Getting Started with the Kintex-7 FPGA KC705 Embedded Kit

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This document applies to the following software versions: ISE Design Suite 13.4 to 14.3

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Revision History

The following table shows the revision history for this document.

Date	Version	Revision
05/23/12	1.0	Initial Xilinx release.
05/31/12	1.0.1	Updated PDF document properties.
08/16/12	1.1	Replaced ISE software with Xilinx Design Tools throughout. Added Vivado tools to KC705 Embedded Kit Contents, page 5. Updated URL for Kintex-7 FPGA embedded kit in What's Available Online, page 6. Updated Figure 1-1, Figure 1-4, Figure 1-5, Figure 1-7, and Figure 1-8. Updated steps in Running the Video Demonstration, page 9. Updated Next Steps, page 15. Updated Table 1-1. Added Documentation, page 16. Updated title of Appendix C, Installation and Licensing of Xilinx Design Tools.
10/31/12	1.2	Removed mention of flash drives throughout. Added jumper settings to step 1 of Video Demonstration Hardware Setup Instructions, page 8. In step 3 of Running the Video Demonstration, page 9, changed 14.1 to 14.x.
11/27/12	1.2.1	Updated XPN number on the title page.

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Getting Started with the Kintex-7 FPGA KC705 Embedded Kit

Introduction

The Kintex®-7 FPGA embedded kit conveniently delivers the key components of the Xilinx® Embedded Targeted Design Platform (TDP) required for developing embedded software and hardware in a wide range of applications in the broadcast, industrial, medical, and aerospace and defense markets. For software developers, a familiar Eclipse-based integrated development environment (IDE), GNU tools, operating systems, libraries, and a pre-verified reference design enables them to start programming right away. Similarly, hardware designers now have immediate access to a pre-integrated MicroBlaze™ processor subsystem that includes the most commonly used peripheral IP cores, enabling the designers to begin at once developing their custom logic.

This getting started guide identifies the steps required to set up the KC705 board and run the out-of-box video demonstration, which illustrates the flexibility and capability of a MicroBlaze processor subsystem for embedded design. If the Xilinx Design Tools have not already been installed, the user is directed through the steps to install the software, get updates, and generate a license.

KC705 Embedded Kit Contents

What's Inside the Box

- KC705 evaluation board featuring the XC7K325T-2FFG900C FPGA
- USB cables, Ethernet cable, and universal power supply
- SD card
- Xilinx Design Tools (device-locked for the XC7K325T-2FFG900C FPGA) which includes:
  - ISE® Foundation with ISE Simulator
  - PlanAhead™ and Vivado™ design tools
  - Embedded Development Kit (EDK)
  - Xilinx Platform Studio (XPS)
  - Software Development Kit (SDK)
  - ChipScope™ Pro logic analyzer
- Documentation:
  - DS669, *AXI Interface Based KC705 Embedded Kit MicroBlaze Processor Subsystem Data Sheet*

- • UG913, *Getting Started with the Kintex-7 FPGA KC705 Embedded Kit*
- • UG914, *AXI Interface Based KC705 Embedded Kit MicroBlaze Processor Subsystem Hardware Tutorial*
- • UG915, *AXI Interface Based KC705 Embedded Kit MicroBlaze Processor Subsystem Software Tutorial*
- • Reference designs and demonstrations:
  - • BIST - MicroBlaze processor subsystem
  - • Web server-based multi video streams demonstration system

What's Available Online

- • License for ISE Design Suite: Embedded Edition:
  - • http://www.xilinx.com/support/licensing_solution_center.htm
  - • http://www.xilinx.com/tools/faq.htm
- • Embedded kit home page with documentation and reference designs:
  - • http://www.xilinx.com/products/boards-and-kits/DK-K7-EMBD-G.htm
- • Technical support:
  - • http://www.xilinx.com/support

Getting Started with the Video Demonstration

This Kintex-7 FPGA embedded kit comes with a video demonstration available on the embedded kit home page. This demonstration can be run before installing any additional tools to get an overview of the features of the KC705 evaluation board using a MicroBlaze processor subsystem in the Kintex-7 (XC7K325T-FF900-2) FPGA.

Processor System Used for the Video Demonstration

The provided video demonstration uses a pre-built Kintex-7 FPGA design (Figure 1-1) with these features:

- • MicroBlaze processor
- • External DDR3 SDRAM interface
- • External flash memory interface
- • On-chip memory (block RAM)
- • Integrated Tri-Mode Ethernet MAC
- • UART (connected from the KC705 board via the USB-UART connector)
- • Interrupt controller (Intc) and timer
- • GPIO (LCD, LEDs, buttons, switches, and rotary)
- • Software-configurable XADC block

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Figure 1-1: **Kintex-7 FPGA Video Demonstration System**

Video Demonstration Hardware

The following hardware is provided with the evaluation kit:

- KC705 evaluation board with the Kintex-7 XC7K325T-2FFG900C device
- USB-to-Mini-B cable (for UART)
- AC power adapter (12V DC)
- Digilent USB cable (for JTAG)

The following prerequisites are not provided with the evaluation kit:

- One external monitor capable of displaying 1080p video through high-definition multimedia interface (HDMI) or digital visual interface (DVI)
- One HDMI-HDMI or HDMI-DVI cable
- A host PC with TeraTerm Pro terminal program
- Adobe SVG plug-in for Internet Explorer

Video Demonstration Hardware Setup Instructions

1. This demonstration requires default switch and jumper settings on the KC705 board. For more information on the default switch settings, refer to the "Hardware Test Board Setup Requirements" section of UG883, *Kintex-7 FPGA KC705 Evaluation Kit Getting Started Guide*. Ensure the following jumper settings for the video demonstration:

   - Jumper 28: Short pins 2 and 3
   - Jumper 27: Short pins 2 and 3
   - Jumper 29: Short pins 2 and 3
   - Jumper 30: Short pins 2 and 3
   - Jumper 48: Short pins 2 and 3
   - Jumper 69: Short pins 1 and 2
   - Jumper 47: Short pins 1 and 1
   - Jumper 32: Short pins 5 and 6

2. Connect the KC705 board, HDMI cables, display monitor, Ethernet cable, and USB cables as shown in Figure 1-2.

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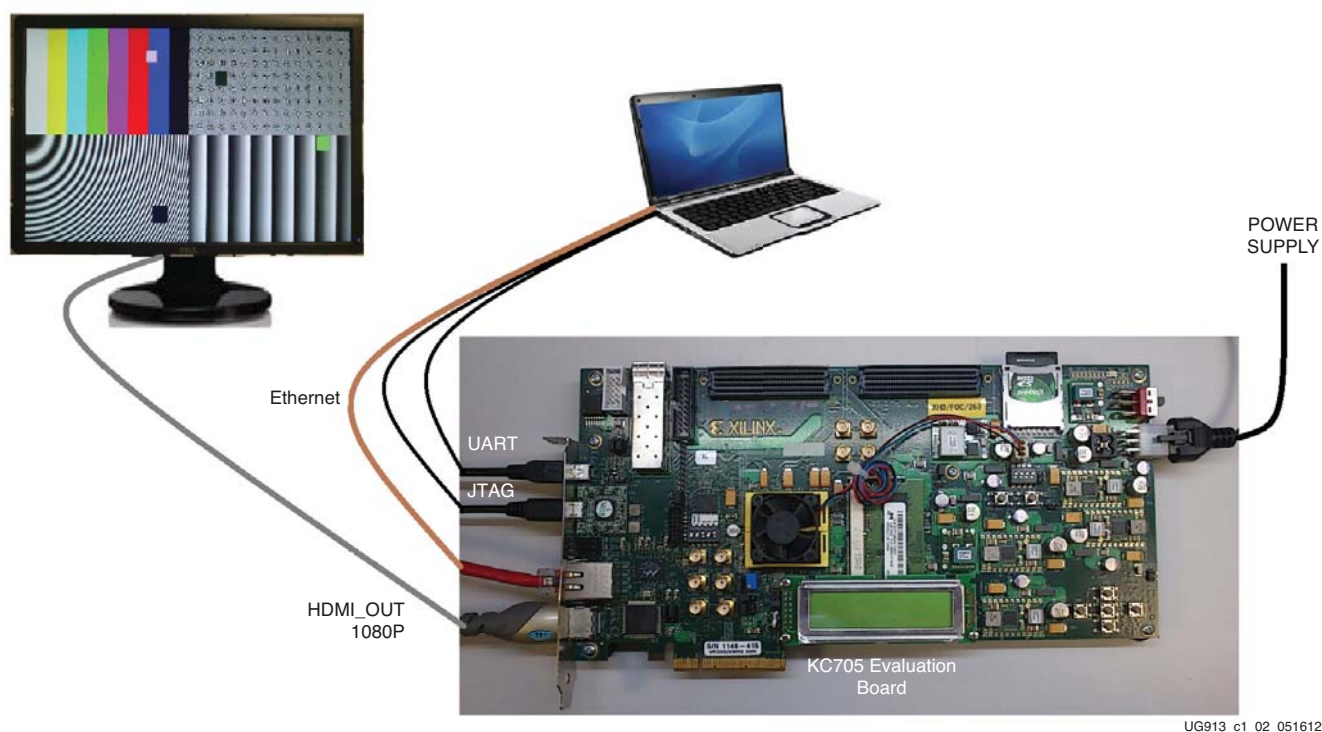
Figure 1-2: **Kintex-7 FPGA Video Demonstration Hardware Setup**

3. Set the IP address of the host PC to 192.168.1.100. Return the IP address of the PC back to its original setting after running the demonstration.

   Note: The demonstration uses a hard-coded MAC address and a fixed IP address of 192.168.1.10 and does not connect to the regular LAN network using DHCP. Do not connect more than one board to the same network segment.

Running the Video Demonstration

To run the video demonstration, copy and unzip the demonstration package files from the Web to the host machine and follow these steps:

1. If the KC705 board is not already powered on, plug in the power adapter to local AC power. Plug the 12V power cable into the board connector on J49. Turn on the power by switching the SW15 to the ON position.

2. Open and configure a serial communications terminal utility program with these settings:
   - Baud Rate: **9600**
   - Data: **8 bit**
   - Parity: **None**
   - Stop: **1 bit**
   - Flow Control: **None**

   Note: Refer to Appendix B, Communicating with the KC705 USB-UART for setting up the UART communication.

3. Open a command shell with the Xilinx Design tools environment settings. Refer to Appendix C, Installation and Licensing of Xilinx Design Tools for Xilinx tool chain installation and licensing help.

   Note: To set environment variables, run the `settings32.bat` file located in the Xilinx installation area. At the command prompt, type
   `C:\Xilinx\14.x\ISE_DS\settings32.bat` (for Windows XP) or
   `C:\Xilinx\14.x\ISE_DS\settings64.bat` (for Windows 7) and press **Enter**.

4. Go to the unzipped directory of the demonstration package and execute these commands to download the design and connect to the MicroBlaze processor:

   `$ cd KC705_Embedded_Kit/Video_Demo/ready_for_download`

   `$ xmd`

   `XMD% fpga -f download.bit`

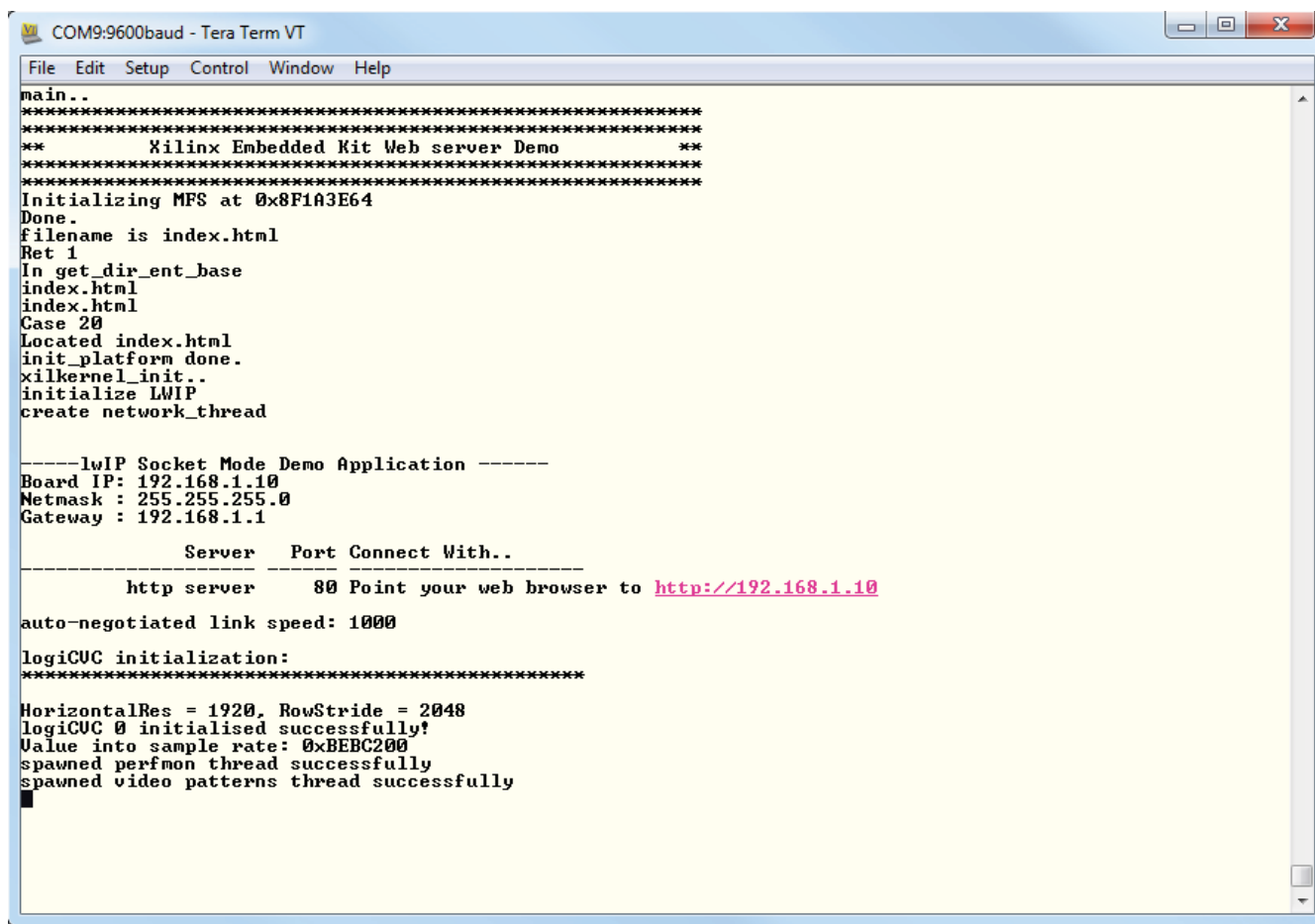   This command downloads the hardware bitstream into the FPGA but does not download the software application:

   `XMD% connect mb mdm`

   This command connects to the MicroBlaze processor debug module:

   `XMD% dow Video_Demo.elf`

   `XMD% con`

5.   The UART output should be as shown in Figure 1-3.

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Figure 1-3:   **Video Demonstration UART Output**

6. Open a Web browser on the host computer and set the URL to 192.168.1.10. The Web page shown in Figure 1-4 should be displayed. The page uses JavaScript, so the browser must have JavaScript enabled.

    Note: If using Internet Explorer, the Adobe SVG viewer plug-in or a similar plug-in that enables viewing of SVG files must be installed to view the graph. This demonstration is tested with Internet Explorer 8 on a Windows XP machine.
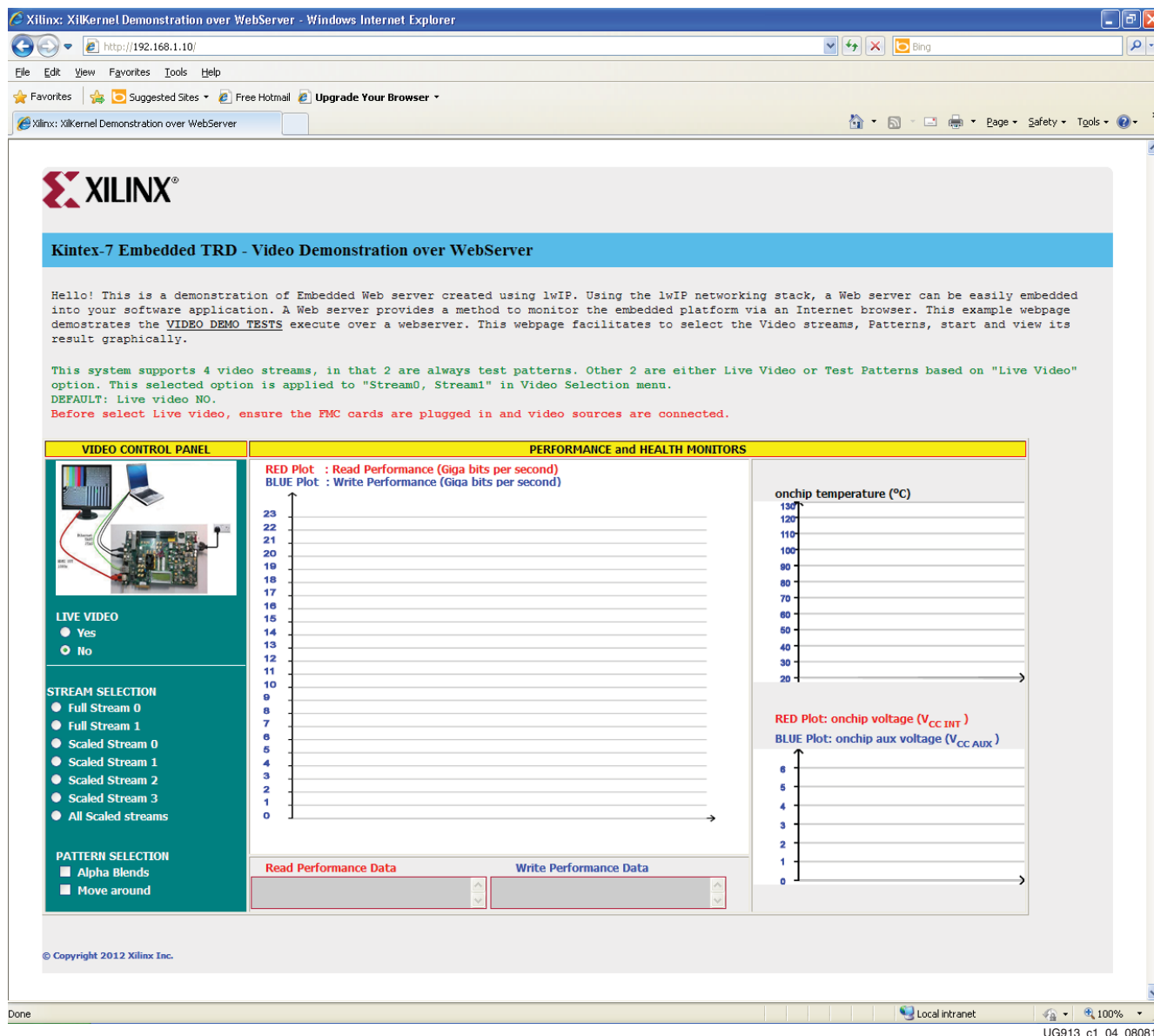

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Figure 1-4: **Initial Video Demonstration Web Page**

7. In the video demonstration Web page, make the following selections as shown in Figure 1-5:

  - Live Video: **No**
  - Stream Selection: **All Scaled streams**

8. The selected options take effect automatically. The performance, temperature, and voltage graphs are also plotted on the Web page (Figure 1-5).
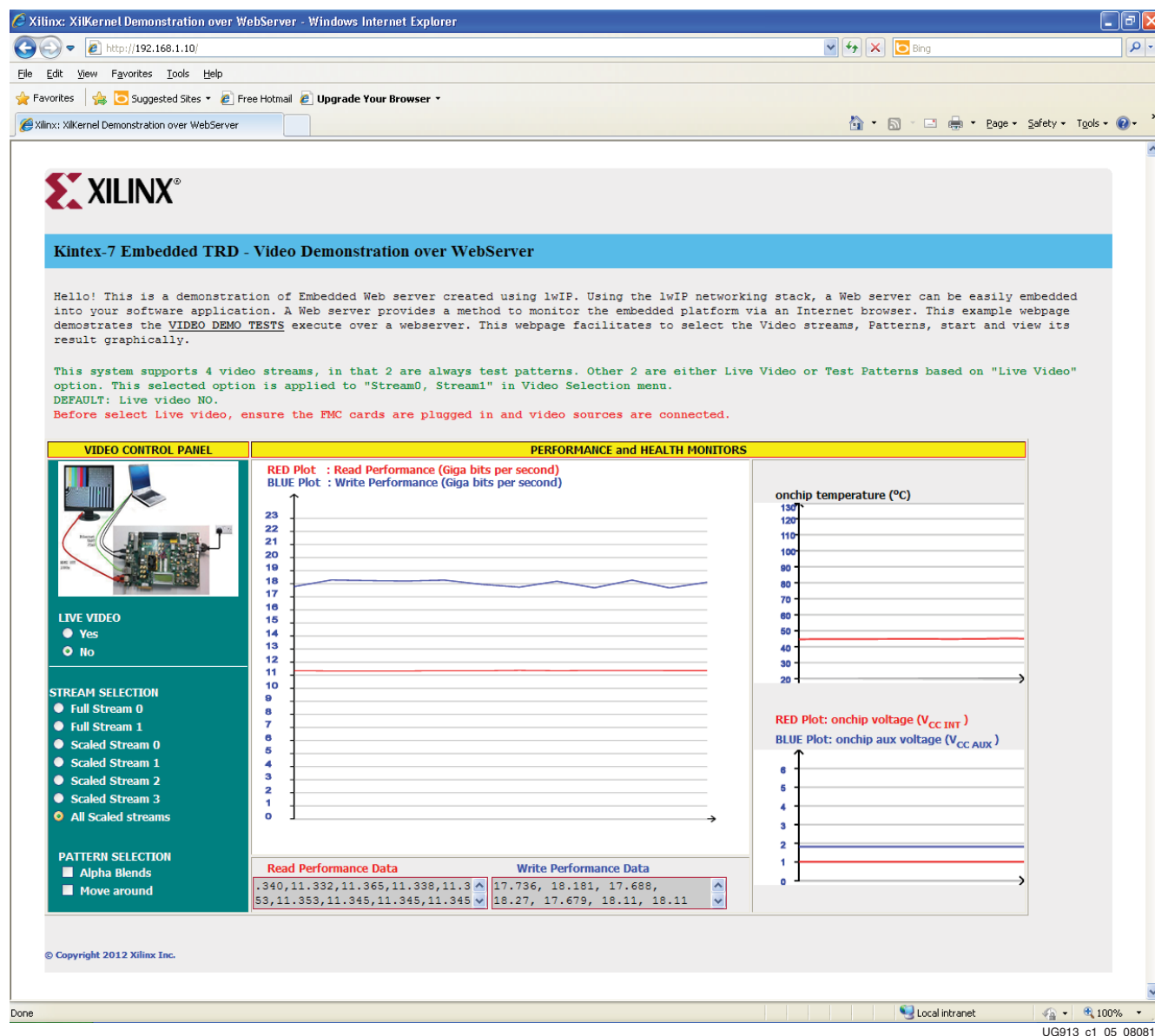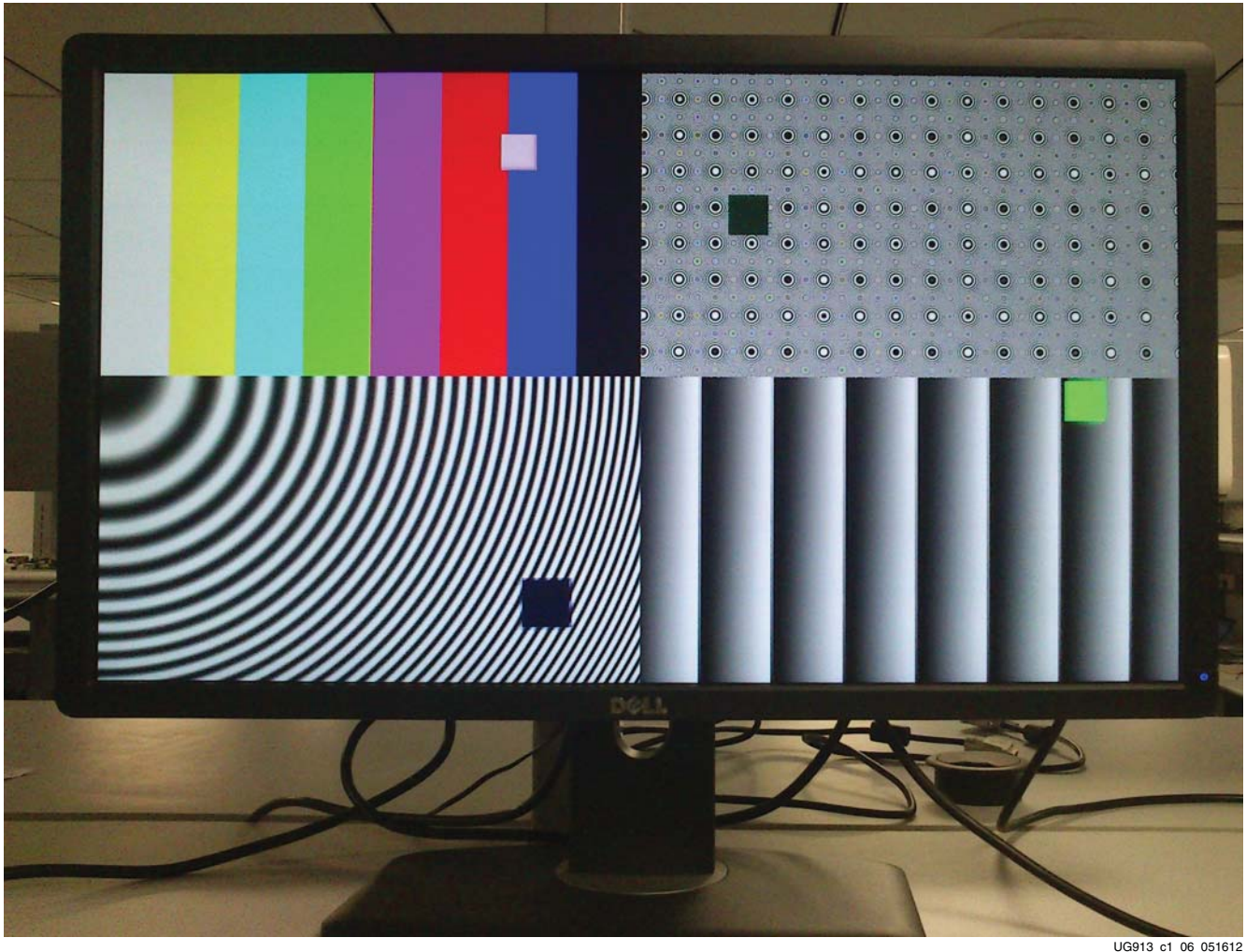

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Figure 1-5: **Video Demonstration Web Page with Data Plotted**

Figure 1-6 shows the output display for the selections made in step 7.

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Figure 1-6: **Output Video Display**

The Web browser receives one packet of results at a time. This packet contain five results:

- Read throughput (Gb/s)
- Write throughput (Gb/s)
- On-chip temperature (°C)
- On-chip V_{CCINT} voltage (V)
- On-chip V_{CCAUX} voltage (V)

JavaScript is used to convert these results into coordinates and update the graphs. The graphs update every time a new data packet is received. The graph holds a maximum of 12 data points at a time. After the maximum has been reached, the oldest data point is dropped and the newest data point is added.

9. Repeat step 7 and step 8 to explore different VIDEO DEMO TESTS options by changing the selections mentioned in step 7.

Running BIST tests

10. A Web server-based BIST demonstration can also be run on the same hardware to test different peripherals. Enter these commands at the XMD prompt to run the BIST demonstration:

```
XMD% stop

XMD% dow ../../KC705_System/ready_for_download/
board_test_app_Webserver.elf

XMD% con
```

11. Reload the Web page with the same URL (192.168.1.10). The Web page should appear as shown in Figure 1-7.
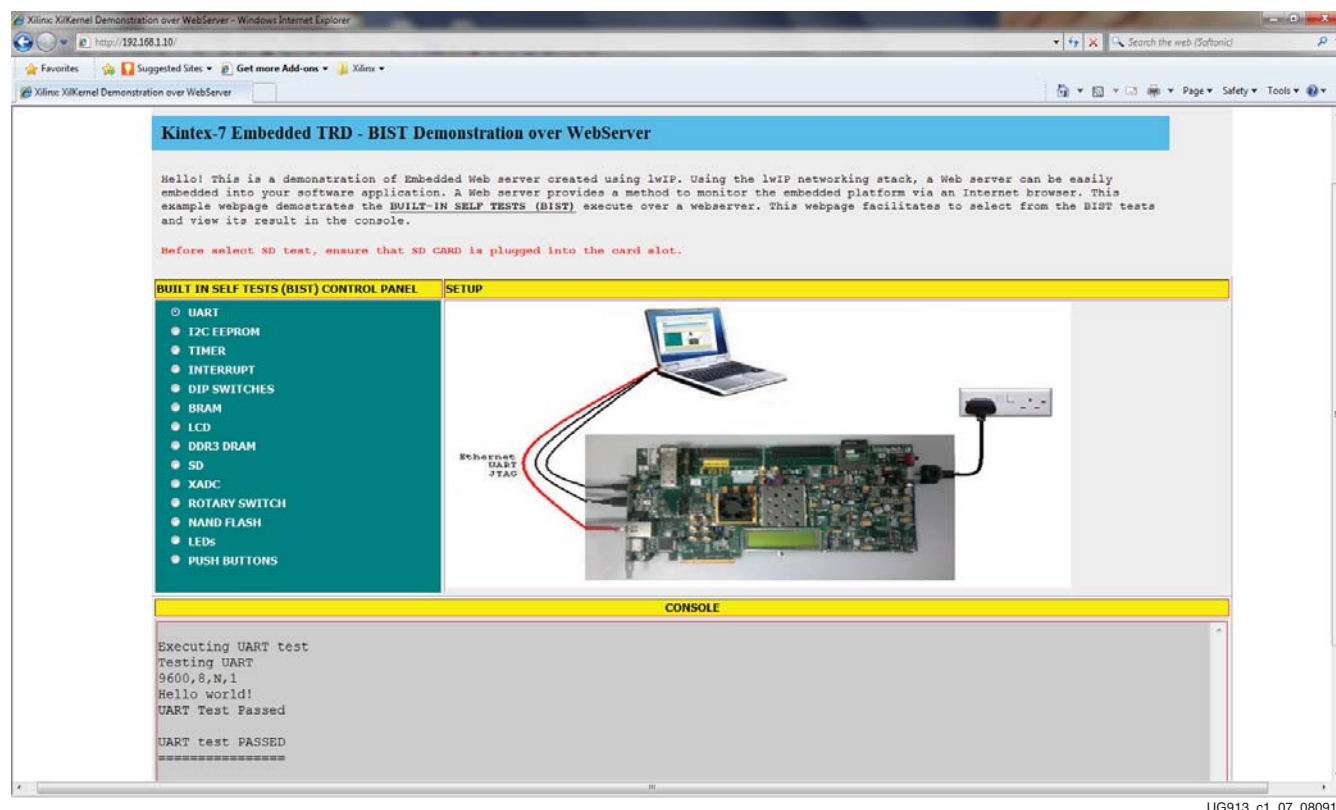

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Figure 1-7: **BIST Demonstration Web Page with DDR3 test results**

12. The left side of the Web page has different options for selecting the type of test to run on the hardware. For running any test, click on the radio button corresponding to the test. The bottom of the Web page has a messaging section that displays the results of the tests.

The Video and BIST demonstrations using the KC705 board are complete. Because a fully configured MicroBlaze processor subsystem has been provided, the user can start developing embedded applications. Because an FPGA is being used, the processor subsystem can also be fully customized. To do this, the Xilinx Design Tools and the USB-UART driver must be installed on the computer (see Appendix C, Installation and Licensing of Xilinx Design Tools).

Next Steps

After running through an FPGA-based embedded processor demonstration and installing the Xilinx Design Tools, the user is ready to create custom embedded systems for the Kintex-7 XC7K325T FPGA.

Figure 1-8 is a snapshot of the directory structure in the `KC705_Embedded_Kit` folder from the Kintex-7 FPGA KC705 Embedded Kit page: http://www.xilinx.com/products/boards-and-kits/DK-K7-EMBD-G.htm. Xilinx recommends saving the files downloaded from this URL to a working area on the user's host computer.

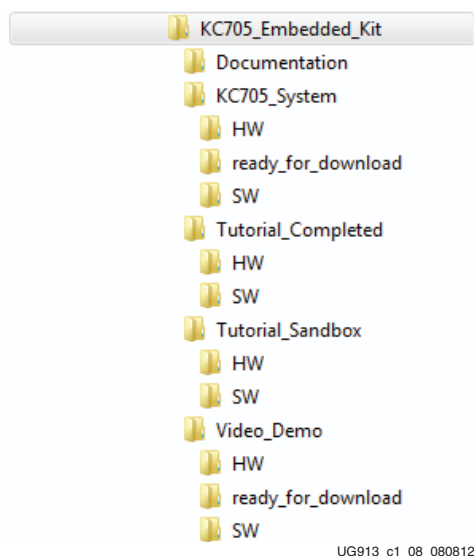*Note:* There should be no spaces in the path name of the working area on the host computer.

Figure 1-8: **KC705 Embedded Kit Directory Structure**

The `KC705_Embedded_Kit` directories and their content are explained in Table 1-1.

Table 1-1: **KC705 Embedded Kit Directory Structure Contents**

Directory	Purpose
Documentation	Includes the data sheet, tutorials, and other supporting documentation provided with this embedded kit.
KC705_System	BIST MicroBlaze processor subsystem including the software applications and platforms.
Video_Demo	BIST MicroBlaze processor subsystem along with the cores for the video demonstration. Source files for the video demonstration are included here.
Tutorial_Sandbox	Working directory to use for executing the hardware and software tutorials. The tutorials should be performed in this directory.
Tutorial_Completed	Final state of the files after the hardware and software tutorials have been completed.

Reference Designs

MicroBlaze Processor BIST Subsystem

- KC705_System
    - This is the base MicroBlaze processor subsystem including the software applications and platforms.

MicroBlaze Processor Video Subsystem

- Video_Demo
    - This is the MicroBlaze processor subsystem with the video cores that were run as the power-on demonstration. Source files for the demonstration including the software application and platform are included here.

Documentation

- [DS669](#), *AXI Interface Based KC705 Embedded Kit MicroBlaze Processor Subsystem Data Sheet*

    ```
    Documentation\ds669-axi-interface-kc705-microblaze-processor.pdf
    ```

    Detailed data sheet documentation of the MicroBlaze processor subsystem, including block diagram, address map, and system configuration.

- [UG914](#), *AXI Interface Based KC705 Embedded Kit MicroBlaze Processor Subsystem Hardware Tutorial*

    ```
    Documentation\ug914-KC705-embed-kit-microblaze-processor-subsys-hw-tutor.pdf
    ```

    This tutorial guides the user through the steps to open the MicroBlaze processor subsystem using XPS and add the cores necessary for measuring DDR3 throughput to recreate the out-of-the-box embedded kit demonstration.

- [UG915](#), *AXI Interface Based KC705 Embedded Kit MicroBlaze Processor Subsystem Software Tutorial*

    ```
    Documentation\ug915-axi-interface-kc705-microblaze-software-tutorial.pdf
    ```

    This tutorial guides the user through the steps to begin software development using SDK (Eclipse IDE) and the MicroBlaze processor subsystem. The software tutorial shows the user how to create stand-alone (no OS) programs from simple Hello World designs to a more complex board test program. The tutorial also describes the software for the video demonstration that is included with the embedded kit.

Additional Resources

Xilinx Resources

For support resources such as Answers, Documentation, Downloads, and Forums, see the Xilinx Support website at:

http://www.xilinx.com/support.

For a glossary of technical terms used in Xilinx documentation, see:

http://www.xilinx.com/support/documentation/sw_manuals/glossary.pdf.

Communicating with the KC705 USB-UART

This appendix explains the procedure for setting up UART communication between the KC705 board and the host machine.

Installing the USB-UART driver

1. Execute the installer for the Silicon Labs USB-UART virtual COM port (VCP) driver from the `Drivers_and_Tools` folder in the package downloaded from the embedded kit home page:
   `Drivers_and_Tools\CP210x_VCP_Win2K_XP_S2K3.exe`.

2. Follow the installer instructions. Restart the computer when instructed to do so.

Connecting to the KC705 UART

3. Connect a USB Type-A to Mini-B 5-pin cable between the KC705 USB-UART connector (J21) and the host computer.

4. Power on the KC705 evaluation board if it is not already powered on.

Configuring the Host Computer

5. Right-click on **My Computer** and select **Properties**. Select the **Hardware** tab. Click on **Device Manager**.

6. Expand the **Ports (COM & LPT)** entry as shown in Figure B-1. This shows the COM port assigned to the **Silicon Labs CP210x USB to UART Bridge**. This is the COM port to use in the serial communications program.

   Note: The COM port setting for the user system might be different from the one shown in Figure B-1.
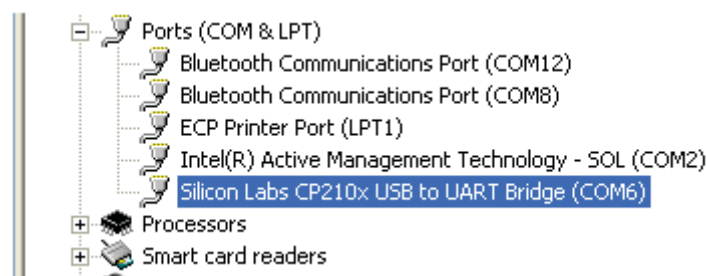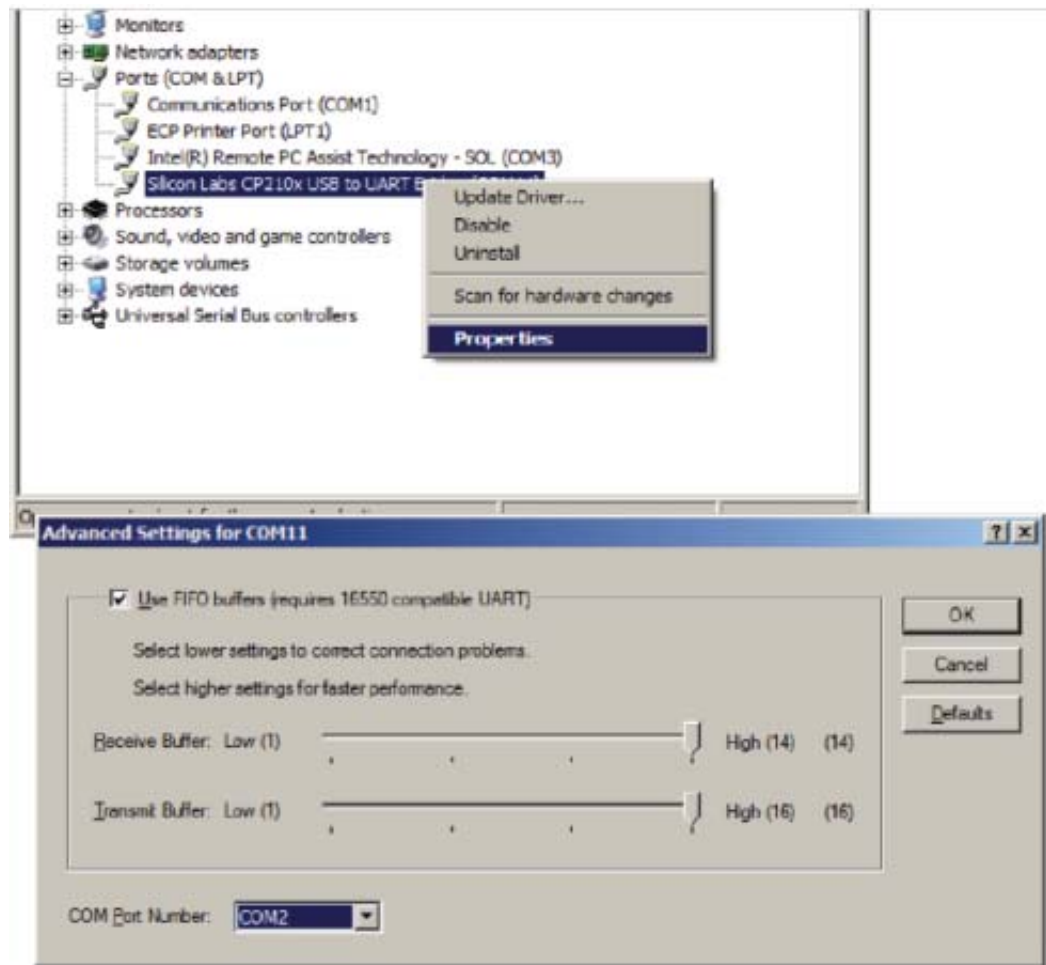

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Figure B-1: **Silicon Labs USB to UART Bridge Properties**

If the Silicon Labs CP210x USB to UART bridge does not appear in the Ports list, a reboot of the computer might be required. After rebooting, repeat step 5 and step 6.

7. If using TeraTerm as the serial communications utility program, right-click on the **Silicon Labs CP210x USB to UART bridge** and select **Properties**.

    a. Click on the **Port Settings** tab and then click **Advanced**.

    b. Set the COM port to an open COM port setting from COM1 to COM4. The COM port setting for the user system might be different from the one shown in Figure B-2.

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Figure B-2: **Setting the COM Port for the Silicon Labs USB to UART Bridge Driver**

8. Click **OK** to exit all open windows.

The Silicon Labs USB-UART VCP driver is now installed.

Installation and Licensing of Xilinx Design Tools

This KC705 embedded kit comes with entitlement to a full set of the Xilinx Design Tools that is device locked to the Kintex-7 XC7K325T device. This software can be installed from the DVD, or the Web installer can be downloaded from http://www.xilinx.com/support/download/index.htm.

For detailed information on licensing and installation, refer to UG798, *Xilinx Design Tools: Installation and Licensing Guide*.

Getting Help and Support

For questions regarding products within your product entitlement account, send an e-mail message to your regional customer service representative:

- Canada, USA, and South America: isscs_cases@xilinx.com
- Europe, Middle East, and Africa: eucases@xilinx.com
- Asia Pacific including Japan: apaccase@xilinx.com

For technical support including the installation and use of your product license file, you may contact Xilinx Online Technical Support at www.support.xilinx.com. On this site you will also find the following resources for assistance:

- Software, IP, and documentation updates
- Access to technical support web tools
- Searchable answer database with over 4,000 solutions
- User forums
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