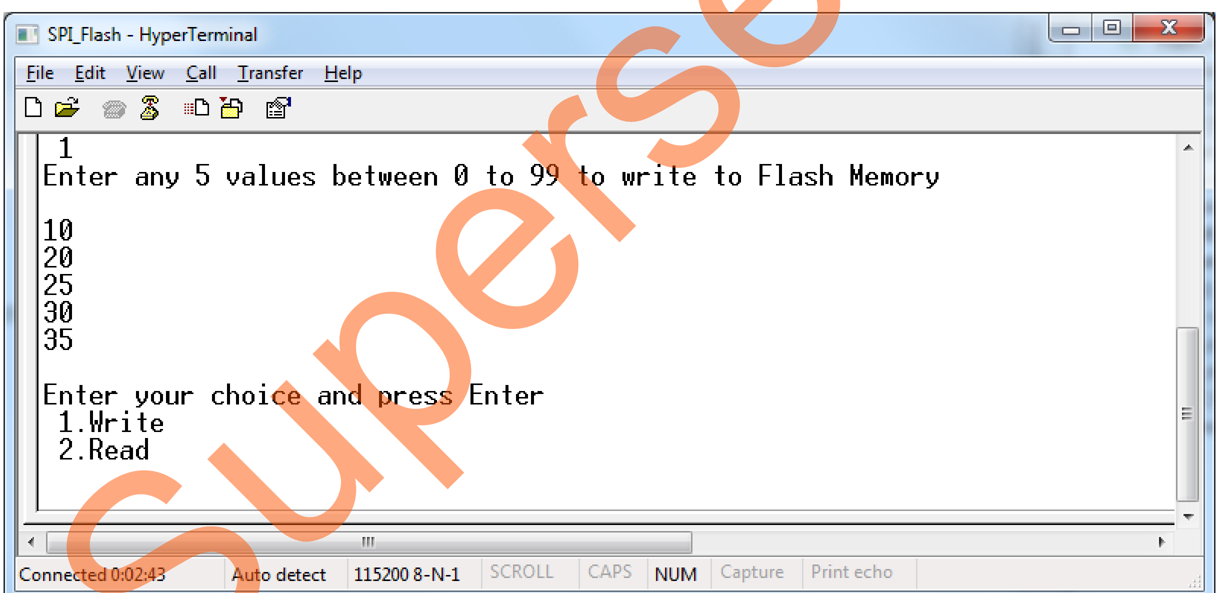

Figure 43 • **HyperTerminal Window - Option 1**

6. Select option 2 to read data from SPI Flash Memory as shown in Figure 44.

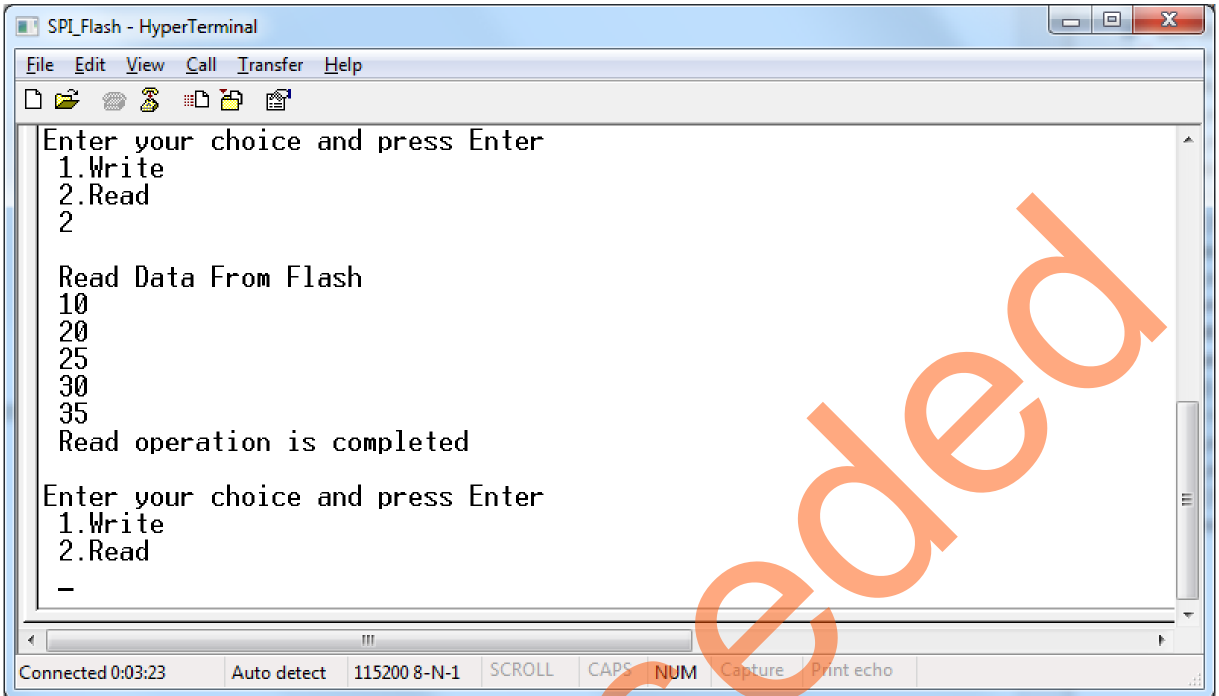

Figure 44 **• HyperTerminal Window - Option 2**

7. Click **View > Register** to view the values of the ARM® Cortex®-M3 processor internal registers as shown in Figure 45.

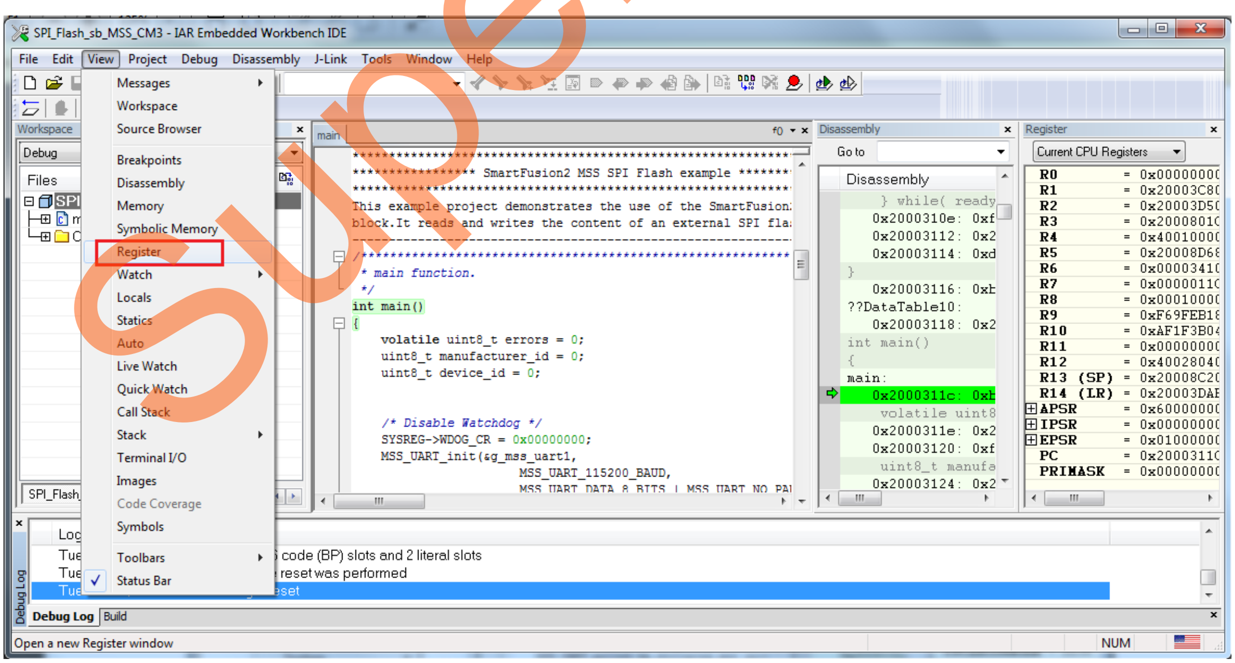

Figure 45 **• Values of Cortex-M3 Internal Registers**

8. Click **View > Statics** to view the values of variables in the source code as shown in Figure 46.

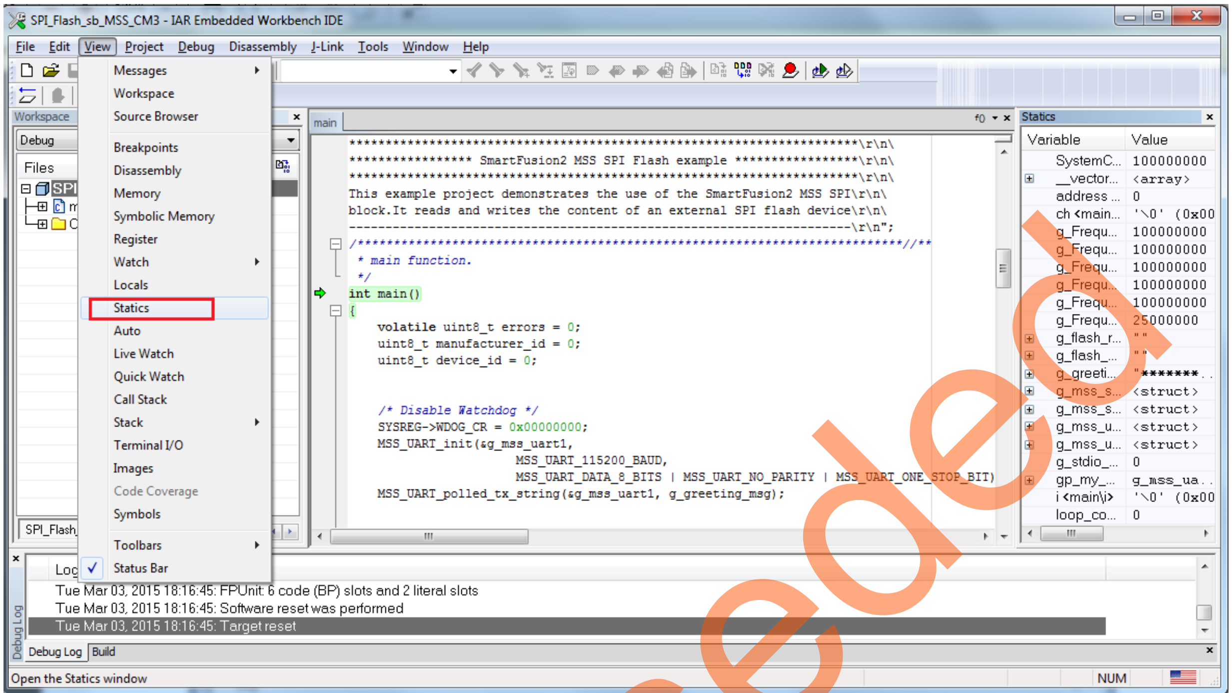

Figure 46 **• Values of Source Code Variables**

9. Click **View > Disassembly** to view the values of variables in the source code as shown in Figure 47.

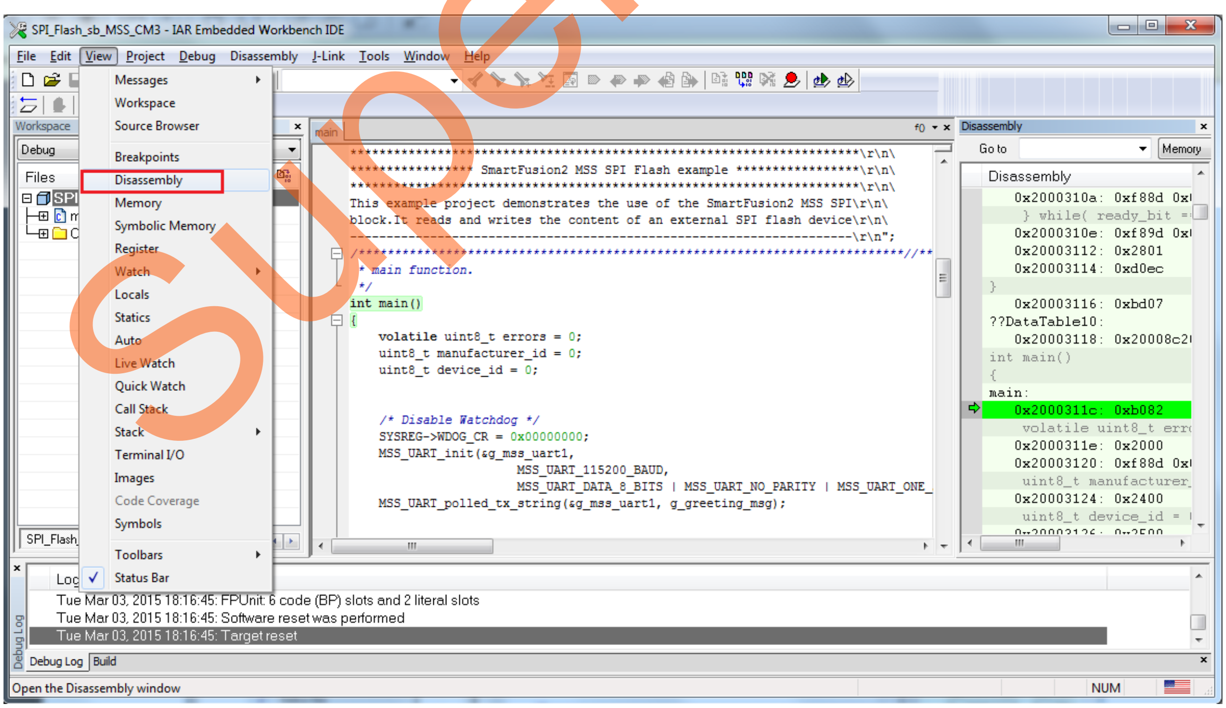

Figure 47 **• Assembly Level Instructions**

10. When debug process is finished, terminate execution of the code by choosing **Debug > Stop Debugging** as shown in Figure 48.

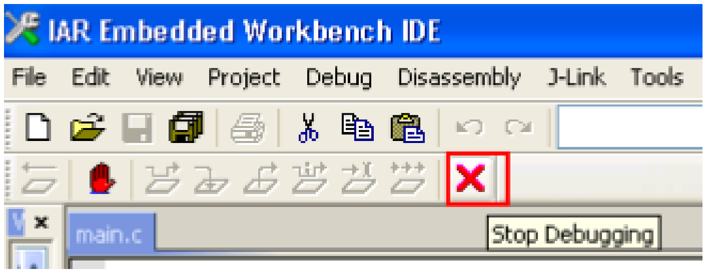

Figure 48 **• IAR Workbench - Stop Debugging Option**

11. The Step Level Debugging can be performed before running the application using Go. These can be accessed from the Debug menu or on the IAR workbench as shown in Figure 49:

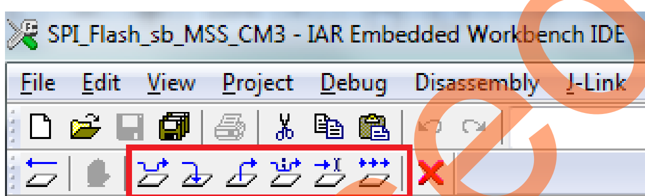

Figure 49 **• IAR Workbench - Step Level Debugging**

   – Source code can be single-stepped by selecting from the Debug menu **Debug > Step Into**, **Debug > Step Out**, **Debug > Step Over** or selecting the respective options from the IAR workbench as shown in Figure 49. Observe the changes in the source code window and Disassembly view. Performing a Step Over provides an option for stepping over functions. The entire function is run but there is no need to single-step through each instruction contained in the function.

12. Close **Debug Perspective** by selecting **Close Perspective** from the Window menu.
13. Close IAR Embedded Workbench using **File > Exit**.
14. Close the HyperTerminal using **File > Exit**.

Conclusion

This tutorial provides steps to create a Libero SoC design using the System Builder. It describes the procedure to build, debug, and run an IAR Embedded Workbench application. It also provides a simple design to access the SPI flash.

Appendix A - Board Setup for Programming the Tutorial

Figure 1 shows the board setup for programming the tutorial on the SmartFusion2 Security Evaluation Kit board.

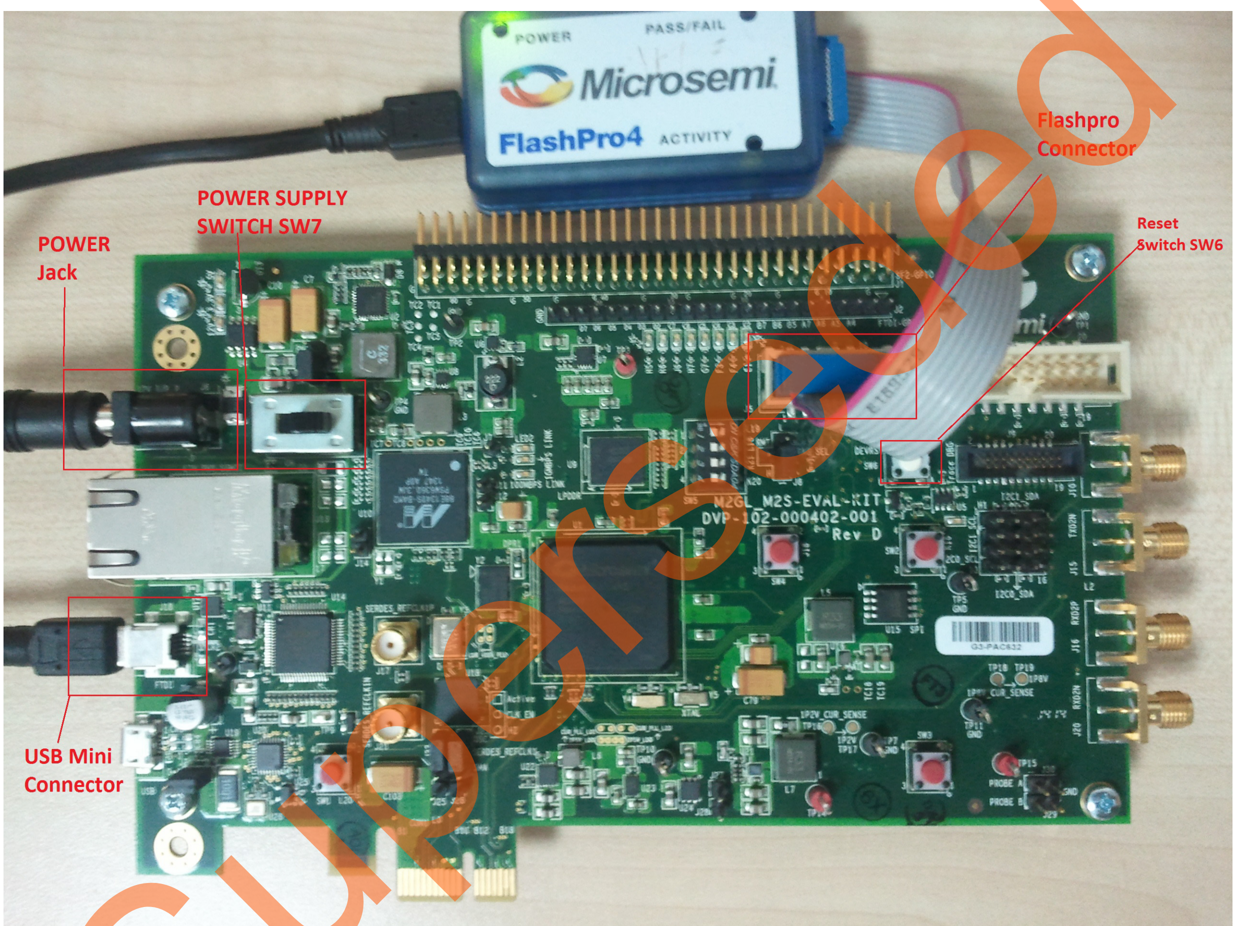

Figure 1 • **SmartFusion2 Security Evaluation Kit Setup**

Appendix B - Board Setup for Running the IAR Tutorial

Figure 1 shows the board setup for running and debugging the tutorial on the SmartFusion2 Security Evaluation Kit board.

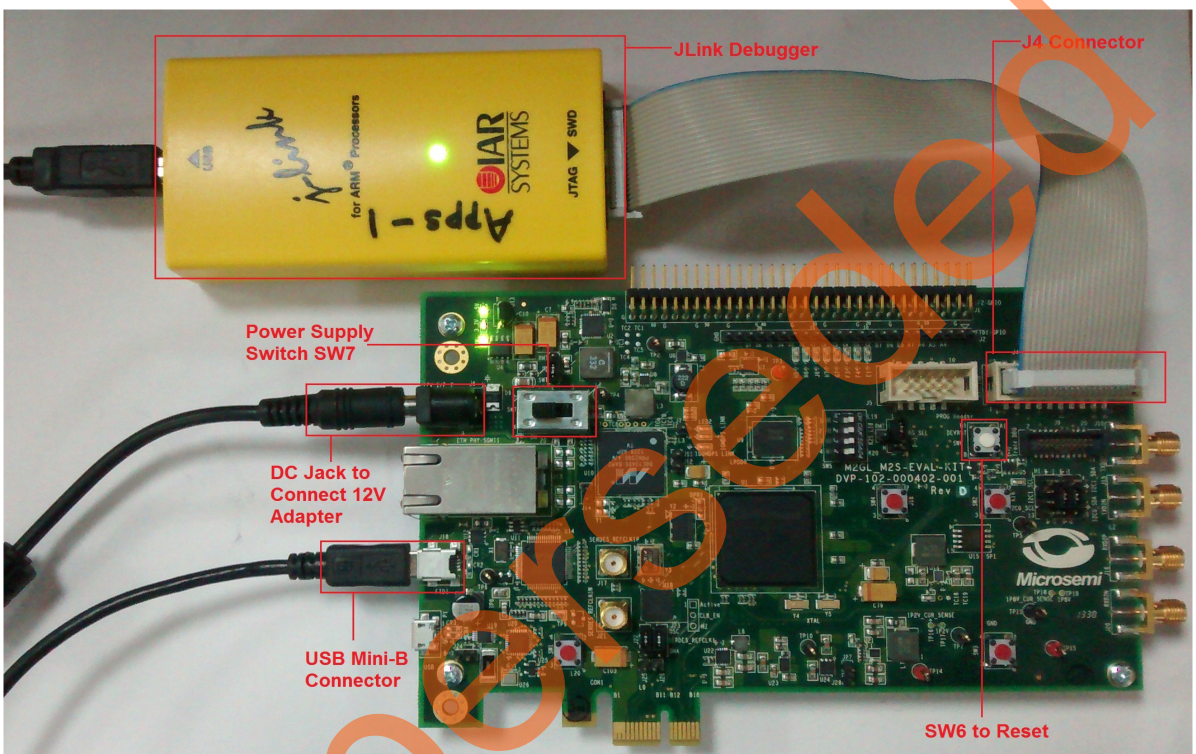

Figure 1 • **SmartFusion2 Security Evaluation Kit J-Link Programmer Connection**

Appendix C - SmartFusion2 Security Evaluation Kit Board Jumper Locations

Figure 1 shows the jumper locations on the SmartFusion2 Security Evaluation Kit board.

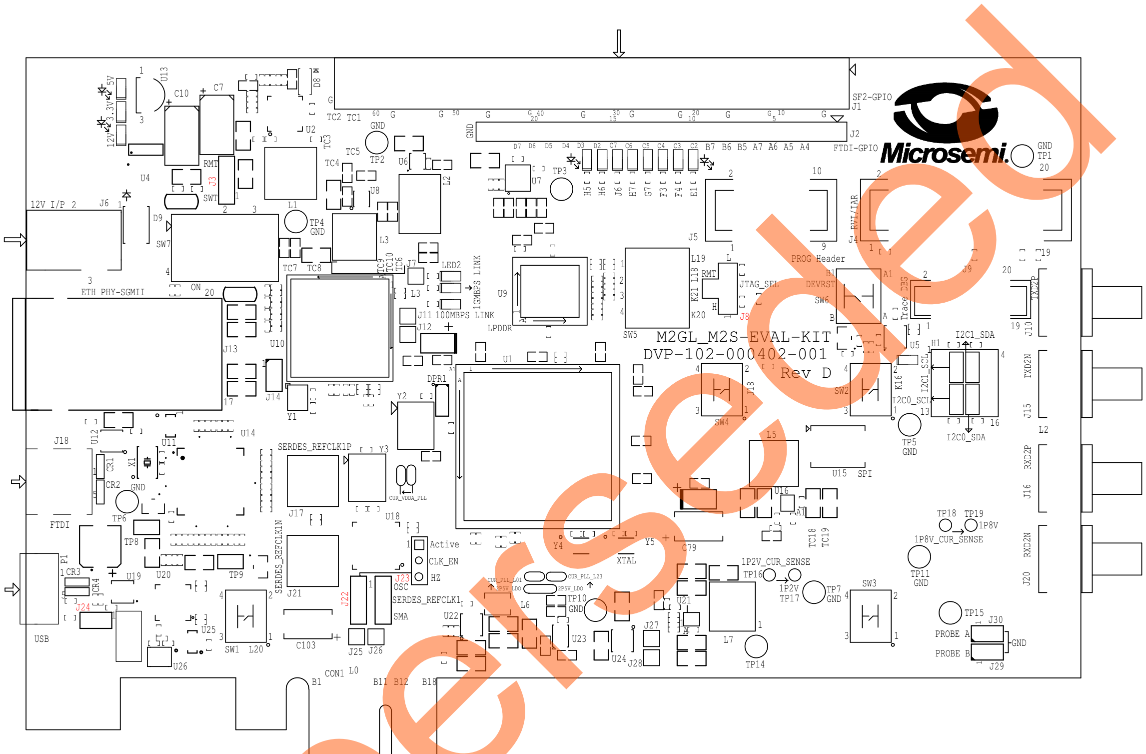

***Figure 1* • SmartFusion2 Security Evaluation Kit Board Jumper Locations**

Notes:

- Jumpers highlighted in red (J22, J23, J24, J8, and J3) are set by default.
- The location of the jumpers in Figure 1 are searchable.

List of Changes

The following table shows important changes made in this document for each revision.

Revision*	Changes	Page
Revision 3 (March 2015)	Updated the document for Libero SoC v11.5 software release (SAR 64188).	N/A
Revision 2 (November 2014)	Updated the document for Libero SoC v11.4 software release (SAR 61628).	N/A
Revision 1 (April 2014)	Initial release.	N/A

Note: **The revision number is located in the part number after the hyphen. The part number is displayed at the bottom of the last page of the document. The digits following the slash indicate the month and year of publication.*

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