

## Introduction

During device operation, Altera® FPGAs store configuration data in SRAM cells. Because SRAM memory is volatile, the SRAM cells must be loaded with configuration data each time the device powers up. You can configure Stratix® series, Cyclone® series, Arria series, APEX™ II, APEX 20K, Mercury™, ACEX® 1K, FLEX® 10K, and FLEX 6000 devices using data stored in an Altera configuration device. Altera configuration devices are offered in different densities and provide a variety of features.

The Altera enhanced configuration devices (EPC16, EPC8, and EPC4) support a single-device configuration solution for high-density FPGAs, including Stratix series, Cyclone series, APEX II, APEX 20K, Mercury, ACEX 1K, and FLEX 10K devices. The enhanced configuration devices are ISP-capable through its Joint Test Action Group (JTAG) interface. Enhanced configuration devices cannot be cascaded nor can the flash interface pins be shared between multiple enhanced configuration devices for implementing a shared bus interface.


The enhanced configuration devices are divided into two major blocks, the controller and the flash memory. Because of its large flash memory size and decompression feature, enhanced configuration devices hold configuration data for one or multiple Altera FPGAs. In addition, unused portions of the flash can be used as memory storage for a programmable logic device (PLD) or processor (e.g., Nios® processor). After configuration, access to the flash memory is through the external flash interface of the enhanced configuration devices. Fast passive parallel (FPP) configuration, where configuration data is sent byte-wide on the DATA [7 . . 0] pins every clock cycle, is also supported for fast configuration times. FPP configuration is supported in Stratix series, and APEX II devices.

 For information on enhanced configuration devices, refer to *Enhanced Configuration Devices (EPC4, EPC8 and EPC16) Data Sheet* and *Altera Enhanced Configuration Devices*.

The Altera serial configuration devices (EPCS4, EPCS1, EPCS16, and EPCS64) support a single-device configuration solution for Stratix II FPGAs and the Cyclone series. Serial configuration devices offer a low cost, low pin count configuration solution for Stratix II FPGAs and the Cyclone series. The serial configuration devices cannot be cascaded. Unused portions of the flash can be accessed using the Nios processor.

 For information on serial configuration devices, refer to *Serial Configuration Devices (EPCS1, EPCS4, EPCS16, EPCS64 and EPCS128) Data Sheet*.

The EPC2, EPC1, and EPC1441 configuration devices provide configuration support for Stratix I and Stratix II, Cyclone I and Cyclone II, APEX II, APEX 20K, Mercury, ACEX 1K, and FLEX 10K devices. The EPC2 device is ISP-capable through its JTAG interface. This enables you to program them on board for a quick and efficient prototyping environment. The EPC2 and EPC1 can be cascaded to hold large configuration files.

 For more information on EPC2, EPC1, and EPC1441 configuration devices, refer to *Configuration Devices for SRAM-Based LUT Devices Data Sheet*.

## Choosing a Configuration Device

Table 1–1 summarizes the features of the Altera configuration devices and the amount of configuration space they hold.

**Table 1–1.** Altera Configuration Devices

Device	Memory Size (bits)	On-Chip Decompression Support	ISP Support	Cascading Support	Reprogrammable	Operating Voltage (V)
EPC16	16,777,216	Yes	Yes	No	Yes	3.3
EPC8	8,388,608	Yes	Yes	No	Yes	3.3
EPC4	4,194,304	Yes	Yes	No	Yes	3.3
EPCS128	134,217,728	No	Yes (1)	No	Yes	3.3
EPCS64	67,108,864	No	Yes (1)	No	Yes	3.3
EPCS16	16,777,216	No	Yes (1)	No	Yes	3.3
EPCS4	4,194,304	No	Yes (1)	No	Yes	3.3
EPCS1	1,048,576	No	Yes (1)	No	Yes	3.3
EPC2	1,695,680	No	Yes	Yes	Yes	5.0 or 3.3
EPC1 (1)	1,046,496	No	No	Yes	No	5.0 or 3.3
EPC1441 (1)	440,800	No	No	No	No	5.0 or 3.3

**Notes to Table 1–1:**

- (1) To program these devices using Altera Programming Unit or Master Programming Unit, refer to *Altera Programming Hardware Data Sheet*.
- (2) The EPCS device can be re-programmed in system by using Byte Blaster II download cable or an external microprocessor using SRRunner. For more information about SRRunner, refer to the *AN418, SRRunner: An Embedded Solution for EPCS Programming* Application Notes on the Altera website at [www.altera.com](http://www.altera.com).

To choose the appropriate configuration device, you need to determine the total configuration space required for your target FPGA or chain of FPGAs. These numbers are listed in each device family section. If you are configuring a chain of FPGAs, you need to add the configuration file size for each FPGA to determine the total configuration space needed. For example, if you are configuring an EP20K200E and an EP20K60E device in a daisy chain, your total configuration space requirement would be 1.964 Mbits + 0.641 Mbits = 2.605 Mbits. Next, use Table 1–1 to determine which configuration device fulfills your configuration space requirements.

Using the example above, to configure an EP20K400E and an EP20K60E device in a chain, 2.605 Mbits would fit in three EPC1 devices, two EPC2, or one EPC4 device. Only EPC2 and EPC1 devices can be cascaded. Using the configuration file size tables in each device family section along with Table 1–1, you can determine the number of configuration devices required to configure your target FPGA or chain of FPGAs.

Table 1-2 shows which configuration devices and how many are needed to configure each Altera FPGA.

**Table 1-2.** Configuration Devices Required (Part 1 of 6)

Family	Device	Data Size (Bits) (1)	EPC1064 /1064V	EPC1213	EPC1441	EPC1	EPC2	EPC4 (2)	EPC8 (2)	EPC16 (2)	EPCS1	EPCS4	EPCS16	EPCS64	EPCS128
Arria GX	EP1AGX20C	9,640,672	—	—	—	—	—	—	—	1	—	—	1	1	1
	EP1AGX35C	9,640,672	—	—	—	—	—	—	—	1	—	—	1	1	1
	EP1AGX35D														
	EP1AGX50C	16,951,824	—	—	—	—	—	—	—	1	—	—	1 (2)	1	1
	EP1AGX50D														
	EP1AGX60C	16,951,824	—	—	—	—	—	—	—	1	—	—	1 (2)	1	1
	EP1AGX60D EP1AGX60E														
EP1AGX90E	25,699,104	—	—	—	—	—	—	—	1	—	—	—	1	1	
Stratix IV	EP4SE110	53,000,000	—	—	—	—	—	—	—	—	—	—	—	1	1
	EP4SE230	104,000,000	—	—	—	—	—	—	—	—	—	—	—	—	1
	EP4SE290 (5)	141,000,000	—	—	—	—	—	—	—	—	—	—	—	—	1 (4)
	EP4SE360 (5)	141,000,000	—	—	—	—	—	—	—	—	—	—	—	—	1 (4)
	EP4SE530 (5)	188,000,000	—	—	—	—	—	—	—	—	—	—	—	—	—
	EP4SE680 (5)	234,000,000	—	—	—	—	—	—	—	—	—	—	—	—	—
	EP4SGX70	53,000,000	—	—	—	—	—	—	—	—	—	—	—	1	1
	EP4SGX110	53,000,000	—	—	—	—	—	—	—	—	—	—	—	1	1
	EP4SGX230	104,000,000	—	—	—	—	—	—	—	—	—	—	—	—	1
	EP4SGX290 (5)	141,000,000	—	—	—	—	—	—	—	—	—	—	—	—	1 (4)
	EP4SGX360 (5)	141,000,000	—	—	—	—	—	—	—	—	—	—	—	—	1 (4)
	EP4SGX530 (5)	188,000,000	—	—	—	—	—	—	—	—	—	—	—	—	—

**Table 1–2.** Configuration Devices Required (Part 2 of 6)

Family	Device	Data Size (Bits) (1)	EPC1064 /1064V	EPC1213	EPC1441	EPC1	EPC2	EPC4 (2)	EPC8 (2)	EPC16 (2)	EPCS1	EPCS4	EPCS16	EPCS64	EPCS128
Stratix III	EP3SL50	22,178,792	—	—	—	—	—	—	—	—	—	—	1 (4)	1	1
	EP3SL70	22,178,792	—	—	—	—	—	—	—	—	—	—	1	1	1
	EP3SL110	47,413,312	—	—	—	—	—	—	—	—	—	—	—	1	1
	EP3SL150	47,413,312	—	—	—	—	—	—	—	—	—	—	—	1	1
	EP3SL200	93,324,656	—	—	—	—	—	—	—	—	—	—	—	1 (4)	1
	EP3SL340	117,384,664	—	—	—	—	—	—	—	—	—	—	—	—	1
	EP3SE50	25,891,968	—	—	—	—	—	—	—	—	—	—	—	1	1
	EP3SE80	48,225,392	—	—	—	—	—	—	—	—	—	—	—	1	1
	EP3SE110	48,225,392	—	—	—	—	—	—	—	—	—	—	—	1	1
EP3SE260	93,324,656	—	—	—	—	—	—	—	—	—	—	—	1 (4)	1	
Stratix II	EP2S15	4,721,544	—	—	—	—	3	1	1	1	—	1 (4)	1	1	1
	EP2S30	9,640,672	—	—	—	—	7	—	1	1	—	—	1	1	1
	EP2S60	16,951,824	—	—	—	—	11	—	—	1	—	—	1 (4)	1	1
	EP2S90	25,699,104	—	—	—	—	17	—	—	—	—	—	1 (4)	1	1
	EP2S130	37,325,760	—	—	—	—	24	—	—	—	—	—	—	1	1
	EP2S180	49,814,760	—	—	—	—	31	—	—	—	—	—	—	1	1
Stratix II GX	EP2SGX30C	9,640,672	—	—	—	—	—	—	—	1	—	—	1	1	1
	EP2SGX30D	9,640,672	—	—	—	—	—	—	—	1	—	—	1	1	1
	EP2SGX60C	16,951,824	—	—	—	—	—	—	—	1	—	—	1 (4)	1	1
	EP2SGX60D	16,951,824	—	—	—	—	—	—	—	1	—	—	1 (4)	1	1
	EP2SGX60E	16,951,824	—	—	—	—	—	—	—	1	—	—	1 (4)	1	1
	EP2SGX90E	25,699,104	—	—	—	—	—	—	—	—	—	—	—	1	1
	EP2SGX90F	25,699,104	—	—	—	—	—	—	—	—	—	—	—	1	1
	EP2SGX130G	37,325,760	—	—	—	—	—	—	—	—	—	—	—	1	1

**Table 1-2.** Configuration Devices Required (Part 3 of 6)

Family	Device	Data Size (Bits) (1)	EPC1064 /1064V	EPC1213	EPC1441	EPC1	EPC2	EPC4 (2)	EPC8 (2)	EPC16 (2)	EPCS1	EPCS4	EPCS16	EPCS64	EPCS128
Stratix	EP1S10	3,534,640	—	—	—	—	3 (3)	1	1	1	—	—	—	—	—
	EP1S20	5,904,832	—	—	—	—	4	1	1	1	—	—	—	—	—
	EP1S25	7,894,144	—	—	—	—	5	—	1	1	—	—	—	—	—
	EP1S30	10,379,368	—	—	—	—	7	—	1	1	—	—	—	—	—
	EP1S40	12,389,632	—	—	—	—	8	—	1	1	—	—	—	—	—
	EP1S60	17,543,968	—	—	—	—	11	—	—	1	—	—	—	—	—
	EP1S80	23,834,032	—	—	—	—	15	—	—	1	—	—	—	—	—
Stratix GX	EP1SGX10	3,534,640	—	—	—	—	3	1	1	1	—	—	—	—	—
	EP1SGX25	7,894,144	—	—	—	—	5	—	1	1	—	—	—	—	—
	EP1SGX40	12,389,632	—	—	—	—	8	—	1	1	—	—	—	—	—
Cyclone III	EP3C5	2,944,088	—	—	—	—	—	—	—	—	—	1	1	1	1
	EP3C10	2,944,088	—	—	—	—	—	—	—	—	—	1	1	1	1
	EP3C16	4,086,848	—	—	—	—	—	—	—	—	—	1	1	1	1
	EP3C25	5,748,552	—	—	—	—	—	—	—	—	—	1 (4)	1	1	1
	EP3C40	9,534,304	—	—	—	—	—	—	—	—	—	—	1	1	1
	EP3C55	14,889,560	—	—	—	—	—	—	—	—	—	—	1	1	1
	EP3C80	19,965,752	—	—	—	—	—	—	—	—	—	—	1 (4)	1	1
	EP3C120	28,571,696	—	—	—	—	—	—	—	—	—	—	—	1	1
Cyclone II	EP2C5	1,223,980	—	—	—	—	1	1	1	1	1 (4)	1	—	1	1
	EP2C8	1,983,792	—	—	—	—	2	1	1	1	—	1	—	1	1
	EP2C20	3,930,986	—	—	—	—	3	1	1	1	—	1	1	1	1
	EP2C35	7,071,234	—	—	—	—	5	—	1	1	—	—	1	1	1
	EP2C50	9,122,148	—	—	—	—	6	—	1	1	—	—	1	1	1
	EP2C70	10,249,694	—	—	—	—	7	—	1	1	—	—	1	1	1

**Table 1-2.** Configuration Devices Required (Part 4 of 6)

Family	Device	Data Size (Bits) (1)	EPC1064 /1064V	EPC1213	EPC1441	EPC1	EPC2	EPC4 (2)	EPC8 (2)	EPC16 (2)	EPCS1	EPCS4	EPCS16	EPCS64	EPCS128
Cyclone	EP1C3	627,376	—	—	—	1	1	1	1	1	1	1	1	1	1
	EP1C4	924,512	—	—	—	1	1	1	1	1	1	1	1	1	1
	EP1C6	1,167,216	—	—	—	1 (4)	1	1	1	1	1 (4)	1	1	1	1
	EP1C12	2,326,528	—	—	—	—	1 (4)	1	1	1	—	1	1	1	1
	EP1C20	3,559,608	—	—	—	—	2 (4)	1	1	1	—	1	1	1	1
APEX II	EP2A15	4,358,512	—	—	—	—	3	1	1	1	—	—	—	—	—
	EP2A25	6,275,200	—	—	—	—	4	1	1	1	—	—	—	—	—
	EP2A40	9,640,528	—	—	—	—	6	—	1	1	—	—	—	—	—
	EP2A70	17,417,088	—	—	—	—	11	—	—	1	—	—	—	—	—
Mercury	EP1M120	1,303,120	—	—	—	—	1	1	—	1	—	—	—	—	—
	EP1M350	4,394,032	—	—	—	—	3	1	—	1	—	—	—	—	—
APEX 20KC	EP20K200C	196,8016	—	—	—	—	2	1	1	1	—	—	—	—	—
	EP20K400C	390,9776	—	—	—	—	3	1	1	1	—	—	—	—	—
	EP20K600C	567,3936	—	—	—	—	4	1	1	1	—	—	—	—	—
	EP20K1000C	8,960,016	—	—	—	—	6	—	1	1	—	—	—	—	—
APEX 20KE	EP20K30E	354,832	—	—	1	1	1	1	1	1	—	—	—	—	—
	EP20K60E	648,016	—	—	—	1	1	1	1	1	—	—	—	—	—
	EP20K100E	1,008,016	—	—	—	1	1	1	1	1	—	—	—	—	—
	EP20K160E	1,524,016	—	—	—	—	1	1	1	1	—	—	—	—	—
	EP20K200E	1,968,016	—	—	—	—	2	1	1	1	—	—	—	—	—
	EP20K300E	2,741,616	—	—	—	—	2	1	1	1	—	—	—	—	—
	EP20K400E	3,909,776	—	—	—	—	3	1	1	1	—	—	—	—	—
	EP20K600E	5,673,936	—	—	—	—	4	1	1	1	—	—	—	—	—
	EP20K1000E	8,960,016	—	—	—	—	6	—	1	1	—	—	—	—	—
	EP20K1500E	12,042,256	—	—	—	—	8	—	1	1	—	—	—	—	—

**Table 1-2.** Configuration Devices Required (Part 5 of 6)

Family	Device	Data Size (Bits) (1)	EPC1064 /1064V	EPC1213	EPC1441	EPC1	EPC2	EPC4 (2)	EPC8 (2)	EPC16 (2)	EPCS1	EPCS4	EPCS16	EPCS64	EPCS128
APEX 20K	EP20K100	993,360	—	—	—	1	1	1	1	1	—	—	—	—	—
	EP20K200	1,950,800	—	—	—	—	2	1	1	1	—	—	—	—	—
	EP20K400	3,880,720	—	—	—	—	3	1	1	1	—	—	—	—	—
ACEX 1K	EP1K10	159,160	—	—	1	1	1	1	1	1	—	—	—	—	—
	EP1K30	473,720	—	—	—	1	1	1	1	1	—	—	—	—	—
	EP1K50	784,184	—	—	—	1	1	1	1	1	—	—	—	—	—
	EP1K100	1,335,720	—	—	—	—	1	1	1	1	—	—	—	—	—
FLEX 10KE	EPF10K30E	473,720	—	—	—	—	1	1	1	1	—	—	—	—	—
	EPF10K50E	784,184	—	—	—	—	1	1	1	1	—	—	—	—	—
	EPF10K50S	784,184	—	—	—	1	1	1	1	1	—	—	—	—	—
	EPF10K100B	1,200,000	—	—	—	—	1	1	1	1	—	—	—	—	—
	EPF10K100E	1,335,720	—	—	—	—	1	1	1	1	—	—	—	—	—
	EPF10K130E	1,838,360	—	—	—	—	2	1	1	1	—	—	—	—	—
	EPF10K200E	2,756,296	—	—	—	—	2	1	1	1	—	—	—	—	—
	EPF10K200S	2,756,296	—	—	—	—	2	1	1	1	—	—	—	—	—
FLEX 10KA	EPF10K10A	120,000	—	—	1	1	1	1	1	1	—	—	—	—	—
	EPF10K30A	406,000	—	—	1	1	1	1	1	1	—	—	—	—	—
	EPF10K50V	621,000	—	—	—	1	1	1	1	1	—	—	—	—	—
	EPF10K100A	1,200,000	—	—	—	—	1	1	1	1	—	—	—	—	—
	EPF10K130V	1,600,000	—	—	—	—	1	1	1	1	—	—	—	—	—
	EPF10K250A	3,300,000	—	—	—	—	2	1	1	1	—	—	—	—	—

**Table 1-2.** Configuration Devices Required (Part 6 of 6)

Family	Device	Data Size (Bits) (1)	EPC1064 /1064V	EPC1213	EPC1441	EPC1	EPC2	EPC4 (2)	EPC8 (2)	EPC16 (2)	EPCS1	EPCS4	EPCS16	EPCS64	EPCS128
FLEX 10K	EPF10K10	118,000	—	—	1	1	1	1	1	1	—	—	—	—	—
	EPF10K20	231,000	—	—	1	1	1	1	1	1	—	—	—	—	—
	EPF10K30	376,000	—	—	1	1	1	1	1	1	—	—	—	—	—
	EPF10K40	498,000	—	—	—	1	1	1	1	1	—	—	—	—	—
	EPF10K50	621,000	—	—	—	1	1	1	1	1	—	—	—	—	—
	EPF10K70	892,000	—	—	—	1	1	1	1	1	—	—	—	—	—
	EPF10K100	1,200,000	—	—	—	—	1	1	1	1	—	—	—	—	—
FLEX 6000/A	EPF6010A	260,000	—	—	1	1	—	—	—	—	—	—	—	—	—
	EPF6016 (5.0 V) / EPF6016A	260,000	—	—	1	1	—	—	—	—	—	—	—	—	—
	EPF6024A	398,000	—	—	1	1	—	—	—	—	—	—	—	—	—
FLEX 8000A	EPF8282A / EPF8282AV (3.3 V)	40,000	1	1	1	1	—	—	—	—	—	—	—	—	—
	EPF8452A	64,000	1	1	1	1	—	—	—	—	—	—	—	—	—
	EPF8636A	96,000	—	1	1	1	—	—	—	—	—	—	—	—	—
	EPF8820A	128,000	—	1	1	1	—	—	—	—	—	—	—	—	—
	EPF81188A	192,000	—	1	1	1	—	—	—	—	—	—	—	—	—
	EPF81500A	250,000	—	—	1	1	—	—	—	—	—	—	—	—	—

**Notes to Table 1-2:**

- (1) Raw Binary Files (.rbf) were used to determine these sizes.
- (2) These values with the enhanced configuration device compression feature enabled.
- (3) EP1S10 ES device requires four EPC2 devices.
- (4) This is with the Stratix II, Stratix II GX, Stratix III, Stratix IV, Arria GX series, or Cyclone series compression feature enabled.
- (5) The largest serial configuration device currently supports 128 Mbits of configuration bitstream. Use Stratix IV decompression features or select FPP or PS configuration scheme for larger Stratix IV devices such as EP4SGX290 and EP4SGX360.



## Referenced Documents

This chapter references the following documents:

- *Enhanced Configuration Devices (EPC4, EPC8 and EPC16) Data Sheet*
- *Altera Enhanced Configuration Devices*
- *Serial Configuration Devices (EPCS1, EPCS4, EPCS16, EPCS64 and EPCS128) Data Sheet*
- *Configuration Devices for SRAM-Based LUT Devices Data Sheet*

## Document Revision History

Table 1-3 shows the revision history for this document.

**Table 1-3.** Document Revision History

Date and Revision	Changes Made	Summary of Changes
October 2008, version 2.4	<ul style="list-style-type: none"> <li>■ Updated “Introduction” and “Choosing a Configuration Device” sections.</li> <li>■ Updated Table 1-1 and Table 1-2.</li> <li>■ Added “Referenced Documents” section.</li> <li>■ Updated new document format.</li> </ul>	—
April 2007, version 2.3	<ul style="list-style-type: none"> <li>■ Added document revision history.</li> </ul>	—
February 2005, version 2.1	<ul style="list-style-type: none"> <li>■ Document format updated.</li> <li>■ Updated Table 1-2.</li> </ul>	—
July 2004, version 2.0	<ul style="list-style-type: none"> <li>■ Document format updated.</li> <li>■ Updated Table 1-2.</li> </ul>	—
September 2003, version 1.0	<ul style="list-style-type: none"> <li>■ Added Stratix II and Cyclone II device information throughout chapter.</li> <li>■ Added EPCS16 and EPCS64 device information throughout chapter.</li> <li>■ Updated data size for EP1C4 and all APEX II devices.</li> </ul>	—

