SmartFusion cSoC Webserver Demo Using uIP and FreeRTOS

User's Guide

Microsemi

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Introduction

The Microsemi SmartFusion® customizable system-on-chip (cSoC) family builds on the technology first introduced with Fusion mixed signal FPGAs. SmartFusion devices are the result of integrating FPGA technology with programmable high-performance analog and hardened ARM® Cortex™-M3 processor microcontroller blocks on a flash semiconductor process. The SmartFusion family takes its name from the fact that these three discrete technologies are integrated on a single chip, enabling the lowest cost of ownership and smallest footprint solution for you.

This demo is designed for the SmartFusion Evaluation Kit Board (A2F-EVAL-KIT) and the SmartFusion Development Kit Board (A2F500-DEV-KIT), which demonstrate SmartFusion device capabilities. In this demo, FreeRTOS™ is running on the Cortex-M3 processor, while managing various tasks such as ACE processing, web service, and LED toggling. UART0-based HyperTerminal and I²C-based OLED interfaces are provided for user interaction. These tasks are explained in detail in the following sections. The programming and design files can be downloaded from the Microsemi SoC Products Group website: www.microsemi.com/soc/products/smartfusion/default.aspx.

To get familiarized with Microsemi SoC Products Group tool chain and design flow, refer to the SmartFusion tutorials at www.microsemi.com/soc/products/smartfusion/docs.aspx#tutorial.

Webserver Demo Requirement

- A2F-EVAL-KIT or A2F500-DEV-KIT with low cost programming stick (LCPS)
- 2 USB cables
- 5 V power cable (for development kit only)
- Ethernet cable and internet connection (for webserver option)
- PC to test HyperTerminal options

SmartFusion Evaluation Kit Board (A2F-EVAL-KIT)

The SmartFusion Evaluation Kit is designed to provide a development platform for you to evaluate a SmartFusion cSoC with hardwired ARM Cortex-M3 powered microcontroller subsystem (MSS) and programmable analog computing engine. The board supports a SmartFusion (A2F200M3F) device in the FG484 package. Additionally, the evaluation board consists of voltage monitor, current monitor, temperature monitor, 10/100 Ethernet, SPI flash, and OLED.

For additional information about the board, refer to the *SmartFusion Evaluation Kit User's Guide*.

SmartFusion Development Kit Board (A2F500-DEV-KIT)

The SmartFusion Development Kit offers a full-featured development platform for the world's only cSoC with hard ARM Cortex-M3 processor and programmable analog block. The device contains on-chip flash and SRAM memory, as well as additional off-chip memory on the board.

The board also contains LEDs, switches, and OLED, with facilities for extensive analog experimentation, including voltage rail monitoring, current POT, temperature diodes, and voltage sweeping using active bipolar prescalers (ABPS), external NOR flash, and external asynchronous SRAM (ASRAM). External memories can be accessed through an on-chip memory controller called the EMC. Interfaces include Ethernet PHY, EtherCAT, CAN, UART, and RS485.

For additional information about the board, refer to the *SmartFusion Development Kit User's Guide*.

Jumper Settings of the Boards

Jumper settings required for the evaluation board and development board are shown in Table 1 and Table 2. The jumpers not listed are 'Don't Care'. These can be left in any state.

Table 1 • **Jumper Settings for Evaluation Board**

Jumper	Pin (From)	Pin (To)
J6	1	2
JP6	2	3
JP7	1	2
JP10	1	2

Table 2 • **Jumper Settings for Development Board**

Jumper	Pin (From)	Pin (To)
JP1	1	2
JP2	1	2
JP4	1	3
	7	9
JP5	1 (F2_TDO)	3 (MUX_TDO)
JP6	2	3
J7	2	3
	6	7
	10	11
	14	15
JP7	1	2
JP8	3	4
	7	8
	11	12
	15	16
JP11	1	2
JP12	1	2
JP13	1	2
JP14	1	2
JP15	1	2
JP16	2	3
JP17	2	3
JP18	1	2
JP19	2	3
JP20	1	2
JP21	1	2
JP22	2	3

Table 2 • **Jumper Settings for Development Board (continued)**

Jumper	Pin (From)	Pin (To)
JP23	1	2
JP24	1	2
JP27	1	2
JP28	1	2
JP32	1	2
	3	4
	5	6

Note: The switch SW9 must always be in the OFF mode.

Terminal Emulation Program

Terminal emulation programs such as HyperTerminal for Windows® XP or PuTTY (Windows 7 or Windows Vista operating system user) should be used for serial communication. Options of the demo are displayed on the terminal. PuTTY may be downloaded using the following link:

www.chiark.greenend.org.uk/~sgtatham/putty/download.html.

Design Description

The SmartFusion demonstration design example showcases the capability and functionality of the SmartFusion cSoC device. This demo design shows the capabilities of the 10/100 Ethernet MAC, UART, GPIO, OLED, LEDs, ACE for temperature, current, and voltage monitoring by using the SmartFusion kits.

You can navigate through demo options by following instructions on the OLED. You can also control the demo from serial communication applications such as HyperTerminal or PuTTY simultaneously.

These two modes run in parallel and you can select different options in each mode using switches or keyboard. The SmartFusion demo design example shows the reference models of almost all external interfaces of the SmartFusion cSoC. Microsemi SoC Products Group provides firmware drivers for accessing the processor and hardware layer of peripherals. Network communication is established using the uIP stack with the 10/100 Ethernet MAC device driver. The flow chart in Figure 1 on page 6 describes the architecture of the demo design.
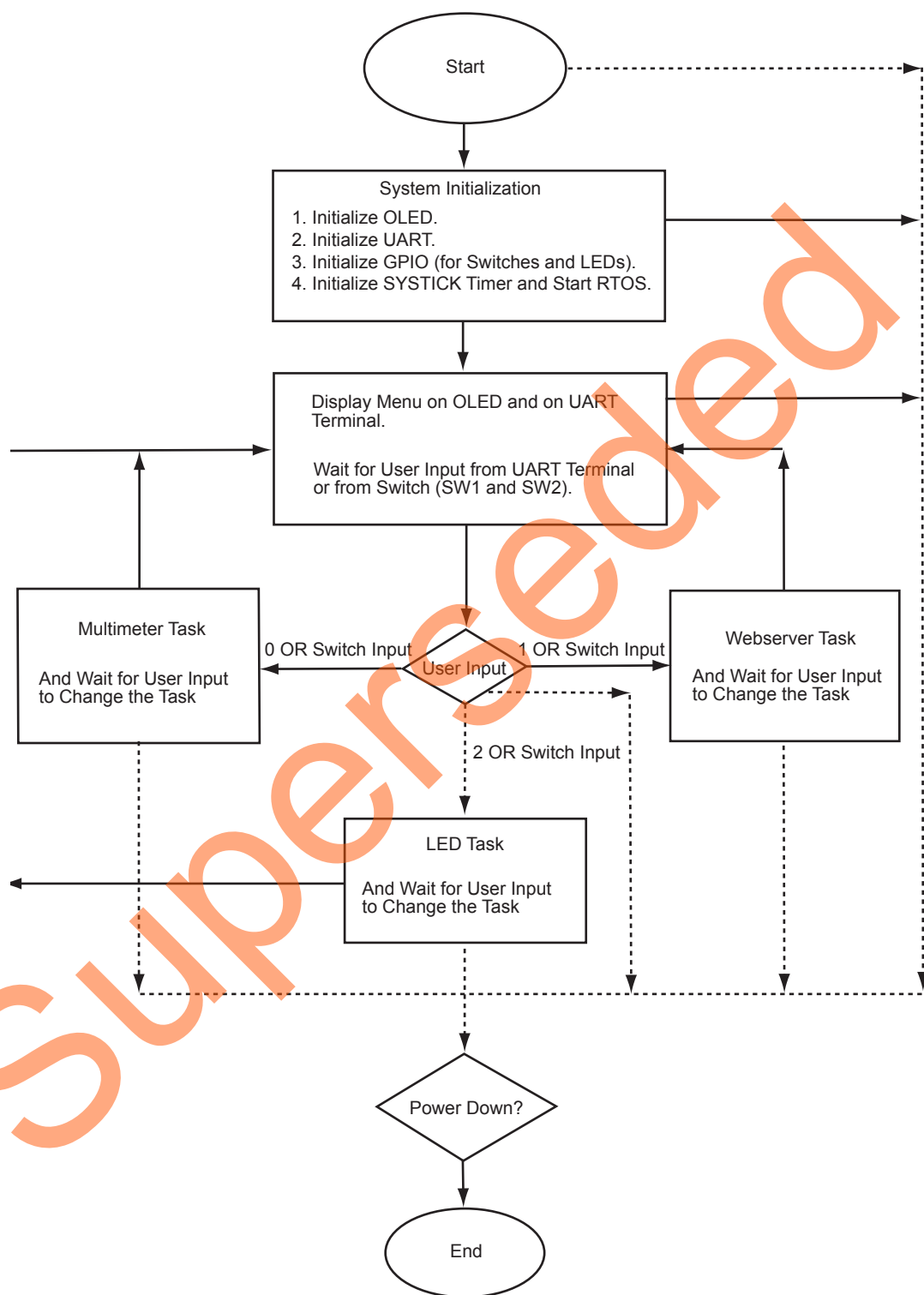
Figure 1 • **Design Flow Chart**

The design is divided into the following tasks.

LED_test

The LED test function drives GPIOs in such a way that the LED blinking provides a running visualization effect. The following example code shows the call of GPIO driver function.

```
gpio_pattern = MSS_GPIO_get_outputs();
gpio_pattern ^= 0xFFFFFFFF;
MSS_GPIO_set_outputs( gpio_pattern );
```

ACE_task

This function reads the values from the post processing engine. The example code and use of the driver functions is shown below.

```
current_channel = ACE_get_first_channel();
first_channel = current_channel;

do {
    adc_result = ACE_get_ppe_sample( current_channel );
    display_value( current_channel, adc_result );
    current_channel = ACE_get_next_channel( current_channel );
} while ( current_channel != first_channel );
```

Standalone_task

This task manages the demo through switches SW1 and SW2. The menus for these switches are displayed on the OLED. You can navigate the menu with switches by using the help displayed on the OLED. This task runs in parallel with the HyperTerminal task.

Hyper_terminal_task

This task manages the UART port. It displays the demo menu on HyperTerminal, accepts your input, and performs the tasks according to the input selected. It runs in parallel with the Standalone task.

Simultaneously, you can navigate the demo by using HyperTerminal and switches SW1 and SW2.

uIP Stack

The uIP TCP/IP stack was developed by the Networked Embedded Systems group at the Swedish Institute of Computer Science and is available free of charge at www.sics.se/~adam/uip/index.php/Main_Page. The uIP stack version is 1.0.

The SmartFusion Webserver is built as an application running on top of the uIP TCP/IP stack. HTML CGI interfaces are used to exchange the real-time data from the SmartFusion board and the user webpage (web client).

- webTask() API is the main entry code for the webserver application.
- mac_init() API call initializes the Ethernet MAC and gets the DHCP open network IP address.
- uIP_Init() API call takes care of initialization of all the uIP TCP/IP stack settings and calls the Webserver application call httpd_init().

FreeRTOS

FreeRTOS is a portable, open source, royalty free, mini Real-Time Kernel (a free to download and free to deploy RTOS that can be used in commercial applications without any requirement to expose your proprietary source code). FreeRTOS is a scalable real time kernel designed specifically for small embedded systems. The FreeRTOS version is 6.0.1. For more information, visit the FreeRTOS website: www.freertos.org.

The following NVIC interrupts are routed to the FreeRTOS interrupt handlers in user boot code:

1. Systick Handler
2. SVC Handler
3. Pend SVC handler

The RTOS configuration is done in the file freeRTOSConfig.h.

Modifying the Webserver with Static IP

1. Open the provided SoftConsole debug project.
2. Comment the line: "#define OPEN_IP" in the web_task.c file under the application_tasks folder, as shown in Figure 2.
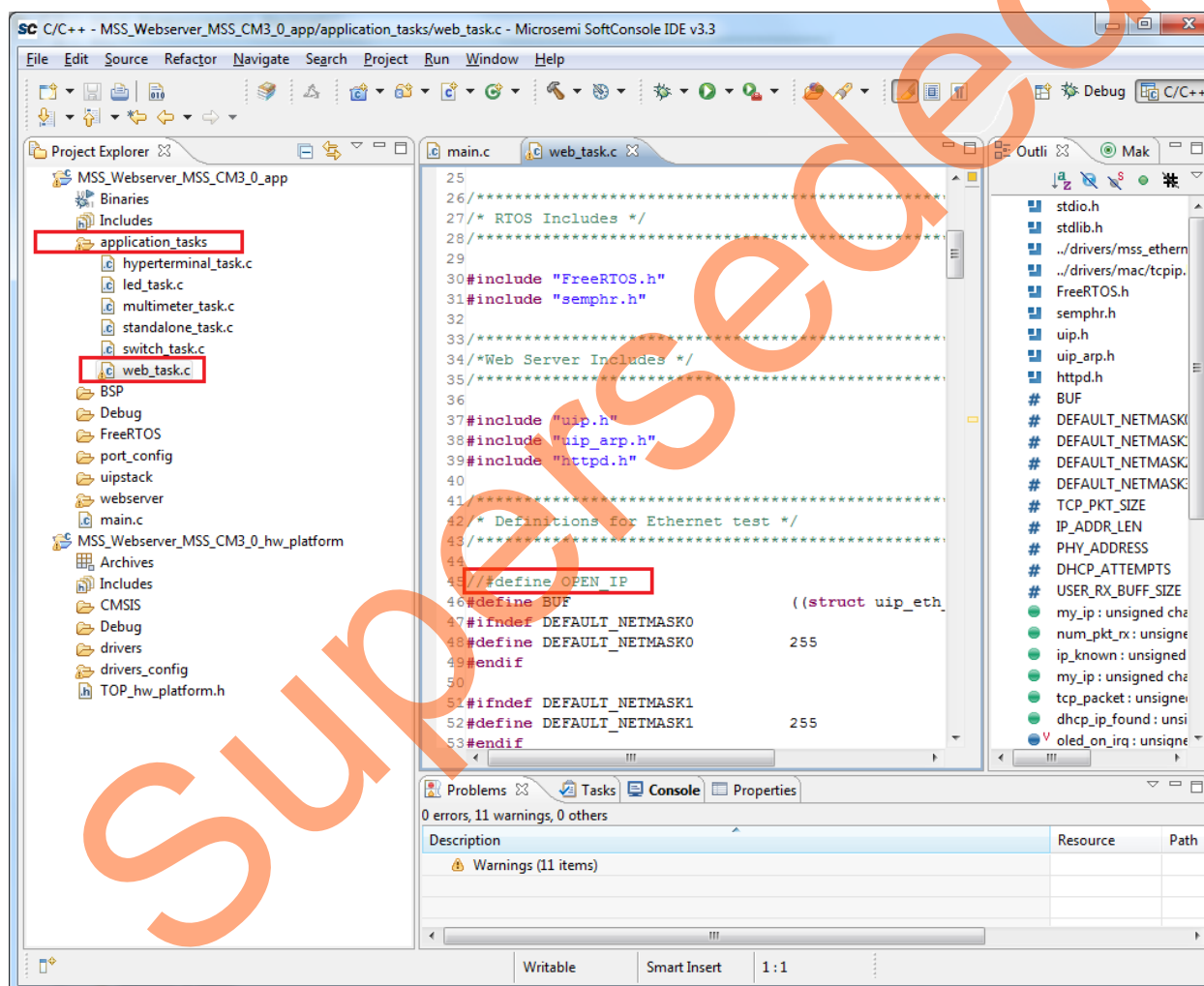

Figure 2 • **Changes To Be Made for Webserver Demo with Static IP**

Demo Setup

Hooking up the Evaluation Board and UART Cable

Connect one end of the USB mini-B cable to the USB connection, J14 (labeled as USB2 in Figure 3) on the A2F-EVAL-KIT Board. Connect the other end of the USB cable to the PC used for testing.

The board is powered through the USB connection. LED1 lights up, indicating the board is powered up. D11 led also lights up, indicating UART link establishment.
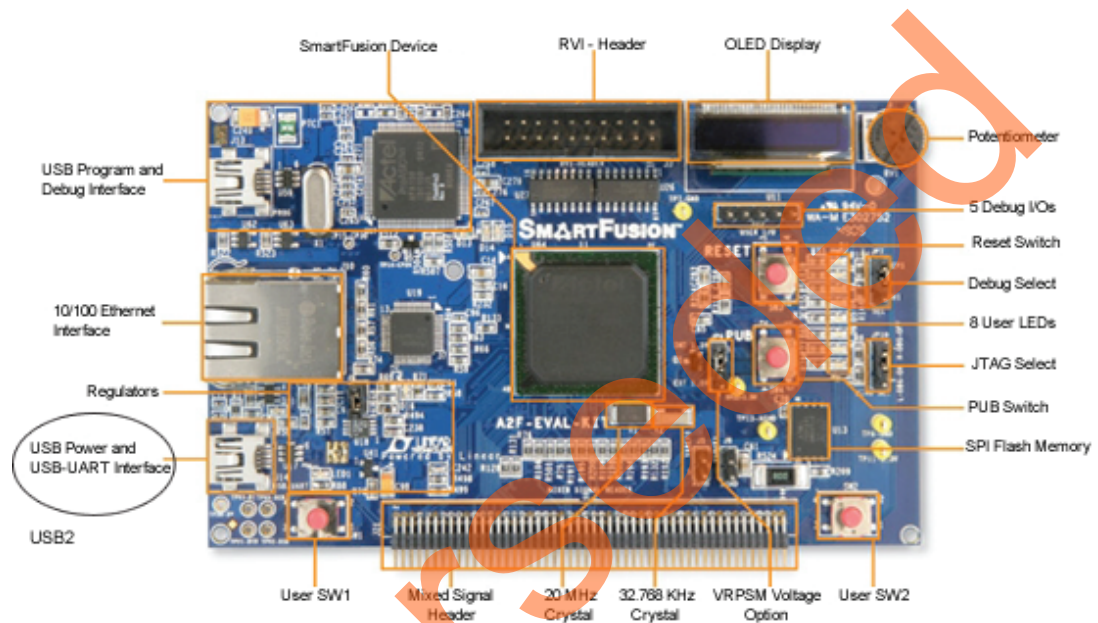

Figure 3 • **USB2**

Hooking up the Board and Ethernet Cable

Connect an Ethernet cable from the local area network to J10, the A2F-EVAL-KIT Ethernet jack.
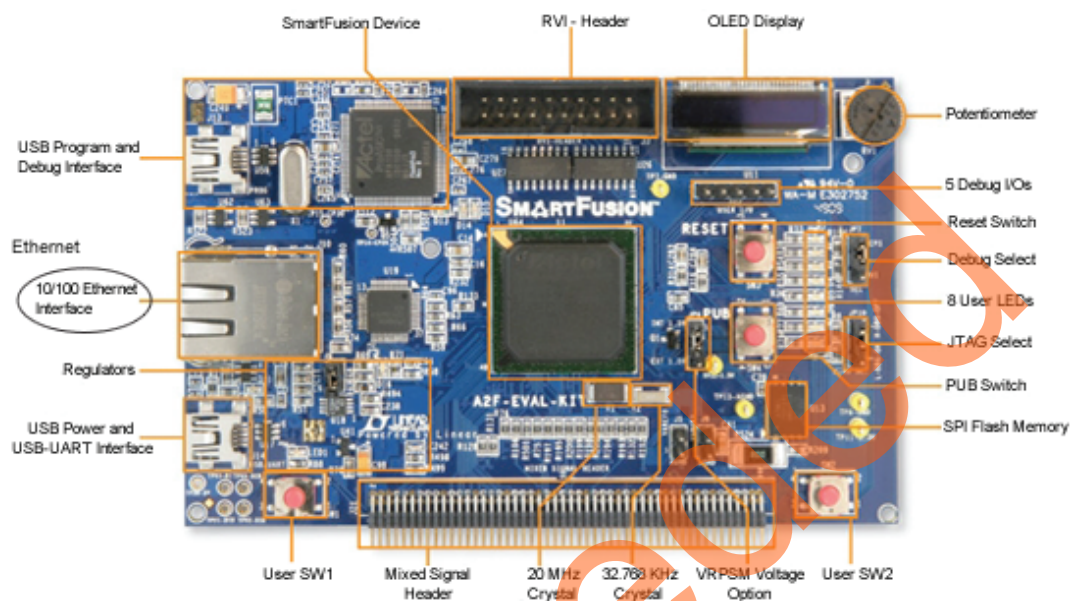
Figure 4 • **Ethernet Jack**

Note: For the board Ethernet test to pass, the local network must be running a DHCP server that assigns an IP address to the webserver on the board. Network firewalls must not block the board webserver. The PC Ethernet card link speed should be in auto detect mode or fixed to 100 Mbps speed.

Hooking up the A2F-EVAL-KIT Board Built-in Programmer to PC

Connect the second mini USB cable to connection J13 on the board (labeled USB1 in Figure 5). Plug in the second side of the cable to the PC USB port. This establishes connection to the built-in programming circuit (FlashPro4) on the board.
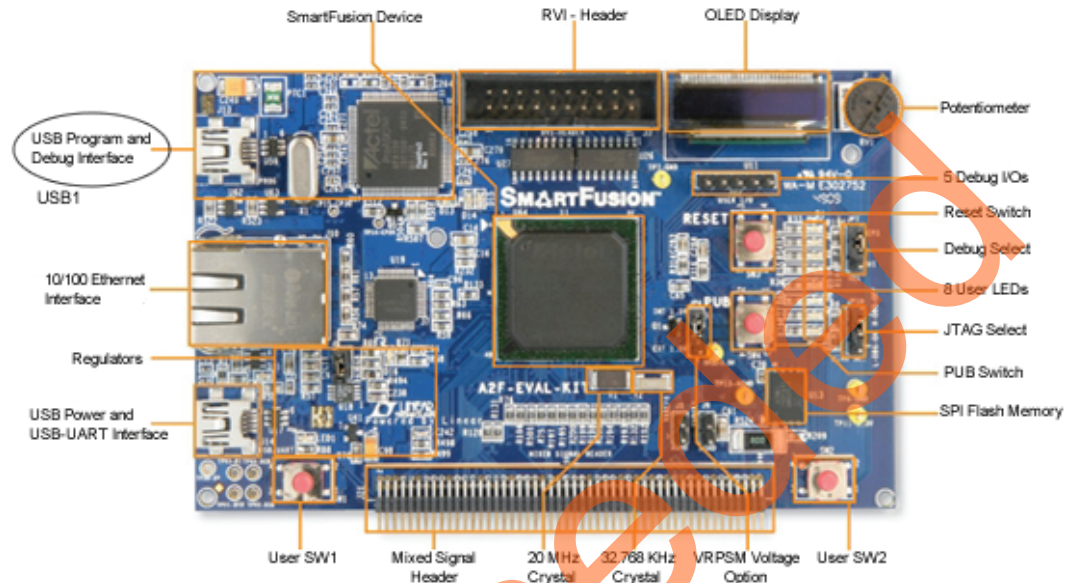

Figure 5 • **USB1**

Hooking up the Development Board and Programming Stick

Connect the low cost programming stick (LCPS) to the board (A2F500-DEV-KIT). Connect the J15 pins on the board to the programmer, as shown in Figure 6 on page 12.

Connect one end of USB mini-B cables to the USB connections on the A2F500-DEV-KIT board and the Microsemi programming stick. These connections are labeled in Figure 6 on page 12. Connect the USB cables to the PC used for testing.

Connect one end of 5 V power supply to power input J1, on the A2F500-DEV-KIT board (Figure 6 on page 12). Flip on the power switch SW6 on the board. LEDs labeled D5, D6, and D8 should light up.

The LED labeled as ON in the programming stick should also be lighted.

Connect an Ethernet cable from the local area network to J10, the A2F500-DEV-KIT Ethernet jack.
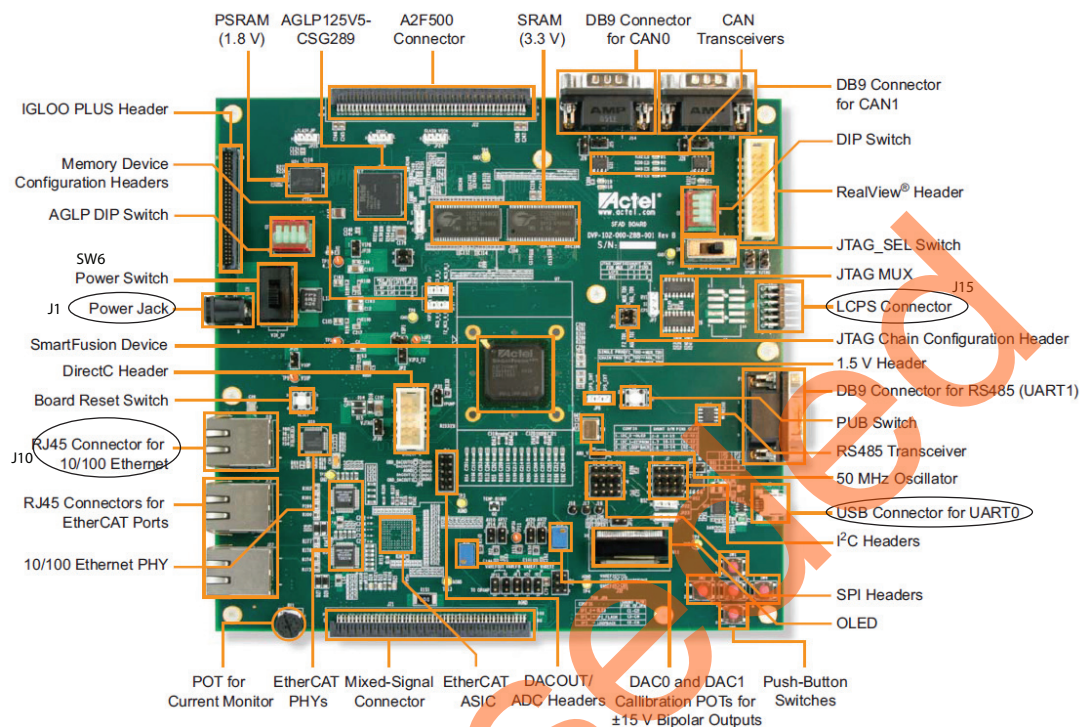

Figure 6 • **A2F500-DEV-KIT**

Note: For the board Ethernet test to pass, the local network must be running a DHCP server that assigns an IP address to the webserver on the board. Network firewalls must not block the board webserver. The PC Ethernet card link speed should be in auto detect mode or fixed to 100 Mbps speed.

Design Files

Design files using SoftConsole, IAR Embedded Workbench® and Keil software tool chains are available on the Microsemi SoC Products Group website for download.

- Design Files Using SoftConsole
  (www.microsemi.com/soc/download/rsc/?f=A2F_Webserver_uIPRTOS_SoftConsole_DF)
- Design Files Using IAR
  (www.microsemi.com/soc/download/rsc/?f=A2F_Webserver_uIPRTOS_IAR_DF)
- Design Files Using KEIL
  (www.microsemi.com/soc/download/rsc/?f=A2F_Webserver_uIPRTOS_Keil_DF)

The design files consist of Libero® system-on-chip (SoC) Verilog and VHDL projects, software project (SoftConsole/IAR/Keil), and programming files (*.STP). In SoftConsole based design files, the software project is provided in both debug mode and release mode. Refer to the Readme.txt file included in the design file for directory structure and description.

If SoftConsole opens without a workspace or displays an error when opening the project then refer to www.microsemi.com/soc/kb/article.aspx?id=KI8879.

Refer to the *Building Executable Image in Release Mode and Loading into eNVM Tutorial* for more information on building an application in release mode.

Running the Demo

Program the SmartFusion Development Kit or SmartFusion Evaluation Kit with the appropriate STPL file provided with the design files (refer to "Design Files" on page 12) using FlashPro. For more information on programming, refer to the *FlashPro User's Guide*.

Reset or power cycle the board after successful programming. OLED displays the following message:

"Hi I am SmartFusion

Want to Play?"

After few seconds, the display changes to main menu on OLED:

SW1: Multimeter

SW2: Menu Scroll

The message indicates that switch SW1 should be used to select the Multimeter option and switch SW2 should be used to scroll through the options provided in the demo.

Note: This application provides you the flexibility to scroll through the demo options using switches and serial communication ports simultaneously.

Multimeter Mode

Press SW1 to select Multimeter mode. The OLED displays the value of voltage, current, and temperature read by the SmartFusion analog computer engine. Rotate the potentiometer (POT) provided on the board to change the value of voltage and current. Running values of voltage, current, and temperature are displayed on the OLED. Press SW1 to go back to the main menu.

Webserver Mode

Press SW2 to scroll through the options. The OLED displays the following:

SW1: Webserver

SW2: Menu Scroll

Press SW1 to select the webserver option.

The OLED displays the IP address captured by DHCP from the network. Make sure that the Ethernet cable is connected to the board and network.

Note: If you do not have a network connection, refer to the "Setup for Running the Webserver with Static IP" section for static IP configurations.

Internet explorer should be used to run the Webserver utility. The IP address displayed on the OLED should be entered in the address bar of Internet Explorer. The main menu of the webserver is shown in Figure 7 on page 14.

You have the following options available:

- "Multi-meter"
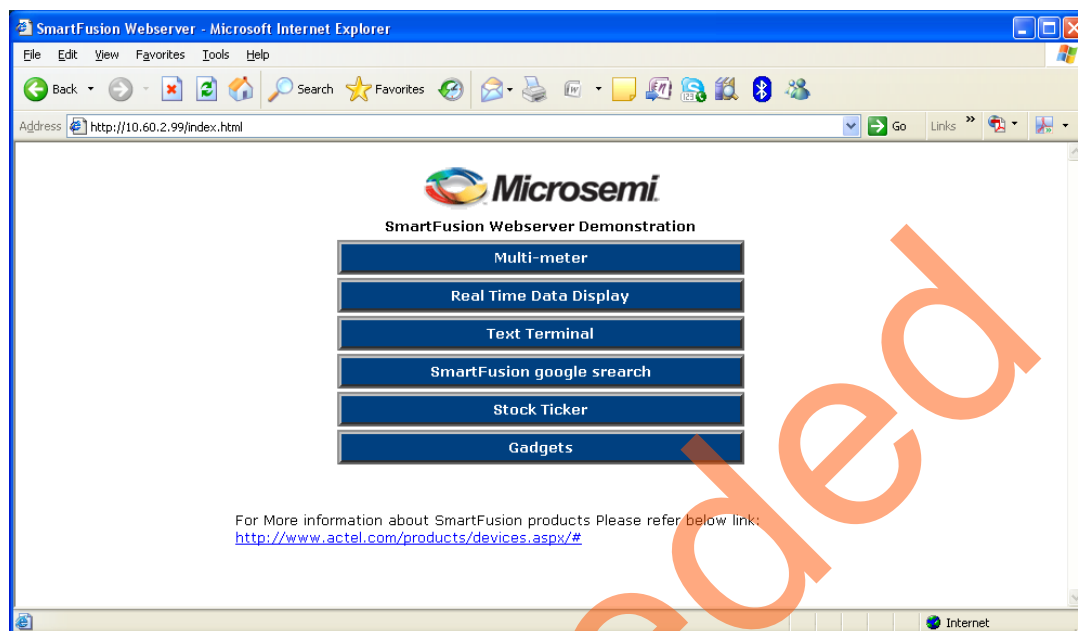- "Real-Time Data Display"
- "Stock Ticker"
- "Gadgets"

Figure 7 • **Webserver Scroll Options**

Setup for Running the Webserver with Static IP

1. Connect the Ethernet cable between the Host PC and board. It is a direct connection between the board and PC and no cross cable is required. In this case the SmartFusion assigns a static IP address to the board and you can access the board from the host PC using the Ethernet cable connected between the host PC and board.

2. Plug in the UART cable between the host PC and board. Figure 8 gives an example of assigning a Static IP address on the Host PC:
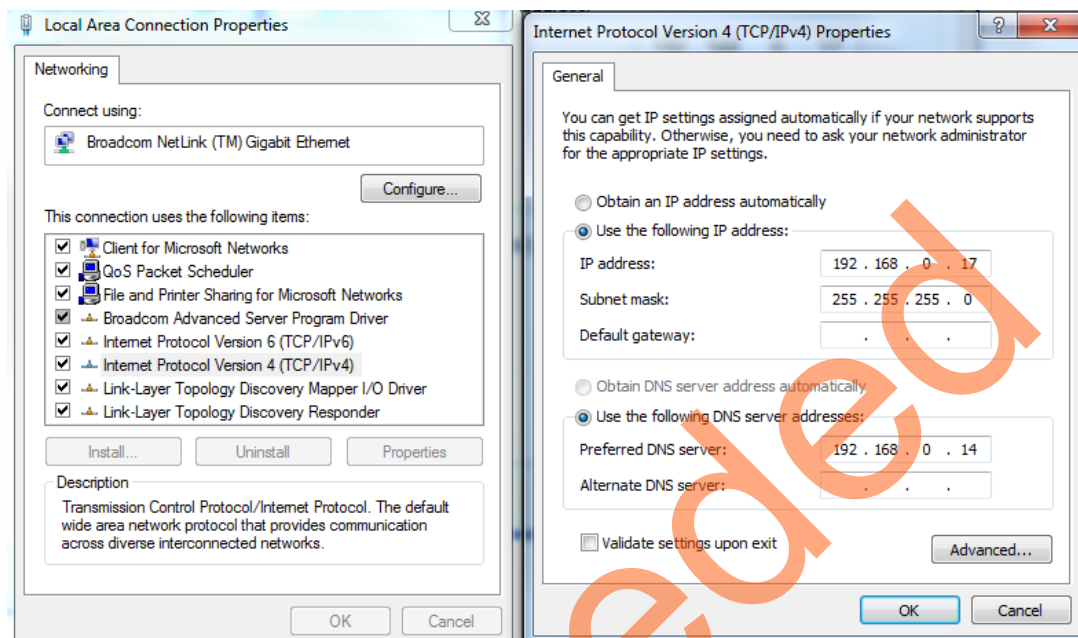
Figure 8 • **Static IP Settings on Host PC**

3. Load the application program using SoftConsole debugger.

4. Make sure that Ethernet port led is blinking (- indicates that the Ethernet connection is proper).

5. Scroll through the menu for the Webserver Demo.

6. Selecting the webserver option gives the static IP of the board.

7. Use the static IP in Internet Explorer to browse the webserver demo.

Multi-meter

Click **Multi-meter** on the main menu from the webserver scroll option. The webpage displays the corresponding values of voltage, current, and temperature. Click **Home** to go back to the main menu.
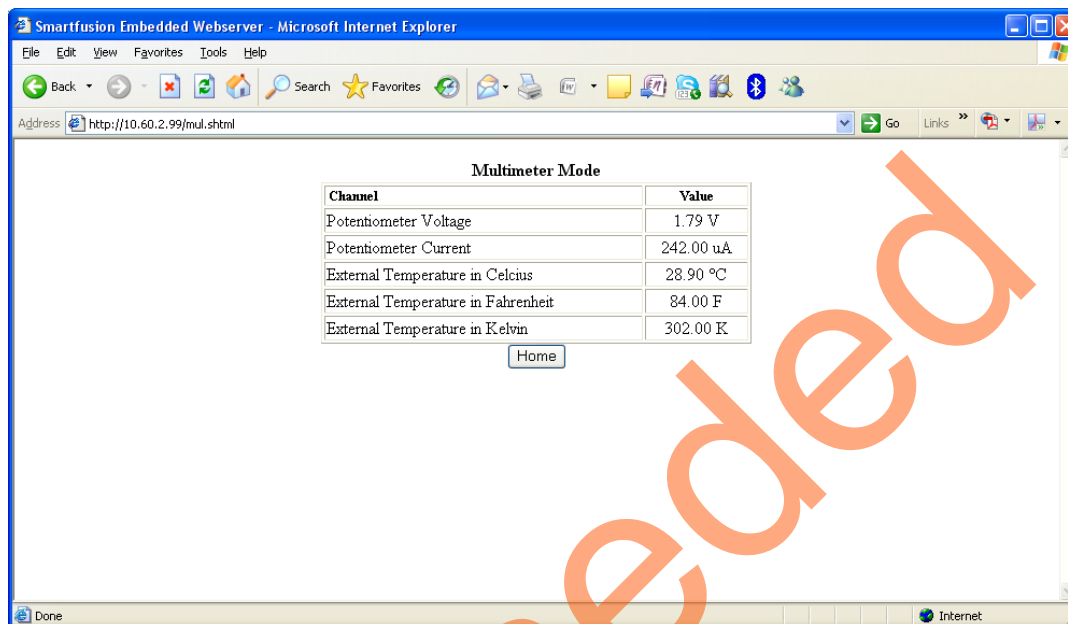

Figure 9 • **Webserver Multimeter Display**

Real-Time Data Display

Click **Real Time Data Display** on the main menu. The webpage displays the real-time data. By varying the potentiometer of the board voltage and current values can be changed. The webpage refreshes periodically and displays updated values of voltage and current. Click **Home** to go back to the main menu.
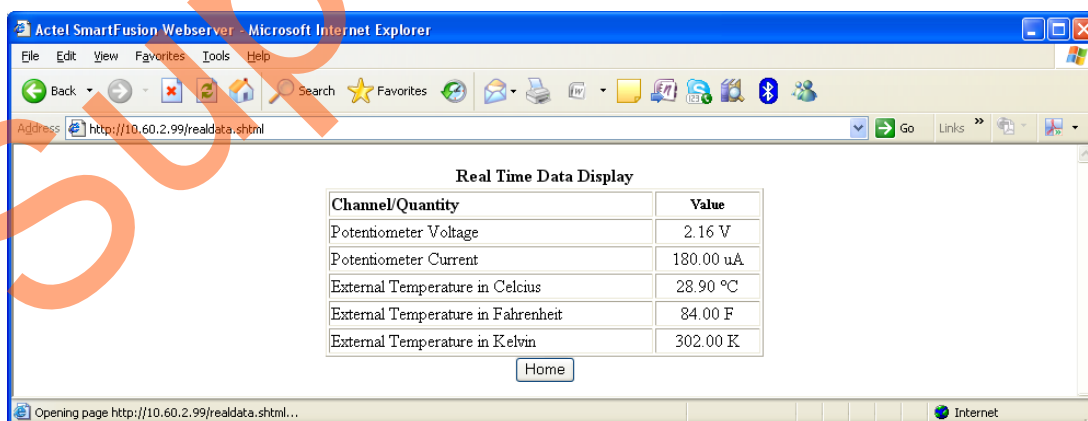

Figure 10 • **Real-Time Data Display**

Stock Ticker

Click **Stock Ticker** on the main menu. You must have an internet connection with proper access rights to get to the Stock Ticker page. The Stock Ticker page displays stock prices in NASDAQ. Click **Home** to go back to the main menu.
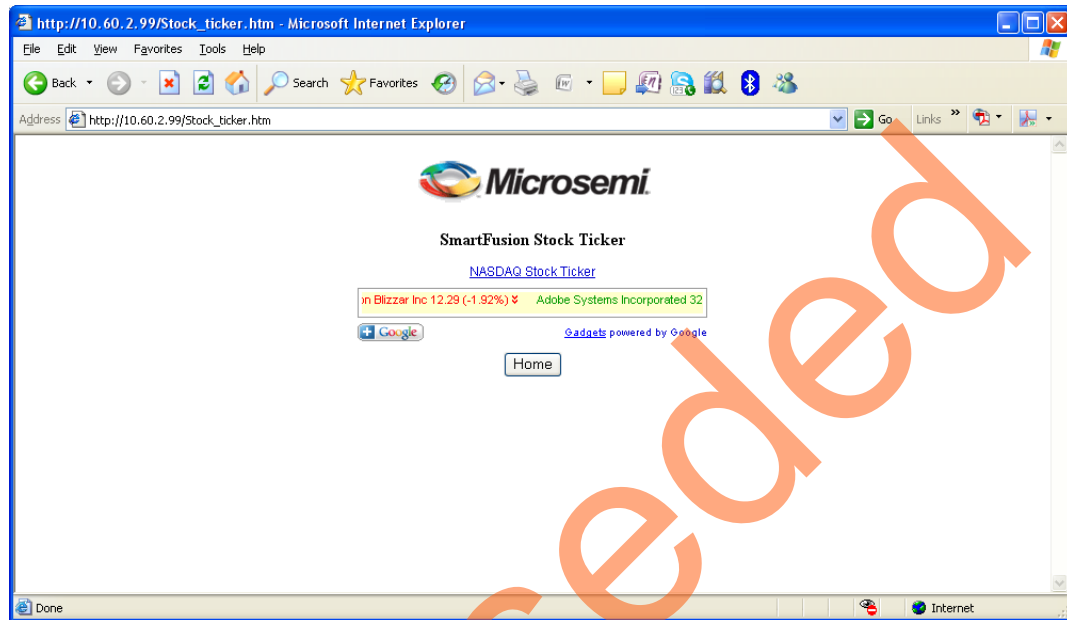

Figure 11 • **Webserver Stock Ticker**

Gadgets

Click **Gadgets** on the main menu. You must have an internet connection with proper access rights to get to the Gadgets page. The Gadgets page displays different applications such as calendar and US Zip code look-up. Click **Home** to go back to the main menu.
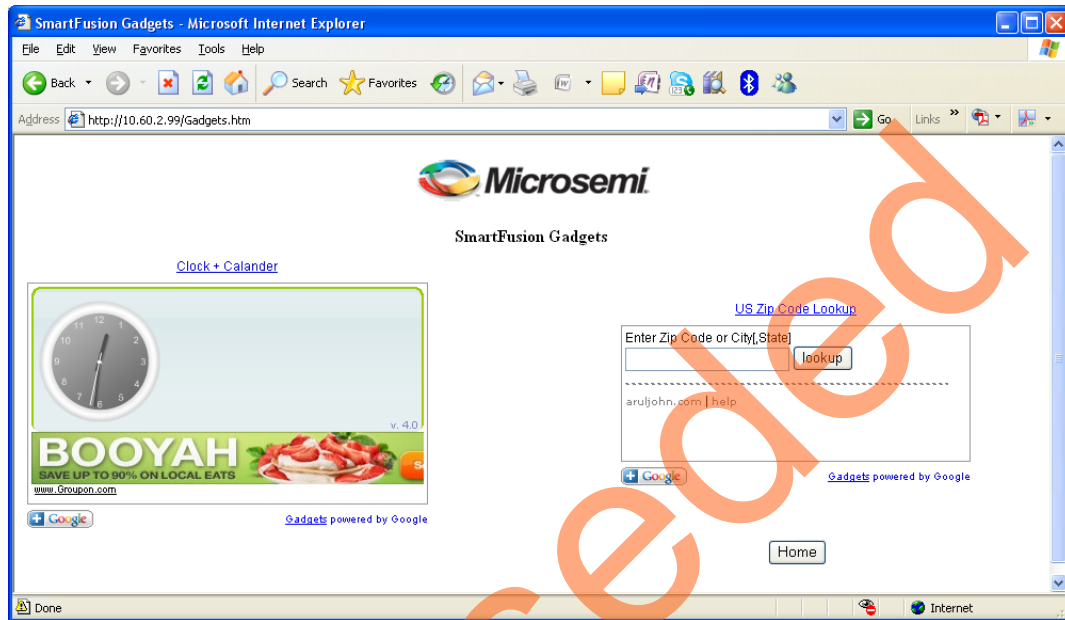

Figure 12 • **Webserver Gadgets Display**

LED Test

Press the SW2 switch. The OLED displays:

SW1: LED Test

SW2: Menu Scroll

Press SW1 to select the LED test. A running LED pattern is displayed on the board. Press SW2 for main menu.

Display on Terminal

Demo options can be seen on the terminal simultaneously. Serial communication applications such as HyperTerminal (Windows XP) and PuTTY (Windows7 or other OS) can be used for communication through the COM port.

Refer to the *Configuring Serial Terminal Emulation Programs* tutorial for configuring HyperTerminal, Tera Term, or PuTTY.

1. Connect a second mini-USB cable between the USB connector on the SmartFusion development board or Evaluation Kit and a USB port of your PC.

The Silicon Labs CP210x USB to UART Bridge drivers are automatically detected (can be verified in Device Manager), as shown in Figure 13.

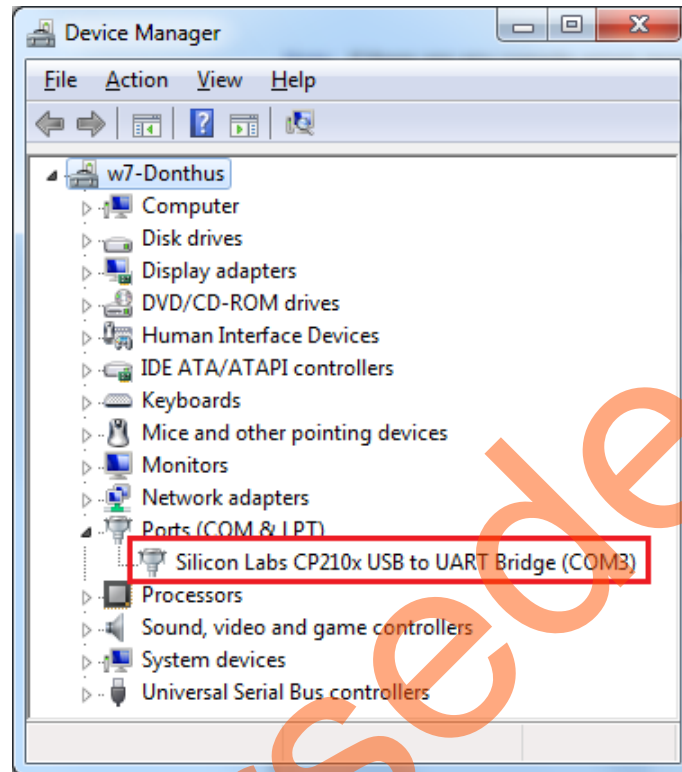If not download the drivers from www.microsemi.com/soc/documents/CP2102_driver.zip and install.

Figure 13 • **RS232 Controller Drivers**

2. Set the properties of the application as follows:
   – Bits per second: 57600
   – Data bits: 8
   – Parity: None
   – Stop bits: 1
   – Flow control: None

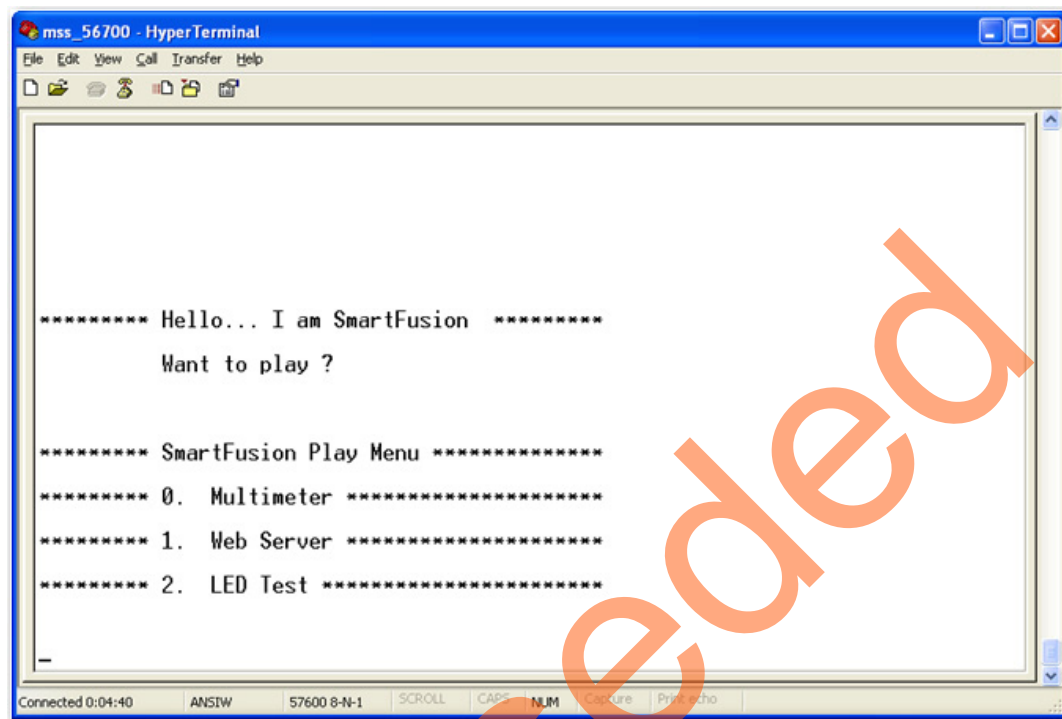HyperTerminal shows three options. The menu is shown in Figure 14.

Figure 14 • **Menu Display on Terminal**

Multimeter

The Multimeter mode shows values of temperature, current, and voltage on the terminal.

Webserver

Select the Webserver option on the SmartFusion Play Menu. The system captures the IP address and displays it on the terminal. Internet Explorer can be used to display the Webserver utility.

LED Test

The LED mode selection provides a running LED pattern.

List of Changes

The following table lists critical changes that were made in each revision of the document.

Revision*	Changes	Page
Revision 3 (February 2012)	The "Design Files" section was modified (SAR 36904).	12
	The "Running the Demo" section was modified (SAR 36904).	13
	The Figure 13 was updated (SAR 36904).	19
Revision 2 (November 2011)	The SmartFusion intelligent mixed signal FPGA is now known as a customizable system-on-chip (cSoC) and the document was updated accordingly (SAR 34959).	N/A
	Libero IDE is now known as Libero SoC (SAR 34959).	N/A
	Sections on "Modifying the Webserver with Static IP" and "Setup for Running the Webserver with Static IP" added (SAR 34959).	8, 14
	Design files have been updated (SAR 34959).	N/A
Revision 1 (January 2011)	The name of the A2F-DEV-KIT was changed to A2F500-DEV-KIT.	N/A
	The "Design Files" section is new.	12
	Images were updated.	Multiple

*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.*

A – Product Support

Microsemi SoC Products Group backs its products with various support services including Customer Service, Customer Technical Support Center, a web site, electronic mail, and worldwide sales offices. This appendix contains information about contacting Microsemi SoC Products Group and using these support services.

Customer Service

Contact Customer Service for non-technical product support, such as product pricing, product upgrades, update information, order status, and authorization.

From North America, call **800-262-1060**
From the rest of the world, call **650.318.4460**
Fax, from anywhere in the world **650.318.8044**

Customer Technical Support Center

Microsemi SoC Products Group staffs its Customer Technical Support Center with highly skilled engineers who can help answer your hardware, software, and design questions about Microsemi SoC Products Group. The Customer Technical Support Center spends a great deal of time creating application notes, common design cycle questions, known issues, and various FAQs. So, before you contact us, please visit our online resources. It is very likely we have already answered your questions.

Technical Support

Visit the Microsemi SoC Products Group Customer support website (www.microsemi.com/soc/support/search/default.aspx) for more information and support. Many answers available on the searchable web resource include diagrams, illustrations, and links to other resources on the website.

Website

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

Contacting the Customer Technical Support Center

Highly skilled engineers staff the Technical Support Center. The Technical Support Center can be contacted by email or through the Microsemi SoC Products Group website.

Email

You can communicate your technical questions to our email address and receive answers back by email, fax, or phone. Also, if you have design problems, you can email your design files to receive assistance. We constantly monitor the email account throughout the day. When sending your request to us, please be sure to include your full name, company name, and your contact information for efficient processing of your request.

The technical support email address is soc_tech@microsemi.com.

My Cases

Microsemi SoC Products Group customers may submit and track technical cases online by going to *My Cases*. Review *Failure Analysis* guidelines for further information.

Outside the U.S.

Customers needing assistance outside the US time zones can either contact technical support via email (soc_tech@microsemi.com) or contact a local sales office. *Sales office listings* can be found at www.microsemi.com/soc/company/contact/default.aspx.

ITAR Technical Support

For technical support on RH and RT FPGAs that are regulated by International Traffic in Arms Regulations (ITAR), contact us via soc_tech_itar@microsemi.com. Alternatively, within *My Cases*, select Yes in the ITAR dropdown list. For a complete list of ITAR-regulated Microsemi FPGAs, visit the *ITAR* web page.

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