The Automotive-Grade Device Handbook

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1 Overview

1.1 Intel Automotive-Grade Devices

Intel automotive-grade devices are available in CPLD, FPGA, system on a chip (SoC), and Enpirion PowerSoC's. You can use these devices for high-temperature environments, such as automotive driver assist, infotainment, and e-vehicle.

Related Links

Automotive page, Intel® website
   Provides more information about Intel automotive solutions.

1.2 Intel Automotive Qualifications

Intel automotive-grade devices comply to the following qualifications:

- ISO-26262
- IEC-61508
- AEC-Q100
- ISO-9001
- TS-16949
- Electronic Industries Alliance (EIA)
- Joint Electron Device Engineering Council (JEDEC)

Related Links

Automotive Quality and Reliability page, Intel website
   Provides more information about automotive quality.

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	Version 17.1 and later	Low-cost, low-power, feature-rich FPGAs
IC, FPGA	Intel Arria® 10	Version 14.0.2 and later	High-performance, low-power 20 nm FPGAs with hard floating-point digital signal processing (DSP) blocks
			continued...

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[1] Starting from version 15.1, the Quartus II software is known as the Intel Quartus® Prime software.

Category	Product Family	Quartus Software Support [1]	Description
IC, power	Enpirion	—	Integrated inductor, combination of small footprint, low noise performance, and high efficiency
IC, FPGA	Intel MAX® 10	Version 14.0.2 and later	Low-cost, instant-on, small form factor programmable logic device
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)

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 software.

[2] The legacy devices are only supported in the Quartus II software.

2 Supported Automotive-Grade Devices

2.1 Intel Cyclone 10 Devices

2.1.1 Supported Automotive-Grade Devices

Table 2.   Automotive-Grade in Intel Cyclone 10 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
10CL006YE144A7G	10CL006	144-pin EQFP	−40°C to 125°C	−7
10CL006YU256A7G	10CL006	256-pin UBGA	−40°C to 125°C	−7
10CL010YE144A7G	10CL010	144-pin EQFP	−40°C to 125°C	−7
10CL010YM164A7G	10CL010	164-pin MBGA	−40°C to 125°C	−7
10CL010YU256A7G	10CL010	256-pin UBGA	−40°C to 125°C	−7
10CL016YE144A7G	10CL016	144-pin EQFP	−40°C to 125°C	−7
10CL016YM164A7G	10CL016	164-pin MBGA	−40°C to 125°C	−7
10CL016YU256A7G	10CL016	256-pin UBGA	−40°C to 125°C	−7
10CL025YE144A7G	10CL025	144-pin EQFP	−40°C to 125°C	−7
10CL025YU256A7G	10CL025	256-pin UBGA	−40°C to 125°C	−7
10CL025YU484A7G	10CL025	484-pin UBGA	−40°C to 125°C	−7
10CL040YU484A7G	10CL040	484-pin UBGA	−40°C to 125°C	−7
10CL055YU484A7G	10CL055	484-pin UBGA	−40°C to 125°C	−7
10CL080YU484A7G	10CL080	484-pin UBGA	−40°C to 125°C	−7

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**

Package Type
E : Enhance Thin Quad Flat Pack (EQFP)
U : Ultra FineLine BGA (UBGA)
M : Micro FineLine BGA (MBGA)

Operating Temperature
A : Automotive (T_J = -40℃ to 125℃)

Family Variant
L : LP

Family Signature
10C : Intel® Cyclone® 10

`10C` `L` `080` `Y` `U` `484` `A` `7` `GES`

Optional Suffix
Indicates specific device options or shipment method
G : RoHS6-compliant packaging
ES : Engineering sample

Member Code
006 : 6,272 logic elements
010 : 10,320 logic elements
016 : 15,408 logic elements
025 : 24,624 logic elements
040 : 39,600 logic elements
055 : 55,856 logic elements
080 : 81,264 logic elements

Core Voltage
Y : Standard voltage (1.2 V)

FPGA Fabric Speed Grade
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Package Code
EQFP Package Type   **MBGA Package Type**
144 : 144 pins   164 : 164 pins
UBGA Package Type
256 : 256 pins
484 : 484 pins

2.2 Intel Arria 10 Devices

2.2.1 Supported Automotive-Grade Devices

Table 4. **Automotive-Grade in Intel Arria 10 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	Ambient Temperature Range	Speed Grade
10AX016C4U19A3SG	10AX016	484-pin UBGA	−40°C to 125°C	−3
10AX022C4U19A3SG	10AX022	484-pin UBGA	−40°C to 125°C	−3
				continued...

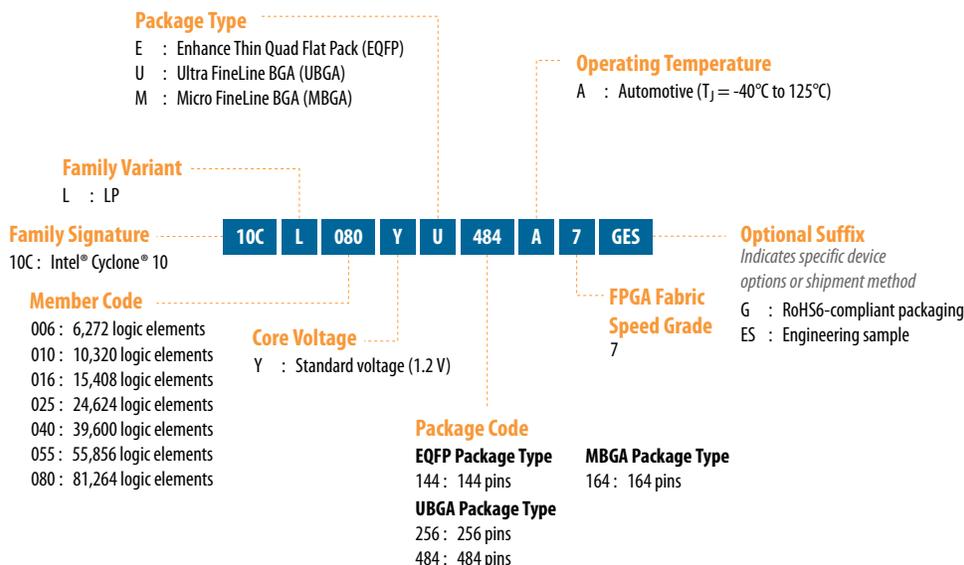| Device Ordering Code	Device	Package	Ambient Temperature Range	Speed Grade
10AX016E4F29A3SG	10AX016	780-pin FBGA	−40°C to 125°C	−3
10AX022E4F29A3SG	10AX022	780-pin FBGA	−40°C to 125°C	−3
10AX027E4F29A3SG	10AX027	780-pin FBGA	−40°C to 125°C	−3
10AX032E4F29A3SG	10AX032	780-pin FBGA	−40°C to 125°C	−3
10AX048E4F29A3SG	10AX048	780-pin FBGA	−40°C to 125°C	−3
10AX027H4F34A3SG	10AX027	1152-pin FBGA	−40°C to 125°C	−3
10AX032H4F34A3SG	10AX032	1152-pin FBGA	−40°C to 125°C	−3
10AX048H4F34A3SG	10AX048	1152-pin FBGA	−40°C to 125°C	−3
10AX057H4F34A3SG	10AX057	1152-pin FBGA	−40°C to 125°C	−3
10AX066H4F34A3SG	10AX066	1152-pin FBGA	−40°C to 125°C	−3

2.2.2 Package Options and Maximum User I/Os

Table 5.   **Package Options and Maximum User I/Os in Intel Arria 10 GX Devices**

Package Type/ Pin Count	Ball Spacing (mm)	Dimensions (mm)	Product Line						
			10AX016	10AX022	10AX027	10AX032	10AX048	10AX057	10AX066
			(160K LEs)	(220K LEs)	(270K LEs)	(320K LEs)	(480K LEs)	(570K LEs)	(660K LEs)
			3 V I/O / LVDS I/O / XCVR						
UBGA-484	0.8	19 × 19	48 / 192 / 6	48 / 192 / 6	—	—	—	—	—
FBGA-780	1	29 × 29	48 / 240 / 12	48 / 240 / 12	48 / 312 / 12	48 / 312 / 12	48 / 312 / 12	—	—
FBGA-1152	1	35 × 35	—	—	48 / 336 / 24	48 / 336 / 24	48 / 444 / 24	48 / 444 / 24	48 / 444 / 24

2.2.3 Device Ordering Codes

Figure 2. **Automotive-Grade Ordering Information for Intel Arria 10 GX Devices**
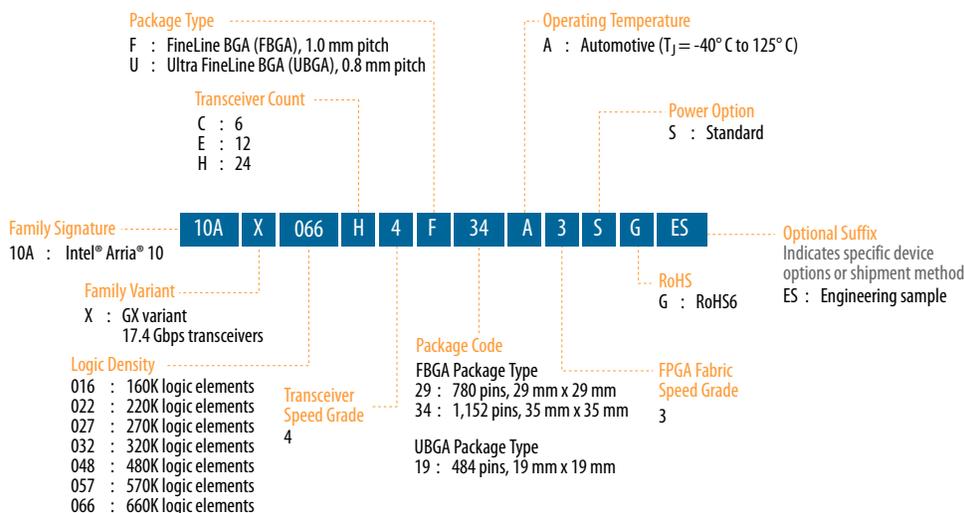
2.3 Enpirion Devices

2.3.1 Supported Automotive-Grade Devices

Table 6. **Automotive-Grade in 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	Device	Package	Ambient Temperature Range
EP5358HUA	EP5358HUA	16-pin QFN	−40°C to 105°C
EP5358LUA	EP5358LUA	16-pin QFN	−40°C to 105°C
EN6310QA	EN6310QA	30-pin QFN	−40°C to 105°C
EP53A8HQA	EP53A8HQA	16-pin QFN	−40°C to 105°C
EP53A8LQA	EP53A8LQA	16-pin QFN	−40°C to 105°C
EN6337QA	EN6337QA	38-pin QFN	−40°C to 105°C
EN6347QA	EN6347QA	38-pin QFN	−40°C to 105°C
EN6360QA	EN6360QA	68-pin QFN	−40°C to 105°C
EN63A0QA	EN63A0QA	76-pin QFN	−40°C to 105°C

2.4 Intel MAX 10 Devices

2.4.1 Supported Automotive-Grade Devices

Table 7.   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
10M02SCM153A7G [3]	10M02SC	153-pin MBGA	−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
10M02DCV36A7G [3]	10M02DC	36-pin WLCSP	−40°C to 125°C	−7
10M04SCE144A7G	10M04SC	144-pin EQFP	−40°C to 125°C	−7
10M04SCM153A7G [3]	10M04SC	153-pin MBGA	−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 [3]	10M04DA	256-pin FBGA	−40°C to 125°C	−7
10M04DCU324A7G	10M04DC	324-pin UBGA	−40°C to 125°C	−7
10M04DAU324A7G [3]	10M04DA	324-pin UBGA	−40°C to 125°C	−7
10M08DCV81A7G [3]	10M08DC	81-pin WLCSP	−40°C to 125°C	−7
10M08DFV81A7G [3]	10M08DF	81-pin WLCSP	−40°C to 125°C	−7
10M08SAU169A7G [3]	10M08SA	169-pin UBGA	−40°C to 125°C	−7
10M08SCE144A7G	10M08SC	144-pin EQFP	−40°C to 125°C	−7
10M08SCM153A7G [3]	10M08SC	153-pin MBGA	−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 [3]	10M08DA	256-pin FBGA	−40°C to 125°C	−7
10M08DCU324A7G	10M08DC	324-pin UBGA	−40°C to 125°C	−7
10M08DAU324A7G [3]	10M08DA	324-pin UBGA	−40°C to 125°C	−7
10M08DCF484A7G [3]	10M08DC	484-pin FBGA	−40°C to 125°C	−7
10M08DAF484A7G [3]	10M08DA	484-pin FBGA	−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 [3]	10M16DA	256-pin FBGA	−40°C to 125°C	−7
				continued...

[3] This automotive-grade ordering code might be available upon request. Faster speed grade devices might be available depending on the application and device feature needed. Consult your Intel sales representative to submit your request.

Device Ordering Code	Device	Package	Junction Temperature Range	Speed Grade
10M16DCU324A7G	10M16DC	324-pin UBGA	−40°C to 125°C	−7
10M16DAU324A7G [3]	10M16DA	324-pin UBGA	−40°C to 125°C	−7
10M16DCF484A7G	10M16DC	484-pin FBGA	−40°C to 125°C	−7
10M16DAF484A7G [3]	10M16DA	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
10M25DAF256A7G [3]	10M25DA	256-pin FBGA	−40°C to 125°C	−7
10M25DCF484A7G [3]	10M25DC	484-pin FBGA	−40°C to 125°C	−7
10M25DAF484A7G [3]	10M25DA	484-pin FBGA	−40°C to 125°C	−7
10M25DCF672A7G [3]	10M25DC	672-pin FBGA	−40°C to 125°C	−7
10M25DAF672A7G [3]	10M25DA	672-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
10M40DAF256A7G [3]	10M40DA	256-pin FBGA	−40°C to 125°C	−7
10M40DCF484A7G [3]	10M40DC	484-pin FBGA	−40°C to 125°C	−7
10M40DAF484A7G [3]	10M40DA	484-pin FBGA	−40°C to 125°C	−7
10M40DCF672A7G [3]	10M40DC	672-pin FBGA	−40°C to 125°C	−7
10M40DAF672A7G [3]	10M40DA	672-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
10M50DAF256A7G [3]	10M50DF	256-pin FBGA	−40°C to 125°C	−7
10M50DCF484A7G [3]	10M50DC	484-pin FBGA	−40°C to 125°C	−7
10M50DAF484A7G [3]	10M50DA	484-pin FBGA	−40°C to 125°C	−7
10M50DCF672A7G [3]	10M50DC	672-pin FBGA	−40°C to 125°C	−7
10M50DAF672A7G [3]	10M50DA	672-pin FBGA	−40°C to 125°C	−7

2.4.2 Pacakge Options and Maximum User I/Os

Table 8.   Package Options and Maximum User I/Os in Intel MAX 10 Single Power Supply Devices

Device	Package			
	Type	M153 153-pin MBGA	U169 169-pin UBGA	E144 144-pin EQFP
	Size	8 mm × 8 mm	11 mm × 11 mm	22 mm × 22 mm
	Ball Pitch	0.5 mm	0.8 mm	0.5 mm
10M02S		112	130	101
10M04S		112	130	101

continued...

Device	Package			
	Type	**M153** **153-pin MBGA**	**U169** **169-pin UBGA**	**E144** **144-pin EQFP**
	Size	**8 mm × 8 mm**	**11 mm × 11 mm**	**22 mm × 22 mm**
	Ball Pitch	**0.5 mm**	**0.8 mm**	**0.5 mm**
10M08S		112	130	101
10M16S		—	130	101
10M25S		—	—	101
10M40S		—	—	101
10M50S		—	—	101

Table 9.   Package Options and Maximum User I/Os in Intel MAX 10 Dual Power Supply Devices

Device	Package					
	Type	**V36** **36-pin** **WLCSP**	**V81** **81-pin** **WLCSP**	**U324** **324-pin** **UBGA**	**F256** **256-pin** **FBGA**	**F484** **484-pin** **FBGA**	**F672** **672-pin** **FBGA**
	Size	**3 mm × 3 mm**	**4 mm × 4 mm**	**15 mm × 15 mm**	**17 mm × 17 mm**	**23 mm × 23 mm**	**27 mm × 27 mm**
	Ball Pitch	**0.4 mm**	**0.4 mm**	**0.8 mm**	**1.0 mm**	**1.0 mm**	**1.0 mm**
10M02D		27	—	160	—	—	—
10M04D		—	—	246	178	—	—
10M08D		—	56	246	178	250	—
10M16D		—	—	246	178	320	—
10M25D		—	—	—	178	360	—
10M40D		—	—	—	178	360	500
10M50D		—	—	—	178	360	500

2.4.3 Device Ordering Codes

Figure 3. **Automotive-Grade Ordering Information for Intel MAX 10 Devices**

Feature Options

SC : Single supply - compact features
SA : Single supply - analog and flash features
       with RSU option
DC : Dual supply - compact features
DF : Dual supply - flash features with RSU option
DA : Dual supply - analog and flash features
       with RSU option

Package Type

V : Wafer-Level Chip Scale (WLCSP)
E : Plastic Enhanced Quad Flat Pack (EQFP)
M : Micro FineLine BGA (MBGA)
U : Ultra FineLine BGA (UBGA)
F : FineLine BGA (FBGA)

Family Signature
10M : Intel® MAX® 10

`10M` `16` `DC` `F` `256` `A` `7` `G`

Operating Temperature

A : Automotive (T_J = -40° C to 125° C)

**FPGA Fabric
Speed Grade**

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Member Code

02: 2K logic elements
04: 4K logic elements
08: 8K logic elements
16: 16K logic elements
25: 25K logic elements
40: 40K logic elements
50: 50K logic elements

Package Code

WLCSP Package Type
36 : 36 pins, 3 mm x 3 mm
81 : 81 pins, 4 mm x 4 mm

EQFP Package Type
144 : 144 pins, 20 mm x 20 mm

MBGA Package Type
153 : 153 pins, 8 mm x 8 mm

UBGA Package Type
169 : 169 pins, 11 mm x 11 mm
324 : 324 pins, 15 mm x 15 mm

FBGA Package Type
256 : 256 pins, 17 mm x 17 mm
484 : 484 pins, 23 mm x 23 mm
672 : 672 pins, 27 mm x 27 mm

Optional Suffix
*Indicates specific device
options or shipment method*
G : RoHS6

2.5 Cyclone V SoC Devices

2.5.1 Supported Automotive-Grade Devices

Table 10. **Automotive-Grade in Cyclone V SoC 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
5CSEBA2U19A7N	5CSEBA2	484-pin UBGA	−40°C to 125°C	−7
5CSEBA2U23A7N	5CSEBA2	672-pin UBGA	−40°C to 125°C	−7
5CSEMA2U23A7N	5CSEMA2	672-pin UBGA	−40°C to 125°C	−7
5CSEBA4U19A7N	5CSEBA4	484-pin UBGA	−40°C to 125°C	−7
5CSEBA4U23A7N	5CSEBA4	672-pin UBGA	−40°C to 125°C	−7
5CSEMA4U23A7N	5CSEMA4	672-pin UBGA	−40°C to 125°C	−7
5CSEBA5U19A7N	5CSEBA5	484-pin UBGA	−40°C to 125°C	−7

continued...

Device Ordering Code	Device	Package	Junction Temperature Range	Speed Grade
5CSEBA5U23A7N	5CSEBA5	672-pin UBGA	–40°C to 125°C	–7
5CSEMA5U23A7N	5CSEMA5	672-pin UBGA	–40°C to 125°C	–7
5CSEMA5F31A7N	5CSEMA5	896-pin FBGA	–40°C to 125°C	–7
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

2.5.2 Package Options and Maximum User I/Os

Table 11. 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 [4]	66 / 151 [4]	66 / 151 [4]	66 / 151 [4]
UBGA-672	0.8	23 x 23	145 / 181 [4]	145 / 181 [4]	145 / 181 [4]	145 / 181 [4]
FBGA-896	1	31 x 31	—	—	288 / 181 [4]	288 / 181 [4]

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

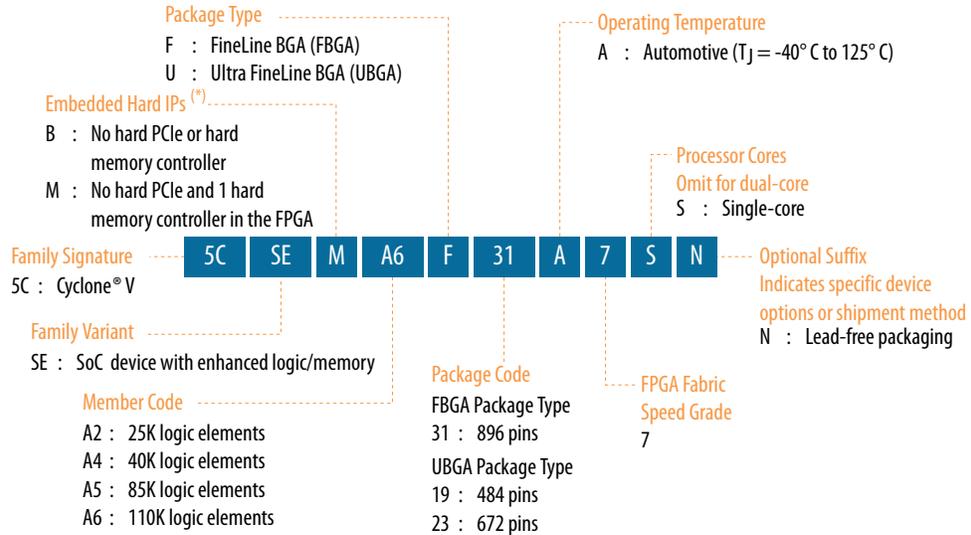| Package Type/ Pin Count	Ball Spacing (mm)	Dimensions (mm)	Product Line			
			5CSXC2	5CSXC4	5CSXC5	5CSXC6
			(25K LEs)	(40K LEs)	(85K LEs)	(110K LEs)
			FPGA I/Os / HPS I/Os / XCVRs			
UBGA-672	0.8	23 x 23	145 / 181 / 6 [4]	145 / 181 / 6 [4]	145 / 181 / 6 [4]	145 / 181 / 6 [4]
FBGA-896	1	31 x 31	—	—	288 / 181 / 9 [5]	288 / 181 / 9 [4]

[4] Package options available with automotive-grade variants.

[5] This automotive-grade ordering code might be available upon request. Faster speed grade devices might be available depending on the application and device feature needed. Consult your Intel sales representative to submit your request.
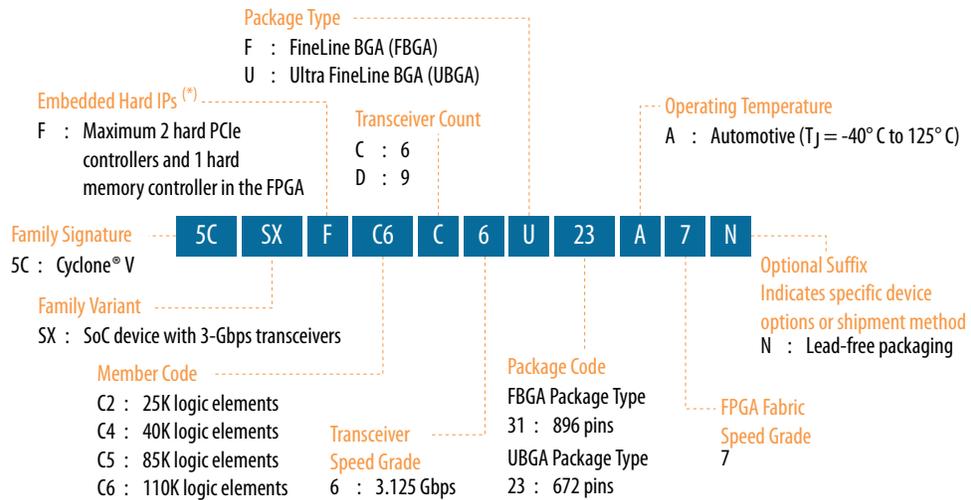
2.5.3 Device Ordering Codes

Figure 4. **Automotive-Grade Ordering Information for Cyclone V SE Devices**

Package Type
F : FineLine BGA (FBGA)
U : Ultra FineLine BGA (UBGA)

Operating Temperature
A : Automotive (T_J = -40° C to 125° C)

Embedded Hard IPs [*]
B : No hard PCIe or hard
memory controller
M : No hard PCIe and 1 hard
memory controller in the FPGA

Processor Cores
Omit for dual-core
S : Single-core

Family Signature
5C : Cyclone® V

5C	SE	M	A6	F	31	A	7	S	N

Optional Suffix
Indicates specific device
options or shipment method
N : Lead-free packaging

Family Variant
SE : SoC device with enhanced logic/memory

Package Code
FBGA Package Type
31 : 896 pins

UBGA Package Type
19 : 484 pins
23 : 672 pins

FPGA Fabric
Speed Grade
7

Member Code
A2 : 25K logic elements
A4 : 40K logic elements
A5 : 85K logic elements
A6 : 110K logic elements

Note:
* All Cyclone V SoC devices include one hard memory controller dedicated to the processor and which can be shared by the FPGA.

Figure 5. **Automotive-Grade Ordering Information for Cyclone V SX Devices**

Package Type
F : FineLine BGA (FBGA)
U : Ultra FineLine BGA (UBGA)

Embedded Hard IPs [*]
F : Maximum 2 hard PCIe
controllers and 1 hard
memory controller in the FPGA

Transceiver Count
C : 6
D : 9

Operating Temperature
A : Automotive (T_J = -40° C to 125° C)

Family Signature
5C : Cyclone® V

5C	SX	F	C6	C	6	U	23	A	7	N

Optional Suffix
Indicates specific device
options or shipment method
N : Lead-free packaging

Family Variant
SX : SoC device with 3-Gbps transceivers

Member Code
C2 : 25K logic elements
C4 : 40K logic elements
C5 : 85K logic elements
C6 : 110K logic elements

Transceiver
Speed Grade
6 : 3.125 Gbps

Package Code
FBGA Package Type
31 : 896 pins

UBGA Package Type
23 : 672 pins

FPGA Fabric
Speed Grade
7

Note:
* All Cyclone V SoC devices include one hard memory controller dedicated to the processor and which can be shared by the FPGA.

2.6 Cyclone V Devices

2.6.1 Supported Automotive-Grade Devices

Table 13.   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
5CGXFC9A6U19A7N	5CGXFC9	484-pin UBGA	−40°C to 125°C	−7
5CGTFD5C5U19A7N	5CGTFD5	484-pin UBGA	−40°C to 125°C	−7
5CGTFD7C5U19A7N	5CGTFD7	484-pin UBGA	−40°C to 125°C	−7
5CGTFD9A5U19A7N	5CGTFD9	484-pin UBGA	−40°C to 125°C	−7

2.6.2 Package Options and Maximum User I/Os

Table 14.   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 [6]	128 [6]	—	—	—
UBGA-324	0.8	15 x 15	176 [7]	176 [7]	—	—	—
							continued...

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[6]   Package options available with automotive-grade variants.

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				
UBGA-484	0.8	19 x 19	224 [6]	224 [6]	224 [6]	240 [6]	—
FBGA-484	1	23 x 23	224 [7]	224 [7]	240 [7]	240 [7]	224 [7]
FBGA-672	1	27 x 27	—	—	—	336 [7]	336 [7]
FBGA-896	1	31 x 31	—	—	—	480 [7]	480 [7]

Table 15.   Package Options and Maximum User I/Os in Cyclone V GX Devices

Package Type/ Pin Count	Ball Spacing (mm)	Dimensions (mm)	Product Line				
			5CGXC3	5CGXC4	5CGXC5	5CGXC7	5CGXC9
			(36K LEs)	(50K LEs)	(77K LEs)	(149.5K LEs)	(301K LEs)
			I/Os / XCVRs				
UBGA-324	0.8	15 x 15	144 / 3 [6]	—	—	—	—
UBGA-484	0.8	19 x 19	208 / 3 [6]	224 / 6 [6]	224 / 6 [6]	240 / 6 [6]	240 / 5 [6]
FBGA-484	1	23 x 23	208 / 3 [7]	240 / 6 [7]	240 / 6 [6]	240 / 6 [7]	224 / 6 [7]
FBGA-672	1	27 x 27	—	336 / 6 [7]	336 / 6 [7]	336 / 9 [7]	336 / 9 [7]
FBGA-896	1	31 x 31	—	—	—	480 / 9 [7]	480 / 12 [7]
FBGA-1152	1	35 x 35	—	—	—	—	560 / 12 [7]

Table 16.   Package Options and Maximum User I/Os in Cyclone V GT Devices

Package Type/ Pin Count	Ball Spacing (mm)	Dimensions (mm)	Product Line		
			5CGTD5	5CGTD7	5CGTD9
			(77K LEs)	(149.5K LEs)	(301K LEs)
			I/Os / XCVRs		
UBGA-484	0.8	19 x 19	224 / 6 [6]	240 / 6 [6]	240 / 5 [6]
FBGA-484	1	23 x 23	240 / 6 [7]	240 / 6 [7]	224 / 6 [7]
FBGA-672	1	27 x 27	336 / 6 [7]	336 / 9 [7]	336 / 9 [7]
FBGA-896	1	31 x 31	—	480 / 9 [7]	480 / 12 [7]
FBGA-1152	1	35 x 35	—	—	560 / 12 [7]

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[7] These package options are not currently available in automotive-grade but might become available upon request. Consult your Intel sales representative to submit your request.

2.6.3 Device Ordering Codes

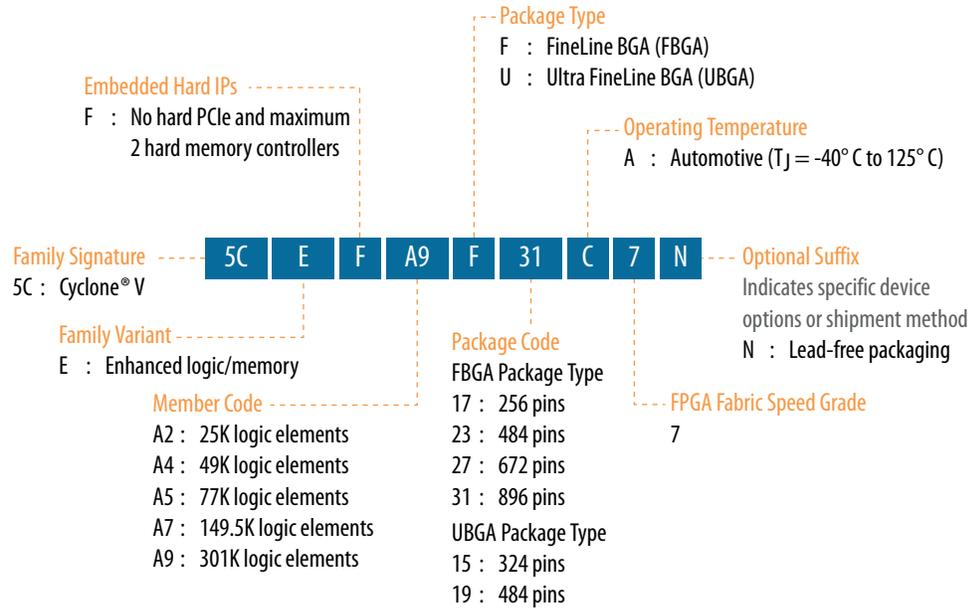**Figure 6.   Automotive-Grade Ordering Information for Cyclone V E Devices**

Package Type
F : FineLine BGA (FBGA)
U : Ultra FineLine BGA (UBGA)

Embedded Hard IPs
F : No hard PCIe and maximum
2 hard memory controllers

Operating Temperature
A : Automotive (T$_J$ = -40° C to 125° C)

Family Signature
5C : Cyclone® V

5C | E | F | A9 | F | 31 | C | 7 | N

Optional Suffix
Indicates specific device
options or shipment method
N : Lead-free packaging

Family Variant
E : Enhanced logic/memory

Member Code
A2 : 25K logic elements
A4 : 49K logic elements
A5 : 77K logic elements
A7 : 149.5K logic elements
A9 : 301K logic elements

Package Code
FBGA Package Type
17 : 256 pins
23 : 484 pins
27 : 672 pins
31 : 896 pins
UBGA Package Type
15 : 324 pins
19 : 484 pins

FPGA Fabric Speed Grade
7

Figure 7.   Automotive-Grade Ordering Information for Cyclone V GX Devices

Transceiver Count
B : 3
A : 5
C : 6

Package Type
F : FineLine BGA (FBGA)
U : Ultra FineLine BGA (UBGA)

Embedded Hard IPs
F : Maximum 2 hard PCIe and
maximum 2 hard memory
controllers

Operating Temperature
A : Automotive (T$_J$ = -40° C to 125° C)

Family Signature
5C : Cyclone® V

5C | GX | F | C7 | C | 6 | U | 19 | A | 7 | N

Family Variant
GX : 3-Gbps transceivers

Optional Suffix
Indicates specific device
options or shipment method
N : Lead-free packaging

Member Code
C3 : 31.5K logic elements
C4 : 50K logic elements
C5 : 77K logic elements
C7 : 149.5K logic elements
C9 : 301K logic elements

Transceiver
Speed Grade
6 : 3.125 Gbps

Package Code
FBGA Package Type
23 : 484 pins
27 : 672 pins
31 : 896 pins
35 : 1,152 pins
UBGA Package Type
15 : 324 pins
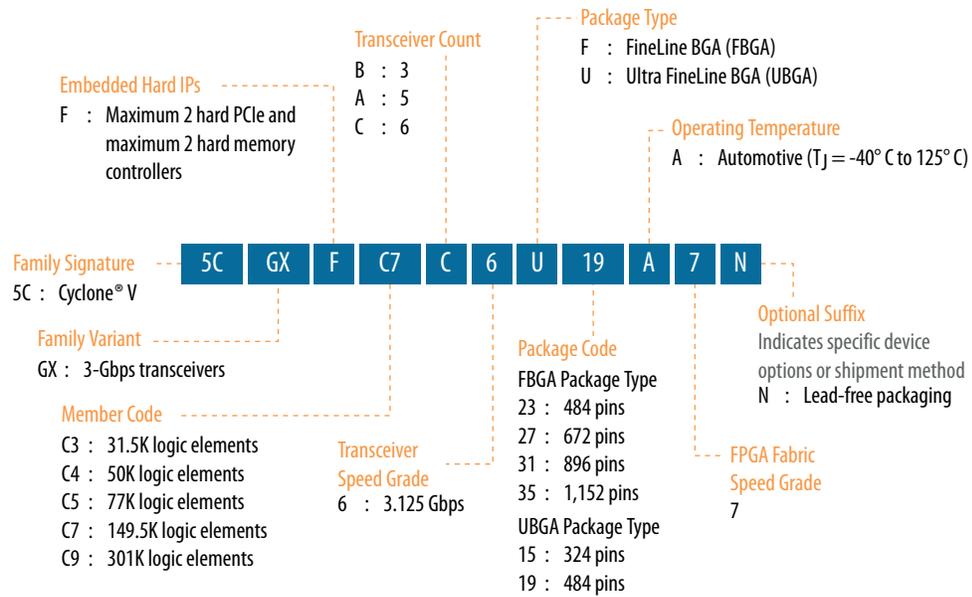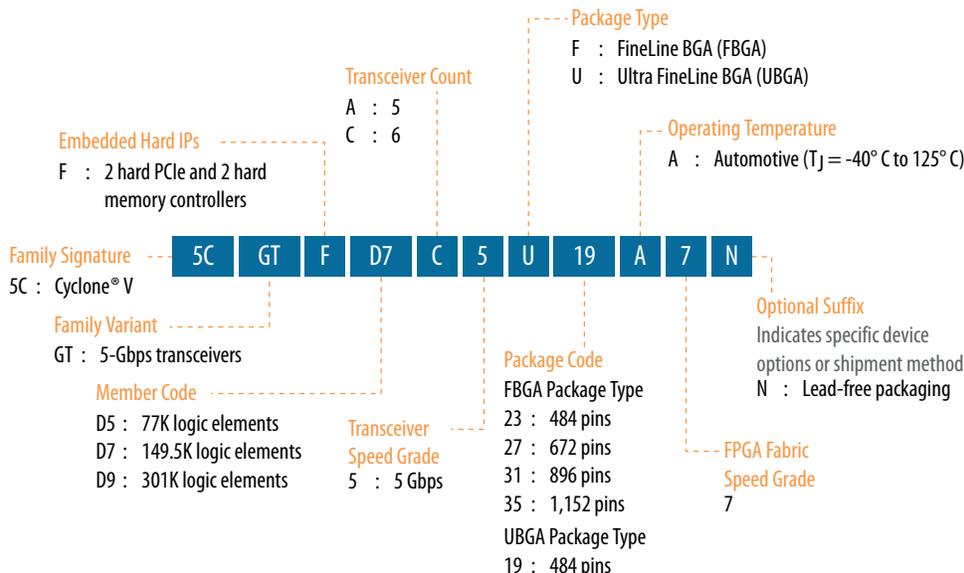19 : 484 pins

FPGA Fabric
Speed Grade
7

Figure 8.   Automotive-Grade Ordering Information for Cyclone V GT Devices

2.7 Cyclone IV Devices

2.7.1 Supported Automotive-Grade Devices

Table 17.   Automotive-Grade in Cyclone IV 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
EP4CE6F17A7N	EP4CE6	256-pin FBGA	−40°C to 125°C	−7
EP4CE6E22A7N	EP4CE6	144-pin EQFP	−40°C to 125°C	−7
EP4CE10F17A7N	EP4CE10	256-pin FBGA	−40°C to 125°C	−7
EP4CE10E22A7N	EP4CE10	144-pin EQFP	−40°C to 125°C	−7
EP4CE15F17A7N	EP4CE15	256-pin FBGA	−40°C to 125°C	−7
EP4CE15F23A7N	EP4CE15	484-pin FBGA	−40°C to 125°C	−7
EP4CE15U14A7N	EP4CE15	256-pin UBGA	−40°C to 125°C	−7
EP4CE22F17A7N	EP4CE22	256-pin FBGA	−40°C to 125°C	−7
EP4CE22E22A7N	EP4CE22	144-pin EQFP	−40°C to 125°C	−7
EP4CE22U14A7N	EP4CE22	256-pin UBGA	−40°C to 125°C	−7
EP4CE30F19A7N	EP4CE30	324-pin FBGA	−40°C to 125°C	−7
EP4CE30F23A7N	EP4CE30	484-pin FBGA	−40°C to 125°C	−7
EP4CE40F19A7N	EP4CE40	324-pin FBGA	−40°C to 125°C	−7
EP4CE40F23A7N	EP4CE40	484-pin FBGA	−40°C to 125°C	−7
				continued...

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

2.7.2 Package Options and Maximum User I/Os

Table 18.   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)	EP4CE75 (75.4K LEs)	EP4CE115 (114.5K LEs)
			I/Os								
EQFP-144	0.5	22 x 22	91 [8]	91 [8]	81 [9]	79 [8]	—	—	—	—	—
MBGA-164	0.5	8 x 8	—	—	89 [9]	—	—	—	—	—	—
UBGA-256	0.8	14 x 14	179 [9]	179 [9]	165 [9]	153 [9]	—	—	—	—	—
FBGA-256	1	17 x 17	179 [8]	179 [8]	165 [8]	153 [8]	—	—	—	—	—
UBGA-484	0.8	19 x 19	—	—	—	—	—	328 [9]	324 [9]	292 [9]	—
FBGA-324	1	19 x 19	—	—	—	—	193 [8]	193 [8]	—	—	—
FBGA-484	1	23 x 23	—	—	343 [8]	—	328 [8]	328 [8]	324 [9]	292 [9]	280 [9]
FBGA-780	1	29 x 29	—	—	—	—	532 [9]	532 [9]	374 [9]	426 [9]	528 [9]

Table 19.   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)	EP4CGX22 (21.3K LEs)	EP4CGX30 (29.4K LEs)	EP4CGX50 (49.9K LEs)	EP4CGX75 (73.9K LEs)	EP4CGX110 (109.4K LEs)	EP4CGX150 (149.8K LEs)
			I/Os						
QFN-148	0.5	11 x 11	72 / 2 [9]	—	—	—	—	—	—
FBGA-169	1	14 x 14	72 / 2 [8]	72 / 2 [9]	72 / 2 [9]	—	—	—	—

continued...

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[8] Package options available with automotive-grade variants.

[9] These package options are not currently available in automotive-grade but might become available upon request. Consult your Intel sales representative to submit your request.

Package Type/ Pin Count	Ball Spacing (mm)	Dimensions (mm)	Product Line						
			EP4CGX15 (14.4K LEs)	EP4CGX22 (21.3K LEs)	EP4CGX30 (29.4K LEs)	EP4CGX50 (49.9K LEs)	EP4CGX75 (73.9K LEs)	EP4CGX110 (109.4K LEs)	EP4CGX150 (149.8K LEs)
			I/Os						
FBGA-324	1	19 x 19	—	150 / 4 [(9)]	150 / 4 [(9)]	—	—	—	—
FBGA-484	1	23 x 23	—	—	290 / 4 [(9)]	290 / 4 [(9)]	290 / 4 [(9)]	270 / 4 [(9)]	270 / 4 [(9)]
FBGA-672	1	27 x 27	—	—	—	310 / 8 [(9)]	310 / 8 [(9)]	393 / 8 [(9)]	393 / 8 [(9)]
FBGA-896	1	31 x 31	—	—	—	—	475 / 8 [(9)]	475 / 8 [(9)]	

2.7.3 Device Ordering Codes

Figure 9.   Automotive-Grade Ordering Information for Cyclone IV E Devices
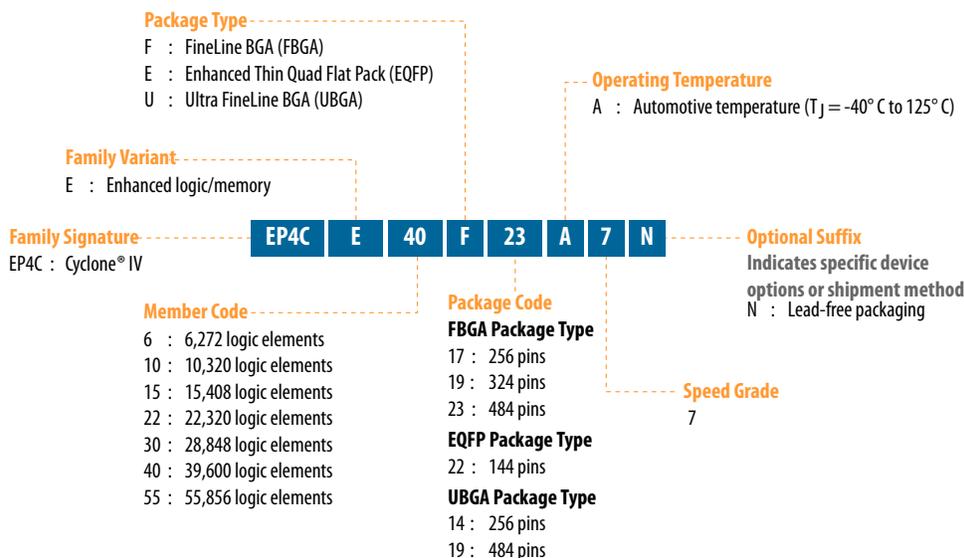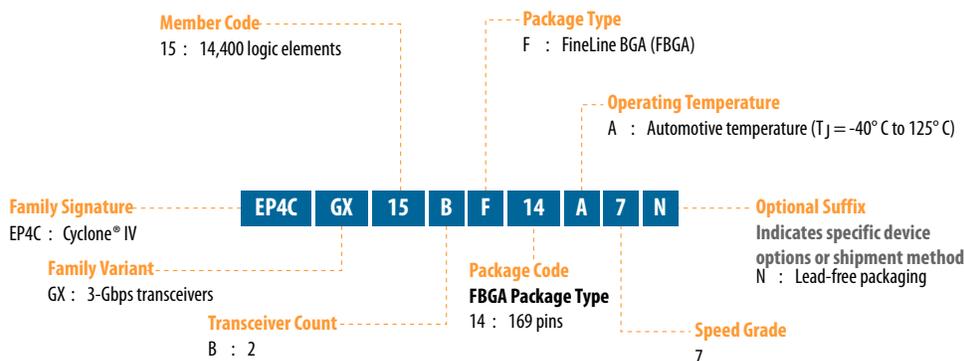

Figure 10.   Automotive-Grade Ordering Information for Cyclone IV GX Devices

2.8 MAX V Devices

2.8.1 Supported Automotive-Grade Devices

Table 20.   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
5M160ZE64A5N	5M160Z	64-pin EQFP	−40°C to 125°C	−5
5M160ZT100A5N	5M160Z	100-pin TQFP	−40°C to 125°C	−5
5M240ZT100A5N	5M240Z	100-pin TQFP	−40°C to 125°C	−5
5M570ZT100A5N	5M570Z	100-pin TQFP	−40°C to 125°C	−5
5M1270ZF256A5N	5M1270Z	256-pin FBGA	−40°C to 125°C	−5
5M1270ZT144A5N	5M1270Z	144-pin TQFP	−40°C to 125°C	−5

2.8.2 Package Options and Maximum User I/Os

Table 21.   Package Options and Maximum User I/Os in MAX V Devices

Package Type/ Pin Count	Ball Spacing (mm)	Dimensions (mm)	Product Line						
			5M40Z (40K LEs)	5M80Z (80K LEs)	5M160Z (160K LEs)	5M240Z (240K LEs)	5M570Z (570K LEs)	5M1270Z (1270K LEs)	5M2210Z (2210K LEs)
			I/Os						
MBGA-64	0.5	4.5 x 4.5	30 [10]	30 [10]	—	—	—	—	—
EQFP-64	0.5	7 x 7	54 [11]	54 [11]	54 [11]	—	—	—	—
MBGA-68	0.5	5 x 5	—	52 [10]	52 [10]	52 [10]	—	—	—
QFP-100	0.5	14 x 14	—	79 [11]	79 [11]	79 [11]	74 [11]	—	—
MBGA-100	0.5	6 x 6	—	—	79 [10]	79 [10]	74 [10]	—	—
DFP-144	0.5	20 x 20	—	—	—	114 [10]	114 [10]	114 [11]	—
FBGA-256	1	17 x 17	—	—	—	—	159 [10]	211 [11]	203 [10]
FBGA-324	1	19 x 19	—	—	—	—	—	271 [10]	271 [10]

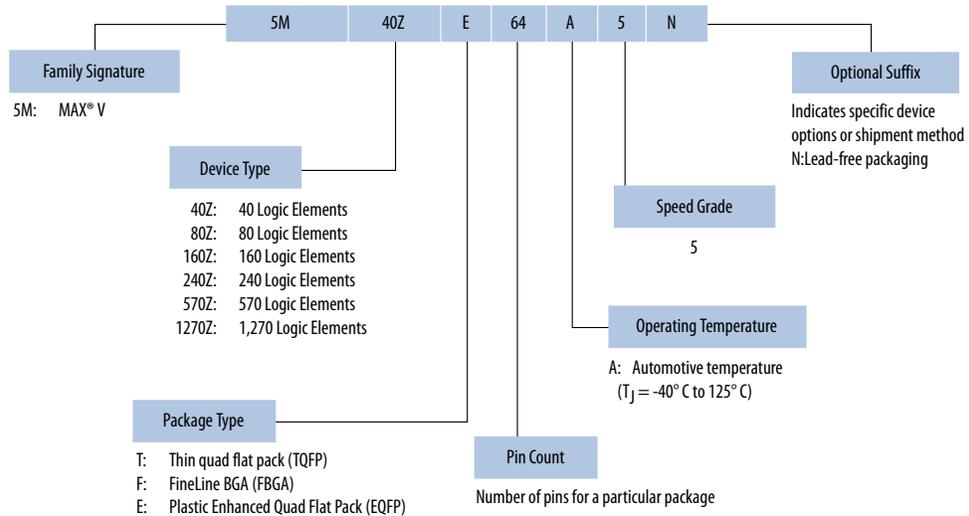[10] These package options are not currently available in automotive-grade but might become available upon request. Consult your Intel sales representative to submit your request.

[11] Package options available with automotive-grade variants.

2.8.3 Device Ordering Codes

Figure 11.   Automotive-Grade Ordering Information for MAX V Devices

2.9 MAX II Devices

2.9.1 Supported Automotive-Grade Devices

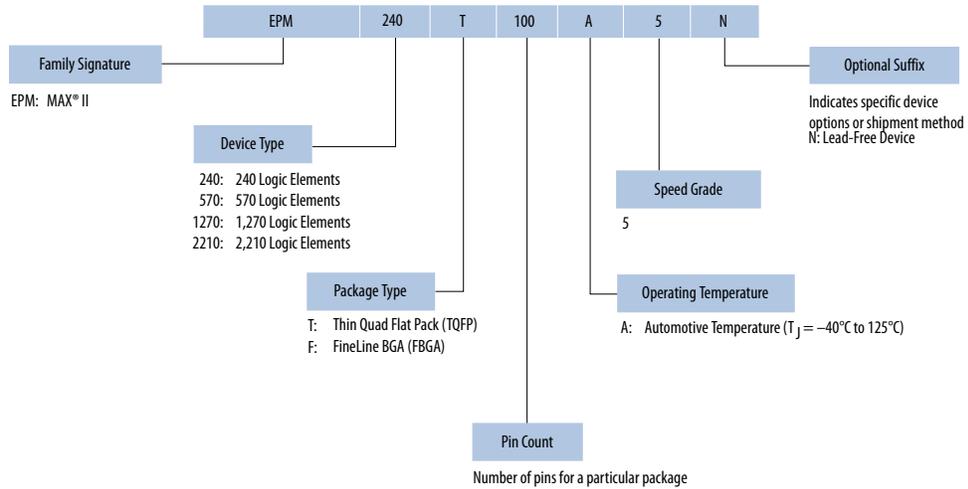**Table 22.   Automotive-Grade in MAX II Devices**

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

2.9.2 Device Ordering Codes

Figure 12. Automotive-Grade Ordering Information for MAX II Devices

2.10 Cyclone III Devices (Legacy Support)

2.10.1 Supported Automotive-Grade Devices

Table 23. Automotive-Grade in Cyclone III Devices

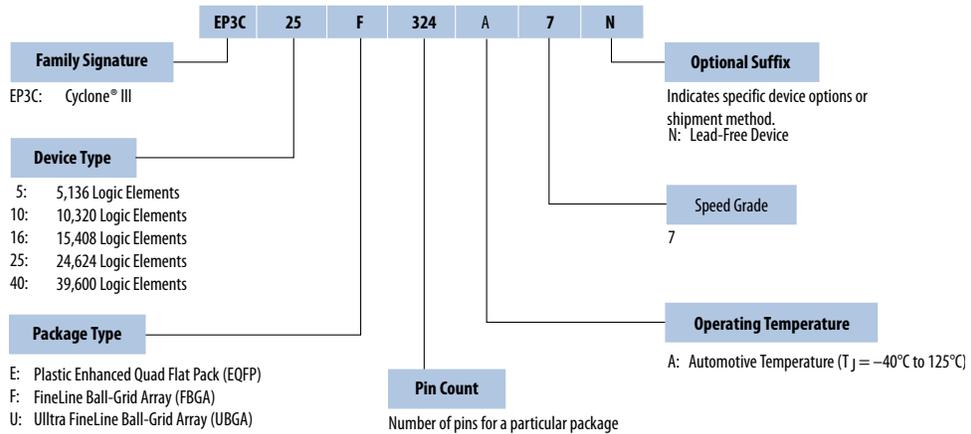| Device Ordering Code	Device	Package	Junction Temperature Range	Speed Grade
EP3C5E144A7N	EP3C5	144-pin EQFP	−40°C to 125°C	−7
EP3C5F256A7N	EP3C5	256-pin FBGA	−40°C to 125°C	−7
EP3C5U256A7N	EP3C5	256-pin UBGA	−40°C to 125°C	−7
EP3C10E144A7N	EP3C10	144-pin EQFP	−40°C to 125°C	−7
EP3C10F256A7N	EP3C10	256-pin 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

continued...

Device Ordering Code	Device	Package	Junction Temperature Range	Speed Grade
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

2.10.2 Device Ordering Codes

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

2.11 Cyclone II Devices (Legacy Support)
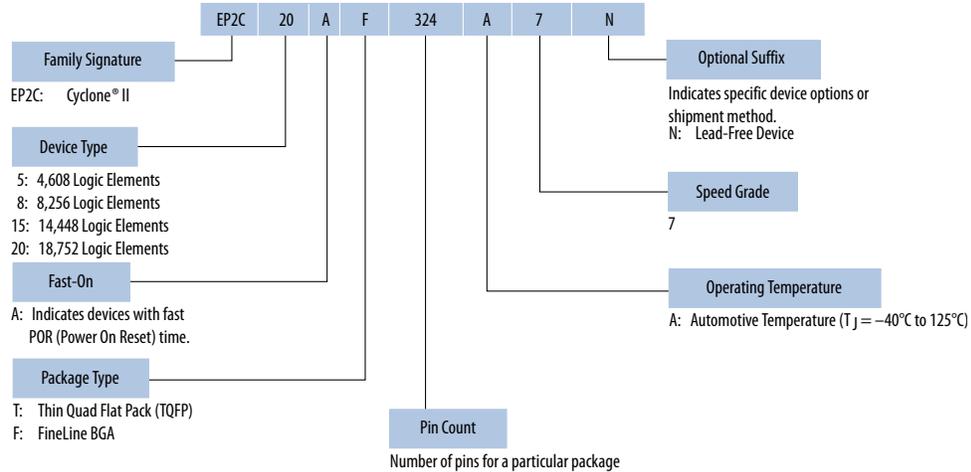
2.11.1 Supported Automotive-Grade Devices

Table 24.   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

2.11.2 Device Ordering Codes

Figure 14.   Automotive-Grade Ordering Information for Cyclone II Devices
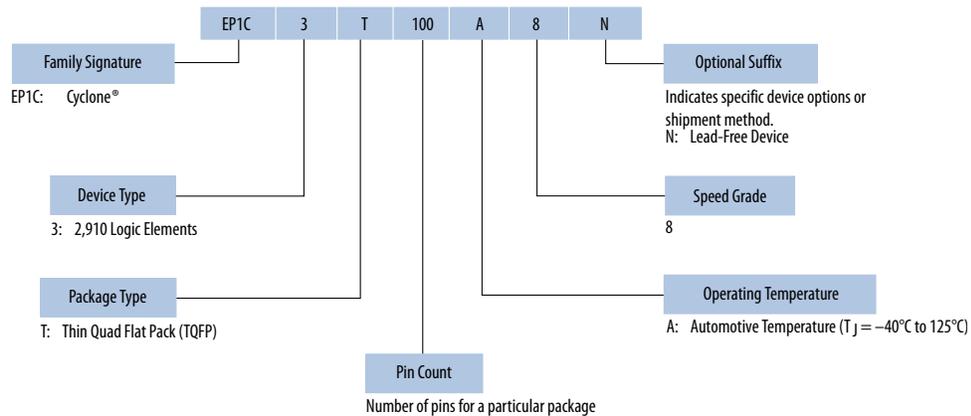

2.12 Cyclone Devices (Legacy Support)

2.12.1 Supported Automotive-Grade Devices

Table 25.   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

2.12.2 Device Ordering Codes

Figure 15.   Automotive-Grade Ordering Information for Cyclone Devices

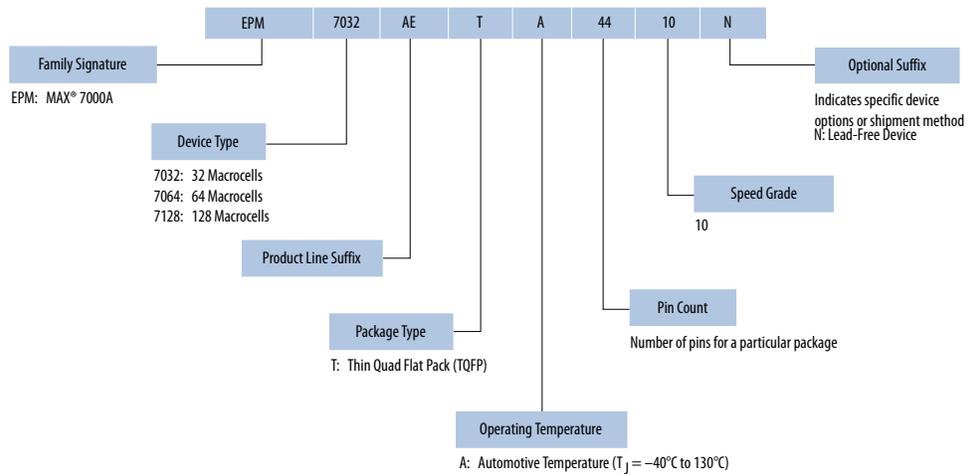## 2.13 MAX 7000A Devices (Legacy Support)

2.13.1 Supported Automotive-Grade Devices

Table 26.   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

2.13.2 Device Ordering Codes

Figure 16.   Automotive-Grade Ordering Information for MAX 7000A Devices

| EPM | 7032 | AE | T | A | 44 | 10 | N |

Family Signature

EPM: MAX® 7000A

Device Type

7032: 32 Macrocells
7064: 64 Macrocells
7128: 128 Macrocells

Product Line Suffix

Package Type

T: Thin Quad Flat Pack (TQFP)

Operating Temperature

A: Automotive Temperature ($T_J = -40°C$ to 130°C)

Pin Count

Number of pins for a particular package

Speed Grade

10

Optional Suffix

Indicates specific device options or shipment method
N: Lead-Free Device

3 Intel Quartus Prime Software Support

The Intel Quartus Prime design software supports the automotive-grade devices in the automotive temperature range. The Intel Quartus Prime software provides a comprehensive environment for SoC design. It also includes HDL and schematic design entry, compilation and logic synthesis, full simulation and advanced timing analysis, Signal Tap II logic analyzer, and device configuration.

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

1. Click **Assignments ➤ Device**. The **Settings** dialog box appears.
2. In the **Family** drop-down list, select your device.
3. Under **Target device**, select **Specific device selected in 'Available devices' list**.
4. In the **Available devices** list, select the appropriate ordering code.

    Note: The Intel Quartus Prime software does not show the "N" suffix, which indicates a lead-free device. For example, the 5CGXFC3B6U15A7N device is shown only as 5CGXFC3B6U15A7.

5. Click **OK**.

Legacy support for the following automotive-grade devices in Intel Quartus Prime software requires special approval. Contact the nearest Intel sales representative to submit your request.

- Cyclone III
- Cyclone II
- Cyclone
- MAX 7000AE

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 Links

- Early Power Estimator for Intel Arria 10 FPGAs User Guide
  Applicable to Intel Arria 10.

- Early Power Estimator User Guide
  Applicable to Cyclone III, Cyclone IV, Cyclone V, Cyclone V SoC devices, Intel Cyclone 10, and Intel Arria 10.

- Early Power Estimator for Intel CPLDs User Guide
  Applicable to MAX II and MAX V devices.

- Early Power Estimator User Guide For Stratix®, Stratix GX & Cyclone FPGAs
  Applicable to Cyclone devices.

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 Links

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

5 DC and Timing Specifications

The automotive-grade devices have the same values for the following specifications as published in the respective device datasheets :

- Absolute maximum ratings

- Recommended operating conditions

- DC electrical characteristics

- Timing specifications over the automotive temperature range

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 on-chip series termination (R_S OCT) specifications for the following automotive-grade devices are as follows:

- Automotive-grade Cyclone III, Cyclone IV, Cyclone V, and Cyclone V SoC devices —same as the corresponding industrial-grade devices

- Automotive-grade Cyclone II devices—same as the corresponding extended-temperature devices

The switching characteristics of the automotive-grade Cyclone III, Cyclone IV, Cyclone V, and Cyclone V SoC devices are the same as the devices with –8 speed grade as published in the respective device datasheets.

Related Links

- Intel Cyclone 10 LP Device Datasheet

- Intel Arria 10 Device Datasheet

- Intel MAX 10 FPGA Device Datasheet

- Cyclone V Device Datasheet

- Cyclone IV Device Datasheet

- DC and Switching Characteristics for MAX V Devices

- DC and Switching Characteristics chapter, MAX II Device Handbook

- Cyclone III Device Datasheet

- DC Characteristics and Timing Specifications chapter, Cyclone II Device Handbook

- DC and Switching Characteristics chapter, Cyclone Device Handbook

- MAX 7000A Programmable Logic Device Data Sheet

6 Pin-Out Information

For more information about the device pin-outs, refer to the respective device pin-out files.

Related Links

Pin-Out Files for Intel Devices page

7 Package and Board Layout Information

Intel provides information on package and PCB design guidelines.

Related Links

- Package and Thermal Resistance page, Intel website
  Provides more information about the package-related information and Package
  Information Datasheet for Intel Devices.

- AN114: Designing With High-Density BGA Packages for Intel Devices
  Provides more information about the PCB design guidelines

- Cadence Capture CIS and Allegro PCB Symbols and Footprints 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

Date	Version	Changes
December 2017	2017.12.15	• Removed Intel Cyclone 10 GX devices. — Removed Intel Cyclone 10 GX devices from *Automotive-Grade in Intel Cyclone 10 GX Devices* table. — Removed *Package Options and Maximum User I/Os in Intel Cyclone 10 GX Devices* table. — Removed *Automotive-Grade Ordering Information for Intel Cyclone 10 GX Devices* diagram. • 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. • Rebranded as Intel.
February 2017	2017.02.13	• Added Intel Arria 10, Cyclone 10, and Enpirion devices. • Removed PowerPlay text from tool name.
		continued...

ISO 9001:2008 Registered

Date	Version	Changes
May 2016	2016.05.03	• Updated the Overview topic to remove ASIC devices. • Updated footnote in Automotive-Grade in MAX 10 Devices table. • Added new automotive-grade devices for the following device families: — MAX 10—10M08SAU169A7G — Cyclone V SoC—5CSXFC6D6F31A7N — Cyclone IV—EP4CE15U14A7N, EP4CE22U14A7N, and EP4CE55F23A7N • Removed the following devices from Automotive-Grade in MAX 10 Devices table. — 10M04SFE144A7G — 10M04SFU169A7G — 10M04DFF256A7G — 10M04DFU324A7G — 10M08SFE144A7G — 10M08SFU169A7G — 10M08DFF256A7G — 10M08DFU324A7G — 10M08DFF484A7G — 10M16SFE144A7G — 10M16SFU169A7G — 10M16DFF256A7G — 10M16DFU324A7G — 10M16DFF484A7G — 10M25SFE144A7G — 10M25DFF256A7G — 10M25DFF484A7G — 10M25DFF672A7G — 10M40SFE144A7G — 10M40DFF256A7G — 10M40DFF484A7G — 10M40DFF672A7G — 10M50SFE144A7G — 10M50DFF256A7G — 10M50DFF484A7G — 10M50DFF672A7G • Updated the Package Options and Maximum User I/Os in Cyclone V GX Devices table. — Updated the LE count for 5CGXC3 from 31.5K LEs to 36K LEs. — Added I/Os / XCVRs count for UBGA-484 package in 5CGXC9 device. • Updated the Package Options and Maximum User I/Os in Cyclone V GT Devices table. — Added I/Os / XCVRs count for UBGA-484 package in 5CGTD9 device. • Updated the following device ordering codes diagrams: — Automotive-Grade Ordering Information for MAX 10 Devices — Automotive-Grade Ordering Information for Cyclone IV E Devices — Automotive-Grade Ordering Information for Cyclone V SE Devices — Automotive-Grade Ordering Information for Cyclone V SX Devices • Changed instances of *Quartus II* to *Quartus Prime*.
		continued...

Date	Version	Changes

September 2014	2014.09.22	• Added MAX 10 devices.
		• Removed HardCopy® II devices.
		• Updated the Quartus II software support versions for the legacy device families.
		  — Cyclone III—Version 8.0 to 13.1
		  — Cyclone II—Version 7.2 SP1 to 13.0
		  — Cyclone—Version 7.2 SP1 to 13.0
		  — MAX 7000AE—Version 7.2 SP1 to 13.0
		• Added new automotive-grade devices for the following device families:
		  — Cyclone V—5CGXFC5C6F23A7N
		  — Cyclone IV—EP4CE40U19A7N and EP4CGX15BF14A7N
		  — MAX V—5M40ZE64A5N, 5M80ZT100A5N, and 5M160ZT100A5N
		• Added Cyclone IV GX ordering information diagram.
		• 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. • 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. • 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.
		• Added Table 4–2, Table 4–3, and Table 5–2.
		• Updated Table 4–1, Table 4–4, Table 6–1, and Table 6–2.
		• Updated Figure 4–1.
		• Listed the following devices under legacy support:
		  — Cyclone III
		  — Cyclone II
		  — Cyclone
		  — MAX 7000A

May 2011	2.0	• Added MAX V devices. • Updated part number for Cyclone III, Cyclone IV, and HardCopy II devices. • Template conversion. • Minor text edits.
March 2010	1.2	• Added Cyclone IV devices. • Removed Referenced Documents section.
October 2008	1.1	• Updated DC and Timing Specifications section. • Converted to new template.
February 2008	1.0	Initial release.