
SmartFusion2 - USB OTG Capabilities - Libero SoC v11.6

DG0476 Demo Guide

Superseded

October 2015



Revision History

Date	Revision	Change
23 October 2015	5	Sixth release
19 February 2015	4	Fifth release
22 October 2014	3	Fourth release
23 June 2014	2	Third release
29 November 2013	1	Second release
10 October 2013	0	First release

Confidentiality Status

This is a non-confidential document.

Superseded

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Preface

About this document

This demo is for the SmartFusion[®]2 system-on-chip (SoC) field programmable gate array (FPGA) devices. It explains the universal serial bus (USB) 2.0 on-the-go (OTG) feature with the help of USB mass storage class.

Intended Audience

SmartFusion2 devices are used by:

- FPGA designers
- Embedded designers
- System-level designers

References

Microsemi Publications

- *UG0331: SmartFusion2 Microcontroller Subsystem User Guide*
- *Configuring Serial Terminal Emulation Programs Tutorial*

Refer to the following web page for a complete and up-to-date listing of SmartFusion2 device documentation: www.microsemi.com/products/fpga-soc/soc-fpga/sf2docs#documents

USB OTG Capabilities of SmartFusion2

Introduction

Microsemi® offers a reference design for the SmartFusion2 SoC FPGA devices that demonstrates the USB controller OTG feature and implements the USB mass storage class. The reference design runs on the SmartFusion2 Security Evaluation Kit. The SmartFusion2 SoC FPGA device contains a USB OTG controller as part of the microcontroller subsystem (MSS). This demo guide describes the mechanism for the USB communication between the SmartFusion2 device and the external USB host/USB device/USB OTG protocol compliant devices provided by the SmartFusion2 USB OTG controller.

OTG is the USB 2.0 mode of operation, where USB 2.0 OTG controller works as either the USB host or the USB device based on the target device and type of the plug connected to the USB OTG controller. Refer to the [UG0331: SmartFusion2 Microcontroller Subsystem User Guide](#), for more information on USB OTG controller and its operations.

Design Requirements

Table 1 lists the hardware and software design requirements.

Table 1 • Design Requirements

Design Requirements	Description
Hardware Requirements	
SmartFusion2 Security Evaluation Kit: <ul style="list-style-type: none">FlashPro4 programmer12 V adapterUSB A to Mini-B cable (for serial communication)Micro-A to B receptacle USB cable (to connect to the USB drive)Micro-B to A USB cable (to connect the SmartFusion2 Security Evaluation Kit board with the host PC)	Rev D or later
Host PC or Laptop	Any 64-bit Windows operating system
Software Requirements	
Libero® System-on-Chip (SoC)	v11.6
FlashPro programming software	v11.6
USB to UART drivers	—

Demo Design

Introduction

The demo design files are available for download from the following path in the Microsemi website:

http://soc.microsemi.com/download/rsc/?f=m2s_dg0476_liberov11p6_df

The demo design files include:

- Libero SoC project
- USB drivers
- STAPL programming file
- readme.txt file

Figure 1 shows the top-level structure of the design files. For details, refer to the readme.txt file.

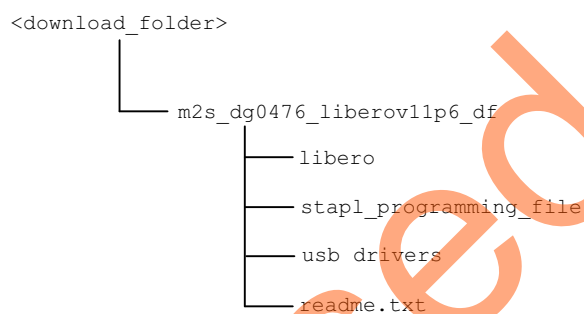


Figure 1 • Demo Design Files Top-Level Structure

Figure 2 shows the demo architecture.

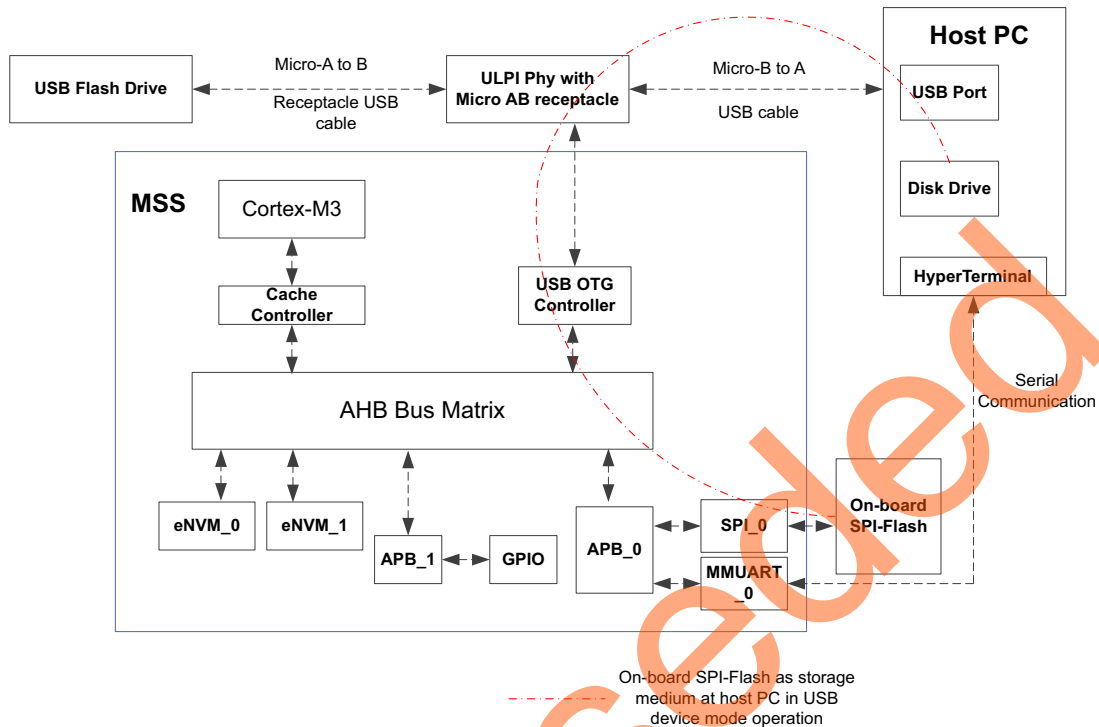


Figure 2 • Top-Level Block Diagram

Note: MSS USB drivers are provided along with the design files. These drivers are customized and used in the demo.

Demo Design Features

The main objective of the demo is to show OTG capability with USB mass storage class. The demo design performs the following operations:

- Switching the USB OTG controller operation between Host mode and Device mode based on the target device and type of plug connected to the USB OTG controller.
- Device mode operation
 - Displaying the on-board SPI flash (8 MB) as storage medium in host PC.
- Host mode operation
 - Detecting the USB 2.0 compliant USB mass storage device connected to the USB OTG controller and listing the file names.

Demo Design Description

The USB OTG controller in the SmartFusion2 device can be configured to operate in the USB device mode/USB host mode/USB OTG mode. In USB OTG mode, the USB OTG controller acts as either USB device or USB host based on the target device and type of plug connected to the USB OTG controller.

If the Micro-A end of the cable is plugged into the SmartFusion2 device through the external PHY, the USB controller takes the role of the host and goes into the Host mode. The Host mode flag is set to 1.

If the Micro-B end of the cable is plugged in, the USB controller goes into the Peripheral mode and the Host mode flag is set to 0.

The demo design application initializes the USB Host mode stack and USB Device mode stack to operate in the USB OTG mode. When the USB OTG controller enters into the Device mode, the application initializes the USB mass storage class and registers with the MSS USB Device mode driver. The on-board SPI flash memory (8 MB) is used as a storage medium in the USB Device mode operation and read/write operations can be performed.

When the USB OTG controller enters into the Host mode, the application registers the USB mass storage class with the MSS USB Host mode driver. The application detects the connected mass storage device and lists the files names. The application uses the FatFs file system library to access the files from the target USB mass storage device.

Refer to the following link for more information on FatFs file system:

http://elm-chan.org/fsw/ff/00index_e.html.

USB OTG Mode Execution Flow

Figure 3 describes the USB OTG mode execution flow.

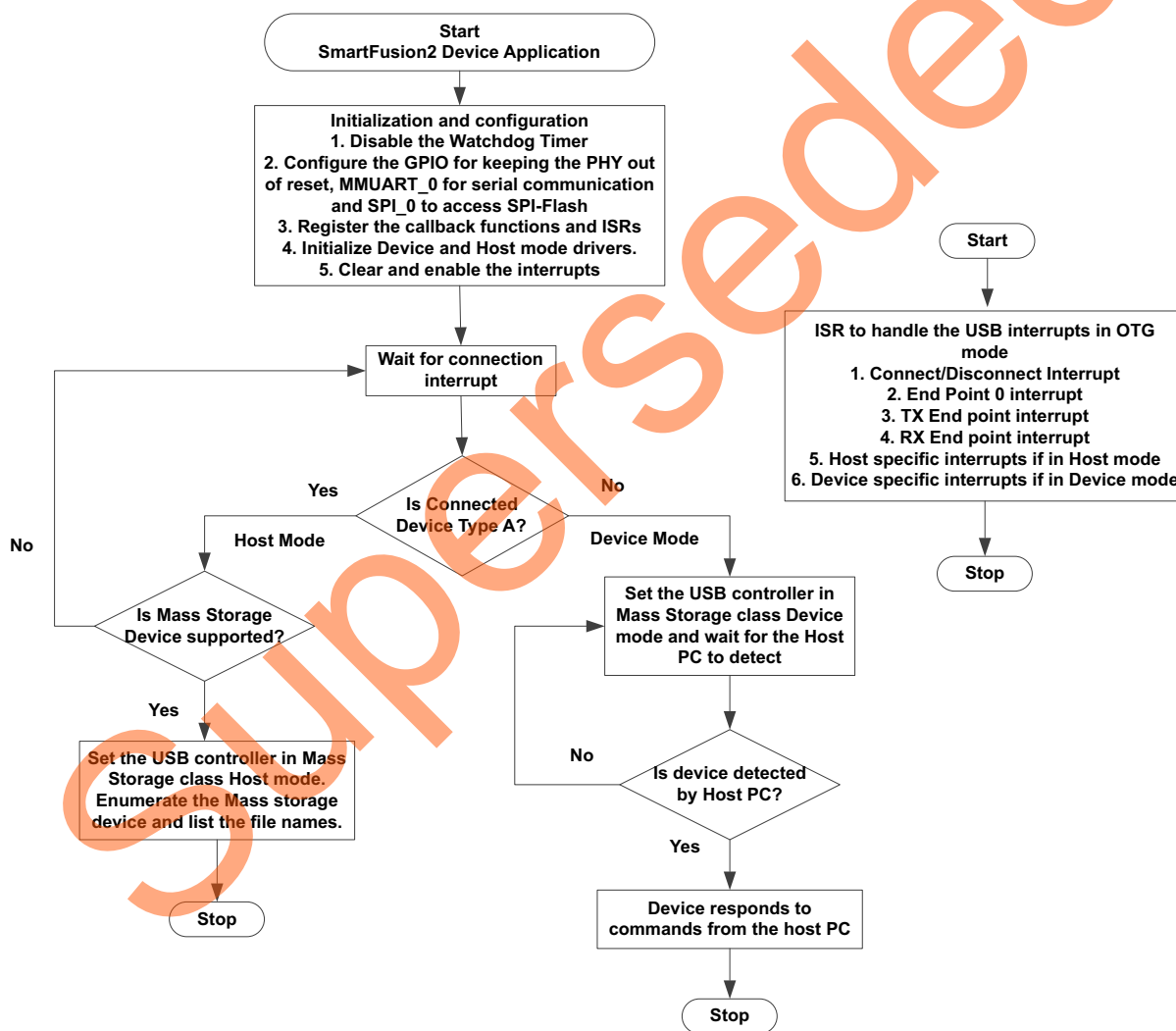


Figure 3 • USB OTG Execution Flow

The demo application configures MMUART_1 for serial communication, SPI_0 to access SPI-Flash, and GPIO to keep the USB controller out of reset. The application registers the USB callback functions and USB interrupt service routine to handle the USB events like connect/disconnect, Host mode specific events, and Device mode specific events.

When the SmartFusion2 device is connected to the host PC with Micro-B to A USB cable, the USB connect interrupt is generated and the Host mode flag is set to 0. The USB controller enters into mass storage class device mode and starts responding to the commands from the host PC. The SmartFusion2 on-board SPI-Flash is accessed by the host PC as a disk drive/volume in the USB Device mode.

When the Micro-A to B receptacle USB cable with the USB mass storage device is connected to the SmartFusion2 device, the connect interrupt is generated and the Host mode flag is set to 1. The USB controller switches to the Host mode from the Device mode and accesses the USB mass storage device. When the USB mass storage device is unplugged from the SmartFusion2 device, the Host mode flag is set to 0 and disconnect interrupt is generated. The application releases the Host mode driver and waits to enter into either the Device mode or Host mode based on the target device and type of plug connected to the USB controller.

Setting Up the Demo Design

The following steps describe how to setup the demo design:

1. Connect the FlashPro4 programmer to the J5 connector of the SmartFusion2 Security Evaluation Kit board.
2. Connect the host PC to the J18 connector on the SmartFusion2 Security Evaluation Kit board using the USB A to Mini-B cable.
3. Ensure that the **USB to UART bridge drivers** are automatically detected. Download and install the drivers from www.microsemi.com/soc/documents/CDM_2.08.24_WHQL_Certified.zip.
4. Of the four COM ports, select the one with **Location as on USD Serial Converter D**. Figure 4 shows an example of the **Device Manager** window that has the **USB Serial Port** and its **properties** showing the port number and location. The COM port number is required to run the demo design, make a note of it.

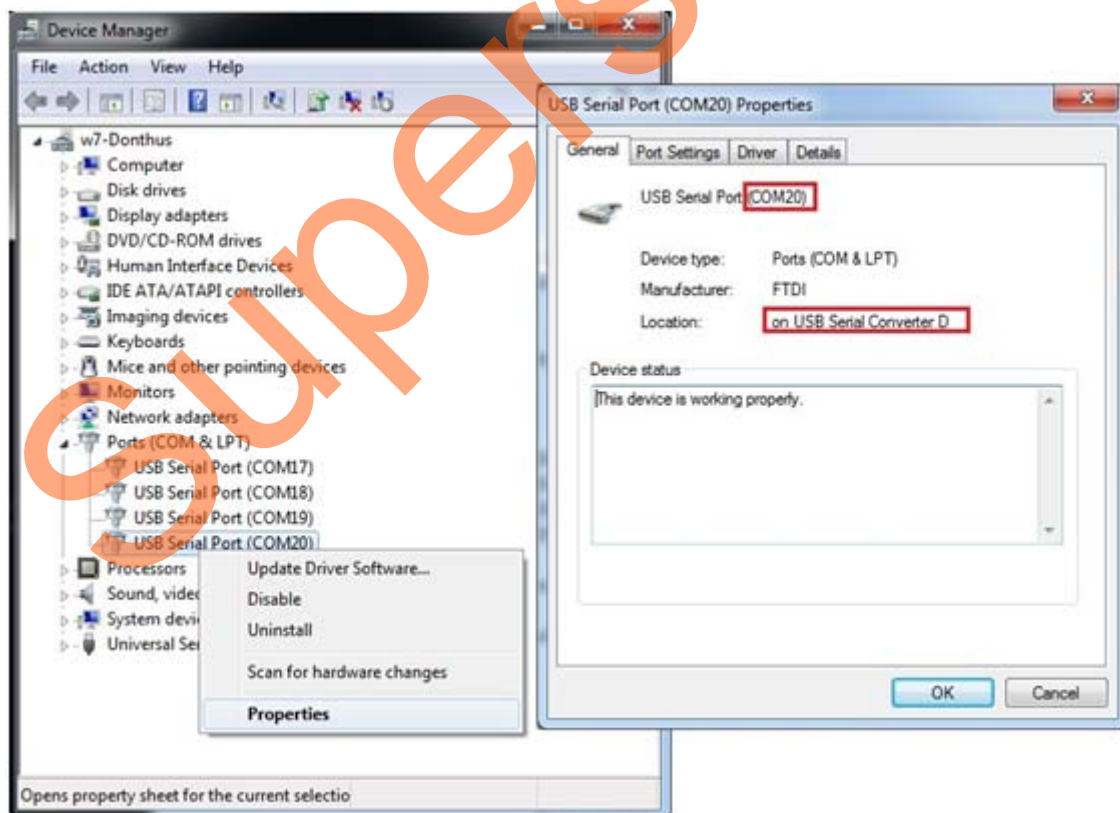


Figure 4 • USB to UART Bridge Drivers

5. Connect the jumpers on the SmartFusion2 Security Evaluation Kit board, as shown in [Table 2](#) on [page 10](#). For more information on jumper locations, refer to "[Appendix 3: Jumper Locations](#)" on [page 18](#).

Caution: Switch **OFF** the power supply switch, **SW7**, before connecting the jumpers.

Table 2 • SmartFusion2 Security Evaluation Kit Jumper Settings

Jumper Number	Pin (from)	Pin (to)	Comments
J22, J23, J8, J3	1	2	These are the default jumper settings of the SmartFusion2 Security Evaluation Kit board. Ensure that these jumpers are set properly.
J24	1	2 (closed)	USB Host mode jumper settings
J24	1	2 (open)	USB Device mode jumper settings

6. Connect the power supply to the J6 DC jack.

Board Setup

Snapshots of the SmartFusion2 Security Evaluation Kit board with the complete set up for both types of connections are given in the following sections:

- "[Appendix 1: Board Set up for USB OTG Controller in USB Device Mode](#)" on [page 16](#)
- "[Appendix 2: Board Setup for USB OTG Controller in USB Host Mode](#)" on [page 17](#)

Running the Demo Design

The following steps describe how to run the demo design:

1. Download the demo design from:
http://soc.microsemi.com/download/rsc/?f=m2s_dg0476_liberov11p6_df
2. Switch **ON** the power supply switch, SW7.
3. Start any serial terminal emulation program such as:

- HyperTerminal
- PuTTY
- TeraTerm

The configuration for the program is:

- Baud Rate: 115200
- 8 Data bits
- 1 Stop bit
- No Parity
- No Flow Control

For information on configuring the serial terminal emulation programs, refer to the [Configuring Serial Terminal Emulation Programs Tutorial](#).

4. Launch the FlashPro software.
5. Click **New Project**.
6. In the **New Project** window, enter the **Project Name**.

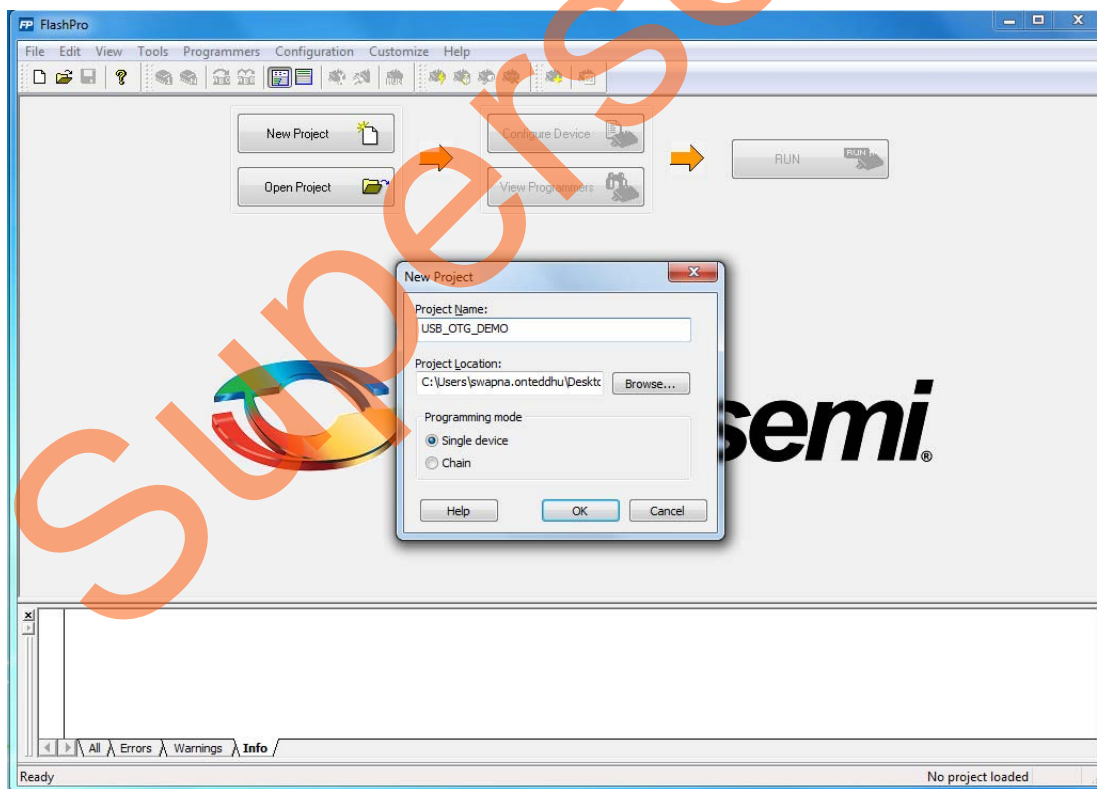


Figure 5 • FlashPro New Project

7. Click **Browse** and navigate to the location where you want to save the project.
8. Select **Single device** as the **Programming mode**.

9. Click **OK** to save the project.
10. Click **Configure Device** on the FlashPro GUI.
11. Click **Browse** and navigate to the location where the `usb_otg_demo.stp` file is located and select the file. The default location is: `<download_folder>stapl_programming_file`. The required programming file is selected and is ready to be programmed in the device.

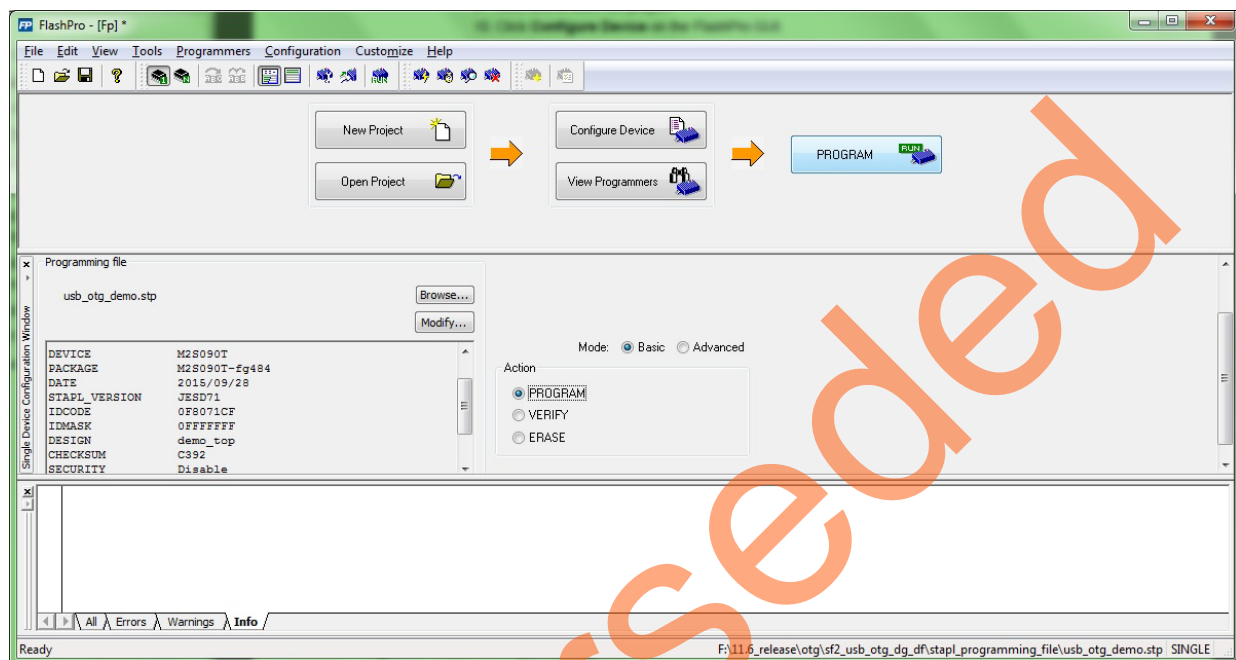


Figure 6 • FlashPro Project Configured

12. Click **PROGRAM** to start programming the device. Wait until a message is displayed indicating that the program passed. This demo requires the SmartFusion2 device to be preprogrammed with the application code to activate the USB OTG functionality. Therefore, the SmartFusion2 device is preprogrammed with the `usb_otg_demo.stp` file using the FlashPro software.

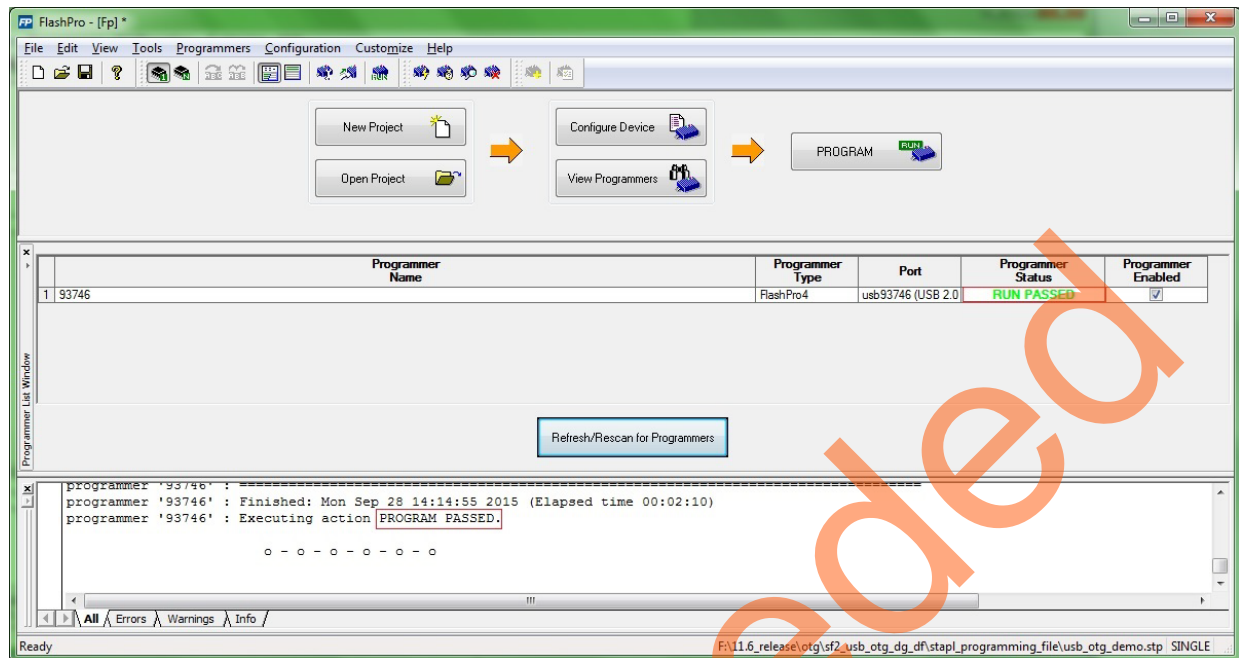


Figure 7 • FlashPro Program Passed

- After successfully programming the SmartFusion2 device using FlashPro, the serial terminal emulation program shows the initialization messages, as shown in Figure 8. The SmartFusion2 USB OTG controller is now set to perform the USB OTG functionality.

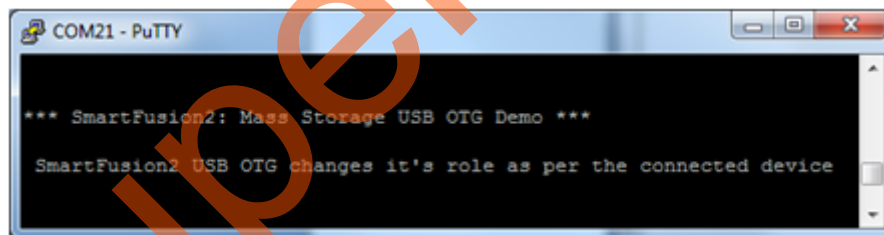


Figure 8 • UART Message

SmartFusion2 USB OTG Controller Acting as USB Device

The following steps describe how to use the SmartFusion2 USB OTG Controller as a USB device:

1. Connect the host PC to the micro AB receptacle (P1 connector) on the SmartFusion2 Security Evaluation Kit board using the Micro-B to A USB cable.

A new disk drive/volume is created in the host PC.

2. Right-click the drive and select properties as shown in [Figure 9](#) to verify the USB device functionality of the SmartFusion2 USB OTG controller.

Note: Format the disk drive when prompted by the host PC and ensure that there is no important data on the SmartFusion2 Security Evaluation Kit on-board SPI-Flash.

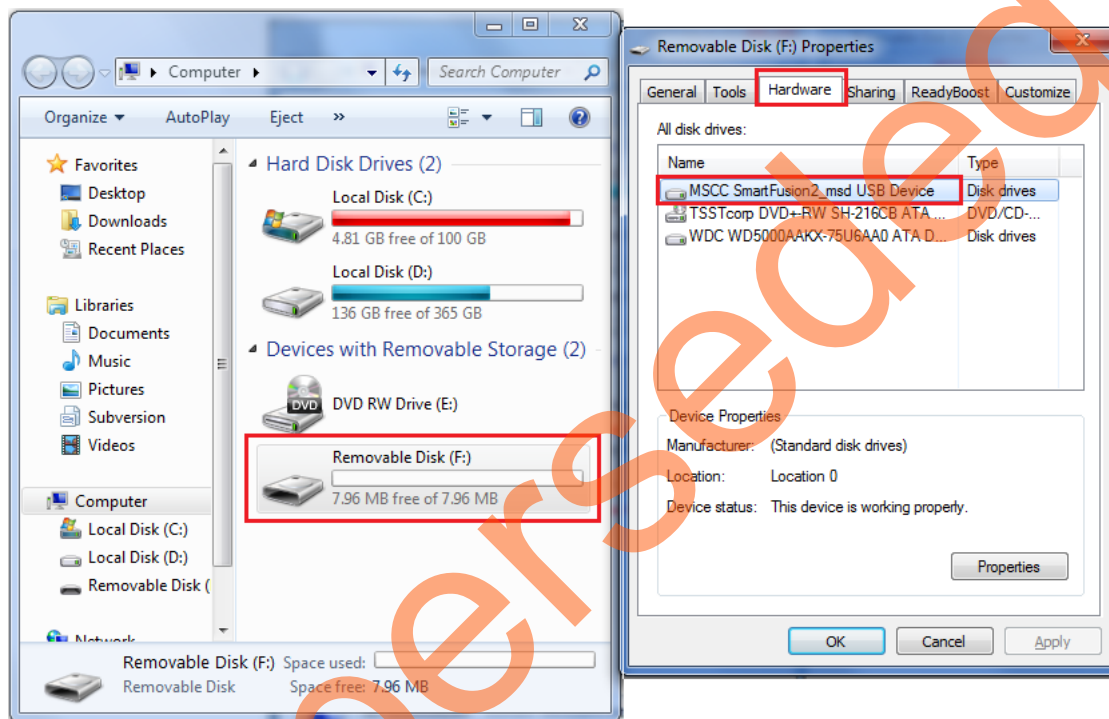


Figure 9 • SmartFusion2 USB Device Detection on Host PC/Laptop

SmartFusion2 USB OTG Controller Acting as USB Host

The following steps describe how to use the SmartFusion2 USB OTG Controller as a USB host:

1. Unplug the Micro-B to A USB cable from the P1 connector of the SmartFusion2 Security Evaluation Kit board.
2. Insert the Micro-A to B USB cable with USB mass storage device at the B type end of the cable, as shown in [Figure 10](#). Ensure that the mass storage device is preformatted.
3. Connect the Micro-A end of the Micro-A to B USB cable to the P1 connector of the SmartFusion2 Security Evaluation Kit board.

The SmartFusion2 USB OTG controller switches to the USB Host mode and detects the connected USB mass storage device to perform transactions as the USB host. The application enumerates the USB mass storage device and reads all file names on the USB drive to display the list on the serial terminal emulation program, as shown in [Figure 11](#).



Figure 10 • Micro-A to B USB Cable with Mass Storage at the End B

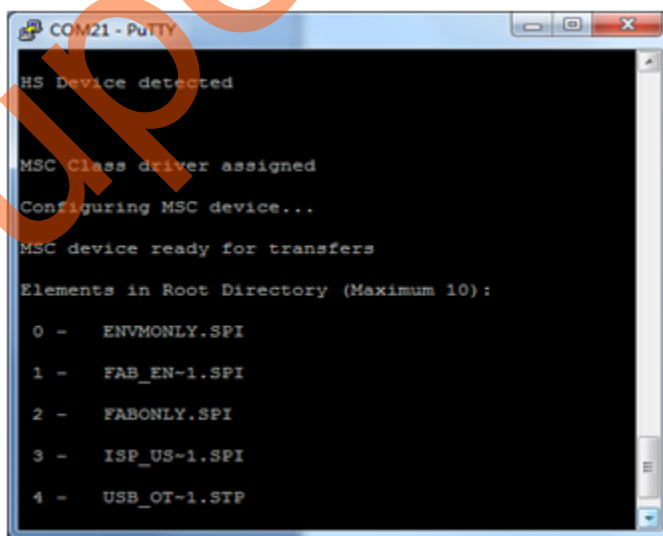


Figure 11 • USB Host Mode Results

To verify the USB OTG functionality again repeat the process of the SmartFusion2 USB OTG controller acting as a USB device and USB host.

Appendix 1: Board Set up for USB OTG Controller in USB Device Mode

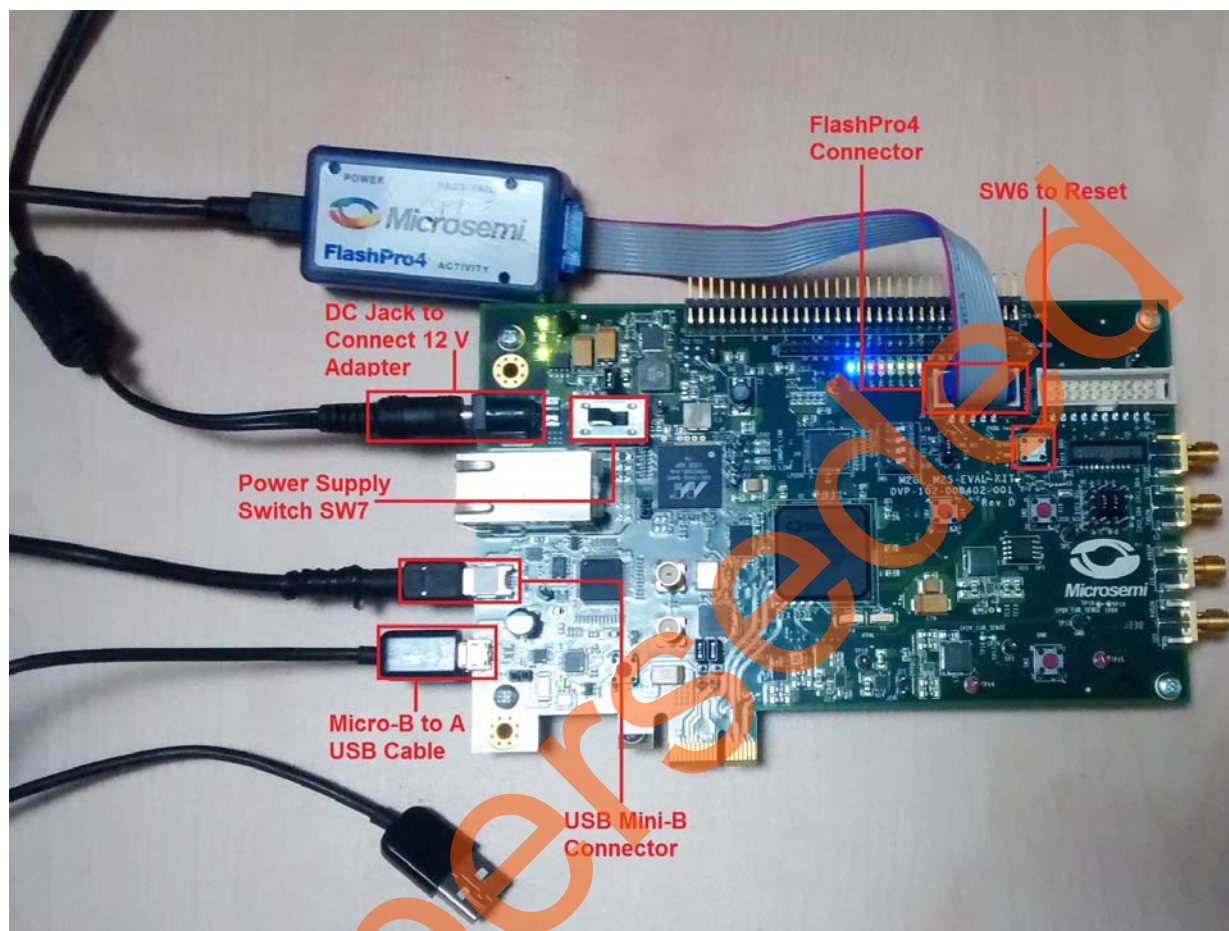


Figure 12 • Setup for USB OTG Controller in USB Device Mode

Appendix 2: Board Setup for USB OTG Controller in USB Host Mode

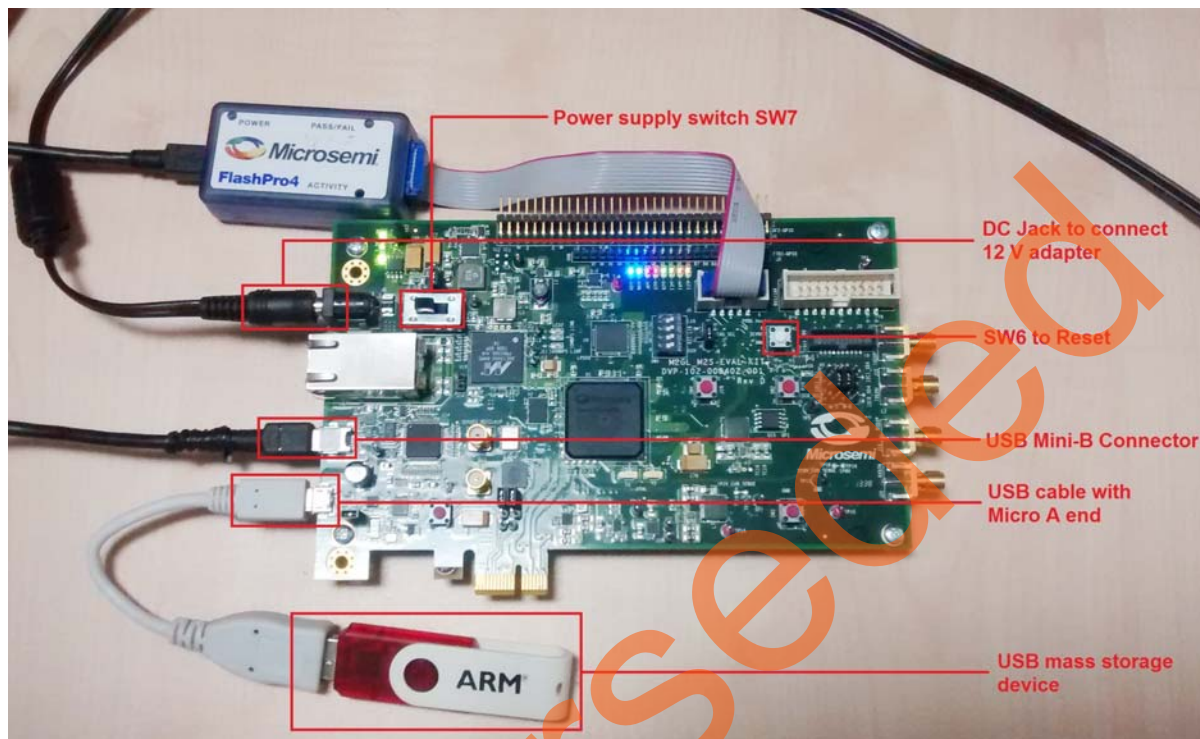


Figure 13 • Setup for USB OTG Controller in USB Host Mode

Appendix 3: Jumper Locations

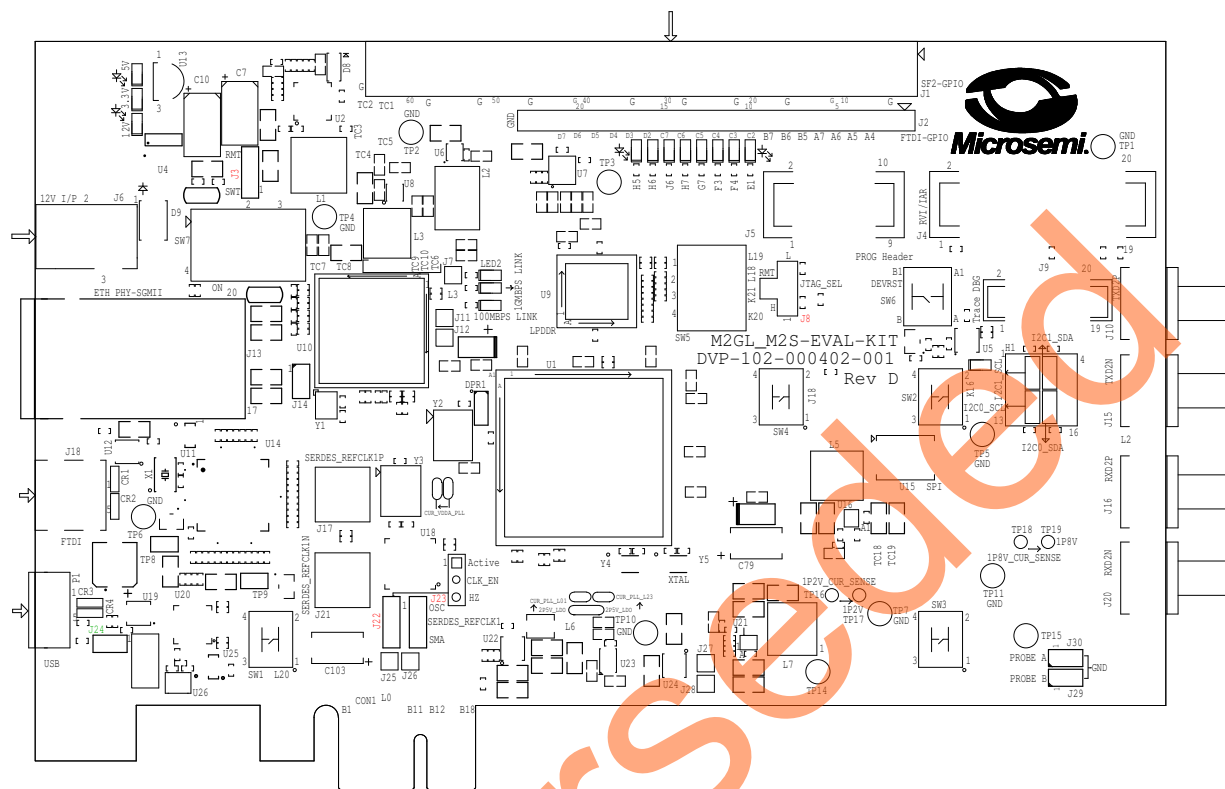


Figure 14 • SmartFusion2 Security Evaluation Kit Silkscreen Top View

Figure 14 shows the jumper locations in the SmartFusion2 Security Evaluation Kit board.

Notes:

- Jumpers highlighted in red (J22, J23, J8, J3) are set as default.
- Jumpers highlighted in green (J24) need to be set manually.
- The locations of the jumpers in Figure 14 are searchable.

A – List of Changes

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

Date	Changes	Page
Revision 5 (October 2015)	Updated the document for Libero v11.6 software release (SAR 72555).	NA
Revision 4 (February 2015)	Updated the document for Libero v11.5 software release (SAR 64193).	NA
Revision 3 (October 2014)	Updated the document for Libero v11.4 software release (SAR 61626).	NA
Revision 2 (June 2014)	Updated the document for Libero v11.3 software release (SAR 58734).	NA
Revision 1 (November 2013)	Updated the document for Libero v11.2 software release (SAR 52961).	NA
Revision 0 (October 2013)	Initial Release	NA

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Fax, from anywhere in the world, 408.643.6913

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<http://www.microsemi.com/products/fpga-soc/design-support/fpga-soc-support>.

Website

You can browse a variety of technical and non-technical information on the Microsemi SoC Products Group home page, at <http://www.microsemi.com/products/fpga-soc/fpga-and-soc>.

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