

The Automotive-Grade Device Handbook



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Contents

Overview.....	1-1
Altera Automotive-Grade Devices.....	1-1
Altera Automotive Qualifications.....	1-1
Supported Device Families.....	1-2
 Supported Automotive-Grade Devices.....	 2-1
MAX 10 Devices.....	2-1
Supported Automotive-Grade Devices.....	2-1
Package Options and Maximum User I/Os.....	2-3
Device Ordering Codes.....	2-5
Cyclone V SoC Devices.....	2-5
Supported Automotive-Grade Devices.....	2-5
Package Options and Maximum User I/Os.....	2-6
Device Ordering Codes.....	2-7
Cyclone V Devices.....	2-8
Supported Automotive-Grade Devices.....	2-8
Package Options and Maximum User I/Os.....	2-9
Device Ordering Codes.....	2-11
Cyclone IV Devices.....	2-13
Supported Automotive-Grade Devices.....	2-13
Package Options and Maximum User I/Os.....	2-14
Device Ordering Codes.....	2-16
MAX V Devices.....	2-17
Supported Automotive-Grade Devices.....	2-17
Package Options and Maximum User I/Os.....	2-17
Device Ordering Codes.....	2-18
MAX II Devices.....	2-19
Supported Automotive-Grade Devices.....	2-19
Device Ordering Codes.....	2-19
Cyclone III Devices (Legacy Support).....	2-20
Supported Automotive-Grade Devices.....	2-20
Device Ordering Codes.....	2-21
Cyclone II Devices (Legacy Support).....	2-21
Supported Automotive-Grade Devices.....	2-21
Device Ordering Codes.....	2-22
Cyclone Devices (Legacy Support).....	2-22
Supported Automotive-Grade Devices.....	2-22
Device Ordering Codes.....	2-23
MAX 7000A Devices (Legacy Support).....	2-23
Supported Automotive-Grade Devices.....	2-23
Device Ordering Codes.....	2-24

Quartus Prime Software Support.....	3-1
Power Analysis and Estimation.....	4-1
PowerPlay Early Power Estimator.....	4-1
PowerPlay Power Analyzer.....	4-1
DC and Timing Specifications.....	5-1
Pin-Out Information.....	6-1
Package and Board Layout Information.....	7-1
Document Revision History for the Automotive-Grade Device Handbook.....	A-1

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Altera Automotive-Grade Devices

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

Related Information

[Automotive page, Altera website](#)

Provides more information about Altera automotive solutions

Altera Automotive Qualifications

Altera 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 Information

[Automotive Quality and Reliability page, Altera website](#)

Provides more information about the certificates.

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Supported Device Families

Table 1-1: Altera Automotive-Grade Device Families

Category	Product Family	Quartus Software Support ⁽¹⁾	Description
IC, FPGA	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)

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

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

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MAX 10 Devices

Supported Automotive-Grade Devices

Table 2-1: Automotive-Grade in 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

⁽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 Altera sales representative to submit your request.

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Device Ordering Code	Device	Package	Junction Temperature Range	Speed Grade
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
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

Device Ordering Code	Device	Package	Junction Temperature Range	Speed Grade
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

Package Options and Maximum User I/Os

Table 2-2: Package Options and Maximum User I/Os in 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
10M02		112	130	101
10M04		112	130	101
10M08		112	130	101
10M16		—	130	101
10M25		—	—	101
10M40		—	—	101
10M50		—	—	101

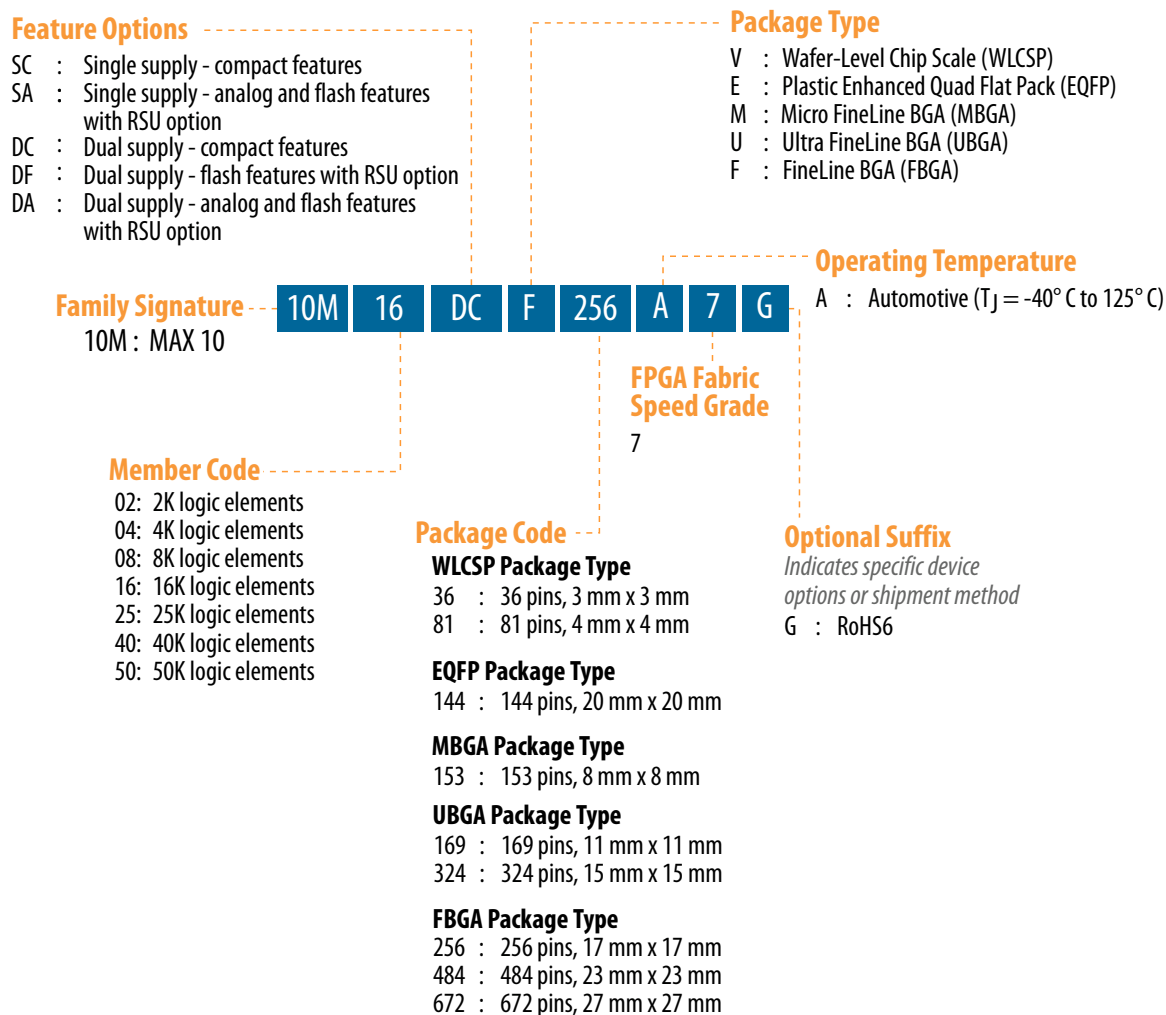
Table 2-3: Package Options and Maximum User I/Os in MAX 10 Dual Power Supply Devices

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
10M02		27	—	160	—	—	—

Device	Package						
	Type	V36	V81	U324	F256	F484	F672
		36-pin WLCSP	81-pin WLCSP	324-pin UBGA	256-pin FBGA	484-pin FBGA	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
10M04		—	—	246	178	—	—
10M08		—	56	246	178	250	—
10M16		—	—	246	178	320	—
10M25		—	—	—	178	360	—
10M40		—	—	—	178	360	500
10M50		—	—	—	178	360	500

Device Ordering Codes

Figure 2-1: Automotive-Grade Ordering Information for MAX 10 Devices



Cyclone V SoC Devices

Supported Automotive-Grade Devices

Table 2-4: Automotive-Grade in Cyclone V SoC Devices

Other automotive-grade product line/package combinations or ordering codes might be available upon request. Consult your Altera 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

Device Ordering Code	Device	Package	Junction Temperature Range	Speed Grade
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
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

Package Options and Maximum User I/Os

Table 2-5: 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⁾

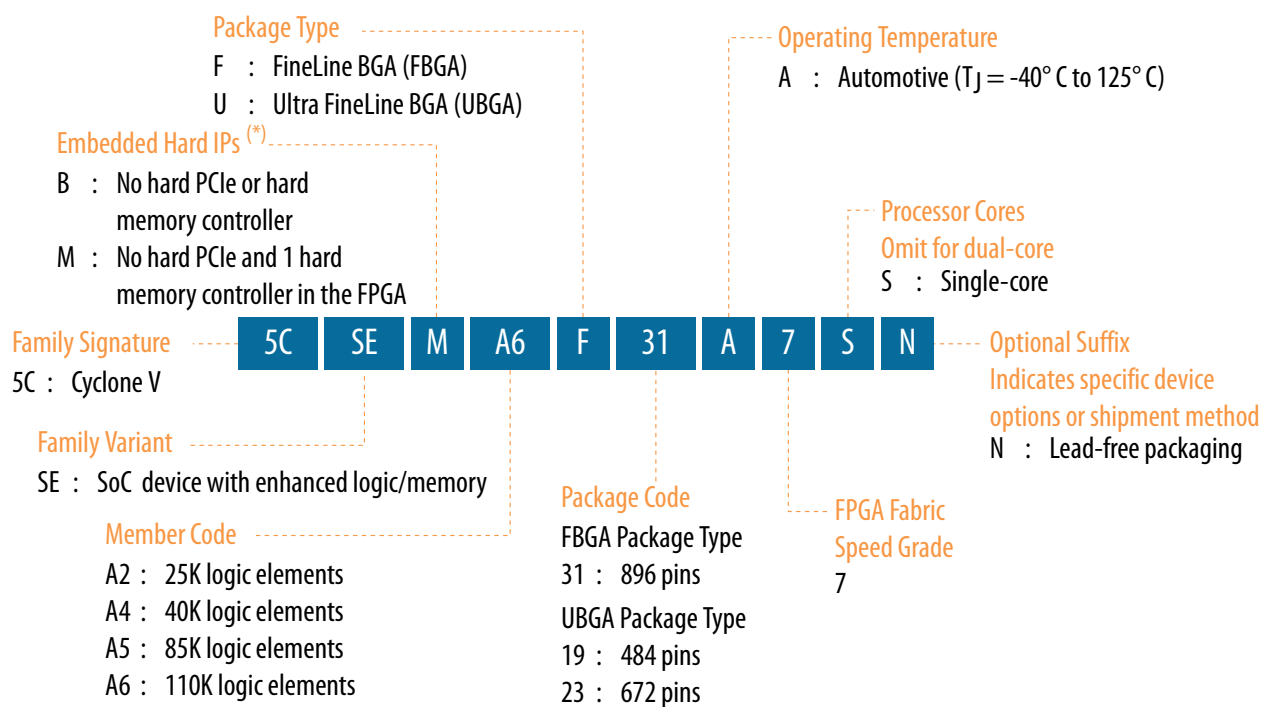
⁽⁴⁾ Package options available with automotive-grade variants.

Table 2-6: 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⁾

Device Ordering Codes

Figure 2-2: Automotive-Grade Ordering Information for Cyclone V SE Devices

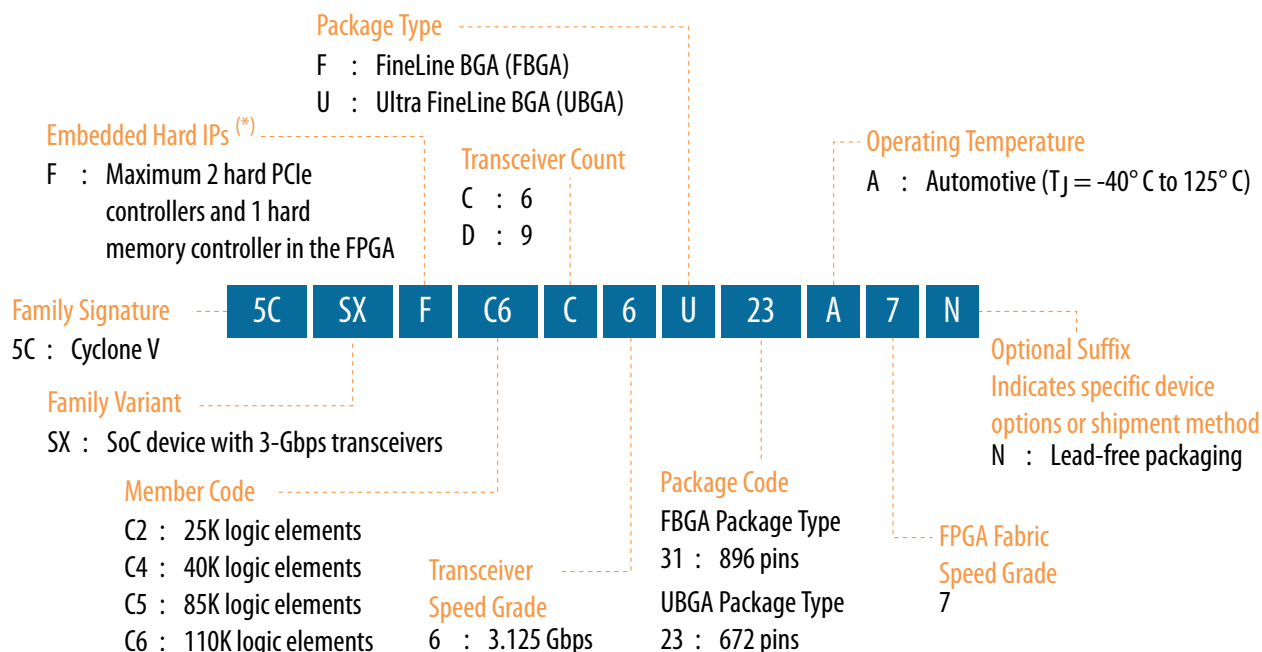


Note:

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

⁽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 Altera sales representative to submit your request.

Figure 2-3: Automotive-Grade Ordering Information for Cyclone V SX Devices



Note:

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

Cyclone V Devices

Supported Automotive-Grade Devices

Table 2-7: Automotive-Grade in Cyclone V Devices

Other automotive-grade product line/package combinations or ordering codes might be available upon request. Consult your Altera 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

Device Ordering Code	Device	Package	Junction Temperature Range	Speed Grade
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

Package Options and Maximum User I/Os

Table 2-8: Package Options and Maximum User I/Os in Cyclone V E Devices

Package Type/ Pin Count	Ball Spacing (mm)	Dimension s (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⁾	—	—	—
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⁾

⁽⁶⁾ Package options available with automotive-grade variants.

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

Table 2-9: Package Options and Maximum User I/Os in Cyclone V GX Devices

Package Type/ Pin Count	Ball Spacing (mm)	Dimension s (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 2-10: 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⁾

Device Ordering Codes

Figure 2-4: Automotive-Grade Ordering Information for Cyclone V E Devices

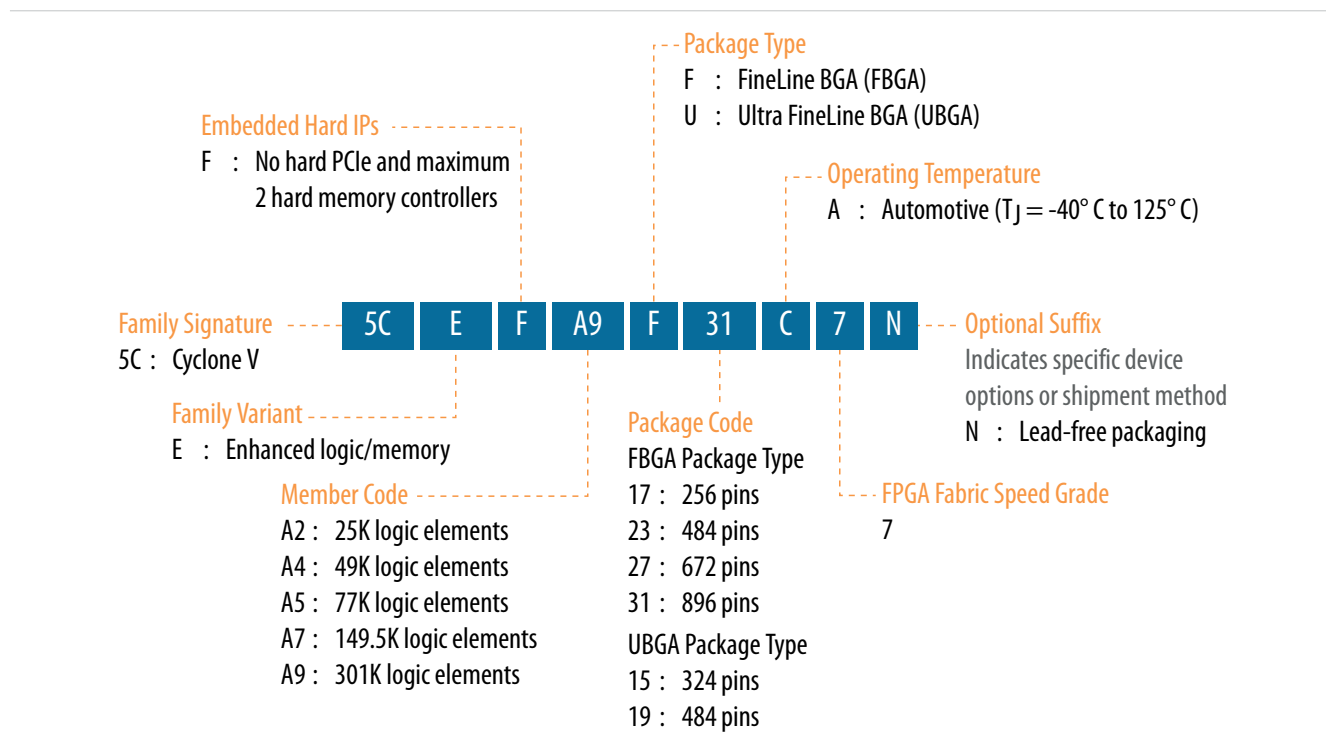


Figure 2-5: Automotive-Grade Ordering Information for Cyclone V GX Devices

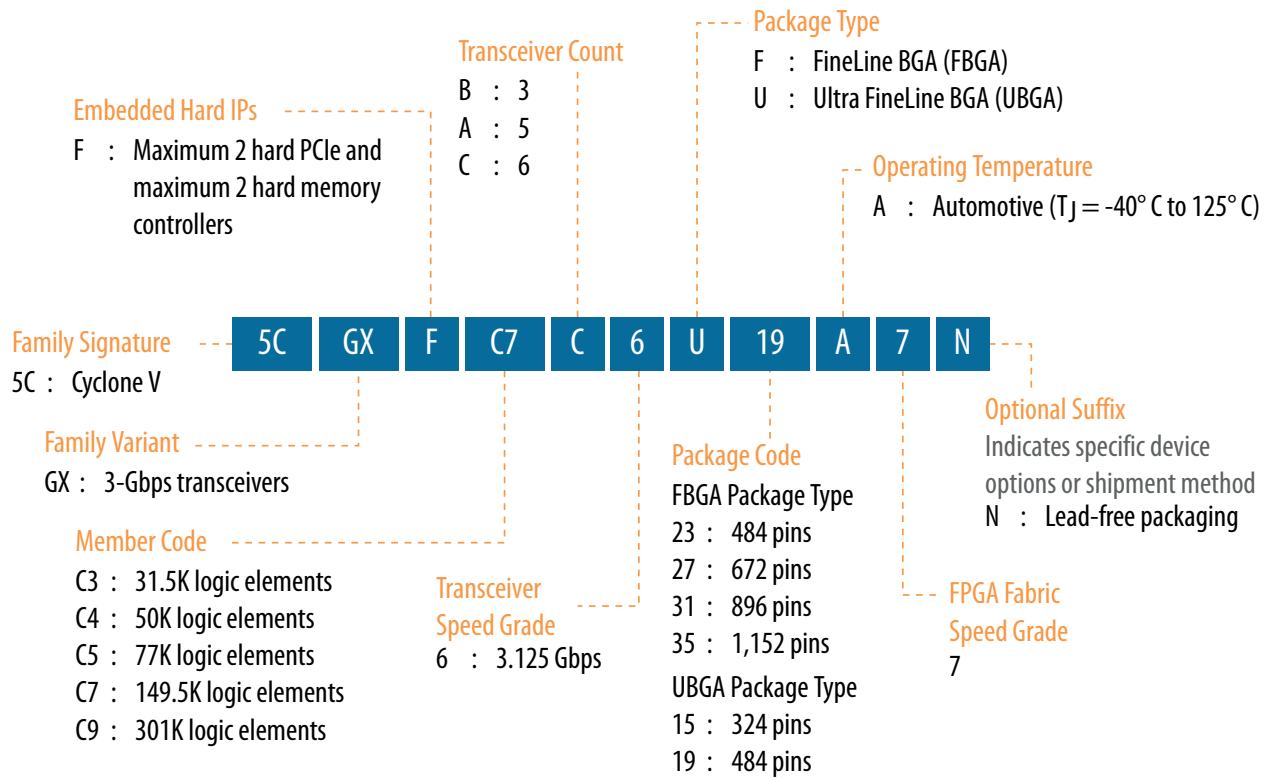
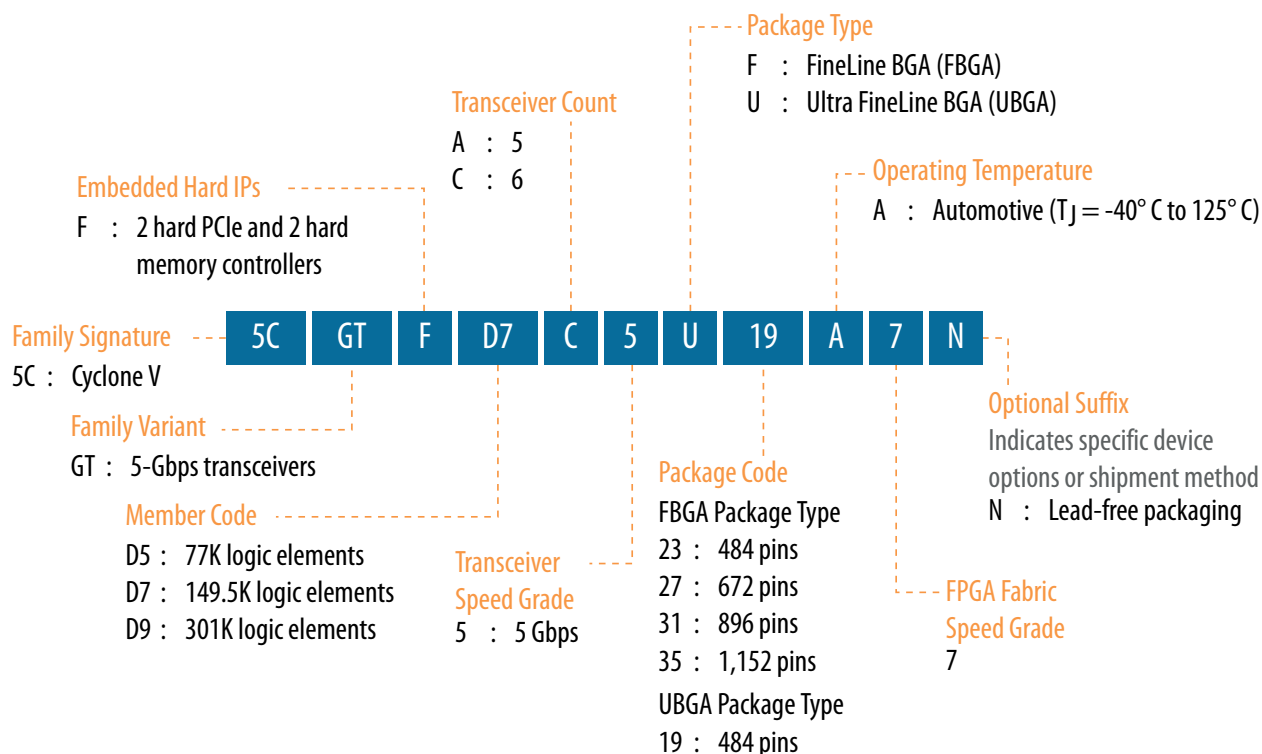


Figure 2-6: Automotive-Grade Ordering Information for Cyclone V GT Devices

Cyclone IV Devices

Supported Automotive-Grade Devices

Table 2-11: Automotive-Grade in Cyclone IV Devices

Other automotive-grade product line/package combinations or ordering codes might be available upon request. Consult your Altera 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

Device Ordering Code	Device	Package	Junction Temperature Range	Speed Grade
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
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

Package Options and Maximum User I/Os

Table 2-12: Package Options and Maximum User I/Os in Cyclone IV E Devices

Package Type/ Pin Count	Ball Spacing (mm)	Dimensions (mm)	Product Line								
			EP4CE 6 (6.3K LEs)	EP4CE 10 (10.3K LEs)	EP4CE 15 (15.4K LEs)	EP4CE 22 (22.3K LEs)	EP4CE 30 (28.8K LEs)	EP4CE 40 (39.6K LEs)	EP4CE 55 (55.9K LEs)	EP4CE 75 (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⁾	—	—	—

⁽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 Altera sales representative to submit your request.

Package Type/ Pin Count	Ball Spacing (mm)	Dimensions (mm)	Product Line								
			EP4CE 6 (6.3K LEs)	EP4CE 10 (10.3K LEs)	EP4CE 15 (15.4K LEs)	EP4CE 22 (22.3K LEs)	EP4CE 30 (28.8K LEs)	EP4CE 40 (39.6K LEs)	EP4CE 55 (55.9K LEs)	EP4CE 75 (75.4K LEs)	EP4CE115 (114.5K LEs)
			I/Os								
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 2-13: Package Options and Maximum User I/Os in Cyclone IV GX Devices

Package Type/ Pin Count	Ball Spacing (mm)	Dimensions (mm)	Product Line							
			EP4CGX1 5 (14.4K LEs)	EP4CGX2 2 (21.3K LEs)	EP4CGX3 0 (29.4K LEs)	EP4CGX5 0 (49.9K LEs)	EP4CGX7 5 (73.9K LEs)	EP4CGX1 10 (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⁾	—	—	—	—	—
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⁾	—

Device Ordering Codes

Figure 2-7: Automotive-Grade Ordering Information for Cyclone IV E Devices

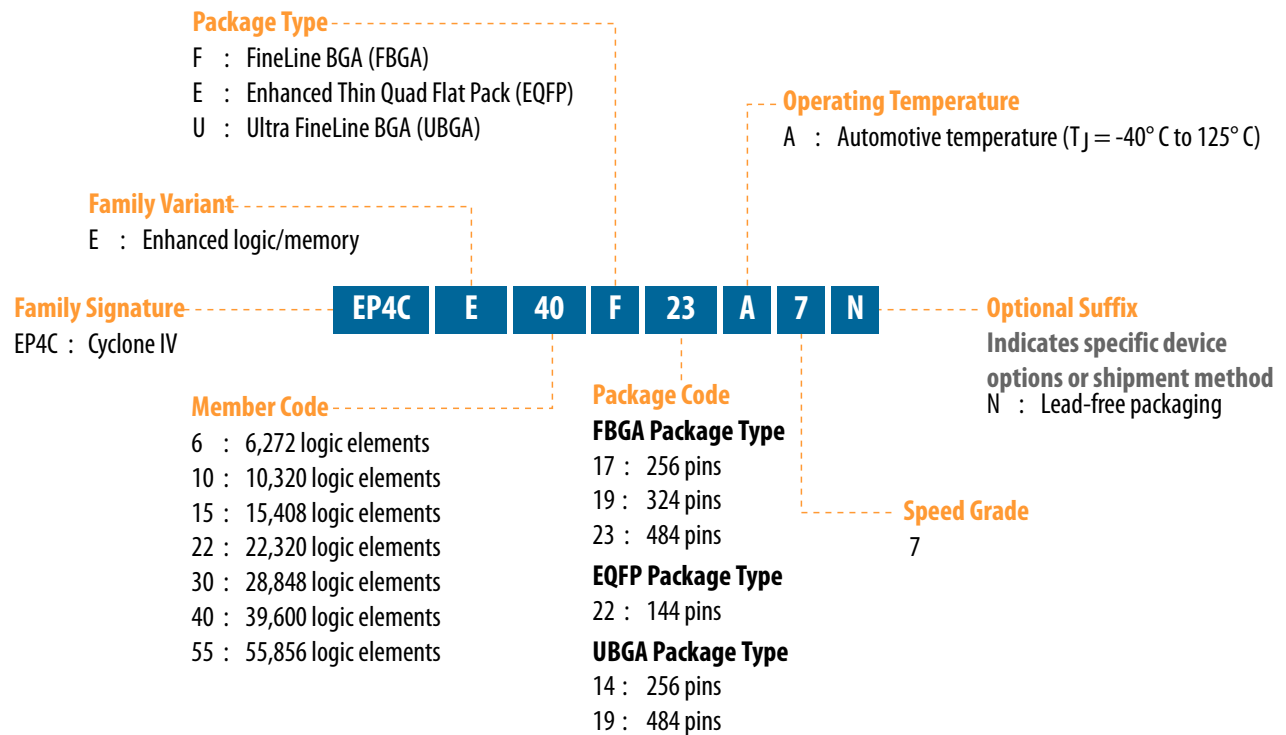
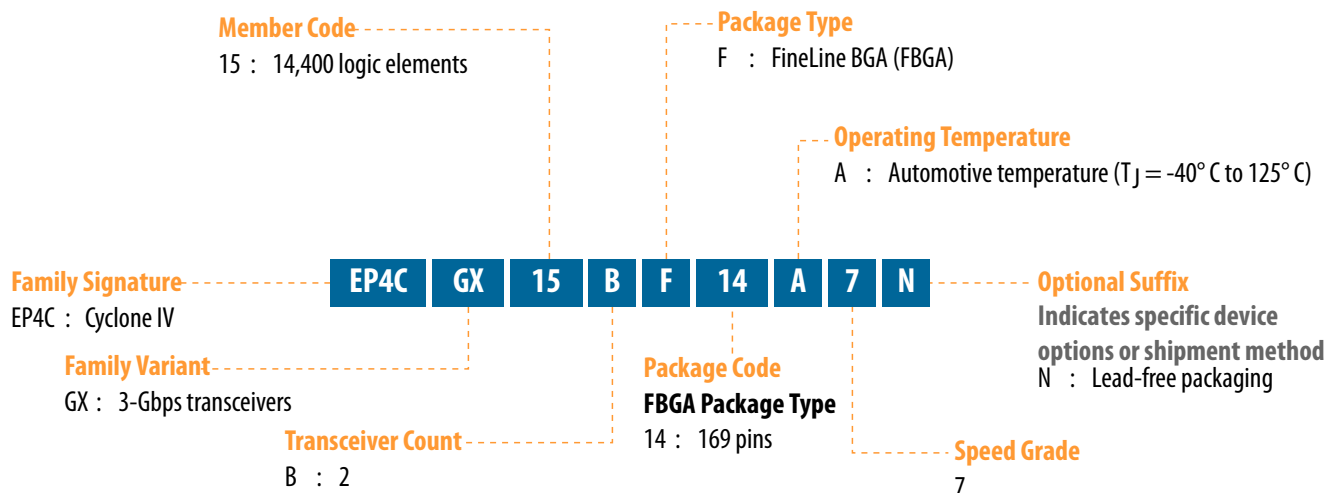


Figure 2-8: Automotive-Grade Ordering Information for Cyclone IV GX Devices



MAX V Devices

Supported Automotive-Grade Devices

Table 2-14: Automotive-Grade in MAX V Devices

Other automotive-grade product line/package combinations or ordering codes might be available upon request. Consult your Altera 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

Package Options and Maximum User I/Os

Table 2-15: 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⁾	—	—

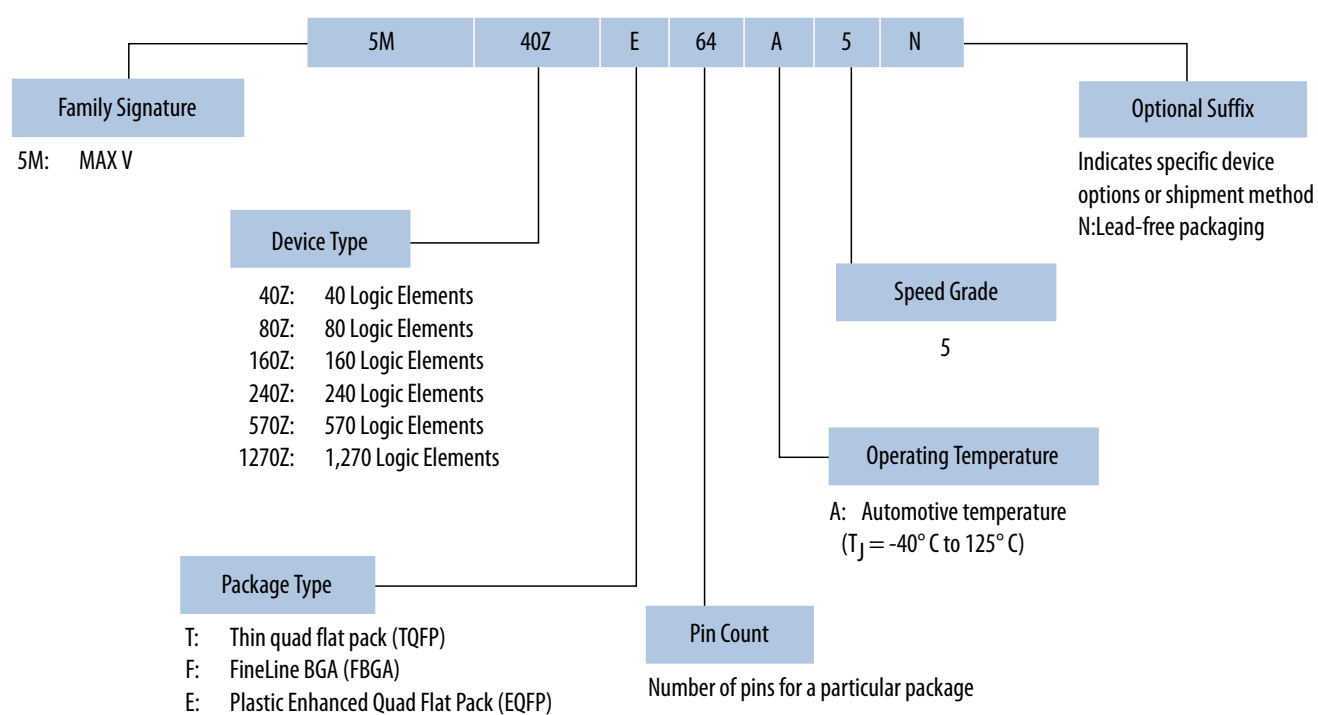
⁽¹⁰⁾ These package options are not currently available in automotive-grade but might become available upon request. Consult your Altera sales representative to submit your request.

⁽¹¹⁾ Package options available with automotive-grade variants.

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						
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⁾

Device Ordering Codes

Figure 2-9: Automotive-Grade Ordering Information for MAX V Devices



MAX II Devices

Supported Automotive-Grade Devices

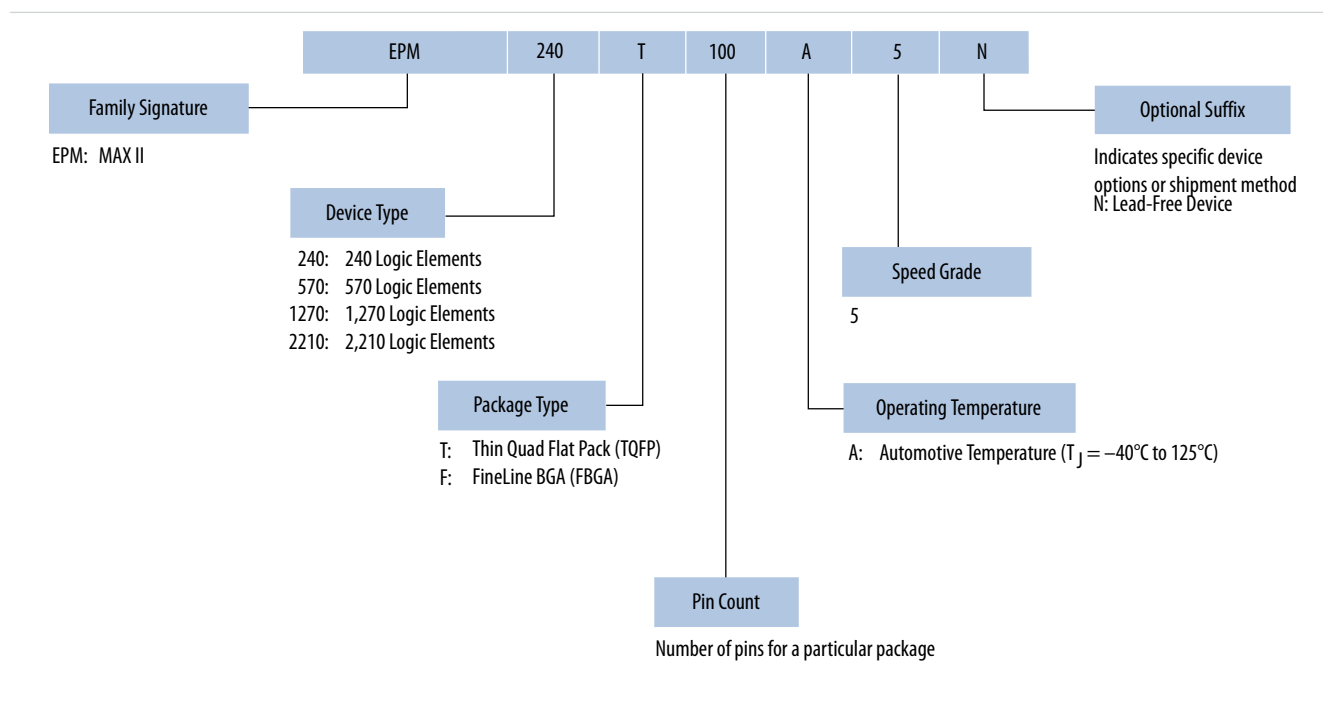
Table 2-16: Automotive-Grade in MAX II Devices

Other automotive-grade product line/package combinations or ordering codes might be available upon request. Consult your Altera 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

Device Ordering Codes

Figure 2-10: Automotive-Grade Ordering Information for MAX II Devices



Cyclone III Devices (Legacy Support)

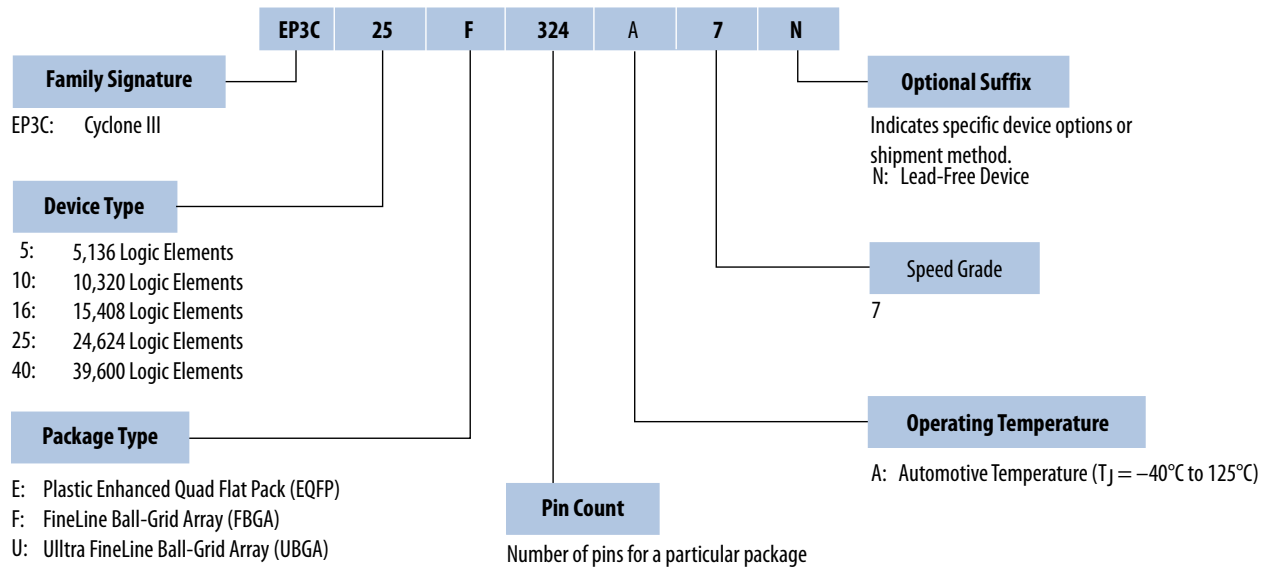
Supported Automotive-Grade Devices

Table 2-17: 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

Device Ordering Codes

Figure 2-11: Automotive-Grade Ordering Information for Cyclone III Devices



Cyclone II Devices (Legacy Support)

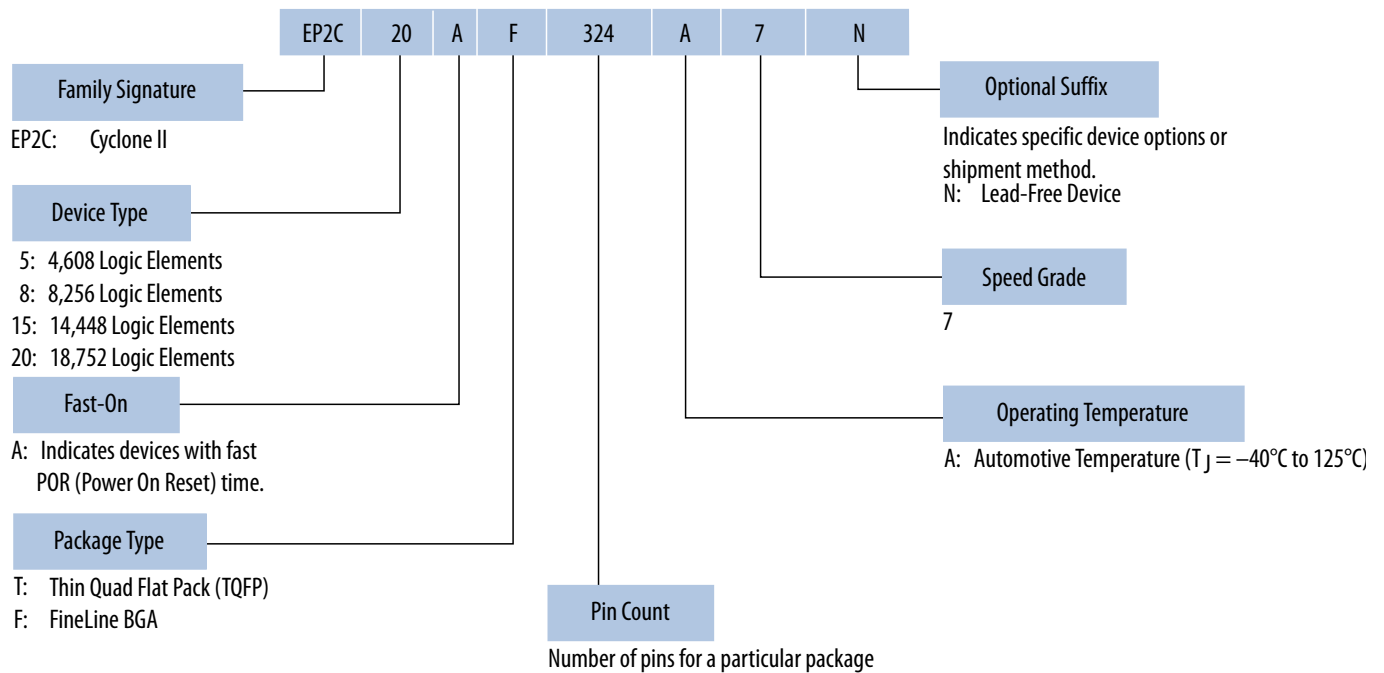
Supported Automotive-Grade Devices

Table 2-18: 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

Device Ordering Codes

Figure 2-12: Automotive-Grade Ordering Information for Cyclone II Devices



Cyclone Devices (Legacy Support)

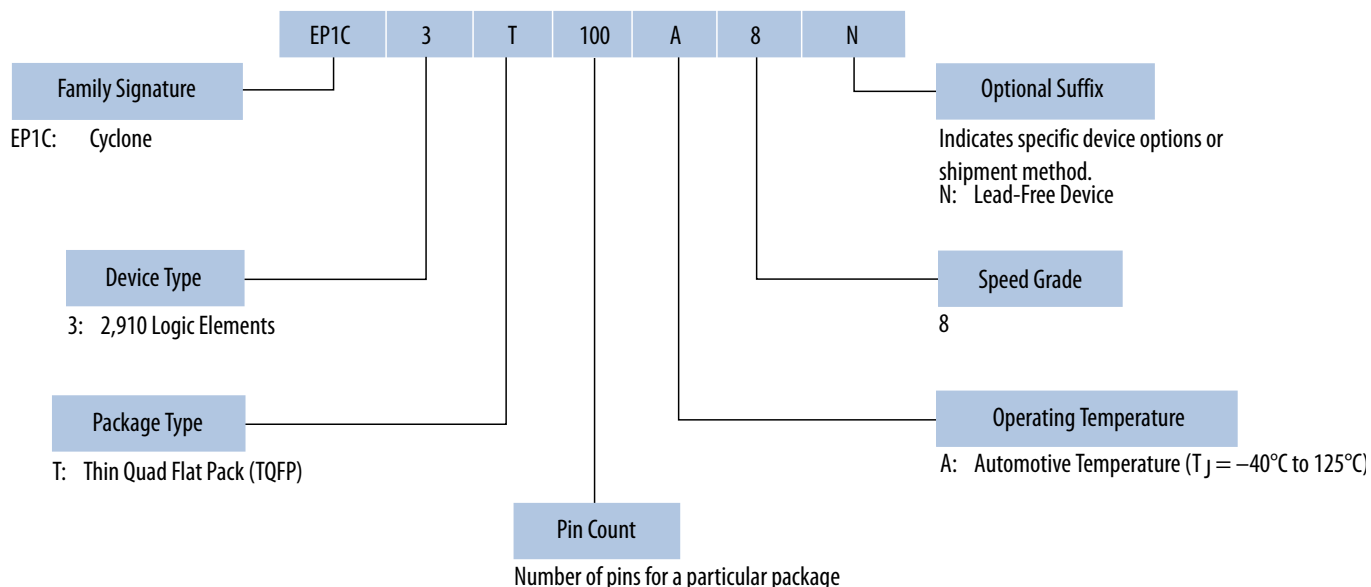
Supported Automotive-Grade Devices

Table 2-19: 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

Device Ordering Codes

Figure 2-13: Automotive-Grade Ordering Information for Cyclone Devices



MAX 7000A Devices (Legacy Support)

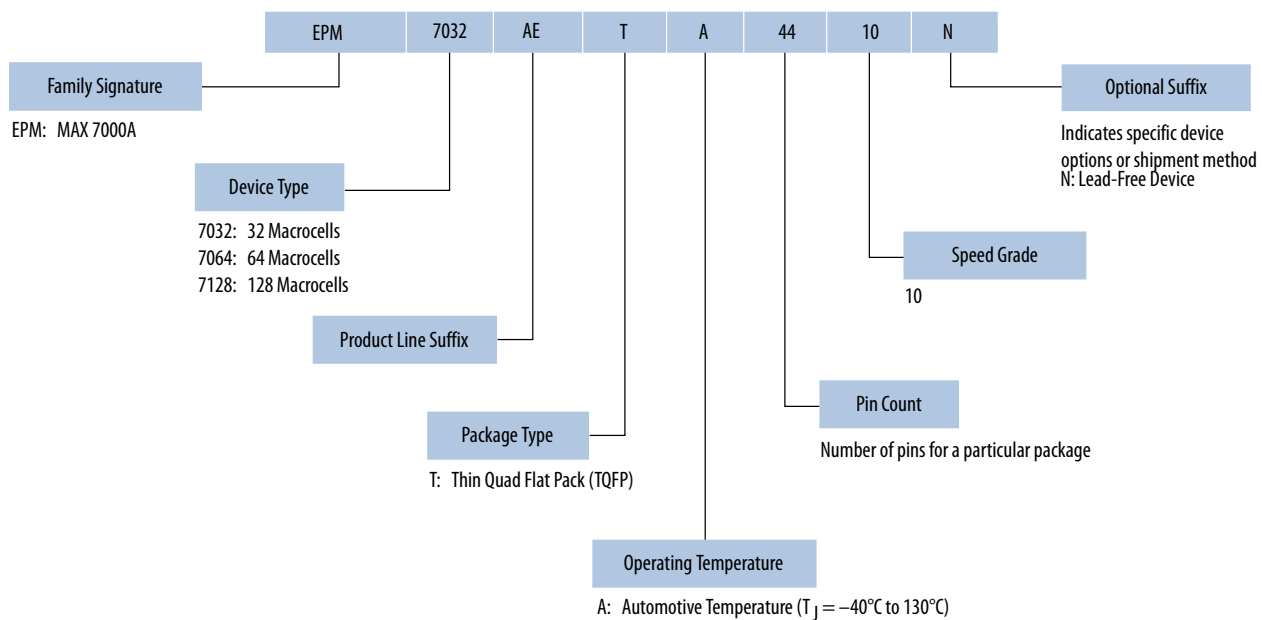
Supported Automotive-Grade Devices

Table 2-20: 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

Device Ordering Codes

Figure 2-14: Automotive-Grade Ordering Information for MAX 7000A Devices



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The Altera Quartus Prime design software supports the automotive-grade devices in the automotive temperature range. The 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, SignalTap™ II logic analyzer, and device configuration.

To target an automotive-grade device in your design in the 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 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 Altera Quartus Prime software requires special approval. Contact the nearest Altera sales representative to submit your request.

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

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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 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

- **PowerPlay Early Power Estimator User Guide**
Applicable to Cyclone III, Cyclone IV, Cyclone V, Cyclone V SoC devices.
- **PowerPlay Early Power Estimator for Altera CPLDs User Guide**
Applicable to MAX II and MAX V devices.
- **PowerPlay Early Power Estimator User Guide For Stratix, Stratix GX & Cyclone FPGAs**
Applicable to Cyclone devices.

PowerPlay Power Analyzer

The PowerPlay Power Analyzer tool in the 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

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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 the following three parts:

- Specifying sources of input data
- Specifying operating conditions
- 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 Prime 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.

Related Information

[PowerPlay Power Analysis chapter, Quartus Prime Handbook](#)



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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 Information

- [MAX 7000A Programmable Logic Device Data Sheet](#)
- [DC and Switching Characteristics chapter, Cyclone Device Handbook](#)
- [DC Characteristics and Timing Specifications chapter, Cyclone II Device Handbook](#)
- [Cyclone III Device Datasheet](#)
- [Cyclone IV Device Datasheet](#)
- [Cyclone V Device Datasheet](#)
- [DC and Switching Characteristics chapter, MAX II Device Handbook](#)
- [DC and Switching Characteristics for MAX V Devices](#)
- [MAX 10 FPGA Device Datasheet](#)

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

Related Information

[Pin-Out Files for Altera Devices page](#)

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Altera provides information on package and PCB design guidelines.

Related Information

- **[Package and Thermal Resistance page, Altera website](#)**
Provides more information about the package-related information and Package Information Datasheet for Altera Devices.
- **[AN114: Designing With High-Density BGA Packages for Altera 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.

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Document Revision History for the Automotive-Grade Device Handbook



2016.05.03

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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



Date	Version	Changes
		- 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 <i>Quartus II</i> to <i>Quartus Prime</i>.
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.

Date	Version	Changes
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.

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[5CSEMA2U23I7N](#) [5CSEBA4U23A7N](#) [5CSEBA2U19I7N](#) [5CSEMA4U23C6N](#) [5CSEBA2U19C8SN](#)
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[5CSEMA4U23I7N](#) [5CSEBA4U23C7SN](#) [5CSEBA2U23A7N](#) [5CSEBA4U23I7N](#) [5CSXFC4C6U23I7N](#)
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[5CSXFC2C6U23C7N](#) [5CSXFC6D6F3I7](#) [5CSXFC6D6F3I7NES](#) [5CSXFC4C6U23C8N](#) [5CSXFC2C6U23I7N](#)
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