

Integrator™/LM-XCV600E+
Integrator™/LM-EP20K600E+
User Guide

ARM

Integrator/LM-XCV600E+ Integrator/LM-EP20K600E+ User Guide

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Release Information

Date	Issue	Change
24 November 2000	A	New document.
11 December 2000	B	Errors in switch settings corrected in Sections 4.3 and 5.3.
23 July 2001	C	Incorrect dimension in figure B-1 corrected.

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Preface

This preface introduces the ARM Integrator/LM logic modules and their reference documentation. It contains the following sections:

- *About this document* on page viii
- *Further reading* on page x
- *Feedback* on page xi.

About this document

This document describes how to set up and use the ARM Integrator/LM-XCV600E+ and Integrator/LM-EP20K600E+ logic modules.

Intended audience

This document has been written for experienced hardware and software developers as an aid to developing ARM-based products using these ARM Integrator logic modules as a standalone development system or with an Integrator motherboard.

Organization

This document is organized into the following chapters:

Chapter 1 *Introduction*

Read this chapter for an introduction to the logic module.

Chapter 2 *Getting Started*

Read this chapter for a description of how to set up and start using the logic module.

Chapter 3 *Hardware Description*

Read this chapter for a description of the hardware architecture of the logic module. This includes clocks, resets, and debug features.

Chapter 4 *Configuring Altera Logic Modules*

Read this chapter for a description of how an Altera FPGA is configured at power-up, the configuration options available, and how to download your own FPGA configurations.

Chapter 5 *Configuring Xilinx Logic Modules*

Read this chapter for a description of how a Xilinx FPGA is configured at power-up, the configuration options available, and how to download your own FPGA configurations.

Chapter 6 *Supplied FPGA Examples*

Read this chapter for a description of the example FPGA configurations supplied with the logic module. This chapter provides information essential for understanding the memory map and register functions necessary to support the logic module as part of an Integrator development system.

Appendix A *Signal Descriptions*

Refer to this appendix for connector pinouts.

Appendix B *Mechanical Specification*

Refer to this appendix for mechanical details of the logic module.

Typographical conventions

The following typographical conventions are used in this book:

<i>italic</i>	Highlights important notes, introduces special terminology, denotes internal cross-references, and citations.
bold	Highlights interface elements, such as menu names. Denotes ARM processor signal names. Also used for terms in descriptive lists, where appropriate.
<code>monospace</code>	Denotes text that can be entered at the keyboard, such as commands, file and program names, and source code.
<u><code>monospace</code></u>	Denotes a permitted abbreviation for a command or option. The underlined text can be entered instead of the full command or option name.
<i>monospace italic</i>	Denotes arguments to commands and functions where the argument is to be replaced by a specific value.
<code>monospace bold</code>	Denotes language keywords when used outside example code.

Further reading

This section lists related publications by ARM Limited and other companies that provide additional information and examples.

ARM publications

The following publications provide information about related ARM products and toolkits:

- *ARM Integrator/AP User Guide* (ARM DUI 0098)
- *ARM Integrator/SP User Guide* (ARM DUI 0099)
- *ARM Multi-ICE User Guide* (ARM DUI 0048)
- *AMBA Specification* (ARM IHI 0011)
- *ARM Architectural Reference Manual* (ARM DDI 0100)
- *ARM Firmware Suite Reference Guide* (ARM DUI 0102)
- *ARM Software Development Toolkit User Guide* (ARM DUI 0040)
- *ARM Software Development Toolkit Reference Guide* (ARM DUI 0041)
- *ADS Tools Guide* (ARM DUI 0067)
- *ADS Debuggers Guide* (ARM DUI 0066)
- *ADS Debug Target Guide* (ARM DUI 0058)
- *ADS Developer Guide* (ARM DUI 0056)
- *ADS CodeWarrior IDE Guide* (ARM DUI 0065).

Other publications

The following publication provides information about the clock controller chip used on the Integrator modules:

- *MicroClock OSCaR User Configurable Clock Data Sheet* (MDS525), MicroClock Division of ICS, San Jose, CA.

Feedback

ARM Limited welcomes feedback both on the ARM Integrator/LM and on the documentation.

Feedback on this document

If you have any comments about this document, please send email to errata@arm.com giving:

- the document title
- the document number
- the page number(s) to which your comments refer
- an explanation of your comments.

General suggestions for additions and improvements are also welcome.

Feedback on the ARM Integrator/LM-XCV600E+ and LM-EP20K600E+

If you have any comments or suggestions about this product, please contact your supplier giving:

- the product name
- an explanation of your comments.

Chapter 1

Introduction

This chapter provides an introduction to the ARM Integrator/LM logic modules. It contains the following sections:

- *About the ARM Integrator/LM logic module* on page 1-2
- *Logic module architecture* on page 1-5
- *Links, indicators, and switches* on page 1-6
- *Differences between core and logic modules* on page 1-8
- *Care of modules* on page 1-9.

1.1 About the ARM Integrator/LM logic module

The Integrator/LM logic module is designed as a platform for developing *Advanced Microcontroller Bus Architecture* (AMBA™) *Advanced System Bus* (ASB), *Advanced High-performance Bus* (AHB), and *Advanced Peripheral Bus* (APB) peripherals for use with ARM cores.

You can use the logic module in three ways:

- as a standalone system
- with an Integrator core module, and an Integrator/AP or Integrator/SP motherboard
- as a core module with either Integrator/AP or Integrator/SP motherboard if a synthesized ARM core, such as the ARM7TDMI-S, is programmed into the FPGA.
- stacked without a motherboard, if one module in the stack provides system controller functions of a motherboard.

Figure 1-1 on page 1-3 and Figure 1-2 on page 1-4 show the layout of the logic module.

There are two main variants of this logic module:

- the Integrator/LM-EP20K600E+ is fitted with an Altera Apex FPGA
- the Integrator/LM-XCV600E+ is fitted with a Xilinx Virtex E FPGA.

The functionality of the logic module is defined by a configuration image loaded into the FPGA at power-up. Two FPGA configuration examples are preloaded into flash to get you started with AMBA AHB or ASB designs. You can also download your own configurations using Multi-ICE® or using other tools supported by the FPGA manufacturer.

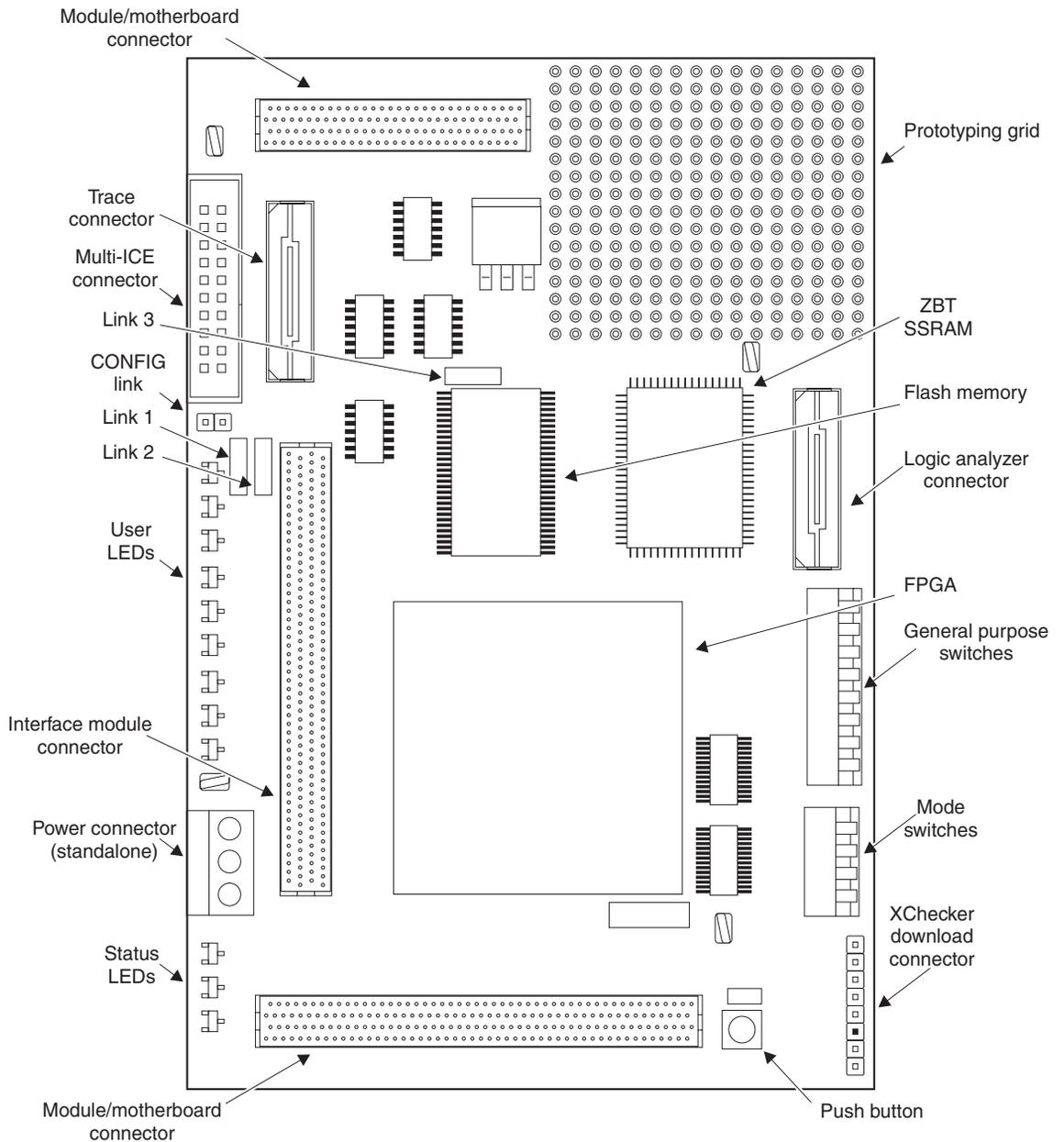


Figure 1-1 Integrator/LM-XCV600E+ layout

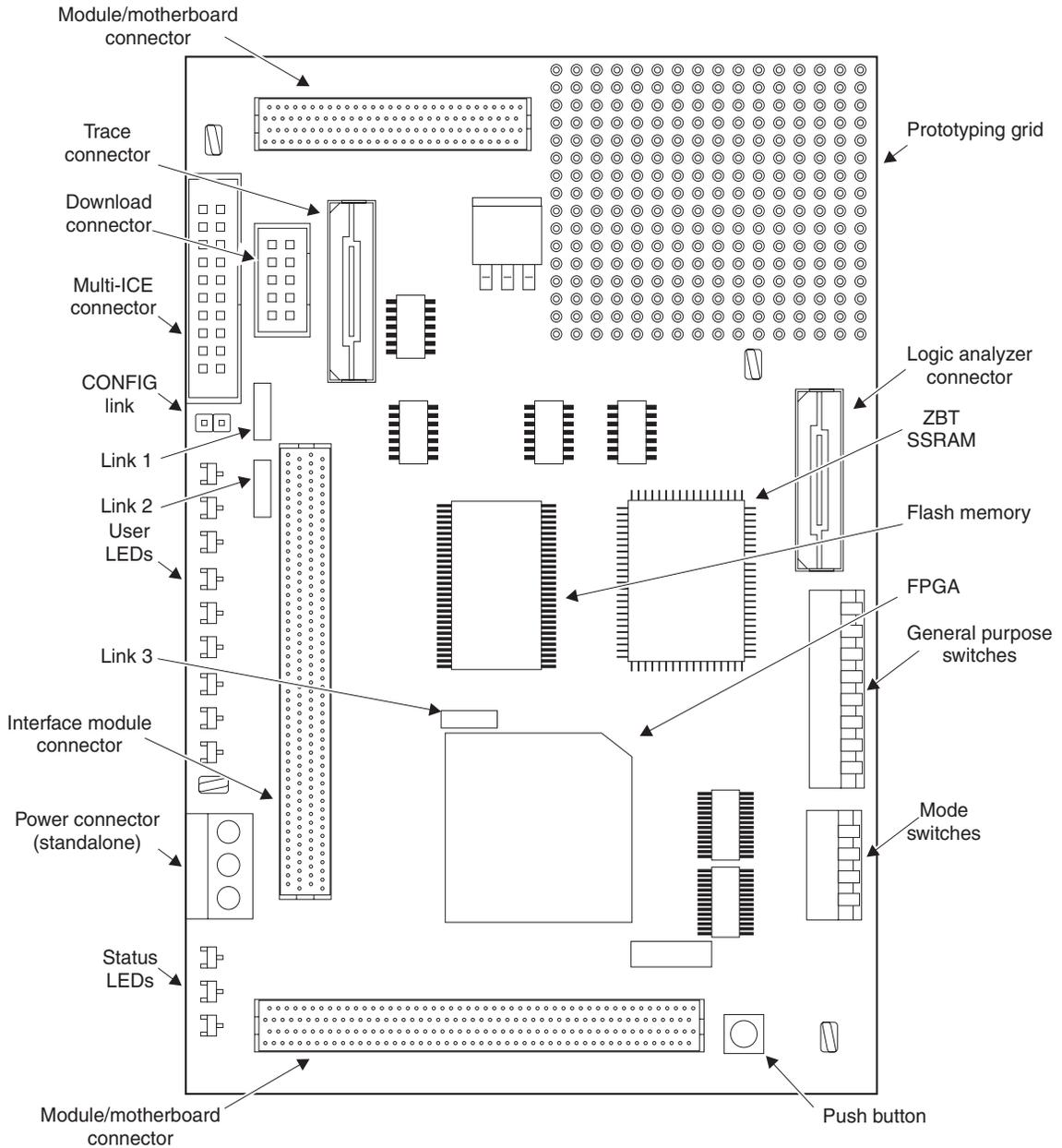


Figure 1-2 Integrator/LM-EP20K600E+ layout

1.2 Logic module architecture

Figure 1-3 shows the architecture of the logic module.

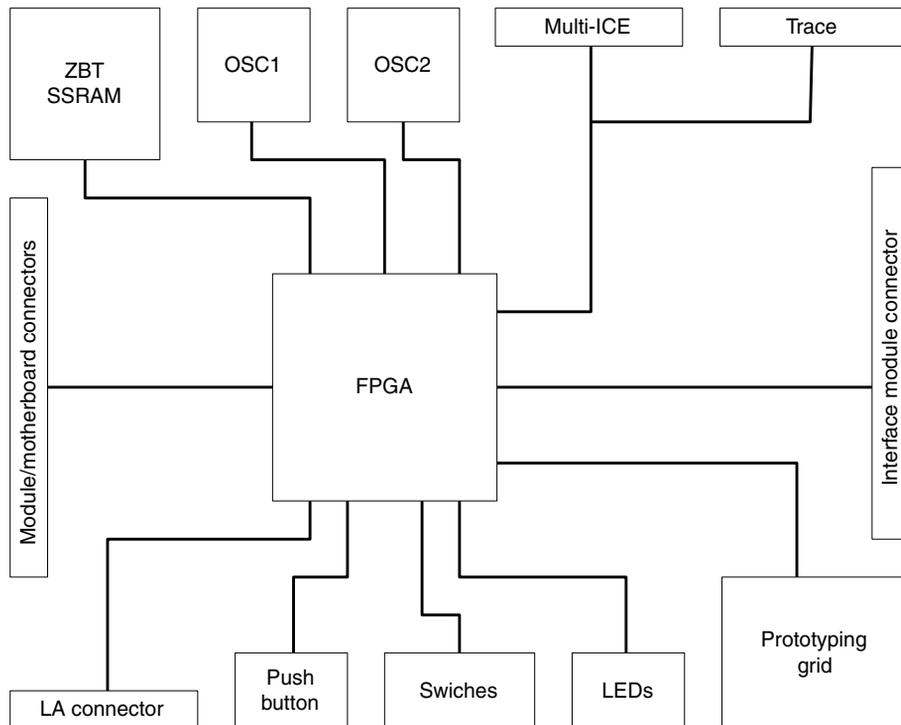


Figure 1-3 System architecture

The logic module comprises the following:

- Altera or Xilinx FPGA
- configuration PLD and flash memory for storing FPGA configurations
- 1MB ZBT SSRAM
- clock generators and reset sources
- swiches
- LEDS
- prototyping grid
- JTAG, Trace, and logic analyzer connectors
- system bus connectors to a motherboard or other modules.

These components are discussed in detail in Chapter 3 *Hardware Description*.

1.3 Links, indicators, and switches

The logic module provides:

- CONFIG link
- nine user-definable surface-mounted LEDs
- user-definable push button
- 4-way mode switch and 8-way user definable switch.

You can also add your own links, switches, and small integrated circuits to the prototyping grid if required.

1.3.1 CONFIG link

The CONFIG link enables *configuration mode*. Configuration mode changes the JTAG signal routing and is used to download new PLD or FPGA configurations.

1.3.2 LEDs summary

The LEDs are listed in Table 1-1 on page 1-6.

Table 1-1 LED summary

Name	Color	Function
CFGLED	Orange	Configuration mode. This LED is lit when the CONFIG link is fitted.
POWER	Green	Power supply OK. This LED is lit when 3.3V power is supplied to the board.
FPGA_OK	Green	FPGA is configured. This LED is lit when power is supplied and the FPGA has loaded its configuration.
PROGFLASH	Orange	PLD is in flash programming mode (Altera only).
LED[7:0]	Green	These are general purpose LEDs connected to FPGA pins. Drive LOW to light.
LED8	Red	General purpose LED that you can use to signal error conditions. This is connected to an FPGA pin and must be driven LOW to light.

1.3.3 Switches

The 8-way DIP switch (S2) and push button (S3) provide general purpose inputs to the FPGA.

The 4-way DIP switch (S1) is used to select which of the FPGA configuration images stored in flash is used when the logic module powers up (see Chapter 4 *Configuring Altera Logic Modules* for Altera types, or Chapter 5 *Configuring Xilinx Logic Modules* for Xilinx types).

1.4 Differences between core and logic modules

Core and logic modules handle the interrupt signals differently. Core modules must receive interrupts, but logic modules, that implement peripherals, generate interrupts.

The signals on HDRB and EXPB concerned with interrupts are different, as shown in Table 1-2 on page 1-8. All signals on these pins must be driven open-collector (open-drain) to prevent conflict when logic and core modules are connected together in the same stack.

Appendix A *Signal Descriptions* provides a full description of all the connector pins.

Table 1-2 Interrupt Pins on HDRB and EXPB

HDRB	Label	Description	EXPB	Label	Description
nFIQ0	H16	Fast interrupt to module 0	-	E16	Not used
nFIQ1	H17	Fast interrupt to module 1	-	E17	Not used
nFIQ2	H18	Fast interrupt to module 2	-	E18	Not used
nFIQ3	H19	Fast interrupt to module 3	-	E19	Not used
nIRQ0	H20	Interrupt to module 0	IRQSRC0	E20	Interrupt source from module 0 to interrupt controller
nIRQ1	H21	Interrupt to module 1	IRQSRC1	E21	Interrupt source from module 1 to interrupt controller
nIRQ2	H22	Interrupt to module 2	IRQSRC2	E22	Interrupt source from module 2 to interrupt controller
nIRQ3	H23	Interrupt to module 3	IRQSRC3	E23	Interrupt source from module 3 to interrupt controller

You can use the logic module to implement a synthesized processor, such as an ARM7TDMI-S, in which case it functions as a core module. As a core module, it receives interrupts, and is installed in the HDRA/B stack.

Also, on the Integrator/AP, the 32 GPIO lines are routed to the EXPB connector, but not the HDRB connector. The GPIO signals are not available on the Integrator/SP.

1.5 Care of modules

This section contains advice about how to prevent damage to your Integrator modules.

———— **Caution** ————

To prevent damage to your logic module, observe the following precautions:

- When removing a core or logic module from a motherboard, or when separating modules, take care not to damage the connectors. Do not apply a twisting force to the ends of the connectors. Loosen each connector first before pulling on both ends of the module at the same time.
 - Use the logic module in a clean environment and avoid debris fouling the connectors on the underside of the PCB. Blocked holes result in damage to connectors on the motherboard or module below. Visually inspect the module to ensure that connector holes are clear before mounting it onto another board.
 - Observe *ElectroStatic Discharge* (ESD) precautions when handling any Integrator board.
-

Chapter 2

Getting Started

This chapter describes how to set up and start using the logic module. It contains the following sections:

- *Using a bench power supply* on page 2-2
- *Using the logic module with an Integrator motherboard* on page 2-3
- *Setting the DIP switches* on page 2-5
- *Using Multi-ICE or other JTAG equipment* on page 2-6.

2.1 Using a bench power supply

To power the logic module as a standalone system, connect a bench power supply capable of supplying +3.3V and +5V using the screw terminals shown in Figure 2-1 on page 2-2. You must apply and remove the 3.3V and 5V supplies simultaneously.

———— **Caution** ————

You must take care to wire the supply correctly, because there is no reverse-polarity protection. The power terminals are marked clearly on the PCB.

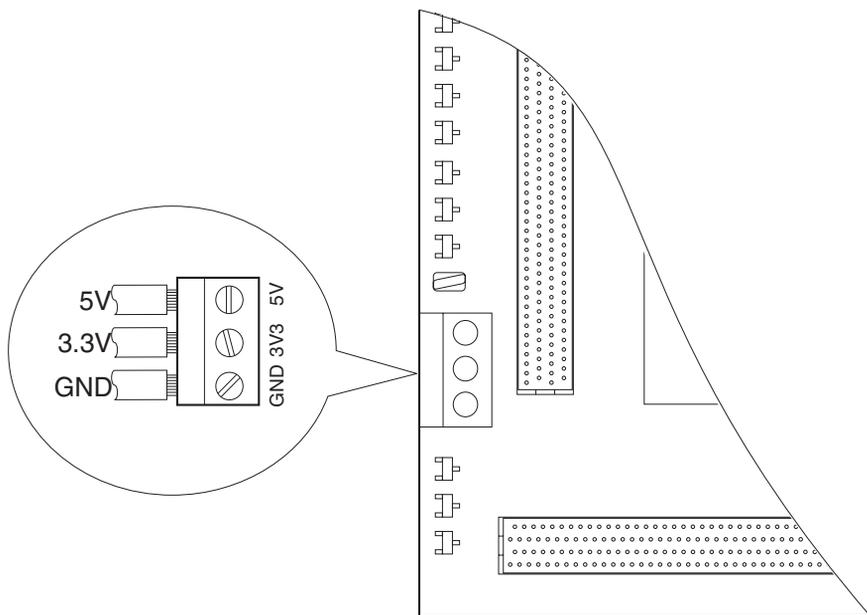


Figure 2-1 Power supply screw terminals

2.2 Using the logic module with an Integrator motherboard

The logic module and core modules can be mounted onto an Integrator/AP or Integrator/SP motherboard, as described in:

- *Mounting the logic module on an Integrator/AP* on page 2-3
- *Mounting on an Integrator/SP* on page 2-4.

———— **Note** ————

The logic module can be configured to support stacking without a motherboard (see *Module stacking options* on page 3-15).

2.2.1 Mounting the logic module on an Integrator/AP

The Integrator/AP provides two module mounting positions. These are used as follows

- logic modules mount onto the connectors EXPA and EXPB
- core modules mount onto the connectors HDRA and HDRB.

Figure 2-2 on page 2-3 shows an example system a core module and four logic modules attached to an Integrator/AP (see the *Integrator/AP User Guide* for more details).

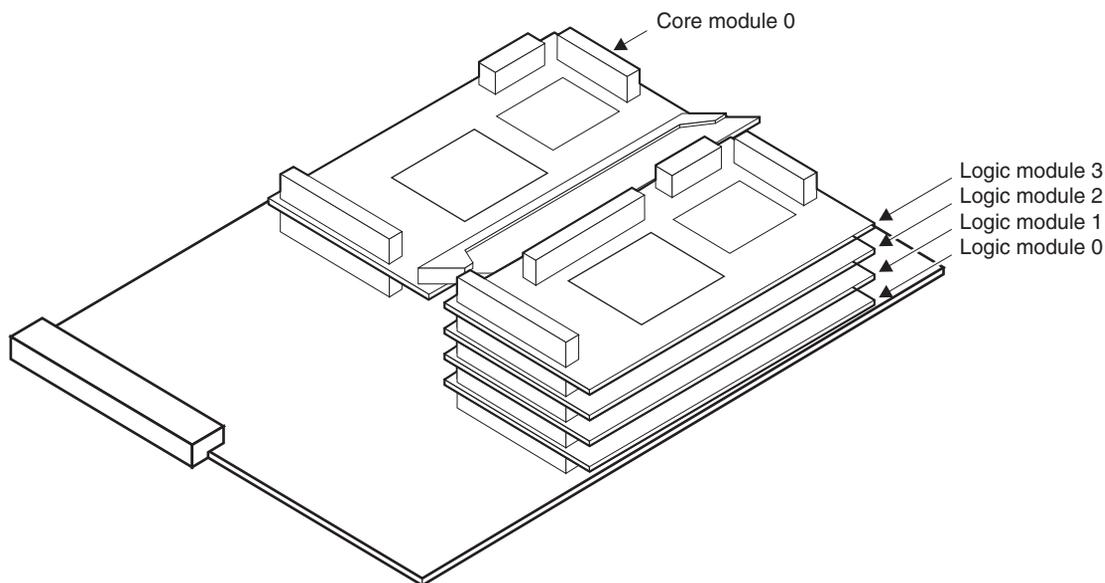


Figure 2-2 Assembled Integrator/AP development system

Note

Logic modules can be mounted on the HDRA and HDRB connector without causing damage. However, there are differences in the routing of some signals on the HDRB and EXPB that affect the operation of the module (see *Differences between core and logic modules* on page 1-8).

Fitting procedure

Caution

To prevent damage to the Integrator/AP and modules:

- Power down before fitting or removing modules.
 - Do not exceed four modules in one stack.
 - Do not exceed a combined total of five modules on the Integrator/AP.
-

Fit a logic module as follows:

1. Place the Integrator/AP on a firm level surface.
2. Align connectors EXPA and EXPB on the logic module with the corresponding connectors on the Integrator/AP.
3. Press firmly on both ends of the logic module so that both connectors close together at the same time.
4. Repeat steps 2 and 3 for additional modules.

2.2.2 Mounting on an Integrator/SP

The Integrator/SP provides one mounting position which means that core and logic modules are mounted in a single stack. This limits the total number of modules that can be fitted to four.

There are differences in the routing of some signals that affect the operation of the logic module if it is mounted on the Integrator/SP. This particularly applies to the interrupt signal routing (see *Differences between core and logic modules* on page 1-8).

2.3 Setting the DIP switches

When the logic module powers up in user mode, the FPGA loads configuration data from flash memory. The flash memory is preloaded with two example configuration images. These are selected as follows:

- The 4-way DIP switch (S1) is used by the preloaded PLD configuration to select the FPGA configuration.
- If the logic module is mounted on a motherboard, the signals **CFGSEL [1:0]** from the motherboard can be used to select the appropriate FPGA configuration. to support operation with an AHB or ASB motherboard.

For a full description of FPGA configuration image selection, see *Configuring the Altera FPGA from flash* on page 4-7 for Altera types, or *Configuring the Xilinx FPGA from flash* on page 5-6 for Xilinx types.

The 8-poles DIP switch (S2) is intended for general-purpose use after configuration.

2.4 Using Multi-ICE or other JTAG equipment

JTAG equipment, such as Multi-ICE, is connected to the 20-way box header, as shown in Figure 2-3 on page 2-6. When multiple core or logic modules are stacked on a motherboard, the JTAG equipment is always connected to the top module in the stack. Refer to *Reset control* on page 3-9 for a description of the JTAG system.

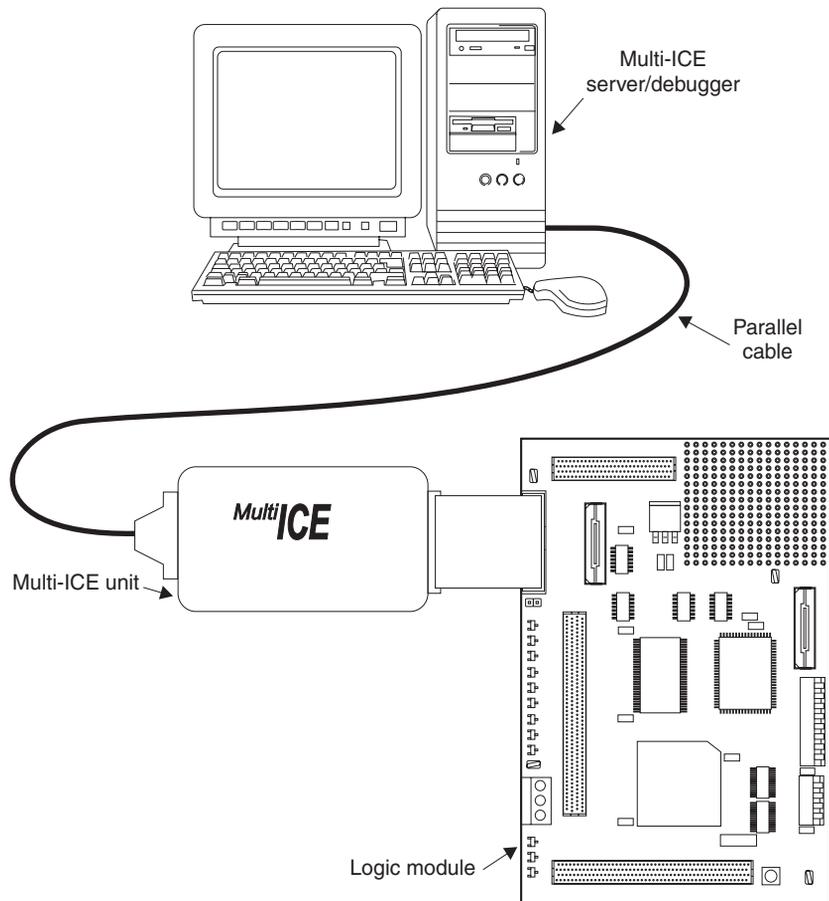


Figure 2-3 Connecting Multi-ICE

———— **Note** ————

The logic module programming utility requires Multi-ICE release 1.4 or above. Refer to the *Multi-ICE User Guide* for details of how to use Multi-ICE.

Chapter 3

Hardware Description

This chapter describes logic module hardware and contains the following sections:

- *FPGA* on page 3-2
- *System bus interface* on page 3-3
- *Clock control* on page 3-4
- *Reset control* on page 3-9
- *JTAG support* on page 3-11
- *Memory* on page 3-19
- *LEDs and switches* on page 3-20
- *Prototyping and expansion* on page 3-21
- *Debug connectors* on page 3-22.

3.1 FPGA

The two types of logic are module fitted with either a Xilinx Virtex or an Altera Apex FPGA. The assignment of the input/output banks and JTAG implementation are described in the following sections:

- *FPGA bank assignment* on page 3-2
- *JTAG and the FPGA* on page 3-2.

For information about how the FPGA is configured, see Chapter 4 *Configuring Altera Logic Modules*, or Chapter 5 *Configuring Xilinx Logic Modules*.

For information about the configurations supplied with your logic module, see Chapter 6 *Supplied FPGA Examples*.

3.1.1 FPGA bank assignment

The FPGA input/output pins are organized into eight banks. Most of the input/output pins are used to support the logic module when it is configured to operate with an Integrator motherboard or core module. Support for prototyping is also provided as follows:

- two banks of input/output signals are connected to the interface module connector EXPIM (see *Interface module connector* on page 3-21)
- one bank of the input/output signals is connected to the prototyping grid as well as the EXPIM connector (see *Prototyping and expansion* on page 3-21).

3.1.2 JTAG and the FPGA

The FPGA contains a hardware JTAG TAP controller. You can use this TAP controller to download new FPGA configurations. In addition, a number of input/output pins are reserved for a virtual TAP controller synthesized into the FPGA configuration. You can use the virtual TAP controller to access devices that are synthesized in the FPGA.

The CONFIG link is used to route the JTAG connector to the hardware TAP controller or the virtual TAP controller (see *JTAG support* on page 3-11).

3.2 System bus interface

The system bus interface connects the logic module with other Integrator modules. This must be implemented according to the AHB or ASB specifications. Example configurations are supplied with the logic module to get you started and to enable you to develop with various bus configurations (see Chapter 6 *Supplied FPGA Examples*).

In a conventional AMBA system, a single central decoder is used to provide a select signal (**DSELx** for ASB) for each slave on the bus. However, in the Integrator family this scheme is varied. Each module is responsible for providing its own select signals. This provides greater flexibility and improves performance.

The Integrator memory map defines the address space of each module depending on its position within the stack and on whether it is mounted in the HDRA/HDRB or EXPA/EXPB stack. When a module is not present, the central decoder on the motherboard provides a default response for bus transfers in the unoccupied address space. This default response is switched off when the module is present.

The scheme requires the central decoder to detect which modules are present and for each module to detect its position in the stack, and in which stack it is mounted. A module must respond to all memory accesses within its allocated address space but not to accesses outside of its allocated space.

The signals **ID[3:0]**, **nPPRES[3:0]**, and **nEPRES[3:0]** and a signal rotation scheme are used by modules to determine their position in the stack and to signal their presence to the central decoder. A logic module can determine its position from **ID[3:0]**, and therefore its address range. Table 3-1 on page 3-3 shows addresses for modules in either stack position.

Table 3-1 Module base addresses

ID[3:0]	Module ID	EXPA/EXPB	HDRA/HDRB	Size
1101	3 (top)	0xF0000000	0xB0000000	256MB
1011	2	0xE0000000	0xA0000000	256MB
0111	1	0xD0000000	0x90000000	256MB
1110	0 (bottom)	0xC0000000	0x80000000	256MB

3.3 Clock control

The FPGA has four dedicated clock inputs for use in user mode. The function and control of the clock signals are described in the following sections:

- *Clock architecture* on page 3-4
- *Programming the on-board clock generators* on page 3-7.

3.3.1 Clock architecture

Figure 3-1 on page 3-4 shows the architecture of the clock subsystem.

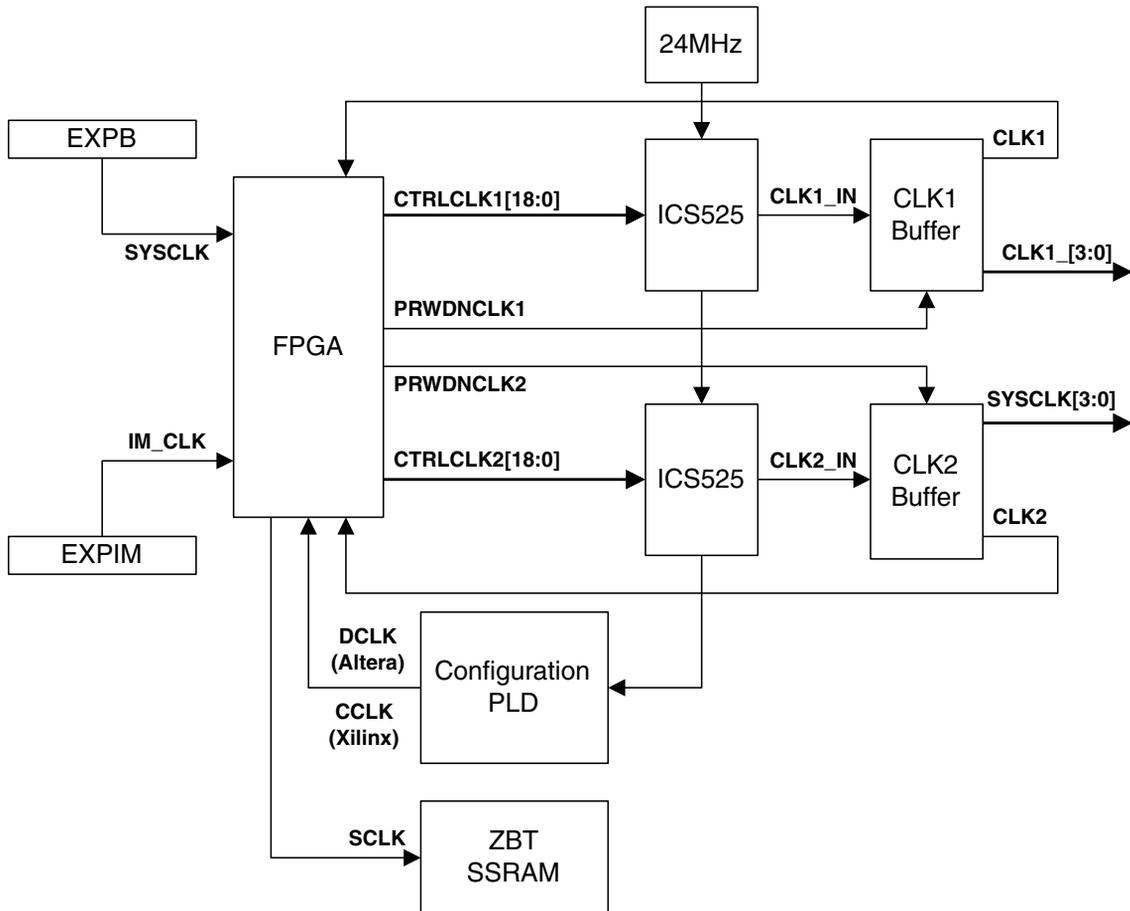


Figure 3-1 Clock architecture

The ICS525 devices are two programmable oscillator devices. These are supplied with a 24MHz reference clock and the frequency of their output clocks are configured by setting signal levels on their *divider* input pins. All divider inputs are connected to the FPGA. Pull-down resistors on the divider inputs ensure that the oscillator outputs default to 4.8MHz if the FPGA is not configured.

The FPGA configuration examples supplied with the logic module provide two registers, LM_OSC1 and LM_OSC2, which control the divider inputs (see *Example 2 programmer's reference* on page 6-5).

The output clocks from the IC525 devices are fed to two buffers. Both are provided with enable inputs (**PWRDN_CLK1** and **PWRDN_CLK2**) from the FPGA. The buffer for **CLK1** defaults to ON and the buffer for **CLK2** defaults to OFF.

Note

The **CLK2** buffer should only be enabled if the logic module is used to clock other modules when stacked without a motherboard (see *Module stacking options* on page 3-15). **CLK2** to the FPGA is always enabled.

The system clocks from the Integrator motherboard are controlled by similar oscillators on the motherboard. See the user guide for your motherboard for more information.

3.3.2 Clock signal summary

Table 3-2 on page 3-5 provides a summary of the clock signals on the logic module.

Table 3-2 Logic module clock signals

Clock name	Clock source
SYCLK	Motherboard system clock
CLK1	On-board clock generator (programmable)
CLK2	On-board clock generator (programmable)
IM_CLK	Clock supplied from an interface module
CCLK (Xilinx) DCLK (Altera)	Configuration clock supplied by the PLD to the FPGA during FPGA configuration

Table 3-2 Logic module clock signals (continued)

Clock name	Clock source
SCLK	This signal provides a clock signal to the ZBT SSRAM
PWRDNCLK1	This signal can be used to enable or disable the CLK1[3:0] and CLK1 outputs
PWRDNCLK2	This signal can be used to enable or disable the SYSCLK[3:0] outputs to HDRB

3.3.3 Programming the on-board clock generators

The two clock generators are independently programmable and produce frequencies in the range 1MHz to 160MHz. Each clock is controlled by an associated set of input signals **CTRLCLKx[18:0]** that are assigned to the control inputs of the oscillators as shown in Table 3-3 on page 3-7.

Table 3-3 Clock control signal assignment

Signals	Control parameter	Label
CTRLCLKx[18:16]	Output divider	S[2:0]
CTRLCLKx[15:9]	Reference divider	R[6:0]
CTRLCLKx[8:0]	VCO divider	V[8:0]

The reference divider and VCO divider are used to calculate the output frequency using the following formula:

$$\text{Frequency} = 48\text{MHz} \cdot \frac{(V[8:0] + 8)}{(R[6:0] + 2) \cdot S}$$

The output divider S can be assigned any of the values shown in Table 3-4.

Table 3-4 Values for output divider S

S	S[2:0]
2	001
4	011
5	100
6	111
7	101
8	010
9	110
10	000

The following operating range limits must be observed:

$$10\text{MHz} < 48\text{MHz} \cdot \frac{(V[8:0] + 8)}{(R[6:0] + 2)}$$

$$R[6:0] < 118$$

———— **Note** —————

You can calculate values for the clock control signals using the ICS525 calculator on the Integrated Circuit Systems website at:

<http://www.icst.com/products/ics525inputForm.html>

3.4 Reset control

The logic module provides three predefined reset signals and a push button that you can use to assert a reset. Figure 3-2 on page 3-9 shows the architecture of the reset system.

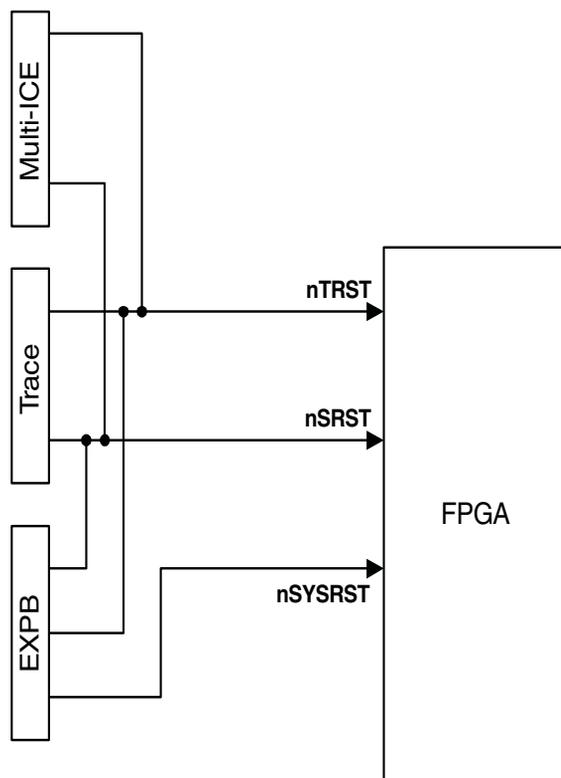


Figure 3-2 Reset architecture

3.4.1 JTAG test reset (nTRST)

The JTAG test reset signal, **nTRST**, is an active LOW open-collector signal. It is connected to an FPGA input/output pin to provide a reset input to the TAP controllers. There are three possible sources of the **nTRST** signal:

- Multi-ICE connector
- Trace (embedded trace macrocell) connector
- motherboard or core module on the EXPB connectors

3.4.2 Multi-ICE system reset (nSRST)

The Multi-ICE system reset signal, **nSRST**, is a bidirectional, active LOW, open-collector signal. It can be driven by JTAG equipment to reset the logic module. Some JTAG equipment monitors this line to sense when the module has been reset by the user. The **nSRST** signal connects to an FPGA input/output pin, and is present on Multi-ICE, Trace, and EXPB connectors in a similar way to the **nTRST** signal.

———— **Note** —————

On the Integrator/AP, the expansion connector (EXPB) **nSRST** signal is completely separate from the core module (HDRB) **nSRST** signal (see the *Integrator/AP User Guide* for more details).

3.4.3 Motherboard reset (nSYSRST)

The motherboard reset signal, **nSYSRST**, is driven by the motherboard system controller, and is routed to an FPGA input/output pin on the logic module (see the *Integrator/AP User Guide* for further information).

3.5 JTAG support

The logic module provides support for programming using JTAG. The Multi-ICE and Trace connectors provide access to the FPGA and PLD TAP controllers. The JTAG hardware is connected to the top board in the stack.

The routing of the JTAG signals depends on the following factors:

- whether the logic module is being used standalone or is mounted on a motherboard
- whether the logic module is in configuration mode or user mode
- whether the board is in flash program mode (Altera type only).

The CONFIG link allows you to select between two JTAG modes:

- configuration mode, used for in-system reprogramming of the FPGA or PLD
- user mode.

———— **Note** —————

The Integrator/AP provides logic module and core module mounting positions. The JTAG signals in these two positions are completely isolated. When the logic module has been programmed, downloading and debugging of ARM code is performed using the JTAG connector on the core module.

3.5.1 Configuration mode

Figure 3-3 on page 3-11 shows the JTAG routing on the logic module in configuration mode.

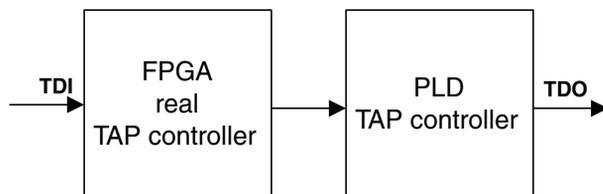


Figure 3-3 Configuration mode JTAG routing

Select configuration mode by fitting the CONFIG link. Fitting the CONFIG link on the top module in a stack selects configuration mode on all of the modules in the same stack. The CONFIG LED is lit on all modules in the same stack.

In configuration mode, the FPGA and the PLD are connected into the **TDI-TDO** chain. This allows the FPGA, PLD, and flash memory to be configured or programmed using the JTAG port.

———— **Note** —————

If more than one module is present when the stack is in configuration mode, reduce the JTAG **TCK** speed to 1MHz or below to ensure reliable operation (see the *Multi-ICE User Guide*).

3.5.2 Flash program mode (Altera only)

Figure 3-4 on page 3-12 shows the JTAG routing for flash program mode.

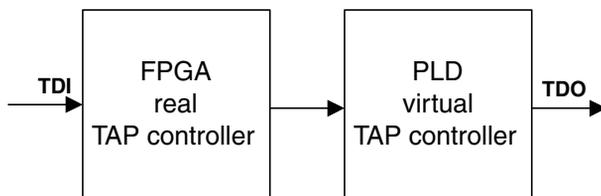


Figure 3-4 Flash program mode JTAG routing

Select flash program mode by inserting the CONFIG link and setting S1[4] to the OPEN position.

———— **Note** —————

The JTAG **TCK** speed must be set to 1MHz to ensure reliable operation.

3.5.3 User mode

Figure 3-5 on page 3-12 shows the JTAG routing for user mode.

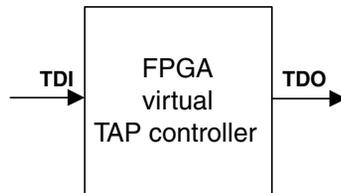


Figure 3-5 User and configuration mode JTAG routing

Select user mode by removing the CONFIG link. This is the default mode.

In user mode, the JTAG signals are connected to FPGA input/output pins provided to enable you to implement a *virtual* TAP controller. This facility is provided for FPGA designs that require a TAP controller, for example, designs that include a synthesized processor.

In user mode, the four standard JTAG signals, along with **RTCK** and **nTRST**, are routed to the virtual TAP controller on the FPGA. The hardware FPGA TAP controller and the PLD are switched out of the **TDI-TDO** path. **RTCK** is a Multi-ICE specific signal used to support adaptive clocking (see *Using Multi-ICE adaptive clocking* on page 3-16).

If your design (or any other module in the same stack) does not implement a TAP controller, then you can ignore these connections. This is usually the case when prototyping AMBA peripherals on the Integrator/AP with the logic module in the expansion position.

Note

If there is another module in the stack that requires JTAG support, the FPGA design must route **TDI** to **TDO** and **TCK** to **RTCK** for the JTAG system to work correctly.

3.5.4 Using JTAG with a multi-module Integrator system

Figure 3-6 on page 3-14 shows the JTAG data routing for two logic modules and a motherboard in user mode.

Routing switches on the logic module are controlled by the signal **nMBDET** from the motherboard. If the logic module is used standalone, **nMBDET** is pulled HIGH and the JTAG path is confined to components on the logic module.

If the logic module is mounted on a motherboard, either directly or on top of another module, as in Figure 3-6 on page 3-14, **nMBDET** is pulled LOW by the motherboard and the **TDI-TDO** data path is routed first down to the motherboard and then up through each module in turn. A maximum of four modules can be stacked in this way. This can be a combination of core and logic modules.

The JTAG port does not normally operate if the logic module is stacked without a motherboard. This is because **nMBDET** is pulled HIGH, isolating the logic module JTAG from other modules.

Note

This logic module can be configured to allow certain core module types to be stacked on it without a motherboard being present (see *Module stacking options* on page 3-15). Refer to the documentation for your core module for information about support for this mode of operation.

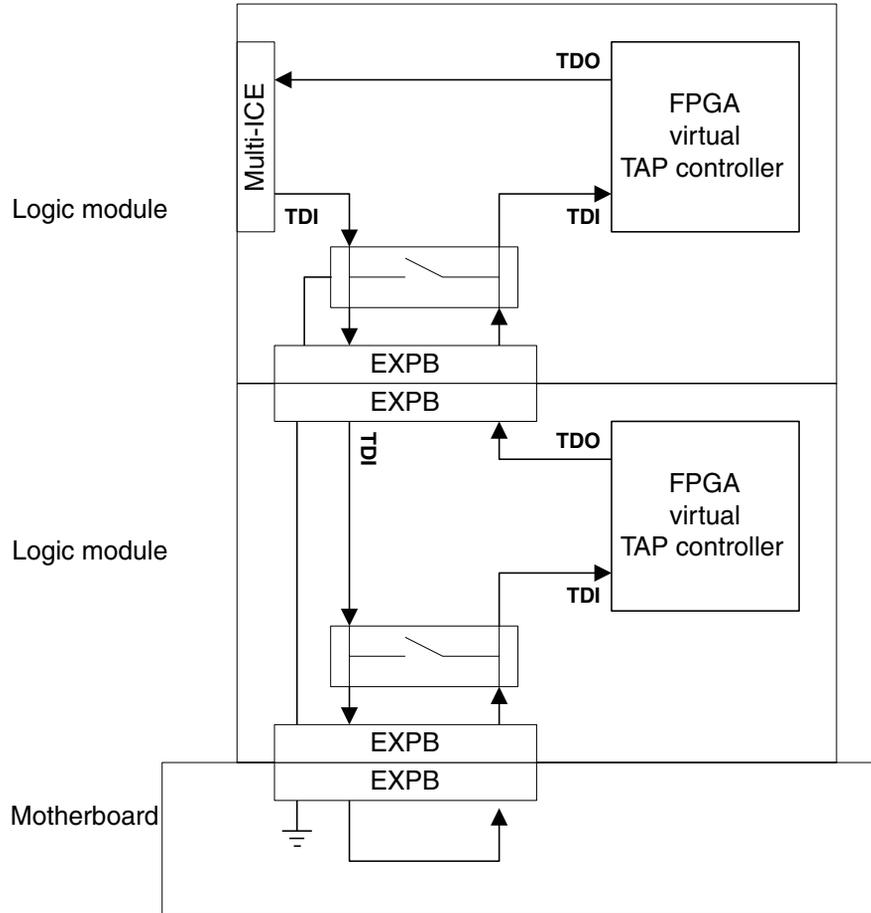


Figure 3-6 JTAG data path (user mode)

3.5.5 Module stacking options

The logic module provides three stacking options that can be selected by moving a surface-mount link (LK3). The link ensures that the **TDI/TDO** and **TCK/RTCK** signals are correctly routed through the stack for each configuration.

Table 3-5 on page 3-15 shows the link position used to select the different stacking options.

Table 3-5 Link positions

Position	Function
B-C	Normal (default)
A-B	LM at bottom of stack with no motherboard
C-D	LM at positions 1, 2, or 3 with no motherboard

The stacking options are:

normal The normal option allows the module to be used standalone or with a motherboard.

Logic module at bottom of the stack and no motherboard

This option uses a logic module at the bottom of a stack of one or more other logic modules. One logic module must provide the system control function (for example, a system bus arbiter) normally provided by the motherboard.

To use this option:

- on the logic module at the bottom of the stack, set LK3 to A-B (see Table 3-5 on page 3-15).
- on any other logic modules, set LK3 to the C-D position.
- on one logic module, program and enable the **CLK2** clock generator (see *Clock architecture* on page 3-4).

Core module at bottom of the stack and no motherboard

This option uses a core module at the bottom of a stack of one or more other modules. One logic module must be included that provides the system control function (for example, a system bus arbiter) normally provided by the motherboard.

———— **Note** ————

Module stacking without a motherboard is supported by later core module types that have a link similar to LK3 on the logic module. At the time of publication supporting core modules are:

- Integrator/CM9x6E-S (rev C and later)
- Integrator/CM9x0T-ETM (rev C and later)
- Integrator/CM10200 (rev C and later).

For up to date information about core module support for this stacking option, refer to the ARM website.

To use this option:

- on the core module at the bottom of the stack, set the link to the appropriate position (see the user guide for your core module).
- on any logic modules, set LK3 to the C-D position.
- on one logic module, program and enable the **CLK2** clock generator (see *Clock architecture* on page 3-4).

3.5.6 Using Multi-ICE adaptive clocking

To use Multi-ICE with adaptive clocking, ensure the following:

- **TCK** is returned on **RTCK** to the Multi-ICE connector.
- The **TCK** signal to any logic module in a stack below the top board is driven by the **RTCK** output of the board above. The signal is then routed down through other modules to the motherboard and then back up to the Multi-ICE connector.

See the *Multi-ICE User Guide* for more information.

3.5.7 JTAG signal descriptions

Table 3-6 on page 3-17 provides a summary of the JTAG signals.

Table 3-6 JTAG and related signals

Signal	Description	Function
TDI	Test Data In (from JTAG tool)	This signal is routed down the stack of modules to the motherboard and then up through any connected JTAG device on each module in the stack and returned to the Multi-ICE connector as TDO .
TDO	Test Data Out (to JTAG tool)	This signal is the return path of the data input signal TDI . The logic module connects to the TDO signal from the module beneath using the TDO_BELOW pin on the EXPB socket. The signal from this pin is routed through TAP controllers in devices on the logic module as TDI and is then routed to the next module up the stack on the TDO pin of the EXPB plug. The length of track driven by the last component in the chain is kept as short as possible.
TCK	Test Clock (from JTAG tool)	This signal synchronizes all JTAG transactions. TCK connects to all JTAG components in the TDI-TDO chain. It makes use of series termination resistors on stubs to reduce reflections and maintain good signal integrity. TCK flows down the stack of modules and connects to each JTAG component, but if there is a device in the scan chain that synchronizes TCK to some other clock, then all down-stream devices are connected to the RTCK signal on that component (see RTCK below).
TMS	Test Mode Select (from JTAG tool)	This signal controls transitions in the tap controller state machine. TMS connects to all JTAG components in the scan chain as the signal flows down the module stack.
RTCK	Return TCK (to JTAG tool)	Some devices sample TCK (for example, a synthesizable core with only one clock), and this delays the time at which a component actually captures data. RTCK is used to return the sampled clock to the JTAG equipment, so that the TCK is not advanced until the synchronizing device has captured the data. In adaptive clocking mode, Multi-ICE must detect an edge on RTCK before changing TCK . In a multiple-device JTAG chain, the RTCK output from a component connects to the TCK input of the down-stream device. The RTCK signal on the module connectors HDRB/EXPB returns TCK to the JTAG equipment. If there are no synchronizing components in the TDI-TDO chain then, it is not necessary to use the RTCK signal and it is connected to ground on the motherboard.

Table 3-6 JTAG and related signals (continued)

Signal	Description	Function
nRTCKEN	Return TCK enable (from module to motherboard)	This active LOW signal is driven by any module that requires RTCK to be routed back to the JTAG equipment. If nRTCKEN is HIGH the motherboard drives RTCK LOW. If nRTCKEN is LOW, the motherboard drives the TCK signal back up the stack to the JTAG equipment. The logic module drives this signal LOW when it is not in configuration mode. This signal is left unconnected by modules that do not require adaptive clocking.
nCFGEN	Configuration enable (from jumper on module at the top of the stack)	This active LOW signal is used to put the boards into configuration mode. In configuration mode all FPGAs and PLDs are connected to the TDI-TDO chain so that they can be configured by the JTAG equipment.
FPGA_DONE (Altera) GLOBAL_DONE (Xilinx)	All FPGAs are configured	This open-collector signal indicates when all FPGAs in the system have configured. This signal is not part of the JTAG scheme, but is relevant to how the boards are reset and, therefore, has an effect on nSRST . The signal is routed between all FPGAs in the system through a pin on the HDRB/EXPB connectors. The master reset controller on the motherboard senses this line and holds all the boards in reset (by driving nSRST LOW) until all the FPGAs are configured. It is essential that a pull-up is added to the FPGA input/output pad during synthesis.

———— **Note** —————

This note refers to Xilinx types only. The signal naming on this logic module differs slightly from the rest of the Integrator system. The logic module provides separate **LOCAL_DONE** and **GLOBAL_DONE** signals to make the scope of each signal clear. When **GLOBAL_DONE** reaches the EXPB connector it is known as **FPGADONE** to the rest of the Integrator system.

3.6 Memory

The logic module provides 1MB of ZBT SSRAM and 4MB of flash memory.

3.6.1 SSRAM

A 256K x 32-bit ZBT-SSRAM (Micron part number MT55LC256K32F) is provided with address, data, and control signals routed to the FPGA. The address and data lines to the SSRAM are completely separate from the AMBA buses.

3.6.2 Flash memory

This is used for FPGA configuration, and must not be used for any other purpose. Configuration is managed by the configuration PLD.

3.7 LEDs and switches

This section describes the LEDs and switches on the logic module.

3.7.1 LEDs

There are eight general-purpose green LEDs. These are lit by driving the associated LED output pin LOW. A red LED is also provided to indicate a user-defined error condition.

The Example 2 FPGA configuration supplied with the logic module provides the register LM_LEDS to control the LEDs (see *User LEDs control register* on page 6-9).

The location of the LEDs is illustrated in Figure 1-1 on page 1-3.

3.7.2 DIP switches

The logic module provides two DIP switches:

- a 4-way DIP switch used to select the FPGA image
- an 8-way DIP switch on the module that is provided for user-defined operation

The configuration PLD monitors the 4-way DIP switch and uses the settings to select an FPGA image from the flash memory. See *Configuring the Altera FPGA from flash* on page 4-7 or *Configuring the Xilinx FPGA from flash* on page 5-6.

The Example 2 FPGA configuration supplied with the logic module provides the register LM_SW to allow you to read the settings of the 8-way switch (see *Switches register* on page 6-10).

———— **Note** ————

The FPGA pins that are used to monitor the switches must always be configured as an input or high impedance. This is because the signals are grounded when the switch is in the ON position.

—————

3.7.3 Push button

The push button is general purpose switch that provides an active LOW input to an input/output pin on the FPGA. It can be used, for example, to implement a reset button if the FPGA is configured to supports this.

3.8 Prototyping and expansion

The logic module allows expansion using the interface module connector or the prototyping grid.

3.8.1 Interface module connector

The logic module provides the general-purpose interface module connector EXPIM to enable you to add an interface module to the system. The connector provides access to FPGA input/output banks 0 and 1 (Xilinx) or 5 and 6 (Altera) plus a number of control signals. This facility enables you to add additional hardware, such as interface circuitry and connectors (see *EXPIM* on page A-10 for pinout details).

Some of the signals to the EXPIM connectors are also routed to the prototyping grid.

3.8.2 Prototyping grid

The prototyping grid consists of an 16 x 17 grid of 0.1 inch pitch plated-through holes. The holes are labelled A to P, and 0 to 16.

The holes on the left side of the grid are connected to FPGA input/output pins from the FPGA and various other signals. Power and ground signals are provided around an area of open circuit holes on the right side. The screen printing on the module indicates the power and ground holes.

You can use the prototyping grid to mount small components, wire to off-board circuitry, or to mount connectors.

All of the signals from FPGA bank 0 (Xilinx) or 5 (Altera) are routed to the prototyping grid so that you can utilize the various input/output standards supported by the FPGA.

3.8.3 Voltage selection

The output voltages for banks 0 and 1 (Xilinx), or 5 and 6 (Altera) are user selectable. LK1 selects the voltage for bank 0 (Xilinx) or 5 (Altera). LK2 selects the voltage for bank 1 (Xilinx) or 6 (Altera). There are three options:

- 3.3V supplied from the logic module (default position)
- 1.8V supplied from the logic module
- user-supplied voltage from prototyping hole G9 for bank 0/5 or H9 for bank 1/6.

The first two options are selected by moving the soldered link to the appropriate position, indicated by the screen printing on the module. The third option is selected by removing the link completely (see Table A-5 on page A-11).

3.9 Debug connectors

The logic module provides a logic analyzer connector and a Trace connector.

3.9.1 Logic analyzer connector

A 38-way Mictor connector is provided for debugging or monitoring purposes. Two 16-bit channels and clocks are routed directly to FPGA pins. These input/output pins are shared with the prototyping area.

3.9.2 Trace connector

The trace connector is intended for use with FPGA configurations that implement a synthesized ARM processor core with an *Embedded Trace Macrocell* (ETM). In this application the logic module is generally used standalone, or as a core module.

A 38-way Mictor connector is used. You can use it to route additional signals to a logic analyzer in a non-ETM FPGA design.

Chapter 4

Configuring Altera Logic Modules

This chapter describes how the Altera FPGA is configured at power-up, the configuration options available, and how to download your own FPGA configurations. It contains the following sections:

- *Altera FPGA configuration system architecture* on page 4-2
- *Altera FPGA tool flow* on page 4-4
- *Configuring the Altera FPGA from flash* on page 4-7
- *Loading new Altera FPGA configurations* on page 4-9
- *Reprogramming the PLD* on page 4-11.

4.1 Altera FPGA configuration system architecture

When the logic module is powered up in user mode, the FPGA loads configuration data to its internal configuration memory. Figure 4-1 on page 4-2 shows the architecture of the FPGA configuration system.

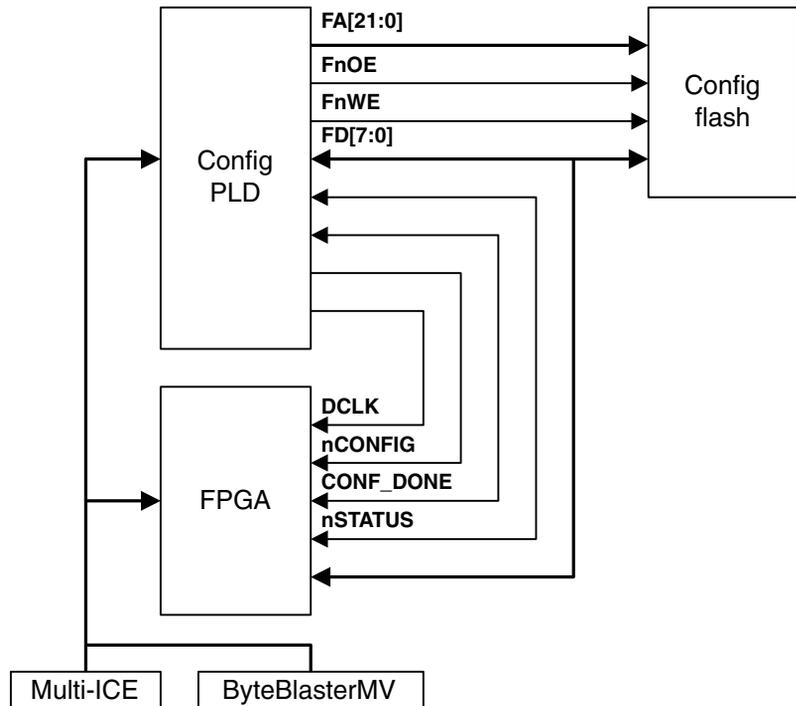


Figure 4-1 FPGA configuration architecture

The Altera logic module type has three programming/configuration modes that are selected by the S1[4] and by the CONFIG link, as shown in Table 4-1 on page 4-2.

Table 4-1 FPGA programming modes

S1[4]	CONFIG	Mode selected
OPEN	OUT	Byte streamer mode (user mode)
OPEN	IN	ByteblasterMV mode
CLOSED	OUT	Not used
CLOSED	IN	PLD operates in flash programmer mode

4.1.1 Byte streamer mode

This is the normal operating mode and is selected by setting S1[4] to OPEN and leaving the CONFIG link OUT. In this mode, S1[3:0] are used to determine which configuration image stored in flash is selected (see *Configuring the Altera FPGA from flash* on page 4-7).

4.1.2 ByteblasterMV mode

This mode is used to download volatile FPGA images using the Altera ByteblasterMV cable (refer to Altera documentation). Select ByteblasterMV mode by setting S1[4] to OPEN and fitting the CONFIG link.

4.1.3 Flash programmer mode

Flash programmer mode is used to download new configurations into the flash memory. Select this mode by setting S1[4] to CLOSED and fitting the CONFIG link.

4.2 Altera FPGA tool flow

Preparing FPGA configuration files entails two steps:

1. Synthesis.
2. Place and route.

Figure 4-2 on page 4-4 illustrates the basic tool flow process.

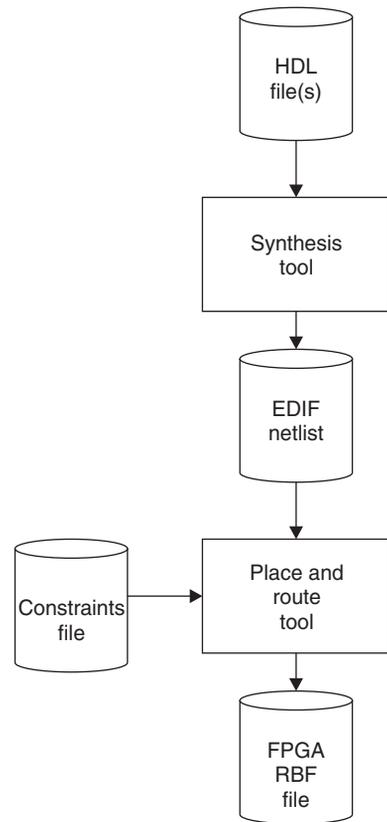


Figure 4-2 Basic tool flow

4.2.1 Synthesis

The synthesis stage of the tool flow takes the HDL files (either VHDL, Verilog, or a combination) and compiles them into a netlist targeted at a particular technology. In the case of this type of logic module, the target technology is Altera Apex. There are several synthesis tools available for both Windows and UNIX platforms, that provide support for a variety of programmable logic vendors. Synthesis information is supplied either through a GUI front end or command-line script. The information typically includes:

- a list of HDL files
- the target technology
- required optimization, such as area or delay
- timing and frequency requirements
- required pull-ups or pull-downs on the FPGA input/output pads
- output drive strengths.

Refer to the documentation for your particular software tool for further information.

A common netlist file format produced by synthesis is *Electronic Data Interchange Format* (EDIF) (for example, filename.edf). This file is used by the next stage of the tool flow, which is place and route.

4.2.2 Place and route

Place and route for this logic module type is performed using the Altera Quartus place and route tool. This produces a .rbf file that is used to program the FPGA in flash program mode (see *Flash program mode (Altera only)* on page 3-12. A .sof file is also produced for use with the ByteBlasterMV cable.

The Altera targeted .edf is aimed at a particular device, and takes into account the device size, package type, and speed grade. However, to ensure that Quartus generates a file that operates correctly with the logic module, use the following settings:

1. From the **Processing** menu, select the **Compiler settings** option.
2. Select the **Chips & Devices** tab, and then click the **Device & Pin Options** button. The **Device & Pin Options** dialog is displayed. Do the following (in any order).
 - Select the **General** tab and check the **Enable INIT_DONE output** box.
 - Select the **Configuration** tab, set **Configuration scheme** to **Passive Parallel Synchronous (for flash configuration)**, and set all **Dual-purpose pins usage after configuration** options to OFF.
 - If you are using Multi-ICE to program in flash programming mode, select **Programming files** tab and check the **Raw Binary File** box.

- Select the **Reserve all unused pins** tab and set all unused pins as inputs, tri-stated.

Use the default for all other settings.

Signal names from the top-level HDL are mapped onto actual device pins by a user compiler setting file .csf. You can also specify the timing requirements within this file.

———— **Note** —————

The `pinout.csf` file for the complete logic module FPGA pin allocation is supplied on the CD. This is intended as a starting point for any design, and will need to be edited before using in the place and route process.

4.3 Configuring the Altera FPGA from flash

The FPGA is configured from the flash when S1[4] is set to OPEN and the CONFIG link is OUT. The flash memory has space to store up to four configurations for EP20K600E or up to two configurations for EP20K1000E types. The configuration image is selected when the logic module is powered according to the setting of S1[3] and the **CFGSEL[1:0]** signals from the motherboard:

- If S1[3] is OPEN, then S1[1] and S1[2] are used to select the image
- If S1[3] is CLOSED and there is motherboard present, the signals **CFGSEL[1:0]** are used to select the image. If there is no motherboard present, then S1[1] and S1[2] are used to select the image.

Table 4-2 on page 4-7 and Table 4-3 on page 4-7 show the FPGA image selection options.

Table 4-2 Image selection for the EP20K600E FPGA

Flash image	Image base address	CFGSEL[1:0]	S1[1]	S1[2]	S1[3]	S1[4]
0	0x000000	x	CLOSED	CLOSED	OPEN	OPEN
1	0x100000	x	CLOSED	OPEN	OPEN	OPEN
2	0x200000	x	OPEN	CLOSED	OPEN	OPEN
3	0x300000	x	OPEN	OPEN	OPEN	OPEN
0	0x000000	00	x	x	CLOSED	OPEN
1	0x100000	01	x	x	CLOSED	OPEN
2	0x200000	10	x	x	CLOSED	OPEN
3	0x300000	11	x	x	CLOSED	OPEN

Table 4-3 Image selection for the EP20K1000E FPGA

Flash image	Image base address	CFGSEL[1:0]	S1[1]	S1[2]	S1[3]	S1[4]
0	0x000000	xx	CLOSED	x	OPEN	OPEN
1	0x200000	xx	OPEN	x	OPEN	OPEN
0	0x000000	0x	CLOSED	x	CLOSED	OPEN
1	0x200000	1x	OPEN	x	CLOSED	OPEN

———— **Note** ————

The switch labels used in the Table 4-2 on page 4-7 and Table 4-3 on page 4-7 refer to the markings on the switch. These correspond with the register bits named **SW[3:0]** in the configuration examples.

The positions of the switches S1[3:1] have no effect on the flash programming operation, only image selection on power-up.

See *Example 2 programmer's reference* on page 6-5 for a description of the example images stored in flash when the logic module is shipped.

4.4 Loading new Altera FPGA configurations

You can program the FPGA by writing configuration data into the flash memory using Multi-ICE, or directly using the Altera ByteblasterMV cable.

To reconfigure the FPGA, the logic module must be in CONFIG mode. This is enabled by fitting the CONFIG link (J11). The CFGLED is lit as an indication that configure mode is selected.

To enable flash program mode, the CONFIG link must be fitted and S1[4] must be CLOSED.

———— **Note** —————

The CONFIG LED lights when S1[4] is CLOSED. However the CONFIG link must be fitted for flash program mode to work.

—————

4.4.1 Reconfiguring the FPGA directly with JTAG

Use the DOWNLOAD connector (J10) with the Altera ByteblasterMV cable. Refer to Altera documentation for the use and operation of this tool.

4.4.2 Downloading new the FPGA configurations into flash

The flash memory on the logic module configures the FPGA during power-up if the CONFIG link is not fitted and the PLD is in byte streamer mode. The progcards utility is used to program the flash and can be optionally used again to verify the flash image against a bit file. Flash programming requires Progcards 2.00 or later.

———— **Note** —————

Multi-ICE 2.00 and later autodetects the logic module. If you are using Multi-ICE 1.4, you must manually configure the Multi-ICE server. You will need to ensure that the `irlength.arm` file in the Multi-ICE directory contains the following lines, as appropriate for the FPGA fitted to your logic module:

```
EP20K600E=10      ; for a 600E size FPGA
EP20K1000E=10    ; for a 1000E size FPGA
ARMFLASH=5       ; needed for all FPGA sizes
```

Refer to the *Multi-ICE User Guide* for further information about using Multi-ICE. Manual configuration files are provided on the CD supplied with the logic module.

—————

To load a new configuration into the FPGA:

1. Produce a <filename>.rbf file.
2. Produce a <filename>.brd for your design. This is a configuration file for progcards.exe.
3. Put the logic module in flash program mode by fitting the CONFIG link and setting S1[4] to CLOSED.
4. Configure the Multi-ICE server using a configuration file. For example, \\LM-ep20k600e\configure\ep20k600e_flash_program.cfg.

———— **Note** ————

The Altera-equipped logic module requires the JTAG **TCK** signal to operate at 1MHz maximum for flash programming. The Multi-ICE autodetect feature works with this logic module, but you must reduce the clock speed from the 10MHz default. Alternatively, load Multi-ICE with a manual configuration file (for example, ep20k600e_flash_program.cfg). This sets **TCK** to 1MHz.

5. Run the progcards utility. All .brd files present in the current directory that match the TAP configuration are offered as options.
6. Remove the CONFIG link and set S1[4] to OPEN.
7. Power the logic module down.
8. Power the logic module up again.

4.5 Reprogramming the PLD

The logic module is supplied with the PLD already programmed.

———— **Caution** ————

You are advised not to reprogram this device with any image other than those provided.

Program the PLD as follows:

1. Put the logic module into configuration mode by fitting the CONFIG link (J11) and power-up.
2. Start the Multi-ICE server and the load the configuration file for your logic module. For example:
`<CDdrive>:\LM-ep20k600e\configure\ep20k600e_pld_program.cfg`
3. Start a command prompt and move to the directory `\LM-ep20k600e\configure\`
4. Run the progcards utility by typing: `progcards <ret>`
5. Choose the required PLD image. If there is only one suitable match for your hardware, programming starts immediately with no menu being displayed.

Chapter 5

Configuring Xilinx Logic Modules

This chapter describes how the Xilinx FPGA is configured at power-up, the configuration options available, and how to download your own FPGA configurations. It contains the following sections:

- *Xilinx FPGA configuration system architecture* on page 5-2
- *Xilinx FPGA tool flow* on page 5-4
- *Configuring the Xilinx FPGA from flash* on page 5-6
- *Loading new Xilinx FPGA configurations* on page 5-8
- *Reprogramming the PLD* on page 5-11.

5.1 Xilinx FPGA configuration system architecture

At power-up the FPGA loads configuration data to its internal configuration memory. Figure 5-1 on page 5-2 shows the architecture of the FPGA configuration system.

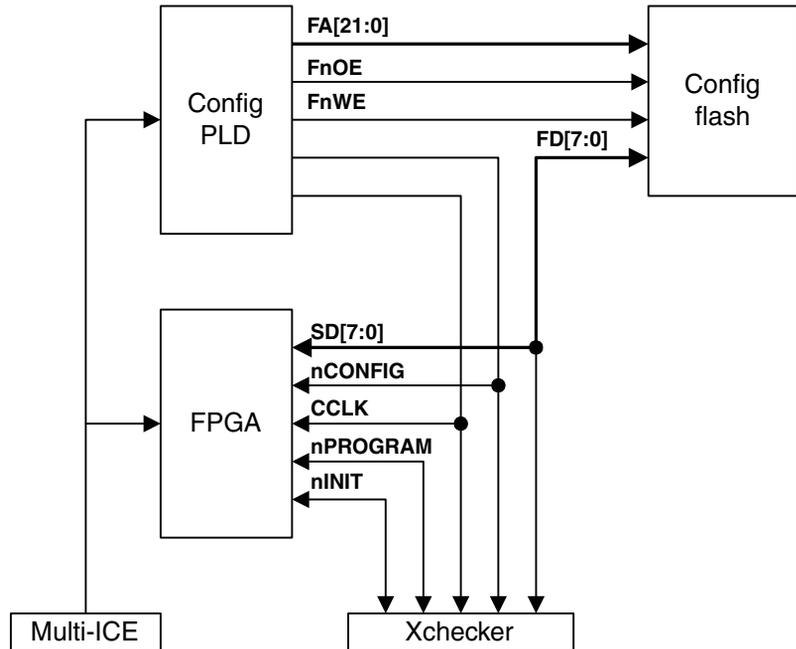


Figure 5-1 FPGA configuration architecture

The FPGA provides two configuration modes and the logic module provides three ways to load configuration data into the FPGA. The configuration modes are selected by the mode pins (**M[2:0]**) on the FPGA. The values of M1 and M2 are fixed but the M0 is controlled by the CONFIG link, as shown in Table 5-1 on page 5-2.

Table 5-1 FPGA programming modes

M0	Mode selected
1	Slave serial mode, CONFIG link fitted
0	Select MAP mode, CONFIG link removed

Note

The signals **FD[7:0]** are connected with **SD[7:0]**. The signals are used for flash data transfers during FPGA configuration and for configuration downloads into flash. At all other times the signals are used for SSRAM transfers. All designs must drive **FnOE** and **FnWE HIGH** to inhibit reads and writes to the flash.

5.1.1 Select MAP mode

This mode is the normal FPGA configuration mode. The FPGA configuration is loaded from flash memory and the process is managed by the configuration *Programmable Logic Device* (PLD). The flash must contain valid configuration data and the CONFIG link must not be fitted.

The flash memory can store multiple configuration images. The image is selected either by the DIP switched or by **CFGSEL[1:0]** from the motherboard (see *Configuring the Xilinx FPGA from flash* on page 5-6).

5.1.2 Slave serial mode

You can use slave serial mode to configure the FPGA with the XChecker tool (refer to the Xilinx documentation for information about using this tool). This mode is selected by fitting the CONFIG link.

5.1.3 Boundary scan programming (JTAG)

You can use the Multi-ICE JTAG port to download configurations when the CONFIG link is fitted (see *Reconfiguring the FPGA directly with JTAG* on page 4-9).

5.2 Xilinx FPGA tool flow

Preparing FPGA configuration files entails two steps:

1. Synthesis.
2. Place and route.

Figure 5-2 illustrates the basic tool flow process.

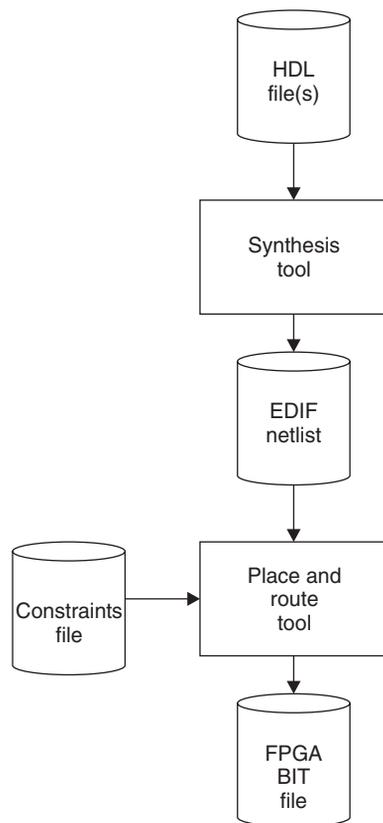


Figure 5-2 Basic tool flow

5.2.1 Synthesis

The synthesis stage of the tool flow takes the HDL files (either VHDL, Verilog, or a combination) and compiles them into a netlist targeted at a particular technology. In the case of Xilinx Virtex, there are several synthesis tools available for both Windows and UNIX platforms, that provide support for a variety of programmable logic vendors.

Synthesis information is supplied either through a GUI front end, or in the form of a command-line script. The information typically includes:

- a list of HDL files
- the target technology
- required optimization, such as area or delay
- timing and frequency requirements
- required pull-ups or pull-downs on the FPGA input/output pads
- output drive strengths.

Refer to the documentation for your particular software tool for further information.

A common netlist file format produced by synthesis is *Electronic Data Interchange Format* (EDIF) (for example, filename.edf). This file is used by the next stage of the tool flow, place and route.

5.2.2 Place and route

Place and route for this logic module type is performed using Xilinx-specific software. This produces a .bit file that is used to program the FPGA. The .edf file is aimed at a particular device, taking into account the device size, package type, and speed grade.

———— Note ————

Always specify **CCLK** as the start up clock for your design. The progcards utility automatically sets the startup clock to the JTAG clock option when you program the FPGA directly. Selecting **CCLK** ensures that the process always works for download into the FPGA or into flash.

Signal names from the top-level HDL are mapped onto actual device pins by a user constraints file .ucf. You can also specify the timing requirements within this file.

———— Note ————

The pinout.ucf file for the complete logic module FPGA pin allocation is supplied on the CD. This is intended as a starting point for any design, and must be edited before use in the place and route process.

5.3 Configuring the Xilinx FPGA from flash

The flash memory has space to store up to four configurations for XCV600E or XCV1000E FPGA types, or up to two configurations for XCV1600E or XCV2000E types. The configuration image is selected when the logic module is powered according to the setting of S1[3] and the **CFGSEL[1:0]** signals from the motherboard:

- if S1[3] is OPEN, then S1[1] and S1[2] are used to select the image
- If S1[3] is CLOSED and there is motherboard present, the signals **CFGSEL[1:0]** are used to select the image. If there is no motherboard present, then S1[1] and S1[2] are used to select the image.

Table 5-2 on page 5-6 and Table 5-3 on page 5-6 show the FPGA image selection options.

Table 5-2 Image selection for XVC600E and XVC1000E FPGAs

Flash image	Image base address	CFGSEL[1:0]	S1[1]	S1[2]	S1[3]	S1[4]
0	0x000000	xx	CLOSED	CLOSED	OPEN	x
1	0x100000	xx	CLOSED	OPEN	OPEN	x
2	0x200000	xx	OPEN	CLOSED	OPEN	x
3	0x300000	xx	OPEN	OPEN	OPEN	x
0	0x000000	00	x	x	CLOSED	x
1	0x100000	01	x	x	CLOSED	x
2	0x200000	10	x	x	CLOSED	x
3	0x300000	11	x	x	CLOSED	x

Table 5-3 Image selection for XVC1600E and XVC2000E FPGAs

Flash image	Image base address	CFGSEL[1:0]	S1[1]	S1[2]	S1[3]	S1[4]
0	0x000000	xx	CLOSED	x	OPEN	x
1	0x200000	xx	OPEN	x	OPEN	x
0	0x000000	0x	CLOSED	x	CLOSED	x
1	0x200000	1x	OPEN	x	CLOSED	x

Note

The switch labels used in the Table 5-2 on page 5-6 and Table 5-3 on page 5-6 refer to the markings on the switch. These correspond with the register bits named **S[3:0]** in the configuration examples.

The positions of the switches have no effect on the flash programming operation, only image selection on power-up.

See Chapter 6 *Supplied FPGA Examples* for a description of the example images stored in flash when the logic module is shipped.

5.4 Loading new Xilinx FPGA configurations

You can program the FPGA in two ways:

- writing configuration data directly to the FPGA using Multi-ICE, or the Xilinx XChecker cable
- writing configuration data to the flash memory using Multi-ICE.

To reconfigure the FPGA, the logic module must be in CONFIG mode. This is enabled by fitting the CONFIG link (J11). The CFGLED is lit as an indication that configure mode is selected.

For a description of CONFIG mode, see *Configuration mode* on page 3-11.

5.4.1 Reconfiguring the FPGA directly

Using JTAG to program the FPGA is fast, but the configuration is lost when the power supply is removed. Programming takes between 10 and 15 seconds to complete using Multi-ICE on a fast computer (for example, a 400MHz Windows computer).

Using Xilinx XChecker cable

Use the DOWNLOAD connector (J5) with the Xilinx XChecker cable. Refer to Xilinx documentation for the use and operation of this tool.

———— **Note** —————

A 3.3V voltage adapter must be used with Virtex E devices.

Using Multi-ICE

You can reprogram the FPGA using Multi-ICE. A Multi-ICE client application called progcards is provided to read .bit files and configure the FPGA using the Multi-ICE hardware. You must use a board file (.brd) to tell the progcards utility about the method of programming. Examples are provided on the CD supplied with the logic module.

———— **Note** —————

The progcards utility requires Multi-ICE release 1.4 or later.

For a full description of this utility, refer to the document file progcards.pdf on the supplied CD.

To load a new configuration into the FPGA:

1. Produce a <filename>.bit file for your design.
2. Produce a <filename>.brd for your design. This is a configuration file for progcards.exe.
3. Put the logic module in configuration mode by fitting the CONFIG link.
4. Configure the Multi-ICE server using a configuration file. For example, LMXCV2000e.cfg.
5. Run the progcards utility. All .brd files present in the current directory that match the TAP configuration are offered as options.

Note

Multi-ICE 2.00 and later autodetects the logic module. If you are using Multi-ICE 1.4, you must manually configure the Multi-ICE server. Ensure that the irlength.arm file in the Multi-ICE directory contains one of the following lines, as appropriate for the FPGA fitted to your logic module:

```
XCV600E=5           ;for 600E size FPGA
XCV1000E=5          ;for 1000E size FPGA
XCV1600E=5          ;for 1600E size FPGA
XCV2000E=5          ;for 2000E size FPGA
```

Refer to the *Multi-ICE User Guide* for further information about using Multi-ICE. Manual configuration files are provided on the CD supplied with the logic module.

5.4.2 Downloading new the FPGA configurations into FLASH

The flash memory on the logic module configures the FPGA on power-up when the CONFIG link is not fitted. The progcards utility is used to program the flash. It first loads a flash programmer design into the FPGA, then writes the bit file to the flash memory. You can use the progcards utility to verify the flash image against a bit file.

The steps in writing a bit file to flash are similar to those described in *Reconfiguring the FPGA directly* on page 5-8. The only difference is the contents of the .brd file (examples are provided on the CD).

To load the FPGA configuration from flash:

1. Remove the CONFIG link.

2. Power the logic module down.
3. Power the logic module up again.

5.5 Reprogramming the PLD

The logic module is supplied with the PLD already programmed.

———— **Caution** ————

You are advised not to reprogram this device with any image other than those provided.

Program the PLD as follows:

1. Put the logic module into configuration mode by fitting the CONFIG link (J11) and power-up.
2. Start the Multi-ICE server and load the configuration file for your logic module. For example: <CDrive>:\LM-XCV600e\configure\LMXCV2000e.cfg
3. Start a command prompt and move to the directory
<CDrive>:\LM-XCV600e\configure\
4. Run the progcards utility.
5. Choose the required PLD image. If there is only one suitable match for your hardware, programming starts immediately with no menu being displayed.

Chapter 6

Supplied FPGA Examples

This chapter describes the FPGA configurations supplied with the logic module. It contains the following sections:

- *About the FPGA configuration examples* on page 6-2
- *Example 2 programmer's reference* on page 6-5.

6.1 About the FPGA configuration examples

The logic module is supplied with two example FPGA configurations for each FPGA type. These are supplied to allow you to gain experience with synthesis, design, and place and route for the logic module. VHDL and Verilog versions of the examples are provided.

6.1.1 Example 1

Example 1 provides an entry to designing with the logic module as a standalone platform. It is intended to verify that the correct methods are being used for synthesis, place and route, and programming. This example flashes the LEDs, with frequency controlled by S2[1:0], and places a binary count on the logic analyzer connector.

6.1.2 Example 2

Two versions of Example 2 are provided to support the following implementations:

- AHB motherboard and AHB peripherals
- ASB motherboard and AHB peripherals

———— **Note** ————

The two versions of Example 2 are preloaded into flash (see *Configuring the Altera FPGA from flash* on page 4-7 for Altera types or *Configuring the Xilinx FPGA from flash* on page 5-6).

All versions of Example 2 are intended for use with the Integrator/AP motherboard with the logic module fitted in the expansion position. The interrupt request signal from the logic module is routed to the interrupt controller on the Integrator/AP.

The Example 2 configurations are built from common blocks with a top level specific to the bus implementation. Each version includes:

- a ZBT SSRAM controller
- an AHB to APB bridge
- an APB register peripheral
- an APB interrupt controller
- an address decoder.

Figure 6-1 on page 6-3 shows the examples without a system bus bridge.

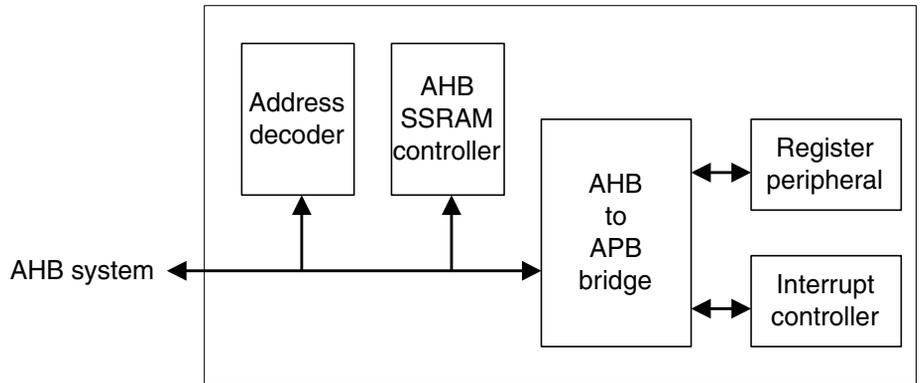


Figure 6-1 Example without an ASB to AHB bridge

Figure 6-2 on page 6-3 shows the example with a system bus bridge.

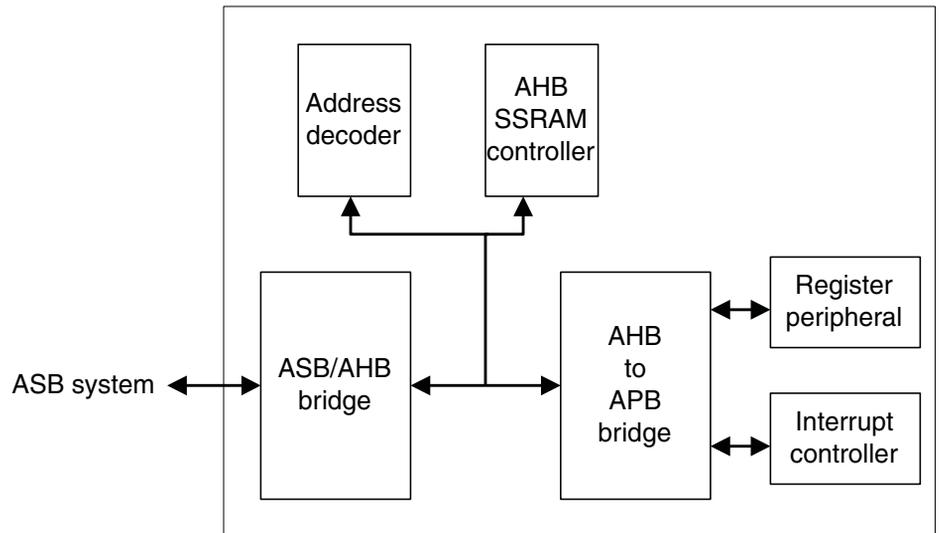


Figure 6-2 Example with an ASB to AHB bridge

Table 6-1 on page 6-4 provides a summary description of the supplied HDL files. A more detailed description of each HDL block is included within the files in the form of comments.

Table 6-1 HDL file descriptions

File	Description
ASBAHBTop AHBASBTop	These files are the top-level HDL that instantiate all of the high-speed peripherals, decoder, and all necessary support and glue logic to make a working system. The files are named so that, for example, ASBAHBTop.vhd is the top level for AHB peripherals connected to an ASB system bus.
ASB2AHB	This is the bridge required to connect AHB peripherals to an ASB Integrator system.
AHBDecoder	The decoder block provides the high-speed peripherals with select lines. These are generated from the address lines and the module ID (position in stack) signals from the motherboard. The decoder blocks also contain the default slave peripheral to simplify the example structure. The Integrator family of boards uses a distributed address decoding system (see <i>Example 2 memory map</i> on page 6-6).
AHBMuxS2M	This is the AHB multiplexor that connects the read data buses from all of the slaves to the AHB master(s).
AHBZBTRAM	High-speed peripherals require that SSRAM controller block supports word, halfword, and byte operations to the SSRAM on the logic module.
AHB2APB	This is the bridge blocks required to connect APB peripherals to the high-speed AMBA AHB bus. They produce the peripheral select signals for each of the APB peripherals.
AHBAPBSys	The components required for an APB system are instantiated in this block. These include the bridge and the APB peripherals. This file also multiplexes the APB peripheral read buses and concatenates the interrupt sources to feed into the interrupt controller peripheral.
APBRegs	The APB register peripheral provides memory-mapped registers that you can use to: <ul style="list-style-type: none"> • configure the two clock generators (protected by the LM_LOCK register) • write to the user LEDs • read the user switch inputs. It also latches the pressing of the push button to generate an expansion interrupt.
APBIntcon	The APB interrupt controller contains all of the standard interrupt controller registers and has an input port for four APB interrupts. (The example only uses one of them. The remaining three are set inactive in the AHBAPBSys block.) Four software interrupts are implemented.

———— **Note** ————

The files listed in Table 6-1 on page 6-4 are supplied in both Verilog (.v) and VHDL (.vhd) versions.

6.2 Example 2 programmer's reference

The software sources and precompiled .axf file for this example demonstrate the operation of the SSRAM controller and APB peripherals. They are common for both versions of Example 2.

There are separate project files for both the Software Development Toolkit v2.51 and the ARM Developer Suite v1.0.1 and above.

6.2.1 Software description

There are four source files included in Example 2:

logic.c	The main C code.
logic.h	Constants.
platform.h	Constants.
rw_support.s	Assembler functions for SSRAM testing.

After the FPGAs have been configured, indicated by the FPGA_OK LED being lit, you can download and execute the example software on the core module.

The example code operates as follows:

1. Determines DRAM size on the core module and sets up the system controller.
2. Checks that the logic module is present in the AP expansion position.
3. Reports module information.
4. Sets the logic module clock frequencies.
5. Tests SSRAM for word, halfword, and byte accesses.
6. Flashes the LEDs.
7. Remains in a loop that displays the switch value on the LEDs.

6.2.2 Example 2 memory map

Example 2 sets up the memory map for the logic module as shown in Figure 6-3 on page 6-6. This shows the locations to which logic modules are assigned by the main address decoder on the motherboard. The diagram also shows how Example 2 decodes the address space for the logic module when it is LM0.

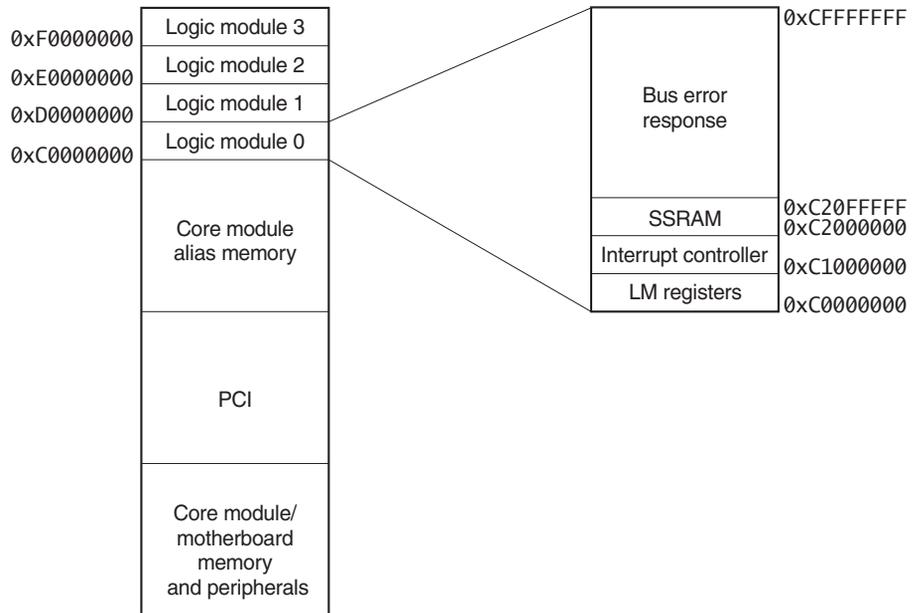


Figure 6-3 Integrator memory map

———— **Note** ————

The Integrator system implements a distributed address decoding scheme in which each core or logic module is responsible for decoding its own address space. It is important when implementing a logic module design, to ensure that the module responds to *all* memory accesses in the appropriate memory region (see *System bus interface* on page 3-3).

6.2.3 Example 2 APB register peripheral

Table 6-2 on page 6-7 shows the mapping of the logic module registers. The addresses shown are offsets from the base addresses shown in Figure 6-3 on page 6-6.

Table 6-2 Logic module registers

Offset address	Name	Type	Size	Function
0x0000000	LM_OSC1	Read/write	19	Oscillator divisor register 1
0x0000004	LM_OSC2	Read/write	19	Oscillator divisor register 2
0x0000008	LM_LOCK	Read/write	17	Oscillator lock register
0x000000C	LM_LEDS	Read/write	9	User LEDs control register
0x0000010	LM_INT	Read/write	1	Push button interrupt register
0x0000014	LM_SW	Read	8	Switches register

Oscillator divisor registers

The oscillator registers control the frequency of the clocks generated by the two clock generators (see *Clock control* on page 3-4).

Before writing to the oscillator registers, you must unlock them by writing the value 0x0000A05F to the LM_LOCK register. After writing the oscillator register, relock them by writing any value other than 0x0000A05F to the LM_LOCK register.

Table 6-3 on page 6-8 describes the oscillator register bits.

Table 6-3 LM_OSCx registers

Bits	Name	Access	Function	Default
18:16	OD	Read/write	Output divider: 000 = divide by 10 001 = divide by 2 010 = divide by 8 011 = divide by 4 100 = divide by 5 101 = divide by 7 110 = divide by 9 111 = divide by 6.	110
15:9	RDW	Read/write	Reference divider word. Defines the binary value of the R[6:0] pins of the clock generator.	0111110
8:0	VDW	Read/write	VCO divider word. Defines the binary value of the V[8:0] pins of the clock generator.	000000100

———— **Note** —————

The reset value of this register sets the oscillators to 1MHz.

For information about setting the clock frequency, see *Clock control* on page 3-4.

Oscillator lock register

The lock register is used to control access to the oscillator registers, allowing them to be locked and unlocked. This mechanism prevents the oscillator registers from being overwritten accidentally. Table 6-4 on page 6-9 describes the lock register bits.

Table 6-4 LM_LOCK register

Bits	Name	Access	Function
16	LOCKED	Read	This bit indicates if the oscillator registers are locked or unlocked: 0 = unlocked 1 = locked.
15:0	LOCKVAL	Read/write	Write the value 0x0000A05F to this register to enable write accesses to the oscillator registers. Write any other value to this register to lock the oscillator registers.

User LEDs control register

The LEDs register is used to control the user LEDs (see *LEDs summary* on page 1-6). Writing a 0 to a bit lights the associated LED.

Push button interrupt register

The push button interrupt register contains 1 bit. It is a latched indication that the push button has been pressed. The output from this register is used to drive an input to the interrupt controller. Table 6-5 on page 6-9 describes the operation of this register.

Table 6-5 LM_INT register

Bits	Name	Access	Function
0	LM_INT	Read	This bit when SET is a latched indication that the push button has been pressed.
		Write	Write 0 to this register to CLEAR the latched indication. Writing 1 to this register has the same effect as pressing the push button.

Switches register

This register is used to read the setting of the 8-way DIP switch. A 0 indicates that the associated switch element is CLOSED (ON).

6.2.4 Example 2 interrupt controller

The interrupt control registers are listed in Table 6-6 on page 6-10.

Table 6-6 Interrupt controller registers

Register name	Address offset	Access	Size	Description
LM_ISTAT	0x1000000	Read	8 bits	Interrupt status register
LM_IRSTAT	0x1000004	Read	8 bits	Interrupt raw status register
LM_IENSET	0x1000008	Read/write	8 bits	Interrupt enable set
LM_IENCLR	0x100000C	Write	8 bits	Interrupt enable clear
LM_SOFTINT	0x1000010	Write	4 bits	Software interrupt register

The interrupt controller provides three registers for controlling and handling interrupts. These are:

- status register
- raw status register
- enable register, which is accessed using the enable set and enable clear locations.

The way that the interrupt enable, clear, and status bits function for each interrupt is illustrated in Figure 6-4 on page 6-11 and described in the following subsections. This figure shows the control for one interrupt bit. The logic module interrupts are routed to the system interrupt controller on the motherboard to one of the **EXPINT[3:0]** interrupts, depending on the position of the logic module in the stack.

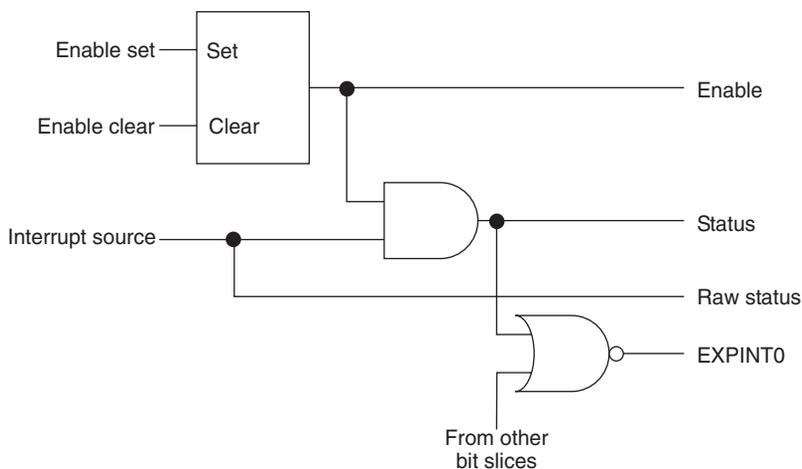


Figure 6-4 Interrupt control

Interrupt status register

The status register contains the logical AND of the bits in the raw status register and the enable register.

Interrupt raw status register

The raw status register indicates the signal levels on the interrupt request inputs. A bit set to 1 indicates that the corresponding interrupt request is active.

Interrupt enable set

Use the enable set locations to set bits in the enable register as follows:

- Set bits in the enable register by writing to the ENSET location:
 - 1 = SET the bit
 - 0 = leave the bit unchanged.
- Read the current state of the enable bits from the ENSET location.

Interrupt enable clear

Use the clear set locations to set bits in the enable register as follows:

- Clear bits in the enable register by writing to the ENCLR location:
 - 1 = CLEAR the bit

0 = leave the bit unchanged.

Software interrupt register

This register is used by software to generate interrupts.

Interrupt register bit assignment

The bit assignments for the status, raw status, and enable registers are shown in Table 6-7 on page 6-12.

Table 6-7 Interrupt register bit assignment

Bit	Name	Function
7:5	-	Spare
4	PBINT	Push button interrupt
3:0	SOFTINT[3:0]	Interrupt generated by writing to the LM_SOFTINT location

Appendix A

Signal Descriptions

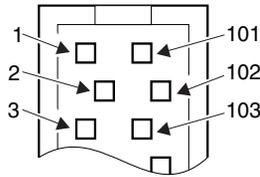
This appendix describes the Integrator/LM interface connectors and signal connections. It contains the following sections:

- *EXPA* on page A-2
- *EXPB* on page A-5
- *EXPIM* on page A-10
- *Diagnostic connectors* on page A-13.

A.1 EXPA

Figure A-1 on page A-2 shows the pin numbers of the EXPA plug and socket. All pins on the EXPA socket are connected to the corresponding pins on the EXPA plug.

Pin numbers for 200-way plug, viewed from above board



Samtec TOLC series

1	A0	GND	GND	101
2	A1	GND	D0	102
3	A2	GND	D1	103
4	A3	A2	D2	104
5	A3	GND	D3	105
6	A4	GND	D4	106
7	A4	GND	D4	107
8	A5	GND	D5	108
9	A5	GND	D5	109
10	A6	GND	D6	110
11	A7	GND	D7	111
12	A7	GND	D7	112
13	A8	GND	D8	113
14	A9	GND	D9	114
15	A10	GND	D10	115
16	A11	GND	D11	116
17	A12	GND	D12	117
18	A13	GND	D13	118
19	A14	GND	D14	119
20	A15	GND	D15	120
21	A16	GND	D16	121
22	A17	GND	D17	122
23	A18	GND	D18	123
24	A19	GND	D19	124
25	A20	GND	D20	125
26	A21	GND	D21	126
27	A22	GND	D22	127
28	A23	GND	D23	128
29	A24	GND	D24	129
30	A25	GND	D25	130
31	A26	GND	D26	131
32	A27	GND	D27	132
33	A28	GND	D28	133
34	A29	GND	D29	134
35	A30	GND	D30	135
36	A31	GND	D31	136
37	B0	GND	C0	137
38	B1	GND	C1	138
39	B2	GND	C2	139
40	B3	GND	C3	140
41	B4	GND	C4	141
42	B5	GND	C5	142
43	B6	GND	C6	143
44	B7	GND	C7	144
45	B8	GND	C8	145
46	B9	GND	C9	146
47	B10	GND	C10	147
48	B11	GND	C11	148
49	B12	GND	C12	149
50	B13	GND	C13	150
51	B14	GND	C14	151
52	B15	GND	C15	152
53	B16	GND	C16	153
54	B17	GND	C17	154
55	B18	GND	C18	155
56	B19	GND	C19	156
57	B20	GND	C20	157
58	B21	GND	C21	158
59	B22	GND	C22	159
60	B23	GND	C23	160
61	B24	GND	C24	161
62	B25	GND	C25	162
63	B26	GND	C26	163
64	B27	GND	C27	164
65	B28	GND	C28	165
66	B29	GND	C29	166
67	B30	GND	C30	167
68	B31	GND	C31	168
69	5V	3V3	12V	169
70	5V	3V3	12V	170
71	5V	3V3	12V	171
72	5V	3V3	12V	172
73	5V	3V3	12V	173
74	5V	3V3	12V	174
75	5V	3V3	12V	175
76	5V	3V3	12V	176
77	5V	3V3	12V	177
78	5V	3V3	12V	178
79	5V	3V3	12V	179
80	5V	3V3	12V	180
81	5V	3V3	12V	181
82	5V	3V3	12V	182
83	5V	3V3	12V	183
84	5V	3V3	12V	184
85	5V	3V3	12V	185
86	5V	3V3	12V	186
87	5V	3V3	12V	187
88	5V	3V3	12V	188
89	5V	3V3	12V	189
90	5V	3V3	12V	190
91	5V	3V3	12V	191
92	5V	3V3	12V	192
93	5V	3V3	12V	193
94	5V	3V3	12V	194
95	5V	3V3	12V	195
96	5V	3V3	12V	196
97	5V	3V3	12V	197
98	5V	3V3	12V	198
99	5V	3V3	12V	199
100	5V	3V3	12V	200

Figure A-1 EXPA plug pin numbering

A.1.1 AHB signal descriptions

The signals present on the pins labeled A[31:0], B[31:0], C[31:0], and D[31:0] are described in Table A-1 on page A-3 for an AHB system bus.

Table A-1 Bus bit assignment (for an AMBA AHB bus)

Pin label	Signal (AHB)	Description
A[31:0]	HADDR[31:0]	System address bus
B[31:0]	Not used	-
C[31:16]	Not used	-
C15	HMASTLOCK	Locked transaction
C[14:13]	HRESP[1:0]	Slave response
C12	HREADY	Slave ready
C11	HWRITE	Write transaction
C[10:8]	HPROT[2:0]	Transaction protection type
C[7:5]	HBURST[2:0]	Transaction burst size
C4	HPROT[3]	Transaction protection type
C[3:2]	HSIZE[1:0]	Transaction width
C[1:0]	HTRANS[1:0]	Transaction type
D[31:0]	HDATA[31:0]	System data bus

A.1.2 ASB signal description

The signals present on the pins labeled A[31:0], B[31:0], C[31:0], and D[31:0] are described in Table A-2 on page A-4 for an ASB system.

Table A-2 Bus bit assignment (for an AMBA ASB bus)

Pin label	Signal (ASB)	Description
A[31:0]	BA[31:0]	System address bus
B[31:0]	Not used	-
C[31:16]	Not used	-
C15	BLOK	Locked transaction
C14	BLAST	Last response
C13	BERROR	Error response
C12	BWAIT	Wait response
C11	BWRITE	Write transaction
C10	Not used	-
C[9:8]	BPROT[1:0]	Transaction protection type
C7	Not used	-
C[6:5]	BURST[1:0]	Transaction burst size
C4	Not used	-
C[3:2]	BSIZE[1:0]	Transaction width
C[1:0]	BTRAN[1:0]	Transaction type
D[31:0]	BD[31:0]	System data bus

A.2 EXPB

The EXPB plug and socket have slightly different pinouts. A signal rotation scheme is used to route some of the signals to specific logic modules (see *Through-board signal routing* on page A-7).

A.2.1 EXPB socket pinout

Figure A-2 on page A-5 shows the pin numbers of the socket EXPB on the underside of the logic module.

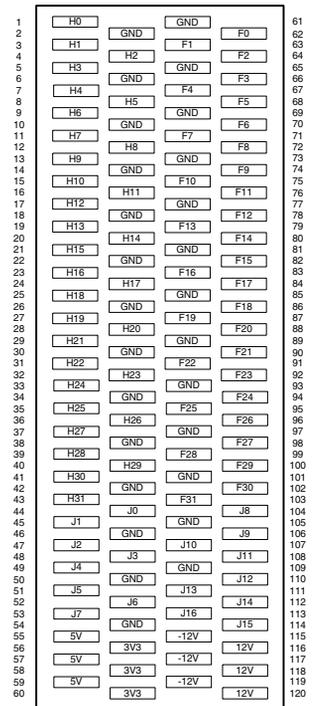


Figure A-2 EXPB socket pin numbering

A.2.2 EXPB plug pinout

Figure A-3 on page A-6 shows the pin numbers of the EXPB plug on the top of the logic module.

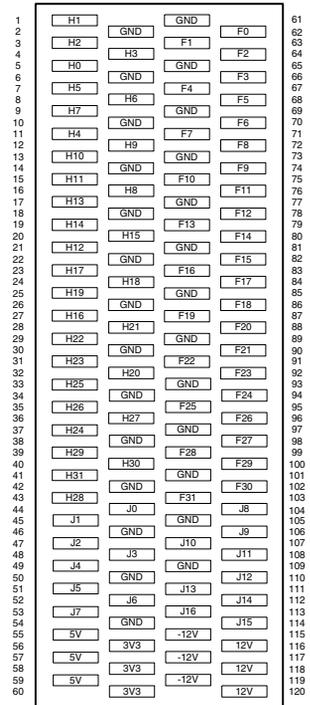


Figure A-3 EXPB plug pin numbering

A.2.3 Through-board signal routing

The signals on the pins labeled H[31:0] are cross-connected between the plug and socket so that the signals are rotated through the stack in groups of four. This ensures that each module in the stack connects to one specific signal in each group. For example, the first block of four are connected as shown in Table A-3 on page A-7.

Table A-3 Signal cross-connections (example)

Plug		Socket
H0	connects to	H1
H1	connects to	H2
H2	connects to	H3
H3	connects to	H0

The signals on the pins labeled F[31:0] and J[16:0] on the socket are routed to the same pins on all modules in the stack and so connect to the corresponding pins on the plug.

A.2.4 EXPB signal descriptions

Table A-4 on page A-8 describes the signals on the pins labeled H[31:0], J[16:0], and F[31:0] for an AHB system bus.

Table A-4 EXPB signal description (AHB)

Pin label	Name	Description
H[31:28]	SYSCLK[3:0]	System clock to each core logic module
H[27:24]	nEPRES[3:0]	Logic module present
H[23:20]	nIRQSRC[3:0]	Interrupt request from logic module 3, 2, 1, and 0 respectively
H[19:16]	-	Not connected
H[15:12]	ID[3:0]	Logic module stack position indicator
H[11:8]	SLOCK[3:0]	System bus lock from processor 3, 2, 1, and 0 respectively (not used in ASB).
H[7:4]	SGNT[3:0]	System bus grant
H[3:0]	SREQ[3:0]	System bus request
J16	nRTCKEN	RTCK AND gate enable
J[15:14]	CFGSEL[1:0]	FPGA configuration select
J13	nCFGEN	Sets motherboard into configuration mode
J12	nSRST	Multi-ICE reset (open collector)
J11	FPGADONE	Indicates when FPGA configuration is complete (open collector)
J10	RTCK	Returned JTAG test clock
J9	nSYSRST	Buffered system reset
J8	nTRST	JTAG reset
J7	TDO	JTAG test data out. The TDO signal is routed through devices on each board as it passes up through the stack. For a description of how the JTAG signals are routed, see <i>JTAG support</i> on page 3-11. For a description of the JTAG signals, see <i>JTAG signal descriptions</i> on page 3-17.

Table A-4 EXPB signal description (AHB) (continued)

Pin label	Name	Description
J6	TDI	<p>JTAG test data in. The TDI signals is routed straight down to the motherboard at the bottom of the stack. From the motherboard it becomes TDO.</p> <p>For a description of how the JTAG signals are routed, see <i>JTAG support</i> on page 3-11. For a description of the JTAG signals, see <i>JTAG signal descriptions</i> on page 3-17.</p>
J5	TMS	JTAG test mode select
J4	TCK	<p>JTAG test clock. The TCK signal is routed through devices on each module as it passes down through the stack.</p> <p>For a description of how the JTAG signals are routed, see <i>JTAG support</i> on page 3-11. For a description of the JTAG signals, see <i>JTAG signal descriptions</i> on page 3-17.</p>
J[3:1]	MASTER[2:0]	<p>Master ID. Binary encoding of the master currently performing a transfer on the bus. Corresponds to the module ID and to the HBUSREQ and HGRANT line numbers.</p>
J0	nMBDET	Motherboard detect pin
F[31:0]/GPIO [31:0]		<p>If the logic module is mounted in the EXPA/EXPB position on an Integrator/AP, these pins connect to the GPIO bus on the Integrator/AP. This bus is routed between the system controller FPGA on the motherboard and the FPGA on the logic module. These signals are available for your own applications.</p> <p>If the logic module is mounted in the HDRA/HDRB position on the motherboard, these pins connect to the F bus that is routed between any modules in the stack. There are no signals from the motherboard present on these pins.</p>

A.3 EXPIM

These connectors are the same type of as those used for EXPA. Figure A-4 on page A-10 shows the pin numbers for EXPIM.

1	GND		GND				101
2	IM_A0	GND	IM_B0	GND			102
3		IM_A1		IM_B1			103
4	IM_A2		IM_B2		IM_B1		104
5		GND		GND			105
6	IM_A3		IM_B3				106
7		IM_A4		IM_B4			107
8	IM_A5	IM_A4	IM_B5		IM_B4		108
9		IM_A6		IM_B6			109
10	IM_A6	GND	IM_B6	GND			110
11		IM_A7		IM_B7			111
12	IM_A8	IM_A7	IM_B8		IM_B7		112
13		GND		GND			113
14	IM_A9		IM_B9				114
15		IM_A10		IM_B10			115
16	IM_A11	IM_A10	IM_B11		IM_B10		116
17		GND		GND			117
18	IM_A12		IM_B12		GND		118
19		IM_A13		IM_B13			119
20	IM_A14	IM_A13	IM_B14		IM_B13		120
21		GND		GND			121
22	IM_A15		IM_B15				122
23		IM_A16		IM_B16			123
24	IM_A17	IM_A16	IM_B17		IM_B16		124
25		GND		GND			125
26	IM_A18		IM_B18				126
27		IM_A19		IM_B19			127
28	IM_A20	IM_A19	IM_B20		IM_B19		128
29		GND		GND			129
30	IM_A21		IM_B21				130
31		IM_A22		IM_B22			131
32	IM_A23	IM_A22	IM_B23		IM_B22		132
33		GND		GND			133
34	IM_A24		IM_B24				134
35		IM_A25		IM_B25			135
36	IM_A26	IM_A25	IM_B26		IM_B25		136
37		GND		GND			137
38	IM_A27		IM_B27				138
39		IM_A28		IM_B28			139
40	IM_A29	IM_A28	IM_B29		IM_B28		140
41		GND		GND			141
42	IM_A30		IM_B30				142
43		IM_A31		IM_B31			143
44	IM_A32	IM_A31	IM_B32		IM_B31		144
45		GND		GND			145
46	IM_A33		IM_B33				146
47		IM_A34		IM_B34			147
48	IM_A35	IM_A34	IM_B35		IM_B34		148
49		GND		GND			149
50	IM_A36		IM_B36				150
51		IM_A37		IM_B37			151
52	IM_A38	IM_A37	IM_B38		IM_B37		152
53		GND		GND			153
54	IM_A39		IM_B39				154
55		IM_A40		IM_B40			155
56	IM_A41	IM_A40	IM_B41		IM_B40		156
57		GND		GND			157
58	IM_A42		IM_B42				158
59		IM_A43		IM_B43			159
60	IM_A44	IM_A43	IM_B44		IM_B43		160
61		GND		GND			161
62	IM_A45		IM_B45				162
63		IM_A46		IM_B46			163
64	IM_A47	IM_A46	IM_B47		IM_B46		164
65		GND		GND			165
66	IM_A48		IM_B48				166
67		IM_A49		IM_B49			167
68	IM_A50	IM_A49	IM_B50		IM_B49		168
69		GND		GND			169
70	IM_A51		IM_B51				170
71		IM_A52		IM_B52			171
72	IM_A53	IM_A52	IM_B53		IM_B52		172
73		GND		GND			173
74	IM_A54		IM_B54				174
75		IM_A55		IM_B55			175
76	IM_A56	IM_A55	IM_B56		IM_B55		176
77		GND		GND			177
78	IM_A57		IM_B57				178
79		IM_A58		IM_B58			179
80	IM_A59	IM_A58	IM_B59		IM_B58		180
81		GND		GND			181
82	IM_A60		IM_B60				182
83		IM_A61		IM_B61			183
84	EXP95	IM_A61	EXP185		IM_B61		184
85		GND		GND			185
86	EXP87		EXP187				186
87		EXP88	EXP188				187
88	EXP89	EXP88	EXP189		EXP188		188
89		GND		GND			189
90	EXP91		EXP191				190
91		EXP92	EXP192		EXP191		191
92	EXP93	EXP92	EXP193		EXP192		192
93		GND		GND			193
94	EXP95		EXP195		EXP194		194
95		EXP96	EXP196				195
96	EXP97	EXP96	EXP197		EXP196		196
97		EXP98	EXP198				197
98	1V8	EXP98	EXP198		EXP198		198
99		1V8		1V8			199
100		1V8		1V8			200

Figure A-4 EXPIM connectors pin numbering

These connector provides expansion connections to the FPGA and to some of the plated through holes in the prototyping area. Signals are routed as follows:

- FPGA connections are routed to the same pins on the plug and the socket
- connections to the prototyping area are routed to pins on the plug only
- a number of fixed and configurable power supply rails are routed to pins on the plug only.

Table A-5 on page A-11 shows the signals for both Altera and Xilinx logic module types.

Table A-5 EXPIM signal description

Label	Altera	Xilinx	Description
IM_A[61:0]	IM_5BANK[61:0]	IM_0BANK[61:0]	FPGA input/output pins.
IM_B[61:0]	IM_6BANK[61:0]	IM_1BANK[61:0]	FPGA input/output pins.
EXP85	nPOR	nPOR	Power on reset (plug). Not connected (socket).
EXP87	nPBUTT	nPBUTT	Push button S3 (plug). Not connected (socket).
EXP88	FAST2	Not connected	FAST2 input to the FPGA.
EXP89	IM_PROTO0	IM_PROTO0	Prototyping area A10 (plug). Not connected (socket).
EXP91	IM_PROTO1	IM_PROTO1	Prototyping area B10 (plug). Not connected (socket).
EXP92	IM_PROTO2	IM_PROTO2	Prototyping area C10 (plug). Not connected (socket).
EXP93	IM_CLK	IM_CLK	Clock input to the FPGA
EXP95	IM_PROTO3	IM_PROTO3	Prototyping area D10 (plug). Not connected (socket).
EXP96	IM_PROTO4	IM_PROTO4	Prototyping area E10 (plug). Not connected (socket).
EXP97	VCCO_5	VCCO_0	Configurable voltage power supply rail (plug). Not connected (socket).
EXP98	VCCO_5	VCCO_0	Configurable voltage power supply rail (plug). Not connected (socket).
EXP185	-	-	Reserved
EXP187	IM_PROTO5	IM_PROTO5	Prototyping area F10 (plug). Not connected (socket).
EXP188	IM_PROTO6	IM_PROTO6	Prototyping area G10 (plug). Not connected (socket).
EXP189	CLK1_0	CLK1_0	Clock signal from the CLK1 buffer (plug), see <i>Clock control</i> on page 3-4. Not connected (socket).

Table A-5 EXPIM signal description (continued)

Label	Altera	Xilinx	Description
EXP191	CLK1_1	CLK1_1	Clock signal from the CLK1 buffer (plug), see <i>Clock control</i> on page 3-4. Not connected (socket).
EXP192	IM_PROTO7	IM_PROTO7	Prototyping area H10 (plug). Not connected (socket).
EXP193	IM_PROTO8	IM_PROTO8	Prototyping area A11 (plug). Not connected (socket).
EXP195	IM_PROTO9	IM_PROTO9	Prototyping area B12 (plug). Not connected (socket).
EXP196	FAST3	IM_PROTO10	FAST2 is from the FPGA (plug, Altera only) Prototyping area C12 (plug, Xilinx only) Not connected (socket)
EXP197	VCCO_6	VCCO_1	Configurable voltage power supply rail (plug). Not connected (socket).
EXP198	VCCO_6	VCCO_1	Configurable voltage power supply rail (plug). Not connected (socket).

A.4 Diagnostic connectors

This section provides details about the logic analyzer and Trace connectors. Figure A-5 on page A-13 shows the pin numbers of this type of connector.

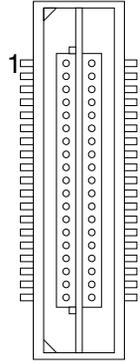


Figure A-5 Diagnostic connector pin locations

A.4.1 Trace

Table A-6 on page A-14 shows the pinout of the Trace type B connector.

Table A-6 Trace connector pinout

Channel	Pin	Pin	Channel
No connect	1	2	No connect
No connect	3	4	No connect
GND	5	6	TRCCLK
DBGREQ	7	8	DBGACK
nSRST	9	10	EXTTRIG
TDO	11	12	VDD (3.3V)
RTCK	13	14	VDD (3.3V)
TCK	15	16	TRCPKT7
TMS	17	18	TRCPKT6
TDI	19	20	TRCPKT5
nTRST	21	22	TRCPKT4
TRCPKT15	23	24	TRCPKT3
TRCPKT14	25	26	TRCPKT2
TRCPKT13	27	28	TRCPKT1
TRCPKT12	29	30	TRCPKT0
TRCPKT11	31	32	TRCSYNC
TRCPKT10	33	34	PIPESTAT2
TRCPKT9	35	36	PIPESTAT1
TRCPKT8	37	38	PIPESTAT0

A.4.2 Logic analyzer connector

Table A-7 on page A-15 shows the pinout of the logic analyzer connector J7.

Table A-7 Logic analyzer connector pinout

Pin	Signal	Pin	Signal
1	-	2	-
3	GND	4	-
5	LA_ACLK	6	LA_BCLK
7	LA_A15	8	LA_B15
9	LA_A14	10	LA_B14
11	LA_A13	12	LA_B13
13	LA_A12	14	LA_B12
15	LA_A11	16	LA_B11
17	LA_A10	18	LA_B10
19	LA_A9	20	LA_B9
21	LA_A8	22	LA_B8
23	LA_A7	24	LA_B7
25	LA_A6	26	LA_B6
27	LA_A5	28	LA_B5
29	LA_A4	30	LA_B4
31	LA_A3	32	LA_B3
33	LA_A2	34	LA_B2
35	LA_A1	36	LA_B1
37	LA_A0	38	LA_B0

A.4.3 Multi-ICE (JTAG)

Figure A-6 on page A-16 shows the pinout of the Multi-ICE connector J12. For a detailed description of the JTAG signals, see *JTAG signal descriptions* on page 3-17.

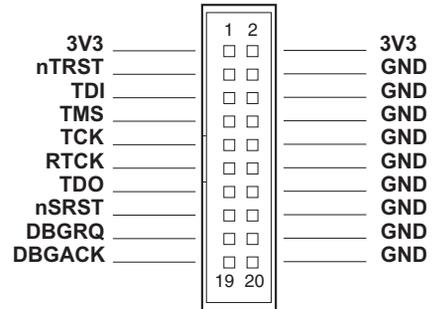


Figure A-6 Multi-ICE connector pinout

Appendix B

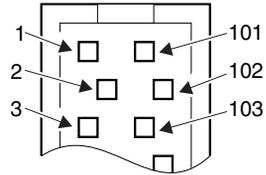
Mechanical Specification

This appendix contains the specifications for the logic module. It contains the following section:

- *Mechanical details* on page B-2.

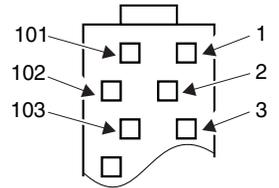
Figure B-2 on page B-3 shows how the pins of the Samtec connectors are numbered.

Pin numbers for 200-way plug,
viewed from above board



Samtec TOLC series

Pin numbers for 200-way socket,
viewed from below board



Samtec SOLC series

Figure B-2 Samtec connector pin numbering

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The items in this index are listed in alphabetical order, with symbols and numerics appearing at the end. The references given are to page numbers.

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