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

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

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

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

#### **Details**

Product Status	Obsolete
Architecture	MCU, FPGA
Core Processor	Dual ARM® Cortex®-A9 MPCore™ with CoreSight™
Flash Size	-
RAM Size	64KB
Peripherals	DMA, POR, WDT
Connectivity	EBI/EMI, Ethernet, I <sup>2</sup> C, MMC/SD/SDIO, SPI, UART/USART, USB OTG
Speed	800MHz
Primary Attributes	FPGA - 462K Logic Elements
Operating Temperature	-40°C ~ 100°C (TJ)
Package / Case	1517-BBGA, FCBGA
Supplier Device Package	1517-FBGA, FC (40x40)
Purchase URL	<a href="https://www.e-xfl.com/product-detail/intel/5astfd5k3f40i5n">https://www.e-xfl.com/product-detail/intel/5astfd5k3f40i5n</a>

Advantage	Supporting Feature
Lowest system cost	<ul style="list-style-type: none"> <li>Requires as few as four power supplies to operate</li> <li>Available in thermal composite flip chip ball-grid array (BGA) packaging</li> <li>Includes innovative features such as Configuration via Protocol (CvP), partial reconfiguration, and design security</li> </ul>

## Summary of Arria V Features

Table 2: Summary of Features for Arria V Devices

Feature	Description
Technology	<ul style="list-style-type: none"> <li>TSMC's 28-nm process technology: <ul style="list-style-type: none"> <li>Arria V GX, GT, SX, and ST—28-nm low power (28LP) process</li> <li>Arria V GZ—28-nm high performance (28HP) process</li> </ul> </li> <li>Lowest static power in its class (less than 1.2 W for 500K logic elements (LEs) at 85°C junction under typical conditions)</li> <li>0.85 V, 1.1 V, or 1.15 V core nominal voltage</li> </ul>
Packaging	<ul style="list-style-type: none"> <li>Thermal composite flip chip BGA packaging</li> <li>Multiple device densities with identical package footprints for seamless migration between different device densities</li> <li>Leaded<sup>(1)</sup>, lead-free (Pb-free), and RoHS-compliant options</li> </ul>
High-performance FPGA fabric	<ul style="list-style-type: none"> <li>Enhanced 8-input ALM with four registers</li> <li>Improved routing architecture to reduce congestion and improve compilation time</li> </ul>
Internal memory blocks	<ul style="list-style-type: none"> <li>M10K—10-kilobits (Kb) memory blocks with soft error correction code (ECC) ( Arria V GX, GT, SX, and ST devices only)</li> <li>M20K—20-Kb memory blocks with hard ECC ( Arria V GZ devices only)</li> <li>Memory logic array block (MLAB)-640-bit distributed LUTRAM where you can use up to 50% of the ALMs as MLAB memory</li> </ul>

<sup>(1)</sup> Contact Altera for availability.

Feature	Description	
Embedded Hard IP blocks	Variable-precision DSP	<ul style="list-style-type: none"> <li>Native support for up to four signal processing precision levels:               <ul style="list-style-type: none"> <li>Three 9 x 9, two 18 x 18, or one 27 x 27 multiplier in the same variable-precision DSP block</li> <li>One 36 x 36 multiplier using two variable-precision DSP blocks ( Arria V GZ devices only)</li> </ul> </li> <li>64-bit accumulator and cascade for systolic finite impulse responses (FIRs)</li> <li>Embedded internal coefficient memory</li> <li>Preadder/subtractor for improved efficiency</li> </ul>
	Memory controller ( Arria V GX, GT, SX, and ST only)	DDR3 and DDR2
	Embedded transceiver I/O	<ul style="list-style-type: none"> <li>Custom implementation:               <ul style="list-style-type: none"> <li>Arria V GX and SX devices—up to 6.5536 Gbps</li> <li>Arria V GT and ST devices—up to 10.3125 Gbps</li> <li>Arria V GZ devices—up to 12.5 Gbps</li> </ul> </li> <li>PCI Express® (PCIe®) Gen2 (x1, x2, or x4) and Gen1 (x1, x2, x4, or x8) hard IP with multifunction support, endpoint, and root port</li> <li>PCIe Gen3 (x1, x2, x4, or x8) support ( Arria V GZ only)</li> <li>Gbps Ethernet (GbE) and XAUI physical coding sublayer (PCS)</li> <li>Common Public Radio Interface (CPRI) PCS</li> <li>Gigabit-capable passive optical network (GPON) PCS</li> <li>10-Gbps Ethernet (10GbE) PCS ( Arria V GZ only)</li> <li>Serial RapidIO® (SRIO) PCS</li> <li>Interlaken PCS ( Arria V GZ only)</li> </ul>
Clock networks	<ul style="list-style-type: none"> <li>Up to 650 MHz global clock network</li> <li>Global, quadrant, and peripheral clock networks</li> <li>Clock networks that are not used can be powered down to reduce dynamic power</li> </ul>	
Phase-locked loops (PLLs)	<ul style="list-style-type: none"> <li>High-resolution fractional PLLs</li> <li>Precision clock synthesis, clock delay compensation, and zero delay buffering (ZDB)</li> <li>Integer mode and fractional mode</li> <li>LC oscillator ATX transmitter PLLs ( Arria V GZ only)</li> </ul>	



Feature	Description
FPGA General-purpose I/Os (GPIOs)	<ul style="list-style-type: none"> <li>1.6 Gbps LVDS receiver and transmitter</li> <li>800 MHz/1.6 Gbps external memory interface</li> <li>On-chip termination (OCT)</li> <li>3.3 V support <sup>(2)</sup></li> </ul>
External Memory Interface	<p>Memory interfaces with low latency:</p> <ul style="list-style-type: none"> <li>Hard memory controller-up to 1.066 Gbps</li> <li>Soft memory controller-up to 1.6 Gbps</li> </ul>
Low-power high-speed serial interface	<ul style="list-style-type: none"> <li>600 Mbps to 12.5 Gbps integrated transceiver speed</li> <li>Less than 105 mW per channel at 6 Gbps, less than 165 mW per channel at 10 Gbps, and less than 170 mW per channel at 12.5 Gbps</li> <li>Transmit pre-emphasis and receiver equalization</li> <li>Dynamic partial reconfiguration of individual channels</li> <li>Physical medium attachment (PMA) with soft PCS that supports 9.8304 Gbps CPRI ( Arria V GT and ST only)</li> <li>PMA with hard PCS that supports up to 9.8 Gbps CPRI ( Arria V GZ only)</li> <li>Hard PCS that supports 10GBASE-R and 10GBASE-KR ( Arria V GZ only)</li> </ul>
HPS ( Arria V SX and ST devices only)	<ul style="list-style-type: none"> <li>Dual-core ARM Cortex-A9 MPCore processor—up to 1.05 GHz maximum frequency with support for symmetric and asymmetric multiprocessing</li> <li>Interface peripherals—10/100/1000 Ethernet media access control (EMAC), USB 2.0 On-The-GO (OTG) controller, quad serial peripheral interface (QSPI) flash controller, NAND flash controller, Secure Digital/MultiMediaCard (SD/MMC) controller, UART, serial peripheral interface (SPI), I2C interface, and up to 85 HPS GPIO interfaces</li> <li>System peripherals—general-purpose timers, watchdog timers, direct memory access (DMA) controller, FPGA configuration manager, and clock and reset managers</li> <li>On-chip RAM and boot ROM</li> <li>HPS-FPGA bridges—include the FPGA-to-HPS, HPS-to-FPGA, and lightweight HPS-to-FPGA bridges that allow the FPGA fabric to issue transactions to slaves in the HPS, and vice versa</li> <li>FPGA-to-HPS SDRAM controller subsystem—provides a configurable interface to the multiport front end (MPFE) of the HPS SDRAM controller</li> <li>ARM CoreSight™ JTAG debug access port, trace port, and on-chip trace storage</li> </ul>

<sup>(2)</sup> Arria V GZ devices support 3.3 V with a 3.0 V V<sub>CCIO</sub>.

Feature	Description
Configuration	<ul style="list-style-type: none"><li>• Tamper protection-comprehensive design protection to protect your valuable IP investments</li><li>• Enhanced advanced encryption standard (AES) design security features</li><li>• CvP</li><li>• Partial and dynamic reconfiguration of the FPGA</li><li>• Active serial (AS) x1 and x4, passive serial (PS), JTAG, and fast passive parallel (FPP) x8, x16, and x32 ( Arria V GZ) configuration options</li><li>• Remote system upgrade</li></ul>

## Arria V Device Variants and Packages

Table 3: Device Variants for the Arria V Device Family

Variant	Description
Arria V GX	FPGA with integrated 6.5536 Gbps transceivers that provides bandwidth, cost, and power levels that are optimized for high-volume data and signal-processing applications
Arria V GT	FPGA with integrated 10.3125 Gbps transceivers that provides enhanced high-speed serial I/O bandwidth for cost-sensitive data and signal processing applications
Arria V GZ	FPGA with integrated 12.5 Gbps transceivers that provides enhanced high-speed serial I/O bandwidth for high-performance and cost-sensitive data and signal processing applications
Arria V SX	SoC with integrated ARM-based HPS and 6.5536 Gbps transceivers
Arria V ST	SoC with integrated ARM-based HPS and 10.3125 Gbps transceivers

### Arria V GX

This section provides the available options, maximum resource counts, and package plan for the Arria V GX devices.

The information in this section is correct at the time of publication. For the latest information and to get more details, refer to the Altera Product Selector.

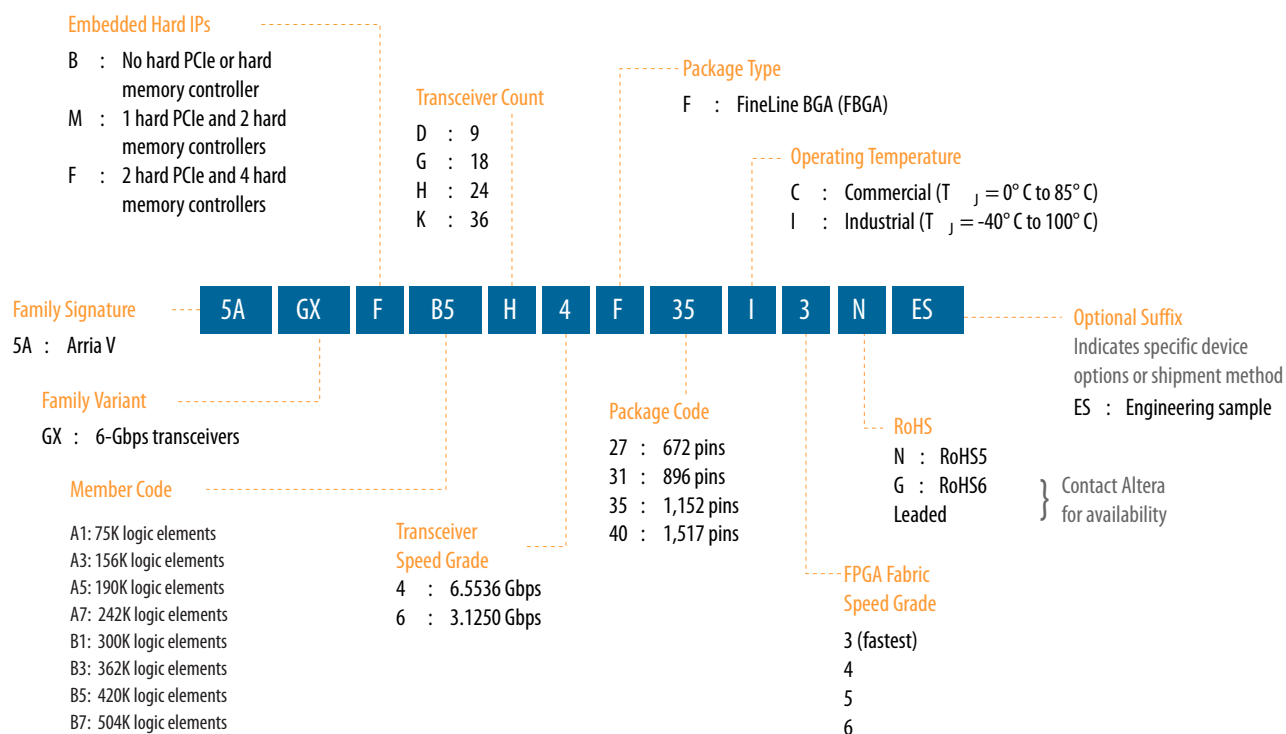
#### Related Information

##### [Altera Product Selector](#)

Provides the latest information about Altera products.

## Available Options

Figure 1: Sample Ordering Code and Available Options for Arria V GX Devices



## Maximum Resources

Table 4: Maximum Resource Counts for Arria V GX Devices

Resource		Member Code							
		A1	A3	A5	A7	B1	B3	B5	B7
Logic Elements (LE) (K)		75	156	190	242	300	362	420	504
ALM		28,302	58,900	71,698	91,680	113,208	136,880	158,491	190,240
Register		113,208	235,600	286,792	366,720	452,832	547,520	633,964	760,960
Mem ory (Kb)	M10K	8,000	10,510	11,800	13,660	15,100	17,260	20,540	24,140
	MLAB	463	961	1,173	1,448	1,852	2,098	2,532	2,906
Variable- precision DSP Block		240	396	600	800	920	1,045	1,092	1,156
18 x 18 Multiplier		480	792	1,200	1,600	1,840	2,090	2,184	2,312
PLL		10	10	12	12	12	12	16	16

The information in this section is correct at the time of publication. For the latest information and to get more details, refer to the Altera Product Selector.

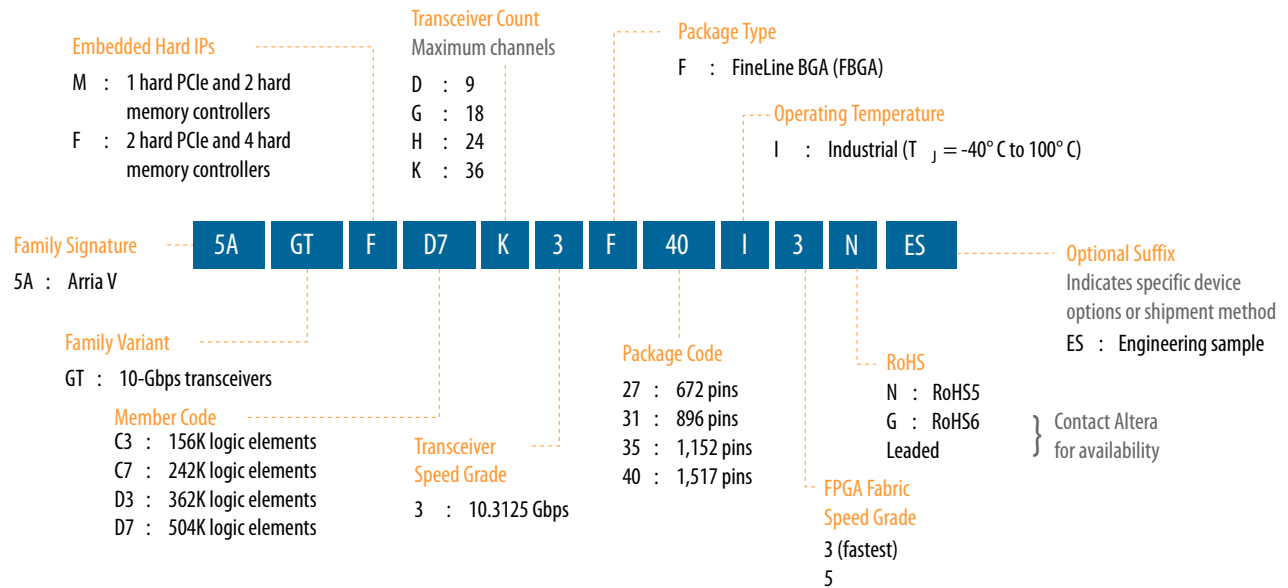
### Related Information

#### Altera Product Selector

Provides the latest information about Altera products.

## Available Options

Figure 2: Sample Ordering Code and Available Options for Arria V GT Devices



## Maximum Resources

Table 6: Maximum Resource Counts for Arria V GT Devices

Resource		Member Code			
		C3	C7	D3	D7
Logic Elements (LE) (K)		156	242	362	504
ALM		58,900	91,680	136,880	190,240
Register		235,600	366,720	547,520	760,960
Memory (Kb)	M10K	10,510	13,660	17,260	24,140
	MLAB	961	1,448	2,098	2,906
Variable-precision DSP Block		396	800	1,045	1,156
18 x 18 Multiplier		792	1,600	2,090	2,312
PLL		10	12	12	16

Resource		Member Code			
		C3	C7	D3	D7
Transceiver	6 Gbps <sup>(4)</sup>	3 (9)	6 (24)	6 (24)	6 (36)
	10 Gbps <sup>(5)</sup>	4	12	12	20
GPIO <sup>(6)</sup>		416	544	704	704
LVDS	Transmitter	68	120	160	160
	Receiver	80	136	176	176
PCIe Hard IP Block		1	2	2	2
Hard Memory Controller		2	4	4	4

#### Related Information

- [High-Speed Differential I/O Interfaces and DPA in Arria V Devices chapter, Arria V Device Handbook](#)

Provides the number of LVDS channels in each device package.

- [Transceiver Architecture in Arria V Devices](#)

Describes 10 Gbps channels usage conditions and SFF-8431 compliance requirements.

## Package Plan

**Table 7: Package Plan for Arria V GT Devices**

Member Code	F672 (27 mm)			F896 (31 mm)			F1152 (35 mm)			F1517 (40 mm)		
	GPIO	XCVR		GPIO	XCVR		GPIO	XCVR		GPIO	XCVR	
		6-Gbps	10-Gbps		6-Gbps	10-Gbps		6-Gbps	10-Gbps		6-Gbps	10-Gbps
C3	336	3 (9)	4	416	3 (9)	4	—	—	—	—	—	—
C7	—	—	—	384	6 (18)	8	544	6 (24)	12	—	—	—
D3	—	—	—	384	6 (18)	8	544	6 (24)	12	704	6 (24)	12
D7	—	—	—	—	—	—	544	6 (24)	12	704	6 (36)	20

The 6-Gbps transceiver counts are for dedicated 6-Gbps channels. You can also configure any pair of 10-Gbps channels as three 6-Gbps channels—the total number of 6-Gbps channels are shown in brackets. For example, you can also configure the Arria V GT D7 device in the F1517 package with nine 6-Gbps

<sup>(4)</sup> The 6 Gbps transceiver counts are for dedicated 6-Gbps channels. You can also configure any pair of 10 Gbps channels as three 6 Gbps channels—the total number of 6 Gbps channels are shown in brackets.

<sup>(5)</sup> Chip-to-chip connections only. For 10 Gbps channel usage conditions, refer to the Transceiver Architecture in Arria V Devices chapter.

<sup>(6)</sup> The number of GPIOs does not include transceiver I/Os. In the Quartus Prime software, the number of user I/Os includes transceiver I/Os.



Resource		Member Code	
		B3	B5
FPGA PLL		14	14
HPS PLL		3	3
6 Gbps Transceiver		30	30
FPGA GPIO <sup>(8)</sup>		540	540
HPS I/O		208	208
LVDS	Transmitter	120	120
	Receiver	136	136
PCIe Hard IP Block		2	2
FPGA Hard Memory Controller		3	3
HPS Hard Memory Controller		1	1
ARM Cortex-A9 MPCore Processor		Dual-core	Dual-core

**Related Information**

[High-Speed Differential I/O Interfaces and DPA in Arria V Devices chapter, Arria V Device Handbook](#)

Provides the number of LVDS channels in each device package.

**Package Plan****Table 11: Package Plan for Arria V SX Devices**

The HPS I/O counts are the number of I/Os in the HPS and does not correlate with the number of HPS-specific I/O pins in the FPGA. Each HPS-specific pin in the FPGA may be mapped to several HPS I/Os.

Member Code	F896 (31 mm)			F1152 (35 mm)			F1517 (40 mm)		
	FPGA GPIO	HPS I/O	XCVR	FPGA GPIO	HPS I/O	XCVR	FPGA GPIO	HPS I/O	XCVR
B3	250	208	12	385	208	18	540	208	30
B5	250	208	12	385	208	18	540	208	30

**Arria V ST**

This section provides the available options, maximum resource counts, and package plan for the Arria V ST devices.

The information in this section is correct at the time of publication. For the latest information and to get more details, refer to the Altera Product Selector.

<sup>(8)</sup> The number of GPIOs does not include transceiver I/Os. In the Quartus Prime software, the number of user I/Os includes transceiver I/Os.

## I/O Vertical Migration for Arria V Devices

**Figure 6: Vertical Migration Capability Across Arria V Device Packages and Densities**

The arrows indicate the vertical migration paths. Some packages have several migration paths. The devices included in each vertical migration path are shaded. You can also migrate your design across device densities in the same package option if the devices have the same dedicated pins, configuration pins, and power pins.

Variant	Member Code	Package				
		F672	F780	F896	F 1152	F1517
Arria V GX	A1					
	A3					
	A5					
	A7					
	B1					
	B3					
	B5					
	B7					
Arria V GT	C3					
	C7					
	D3					
	D7					
Arria V GZ	E1					
	E3					
	E5					
	E7					
Arria V SX	B3					
	B5					
Arria V ST	D3					
	D5					

You can achieve the vertical migration shaded in red if you use only up to 320 GPIOs, up to nine 6 Gbps transceiver channels, and up to four 10 Gbps transceiver (for Arria V GT devices). This migration path is not shown in the Quartus Prime software Pin Migration View.

**Note:** To verify the pin migration compatibility, use the Pin Migration View window in the Quartus Prime software Pin Planner.

**Note:** Except for Arria V GX A5 and A7, and Arria V GT C7 devices, all other Arria V GX and GT devices require a specific power-up sequence. If you plan to migrate your design from Arria V GX A5 and A7, and Arria V GT C7 devices to other Arria V devices, your design must adhere to the same required power-up sequence.

**Related Information**

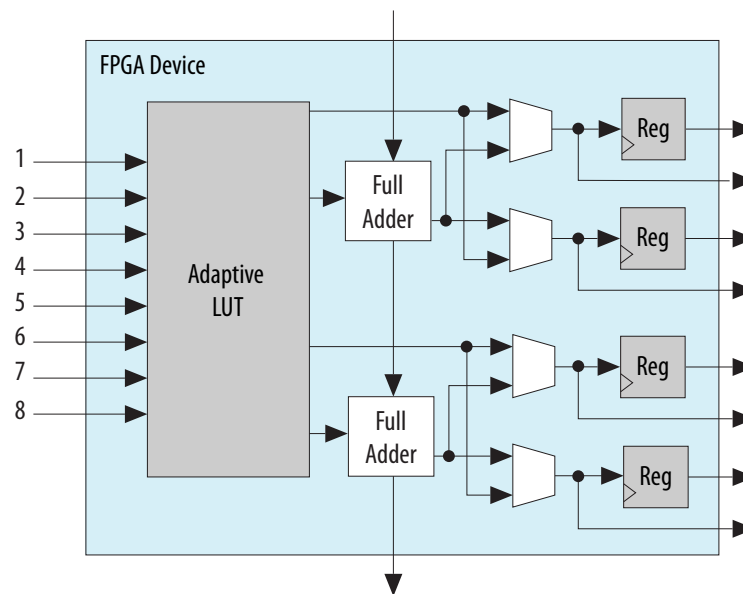
- **Managing Device I/O Pins chapter, Quartus Prime Handbook**  
Provides more information about vertical I/O migrations.
- **Power Management in Arria V Devices**  
Describes the power-up sequence required for Arria V GX and GT devices.

## Adaptive Logic Module

Arria V devices use a 28 nm ALM as the basic building block of the logic fabric.

The ALM, as shown in following figure, uses an 8-input fracturable look-up table (LUT) with four dedicated registers to help improve timing closure in register-rich designs and achieve an even higher design packing capability than previous generations.

**Figure 7: ALM for Arria V Devices**



You can configure up to 50% of the ALMs in the Arria V devices as distributed memory using MLABs.

**Related Information**

**Embedded Memory Capacity in Arria V Devices** on page 20

Lists the embedded memory capacity for each device.

**Table 15: Number of Multipliers in Arria V Devices**

The table lists the variable-precision DSP resources by bit precision for each Arria V device.

Variant	Member Code	Variable-precision DSP Block	Independent Input and Output Multiplications Operator				18 x 18 Multiplier Adder Mode	18 x 18 Multiplier Adder Summed with 36 bit Input
			9 x 9 Multiplier	18 x 18 Multiplier	27 x 27 Multiplier	36 x 36 Multiplier		
Arria V GX	A1	240	720	480	240	—	240	240
	A3	396	1,188	792	396	—	396	396
	A5	600	1,800	1,200	600	—	600	600
	A7	800	2,400	1,600	800	—	800	800
	B1	920	2,760	1,840	920	—	920	920
	B3	1,045	3,135	2,090	1,045	—	1,045	1,045
	B5	1,092	3,276	2,184	1,092	—	1,092	1,092
	B7	1,156	3,468	2,312	1,156	—	1,156	1,156
Arria V GT	C3	396	1,188	792	396	—	396	396
	C7	800	2,400	1,600	800	—	800	800
	D3	1,045	3,135	2,090	1,045	—	1,045	1,045
	D7	1,156	3,468	2,312	1,156	—	1,156	1,156
Arria V GZ	E1	800	2,400	1,600	800	400	800	800
	E3	1,044	3,132	2,088	1,044	522	1,044	1,044
	E5	1,092	3,276	2,184	1,092	546	1,092	1,092
	E7	1,139	3,417	2,278	1,139	569	1,139	1,139
Arria V SX	B3	809	2,427	1,618	809	—	809	809
	B5	1,090	3,270	2,180	1,090	—	1,090	1,090
Arria V ST	D3	809	2,427	1,618	809	—	809	809
	D5	1,090	3,270	2,180	1,090	—	1,090	1,090

## Embedded Memory Blocks

The embedded memory blocks in the devices are flexible and designed to provide an optimal amount of small- and large-sized memory arrays to fit your design requirements.

Variant	Member Code	M20K		M10K		MLAB		Total RAM Bit (Kb)
		Block	RAM Bit (Kb)	Block	RAM Bit (Kb)	Block	RAM Bit (Kb)	
Arria V ST	D3	—	—	1,729	17,290	3223	2,014	19,304
	D5	—	—	2,282	22,820	4253	2,658	25,478

## Embedded Memory Configurations

**Table 17: Supported Embedded Memory Block Configurations for Arria V Devices**

This table lists the maximum configurations supported for the embedded memory blocks. The information is applicable only to the single-port RAM and ROM modes.

Memory Block	Depth (bits)	Programmable Width
MLAB	32	x16, x18, or x20
	64 <sup>(11)</sup>	x10
M20K	512	x40
	1K	x20
	2K	x10
	4K	x5
	8K	x2
	16K	x1
M10K	256	x40 or x32
	512	x20 or x16
	1K	x10 or x8
	2K	x5 or x4
	4K	x2
	8K	x1

## Clock Networks and PLL Clock Sources

650 MHz Arria V devices have 16 global clock networks capable of up to operation. The clock network architecture is based on Altera's global, quadrant, and peripheral clock structure. This clock structure is supported by dedicated clock input pins and fractional PLLs.

**Note:** To reduce power consumption, the Quartus Prime software identifies all unused sections of the clock network and powers them down.

<sup>(11)</sup> Available for Arria V GZ devices only.

## PLL Features

The PLLs in the Arria V devices support the following features:

- Frequency synthesis
- On-chip clock deskew
- Jitter attenuation
- Counter reconfiguration
- Programmable output clock duty cycles
- PLL cascading
- Reference clock switchover
- Programmable bandwidth
- Dynamic phase shift
- Zero delay buffers

## Fractional PLL

In addition to integer PLLs, the Arria V devices use a fractional PLL architecture. The devices have up to 16 PLLs, each with 18 output counters. One fractional PLL can use up to 18 output counters and two adjacent fractional PLLs share the 18 output counters. You can use the output counters to reduce PLL usage in two ways:

- Reduce the number of oscillators that are required on your board by using fractional PLLs
- Reduce the number of clock pins that are used in the device by synthesizing multiple clock frequencies from a single reference clock source

If you use the fractional PLL mode, you can use the PLLs for precision fractional-N frequency synthesis—removing the need for off-chip reference clock sources in your design.

The transceiver fractional PLLs that are not used by the transceiver I/Os can be used as general purpose fractional PLLs by the FPGA fabric.

## FPGA General Purpose I/O

Arria V devices offer highly configurable GPIOs. The following list describes the features of the GPIOs:

- Programmable bus hold and weak pull-up
- LVDS output buffer with programmable differential output voltage ( $V_{OD}$ ) and programmable pre-emphasis
- On-chip parallel termination ( $R_T$  OCT) for all I/O banks with OCT calibration to limit the termination impedance variation
- On-chip dynamic termination that has the ability to swap between series and parallel termination, depending on whether there is read or write on a common bus for signal integrity
- Unused voltage reference ( $V_{REF}$ ) pins that can be configured as user I/Os (Arria V GX, GT, SX, and ST only)
- Easy timing closure support using the hard read FIFO in the input register path, and delay-locked loop (DLL) delay chain with fine and coarse architecture

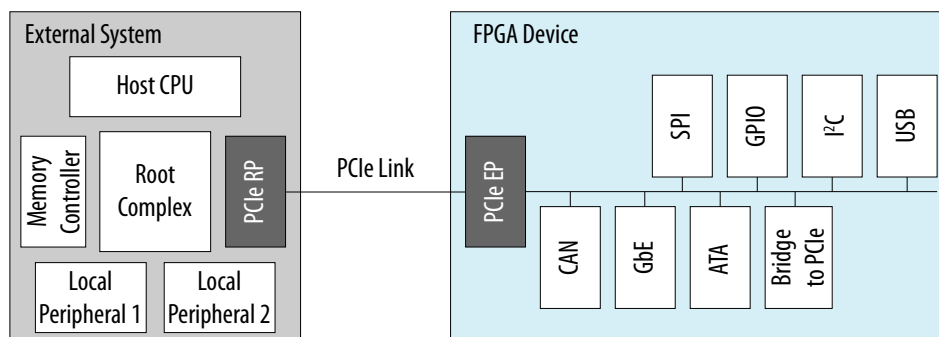
## PCIe Gen1, Gen2, and Gen 3 Hard IP

Arria V devices contain PCIe hard IP that is designed for performance and ease-of-use. The PCIe hard IP consists of the MAC, data link, and transaction layers.

The PCIe hard IP supports PCIe Gen3, Gen 2, and Gen 1 end point and root port for up to x8 lane configuration.

The PCIe endpoint support includes multifunction support for up to eight functions, as shown in the following figure. The integrated multifunction support reduces the FPGA logic requirements by up to 20,000 LEs for PCIe designs that require multiple peripherals.

**Figure 8: PCIe Multifunction for Arria V Devices**



The Arria V PCIe hard IP operates independently from the core logic. This independent operation allows the PCIe link to wake up and complete link training in less than 100 ms while the Arria V device completes loading the programming file for the rest of the device.

In addition, the PCIe hard IP in the Arria V device provides improved end-to-end datapath protection using ECC.

## External Memory Interface

This section provides an overview of the external memory interface in Arria V devices.

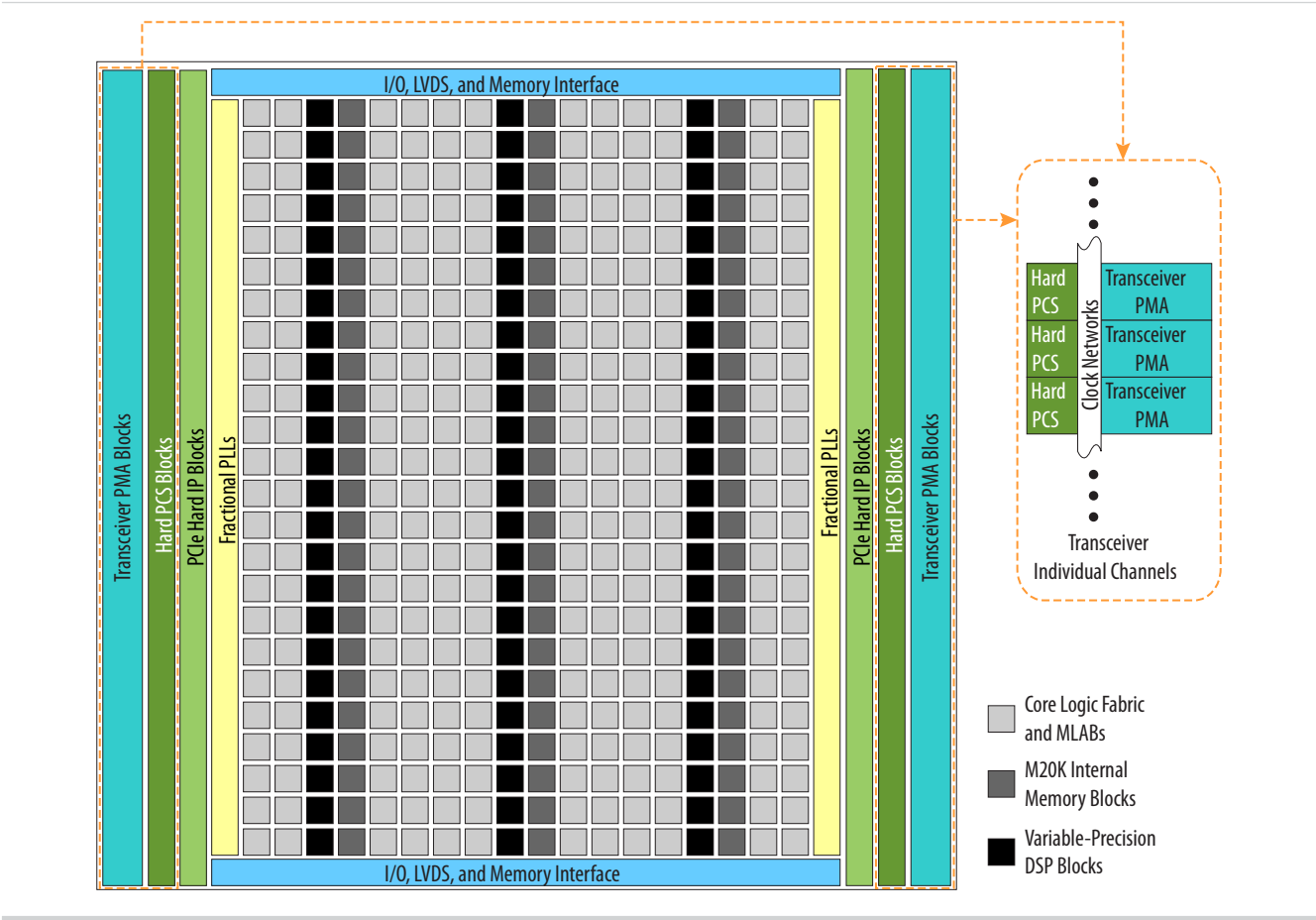
### Hard and Soft Memory Controllers

Arria V GX,GT, SX, and ST devices support up to four hard memory controllers for DDR3 and DDR2 SDRAM devices. Each controller supports 8 to 32 bit components of up to 4 gigabits (Gb) in density with two chip selects and optional ECC. For the Arria V SoC devices, an additional hard memory controller in the HPS supports DDR3, DDR2, and LPDDR2 SDRAM devices.

All Arria V devices support soft memory controllers for DDR3, DDR2, and LPDDR2 SDRAM devices, QDR II+, QDR II, and DDR II+ SRAM devices, and RLDRAM II devices for maximum flexibility.

**Note:** DDR3 SDRAM leveling is supported only in Arria V GZ devices.

Figure 10: Device Chip Overview for Arria V GZ Devices





Features	Capability
PLL-based clock recovery	Superior jitter tolerance
Programmable serializer and deserializer (SERDES)	Flexible SERDES width
Equalization and pre-emphasis	<ul style="list-style-type: none"> <li>Arria V GX, GT, SX, and ST devices—Up to 14.37 dB of pre-emphasis and up to 4.7 dB of equalization</li> <li>Arria V GZ devices—4-tap pre-emphasis and de-emphasis</li> </ul>
Ring oscillator transmit PLLs	611 Mbps to 10.3125 Gbps
LC oscillator ATX transmit PLLs (Arria V GZ devices only)	600 Mbps to 12.5 Gbps
Input reference clock range	27 MHz to 710 MHz
Transceiver dynamic reconfiguration	Allows the reconfiguration of a single channel without affecting the operation of other channels

## PCS Features

The Arria V core logic connects to the PCS through an 8, 10, 16, 20, 32, 40, 64, 66, or 67 bit interface, depending on the transceiver data rate and protocol. Arria V devices contain PCS hard IP to support PCIe Gen1, Gen2, and Gen3, GbE, Serial RapidIO (SRIO), GPON, and CPRI.

All other standard and proprietary protocols within the following speed ranges are also supported:

- 611 Mbps to 6.5536 Gbps—supported through the custom double-width mode (up to 6.5536 Gbps) and custom single-width mode (up to 3.75 Gbps) of the transceiver PCS hard IP.
- 6.5536 Gbps to 10.3125 Gbps—supported through dedicated 80 or 64 bit interface that bypass the PCS hard IP and connects the PMA directly to the core logic. In Arria V GZ, this is supported in the transceiver PCS hard IP.

**Table 21: Transceiver PCS Features for Arria V GX, GT, ST, and SX Devices**

PCS Support <sup>(13)</sup>	Data Rates (Gbps)	Transmitter Data Path Feature	Receiver Data Path Feature
Custom single- and double-width modes	0.611 to ~6.5536	<ul style="list-style-type: none"> <li>Phase compensation FIFO</li> <li>Byte serializer</li> <li>8B/10B encoder</li> </ul>	<ul style="list-style-type: none"> <li>Word aligner</li> <li>8B/10B decoder</li> <li>Byte deserializer</li> <li>Phase compensation FIFO</li> </ul>
SRIO	1.25 to 6.25		
Serial ATA	1.5, 3.0, 6.0		

<sup>(13)</sup> Data rates above 6.5536 Gbps up to 10.3125 Gbps, such as 10GBASE-R, are supported through the soft PCS.

Table 22: Transceiver PCS Features for Arria V GZ Devices

Protocol	Data Rates (Gbps)	Transmitter Data Path Features	Receiver Data Path Features
Custom PHY	0.6 to 9.80	<ul style="list-style-type: none"> <li>Phase compensation FIFO</li> <li>Byte serializer</li> <li>8B/10B encoder</li> <li>Bit-slip</li> <li>Channel bonding</li> </ul>	<ul style="list-style-type: none"> <li>Word aligner</li> <li>Deskew FIFO</li> <li>Rate match FIFO</li> <li>8B/10B decoder</li> <li>Byte deserializer</li> <li>Byte ordering</li> </ul>
GPON	1.25 and 2.5		
Custom 10G PHY	9.98 to 12.5	<ul style="list-style-type: none"> <li>TX FIFO</li> <li>Gear box</li> <li>Bit-slip</li> </ul>	<ul style="list-style-type: none"> <li>RX FIFO</li> <li>Gear box</li> </ul>
PCIe Gen1 (x1, x2, x4, x8)	2.5 and 5.0	<ul style="list-style-type: none"> <li>Phase compensation FIFO</li> <li>Byte serializer</li> <li>8B/10B encoder</li> <li>Bit-slip</li> <li>Channel bonding</li> <li>PIPE 2.0 interface to core logic</li> </ul>	<ul style="list-style-type: none"> <li>Word aligner</li> <li>Deskew FIFO</li> <li>Rate match FIFO</li> <li>8B/10B decoder</li> <li>Byte deserializer,</li> <li>Byte ordering</li> <li>PIPE 2.0 interface to core logic</li> </ul>
PCIe Gen2 (x1, x2, x4, x8)			
PCIe Gen3 (x1, x2, x4, x8)	8.0	<ul style="list-style-type: none"> <li>Phase compensation FIFO</li> <li>128B/130B encoder</li> <li>Scrambler</li> <li>Gear box</li> <li>Bit-slip</li> </ul>	<ul style="list-style-type: none"> <li>Block synchronization</li> <li>Rate match FIFO</li> <li>128B/130B decoder</li> <li>Descrambler</li> <li>Phase compensation FIFO</li> </ul>
10GbE	10.3125	<ul style="list-style-type: none"> <li>TX FIFO</li> <li>64B/66B encoder</li> <li>Scrambler</li> <li>Gear box</li> </ul>	<ul style="list-style-type: none"> <li>RX FIFO</li> <li>64B/66B decoder</li> <li>Descrambler</li> <li>Block synchronization</li> <li>Gear box</li> </ul>
Interlaken	3.125 to 12.5	<ul style="list-style-type: none"> <li>TX FIFO</li> <li>Frame generator</li> <li>CRC-32 generator</li> <li>Scrambler</li> <li>Disparity generator</li> <li>Gear box</li> </ul>	<ul style="list-style-type: none"> <li>RX FIFO</li> <li>Frame generator</li> <li>CRC-32 checker</li> <li>Frame decoder</li> <li>Descrambler</li> <li>Disparity checker</li> <li>Block synchronization</li> <li>Gear box</li> </ul>

Mode	Data Width	Max Clock Rate (MHz)	Max Data Rate (Mbps)	Decompression	Design Security	Partial Reconfiguration <sup>(20)</sup>	Remote System Update
FPP	8 bits	125	—	Yes	Yes	—	Parallel flash loader
	16 bits	125	—	Yes	Yes	Yes <sup>(21)</sup>	
	32 bits <sup>(22)</sup>	100	—	Yes	Yes	—	
CvP (PCIe)	x1, x2, x4, and x8 lanes	—	—	Yes	Yes	Yes	—
JTAG	1 bit	33	33	—	—	—	—
Configuration via HPS	16 bits	125	—	Yes	Yes	Yes <sup>(21)</sup>	Parallel flash loader
	32 bits	100	—	Yes	Yes	—	

Instead of using an external flash or ROM, you can configure the Arria V devices through PCIe using CvP. The CvP mode offers the fastest configuration rate and flexibility with the easy-to-use PCIe hard IP block interface. The Arria V CvP implementation conforms to the PCIe 100 ms power-up-to-active time requirement.

**Note:** Although Arria V GZ devices support PCIe Gen3, you can use only PCIe Gen1 and PCIe Gen2 for CvP configuration scheme.

#### Related Information

#### [Configuration via Protocol \(CvP\) Implementation in Altera FPGAs User Guide](#)

Provides more information about CvP.

## Power Management

Leveraging the FPGA architectural features, process technology advancements, and transceivers that are designed for power efficiency, the Arria V devices consume less power than previous generation Arria V FPGAs:

- Total device core power consumption—less by up to 50%.
- Transceiver channel power consumption—less by up to 50%.

Additionally, Arria V devices contain several hard IP blocks, including PCIe Gen1, Gen2, and Gen3, GbE, SRIO, GPON, and CPRI protocols, that reduce logic resources and deliver substantial power savings of up to 25% less power than equivalent soft implementations.

<sup>(20)</sup> Partial reconfiguration is an advanced feature of the device family. If you are interested in using partial reconfiguration, contact Altera for support.

<sup>(21)</sup> Supported at a maximum clock rate of 62.5 MHz.

<sup>(22)</sup> Arria V GZ only

## Document Revision History

Date	Version	Changes
December 2015	2015.12.21	<ul style="list-style-type: none"> <li>Updated RoHS and optional suffix information in sample ordering code and available options diagrams for Arria V GX and GT devices.</li> <li>Changed instances of <i>Quartus II</i> to <i>Quartus Prime</i>.</li> </ul>
January 2015	2015.01.23	<ul style="list-style-type: none"> <li>Updated package dimension for Arria V GZ H780 package from 29 mm to 33 mm.</li> <li>Updated dual-core ARM Cortex-A9 MPCore processor maximum frequency from 800 MHz to 1.05 GHz.</li> </ul>
December 2013	2013.12.26	<ul style="list-style-type: none"> <li>10-Gbps Ethernet (10GbE) PCS and Interlaken PCS are for Arria V GZ only.</li> <li>Removed "Preliminary" texts from Ordering Code figures, Maximum Resources, Package Plan and I/O Vertical Migration tables.</li> <li>Added link to <a href="#">Altera Product Selector</a> for each device variant.</li> <li>Added leaded package options.</li> <li>Removed the note "The number of PLLs includes general-purpose fractional PLLs and transceiver fractional PLLs." for all PLLs in the Maximum Resource Counts table.</li> <li>Corrected FPGA GPIO for Arria V SX B3 and B5 as well as Arria V ST D3 and D5 F896 package from 170 to 250.</li> <li>Corrected FPGA GPIO for Arria V SX B3 and B5 as well as Arria V ST D3 and D5 F1152 package from 350 to 385.</li> <li>Corrected FPGA GPIO for Arria V SX B3 and B5 as well as Arria V ST D3 and D5 F1517 package from 528 to 540.</li> <li>Corrected LVDS Transmitter for Arria V SX B3 and B5 as well as Arria V ST D3 and D5 devices from 121 to 120.</li> <li>Added links to Altera's <a href="#">External Memory Spec Estimator</a> tool to the topics listing the external memory interface performance.</li> <li>Added x2 for PCIe Gen3, Gen 2, and Gen 1.</li> </ul>
August 2013	2013.08.19	<ul style="list-style-type: none"> <li>Removed the note about the PCIe hard IP on the right side of the device in the F896 package of the Arria V GX variant. These devices do not have PCIe hard IP on the right side.</li> <li>Added transceiver speed grade 6 to the available options of the Arria V SX variant.</li> <li>Corrected the maximum LVDS transmitter channel counts for the Arria V GX A1 and A3 devices from 68 to 67.</li> <li>Corrected the maximum FPGA GPIO count for Arria V ST D5 devices from 540 to 528.</li> </ul>

Date	Version	Changes
June 2013	2013.06.03	<ul style="list-style-type: none"><li>Removed statements about contacting Altera for SFF-8431 compliance requirements. Refer to the <a href="#">Transceiver Architecture in Arria V Devices</a> chapter for the requirements.</li></ul>
May 2013	2013.05.06	<ul style="list-style-type: none"><li>Moved all links to the Related Information section of respective topics for easy reference.</li><li>Added link to the known document issues in the Knowledge Base.</li><li>Updated the available options, maximum resource counts, and per package information for the Arria V SX and ST device variants.</li><li>Updated the variable DSP multipliers counts for the Arria V SX and ST device variants.</li><li>Clarified that partial reconfiguration is an advanced feature. Contact Altera for support of the feature.</li><li>Added footnote to clarify that MLAB 64 bits depth is available only for Arria V GZ devices.</li><li>Updated description about power-up sequence requirement for device migration to improve clarity.</li></ul>
January 2013	2013.01.11	<ul style="list-style-type: none"><li>Added the L optional suffix to the Arria V GZ ordering code for the – I3 speed grade.</li><li>Added a note about the power-up sequence requirement if you plan to migrate your design from the Arria V GX A5 and A7, and Arria V GT C7 devices to other Arria V devices.</li></ul>
November 2012	2012.11.19	<ul style="list-style-type: none"><li>Updated the summary of features.</li><li>Updated Arria V GZ information regarding 3.3 V I/O support.</li><li>Removed Arria V GZ engineering sample ordering code.</li><li>Updated the maximum resource counts for Arria V GX and GZ.</li><li>Updated Arria V ST ordering codes for transceiver count.</li><li>Updated transceiver counts for Arria V ST packages.</li><li>Added simplified floorplan diagrams for Arria V GZ, SX, and ST.</li><li>Added FPP x32 configuration mode for Arria V GZ only.</li><li>Updated CvP (PCIe) remote system update support information.</li><li>Added HPS external memory performance information.</li><li>Updated template.</li></ul>
October 2012	3.0	<ul style="list-style-type: none"><li>Added Arria V GZ information.</li><li>Updated Table 1, Table 2, Table 3, Table 14, Table 15, Table 16, Table 17, Table 18, Table 19, Table 20, and Table 21.</li><li>Added the “Arria V GZ” section.</li><li>Added Table 8, Table 9 and Table 22.</li></ul>