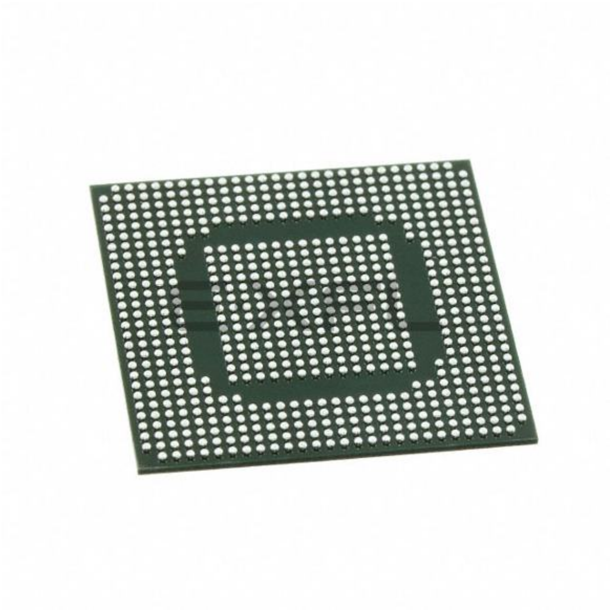
# Intel - 5CSEBA2U23A7N Datasheet



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## Embedded - System On Chip (SoC): The Heart of Modern Embedded Systems

Embedded - System On Chip (SoC) refers to an integrated circuit that consolidates all the essential components of a computer system into a single chip. This includes a microprocessor, memory, and other peripherals, all packed into one compact and efficient package. SoCs are designed to provide a complete computing solution, optimizing both space and power consumption, making them ideal for a wide range of embedded applications.

## What are Embedded - System On Chip (SoC)?

**System On Chip (SoC)** integrates multiple functions of a computer or electronic system onto a single chip. Unlike traditional multi-chip solutions, SoCs combine a central

| **Details** | |
|---|---|
| Product Status | Active |
| Architecture | MCU, FPGA |
| Core Processor | Dual ARM® Cortex®-A9 MPCore™ with CoreSight™ |
| Flash Size | - |
| RAM Size | 64KB |
| Peripherals | DMA, POR, WDT |
| Connectivity | CANbus, EBI/EMI, Ethernet, I²C, MMC/SD/SDIO, SPI, UART/USART, USB OTG |
| Speed | 700MHz |
| Primary Attributes | FPGA - 25K Logic Elements |
| Operating Temperature | -40°C ~ 125°C (TJ) |
| Package / Case | 672-FBGA |
| Supplier Device Package | 672-UBGA (23x23) |
| Purchase URL | https://www.e-xfl.com/product-detail/intel/5cseba2u23a7n |

Email: info@E-XFL.COM

Address: Room A, 16/F, Full Win Commercial Centre, 573 Nathan Road, Mongkok, Hong Kong

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- A Safety Methodology for ADAS Designs in FPGAs white paper
  Provides more information on Advanced Driver Assisted Systems (ADAS) applications.
- Next-Generation Transportation, Intel page
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  Provides more information on functional safety for automotive applications.
- Industrial Automation, Intel page
  Provides more information on functional safety for industrial automation.
- Intel Programmable Solutions Group ISO 9001:2015 Certification

## 1.3. Supported Device Families

**Table 1. Intel Automotive-Grade Device Families**

| Category | Product Family | Quartus Software Support (1) | Description |
|---|---|---|---|
| IC, FPGA | Intel Cyclone 10 LP | Version 17.1 and later | Low-cost, low-power, feature-rich FPGAs |
| IC, FPGA | Intel MAX® 10 | Version 14.0.2 and later | Low-cost, instant-on, small form factor programmable logic device, integrated analog module |
| IC, SoC | Cyclone V SoC | Version 12.1 and later | Low-cost, low-power, user-customizable ARM-based SoC devices |
| IC, FPGA | Cyclone V | Version 11.1 and later | Low-cost, low-power, feature-rich 28 nm FPGAs |
| IC, FPGA | Cyclone IV | Version 9.1 SP2 and later | Low-cost, low-power, feature-rich 60 nm FPGAs (1.2 V) |
| IC, CPLD | MAX V | Version 11.0 and later | High-density, low-power glue logic CPLDs (1.8 V) |
| IC, CPLD | MAX II | Version 7.2 SP1 and later | High-density, low-power glue logic CPLDs (3.3 V, 2.5 V) |
| IC, power | Intel Enpirion | — | Integrated inductor, combination of small footprint, low noise performance, and high efficiency |

| Volume Production Support for Legacy Device Families | | | |
|---|---|---|---|
| Category | Product Family | Quartus Software Support (2) | Description |
| IC, FPGA | Cyclone III | Version 8.0 to 13.1 | Low-cost, feature-rich 65 nm FPGAs |
| IC, FPGA | Cyclone II | Version 7.2 SP1 to 13.0 | Low-cost, feature-rich 90 nm FPGAs |
| IC, FPGA | Cyclone | Version 7.2 SP1 to 13.0 | Low-cost, glue logic 130 nm FPGAs |
| IC, CPLD | MAX 7000AE | Version 7.2 SP1 to 13.0 | High-performance, glue logic CPLDs (5-V I/O compatible) |

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(1) Starting from version 15.1, the Quartus II software is known as the Intel Quartus Prime Standard Edition software.

(2) The legacy devices are only supported in the Quartus II software.

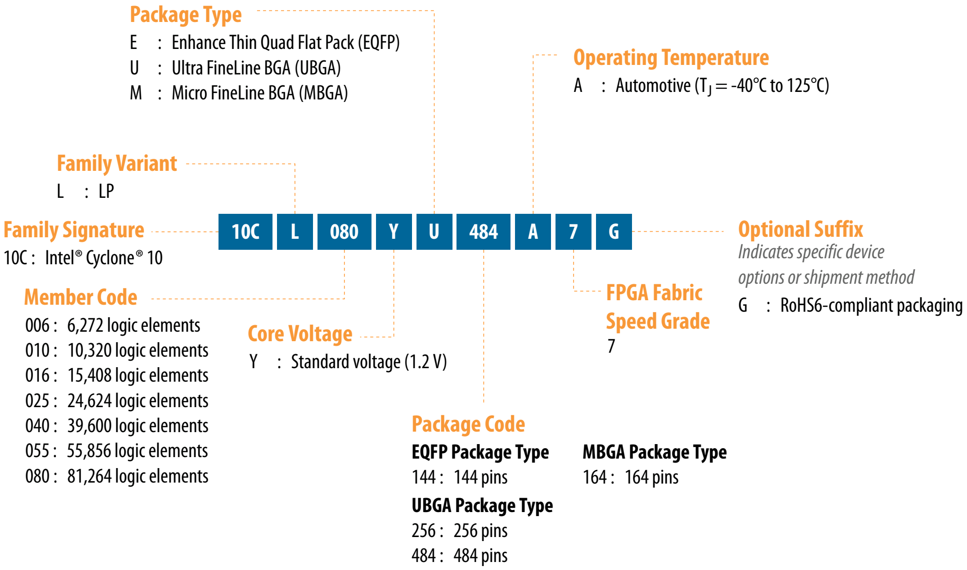
## 2.1.2. Package Options and Maximum User I/Os

### Table 3. Package Options and Maximum User I/Os in Intel Cyclone 10 LP Devices

| Package Type/ Pin Count | Ball Spacing (mm) | Dimensions (mm) | Product Line | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 10CL006 | 10CL010 | 10CL016 | 10CL025 | 10CL040 | 10CL055 | 10CL080 |
| | | | (6K LEs) | (10K LEs) | (16K LEs) | (25K LEs) | (40K LEs) | (55K LEs) | (80K LEs) |
| | | | GPIO / LVDS | | | | | | |
| MBGA-164 | 0.5 | 8 × 8 | — | 71 / 22 | 71 / 22 | — | — | — | — |
| UBGA-256 | 0.8 | 14 × 14 | 176 / 65 | 176 / 65 | 162 / 53 | 150 / 52 | — | — | — |
| UBGA-484 | 0.8 | 19 × 19 | — | — | — | 325 / 124 | 325 / 124 | 321 / 132 | 289 / 110 |
| EQFP-144 | 0.5 | 22 × 22 | 88 / 22 | 88 / 22 | 78 / 19 | 76 / 18 | — | — | — |

## 2.1.3. Device Ordering Codes

### Figure 1. Automotive-Grade Ordering Information for Intel Cyclone 10 LP Devices



## 2.2. Intel Enpirion Devices

## 2.2.1. Supported Automotive-Grade Devices

### Table 4. Automotive-Grade in Intel Enpirion Devices

Other automotive-grade product line/package combinations or ordering codes might be available upon request. Consult your Intel sales representative to submit your request.

| Device Ordering Code | Maximum Output Current | Package | Ambient Operating Temperature Range | Junction Temperature Range |
|---|---|---|---|---|
| EP5358HUA | 600 mA | 16-pin QFN | −40°C to 105°C | −40°C to 125°C |
| EP5358LUA | 600 mA | 16-pin QFN | −40°C to 105°C | −40°C to 125°C |

***continued...***

| Device Ordering Code | Maximum Output Current | Package | Ambient Operating Temperature Range | Junction Temperature Range |
|---|---|---|---|---|
| EN6310QA | 1 A | 30-pin QFN | –40°C to 105°C | –40°C to 125°C |
| EP53A8HQA | 1 A | 16-pin QFN | –40°C to 105°C | –40°C to 125°C |
| EP53A8LQA | 1 A | 16-pin QFN | –40°C to 105°C | –40°C to 125°C |
| EN6337QA | 3 A | 38-pin QFN | –40°C to 105°C | –40°C to 125°C |
| EN6347QA | 4 A | 38-pin QFN | –40°C to 105°C | –40°C to 125°C |
| EN6360QA | 8 A | 68-pin QFN | –40°C to 105°C | –40°C to 125°C |
| EN63A0QA | 12 A | 76-pin QFN | –40°C to 105°C | –40°C to 125°C |

## 2.3. Intel MAX 10 Devices

### 2.3.1. Supported Automotive-Grade Devices

**Table 5. Automotive-Grade in Intel MAX 10 Devices**

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| 10M02SCE144A7G | 10M02SC | 144-pin EQFP | –40°C to 125°C | –7 |
| 10M02SCU169A7G | 10M02SC | 169-pin UBGA | –40°C to 125°C | –7 |
| 10M02DCU324A7G | 10M02DC | 324-pin UBGA | –40°C to 125°C | –7 |
| 10M04SCE144A7G | 10M04SC | 144-pin EQFP | –40°C to 125°C | –7 |
| 10M04SCU169A7G | 10M04SC | 169-pin UBGA | –40°C to 125°C | –7 |
| 10M04DCF256A7G | 10M04DC | 256-pin FBGA | –40°C to 125°C | –7 |
| 10M04DAF256A7G | 10M04DA | 256-pin FBGA | –40°C to 125°C | –7 |
| 10M04DCU324A7G | 10M04DC | 324-pin UBGA | –40°C to 125°C | –7 |
| 10M08SAU169A7G | 10M08SA | 169-pin UBGA | –40°C to 125°C | –7 |
| 10M08SCE144A7G | 10M08SC | 144-pin EQFP | –40°C to 125°C | –7 |
| 10M08SCU169A7G | 10M08SC | 169-pin UBGA | –40°C to 125°C | –7 |
| 10M08DCF256A7G | 10M08DC | 256-pin FBGA | –40°C to 125°C | –7 |
| 10M08DAF256A7G | 10M08DA | 256-pin FBGA | –40°C to 125°C | –7 |
| 10M08DCU324A7G | 10M08DC | 324-pin UBGA | –40°C to 125°C | –7 |
| 10M16SCE144A7G | 10M16SC | 144-pin EQFP | –40°C to 125°C | –7 |
| 10M16SCU169A7G | 10M16SC | 169-pin UBGA | –40°C to 125°C | –7 |
| 10M16DCF256A7G | 10M16DC | 256-pin FBGA | –40°C to 125°C | –7 |
| 10M16DAF256A7G | 10M16DA | 256-pin FBGA | –40°C to 125°C | –7 |
| 10M16DCU324A7G | 10M16DC | 324-pin UBGA | –40°C to 125°C | –7 |
| 10M16DCF484A7G | 10M16DC | 484-pin FBGA | –40°C to 125°C | –7 |
| 10M25SCE144A7G | 10M25SC | 144-pin EQFP | –40°C to 125°C | –7 |
| 10M25DCF256A7G | 10M25DC | 256-pin FBGA | –40°C to 125°C | –7 |

*continued...*

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| 10M25DAF256A7G | 10M25DA | 256-pin FBGA | –40°C to 125°C | –7 |
| 10M40SCE144A7G | 10M40SC | 144-pin EQFP | –40°C to 125°C | –7 |
| 10M40DCF256A7G | 10M40DC | 256-pin FBGA | –40°C to 125°C | –7 |
| 10M50SCE144A7G | 10M50SC | 144-pin EQFP | –40°C to 125°C | –7 |
| 10M50DCF256A7G | 10M50DC | 256-pin FBGA | –40°C to 125°C | –7 |

## 2.3.2. Package Options and Maximum User I/Os

### Table 6. Package Options and Maximum User I/Os in Intel MAX 10 Single Power Supply Devices

| Device | Package | | |
|---|---|---|---|
| | Type | U169<br>169-pin UBGA | E144<br>144-pin EQFP |
| | Size | 11 mm × 11 mm | 22 mm × 22 mm |
| | Pitch | 0.8 mm | 0.5 mm |
| 10M02S | | 130 | 101 |
| 10M04S | | 130 | 101 |
| 10M08S | | 130 | 101 |
| 10M16S | | 130 | 101 |
| 10M25S | | — | 101 |
| 10M40S | | — | 101 |
| 10M50S | | — | 101 |

### Table 7. Package Options and Maximum User I/Os in Intel MAX 10 Dual Power Supply Devices

| Device | Package | | | |
|---|---|---|---|---|
| | Type | U324<br>324-pin UBGA | F256<br>256-pin FBGA | F484<br>484-pin FBGA |
| | Size | 15 mm × 15 mm | 17 mm × 17 mm | 23 mm × 23 mm |
| | Ball Pitch | 0.8 mm | 1.0 mm | 1.0 mm |
| 10M02D | | 160 | — | — |
| 10M04D | | 246 | 178 | — |
| 10M08D | | 246 | 178 | 250 |
| 10M16D | | 246 | 178 | 320 |
| 10M25D | | — | 178 | 360 |
| 10M40D | | — | 178 | 360 |
| 10M50D | | — | 178 | 360 |

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| 5CSEBA6U19A7N | 5CSEBA6 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CSEBA6U23A7N | 5CSEBA6 | 672-pin UBGA | –40°C to 125°C | –7 |
| 5CSEMA6U23A7N | 5CSEMA6 | 672-pin UBGA | –40°C to 125°C | –7 |
| 5CSEMA6F31A7N | 5CSEMA6 | 896-pin FBGA | –40°C to 125°C | –7 |
| 5CSXFC2C6U23A7N | 5CSXFC2 | 672-pin UBGA | –40°C to 125°C | –7 |
| 5CSXFC4C6U23A7N | 5CSXFC4 | 672-pin UBGA | –40°C to 125°C | –7 |
| 5CSXFC5C6U23A7N | 5CSXFC5 | 672-pin UBGA | –40°C to 125°C | –7 |
| 5CSXFC6C6U23A7N | 5CSXFC6 | 672-pin UBGA | –40°C to 125°C | –7 |
| 5CSXFC6D6F31A7N | 5CSXFC6 | 896-pin FBGA | –40°C to 125°C | –7 |

## 2.4.2. Package Options and Maximum User I/Os

### Table 9. Package Options and Maximum User I/Os in Cyclone V SE Devices

| Package Type/ Pin Count | Ball Spacing (mm) | Dimensions (mm) | Product Line | | | |
|---|---|---|---|---|---|---|
| | | | 5CSEA2 | 5CSEA4 | 5CSEA5 | 5CSEA6 |
| | | | (25K LEs) | (40K LEs) | (85K LEs) | (110K LEs) |
| | | | FPGA I/Os / HPS I/Os | | | |
| UBGA-484 | 0.8 | 19 x 19 | 66 / 151 | 66 / 151 | 66 / 151 | 66 / 151 |
| UBGA-672 | 0.8 | 23 x 23 | 145 / 181 | 145 / 181 | 145 / 181 | 145 / 181 |
| FBGA-896 | 1 | 31 x 31 | — | — | 288 / 181 | 288 / 181 |

### Table 10. Package Options and Maximum User I/Os in Cyclone V SX Devices

| Package Type/ Pin Count | Ball Spacing (mm) | Dimensions (mm) | Product Line | | | |
|---|---|---|---|---|---|---|
| | | | 5CSXC2 | 5CSXC4 | 5CSXC5 | 5CSXC6 |
| | | | (25K LEs) | (40K LEs) | (85K LEs) | (110K LEs) |
| | | | FPGA I/Os / HPS I/Os / XCVRs | | | |
| UBGA-672 | 0.8 | 23 x 23 | 145 / 181 / 6 | 145 / 181 / 6 | 145 / 181 / 6 | 145 / 181 / 6 |
| FBGA-896 | 1 | 31 x 31 | — | — | — | 288 / 181 / 9 |

# 2.5. Cyclone V Devices

## 2.5.1. Supported Automotive-Grade Devices

### Table 11. Automotive-Grade in Cyclone V Devices

Other automotive-grade product line/package combinations or ordering codes might be available upon request. Consult your Intel sales representative to submit your request.

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| 5CEBA2F17A7N | 5CEBA2 | 256-pin FBGA | –40°C to 125°C | –7 |
| 5CEFA2U19A7N | 5CEFA2 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CEBA4F17A7N | 5CEBA4 | 256-pin FBGA | –40°C to 125°C | –7 |
| 5CEFA4U19A7N | 5CEFA4 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CEFA5U19A7N | 5CEFA5 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CEFA7U19A7N | 5CEFA7 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CEFA9U19A7N | 5CEFA9 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CGXFC3B6U15A7N | 5CGXFC3 | 324-pin UBGA | –40°C to 125°C | –7 |
| 5CGXFC3B6U19A7N | 5CGXFC3 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CGXFC4C6U19A7N | 5CGXFC4 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CGXFC5C6U19A7N | 5CGXFC5 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CGXFC5C6F23A7N | 5CGXFC5 | 484-pin FBGA | –40°C to 125°C | –7 |
| 5CGXFC7C6U19A7N | 5CGXFC7 | 484-pin UBGA | –40°C to 125°C | –7 |
| 5CGXFC7D6F31A7N | 5CGXFC7 | 896-pin FBGA | –40°C to 125°C | –7 |
| 5CGXFC9A6U19A7N | 5CGXFC9 | 484-pin UBGA | –40°C to 125°C | –7 |

## 2.5.2. Package Options and Maximum User I/Os

### Table 12. Package Options and Maximum User I/Os in Cyclone V E Devices

| Package Type/ Pin Count | Ball Spacing (mm) | Dimensions (mm) | Product Line | | | | |
|---|---|---|---|---|---|---|---|
| | | | 5CEA2 | 5CEA4 | 5CEA5 | 5CEA7 | 5CEA9 |
| | | | (25K LEs) | (49K LEs) | (77K LEs) | (149.5K LEs) | (301K LEs) |
| | | | I/Os | | | | |
| FBGA-256 | 1 | 17 x 17 | 128 | 128 | — | — | — |
| UBGA-484 | 0.8 | 19 x 19 | 224 | 224 | 224 | 240 | 240 |

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| EP4CE40U19A7N | EP4CE40 | 484-pin UBGA | –40°C to 125°C | –7 |
| EP4CE55F23A7N | EP4CE55 | 484-pin FBGA | –40°C to 125°C | –7 |
| EP4CGX15BF14A7N | EP4CGX15 | 169-pin FBGA | –40°C to 125°C | –7 |

## 2.6.2. Package Options and Maximum User I/Os

### Table 15. Package Options and Maximum User I/Os in Cyclone IV E Devices

| Package Type/ Pin Count | Ball Spacing (mm) | Dimensions (mm) | Product Line | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | EP4CE6 (6.3K LEs) | EP4CE10 (10.3K LEs) | EP4CE15 (15.4K LEs) | EP4CE22 (22.3K LEs) | EP4CE30 (28.8K LEs) | EP4CE40 (39.6K LEs) | EP4CE55 (55.9K LEs) |
| | | | I/Os | | | | | | |
| EQFP-144 | 0.5 | 22 x 22 | 91 | 91 | — | 79 | — | — | — |
| UBGA-256 | 0.8 | 14 x 14 | — | — | 165 | 153 | — | — | — |
| FBGA-256 | 1 | 17 x 17 | 179 | 179 | 165 | 153 | — | — | — |
| UBGA-484 | 0.8 | 19 x 19 | — | — | — | — | — | 328 | — |
| FBGA-324 | 1 | 19 x 19 | — | — | — | — | 193 | 193 | — |
| FBGA-484 | 1 | 23 x 23 | — | — | 343 | — | 328 | 328 | 324 |

### Table 16. Package Options and Maximum User I/Os in Cyclone IV GX Devices

| Package Type/ Pin Count | Ball Spacing (mm) | Dimensions (mm) | Product Line |
|---|---|---|---|
| | | | EP4CGX15 (14.4K LEs) |
| | | | I/Os |
| FBGA-169 | 1 | 14 x 14 | 72 / 2 |

### 2.6.3. Device Ordering Codes

**Figure 7.** Automotive-Grade Ordering Information for Cyclone IV E Devices

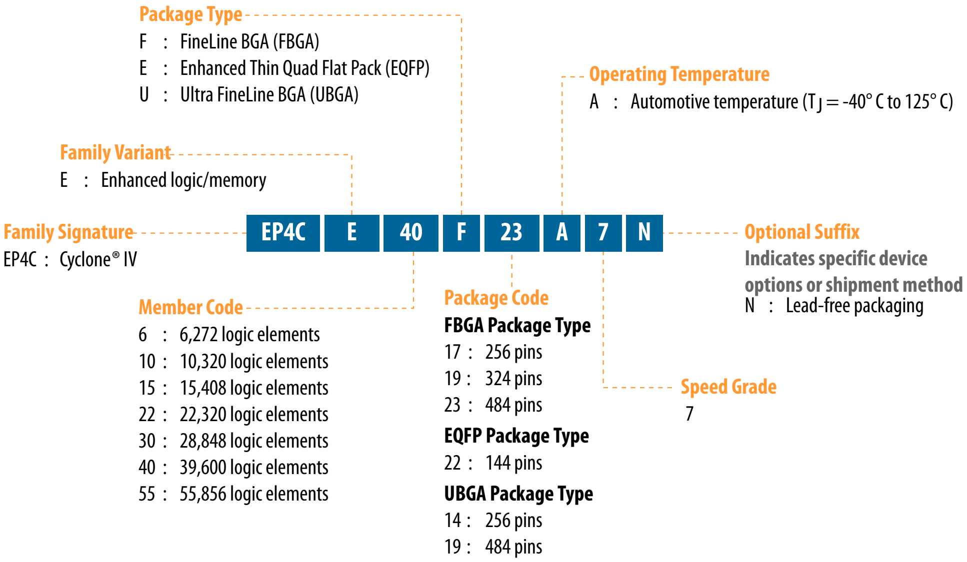
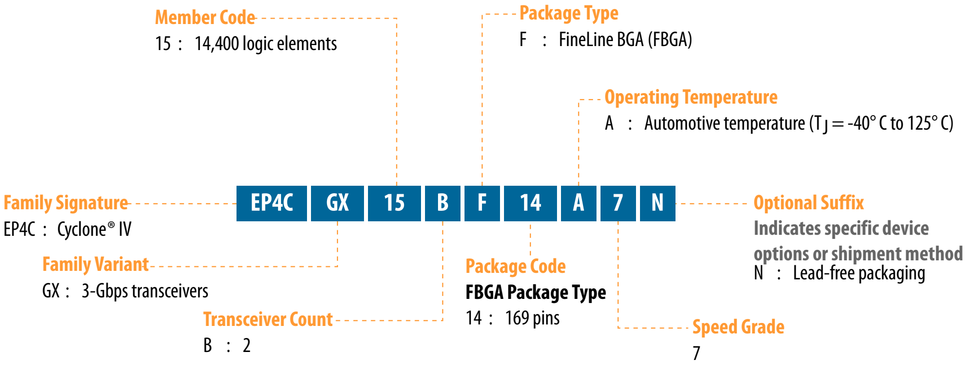


**Figure 8.** Automotive-Grade Ordering Information for Cyclone IV GX Devices



## 2.7. MAX V Devices

### 2.7.1. Supported Automotive-Grade Devices

**Table 17.** Automotive-Grade in MAX V Devices

Other automotive-grade product line/package combinations or ordering codes might be available upon request. Consult your Intel sales representative to submit your request.

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| 5M40ZE64A5N | 5M40Z | 64-pin EQFP | –40°C to 125°C | –5 |
| 5M80ZE64A5N | 5M80Z | 64-pin EQFP | –40°C to 125°C | –5 |
| 5M80ZT100A5N | 5M80Z | 100-pin TQFP | –40°C to 125°C | –5 |

*continued...*

## 2.8. MAX II Devices

### 2.8.1. Supported Automotive-Grade Devices

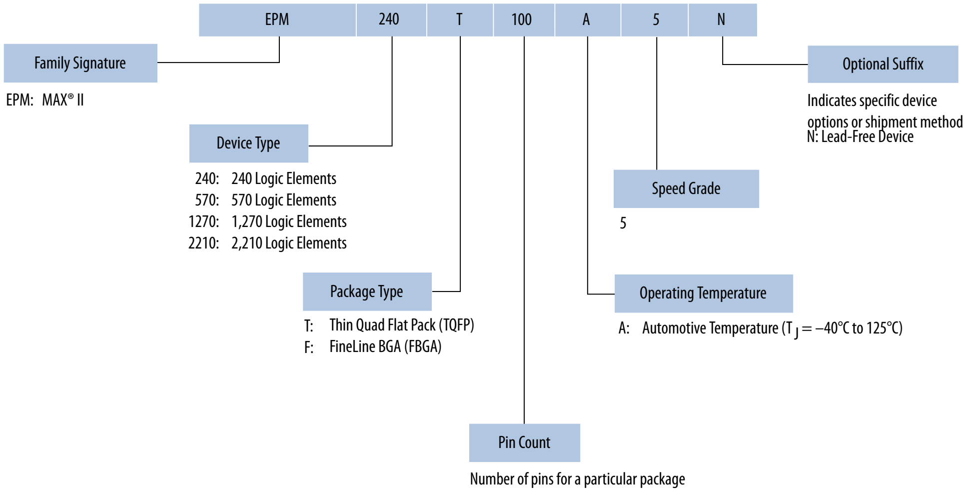
#### Table 19. Automotive-Grade in MAX II Devices

Other automotive-grade product line/package combinations or ordering codes might be available upon request. Consult your Intel sales representative to submit your request.

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| EPM240T100A5N | EPM240 | 100-pin TQFP | –40°C to 125°C | –5 |
| EPM570F100A5N | EPM570 | 100-pin FBGA | –40°C to 125°C | –5 |
| EPM570T100A5N | EPM570 | 100-pin TQFP | –40°C to 125°C | –5 |
| EPM570T144A5N | EPM570 | 144-pin TQFP | –40°C to 125°C | –5 |
| EPM1270T144A5N | EPM1270 | 144-pin TQFP | –40°C to 125°C | –5 |
| EPM1270F256A5N | EPM1270 | 256-pin FBGA | –40°C to 125°C | –5 |
| EPM2210F256A5N | EPM2210 | 256-pin FBGA | –40°C to 125°C | –5 |
| EPM2210F324A5N | EPM2210 | 324-pin FBGA | –40°C to 125°C | –5 |

### 2.8.2. Device Ordering Codes

#### Figure 10. Automotive-Grade Ordering Information for MAX II Devices



# 2.9. Cyclone III Devices (Legacy Support)

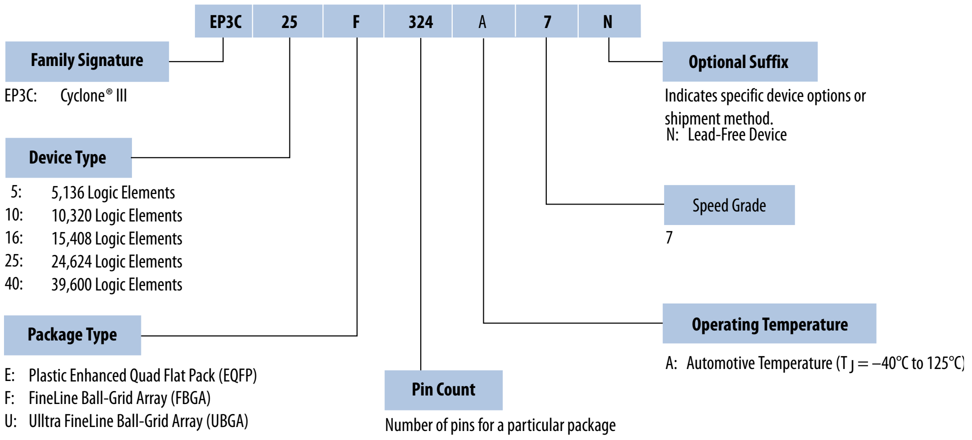
## 2.9.1. Supported Automotive-Grade Devices

### Table 20. Automotive-Grade in Cyclone III Devices

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| EP3C5E144A7N | EP3C5 | 144-pin EQFP | −40°C to 125°C | –7 |
| EP3C5F256A7N | EP3C5 | 256-pin FBGA | −40°C to 125°C | –7 |
| EP3C5U256A7N | EP3C5 | 256-pin UBGA | −40°C to 125°C | –7 |
| EP3C10E144A7N | EP3C10 | 144-pin EQFP | −40°C to 125°C | –7 |
| EP3C10F256A7N | EP3C10 | 256-pin FBGA | −40°C to 125°C | –7 |
| EP3C10U256A7N | EP3C10 | 256-pin UBGA | −40°C to 125°C | –7 |
| EP3C16E144A7N | EP3C16 | 144-pin EQFP | −40°C to 125°C | –7 |
| EP3C16F256A7N | EP3C16 | 256-pin FBGA | −40°C to 125°C | –7 |
| EP3C16U256A7N | EP3C16 | 256-pin UBGA | −40°C to 125°C | –7 |
| EP3C16F484A7N | EP3C16 | 484-pin FBGA | −40°C to 125°C | –7 |
| EP3C16U484A7N | EP3C16 | 484-pin UBGA | −40°C to 125°C | –7 |
| EP3C25E144A7N | EP3C25 | 144-pin EQFP | −40°C to 125°C | –7 |
| EP3C25F256A7N | EP3C25 | 256-pin FBGA | −40°C to 125°C | –7 |
| EP3C25U256A7N | EP3C25 | 256-pin UBGA | −40°C to 125°C | –7 |
| EP3C25F324A7N | EP3C25 | 324-pin FBGA | −40°C to 125°C | –7 |
| EP3C40F324A7N | EP3C40 | 324-pin FBGA | −40°C to 125°C | –7 |
| EP3C40F484A7N | EP3C40 | 484-pin FBGA | −40°C to 125°C | –7 |
| EP3C40U484A7N | EP3C40 | 484-pin UBGA | −40°C to 125°C | –7 |

## 2.9.2. Device Ordering Codes

### Figure 11. Automotive-Grade Ordering Information for Cyclone III Devices



# 2.10. Cyclone II Devices (Legacy Support)

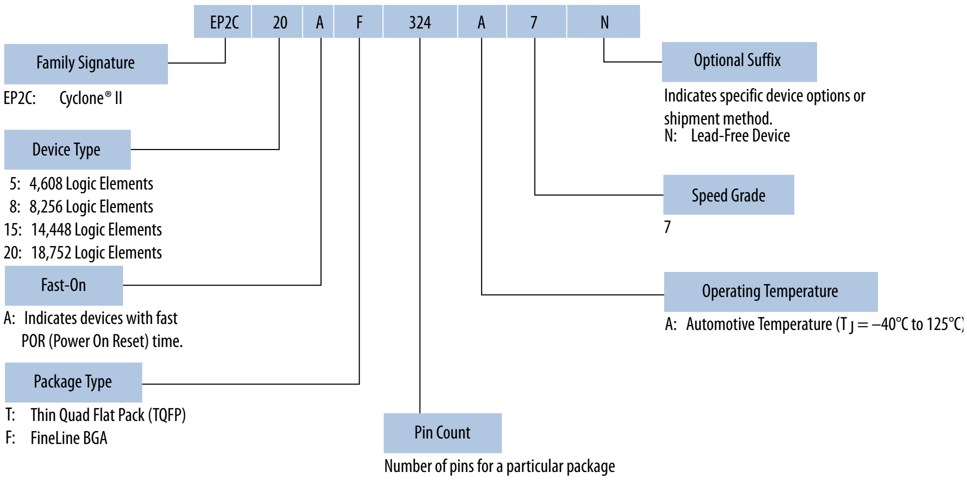
## 2.10.1. Supported Automotive-Grade Devices

### Table 21. Automotive-Grade in Cyclone II Devices

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| EP2C5AT144A7N | EP2C5 | 144-pin TQFP | –40°C to 125°C | –7 |
| EP2C5AF256A7N | EP2C5 | 256-pin FBGA | –40°C to 125°C | –7 |
| EP2C8AF256A7N | EP2C8 | 256-pin FBGA | –40°C to 125°C | –7 |
| EP2C15AF256A7N | EP2C15 | 256-pin FBGA | –40°C to 125°C | –7 |
| EP2C15AF484A7N | EP2C15 | 484-pin FBGA | –40°C to 125°C | –7 |
| EP2C20AF256A7N | EP2C20 | 256-pin FBGA | –40°C to 125°C | –7 |
| EP2C20AF484A7N | EP2C20 | 484-pin FBGA | –40°C to 125°C | –7 |

## 2.10.2. Device Ordering Codes

### Figure 12. Automotive-Grade Ordering Information for Cyclone II Devices



# 2.11. Cyclone Devices (Legacy Support)

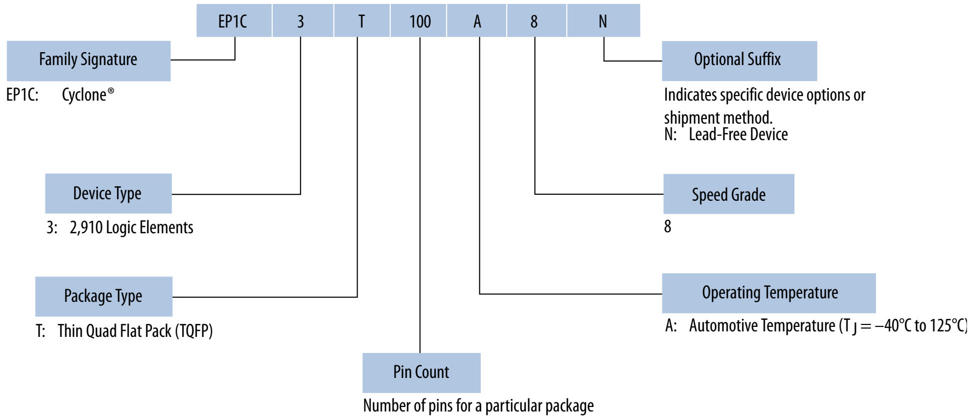
## 2.11.1. Supported Automotive-Grade Devices

### Table 22. Automotive-Grade in Cyclone Devices

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| EP1C3T100A8N | EP1C3 | 100-pin TQFP | –40°C to 125°C | –8 |
| EP1C3T144A8N | EP1C3 | 144-pin TQFP | –40°C to 125°C | –8 |

### 2.11.2. Device Ordering Codes

**Figure 13. Automotive-Grade Ordering Information for Cyclone Devices**



## 2.12. MAX 7000A Devices (Legacy Support)

### 2.12.1. Supported Automotive-Grade Devices

**Table 23. Automotive-Grade in MAX 7000A Devices**

| Device Ordering Code | Device | Package | Junction Temperature Range | Speed Grade |
|---|---|---|---|---|
| EPM7032AETA44-10N | EPM7032AE | 44-pin TQFP | –40°C to 130°C | –10 |
| EPM7064AETA44-10N | EPM7064AE | 44-pin TQFP | –40°C to 130°C | –10 |
| EPM7064AETA100-10N | EPM7064AE | 100-pin TQFP | –40°C to 130°C | –10 |
| EPM7128AETA100-10N | EPM7128AE | 100-pin TQFP | –40°C to 130°C | –10 |
| EPM7128AETA144-10N | EPM7128AE | 144-pin TQFP | –40°C to 130°C | –10 |

# 4. Power Analysis and Estimation

## 4.1. Early Power Estimator

The 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 Intel Quartus Prime 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 respective user guides.

### Related Information

Early Power Estimators (EPE) and Power Analyzer, Intel page
Provides the EPE and user guides.

## 4.2. Power Analyzer

The Power Analyzer tool in the Intel Quartus Prime 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 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 Power Analyzer tool to provide accurate power estimation.

The process of using the Power Analyzer tool consists of the following three parts:

- Specifying sources of input data
- Specifying operating conditions
- Running the 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 Intel Quartus Prime software.

The 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.

**Related Information**

Power Analysis chapter, Intel Quartus Prime Standard Edition Handbook Volume 3: Verification

# 7. Package and Board Layout Information

Intel provides information on package and PCB design guidelines.

**Related Information**

- Package and Thermal Resistance page, Intel website
  Provides more information about the package-related information and Package Information Datasheet for Intel Devices.
- AN 114: Board Design Guidelines for Intel Programmable Device Packages
  Provides more information about the PCB design guidelines.
- Schematic Symbols (Cadence Capture CIS and Allegro DE-HDL (Concept Software)) page
  Provides more information about designing PCBs with the Cadence OrCAD capture component information system and symbols libraries.

# A. Document Revision History for the Automotive-Grade Device Handbook

| Document Version | Changes |
|---|---|
| 2018.10.01 | • Updated the *Intel Automotive-Grade Devices* and *Intel Automotive Qualifications* sections.<br>• Updated Intel Cyclone 10 devices to Intel Cyclone 10 LP devices.<br>• Changed Enpirion to Intel Enpirion.<br>• Removed Intel Arria® 10 devices.<br>— Removed Intel Arria 10 devices from the *Intel Automotive-Grade Device Families* table.<br>— Removed Intel Arria 10 devices from the *Supported Automotive-Grade Devices* section.<br>• Updated the description for Intel MAX 10 in the *Intel Automotive-Grade Device Families* table.<br>• Removed ES optional suffix from the *Automotive-Grade Ordering Information for Intel Cyclone 10 LP Devices* diagram.<br>• Updated the *Automotive-Grade in Intel Enpirion Devices*.<br>— Replaced Device column with Maximum Output Current column.<br>— Renamed the column Ambient Temperature Range as Ambient Operating Temperature Range.<br>— Added the Junction Temperature Range column.<br>• Removed the following devices from the *Automotive-Grade in Intel MAX 10 Devices* table.<br>— 10M02SCM153A7G<br>— 10M02DCV36A7G<br>— 10M04SCM153A7G<br>— 10M04DAU324A7G<br>— 10M08DCV81A7G<br>— 10M08DFV81A7G<br>— 10M08SCM153A7G<br>— 10M08DAU324A7G<br>— 10M08DCF484A7G<br>— 10M08DAF484A7G<br>— 10M16DAU324A7G<br>— 10M16DAF484A7G<br>— 10M25DCF484A7G<br>— 10M25DAF484A7G<br>— 10M25DCF672A7G<br>— 10M25DAF672A7G<br>— 10M40DAF256A7G<br>— 10M40DCF484A7G<br>— 10M40DAF484A7G<br>— 10M40DCF672A7G<br>— 10M40DAF672A7G<br>— 10M50DAF256A7G<br>— 10M50DCF484A7G<br>— 10M50DAF484A7G<br>— 10M50DCF672A7G<br>— 10M50DAF672A7G<br>• Removed M153 package in the *Package Options and Maximum User I/Os in Intel MAX 10 Single Power Supply Devices* table.<br>• Removed V36, V81, and F672 packages in the *Package Options and Maximum User I/Os in Intel MAX 10 Dual Power Supply Devices* table. |

| Document Version | Changes |
|---|---|
| | • Updated the *Automotive-Grade Ordering Information for Intel MAX 10 Devices* diagram.<br>— Removed V and M package types.<br>— Removed WLCSP (36 and 81), MBGA (153), and FBGA (672) package types.<br>— Removed DF feature option.<br>• Removed notes from the following tables:<br>— *Package Options and Maximum User I/Os in Cyclone V SE Devices*<br>— *Package Options and Maximum User I/Os in Cyclone V SX Devices*<br>• Removed the resource count for FBGA-896 package in 5CSXC5 device.<br>• Updated the *Automotive-Grade in Cyclone V Devices* table.<br>— Added 5CGXFC7D6F31A7N<br>— Removed Cyclone V GT devices: 5CGTFD5C5U19A7N, 5CGTFD7C5U19A7N, and 5CGTFD9A5U19A7N<br>• Removed resources for packages that are not currently available in automotive-grade for Cyclone V E and GX devices.<br>• Updated the description for embedded hard IPs in the following diagrams:<br>— *Automotive-Grade Ordering Information for Cyclone V E Devices*<br>— *Automotive-Grade Ordering Information for Cyclone V GX Devices*<br>• Removed QFN-148 package in the *Package Options and Maximum User I/Os in Cyclone IV GX Devices* table.<br>• Removed resources for packages that are not currently available in automotive-grade for Cyclone IV E and GX devices.<br>• Updated the *Package Options and Maximum User I/Os in MAX V Devices* table.<br>— Corrected QFP-100 to TQFP-100 and DFP-144 to TQFP-144.<br>— Removed MBGA-64, MBGA-68, MBGA-100, and FBGA-324 packages.<br>— Removed resources for packages that are not currently available in automotive-grade.<br>• Updated the description for the legacy device families in the *Intel Quartus Prime Software Support* section.<br>• Added Intel Cyclone 10 LP and Intel MAX 10 devices in the *DC and Timing Specifications* section. |

| Date | Version | Changes |
|---|---|---|
| December 2017 | 2017.12.15 | • Removed Intel Cyclone 10 GX devices.<br>— Removed Intel Cyclone 10 GX devices from *Automotive-Grade in Intel Cyclone 10 GX Devices* table.<br>— Removed *Package Options and Maximum User I/Os in Intel Cyclone 10 GX Devices* table.<br>— Removed *Automotive-Grade Ordering Information for Intel Cyclone 10 GX Devices* diagram.<br>• Intel rebranding. |
| July 2017 | 2017.07.13 | Corrected the automotive temperature range in the figure showing the available options for the Intel Arria 10 GX devices from "-40°C to 100°C" to "-40°C to 125°C". |
| May 2017 | 2017.05.08 | • Updated links.<br>• Rebranded as Intel. |
| February 2017 | 2017.02.13 | • Added Intel Arria 10, Cyclone 10, and Intel Enpirion devices.<br>• Removed PowerPlay text from tool name. |
| May 2016 | 2016.05.03 | • Updated the Overview topic to remove ASIC devices.<br>• Updated footnote in Automotive-Grade in MAX 10 Devices table.<br>• Added new automotive-grade devices for the following device families:<br>— MAX 10—10M08SAU169A7G<br>— Cyclone V SoC—5CSXFC6D6F31A7N<br>— Cyclone IV—EP4CE15U14A7N, EP4CE22U14A7N, and EP4CE55F23A7N |

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| Date | Version | Changes |
|---|---|---|
| | | • Removed the following devices from Automotive-Grade in MAX 10 Devices table.<br>— 10M04SFE144A7G<br>— 10M04SFU169A7G<br>— 10M04DFF256A7G<br>— 10M04DFU324A7G<br>— 10M08SFE144A7G<br>— 10M08SFU169A7G<br>— 10M08DFF256A7G<br>— 10M08DFU324A7G<br>— 10M08DFF484A7G<br>— 10M16SFE144A7G<br>— 10M16SFU169A7G<br>— 10M16DFF256A7G<br>— 10M16DFU324A7G<br>— 10M16DFF484A7G<br>— 10M25SFE144A7G<br>— 10M25DFF256A7G<br>— 10M25DFF484A7G<br>— 10M25DFF672A7G<br>— 10M40SFE144A7G<br>— 10M40DFF256A7G<br>— 10M40DFF484A7G<br>— 10M40DFF672A7G<br>— 10M50SFE144A7G<br>— 10M50DFF256A7G<br>— 10M50DFF484A7G<br>— 10M50DFF672A7G<br>• Updated the Package Options and Maximum User I/Os in Cyclone V GX Devices table.<br>— Updated the LE count for 5CGXC3 from 31.5K LEs to 36K LEs.<br>— Added I/Os / XCVRs count for UBGA-484 package in 5CGXC9 device.<br>• Updated the Package Options and Maximum User I/Os in Cyclone V GT Devices table.<br>— Added I/Os / XCVRs count for UBGA-484 package in 5CGTD9 device.<br>• Updated the following device ordering codes diagrams:<br>— Automotive-Grade Ordering Information for MAX 10 Devices<br>— Automotive-Grade Ordering Information for Cyclone IV E Devices<br>— Automotive-Grade Ordering Information for Cyclone V SE Devices<br>— Automotive-Grade Ordering Information for Cyclone V SX Devices<br>• Changed instances of *Quartus II* to *Quartus Prime*. |
| September 2014 | 2014.09.22 | • Added MAX 10 devices.<br>• Removed HardCopy® II devices.<br>• Updated the Quartus II software support versions for the legacy device families.<br>— Cyclone III—Version 8.0 to 13.1<br>— Cyclone II—Version 7.2 SP1 to 13.0<br>— Cyclone—Version 7.2 SP1 to 13.0<br>— MAX 7000AE—Version 7.2 SP1 to 13.0 |

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| Date | Version | Changes |
|---|---|---|
| | | • Added new automotive-grade devices for the following device families:<br>— Cyclone V—5CGXFC5C6F23A7N<br>— Cyclone IV—EP4CE40U19A7N and EP4CGX15BF14A7N<br>— MAX V—5M40ZE64A5N, 5M80ZT100A5N, and 5M160ZT100A5N<br>• Added Cyclone IV GX ordering information diagram.<br>• Updated HPS I/O count for Cyclone V SE and SX devices. |
| September 2013 | 3.4 | • Updated Table 3–2, Table 3–3, and Table 3–4.<br>• Updated Figure 3–1, Figure 3–2, and Figure 3–3. |
| June 2013 | 3.3 | Updated Table 3–1 and Table 3–5. |
| May 2013 | 3.2 | • Updated Figure 3–2, Figure 3–3, Figure 4–1, and Figure 5–1.<br>• Updated Table 3–1, Table 3–5, Table 4–2, Table 5–1, and Table 5–3. |
| February 2013 | 3.1 | Updated Table 2-2, Table 2-3, Table 3–2, Table 3–3, Table 3–4, Table 4–2, Table 4–3, and Table 5–2. |
| January 2013 | 3.0 | • Added Cyclone V and Cyclone V SoC devices.<br>• Added Table 4–2, Table 4–3, and Table 5–2.<br>• Updated Table 4–1, Table 4–4, Table 6–1, and Table 6–2.<br>• Updated Figure 4–1.<br>• Listed the following devices under legacy support:<br>— Cyclone III<br>— Cyclone II<br>— Cyclone<br>— MAX 7000A |
| May 2011 | 2.0 | • Added MAX V devices.<br>• Updated part number for Cyclone III, Cyclone IV, and HardCopy II devices.<br>• Template conversion.<br>• Minor text edits. |
| March 2010 | 1.2 | • Added Cyclone IV devices.<br>• Removed Referenced Documents section. |
| October 2008 | 1.1 | • Updated DC and Timing Specifications section.<br>• Converted to new template. |
| February 2008 | 1.0 | Initial release. |