

SP601 Reference Design User Guide

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Revision History

The following table shows the revision history for this document.

| Date | Version | Revision |
|------------|---------|-------------------------|
| 08/18/2009 | 1.0 | Initial Xilinx release. |
| 09/16/2009 | 1.1 | Minor updates for 11.3. |

Table of Contents

Preface: About This Guide

| | |
|------------------------------------|---|
| Guide Contents | 5 |
| Additional Documentation | 5 |
| Additional Support Resources | 6 |

Chapter 1: SP601 Evaluation Board

| | |
|--|----|
| Introduction | 7 |
| SP601 Features | 8 |
| Reference Designs | 9 |
| Built-In Self Test (BIST) | 9 |
| Memory Interface Generator (MIG) DDR2 Design | 10 |
| MultiBoot Design | 12 |
| Base System Reference Design (BSRD) | 12 |
| Stand-Alone Applications | 13 |
| Restoring Flash Contents | 13 |

Appendix A: References

About This Guide

This user guide introduces several designs that demonstrate Spartan®-6 FPGA features using the SP601 evaluation board. The provided designs include processing systems based on the MultiBoot and the Xilinx Memory Interface Generator (MIG) for the Spartan-6 FPGA.

Guide Contents

This manual contains the following chapters:

- [Chapter 1, “SP601 Evaluation Board,”](#) provides an overview of the Spartan-6 FPGA, components and features of the SP601 board, and supporting reference designs.
- [Appendix A, “References.”](#)

Additional Documentation

The following documents are available for download at <http://www.xilinx.com/products/spartan6/>

- **Spartan®-6 Datasheet: Family Overview**
The features and products of the Spartan®-6 family are outlined in this overview.
- **Spartan®-6 FPGA Data Sheet: DC and Switching Characteristics**
This data sheet contains the DC and Switching Characteristic specifications for the Spartan®-6 family.
- **Spartan®-6 FPGA Packaging and Pinouts User Guide**
This specification includes the tables for device/package combinations and maximum I/Os, pin definitions, pinout tables, pinout diagrams, mechanical drawings, and thermal specifications.
- **Spartan®-6 FPGA Configuration User Guide**
This all-encompassing configuration guide includes chapters on configuration interfaces (Serial, SelectMAP, and Master BPI), bitstream encryption, Boundary-Scan and JTAG configuration, reconfiguration techniques, and readback through the SelectMAP and JTAG interfaces.
- **Spartan®-6 FPGA Select I/O Resources User Guide**
This user guide details input/output characteristics and SelectIO™ logic resources available in Spartan®-6 FPGAs.
- **Spartan®-6 FPGA Clocking Resources User Guide**
This document describes Spartan®-6 FPGA clocking.

- Spartan®-6 FPGA Block RAM Resources User Guide
This guide describes the Spartan®-6 FPGA block RAMs. Block RAMs are used for efficient data storage or buffering, for high-performance state machines or FIFO buffer, for large shift registers, large look-up tables, or ROMs.
- Spartan®-6 FPGA Configurable Logic Block User Guide
This guide describes the Spartan®-6 FPGA configurable logic blocks (CLBs). Including the varying capabilities of the look-up tables (LUTs), the physical direction of the carry propagation, the number and distribution of the available flip-flops, and the availability of the very efficient shift registers.
- Spartan®-6 FPGA GTP Transceivers User Guide
This document shows how to use the GTP transceivers in Spartan®-6 FPGAs.
- Spartan®-6 FPGA Memory Controller User Guide
This document describes the Spartan®-6 FPGA memory controller.
- Spartan®-6 FPGA DSP48A1 Slice User Guide
This user guide is a detailed functional description of the DSP48A1 slice in Spartan®-6 FPGAs. The Spartan®-6 family offers a high ratio of DSP48A1 slices to logic, making it ideal for math-intensive applications. Refer to the Spartan®-6 Family Overview for the number of DSP48A1 slices for each Spartan®-6 device.
- Spartan®-6 FPGA Hardware User Guide
Chapters in this manual cover the following topics:
 - Clocking Resources
 - Clock Management Technology (CMT)
 - Phase-Locked Loops (PLLs)
 - Block RAM
 - Configurable Logic Blocks (CLBs)
 - SelectIO™ Resources
 - SelectIO Logic Resources
 - Advanced SelectIO Logic Resources
- LogiCORE Datasheet: Multi-port Memory Controller (MPMC)
This datasheet details the use of the MPMC compatible with the Spartan®-6 FPGAs.

Additional Support Resources

To search the database of silicon and software questions and answers, or to create a technical support case in WebCase, see the Xilinx website at:
<http://www.xilinx.com/support>.

SP601 Evaluation Board

Introduction

The Spartan®-6 family [Ref 1] provides leading system integration capabilities with the lowest total cost for high-volume applications. The thirteen-member family delivers expanded densities ranging from 3,400 to 148,000 logic cells, with half the power consumption of previous Spartan families and faster, more comprehensive connectivity. Built on a mature 45 nm low-power copper process technology that delivers the optimal balance of cost, power, and performance, the Spartan®-6 family offers a new, more efficient, dual-register 6-input look-up table (LUT) logic and a rich selection of built-in system-level blocks. These include 18 Kb block RAMs, second generation DSP48A1 slices, SDRAM memory controllers, enhanced mixed-mode clock management blocks, SelectIO™ technology, power-optimized high-speed serial transceiver blocks, PCI Express™ compatible Endpoint blocks, advanced system-level power management modes, autodetect configuration options, and enhanced IP security with AES and Device DNA protection. These features provide a low-cost programmable alternative to custom ASIC products with unprecedented ease-of-use. Spartan®-6 FPGAs are the programmable silicon foundation for Targeted Design Platforms that deliver integrated software and hardware components to enable designers to focus on innovation as soon as their development cycle begins.

The SP601 Evaluation Kit is based on the XC6SLX16-2CSG324 Spartan-6 FPGA. This FPGA contains 14,579 logic cells, a rating that reflects the increased logic capacity offered by the new six-input LUT architecture. For additional information, see the *Spartan-6 Family FPGAs Product Table* at

http://www.xilinx.com/publications/prod_mktg/Spartan6_Product_Table.pdf.

The Built-In Self Test (BIST), feature demonstrations, and reference design files are provided with the SP601 Evaluation Kit. The onboard Linear BPI Flash is pre-programmed with a BIST application. The BIST provides a convenient way to test many of the board's features on power-up and upon reconfiguration using BPI-UP mode. After running through the tutorial provided in *Getting Started with the Xilinx Spartan-6 FPGA SP601 Evaluation Kit* [Ref 2], the tutorials and reference designs available on the SP601 Web page can be used to further explore the capabilities of the SP601 and the Spartan-6 FPGA.

For the most up-to-date information on the tutorial content provided with the SP601 Evaluation Kit, see the SP601 Reference Design Web page at

http://www.xilinx.com/products/boards/sp601/reference_designs.htm.

SP601 Features

The SP601 designs demonstrate Spartan-6 FPGA features using the SP601 evaluation board. These features include:

- DDR2 component
- SPI x4 Flash and headers
- Linear BPI Flash
- 10/100/1000 Ethernet PHY
- RS232 UART (USB Bridge)
- IIC
- 200 MHz differential clock, 27 MHz socketed oscillator, clock SMA connectors
- VITA 57.1 FMC-LPC connector
- LEDs
- DIP switch
- Pushbuttons
- 12-pin (8 I/O) header
- USB JTAG
- Onboard power

For detailed information on the features of the SP601 board, see the *SP601 Hardware User Guide*. [\[Ref 3\]](#)

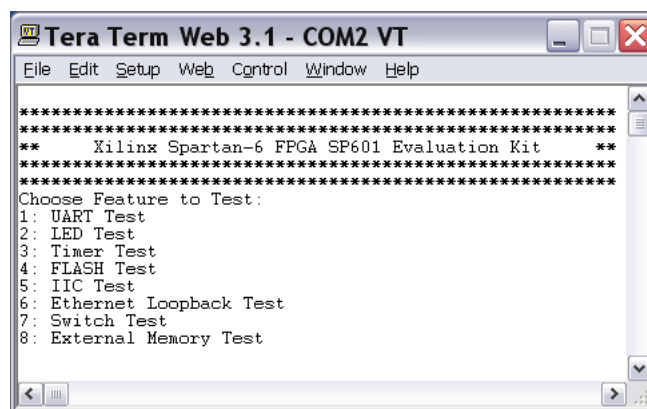
Reference Designs

- [Built-In Self Test \(BIST\)](#)
- [Memory Interface Generator \(MIG\) DDR2 Design](#)
- [MultiBoot Design](#)
- [Base System Reference Design \(BSRD\)](#)
- [Stand-Alone Applications](#)

Built-In Self Test (BIST)

The BIST tests the operation of many of the SP601 Evaluation Kit features. When configured to boot from the linear flash, the BIST menu appears upon power-up. After FPGA configuration, the text shown in [Figure 1-1](#) appears in a terminal program window, such as Tera Term. Type the number associated with one of the listed tests to run the test application. For example, typing a "5" runs the IIC Test application.

See the *SP601 Built-In Self Test Flash Application* tutorial for more information on the BIST software and its operation. [\[Ref 18\]](#)



```
Tera Term Web 3.1 - COM2 VT
File Edit Setup Web Control Window Help
*****
** Xilinx Spartan-6 FPGA SP601 Evaluation Kit **
*****
Choose Feature to Test:
1: UART Test
2: LED Test
3: Timer Test
4: FLASH Test
5: IIC Test
6: Ethernet Loopback Test
7: Switch Test
8: External Memory Test
```

Figure 1-1: BIST Initial Screen

The default location of the BIST program is the in the Numonyx 28F128J3D Linear BPI Flash device on the SP601 board. The *SP601 Restoring Flash Contents* tutorial provides instructions for restoring the image to its factory default content. [\[Ref 22\]](#)

Memory Interface Generator (MIG) DDR2 Design

The Spartan-6 FPGA contains dedicated Memory Controller Blocks (MCB) for simplified DRAM interfaces, including up to four MCB cores in a single Spartan-6 device. The FPGA also contains an embedded controller and physical (PHY) interface, 4-bit, 8-bit, or 16-bit single component memory support, and memory densities up to 4 Gb. Additionally, the Spartan-6 FPGA is capable of performance up to 800 Mb/s (400 MHz double data rate).

For the logic designer, the MIG tool (Figure 1-2) can be used to create a simple user interface that abstracts away the complexity of memory transactions. The integrated memory controller block's assembly and signal connectivity is made transparent to the user.

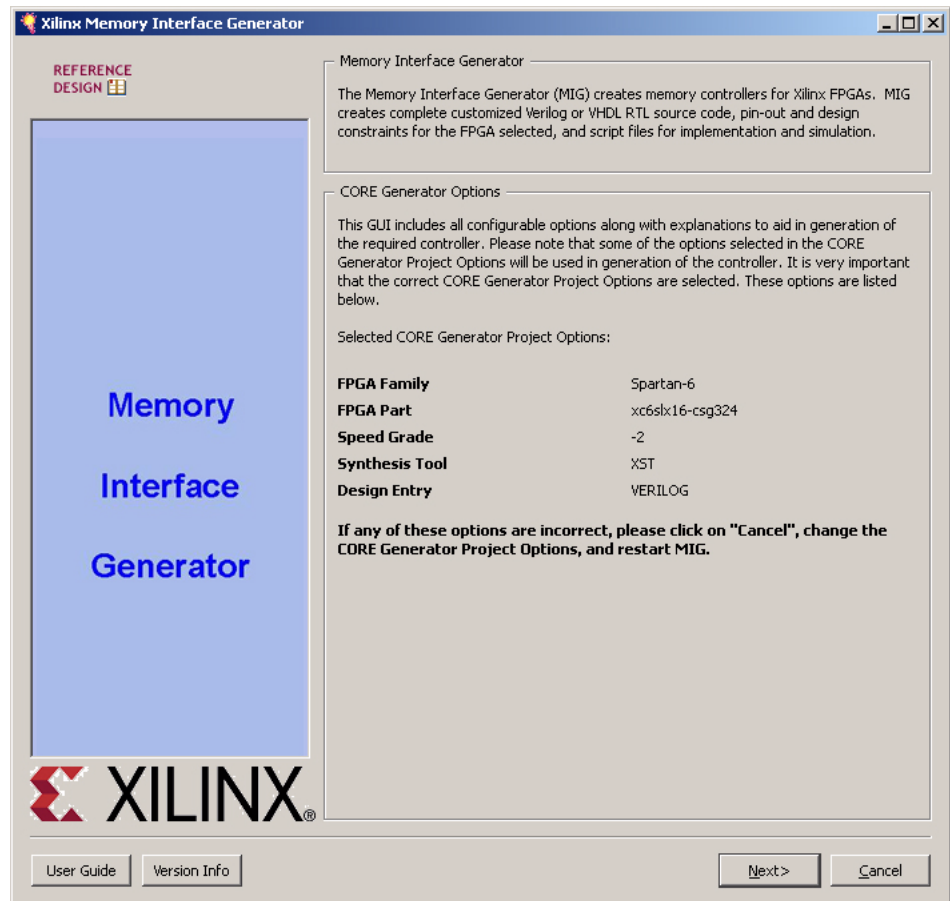
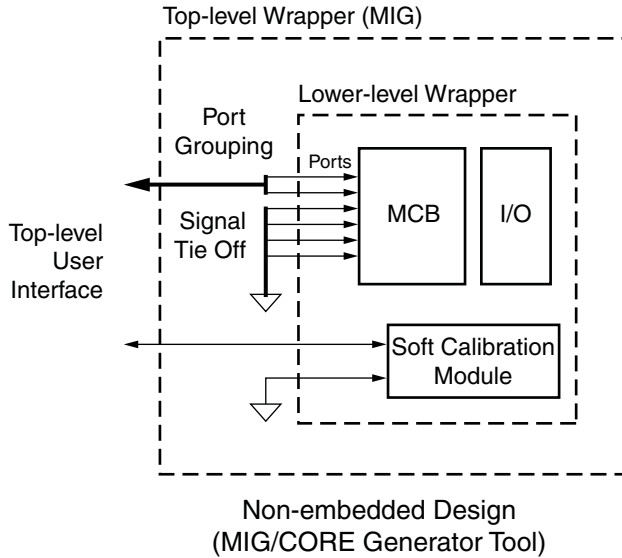


Figure 1-2: MIG Graphical User Interface



UG524_03_091409

Figure 1-3: MIG Wrapper for Non-embedded Design

The LogiCORE™ MIG example debug design tests the DDR2 memory interface through a series of writes and reads with pattern verification. The example design was generated using the option to include the debug interface. The results can be viewed in the ChipScope Pro Analyzer tool as shown in Figure 1-4, page 11. [Ref 19]

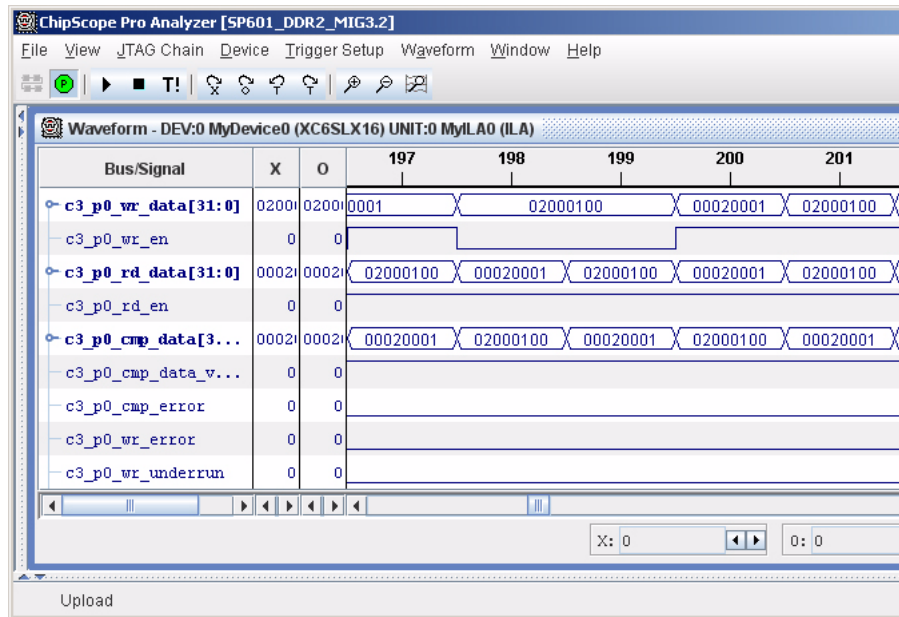


Figure 1-4: ChipScope Pro Analyzer Tool

For more information on the MCB, see the *Spartan-6 FPGA Memory Controller User Guide* [Ref 12]. For information about the ChipScope Pro Analyzer tool, refer to the *ChipScope Pro Software and Cores User Guide* [Ref 14].

MultiBoot Design

Figure 1-5, page 12 illustrates the MultiBoot operation. MultiBoot is the process by which the FPGA selectively reprograms and reloads its bitstream from an attached external memory. This feature allows field updating of a stored bitstream with a new bitstream while guarding against system upsets due to an update failure. A general update process is accomplished in a five step procedure:

1. New MultiBoot image is created
2. System setup to receive the new image
3. User application erases section of Flash
4. The new image is delivered into the system's Flash
5. User application resets system

For additional information on the Spartan-6 MultiBoot feature, see the *Spartan-6 FPGA Configuration User Guide* [Ref 5]. For a demonstration of this operation on the Spartan-6 FPGA, see the *SP601 MultiBoot Demonstration* [Ref 20].

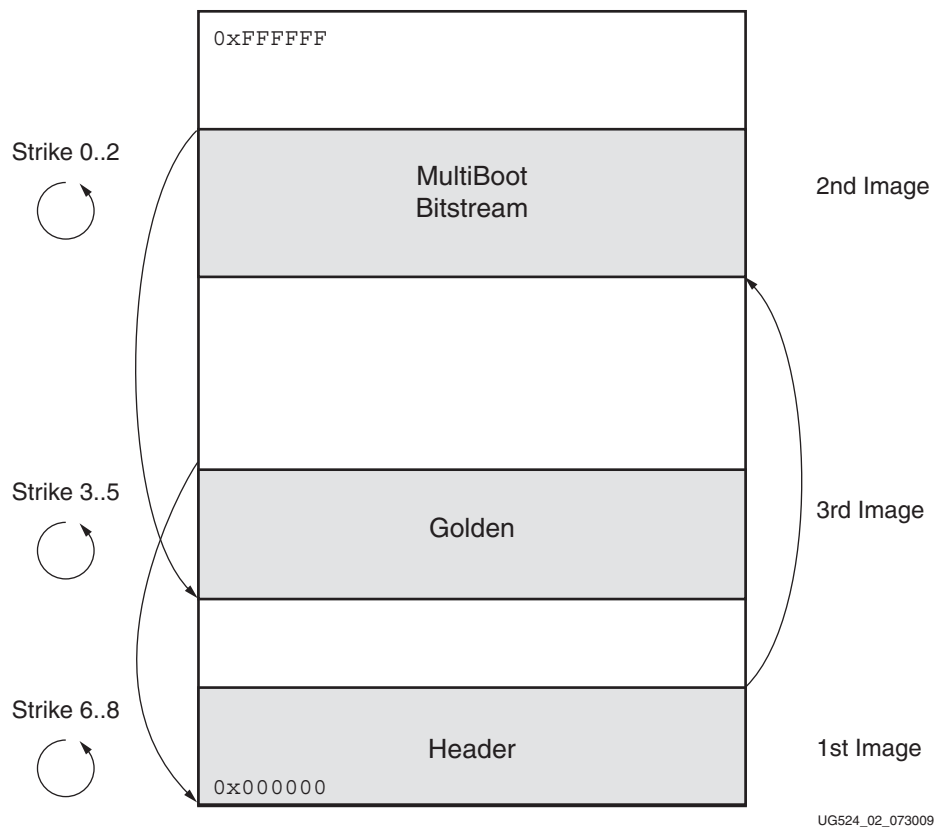


Figure 1-5: MultiBoot Operation

Base System Reference Design (BSRD)

An image processing and networking application is shown through the BSRD design programmed into the SPI Flash. The getting started guide [Ref 2] describes the components of the BSRD application and how to run the reference design.

Stand-Alone Applications

Each feature on the board can be tested for functionality by using the on-board BIST application [Ref 18] or by using the stand-alone applications [Ref 21] offered on the SP601 reference designs Web page.

Table 1-1: Stand-Alone Applications

| Feature | Feature Test Capability |
|-----------------------------|---|
| Spartan-6 FPGA | BIST |
| DDR2 Component | BIST |
| SPI x4 Flash | SPI Configuration Mode |
| Linear BPI Flash | BIST, BPI-UP Configuration Mode |
| 10/100/1000 Ethernet PHY | BIST, SPI Base System Reference Design (BSRD) Demonstration |
| RS232 UART (USB Bridge) | BIST |
| IIC | BIST |
| Clock, socket, SMA | 200 MHz system clock, 27MHz populated socket, User SMA |
| VITA 57.1 FMC-LPC connector | Factory Test |
| LEDs (Ethernet PHY) | BIST |
| Suspend Header / Awake LED | Web Tutorial |
| LEDs (INIT/DONE) | BIST |
| User LED | BIST |
| User DIP Switch | BIST |
| User Pushbutton | BIST |
| User 12-pin (8 I/O) Header | Web Tutorial |
| Pushbutton (PROG) | BIST |
| USB JTAG | Configuration |
| Onboard Power | BIST |

Restoring Flash Contents

The SP601 Evaluation Kit contains several non-volatile memories (Linear BPI Flash, SPI Flash) that can be overwritten by user created designs. The *Restoring Flash Contents* tutorial [Ref 22] provides a means to re-establish the original functionality programmed into the Linear BPI Flash and the SPI Flash.

References

This section provides references to documentation supporting Spartan-6 FPGAs, tools, and IP. For additional information, see www.xilinx.com/support/documentation/index.htm.

Documents supporting the SP601 Evaluation Board:

1. [DS160](#), *Spartan-6 Family Overview*
2. [UG523](#), *Getting Started with the Xilinx Spartan-6 FPGA SP601 Evaluation Kit*
3. [UG518](#), *SP601 Hardware User Guide*
4. [DS162](#), *Spartan-6 FPGA Data Sheet: DC and Switching Characteristics*
5. [UG380](#), *Spartan-6 FPGA Configuration User Guide*
6. [UG381](#), *Spartan-6 FPGA SelectIO Resources User Guide*
7. [UG382](#), *Spartan-6 FPGA User Guide: Clocking Resources*
8. [UG383](#), *Spartan-6 FPGA Block RAM Resources User Guide*
9. [UG384](#), *Spartan-6 FPGA Configurable Logic Block User Guide*
10. [UG385](#), *Spartan-6 FPGA Packaging and Pinouts*
11. [UG386](#), *Spartan-6 FPGA GTP Transceivers User Guide*
12. [UG388](#), *Spartan-6 FPGA Memory Controller User Guide*
13. [UG389](#), *Spartan-6 FPGA DSP48A1 Slice User Guide*
14. [UG029](#), *ChipScope Pro Software and Cores User Guide*
15. [DS614](#), *Clock Generator (v3.01a) Data Sheet*
16. [DS643](#), *Multi-Port Memory Controller (MPMC) (v5.02a) Data Sheet*
17. [UG138](#), *LogiCORE™ IP Tri-Mode Ethernet MAC v4.2 User Guide*

The following SP601 tutorials, demonstration, and design files are located at http://www.xilinx.com/products/boards/sp601/reference_designs.htm:

18. [XTP041](#), *SP601 Built-In Self Test Flash Application* ([rdf0045.zip](#))
19. [XTP039](#), *SP601 MIG Design Creation* ([rdf0005.zip](#))
20. [XTP038](#), *SP601 MultiBoot Design* ([rdf0006.zip](#))
21. [XTP053](#), *SP601 Stand-Alone Applications* ([rdf0015.zip](#))
22. [XTP040](#), *SP601 Restoring Flash Contents* ([rdf0004.zip](#))