The Automotive-Grade Device Handbook

101 Innovation Drive
San Jose, CA 95134
www.altera.com

AUT5V1-2.0

Document last updated for Altera Complete Design Suite version: 11.0
Document publication date: May 2011

Subscribe

Contents

1. Introduction

Altera Automotive-Grade Devices

The Altera® automotive product portfolio consists of the best-in-class end-application solutions, devices, and development tools supporting the automotive industry. This select group of automotive-grade devices provides engineers with the design flexibility and short time-to-market that programmable logic is well-known for, while meeting the high-quality standards and extended temperature range needed for automotive electronics.

Altera is the only supplier offering both programmable devices and structured ASICs. Whether you need a simple low-cost, low-power glue logic or a complex graphics controller solution driving your in-dash infotainment display, Altera has the reference designs and expertise to help you succeed in the market. Altera automotive solutions offer the following advantages:

- Reference designs or design examples for infotainment, driver assistance, hybrid engineer control units, and other electronic modules.
- 30–50% lower power consumption in Altera CPLDs and FPGAs compared to competitor products.
- Unique FPGA-to-structured-ASIC flow where Stratix® II devices are converted to HardCopy® II devices resulting in a quick prototyping process, rapid production ramp, and lower costs.
- Extensive range of on-chip functionalities and IP cores. Examples of on-chip functionalities include RAM blocks, digital signal processing (DSP) blocks, and phase-locked loops (PLLs). Examples of IP cores include the Nios® II 32-bit embedded soft processor, controller area network (CAN), and media-oriented systems transport (MOST).
- AEC-Q100 qualified devices, TS-16949 certified manufacturing sites, and production part approval process (PPAP) documentation.

For more information about Altera automotive solutions, visit www.altera.com/end-markets/auto/aut-index.html.

This chapter contains the following sections:

Altera Automotive Qualifications

The Altera automotive-grade devices offer the same functionalities as commercial and industrial-grade devices, but operate over the full automotive temperature range ($T_{junction}$ = –40°C to 125°C).

Altera is a member of the Automotive Electronics Council (AEC) and adheres to the automotive quality standard, AEC-Q100.

For device-specific details about the AEC-Q100 qualification testing, contact Altera at customer-quality@altera.com.

For more information about the AEC-Q100 qualification, refer to www.aecouncil.com/AECDocuments.html.

Altera is also an ISO-9001 certified supplier. Altera's manufacturing fab partners (TSMC and Wafertech) and its packaging and test partners (ASE and AMKOR) producing automotive-grade products are registered and certified to the ISO and TS-16949 quality standards.

To view the certificates, refer to www.altera.com/end-markets/auto/quality/aut-quality.html.

Altera performs stringent reliability qualification and monitoring on a product family basis. Altera devices exceed the reliability requirements established by the Electronic Industries Alliance (EIA) and the Joint Electron Device Engineering Council (JEDEC). JEDEC qualification tests ensure that Altera devices meet or exceed these reliability standards.

For more information about the reliability qualification and monitoring programs for Altera products, refer to the Altera *Reliability Report*.

All Altera automotive-grade devices have a PPAP document.

For device-specific details about the PPAP documentation, contact Altera at customer-quality@altera.com.

Supported Devices

Altera offers automotive-grade products in the following IC categories: CPLDs, FPGAs, and structured ASICs. Also available are configuration IC devices that you can use to program the FPGAs.

Table 1–1 lists the product families offering automotive-grade devices.

Table 1–1. The Altera Automotive-Grade Products ***(Note 1)***

Category	Product Family	Description
IC, CPLD	MAX® 7000A	High-performance, glue logic CPLDs (5-V I/O compatible)
IC, CPLD	MAX II	High-density, low-power glue logic CPLDs
IC, CPLD	MAX V	High-density, ultra low-power glue logic CPLDs
IC, FPGA	Cyclone®	Low-cost, simple FPGAs
IC, FPGA	Cyclone II	Low-cost, feature-rich FPGAs
IC, FPGA	Cyclone IV	Low-cost, lowest-power, feature-rich FPGAs
IC, ASIC	HardCopy II	Low-cost, one-million-gate structured ASICs

Note to Table 1–1:

(1) Refer to the following chapters for the complete list of automotive-grade devices.

Document Revision History

Table 1–2 lists the revision history for this chapter.

Table 1–2. Document Revision History

Date	Version	Changes
May 2011	2.0	■ Updated Table 1–1 to include MAX V devices. ■ Template conversion. ■ Minor text edits.
March 2010	1.2	Removed Referenced Documents section.
October 2008	1.1	Converted to new template.
February 2008	1.0	Initial release.

2. MAX 7000A Devices

Supported Automotive-Grade Devices

Altera offers MAX® 7000A devices in the automotive temperature range. These devices are available only in the –10 speed grade.

Table 2–1 lists the automotive-grade devices in the MAX 7000A device family.

Table 2–1. Automotive-Grade MAX 7000A Devices

Device Ordering Code	Package
EPM7032AETA44-10N	44-Pin TQFP
EPM7064AETA44-10N	44-Pin TQFP
EPM7064AETA100-10N	100-Pin TQFP
EPM7128AETA100-10N	100-Pin TQFP
EPM7128AETA144-10N	144-Pin TQFP

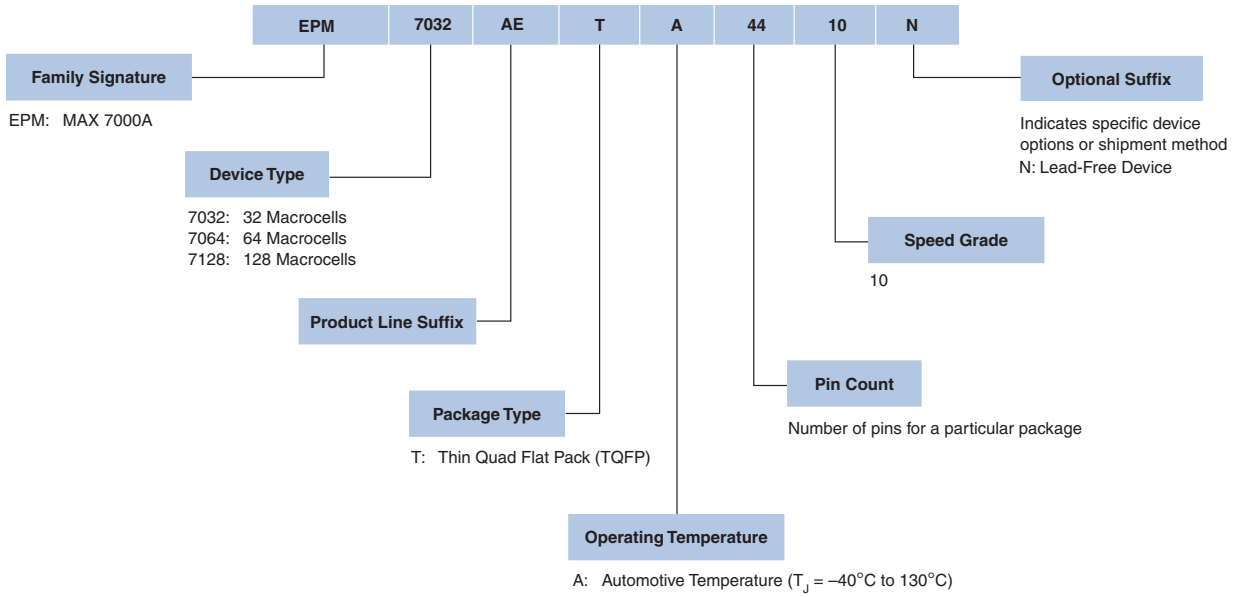
This chapter contains the following sections:

Device Ordering Codes

Figure 2–1 shows the ordering codes for automotive-grade devices offered in the MAX 7000A device family.

For more information about a specific package, refer to the *Package Information Datasheet for Altera Devices*.

Figure 2–1. Automotive-Grade Ordering Information for MAX 7000A Devices



Quartus II Software Support

The Altera® Quartus® II design software supports the MAX 7000A devices in the automotive temperature range. The Quartus II software includes HDL and schematic design entry, compilation and logic synthesis, full simulation and advanced timing analysis, and device programming.

For more information about the Quartus II software features, refer to the *Quartus II Handbook*.

To target an automotive-grade MAX 7000A device in your design in the Quartus II software, follow these steps:

1. On the Assignments menu, click **Device**. The **Settings** dialog box appears.
2. In the **Family** drop-down list, select **MAX7000AE**.
3. Under Target device, select **Specific device selected in 'Available devices' list**.
4. In the **Available devices** list, select the appropriate ordering code, as listed in Table 2–1.

The Quartus II software does not show the "N" suffix, which indicates a lead-free device. For example, the EPM7032AETA44-10N device is shown only as EPM7032AETA44-10.

5. Click **OK**.

Support for the automotive-grade MAX 7000A devices is only available in the Quartus II software version 7.2 SP1 and later.

Power Analysis and Estimation

Altera provides the following power analysis and estimation tools for your design:

- "PowerPlay Early Power Estimator"
- "PowerPlay Power Analyzer"

PowerPlay Early Power Estimator

The PowerPlay Early Power Estimator (EPE) is a power estimation tool that helps you estimate the power consumption of your design during the system planning phase for proper power supply planning and consideration. The EPE allows you to enter design information based on architectural features and calculates the power consumed by each architectural feature. Inputs to the EPE are environmental conditions and device resources (such as clock frequency) that you expect to use in your design. The EPE then calculates the static and dynamic power, current estimates, and thermal analysis for your design.

You can either enter the design information manually into the spreadsheet or import a power estimator file of a fully or partially completed design from the Quartus II software. After importing a file, you can edit some of the input parameters including V_{CCINT}, ambient temperature, airflow, clock frequency, and toggle percentage to suit your system requirements.

The value obtained from the EPE is only an estimation and should not be used as a specification. The accuracy of the EPE results depends on how close your input of the design information into the EPE resembles that of the final design.

PowerPlay Power Analyzer

The PowerPlay Power Analyzer tool in the Quartus II software is a power analysis tool that helps you calculate your design power consumption accurately to ensure thermal and power supply budgets are not violated after your design is complete. The PowerPlay Power Analyzer tool requires your design to be synthesized and fitted to the target device. Availability of information such as design resources, how the design is placed and routed on the target device, and the I/O standards assigned to each I/O cell allow the PowerPlay Power Analyzer tool to provide accurate power estimation.

The process of using the PowerPlay Power Analyzer tool consists of three parts—specifying sources of input data, specifying operating conditions, and running the PowerPlay Power Analyzer tool.

The input data consists of the signal activities data (toggle rates and static probabilities) of the compiled design. Signal activity data can be derived from simulation results, user assignment in the Assignment Editor, user-defined default toggle rate, and vectorless estimation.

The operating conditions include device power characteristic, ambient and junction temperature, cooling solution, and board thermal model, all of which can be set in the Quartus II software.

The PowerPlay Power Analyzer tool calculates the dynamic, static and I/O thermal power consumption, current consumed from voltage source, a summary of the signal activities used for analysis, and a confidence metric that reflects the overall quality of the data sources for the signal activities.

For more information about the PowerPlay Power Analyzer tool, refer to the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

DC and Timing Specifications

Automotive-grade MAX 7000A devices have the same absolute maximum ratings, recommended operating conditions, and DC electrical characteristics as those published for the MAX 7000A devices in the *MAX 7000A Programmable Logic Device Data Sheet*.

The timing specifications of the automotive-grade MAX 7000A devices are the same as those published for the MAX 7000A devices in the *MAX 7000A Programmable Logic Device Data Sheet*. The automotive-grade devices meet these timing specifications over the automotive temperature range (–40°C to 130°C).

Table 2–2 lists the automotive-grade ordering codes and their equivalent timing specifications for MAX 7000A devices.

Table 2–2. Automotive-Grade Ordering Codes and Their Equivalent Timing Specifications for MAX 7000A Devices

Automotive-Grade Device Ordering Code	Device Timing Specification		
	Device	Temperature Range	Speed Grade
EPM7032AETA44-10N	EPM7032AE	–40°C to 130°C	–10
EPM7064AETA44-10N	EPM7064AE	–40°C to 130°C	–10
EPM7064AETA100-10N	EPM7064AE	–40°C to 130°C	–10
EPM7128AETA100-10N	EPM7128AE	–40°C to 130°C	–10
EPM7128AETA144-10N	EPM7128AE	–40°C to 130°C	–10

Pin-Out Information

For more information about the MAX 7000A device pin-outs, refer to the MAX 7000, MAX 7000A, and MAX 7000B Device Pin-Out Files page.

Package and Board Layout Information

For package-related information (for example, dimensions and thermal resistance values) about MAX 7000A devices, refer to the *Package Information Datasheet for Altera Devices*.

For PCB design guidelines, refer to *AN114: Designing With High-Density BGA Packages for Altera Devices*.

Document Revision History

Table 2–3 lists the revision history for this chapter.

Table 2–3. Document Revision History

Date	Version	Changes
May 2011	2.0	■ Template conversion. ■ Minor text edits.
March 2010	1.2	Removed Referenced Documents section.
October 2008	1.1	Converted to new template.
February 2008	1.0	Initial release.

Supported Automotive-Grade Devices

Altera offers MAX® II devices in the automotive temperature range. These devices are available only in the –5 speed grade.

Table 3–1 lists the automotive-grade devices in the MAX II device family.

Table 3–1. Automotive-Grade MAX II Devices

Device Ordering Code	Package
EPM240T100A5N	100-Pin TQFP
EPM570T100A5N	100-Pin TQFP
EPM570T144A5N	144-Pin TQFP
EPM1270T144A5N	144-Pin TQFP
EPM1270F256A5N	256-Pin FineLine BGA
EPM2210F256A5N	256-Pin FineLine BGA
EPM2210F324A5N	324-Pin FineLine BGA

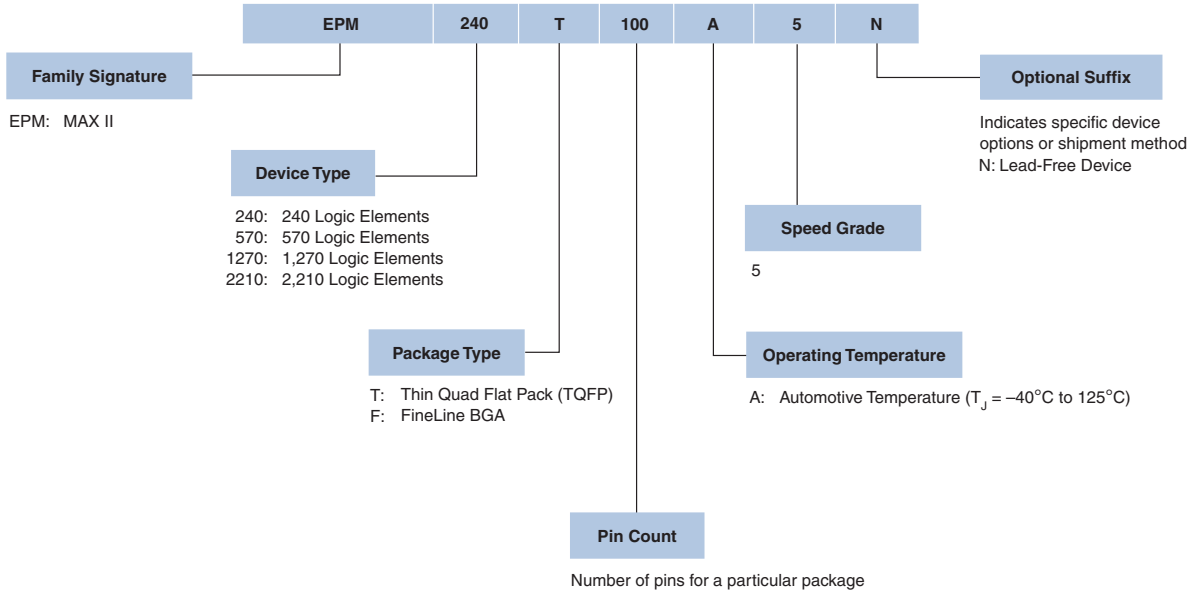
This chapter contains the following sections:

Device Ordering Codes

Figure 3–1 shows the ordering codes for automotive-grade devices offered in the MAX II device family.

For more information about a specific package, refer to the *Package Information Datasheet for Altera Devices*.

Figure 3–1. Automotive-Grade Ordering Information for MAX II Devices



Quartus II Software Support

The Altera® Quartus® II design software supports the MAX II devices in the automotive temperature range. The Quartus II software includes HDL and schematic design entry, compilation and logic synthesis, full simulation and advanced timing analysis, and device programming.

For more information about the Quartus II software features, refer to the *Quartus II Handbook*.

To target an automotive-grade MAX II device in your design in the Quartus II software, follow these steps:

1. On the Assignments menu, click **Device**. The **Settings** dialog box appears.
2. In the **Family** drop-down list, select **MAX II**.
3. Under Target device, select **Specific device selected in 'Available devices' list**.
4. In the **Available devices** list, select the appropriate ordering code, as listed in Table 3–1.

The Quartus II software does not show the "N" suffix, which indicates a lead-free device. For example, the device EPM240T100A5N is shown only as EPM240T100A5.

5. Click **OK**.

Support for the automotive-grade MAX II devices is only available in the Quartus II software version 7.2 SP1 and later.

Power Analysis and Estimation

Altera provides the following power analysis and estimation tools for your design:

- "PowerPlay Early Power Estimator"
- "PowerPlay Power Analyzer"

PowerPlay Early Power Estimator

The PowerPlay Early Power Estimator (EPE) is a power estimation tool that helps you estimate the power consumption of your design during the system planning phase for proper power supply planning and consideration. The EPE allows you to enter design information based on architectural features and calculates the power consumed by each architectural feature. Inputs to the EPE are environmental conditions and device resources (such as clock frequency) that you expect to use in your design. The EPE then calculates the static and dynamic power, current estimates, and thermal analysis for your design.

You can either enter the design information manually into the spreadsheet or import a power estimator file of a fully or partially completed design from the Quartus II software. After importing a file, you can edit some of the input parameters including V_{CCINT}, ambient temperature, airflow, clock frequency, and toggle percentage to suit your system requirements.

The value obtained from the EPE is only an estimation and should not be used as a specification. The accuracy of the EPE results depends on how close your input of the design information into the EPE resembles that of the final design.

For more information about the EPE, and how to generate and import the power estimator file, refer to the *PowerPlay Early Power Estimator for Altera CPLDs User Guide*.

PowerPlay Power Analyzer

The PowerPlay Power Analyzer tool in the Quartus II software is a power analysis tool that helps you calculate your design power consumption accurately to ensure thermal and power supply budgets are not violated after your design is complete. The PowerPlay Power Analyzer tool requires your design to be synthesized and fitted to the target device. Availability of information such as design resources, how the design is placed and routed on the target device, and the I/O standards assigned to each I/O cell allow the PowerPlay Power Analyzer tool to provide accurate power estimation.

The process of using the PowerPlay Power Analyzer tool consists of three parts—specifying sources of input data, specifying operating conditions, and running the PowerPlay Power Analyzer tool.

The input data consists of the signal activities data (toggle rates and static probabilities) of the compiled design. Signal activity data can be derived from simulation results, user assignment in the Assignment Editor, user-defined default toggle rate, and vectorless estimation.

The operating conditions include device power characteristic, ambient and junction temperature, cooling solution, and board thermal model, all of which can be set in the Quartus II software.

The PowerPlay Power Analyzer tool calculates the dynamic, static and I/O thermal power consumption, current consumed from voltage source, a summary of the signal activities used for analysis, and a confidence metric that reflects the overall quality of the data sources for the signal activities.

For more information about the PowerPlay Power Analyzer tool, refer to the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

DC and Timing Specifications

Automotive-grade MAX II devices have the same absolute maximum ratings, recommended operating conditions, and DC electrical characteristics as those published for the MAX II devices in the *DC and Switching Characteristics* chapter of the *MAX II Device Handbook*.

The timing specifications of the automotive-grade MAX II devices are the same as those published for the MAX II devices in the *DC and Switching Characteristics* chapter of the *MAX II Device Handbook*. The automotive-grade devices meet these timing specifications over the automotive temperature range (–40°C to 125°C).

Table 3–2 lists the automotive-grade ordering codes and their equivalent timing specifications for MAX II devices.

Table 3–2. Automotive-Grade Ordering Codes and Their Equivalent Timing Specifications for MAX II Devices

Automotive-Grade Device Ordering Code	Device Timing Specification		
	Device	Temperature Range	Speed Grade
EPM240T100A5N	EPM240	–40°C to 125°C	–5
EPM570T100A5N	EPM570	–40°C to 125°C	–5
EPM570T144A5N	EPM570	–40°C to 125°C	–5
EPM1270T144A5N	EPM1270	–40°C to 125°C	–5
EPM1270F256A5N	EPM1270	–40°C to 125°C	–5
EPM2210F256A5N	EPM2210	–40°C to 125°C	–5
EPM2210F324A5N	EPM2210	–40°C to 125°C	–5

Pin-Out Information

For more information about the MAX II device pin-outs, refer to the MAX II Device Pin-Out Files page.

Package and Board Layout Information

For package-related information (for example, dimensions and thermal resistance values) on MAX II devices, refer to the *Package Information Datasheet for Altera Devices*.

For PCB design guidelines, refer to *AN114: Designing With High-Density BGA Packages for Altera Devices*.

If you are designing PCBs with the Cadence OrCAD capture component information system, you can download the symbol libraries from the Cadence Capture CIS and Allegro PCB Symbols and Footprints page.

Document Revision History

Table 3–3 lists the revision history for this chapter.

Table 3–3. Document Revision History

Date	Version	Changes
May 2011	2.0	■ Template conversion. ■ Minor text edits.
March 2010	1.2	Removed Referenced Documents section.
October 2008	1.1	Converted to new template.
February 2008	1.0	Initial release.

Supported Automotive-Grade Devices

Altera offers MAX® V devices in the automotive temperature range. These devices are available only in the –5 speed grade.

Table 4–1 lists the automotive-grade devices in the MAX V device family.

Table 4–1. Automotive-Grade in MAX V Devices

Device Ordering Code	Package
5M40ZE64A5N	64-Pin EQFP
5M40ZM64A5N	64-Pin MBGA
5M80ZE64A5N	64-Pin EQFP
5M80ZM64A5N	64-Pin MBGA
5M80ZM68A5N	68-Pin MBGA
5M80ZT100A5N	100-Pin TQFP
5M160ZE64A5N	64-Pin EQFP
5M160ZM100A5N	100-Pin MBGA
5M160ZM68A5N	68-Pin MBGA
5M160ZT100A5N	100-Pin TQFP
5M240ZM100A5N	100-Pin MBGA
5M240ZM68A5N	68-Pin MBGA
5M240ZT100A5N	100-Pin TQFP
5M240ZT144A5N	144-Pin TQFP
5M570ZF256A5N	256-Pin FBGA
5M570ZM100A5N	100-Pin MBGA
5M570ZT100A5N	100-Pin TQFP
5M570ZT144A5N	144-Pin TQFP
5M1270ZF256A5N	256-Pin FBGA
5M1270ZF324A5N	324-Pin FBGA
5M1270ZT144A5N	144-Pin TQFP
5M2210ZF256A5N	256-Pin FBGA
5M2210ZF324A5N	324-Pin FBGA

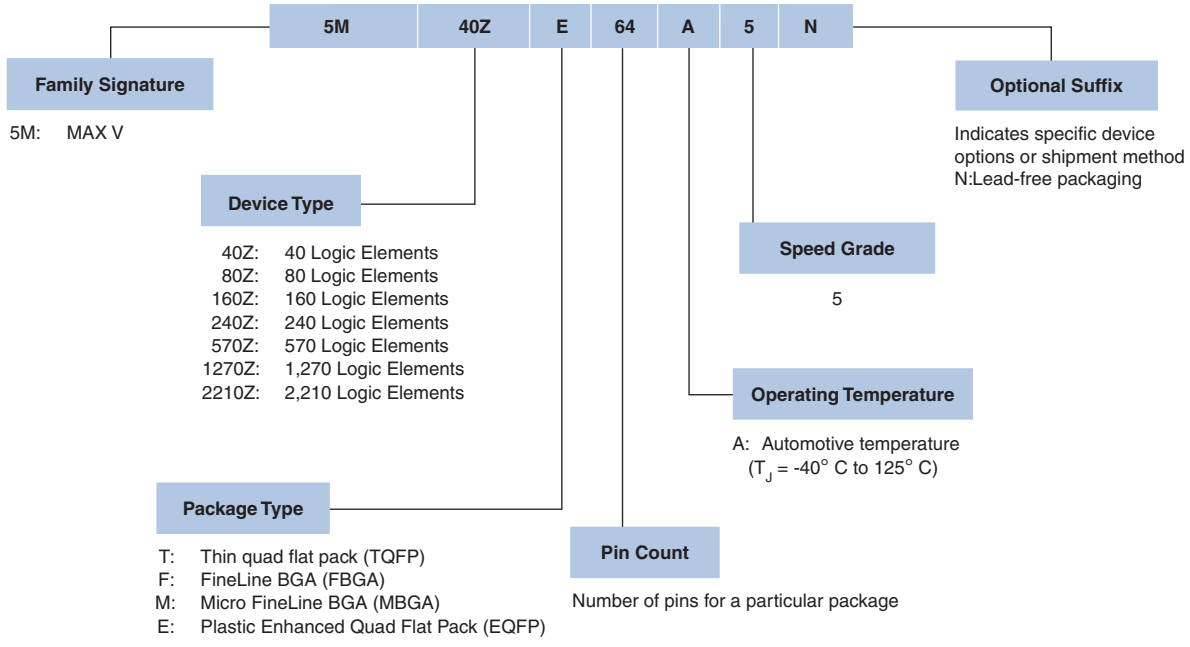
This chapter contains the following sections:

Device Ordering Codes

Figure 4–1 shows the ordering codes for automotive-grade devices offered in the MAX V device family.

For more information about a specific package, refer to the *Package Information Datasheet for Altera Devices*.

Figure 4–1. Automotive-Grade Ordering Information for MAX V Devices



Quartus II Software Support

The Altera® Quartus® II design software supports the MAX V devices in the automotive temperature range. The Quartus II software includes HDL and schematic design entry, compilation and logic synthesis, full simulation and advanced timing analysis, and device programming.

For more information about the Quartus II software features, refer to the *Quartus II Handbook*.

To target an automotive-grade MAX V device in your design in the Quartus II software, follow these steps:

1. On the Assignments menu, click **Device**. The **Settings** dialog box appears.
2. In the **Family** drop-down list, select **MAX V**.
3. Under Target device, select **Specific device selected in 'Available devices' list**.
4. In the **Available devices** list, select the appropriate ordering code, as listed in Table 4–1.

   The Quartus II software does not show the "N" suffix, which indicates a lead-free device. For example, the device 5M40ZE64A5N is shown only as 5M40ZE64A5.

5. Click **OK**.

Support for the automotive-grade MAX V devices is only available in the Quartus II software version 11.0 and later.

Power Analysis and Estimation

Altera provides the following power analysis and estimation tools for your design:

- "PowerPlay Early Power Estimator"
- "PowerPlay Power Analyzer"

PowerPlay Early Power Estimator

The PowerPlay Early Power Estimator (EPE) is a power estimation tool that helps you estimate the power consumption of your design during the system planning phase for proper power supply planning and consideration. The EPE allows you to enter design information based on architectural features and calculates the power consumed by each architectural feature. Inputs to the EPE are environmental conditions and device resources (such as clock frequency) that you expect to use in your design. The EPE then calculates the static and dynamic power, current estimates, and thermal analysis for your design.

You can either enter the design information manually into the spreadsheet or import a power estimator file of a fully or partially completed design from the Quartus II software. After importing a file, you can edit some of the input parameters including V_{CCINT}, ambient temperature, airflow, clock frequency, and toggle percentage to suit your system requirements.

The value obtained from the EPE is only an estimation and should not be used as a specification. The accuracy of the EPE results depends on how close your input of the design information into the EPE resembles that of the final design.

For more information about the EPE, and how to generate and import the power estimator file, refer to the *PowerPlay Early Power Estimator for Altera CPLDs User Guide*.

PowerPlay Power Analyzer

The PowerPlay Power Analyzer tool in the Quartus II software is a power analysis tool that helps you calculate your design power consumption accurately to ensure thermal and power supply budgets are not violated after your design is complete. The PowerPlay Power Analyzer tool requires your design to be synthesized and fitted to the target device. Availability of information such as design resources, how the design is placed and routed on the target device, and the I/O standards assigned to each I/O cell allow the PowerPlay Power Analyzer tool to provide accurate power estimation.

The process of using the PowerPlay Power Analyzer tool consists of three parts—specifying sources of input data, specifying operating conditions, and running the PowerPlay Power Analyzer tool.

The input data consists of the signal activities data (toggle rates and static probabilities) of the compiled design. Signal activity data can be derived from simulation results, user assignment in the Assignment Editor, user-defined default toggle rate, and vectorless estimation.

The operating conditions include device power characteristic, ambient and junction temperature, cooling solution, and board thermal model, all of which can be set in the Quartus II software.

The PowerPlay Power Analyzer tool calculates the dynamic, static and I/O thermal power consumption, current consumed from voltage source, a summary of the signal activities used for analysis, and a confidence metric that reflects the overall quality of the data sources for the signal activities.

For more information about the PowerPlay Power Analyzer tool, refer to the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

DC and Timing Specifications

The automotive-grade MAX V devices have the same absolute maximum ratings, recommended operating conditions, and DC electrical characteristics as those published for the MAX V devices in the *DC and Switching Characteristics for MAX V Devices* chapter of the *MAX V Device Handbook*.

The timing specifications of the automotive-grade MAX V devices are the same as those published for the MAX V devices in the *DC and Switching Characteristics for MAX V Devices* chapter of the *MAX V Device Handbook*. The automotive-grade devices meet these timing specifications over the automotive temperature range (–40°C to 125°C).

Table 4–2 lists the automotive-grade ordering codes and their equivalent timing specifications for MAX V devices.

Table 4–2. Automotive-Grade Ordering Codes and Their Equivalent Timing Specifications for MAX V Devices

Automotive-Grade Device Ordering Code	Device Timing Specification		
	Device	Temperature Range	Speed Grade
5M40ZE64A5N	5M40Z	–40°C to 125°C	–5
5M40ZM64A5N	5M40Z	–40°C to 125°C	–5
5M80ZE64A5N	5M80Z	–40°C to 125°C	–5
5M80ZM64A5N	5M80Z	–40°C to 125°C	–5
5M80ZM68A5N	5M80Z	–40°C to 125°C	–5
5M80ZT100A5N	5M80Z	–40°C to 125°C	–5
5M160ZE64A5N	5M160Z	–40°C to 125°C	–5
5M160ZM100A5N	5M160Z	–40°C to 125°C	–5
5M160ZM68A5N	5M160Z	–40°C to 125°C	–5
5M160ZT100A5N	5M160Z	–40°C to 125°C	–5
5M240ZM100A5N	5M240Z	–40°C to 125°C	–5
5M240ZM68A5N	5M240Z	–40°C to 125°C	–5
5M240ZT100A5N	5M240Z	–40°C to 125°C	–5
5M240ZT144A5N	5M240Z	–40°C to 125°C	–5
5M570ZF256A5N	5M570Z	–40°C to 125°C	–5
5M570ZM100A5N	5M570Z	–40°C to 125°C	–5
5M570ZT100A5N	5M570Z	–40°C to 125°C	–5
5M570ZT144A5N	5M570Z	–40°C to 125°C	–5
5M1270ZF256A5N	5M1270Z	–40°C to 125°C	–5
5M1270ZF324A5N	5M1270Z	–40°C to 125°C	–5
5M1270ZT144A5N	5M1270Z	–40°C to 125°C	–5
5M2210ZF256A5N	5M2210Z	–40°C to 125°C	–5
5M2210ZF324A5N	5M2210Z	–40°C to 125°C	–5

Pin-Out Information

For more information about the MAX V device pin-outs, refer to the MAX V Device Pin-Out Files page.

Package and Board Layout Information

For package-related information (for example, dimensions and thermal resistance values) about MAX V devices, refer to the *Package Information Datasheet for Altera Devices*.

For PCB design guidelines, refer to *AN114: Designing With High-Density BGA Packages for Altera Devices*.

If you are designing PCBs with the Cadence OrCAD capture component information system, you can download the symbol libraries from the Cadence Capture CIS and Allegro PCB Symbols and Footprints page.

Document Revision History

Table 4–3 lists the revision history for this chapter.

Table 4–3. Document Revision History

Date	Version	Changes
May 2011	1.0	Initial release.

5. Cyclone Devices

Supported Automotive-Grade Devices

Altera offers Cyclone® devices in the automotive temperature range. These devices are available only in the –8 speed grade.

Table 5–1 lists the automotive-grade devices in the Cyclone device family.

Table 5–1. Automotive-Grade in Cyclone Devices

Device Ordering Code	Package
EP1C3T100A8N	100-Pin TQFP
EP1C3T144A8N	144-Pin TQFP

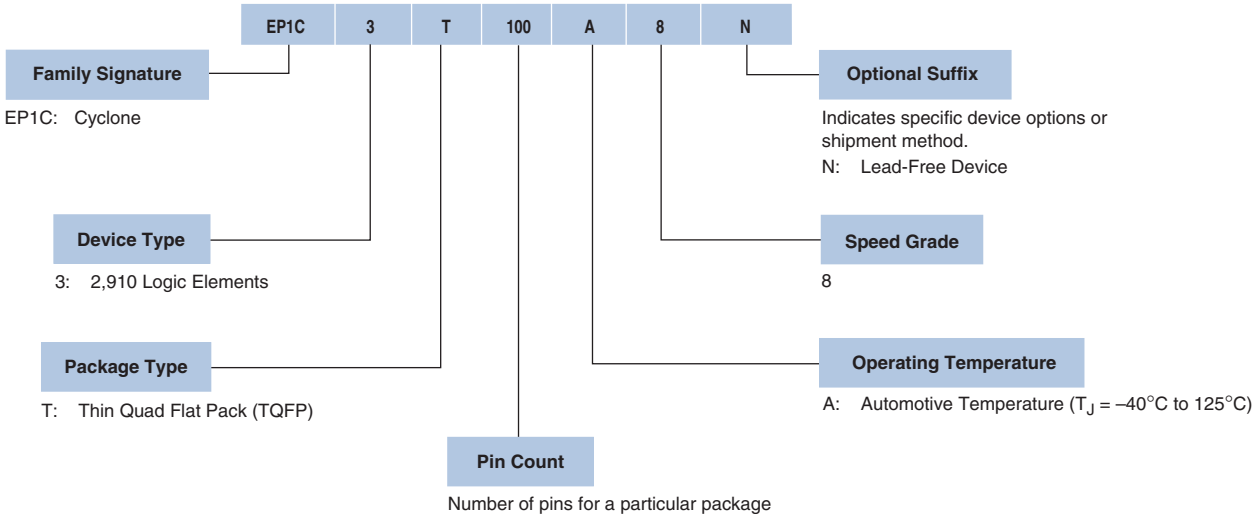
This chapter contains the following sections:

Device Ordering Codes

Figure 5–1 shows the ordering codes for automotive-grade devices offered in the Cyclone device family.

For more information on a specific package, refer to the *Package Information Datasheet for Altera Devices*.

Figure 5–1. Automotive-Grade Ordering Information for Cyclone Devices



Quartus II Software Support

The Altera® Quartus® II design software supports the Cyclone devices in the automotive temperature range. The Quartus II software provides a comprehensive environment for system on a chip (SoC) design. It also includes HDL and schematic design entry, compilation and logic synthesis, full simulation and advanced timing analysis, SignalTap™ II logic analyzer, and device configuration.

For more information about the Quartus II software features, refer to the *Quartus II Handbook*.

To target an automotive-grade Cyclone device in your design in the Quartus II software, follow these steps:

1. On the Assignments menu, click **Device**. The **Settings** dialog box appears.
2. In the **Family** drop-down list, select **Cyclone**.
3. Under Target device, select **Specific device selected in 'Available devices' list**.

4. In the **Available devices** list, select the appropriate ordering code, as listed in Table 5–1.

   The Quartus II software does not show the "N" suffix, which indicates a lead-free device. For example, the EP1C3T100A8N device is shown only as EP1C3T100A8.

5. Click **OK**.

Support for the automotive-grade Cyclone devices is only available in the Quartus II software version 7.2 SP1 and later.

Power Analysis and Estimation

Altera provides the following power analysis and estimation tools for your design:

- "PowerPlay Early Power Estimator"
- "PowerPlay Power Analyzer"

PowerPlay Early Power Estimator

The PowerPlay Early Power Estimator (EPE) is a power estimation tool that helps you estimate the power consumption of your design during the system planning phase for proper power supply planning and consideration. The EPE allows you to enter design information based on architectural features and calculates the power consumed by each architectural feature. Inputs to the EPE are environmental conditions and device resources (such as clock frequency, RAM blocks, and digital signal processing [DSP] blocks) that you expect to use in your design. The EPE then calculates the static and dynamic power, current estimates, and thermal analysis for your design.

You can either enter the design information manually into the spreadsheet or import a power estimator file of a fully or partially completed design from the Quartus II software. After importing a file, you can edit some of the input parameters including V_{CCINT}, ambient temperature, airflow, clock frequency, and toggle percentage to suit your system requirements.

The value obtained from the EPE is only an estimation and should not be used as a specification. The accuracy of the EPE results depends on how close your input of the design information into the EPE resembles that of the final design.

For more information about the EPE, and how to generate and import the power estimator file, refer to the *PowerPlay Early Power Estimator User Guide for Stratix, Stratix GX, and Cyclone FPGAs*.

PowerPlay Power Analyzer

The PowerPlay Power Analyzer tool in the Quartus II software is a power analysis tool that helps you calculate your design power consumption accurately to ensure thermal and power supply budgets are not violated after your design is complete. The PowerPlay Power Analyzer tool requires your design to be synthesized and fitted to the target device. Availability of information such as design resources, how the design is placed and routed on the target device, and the I/O standards assigned to each I/O cell allow the PowerPlay Power Analyzer tool to provide accurate power estimation.

The process of using the PowerPlay Power Analyzer tool consists of three parts—specifying sources of input data, specifying operating conditions, and running the PowerPlay Power Analyzer tool.

The input data consists of the signal activities data (toggle rates and static probabilities) of the compiled design. Signal activity data can be derived from simulation results, user assignment in the Assignment Editor, user-defined default toggle rate, and vectorless estimation.

The operating conditions include device power characteristic, ambient and junction temperature, cooling solution, and board thermal model, all of which can be set in the Quartus II software.

The PowerPlay Power Analyzer tool calculates the dynamic, static and I/O thermal power consumption, current consumed from voltage source, a summary of the signal activities used for analysis, and a confidence metric that reflects the overall quality of the data sources for the signal activities.

For more information about the PowerPlay Power Analyzer tool, refer to the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

DC and Timing Specifications

Automotive-grade Cyclone devices have the same absolute maximum ratings, recommended operating conditions, and DC electrical characteristics as those published for the Cyclone devices in the *DC and Switching Characteristics* chapter of the *Cyclone Device Handbook*. For the maximum power-up current (I_{CCINT}) required to power up an automotive-grade Cyclone device, use the value specified for the corresponding industrial-grade device.

The timing specifications of the automotive-grade Cyclone devices are the same as those published for the Cyclone devices in the *DC and Switching Characteristics* chapter of the *Cyclone Device Handbook*. The automotive-grade devices meet these timing specifications over the automotive temperature range (–40°C to 125°C).

Table 5–2 lists the automotive-grade ordering codes and their equivalent timing specifications for Cyclone devices.

Table 5–2. Automotive-Grade Ordering Codes and Their Equivalent Timing Specifications for Cyclone Devices

Automotive-Grade Device Ordering Code	Device Timing Specification		
	Device	Temperature Range	Speed Grade
EP1C3T100A8N	EP1C3	–40°C to 125°C	–8
EP1C3T144A8N	EP1C3	–40°C to 125°C	–8

Pin-Out Information

For more information about the Cyclone device pin-outs, refer to the Cyclone Device Pin-Out Files page.

Package and Board Layout Information

For package-related information (for example, dimensions and thermal resistance values) on Cyclone devices, refer to the *Package Information Datasheet for Altera Devices*.

For PCB design guidelines, refer to *AN114: Designing With High-Density BGA Packages for Altera Devices*.

If you are designing PCBs with the Cadence OrCAD capture component information system, you can download the symbol libraries from the *Cadence Capture CIS and Allegro PCB Symbols and Footprints* page.

Document Revision History

Table 5–3 lists the revision history for this chapter.

Table 5–3. Document Revision History

Date	Version	Changes
May 2011	2.0	■ Template conversion. ■ Minor text edits.
March 2010	1.2	Removed Referenced Documents section.
October 2008	1.1	Converted to new template.
February 2008	1.0	Initial release.

6. Cyclone II Devices

Supported Automotive-Grade Devices

Altera offers Cyclone® II devices in the automotive temperature range. These devices are available in the –7 speed grade.

Table 6–1 lists the automotive-grade devices in the Cyclone II device family.

Table 6–1. Automotive-Grade in Cyclone II Devices

Device Ordering Code	Package
EP2C5AT144A7N	144-Pin TQFP
EP2C5AF256A7N	256-Pin FineLine BGA
EP2C8AF256A7N	256-Pin FineLine BGA
EP2C15AF256A7N	256-Pin FineLine BGA
EP2C15AF484A7N	484-Pin FineLine BGA
EP2C20AF256A7N	256-Pin FineLine BGA
EP2C20AF484A7N	484-Pin FineLine BGA

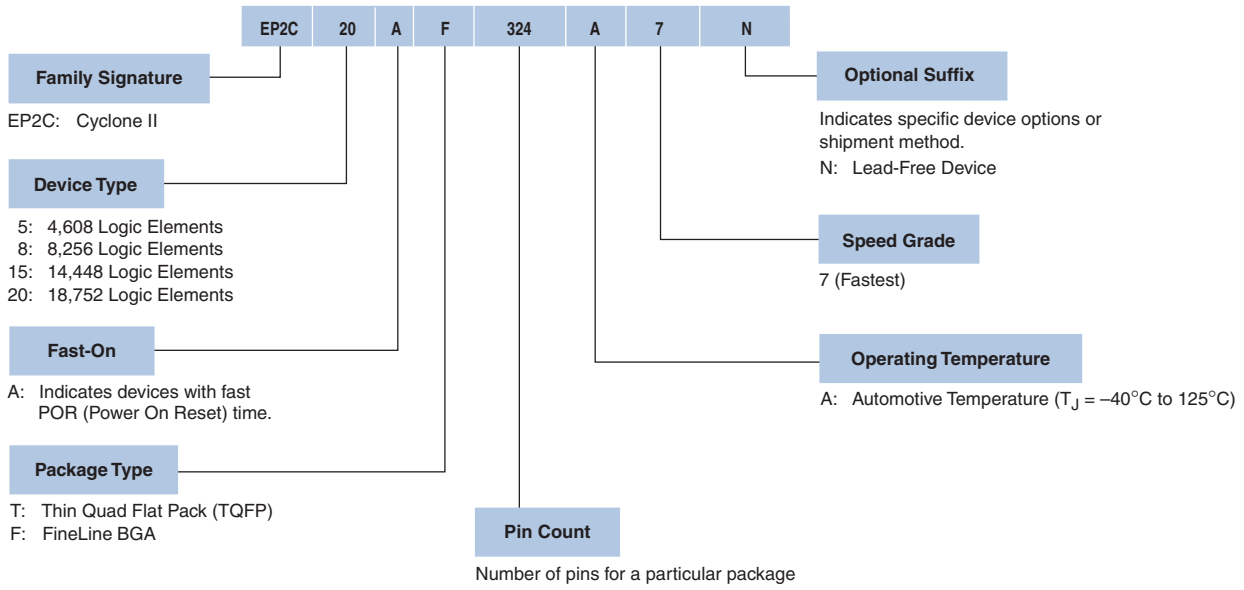
This chapter contains the following sections:

Device Ordering Codes

Figure 6–1 shows the ordering codes for automotive-grade devices offered in the Cyclone II device family.

For more information about a specific package, refer to the *Package Information Datasheet for Altera Devices*.

Figure 6–1. Automotive-Grade Ordering Information for Cyclone II Devices



Quartus II Software Support

The Altera® Quartus® II design software supports the Cyclone II devices in the automotive temperature range. The Quartus II software provides a comprehensive environment for system on a chip (SoC) design. It also includes HDL and schematic design entry, compilation and logic synthesis, full simulation and advanced timing analysis, SignalTap™ II logic analyzer, and device configuration.

For more information about the Quartus II software features, refer to the *Quartus II Handbook*.

To target an automotive-grade Cyclone II device in your design in the Quartus II software, follow these steps:

1. On the Assignments menu, click **Device**. The **Settings** dialog box appears.
2. In the **Family** drop-down list, select **Cyclone II**.
3. Under Target device, select **Specific device selected in 'Available devices' list**.

4. In the **Available devices** list, select the appropriate ordering code, as listed in Table 6–1.

   The Quartus II software does not show the "N" suffix, which indicates a lead-free device. For example, the EP2C5AT144A7N device is shown only as EP2C5AT144A7.

5. Click **OK**.

Support for the automotive-grade Cyclone II devices is only available in the Quartus II software version 7.2 SP1 and later.

Power Analysis and Estimation

Altera provides the following power analysis and estimation tools for your design:

- "PowerPlay Early Power Estimator"
- "PowerPlay Power Analyzer"

PowerPlay Early Power Estimator

The PowerPlay Early Power Estimator (EPE) is a power estimation tool that helps you estimate the power consumption of your design during the system planning phase for proper power supply planning and consideration. The EPE allows you to enter design information based on architectural features and calculates the power consumed by each architectural feature. Inputs to the EPE are environmental conditions and device resources (such as clock frequency, RAM blocks, and digital signal processing [DSP] blocks) that you expect to use in your design. The EPE then calculates the static and dynamic power, current estimates, and thermal analysis for your design.

You can either enter the design information manually into the spreadsheet or import a power estimator file of a fully or partially completed design from the Quartus II software. After importing a file, you can edit some of the input parameters including V_{CCINT}, ambient temperature, airflow, clock frequency, and toggle percentage to suit your system requirements.

The value obtained from the EPE is only an estimation and should not be used as a specification. The accuracy of the EPE results depends on how close your input of the design information into the EPE resembles that of the final design.

For more information about the EPE, and how to generate and import the power estimator file, refer to the *PowerPlay Early Power Estimator User Guide for Cyclone II FPGAs*.

PowerPlay Power Analyzer

The PowerPlay Power Analyzer tool in the Quartus II software is a power analysis tool that helps you calculate your design power consumption accurately to ensure thermal and power supply budgets are not violated after your design is complete. The PowerPlay Power Analyzer tool requires your design to be synthesized and fitted to the target device. Availability of information such as design resources, how the design is placed and routed on the target device, and the I/O standards assigned to each I/O cell allow the PowerPlay Power Analyzer tool to provide accurate power estimation.

The process of using the PowerPlay Power Analyzer tool consists of three parts—specifying sources of input data, specifying operating conditions, and running the PowerPlay Power Analyzer tool.

The input data consists of the signal activities data (toggle rates and static probabilities) of the compiled design. Signal activity data can be derived from simulation results, user assignment in the Assignment Editor, user-defined default toggle rate, and vectorless estimation.

The operating conditions include device power characteristic, ambient and junction temperature, cooling solution, and board thermal model, all of which can be set in the Quartus II software.

The PowerPlay Power Analyzer tool calculates the dynamic, static and I/O thermal power consumption, current consumed from voltage source, a summary of the signal activities used for analysis, and a confidence metric that reflects the overall quality of the data sources for the signal activities.

For more information about the PowerPlay Power Analyzer tool, refer to the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

DC and Timing Specifications

The automotive-grade Cyclone II devices have the same absolute maximum ratings, recommended operating conditions, and DC electrical characteristics as those published for the Cyclone II devices in the *DC Characteristics and Timing Specifications* chapter of the *Cyclone II Device Handbook*.

For on-chip series termination (R_S OCT), use the tolerance values for extended-temperature devices as the tolerance values for the automotive-grade Cyclone II devices.

For the timing specifications of the automotive-grade Cyclone II devices, refer to the *DC Characteristics and Timing Specifications* chapter of the *Cyclone II Device Handbook*.

The automotive-grade devices meet these timing specifications over the automotive temperature range (–40°C to 125°C). The fast corner timing specifications of the automotive-grade Cyclone II devices are the same as those of their corresponding industrial-grade devices.

Table 6–2 lists the automotive-grade ordering codes and their equivalent timing specifications for Cyclone II devices.

Table 6–2. Automotive-Grade Ordering Codes and Their Equivalent Timing Specifications for Cyclone II Devices

Automotive-Grade Device Ordering Code	Device Timing Specification		
	Device	Temperature Range	Speed Grade
EP2C5AT144A7N	EP2C5	–40°C to 125°C	–7
EP2C5AF256A7N	EP2C5	–40°C to 125°C	–7
EP2C8AF256A7N	EP2C8	–40°C to 125°C	–7
EP2C15AF256A7N	EP2C15	–40°C to 125°C	–7
EP2C15AF484A7N	EP2C15	–40°C to 125°C	–7
EP2C20AF256A7N	EP2C20	–40°C to 125°C	–7

Pin-Out Information

For more information about the Cyclone II device pin-outs, refer to the Cyclone II Device Pin-Out Files page.

Package and Board Layout Information

For package-related information (for example, dimensions and thermal resistance values) on Cyclone II devices, refer to the *Package Information Datasheet for Altera Devices*.

For PCB design guidelines, refer to *AN114: Designing With High-Density BGA Packages for Altera Devices*.

If you are designing PCBs with the Cadence OrCAD capture component information system, you can download the symbol libraries from the *Cadence Capture CIS and Allegro PCB Symbols and Footprints* page.

Document Revision History

Table 6–3 lists the revision history for this chapter.

Table 6–3. Document Revision History

Date	Version	Changes
May 2011	2.0	■ Template conversion. ■ Minor text edits.
March 2010	1.2	Removed Referenced Documents section.
October 2008	1.1	■ Converted to new template. ■ Updated "DC and Timing Specifications" section.
February 2008	1.0	Initial release.

Supported Automotive-Grade Devices

Altera offers Cyclone® IV devices in the automotive temperature range. These devices are available only in the –7 speed grade.

Table 7–1 lists the automotive-grade devices in the Cyclone IV device family.

Table 7–1. Automotive-Grade in Cyclone IV Devices

Device Ordering Code	Package
EP4CE6E22A7N	144-Pin EQFP
EP4CE10E22A7N	144-Pin EQFP
EP4CE22E22A7N	144-Pin EQFP
EP4CE6F17A7N	256-Pin FBGA
EP4CE10F17A7N	256-Pin FBGA
EP4CE15F17A7N	256-Pin FBGA
EP4CE22F17A7N	256-Pin FBGA
EP4CE15F23A7N	484-Pin FBGA
EP4CE30F23A7N	484-Pin FBGA
EP4CE40F23A7N	484-Pin FBGA

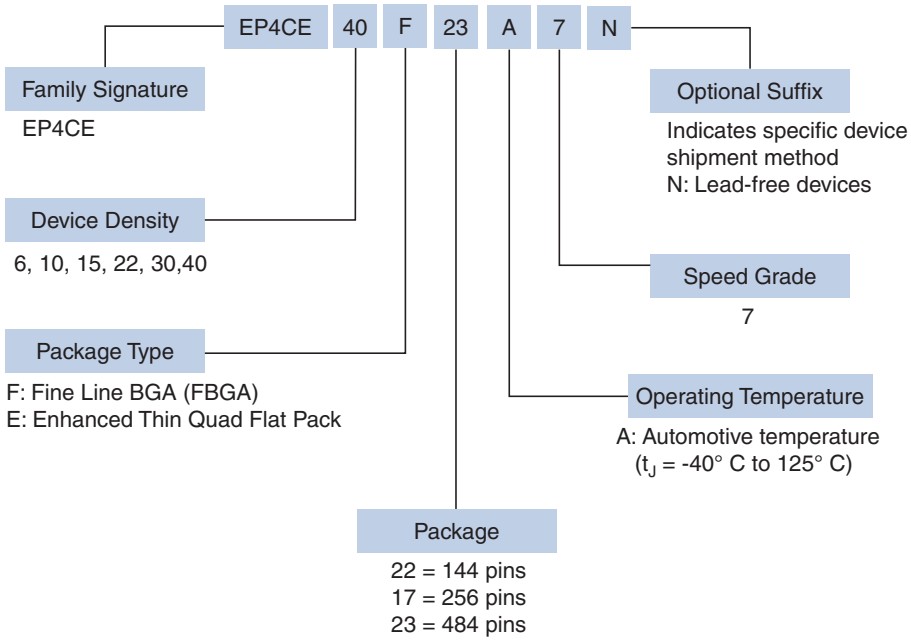
This chapter contains the following sections:

Device Ordering Codes

Figure 7–1 shows the ordering codes for automotive-grade devices offered in the Cyclone IV device family.

For more information about a specific package, refer to the *Package Information Datasheet for Altera Devices*.

Figure 7–1. Automotive-Grade Ordering Information for Cyclone IV Devices



Quartus II Software Support

The Altera® Quartus® II design software supports the Cyclone IV devices in the automotive temperature range. The Quartus II software provides a comprehensive environment for system on a chip (SoC) design. It also includes HDL and schematic design entry, compilation and logic synthesis, full simulation and advanced timing analysis, SignalTap™ II logic analyzer, and device configuration.

For more information about the Quartus II software features, refer to the *Quartus II Handbook*.

To target an automotive-grade Cyclone IV device in your design in the Quartus II software, follow these steps:

1. On the Assignments menu, click **Device**. The **Settings** dialog box appears.
2. In the **Family** drop-down list, select **Cyclone IV**.
3. Under Target device, select **Specific device selected in 'Available devices' list**.

4. In the **Available devices** list, select the appropriate ordering code, as listed in Table 7–1.

   The Quartus II software does not show the "N" suffix, which indicates a lead-free device. For example, the EP4CE6F17A7N device is shown only as EP4CE6F17A7.

5. Click **OK**.

Support for the automotive-grade Cyclone IV devices is only available in the Quartus II software version v9.1 SP2 and later.

Power Analysis and Estimation

Altera provides the following power analysis and estimation tools for your design:

- "PowerPlay Early Power Estimator"
- "PowerPlay Power Analyzer"

PowerPlay Early Power Estimator

The PowerPlay Early Power Estimator (EPE) is a power estimation tool that helps you estimate the power consumption of your design during the system planning phase for proper power supply planning and consideration. The EPE allows you to enter design information based on architectural features and calculates the power consumed by each architectural feature. Inputs to the EPE are environmental conditions and device resources (such as clock frequency, RAM blocks, and digital signal processing [DSP] blocks) that you expect to use in your design. The EPE then calculates the static and dynamic power, current estimates, and thermal analysis for the design.

You can either enter the design information manually into the spreadsheet or import a power estimator file of a fully or partially completed design from the Quartus II software. After importing a file, you can edit some of the input parameters including V_{CCINT}, ambient temperature, airflow, clock frequency, and toggle percentage to suit your system requirements.

The value obtained from the EPE is only an estimation and should not be used as a specification. The accuracy of the EPE results depends on how close your input of the design information into the EPE resembles that of the final design.

For more information about the EPE, and how to generate and import the power estimator file, refer to the *PowerPlay Early Power Estimator User Guide*.

PowerPlay Power Analyzer

The PowerPlay Power Analyzer tool in the Quartus II software is a power analysis tool that helps you calculate your design power consumption accurately to ensure thermal and power supply budgets are not violated after your design is complete. The PowerPlay Power Analyzer tool requires your design to be synthesized and fitted to the target device. Availability of information such as design resources, how the design is placed and routed on the target device, and the I/O standards assigned to each I/O cell allow the PowerPlay Power Analyzer tool to provide accurate power estimation.

The process of using the PowerPlay Power Analyzer tool consists of three parts—specifying sources of input data, specifying operating conditions, and running the PowerPlay Power Analyzer tool.

The input data consists of the signal activities data (toggle rates and static probabilities) of the compiled design. Signal activity data can be derived from simulation results, user assignment in the Assignment Editor, user-defined default toggle rate, and vectorless estimation.

The operating conditions include device power characteristic, ambient and junction temperature, cooling solution, and board thermal model, all of which can be set in the Quartus II software.

The PowerPlay Power Analyzer tool calculates the dynamic, static and I/O thermal power consumption, current consumed from voltage source, a summary of the signal activities used for analysis, and a confidence metric that reflects the overall quality of the data sources for the signal activities.

For more information about the PowerPlay Power Analyzer tool, refer to the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

DC and Timing Specifications

The automotive-grade Cyclone IV devices have the same absolute maximum ratings, recommended operating conditions, and DC electrical characteristics as those published for the Cyclone IV devices in the *Cyclone IV Device Datasheet* chapter in volume 3 of the *Cyclone IV Device Handbook*.

The on-chip series termination (R_S OCT) specifications of the automotive-grade Cyclone IV devices are the same as those of their corresponding industrial-grade Cyclone IV devices. The switching characteristics of the automotive-grade devices are the same as those of the Cyclone IV devices with –8 speed grade published in the *Cyclone IV Device Datasheet* chapter in volume 3 of the *Cyclone IV Device Handbook*.

For the timing specifications of the automotive-grade Cyclone IV devices, refer to the *Cyclone IV Device Datasheet* chapter in the volume 3 of the *Cyclone IV Device Handbook*.

The automotive-grade devices meet these timing specifications over the automotive temperature range (–40°C to 125°C).

Table 7–2 lists the automotive-grade ordering codes and their equivalent timing specifications for Cyclone IV devices.

Table 7–2. Automotive-Grade Ordering Codes and Their Equivalent Timing Specifications for Cyclone IV Devices

Automotive-Grade Device Ordering Code	Device Timing Specification		
	Device	Temperature Range	Speed Grade
EP4CE6F17A7N	EP4CE6	–40°C to 125°C	–7
EP4CE6E22A7N	EP4CE6	–40°C to 125°C	–7
EP4CE10F17A7N	EP4CE10	–40°C to 125°C	–7
EP4CE10E22A7N	EP4CE10	–40°C to 125°C	–7
EP4CE15F17A7N	EP4CE15	–40°C to 125°C	–7
EP4CE15F23A7N	EP4CE15	–40°C to 125°C	–7
EP4CE22F17A7N	EP4CE22	–40°C to 125°C	–7
EP4CE22E22A7N	EP4CE22	–40°C to 125°C	–7
EP4CE30F23A7N	EP4CE30	–40°C to 125°C	–7
EP4CE40F23A7N	EP4CE40	–40°C to 125°C	–7

Pin-Out Information

For more information about the Cyclone IV device pin-outs, refer to the Cyclone IV Device Pin-Out Files page.

Package and Board Layout Information

For package-related information (for example, dimensions and thermal resistance values) on Cyclone IV devices, refer to the *Package Information Datasheet for Altera Devices*.

For PCB design guidelines, refer to *AN114: Designing With High-Density BGA Packages for Altera Devices*.

If you are designing PCBs with the Cadence OrCAD capture component information system, you can download the symbol libraries from the *Cadence Capture CIS and Allegro PCB Symbols and Footprints* page.

Document Revision History

Table 7–3 lists the revision history for this chapter.

Table 7–3. Document Revision History

Date	Version	Changes
May 2011	2.0	■ Updated part number from AUT51006 to AUT51008. ■ Template conversion. ■ Minor text edits.
March 2010	1.0	Initial release.

8. HardCopy II Devices

Supported Automotive-Grade Devices

Altera offers HardCopy® II devices in the automotive temperature range. Table 8–1 lists the automotive-grade devices in the HardCopy II device family.

Table 8–1. Automotive-Grade in HardCopy II Devices

Device Ordering Code	Package
HC210WF484 *(1)*	484-Pin FineLine BGA

Note to Table 8–1:

(1) The HC210W device is in a wire bond package.

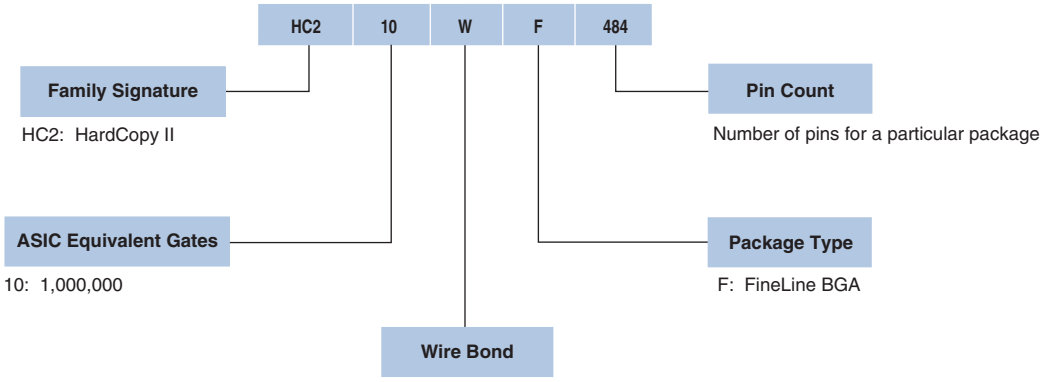
This chapter contains the following sections:

Device Ordering Codes

Figure 8–1 shows the ordering codes for automotive-grade devices offered in the HardCopy II device family.

For more information about a specific package, refer to the *Package Information Datasheet for Altera Devices*.

Figure 8–1. Automotive-Grade Ordering Information for HardCopy II Devices



Quartus II Software Support

The Altera® Quartus® II design software supports the HardCopy II devices in the automotive temperature range. The Quartus II software provides a comprehensive environment for system on a chip (SoC) design. It also includes HDL and schematic design entry, compilation and logic synthesis, full simulation and advanced timing analysis, SignalTap™ II logic analyzer, and device configuration.

For more information about using the Quartus II software for the HardCopy II development flow and settings, refer to the *Quartus II Support for HardCopy II Devices* chapter in volume 1 of the *HardCopy II Device Handbook*.

To target an automotive-grade HardCopy II device in your design in the Quartus II software, follow these steps:

1. On the Assignments menu, click **Device**. The **Settings** dialog box appears.
2. In the **Family** drop-down list, select **HardCopy II**.
3. Under Target device, select **Specific device selected in 'Available devices' list**.
4. In the **Available devices** list, select the appropriate ordering code, as listed in Table 8–1.
5. Click **OK**.

Support for the automotive-grade HardCopy II devices is only available in the Quartus II software version 7.2 SP1 and later.

Power Analysis and Estimation

Altera provides the following power analysis and estimation tools for your design:

- "PowerPlay Early Power Estimator"
- "PowerPlay Power Analyzer"

PowerPlay Early Power Estimator

The PowerPlay Early Power Estimator (EPE) is a power estimation tool that helps you estimate the power consumption of your design during the system planning phase for proper power supply planning and consideration. The EPE allows you to enter design information based on architectural features and calculates the power consumed by each architectural feature. Inputs to the EPE are environmental conditions and device resources (such as clock frequency) that you expect to use in your design. The EPE then calculates the static and dynamic power, current estimates, and thermal analysis for your design.

You can either enter the design information manually into the spreadsheet or import a power estimator file of a fully or partially completed design from the Quartus II software. After importing a file, you can edit some of the input parameters including V_{CCINT}, ambient temperature, airflow, clock frequency, and toggle percentage to suit your system requirements.

The value obtained from the EPE is only an estimation and should not be used as a specification. The accuracy of the EPE results depends on how close your input of the design information into the EPE resembles that of the final design.

PowerPlay Power Analyzer

The PowerPlay Power Analyzer tool in the Quartus II software is a power analysis tool that helps you calculate your design power consumption accurately to ensure thermal and power supply budgets are not violated after your design is complete. The PowerPlay Power Analyzer tool requires your design to be synthesized and fitted to the target device. Availability of information such as design resources, how the design is placed and routed on the target device, and the I/O standards assigned to each I/O cell allow the PowerPlay Power Analyzer tool to provide accurate power estimation.

The process of using the PowerPlay Power Analyzer tool consists of three parts—specifying sources of input data, specifying operating conditions, and running the PowerPlay Power Analyzer tool.

The input data consists of the signal activities data (toggle rates and static probabilities) of the compiled design. Signal activity data can be derived from simulation results, user assignment in the Assignment Editor, user-defined default toggle rate, and vectorless estimation.

The operating conditions include device power characteristic, ambient and junction temperature, cooling solution, and board thermal model, all of which can be set in the Quartus II software.

The PowerPlay Power Analyzer tool calculates the dynamic, static and I/O thermal power consumption, current consumed from voltage source, a summary of the signal activities used for analysis, and a confidence metric that reflects the overall quality of the data sources for the signal activities.

For more information about the PowerPlay Power Analyzer tool, refer to the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

DC and Timing Specifications

The automotive-grade HardCopy II devices have the same absolute maximum ratings, recommended operating conditions, and DC electrical characteristics as their equivalent industrial-grade devices. The timing specifications is equivalent to the speed grade of the prototype FPGA, except when noted as part of the HardCopy II timing specification design review process.

The operating junction temperature, T_j, for the automotive-grade HardCopy II devices is from –40°C to 125°C.

For more information about the DC characteristics of the industrial-grade HardCopy II devices, refer to the *DC and Switching Specifications and Operating Conditions* chapter in volume 1 of the *HardCopy II Device Handbook*.
However, the following exceptions apply:

- The delay-locked loop (DLL) frequency range is bounded by the minimum frequencies listed in Table 8–2.

  Table 8–2 lists the minimum DLL frequency for each frequency mode.

Table 8–2. Minimum DLL Frequency

Mode	Frequency (MHz)
Frequency Mode 0	120
Frequency Mode 1	170
Frequency Mode 2	220
Frequency Mode 3	270

- Non-calibrated on-chip termination (OCT) is bounded by:
  - ±40% for series resistance.
  - ±50% for 1.2-V series resistance.
- Hot-socketing DC limit is raised to 350 µA.
- The I/O f_{MAX} values of automotive-grade HardCopy II devices are 15% lower than their equivalent industrial-grade HardCopy II devices and correspond to the commercial-grade Stratix® II devices of –5 speed. The I/O f_{MAX} values of the industrial-grade HardCopy II devices will be updated in a later revision of the *DC and Switching Specifications and Operating Conditions* chapter in volume 1 of the *HardCopy II Device Handbook*.

For the maximum I/O clock toggle rate specifications in commercial-grade Stratix II devices of –5 speed, refer to the *DC and Switching Characteristics* chapter in volume 1 of the *Stratix II Device Handbook*.

- For LVDS I/O of 2.5 V, the minimum V_{OCM} is 1.1 V and the minimum differential output voltage (V_{OD}) is 240 mV.

Pin-Out Information

For more information about the HardCopy II device pin-outs, refer to the HardCopy II Device Pin-Out Files page.

Package and Board Layout Information

For package-related information (for example, dimensions and thermal resistance values) on HardCopy II devices, refer to the *Package Information Datasheet for Altera Devices*.

For PCB design guidelines, refer to *AN114: Designing With High-Density BGA Packages for Altera Devices*.

Document Revision History

Table 8–3 lists the revision history for this chapter.

Table 8–3. Document Revision History

Date	Version	Changes
May 2011	2.0	■ Template conversion. ■ Minor text edits.
March 2010	1.2	Removed Referenced Documents section.
October 2008	1.1	Converted to new template.
February 2008	1.0	Initial release.

This handbook provides comprehensive information about the Altera® automotive-grade devices.

How to Contact Altera

For the most up-to-date information about Altera products, refer to the following table.

Contact *(1)*	Contact Method	Address
Technical support	Website	www.altera.com/support
Technical training	Website	www.altera.com/training
	Email	custrain@altera.com
Product literature	Website	www.altera.com/literature
Altera literature services	Email	literature@altera.com
Non-technical support (General)	Email	nacomp@altera.com
(Software Licensing)	Email	authorization@altera.com
(Quality)	Email	customer-quality@altera.com

Note:

(1) You can also contact your local Altera sales office or sales representative.

Typographic Conventions

The following table lists the typographic conventions this handbook uses.

Visual Cue	Meaning
Bold Type with Initial Capital Letters	Command names, dialog box titles, checkbox options, and dialog box options are shown in bold, initial capital letters. Example: **Save As** dialog box.
bold type	External timing parameters, directory names, project names, disk drive names, filenames, filename extensions, and software utility names are shown in bold type. Examples: $\mathbf{f_{MAX}}$, **\qdesigns** directory, **d:** drive, **chiptrip.gdf** file.
Italic Type with Initial Capital Letters	Document titles are shown in italic type with initial capital letters. Example: *AN 75: High-Speed Board Design.*
Italic type	Internal timing parameters and variables are shown in italic type. Examples: t_{PIA}, $n + 1$. Variable names are enclosed in angle brackets (< >) and shown in italic type. Example: *<file name>*, *<project name>***.pof** file.
Initial Capital Letters	Keyboard keys and menu names are shown with initial capital letters. Examples: Delete key, the Options menu.

Visual Cue	Meaning
“Subheading Title”	References to sections in a document and titles of on-line help topics are shown in quotation marks. Example: “Typographic Conventions.”
`Courier type`	Signal and port names are shown in lowercase Courier type. Examples: `data1`, `tdi`, `input.` Active-low signals are denoted by suffix `n`, e.g., `resetn`. Anything that must be typed exactly as it appears is shown in Courier type. For example: `c:\qdesigns\tutorial\chiptrip.gdf`. Also, sections of an actual file, such as a Report File, references to parts of files (e.g., the AHDL keyword `SUBDESIGN`), as well as logic function names (e.g., `TRI`) are shown in Courier.
1., 2., 3., and a., b., c., etc.	Numbered steps are used in a list of items when the sequence of the items is important, such as the steps listed in a procedure.
■ ● •	Bullets are used in a list of items when the sequence of the items is not important.
✓	The checkmark indicates a procedure that consists of one step only.
	The hand points to information that requires special attention.
	The caution indicates required information that needs special consideration and understanding and should be read prior to starting or continuing with the procedure or process.
	The warning indicates information that should be read prior to starting or continuing the procedure or processes.
↵	The angled arrow indicates you should press the Enter key.
	The feet direct you to more information on a particular topic.