Spring 2013

Driving Innovative Automotive Solutions

ALTERA®

MEASURABLE ADVANTAGE™

Closing the Technology Gap with Innovation

Twenty years ago, new technology innovations in automotive lagged the consumer space by five to eight years. Today, that gap has narrowed significantly with automotive innovations keeping pace with consumer innovations or, in some cases, leading. Here are two examples:

- Video analytics used in advanced driver assistance systems (ADAS) like pedestrian detection, collision avoidance, and lane departure warning rely on ultra-low latency precision algorithms to analyze real-time video feeds from a vehicle's cameras and make split-second decisions.
- Instrument clusters used to comprise a collection of simple analog gauges to monitor critical vehicle parameters. Today, they have evolved into sophisticated, reconfigurable, high-resolution displays that interface with multiple electronic control units (ECUs) in the vehicle including engine control, ADAS, and infotainment.

Helping You Deliver

With each model year, automotive OEMs are expected to deliver the latest technologies with a high degree of integration while keeping pace with faster design cycles. From driver assist to infotainment to e-vehicles, automotive systems call for leading performance, best-in-class quality, and highly reliable underlying technology, as well as design flexibility to meet emerging needs. More and more, designers are relying on FPGAs, SoCs with integrated ARM® Cortex™-A9 processors, and CPLDs to deliver innovative products to market quickly.

Turn to us to get your unique designs out the door faster. When you need to prototype, demonstrate, and take your designs to production, count on our products to help you meet your timeline—and even make last-minute modifications without changing your board. Without the design respins common in ASIC development, our programmable logic devices also provide significant savings in total cost and development time. What's more, they enable a single, scalable "platform" design that can easily be modified to suit the needs of different vehicle classes, from mass market to luxury models.

We are known and trusted for offering the market's broadest range of high-quality, automotive-grade FPGAs and CPLDs that are compliant to AEC-Q100 standards. We also demonstrate our commitment to the automotive industry by offering reference designs, intellectual property (IP), software tools, a long-term supply strategy, and development kits that help you get off the ground faster and on the road to success.

Advanced Driver Assistance Systems (ADAS)

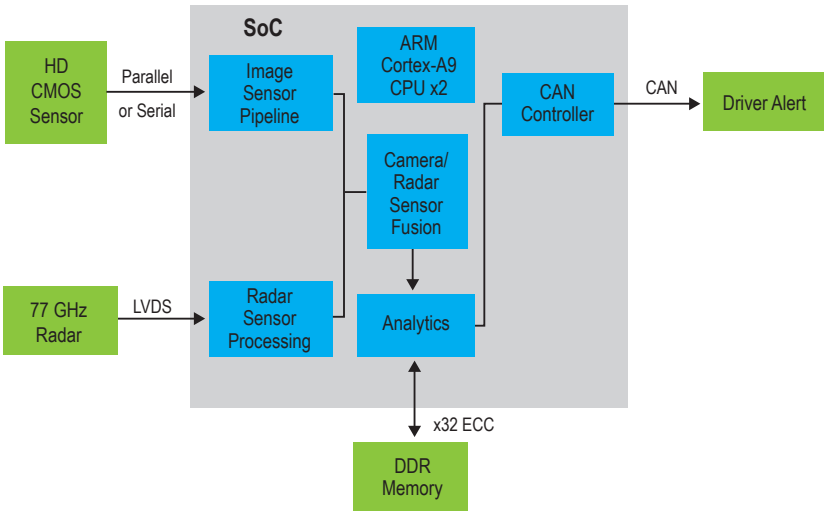
Our FPGAs can help you keep pace with the rapid advancements in driver assistance technology:

- Higher levels of bandwidth and performance needed to process megapixel imaging video streams from multiple cameras
- Complex, real-time processing required to combine the camera and radar/laser/LIDAR sensor data, and apply advanced analytics for object identification and signature recognition
- Transmit, receive, and translate between multiple communication standards (i.e., CAN, local interconnect network (LIN), FlexRay, MOST, Ethernet, LVDS)

Because manufacturers' ADAS requirements differ for each vehicle type, you are faced with the challenge of providing a platform solution that can scale across an entire vehicle lineup.

Our FPGAs provide an ideal platform for developing high-performance, low-power, low-cost ADAS systems with the optimal level of integration and flexibility. You can even incorporate changes late in the design cycle, and in-field upgrades let you differentiate your products and keep pace with your customers' expectations.

Forward-Looking Sensor Fusion ECU



Benefits of Altera FPGAs in ADAS Applications

- Customized image sensor interface for any image sensor
- High-performance, low-latency megapixel image processing pipeline capable of multichannel image stitching and distortion correction
- ARM-based SoCs for advanced video analytics algorithms such as pedestrian detection, traffic sign recognition, and lane departure warning
- Lower cost and reduced size through integration of radar and camera processing in a single device
- <2 W total power consumption for typical ADAS applications
- Designed for functional safety with IEC 61508-certified design tools, intellectual property, and products (ISO 26262 certification under development)

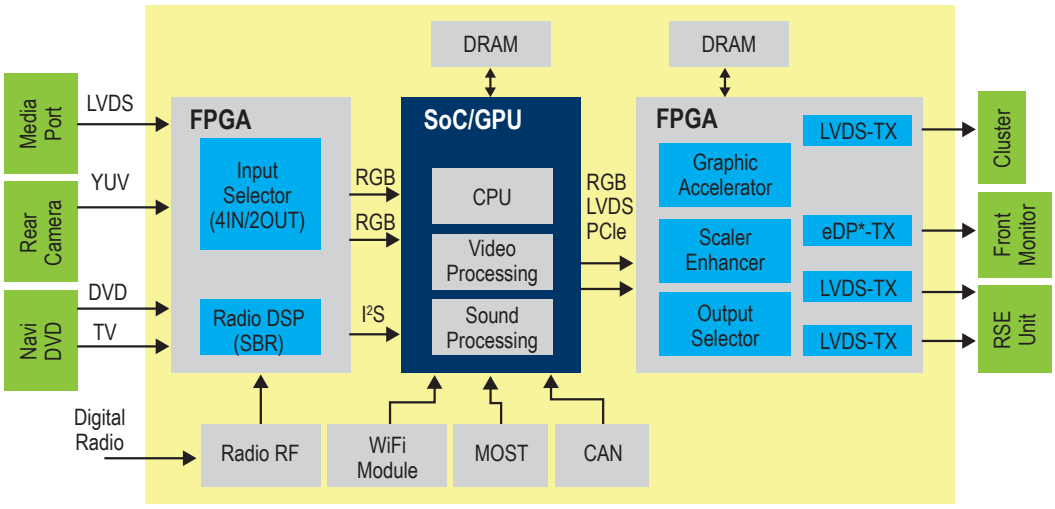
Infotainment

Automotive infotainment systems are an integral part of modern vehicle design and greatly influence sales. You need to continually create compelling new technology that both rivals and complements the latest consumer devices while keeping up with the pace of product obsolescence common in consumer electronics.

It is more important than ever to select the right main system processor to differentiate the system's user interface with the latest graphics. Should you choose a high-performance system on a chip (SoC) with a graphics processing unit (GPU) or a CPU with applications that can be upgraded with software? With multiple models to support, you may need to select several different SoCs due to system variations and emerging interfacing technologies. This is not cost effective or an efficient use of engineering resources.

By using our FPGAs as an I/O companion, you can support any combination of I/O interfaces. You may also leverage the FPGA as an efficient coprocessor to offload functions from your host main processor such as video scaling and graphics acceleration. With an FPGA, your system becomes easily scalable, enabling you to upgrade firmware on the fly to support multiple manufacturers, regions, and models with minimum changes to the hardware.

Infotainment System I/O Companion



* Embedded Display Port

Benefits of Altera FPGAs in Infotainment Applications

- Support multiple camera inputs in any bit rate or resolution via video select and front-end processing
- Support multiple display interfaces and offloads GPU
- Optimize system performance by integrating 2D/3D graphic accelerator, scalar, image enhancer, and interface protocol bridge
- Reduce cost by integrating radio digital signal processing (DSP) into FPGA with software-based radio IP
- Accelerate time to market by supporting the latest generation of interface standards in programmable logic
- Minimize PCB spins and future-proof your system with in-field upgrades to the FPGA

Electric Vehicles

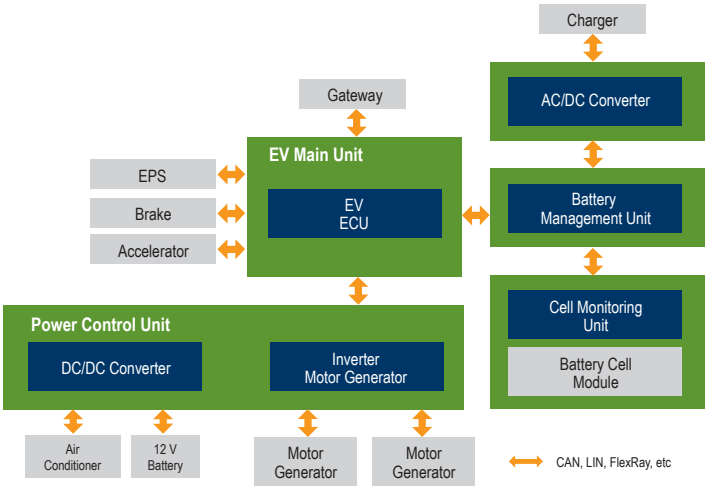
The introduction of hybrid-electric vehicles (HEV) and electric vehicles (EV) have enabled breakthrough innovations and greater efficiency in electric motor controls, power conversion, and battery management systems.

The algorithms driving these systems require continuous upgrades and design changes to optimize performance. ASIC development cycles are too long to meet these market demands. Our FPGAs deliver hardware failsafe logic for insulated gate bipolar transistor (IGBT) bridge protection, efficient motor control with our model-based DSP Builder design flow, and hardware acceleration with faster control loops to improve energy efficiency, reduce noise, and improve reliability of electrical motors.

You can use FPGAs or CPLDs anywhere DSP is needed to improve system performance such as the AC/DC converters, DC/DC converters, battery management systems, and motor inverter systems.

To accelerate your time to market and increase productivity, Altera and its partner network offer a variety of IP and tools. Our motor control IP includes pulse-width modulation (PWM), analog-to-digital (ADC) and digital encoder interfaces, and integrated customizable field-oriented control (FOC) reference designs.

HEV/EV System



FPGA application

Benefits of Altera FPGAs in HEV/EV Applications

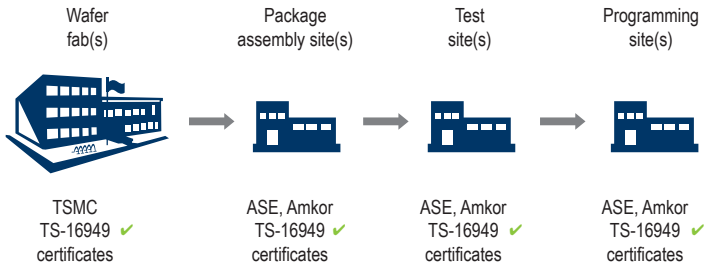
- Improve system performance by using hardware coprocessor to accelerate your motor control algorithm
- Shorten design cycles with model-based design tools, safety methodology, and pre-qualified devices
- Designed for functional safety with IEC 61508-certified design tools, IP, and products (ISO 26262 certification under development)
- Low latency and fast response in FPGA logic for motor control loops

Driving Quality Designs

As automotive digital content and control systems move to high definition, wireless communication, and multi-gigabit bandwidths, automakers and system OEMs will continue to demand top-notch quality semiconductor devices. With more than 10 million programmable logic devices shipped to automotive customers worldwide since 2003, we are well positioned for high-volume automotive production applications.

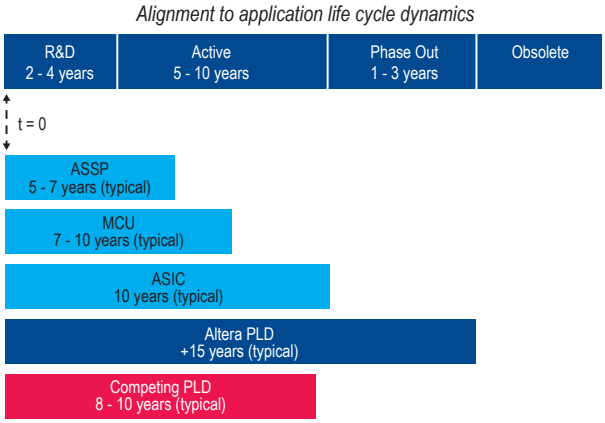
As an active member of the Automotive Electronics Council (AEC), Altera has chaired two AEC subcommittees and qualifies all of its automotive or "A" grade products to the AEC-Q100 standard. Our production part approval process (PPAP) includes the AEC-Q100 qualification results in the document package we provide to qualify your products. The PPAP provides the baseline product details including die, package, wafer fabrication process, package assembly process, and constituent materials.

Altera's TS-16949 Compliant Manufacturing Flow



We have a zero-defect philosophy with rigorous procedures at each phase of development to ensure the highest quality and lowest defective parts per million (DPPM). Our wafer fabs, package, assembly, test, and programming facilities are TS-16949 certified for a quality management system that provides for continual improvement, emphasizes defect prevention, and reduces variation and waste in the supply chain.

Life Cycle Comparison



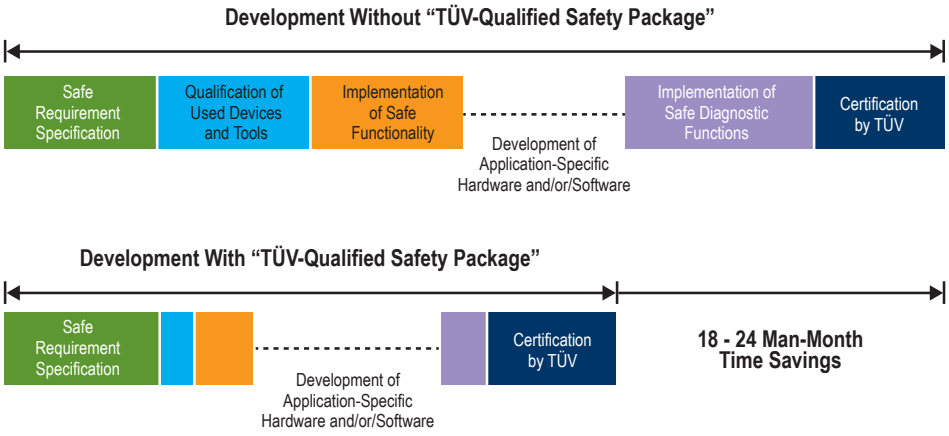
We take business continuity planning (BCP) seriously and employ several initiatives to ensure you have a continuous supply of product, including use of six fabs across four locations, dual fab strategy by Fabmatch methodology, multiple assembly site sourcing, and sub-material sourcing control.

We understand that you need to support your products and vehicles for a minimum of 10 years after release. Our average product cycle is 15 years, with many of our products having lifetimes in excess of 20 years, so you can design in our products with confidence. When change is absolutely mandatory, we take exceptional care to provide special product change notifications so you can manage the delicate rollout of changes to your customers—the automakers—in a coordinated and well-orchestrated manner.

Save Time with Safety Certification for Tools, IP, and Devices

The automotive industry is under increasing pressure to develop new and improved vehicle safety systems. Adapted from the IEC 61508 functional safety standard, the ISO 26262 automotive electronic system safety standard helps you avoid systematic faults and control or mitigate the effects of random hardware failures causing a malfunction of these systems.

To simplify and speed up your certification process, we worked with TÜV Rheinland, an independent third-party assessor specializing in functional safety testing and certification, to receive approval. This makes us the first and only FPGA supplier whose FPGA devices, IP, development tools, and FPGA design flow are certified for IEC 61508 functional safety. TÜV-qualified safety packages typically save our customers 18 to 24 man-months in certifying their safety applications. ISO 26262 certification under development.



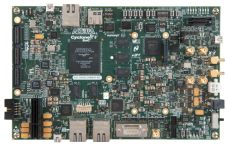
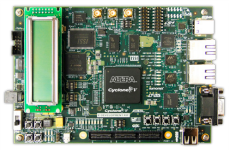
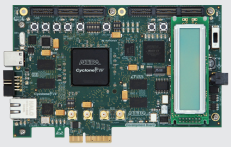
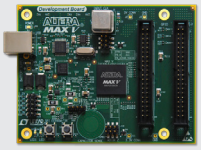
Functional Safety Data Package Components – IEC 61508

Qualified Tools	Qualified IP	Qualified Devices
Quartus® II software v11.0 SP1	Nios® II embedded processor	Cyclone® and Cyclone II, Cyclone III FPGAs
Analysis and elaboration	CRC compiler	Cyclone III 60 nm FPGAs
Altera simulation libraries	DDRx high-performance and next-generation controller supporting both Altmemphy and Uniphy	Cyclone IV except EP4CGX50 and EP4CGX75 FPGAs
Synthesis and place and route	8B/10B encoder/decoder	Arria® GX FPGAs
TimeQuest-timing analyzer	SOPC Builder IP within Quartus II software	Stratix® III FPGAs
Signal Tap II logic analyzer	Diagnostic IP: • CRC checker • SEU checker • Clock checker	Stratix II and Stratix II GX FPGAs
NIOS II debugger		Stratix and Stratix GX FPGAs
In-System memory editor		MAX® II and MAX II Z CPLDs
PowerPlay power analyzer		MAX 3000A, MAX 7000AE/B/S CPLDs

Altera Development Boards

Jump start your prototype with an Altera development board. You can purchase Altera Cyclone development boards from www.altera.com. Additional boards are available from partners.

Altera Development Boards

Family	Status / Price	Image
Cyclone V SX SoC Dual-core ARM Cortex-A9 processor, 110K LE, 3 Gbps Transceiver	May 2013 / $1595 DK-DEV-5CSXC6N/ES	
Cyclone V GT 301K LE, 5 Gbps Transceiver	April 2013 / $1595 DK-DEV-5CGTD9N	
Cyclone V E 149K LE	Available / $1099 DK-DEV-5CEA7N	
Cyclone IV GX 149.8K LE, 3 Gbps Transceiver	Available / $1295 DK-DEV-4CGX150N	
Cyclone IV GX Starter 14.4K LE, 2.5 Gbps Transceiver	Available / $395 DK-START-4CGX15N	
MAX V 570 LE	Available / $75 DK-DEV-5M570ZN	

Common Automotive IP – Altera and Partner

Altera and its IP Partners offer a broad portfolio of off-the-shelf, configurable IP cores for our devices. This pre-validated IP can help you further accelerate your design flow. Examples of licensed and unlicensed automotive IP solutions are shown below:

Examples of Licensed and Unlicensed Automotive IP Solutions

Interface IP	
Standard	**Provider**
CAN	Altera, Bosch, DDC, IFI
LIN	CAST
MOST	IFI, SMSC
FlexRay	Bosch
DisplayPort / eDP	Bitec / Altera
PCI Express (PCIe)	Altera (Hard IP)
USB 2.0 / 3.0	SLS Corp.
HiSPi	Altera

Graphics IP	
Function	**Provider**
VIP Suite: Scaler, Converters, Filters, Alpha Blender, and More	Altera (Suite of Video Functions)
2D / 3D Graphics	TES
Graphics (Athlet)	Imagem
H.264	CAST, Jointwave
MJPEG	CAST

Automotive-Grade Products

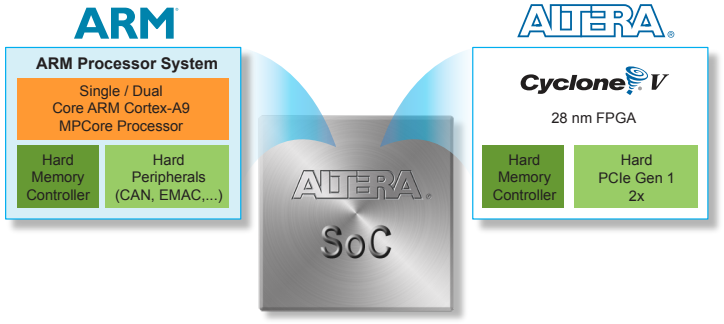
Our automotive-grade devices feature junction temperature range support from -40˚C to +125˚C (or higher on selected devices). These devices meet or exceed ISO 9001:2001 and AEC-Q100 standards. All our automotive-grade devices are manufactured at fully TS-16949-registered/certified sites using some of the programmable logic industry's smallest, highest reliability, and mainstream semiconductor fabrication processes. Our automotive-grade portfolio spans from CPLDs to FPGAs and also includes SoCs and HardCopy® ASIC options to serve all your automotive needs.

Introducing the Cyclone V SoC

The Cyclone V SoC integrates an ARM®-based hard processor system (HPS) with our FPGA fabric. These user-customizable SoCs increase system performance, lower power consumption, and reduce board space requirements, all designed to help you lower your overall system cost.

Cyclone V SoC key features:

- AEC-Q100 automotive-grade options
- Single- or dual-core ARM Cortex™-A9 processors
- Vertical migration across FPGA logic densities (25K, 40K, 85K, and 100K logic elements)
- 3 Gbps and 5 Gbps transceiver options
- Dual CAN controllers (hard IP)
- Dual Ethernet MACs with IEEE 1588 (hard IP)
- Dual PCIe interface (hard IP)
- Full suite of peripherals (hard IP)
- Full error correction code (ECC) support – safety ready
- Horizontal migration across the family



Cyclone V SoC Auto-Grade Device Package Options and Maximum User I/Os

Family	Product Line	Logic Density (K LEs)	PLL FPGA/ HPS (count)	Package Type/ Pin Count														
				UBGA-484 (U19)					UBGA-672 (U23)					FBGA-896 (F31)				
				Ball Spacing (mm)														
				0.8					0.8					1.0				
				Dimensions (mm)														
				19 x 19					23 x 23					31 x 31				
				FPGA I/Os / Processor I/Os / LVDS I/Os / Transceivers (XCVR count)														
				FPGA I/O	HPS I/O	LVDS TX	LVDS RX	XCVR	FPGA I/O	HPS I/O	LVDS TX	LVDS RX	XCVR	FPGA I/O	HPS I/O	LVDS TX	LVDS RX	XCVR
Cyclone V SE SoC	5CSE-A2	25	5 / 3	66	161	15	18	–	145	181	31	35	–	–	–	–	–	–
	5CSE-A4	40	5 / 3	66	161	15	18	–	145	181	31	35	–	–	–	–	–	–
	5CSE-A5	85	6 / 3	66	161	15	18	–	145	181	31	35	–	288	181	72	72	–
	5CSE-A6	110	6 / 3	66	161	15	18	–	145	181	31	35	–	288	181	72	72	–
Cyclone V SX SoC (3 Gbps)	5CSX-C2	25	5 / 3	–	–	–	–	–	145	181	31	35	6	–	–	–	–	–
	5CSX-C4	40	5 / 3	–	–	–	–	–	145	181	31	35	6	–	–	–	–	–
	5CSX-C5	85	6 / 3	–	–	–	–	–	145	181	31	35	6	288	181	72	72	9
	5CSX-C6	110	6 / 3	–	–	–	–	–	145	181	31	35	6	288	181	72	72	9
Cyclone V ST SoC (5 Gbps)	5CST-D5	85	6 / 3	–	–	–	–	–	–	–	–	–	–	288	181	72	72	9
	5CST-D6	110	6 / 3	–	–	–	–	–	–	–	–	–	–	288	181	72	72	9

AEC-Q100 Package options available with automotive-grade variants.

Samples now, A-Grade Production release in Q4, 2013: 5CSE-A5/A6, 5CSX-C5/C6

Samples now, A-Grade Production release in Q1, 2014: 5CSE-A2/A4, 5CSX-C2/C4

Cyclone V Auto-Grade Device Package Options and Maximum User I/Os

Family	Product Line	Logic Density (K LEs)	PLL (count)	Package Type/ Pin Count									
				MBGA -301 (M11)	MBGA -383 (M13)	MBGA -484 (M15)	FBGA -256 (F17)	UBGA -324 (U15)	UBGA -484 (U19)	FBGA -484 (F23)	FBGA -672 (F27)	FBGA -896 (F31)	FBGA -1152 (F35)
				Ball Spacing (mm)									
				0.5	0.5	0.5	1.0	0.8	0.8	1.0	1.0	1.0	1.0
				Dimensions (mm)									
				11 x 11	13 x 13	15 x 15	17 x 17	15 x 15	19 x 19	23 x 23	27 x 27	31 x 31	35 x 35
				I/Os / LVDS / Transceivers (count)									
Cyclone V E	5CE-A2	25	4	–	208 / TBD	–	128 / 32	176 / 44	224 / 56	224 / 56	–	–	–
	5CE-A4	49	4	–	208 / TBD	–	128 / 32	176 / 44	224 / 56	224 / 56	–	–	–
	5CE-A5	77	6	–	208 / TBD	–	–	–	224 / 56	240 / 60	–	–	–
	5CE-A7	149.5	6	–	–	240 / 60	–	–	240 / 60	240 / 60	336 / 84	480 / 120	–
	5CE-A9	301	6	–	–	–	–	–	240 / 122	224 / 56	336 / 84	480 / 120	–
Cyclone V GX (3 Gbps)	5CGX-C3	31.5	4	–	–	–	–	144 / 36 / 3	208 / 52 / 3	208 / 52 / 3	–	–	–
	5CGX-C4	50	6	127 / TBD / 4	175 / TBD / 6	–	–	–	224 / 56 / 6	240 / 60 / 6	336 / 84 / 6	–	–
	5CGX-C5	77	6	127 / TBD / 4	175 / TBD / 6	–	–	–	224 / 56 / 6	240 / 60 / 6	336 / 84 / 6	–	–
	5CGX-C7	149.5	7	–	–	240 / 60 / 3	–	–	240 / 60 / 6	240 / 60 / 6	336 / 84 / 9	480 / 120 / 9	–
	5CGX-C9	301	8	–	–	–	–	–	240 / 60 / 5	224 / 56 / 6	336 / 84 / 9	480 / 120 / 12	560 / 140 / 12
Cyclone V GT (5 Gbps)	5CGT-D5	77	6	127 / TBD / 4	175 / TBD / 6	–	–	–	224 / 56 / 6	240 / 60 / 6	336 / 84 / 6	–	–
	5CGT-D7	149.5	7	–	–	240 / 60 / 3	–	–	240 / 60 / 6	240 / 60 / 6	336 / 84 / 9	480 / 120 / 9	–
	5CGT-D9	301	8	–	–	–	–	–	240 / 60 / 5	224 / 56 / 6	336 / 84 / 9	480 / 120 / 12	560 / 140 / 12

AEC-Q100 Package options available with automotive-grade variants.

True LVDS I/O count only. Does not inlcude eTX/eRX.

Cyclone IV E Auto-Grade Device Package Options and Maximum User I/Os

Family	Product Line	Logic Density (K LEs)	PLL (count)	Package Type/ Pin Count							
				EQFP-144 (E144)	MBGA-164 (M164)	UBGA-256 (U256)	FBGA-256 (F256)	UBGA-484 (U484)	FBGA-324 (F324)	FBGA-484 (F484)	FBGA-780 (F780)
				Ball Spacing (mm)							
				0.5	0.5	0.8	1.0	0.8	1.0	1.0	1.0
				Dimensions (mm)							
				22 x 22	8 x 8	14 x 14	17 x 17	19 x 19	19 x 19	23 x 23	29 x 29
				I/Os / LVDS I/Os (count)							
Cyclone IV E	EP4CE6	6.3	2	91 / 21	–	179 / 66	179 / 66	–	–	–	–
	EP4CE10	10.3	2	91 / 21	–	179 / 66	179 / 66	–	–	–	–
	EP4CE15	15.4	4	81 / 18	89 / 21	165 / 53	165 / 53	–	–	343 / 137	–
	EP4CE22	22.3	4	79 / 17	–	153 / 52	153 / 52	–	–	–	–
	EP4CE30	28.8	4	–	–	–	–	–	195 / 61	328 / 124	532 / 224
	EP4CE40	39.6	4	–	–	–	–	328 / 124	195 / 61	328 / 124	532 / 224
	EP4CE55	55.9	4	–	–	–	–	324 / 132	–	324 / 132	374 / 160
	EP4CE75	75.4	4	–	–	–	–	292 / 110	–	292 / 110	426 / 178
	EP4CE115	114.5	4	–	–	–	–	–	–	280 / 103	528 / 230

AEC-Q100 Package options available with automotive-grade variants.

LVDS count includes dedicated and emulated LVDS pairs, see Handbook.

Cyclone IV GX Auto-Grade Device Package Options and Maximum User I/Os

Family	Product Line	Logic Density (K LEs)	PLL (count)	Package Type/ Pin Count																
				QFN-148 (N148)			FBGA-169 (F169)			FBGA-324 (F324)			FBGA-484 (F484)			FBGA-672 (F672)			FBGA-896 (F896)		
				Ball Spacing (mm)																
				0.5			1.0			1.0			1.0			1.0			1.0		
				Dimensions (mm)																
				11 x 11			14 x 14			19 x 19			23 x 23			27 x 27			31 x 31		
				I/Os / LVDS / Transceivers (count)																
				I/O	LVDS	XCVR	I/O	LVDS	XCVR	I/O	LVDS	XCVR	I/O	LVDS	XCVR	I/O	LVDS	XCVR	I/O	LVDS	XCVR
Cyclone IV GX (2.5/ 3 Gbps)	EP4CGX15	14.4	3	72	25	2	72	25	2	–	–	–	–	–	–	–	–	–	–	–	–
	EP4CGX22	21.3	4	–	–	–	72	25	2	150	64	4	–	–	–	–	–	–	–	–	–
	EP4CGX30	29.4	4 / 6	–	–	–	72	25	2	150	64	4	290	130	4	–	–	–	–	–	–
	EP4CGX50	49.9	8	–	–	–	–	–	–	–	–	–	290	130	4	310	140	8	–	–	–
	EP4CGX75	73.9	8	–	–	–	–	–	–	–	–	–	290	130	4	310	140	8	–	–	–
	EP4CGX110	109.4	8	–	–	–	–	–	–	–	–	–	270	120	4	393	181	8	475	220	8
	EP4CGX150	149.8	8	–	–	–	–	–	–	–	–	–	270	120	4	393	181	8	475	220	8

AEC-Q100 Package options available with automotive-grade variants.

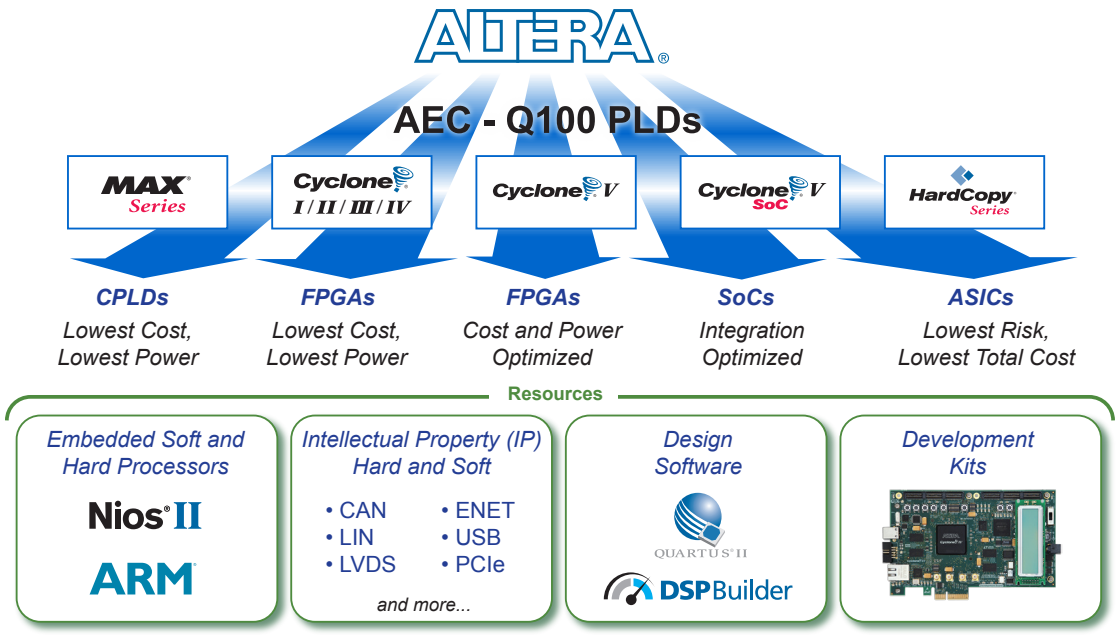
MAX V Auto-Grade Device Package Options and Maximum User I/Os

Family	Product Line	Logic Density (K LEs)	Package Type/ Pin Count							
			MBGA-64 (M64)	EQFP-64 (E64)	MBGA-68 (M68)	TQFP-100 (T100)	MBGA-100 (M100)	TQFP-144 (T144)	FBGA-256 (F256)	FBGA-324 (F324)
			Ball Spacing (mm)							
			0.5	0.4	0.5	0.5	0.5	0.5	1.0	1.0
			Dimensions (mm)							
			4.5 x 4.5	9 x 9	5 x 5	16 x 16	6 x 6	22 x 22	17 x 17	19 x 19
			I/Os (count)							
MAX V	5M40Z	40	30	54	–	–	–	–	–	–
	5M80Z	80	30	54	52	79	–	–	–	–
	5M160Z	160	–	54	52	79	79	–	–	–
	5M240Z	240	–	–	52	79	79	114	–	–
	5M570Z	570	–	–	–	74	74	114	159	–
	5M1270Z	1270	–	–	–	–	–	114	211	271
	5M2210Z	2210	–	–	–	–	–	–	203	271

AEC-Q100 Package options available with automotive-grade variants.

Notes:

1. For a specific list of part numbers for automotive-grade devices, please consult the Automotive-Grade Device Handbook at altera.com.
2. For details on additional product line features (i.e., hard IP blocks, on-chip memory, etc.), please consult the online handbook at altera.com
3. Other automotive-grade options might be available upon request. Please consult your Altera sales representative to submit your request.
4. Consult Quartus II documentation / handbooks for full specifications, features, and I/O count for GPIO, HPS, LVDS, emulated LVDS, and transceivers.



Visit our website for information on legacy automotive-grade devices:

- Cyclone III FPGAs
- Cyclone II FPGAs
- Cyclone FPGAs
- MAX II CPLDs
- MAX 7000A CPLDs

Want to Dig Deeper?

To learn more about Altera's automotive-grade products, contact your local FAE or sales representative. You can download automotive handbooks, white papers, and application notes at www.altera.com/automotive.

Visit: www.altera.com/automotive

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