Haswell (microarchitecture)

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Haswell is the codename for a processor microarchitecture developed by Intel as the "fourth-generation core" successor to the Ivy Bridge microarchitecture.[1] Intel officially announced CPUs based on this microarchitecture on June 4, 2013 at Computex Taipei 2013,[2] while a working Haswell chip was demonstrated at the 2011 Intel Developer Forum.[3] With Haswell, which uses a 22 nm process,[4] Intel also introduced low-power processors designed for convertible or "hybrid" ultrabooks, designated by the "Y" suffix.

Haswell CPUs are used in conjunction with the Intel 8 Series chipsets, Intel 9 Series chipsets, and Intel C220 series chipsets.

Contents

Design

The Haswell architecture is specifically designed[5] to optimize the power savings and performance benefits from the move to FinFET (non-planar, "3D") transistors on the improved 22 nm process node.[6]

Haswell has been launched in three major forms:[7]

- Desktop version (LGA 1150 socket and the new LGA 2011-v3 socket): *Haswell-DT*
- Mobile/Laptop version (PGA socket): *Haswell-MB*
- BGA version:
  - 47 W and 57 W TDP classes: *Haswell-H* (for "All-in-one" systems, Mini-ITX form factor motherboards, and other small footprint formats)
  - 13.5 W and 15 W TDP classes (MCP): *Haswell-ULT* (for Intel's UltraBook platform)
  - 10 W TDP class (SoC): *Haswell-ULX* (for tablets and certain UltraBook-class implementations)

Notes

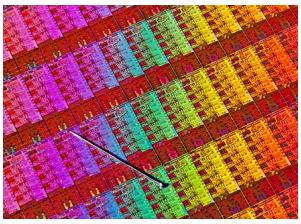
- ULT = *Ultra Low TDP*; ULX = *Ultra Low eXtreme* TDP
- Only certain quad-core variants and BGA R-series stock keeping units (SKUs) receive GT3e (Intel Iris Pro 5200) integrated graphics. All other models have GT3 (Intel HD 5000 or Intel Iris 5100), GT2 (Intel HD 4200, 4400, 4600, P4600 or P4700) or GT1 (Intel HD Graphics) integrated graphics.[8] See also Intel HD and Iris Graphics for more details.
- Due to the low power requirements of tablet and UltraBook platforms, Haswell-ULT and Haswell-ULX are only available in dual-core configurations. All other versions come as dual- or quad-core variants.

Performance

Compared to Ivy Bridge:

- Approximately 8% faster vector processing[9]
- Up to 5% faster single-threaded performance
- 6% faster multi-threaded performance
- Desktop variants of Haswell draw between 8% and 23% more power under load than Ivy Bridge.[9][10][11]
- A 6% increase in sequential CPU performance (eight execution ports per core versus six)[9]
- Up to 20% performance increase over the integrated HD4000 GPU (Haswell HD4600 vs Ivy Bridge's built-in Intel HD4000)[9]
- Total performance improvement on average is about 3%[9]

Haswell



A Haswell wafer with a pin for scale

CPUID code	0306C3h
Product code	80646 (desktop LGA 1150) 80647 (mobile Socket G3) 80648 (desktop LGA 2011-3) 80644 (server LGA 2011-3)
Cores	2–4 (mainstream) 6–8 (enthusiast) 2–18 (Xeon)
L1 cache	64 KB per core
L2 cache	256 KB per core
L3 cache	2–40 MB (shared)
L4 cache	128 MB of eDRAM (Iris Pro models only)
Model	Haswell Haswell Refresh Haswell-E Haswell-EP Haswell-EX
Created	2013
Transistors	22 nm (Tri-Gate)
Architecture	Haswell x86
Instructions	MMX, AES-NI, CLMUL, FMA3
Extensions	x86-64, Intel 64 SSE, SSE2, SSE3, SSSE3, SSE4, SSE4.1, SSE4.2 AVX, AVX2, TXT, and TSX (disabled via microcode, except for Haswell-EX) VT-x, VT-d
Socket(s)	LGA 1150 rPGA 947 BGA 1364 BGA 1168 LGA 2011-v3
Predecessor	Ivy Bridge (Tick)
Successor	Broadwell (Tock/Process)
GPU	HD Graphics 4200 HD Graphics 4400 HD Graphics 4600 HD Graphics 5000 Iris 5100 Iris Pro 5200
Brand name(s)	Core i3 Core i5 Core i7 Xeon E3 v3

- Around 15 °C hotter than Ivy Bridge, while clock frequencies of over 4.6 GHz are achievable[12][13][14][15][16][17]

Xeon E5 v3
Xeon E7 v3
Pentium
Celeron

Technology

Features carried over from Ivy Bridge

- 22 nm manufacturing process[4]
- 3D tri-gate transistors[18]
- Micro-operation cache(Uop Cache) capable of storing 1.5 K micro-operations (approximately 6 KB in size)[19]
- 14- to 19-stage instruction pipeline, depending on the micro-operation cache hit or miss (an approach used in the even earlier Sandy Bridge microarchitecture)[19]
- Mainstream variants are up to quad-core.[20]
- Native support for dual-channel DDR3 memory,[21] with up to 32 GB of RAM on LGA 1150 variants
- 64 KB (32 KB Instruction + 32 KB Data) L1 cache and 256 KB L2 cache per core[22]
- A total of 16 PCI Express 3.0 lanes on LGA 1150 variants[23]

New features

- Wider core: fourth arithmetic logic unit (ALU), third address generation unit (AGU),[24][25][26] second branch execution unit, deeper buffers, higher cache bandwidth, improved front-end and memory controller, higher load/store bandwidth.
- New instructions[27] (HNI, includes Advanced Vector Extensions 2 (AVX2), gather, BMI1, BMI2, ABM and FMA3 support).[28]
- The instruction decode queue, which holds instructions after they have been decoded, is no longer statically partitioned between the two threads that each core can service.[19]
- New sockets and chipsets:
  - LGA 1150 for desktops, and rPGA947 and BGA1364 for the mobile market.[29]
  - Z97 (performance) and H97 (mainstream) chipsets for the Haswell Refresh and Broadwell, in Q2 2014.[30]
  - LGA 2011-v3 with X99 chipset for the enthusiast-class desktop platform *Haswell-E*.[31]
- Intel Transactional Synchronization Extensions (TSX) for the Haswell-EX variant. In August 2014 Intel announced that a bug exists in the TSX implementation on the current steppings of Haswell, Haswell-E, Haswell-EP and early Broadwell CPUs, which resulted in disabling the TSX feature on affected CPUs via a microcode update.[32][33][34][35]
- Hardware graphics support for Direct3D 11.1 and OpenGL 4.3.[36][37][38] Intel 10.18.14.4578 driver is the last planned driver release on Windows 7/8.1.[39]
- DDR4 for the enthusiast and enterprise/server segments[40] and for the Enthusiast-Class Desktop Platform Haswell-E[41]
- Variable Base clock (BClk)[42] like LGA 2011.[43]
- Four versions of the integrated GPU: GT1, GT2, GT3 and GT3e, where GT3 version has 40 execution units (EUs). Haswell's predecessor, Ivy Bridge, has a maximum of 16 EUs. GT3e version with 40 EUs and on-package 128 MB of embedded DRAM (eDRAM), called Crystalwell, is available only in mobile H-SKUs and desktop (BGA-only) R-SKUs. Effectively, this eDRAM is a Level 4 cache; it is shared dynamically between the on-die GPU and CPU, and serving as a victim cache to the CPU's Level 3 cache.[44][45][46][47][48]
- Optional support for Thunderbolt technology and Thunderbolt 2.0[49][50]
- Fully integrated voltage regulator (FIVR), thereby moving some of the components from motherboard onto the CPU.[51][52][53]
- New advanced power-saving system; due to Haswell's new low-power C6 and C7 sleep states, not all power supply units (PSUs) are suitable for computers with Haswell CPUs.[54][55]
- 37, 47, 57 W thermal design power (TDP) mobile processors.[20]
- 35, 45, 65, 84, 88, 95 and 130–140 W (high-end, Haswell-E) TDP desktop processors.[20]
- 15 W or 11.5W TDP processors for the Ultrabook platform (multi-chip package like Westmere)[56] leading to reduced heat, which results in thinner as well as lighter Ultrabooks, but the performance level is slightly lower than the 17 W version.[57]
- Shrink of the Platform Controller Hub (PCH), from 65 nm to 32 nm.[58]

Translation lookaside buffer sizes[59][60]

Cache		Page size		
Name	**Level**	**4 KB**	**2 MB**	**1 GB**
DTLB	1st	64	32	4
ITLB	1st	128	8 / logical core	none
STLB	2nd	1024		none

Server processors features

- Haswell-EP variant, released in September 2014, with up to 18 cores and marketed as the Xeon E5-1600 v3 and Xeon E5-2600 v3 series.[61]
- Haswell-EX variant is expected to be released in 2015, with 18 cores and functioning TSX.[34][62]
- A new cache design.
- Up to 35 MB total unified cache (last level cache, LLC) for Haswell-EP[63] and up to 40 MB for Haswell-EX.
- LGA 2011-v3 socket replaces LGA 2011 for the Haswell EP; the new socket has the same number of pins, but it is keyed differently due to electrical incompatibility.[64][65][66]
- The already launched Xeon E3 v3 Haswells will get a refresh in spring 2014,[67] together with a refreshed Intel C220 series PCH chipset.[68]
- TDP up to 160 W for Haswell-EP.[69]
- Haswell-EP models with ten and more cores support *cluster on die* (COD) operation mode,[70] allowing CPU's multiple columns of cores and last level cache (LLC) slices to

be logically divided into what is presented as two non-uniform memory access (NUMA) CPUs to the operating system. By keeping data and instructions local to the "partition" of CPU which is processing them, therefore decreasing the LLC access latency, COD brings performance improvements to NUMA-aware operating systems and applications.[71]

Haswell Refresh

Around the middle of 2014, Intel released a refresh of Haswell, simply titled *Haswell Refresh*. When compared to the original Haswell CPUs lineup, Haswell Refresh CPUs offer a modest increase in clock frequencies, usually of 100 MHz.[72] Haswell Refresh CPUs are supported by Intel's *9 Series* chipsets (Z97 and H97, codenamed Wildcat Point), while motherboards with *8 Series* chipsets (codenamed Lynx Point) usually require a BIOS update to support Haswell Refresh CPUs.[73]

The CPUs codenamed *Devil's Canyon*, covering the i5 and i7 K-series SKUs, employ a new and improved thermal interface material (TIM) called next-generation polymer thermal interface material (*NGPTIM*). This improved TIM reduces the CPU's operating temperatures and improves the overclocking potential, as something that had been problematic since the introduction of Ivy Bridge.[74] Other changes for the Devil's Canyon CPUs include a TDP increase to 88 W, additional decoupling capacitors to help smooth out the outputs from the fully integrated voltage regulator (FIVR), and support for the VT-d that was previously limited to non-K-series SKUs.[75] TSX was another feature brought over from the non-K-series SKUs, until August 2014 when a microcode update disabled TSX due to a bug that was discovered in its implementation.[34][35]

List of Haswell processors

Desktop processors


Intel Haswell i7-4771 CPU, sitting atop its original packaging that contains an OEM fan-cooled heatsink

- All models support: *MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, F16C, Enhanced Intel SpeedStep Technology (EIST), Intel 64, XD bit (an NX bit implementation), Intel VT-x,* and *Smart Cache*.
  - Core i3, i5 and i7 support *AVX, AVX2, BMI1, BMI2, FMA3,* and *AES-NI*.[76]
  - Core i3 and i7, as well as the Core i5-4570T and i5-4570TE, support *hyper-threading (HT)*.[76]
  - Core i5 and i7 support *Turbo Boost 2.0*.[76]
  - Although it was initially supported on selected models, since August 2014 desktop variants no longer support *TSX* due to a bug that was discovered in its implementation; as a workaround, a microcode update disabled the TSX feature.[32][34][35][76]
  - SKUs below 45xx as well as R-series and K-series SKUs do not support *Trusted Execution Technology* or *vPro*.[76]
  - *Intel VT-d*, which is Intel's IOMMU, is supported on all i5 and i7 "non-K" SKUs and on most, but not all, i5 and i7 "K" SKUs. Two "K" SKUs without VT-d support are the i5-4670K and i7-4770K.[76][77][78] Support for VT-d requires the chipset and motherboard to also support VT-d.
  - Models i5-4690K and i7-4790K, codenamed Devil's Canyon, have a better internal thermal grease to help heat escape and an improved internal voltage regulator ("FIVR"), to help deliver clean power in extreme situations like overclocking.
- Transistors: 1.4 billion[79][80]
- Die size: 177 mm^2[79]
- Intel HD and Iris Graphics in following variants:
  - R-series desktop processors feature Intel Iris Pro 5200 graphics (GT3e).[81]
  - All other currently known i3, i5 and i7 desktop processors include Intel HD 4600 graphics (GT2).[82]
  - The exceptions are processors 41xxx, which include HD 4400 graphics (GT2).
  - Celeron and Pentium processors contain Intel HD Graphics (GT1).
- Pentium G3258, also known as the *Pentium Anniversary Edition*, has an unlocked multiplier and is highly overclockable. Its release marks 20 years of "Pentium" as a brand.[83]

The following table lists available desktop processors.

Target segment	Cores (threads)	Processor branding and model		GPU model	CPU clock rate		Graphics clock rate		Cache		TDP	PCIe 3.0 lane configurations[a]	VT-d[b]	Releas date
					Normal	Turbo	Normal	Turbo	L3	L4[a]				
Enthusiast / High-End	8 (16)	Core i7 Extreme	**5960X (http://ark.intel.com/products/82930)**	N/A	3.0 GHz	3.5 GHz	N/A	N/A	20 MB		140 W	2×16 + 1×8		August 29, 2
	6 (12)		**5930K (http://ark.intel.com/products/82931)**		3.5 GHz	3.7 GHz			15 MB					
			5820K (http://ark.intel.com/products/82932)		3.3 GHz	3.6 GHz						1×16 + 1×8 + 1×4		
			4790K (http://ark.intel.com/products/80807)		4.0 GHz	4.4 GHz		1.25 GHz			88 W			June 2, 2014

Performance	4 (8)	Core i7	**4790 (http://ark.intel.com/products/80806)**	HD 4600 (GT2)	3.6 GHz	4.0 GHz	350 MHz[85]	1.2 GHz	8 MB	N/A	84 W	Yes	May 11, 201
			4790S (http://ark.intel.com/products/80808)		3.2 GHz						65 W		
			4790T (http://ark.intel.com/products/80809)		2.7 GHz	3.9 GHz					45 W		
			4785T (http://ark.intel.com/products/80814)		2.2 GHz	3.2 GHz					35 W		
			4771 (http://ark.intel.com/products/77656)		3.5 GHz	3.9 GHz					84 W		September 1
			4770K (http://ark.intel.com/products/75123)					1.25 GHz				No	
			4770 (http://ark.intel.com/products/75122)		3.4 GHz			1.2 GHz				Yes	
			4770S (http://ark.intel.com/products/75124)		3.1 GHz						65 W		
			4770R (http://ark.intel.com/products/76642)	Iris Pro 5200 (GT3e)	3.2 GHz		200 MHz	1.3 GHz	6 MB	128 MB			June 2, 2013
			4770T (http://ark.intel.com/products/75125)		2.5 GHz	3.7 GHz		1.2 GHz	8 MB		45 W		
			4770TE (http://ark.intel.com/products/75610)		2.3 GHz	3.3 GHz		1 GHz					
			4765T (http://ark.intel.com/products/75121)		2.0 GHz	3.0 GHz					35 W		
			4690K (http://ark.intel.com/products/80811)		3.5 GHz	3.9 GHz					88 W		June 2, 2014
			4690 (http://ark.intel.com/products/8								84 W		

			0810)	HD 4600 (GT2)			350 MHz[85]			N/A				
			4690S (http://ark.intel.com/products/80812)		3.2 GHz			1.2 GHz			65 W			May 11, 201
			4690T (http://ark.intel.com/products/80813)		2.5 GHz	3.5 GHz			6 MB		45 W			
			4670K (http://ark.intel.com/products/75048)		3.4 GHz	3.8 GHz					84 W		No	
			4670 (http://ark.intel.com/products/75047)											
			4670S (http://ark.intel.com/products/75049)		3.1 GHz						65 W			June 2, 2013
	4 (4)		**4670R (http://ark.intel.com/products/76641)**	Iris Pro 5200 (GT3e)	3.0 GHz	3.7 GHz	200 MHz	1.3 GHz	4 MB	128 MB				
			4670T (http://ark.intel.com/products/75050)	HD 4600 (GT2)	2.3 GHz	3.3 GHz	350 MHz[85]	1.2 GHz	6 MB	N/A	45 W			
			4590 (http://ark.intel.com/products/80815)		3.3 GHz	3.7 GHz		1.15 GHz			84 W			May 11, 201
			4590S (http://ark.intel.com/products/80816)		3.0 GHz						65 W			
			4590T (http://ark.intel.com/products/78928)		2.0 GHz	3.0 GHz					35 W			
		Core i5	**4570 (http://ark.intel.com/products/75043)**		3.2 GHz	3.6 GHz					84 W			
			4570S (http://ark.intel.com/products/75044)		2.9 GHz						65 W			
			4570R (http://ark.intel.com/products/76640)	Iris Pro 5200 (GT3e)	2.7 GHz	3.2 GHz	200 MHz		4 MB	128 MB			Yes	June 2, 2013
			4570T (http://ark.intel.com/products		2.9 GHz	3.6 GHz								

	2 (4)		**/75045)**	HD 4600 (GT2)			350 MHz[85]			35 W	1×16		
			4570TE (http://ark.intel.com/products/75468)		2.7 GHz	3.3 GHz		1 GHz					
	4 (4)		**4460 (http://ark.intel.com/products/80817)**		3.2 GHz	3.4 GHz		1.1 GHz	6 MB	84 W			May 11, 201
			4460S (http://ark.intel.com/products/80818)		2.9 GHz					65 W			
			4460T (http://ark.intel.com/products/78927)		1.9 GHz	2.7 GHz				35 W			
			4440 (http://ark.intel.com/products/75038)		3.1 GHz	3.3 GHz				84 W			September 1
			4440S (http://ark.intel.com/products/75040)		2.8 GHz					65 W			
			4430 (http://ark.intel.com/products/75036)		3.0 GHz	3.2 GHz				84 W			June 2, 2013
			4430S (http://ark.intel.com/products/75037)		2.7 GHz					65 W			
			4370 (http://ark.intel.com/products/77495)		3.8 GHz			1.15 GHz		54 W			July 20, 201
			4360 (http://ark.intel.com/products/77493)		3.7 GHz								May 11, 201
			4350 (http://ark.intel.com/products/77491)		3.6 GHz								
			4340 (http://ark.intel.com/products/77771)										September 1
			4330 (http://ark.intel.com/products/77769)		3.5 GHz								
			4370T (http://ark.										

Mainstream	2 (4)	Core i3	**intel.com/products/81207)**	HD 4400 (GT2)	3.3 GHz	200 MHz	1 GHz	4 MB	35 W	2×8 1×8 + 2×4		March 30, 2
			4360T (http://ark.intel.com/products/77494)		3.2 GHz							July 20, 201
			4350T (http://ark.intel.com/products/77492)		3.1 GHz							May 11, 201
			4330T (http://ark.intel.com/products/77770)		3.0 GHz							September 1
			4340TE (http://ark.intel.com/products/77492)		2.6 GHz	350 MHz						May 11, 201
			4330TE (http://ark.intel.com/products/77778)		2.4 GHz							September 1
			4170 (http://ark.intel.com/products/77490)		3.7 GHz		1.15 GHz		54 W			March 30, 2
			4160 (http://ark.intel.com/products/77488)		3.6 GHz							July 20, 201
			4150 (http://ark.intel.com/products/77486)		3.5 GHz							May 11, 201
			4130 (http://ark.intel.com/products/77480)		3.4 GHz							September 1
			4170T (http://ark.intel.com/products/81209)		3.2 GHz	200 MHz			35 W			March 30, 2
			4160T (http://ark.intel.com/products/77489)		3.1 GHz							July 20, 201
			4150T (http://ark.intel.com/products/77487)		3.0 GHz							May 11, 201
			4130T (http://ark.intel.com/products/77481)		2.9 GHz							September 1

		Pentium	**G3470 (http://ark.intel.com/products/87358)**		3.6 GHz	N/A	350 MHz	1.1 GHz	3 MB	N/A	53 W	No	March 30, 2
			G3460 (http://ark.intel.com/products/83428)		3.5 GHz								July 20, 201
			G3450 (http://ark.intel.com/products/80792)		3.4 GHz								May 11, 201
			G3440 (http://ark.intel.com/products/80794)		3.3 GHz								
			G3430 (http://ark.intel.com/products/77777)										December 1
			G3420 (http://ark.intel.com/products/77775)		3.2 GHz								
			G3460T (http://ark.intel.com/products/83429)		3.0 GHz		200 MHz	1.1 GHz			35 W		March 30, 2
			G3450T (http://ark.intel.com/products/80793)		2.9 GHz								July 20, 201
			G3440T (http://ark.intel.com/products/80795)		2.8 GHz								May 11, 201
			G3420T (http://ark.intel.com/products/77776)		2.7 GHz								December 1
			G3320TE (http://ark.intel.com/products/78007)		2.3 GHz			1 GHz					
			G3260 (http://ark.intel.com/products/87356)		3.3 GHz		350 MHz						March 30, 2
			G3258 (http://ark.intel.com/products/82723)[c]										June 2, 2014

	2 (2)			HD Graphics	3.2 GHz			1.1 GHz			53 W		
			G3250 (http://ark.intel.com/products/83538)										July 20, 201
			G3240 (http://ark.intel.com/products/80796)		3.1 GHz								May 11, 201
			G3220 (http://ark.intel.com/products/77773)		3.0 GHz								December 1
			G3260T (http://ark.intel.com/products/87357)		2.9 GHz	200 MHz					35 W		March 30, 2
			G3250T (http://ark.intel.com/products/83539)		2.8 GHz								July 20, 201
			G3240T (http://ark.intel.com/products/80797)		2.7 GHz								May 11, 201
			G3220T (http://ark.intel.com/products/77774)		2.6 GHz								December 1
		Celeron	**G1850 (http://ark.intel.com/products/80798)**		2.9 GHz	350 MHz		1.05 GHz	2 MB		53 W		May 11, 201
			G1840 (http://ark.intel.com/products/80800)		2.8 GHz								
			G1830 (http://ark.intel.com/products/78954)										December 1
			G1820 (http://ark.intel.com/products/78955)		2.7 GHz								
			G1840T (http://ark.intel.com/products/80801)		2.5 GHz	200 MHz					35 W		May 11, 201
			G1820T (http://ark.intel.com/products/78956		2.4 GHz								

			)											
			G1820TE (http://ark.intel.com/products/78957)		2.2 GHz			1 GHz						December 1

[a] Some of these configurations could be disabled by the chipset. For example, H-series chipsets disable all PCIe 3.0 lane configurations except 1×16.

[b] This feature also requires a chipset that supports VT-d like the Q87 chipset or the X99 chipset.

[c] This is called *20th Anniversary Edition* and has an unlocked multiplier.

SKU suffixes to denote:

- K – unlocked (adjustable CPU multiplier up to 63x)
- S – performance-optimized lifestyle (low power with 65 W TDP)
- T – power-optimized lifestyle (ultra low power with 35–45 W TDP)
- R – BGA packaging / High-performance GPU (currently Iris Pro 5200 (GT3e))
- X – extreme performance (adjustable CPU ratio with no ratio limit)

Server processors

- All models support: *MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, AVX (Advanced Vector Extensions), AVX2, FMA3, F16C, BMI (Bit Manipulation Instructions 1)+BMI2, Enhanced Intel SpeedStep Technology (EIST), Intel 64, XD bit (an NX bit implementation), TXT, Intel vPro, Intel VT-x, Intel VT-d, hyper-threading (except E3-1220 v3 and E3-1225 v3), Turbo Boost 2.0, AES-NI*, and *Smart Cache*.
- Haswell-EX models (E7-48xx/88xx v3) support *TSX*, while for Haswell-E, Haswell-WS (E3-12xx v3) and Haswell-EP (E5-16xx/26xx v3) models it was disabled via a microcode update in August 2014, due to a bug that was discovered in the TSX implementation.[34][35]
- Transistors: 5.56 billion[88]
- Die size: 661 mm^2[88]

Intel Xeon E3-1241 v3 CPU, on top of its original packaging with an OEM fan-cooled heatsink

Intel Xeon E5-1650 v3 CPU; its retail box contains no OEM heatsink

The first digit of the model number designates the largest supported multi-socket configuration; thus, E5-26xx v3 models support up to dual-socket configurations, while the E7-48xx v3 and E7-88xx v3 models support up to quad- and eight-socket configurations, respectively. Also, E5-16xx/26xx v3 and E7-48xx/88xx v3 models have no integrated GPU.

Lists of launched server processors are below, split between Haswell E3-12xx v3, E5-16xx/26xx v3 and E7-48xx/88xx v3 models.

Haswell E7-48xx/88xx v3 SKUs[89][90]

Target segment	Cores (threads)	Processor branding and model		CPU clock rate		L3 cache	TDP	Release date	Release price (USD)	Motherboard		
				Normal	Turbo					Socket	Interface	Memory
Server	4 (8)	Xeon E7 v3	**E7-8893v3 (http://ark.intel.com/products/84688/)**	3.2 GHz	3.5 GHz	45 MB	140 W	May 2015	$6,841	LGA 2011-1	QPI (up to 9.6 GT/s[b]) DMI 2.0 PCIe 3.0	Up to DDR4-1866 or DDR3-1600
	10 (20)		**E7-8891v3 (http://ark.intel.com/products/84686/)**	2.8 GHz			165 W					
	18 (36)		**E7-8890v3 (http://ark.intel.com/products/84685/)**	2.5 GHz	3.3 GHz				$7,174			
			E7-8880v3 (http://ark.intel.com/products/84683/)	2.3 GHz	3.1 GHz		150 W		$5,895			
			E7-8880Lv3 (http://ark.intel.com/products/84684/)	2.0 GHz	2.8 GHz		115 W		$6,063			
			E7-8870v3 (http://ark.intel.com/products/84682/)	2.1 GHz	2.9 GHz		140 W		$4,672			
	16 (32)		**E7-8867v3 (http://ark.intel.com/products/84681/)**	2.5 GHz	3.3 GHz		165 W					
			E7-8860v3 (http://ark.intel.com/products/84680/)	2.2 GHz	3.2 GHz	40 MB			$4,061			
	14 (28)		**E7-4850v3 (http://ark.intel.com/products/84679/)**		2.8 GHz	35 MB	115 W		$3,003			
	12 (24)		**E7-4830v3 (http://ark.intel.com/products/84678/)**	2.1 GHz	2.7 GHz	30 MB			$2,170			
	10 (20)		**E7-4820v3 (http://ark.intel.com/products/84677/)**	1.9 GHz	N/A	25 MB			$1,502			
	8 (16)		**E7-4809v3 (http://ark.intel.com/products/84676/)**	2.0 GHz								

Haswell E5-16xx/26xx v3 SKUs

Haswell-EP 10xx/20xx v3 SKUs

Target segment	Cores (threads)	Processor branding and model	CPU clock rate		CPU AVX clock rate[91]		L3 cache	TDP	Release date	Release price (USD) tray / box	Motherboard		
			Normal	Turbo	Normal	Turbo					Socket	Interface	Mem
	18 (36)	**2699v3 (http://ark.intel.com/products/81061/)**	2.3 GHz	3.6 GHz	1.9 GHz	3.3 GHz	45 MB	145 W	September 9, 2014	N/A			
	16 (32)	**2698v3 (http://ark.intel.com/products/81060)**					40 MB	135 W					
		2698Av3[92]	2.8 GHz	3.2 GHz	2.3 GHz	N/A		165 W	November 2014	OEM			
	14 (28)	**2697v3 (http://ark.intel.com/products/81059)**	2.6 GHz	3.6 GHz	2.2 GHz	3.3 GHz	35 MB	145 W		$2,702 / $2,706			
		2695v3 (http://ark.intel.com/products/81057)	2.3 GHz	3.3 GHz	1.9 GHz	3.0 GHz		120 W		$2,424 / $2,428			
	12 (24)	**2690v3 (http://ark.intel.com/products/81713)**	2.6 GHz	3.5 GHz	2.3 GHz	3.2 GHz	30 MB	135 W		$2,090 / $2,094			
	14 (28)	**2683v3 (http://ark.intel.com/products/81055)**	2.0 GHz	3.0 GHz	1.7 GHz	2.7 GHz	35 MB	120 W		$1,846 / —			
	12 (24)	**2680v3 (http://ark.intel.com/products/81908)**	2.5 GHz	3.3 GHz	2.1 GHz	3.1 GHz	30 MB			$1,745 / $1,749			
		2673v3 (https://github.com/Azure/azure-content/commit/c68b7003881a6f1f25dba5e5fd2b146d94a28333)[c]	2.4 GHz	3.1 GHz									up to DDR 2133
		2670v3 (http://ark.intel.com/products/81709)	2.3 GHz	3.1 GHz	2.0 GHz	2.9 GHz		120 W		$1,589 / $1,593			
	8 (16)	**2667v3 (http://ark.intel.com/products/83361)**	3.2 GHz	3.6 GHz	2.7 GHz	3.5 GHz	20 MB	135 W		$2,057 / —			
	10 (20)	**2660v3 (http://ark.intel.com/products/81706)**	2.6 GHz	3.3 GHz	2.2 GHz	3.1 GHz	25 MB	105 W		$1,445 / $1,449			
	12 (24)	**2650Lv3 (http://ark.intel.com/products/81903)**	1.8 GHz	2.5 GHz	1.5 GHz	2.3 GHz	30 MB	65 W		$1,329 / —			
		2658v3 (http://ark.intel.com/products/81905/Intel-Xeon-Processor-	2.2 GHz	2.9 GHz	1.9 GHz	3.0 GHz				$1,832 / —			

Server		Xeon E5 v3	**E5-2658-v3-30M-Cache-2_20-GHz)**						105 W	September 9, 2014		LGA 2011-3	QPI (up to 9.6 GT/s[b]) DMI 2.0 PCIe 3.0	
	10 (20)		**2650v3 (http://ark.intel.com/products/81705)**	2.3 GHz	3.0 GHz	2.0 GHz	2.8 GHz	25 MB			$1,166 / $1,171			
	12 (24)		**2648Lv3 (http://ark.intel.com/products/81901)**	1.8 GHz	2.5 GHz	1.5 GHz	2.2 GHz	30 MB	75 W		$1,544 / —			
	6 (12)		**2643v3 (http://ark.intel.com/products/81900)**	3.4 GHz	3.7 GHz	2.8 GHz	3.6 GHz	20 MB	135 W		$1,552 / —			
	8 (16)		**2640v3 (http://ark.intel.com/products/83359)**	2.6 GHz	3.4 GHz	2.2 GHz	3.4 GHz	20 MB	90 W		$939 / $944			up to DDR 1866
	4 (8)		**2637v3 (http://ark.intel.com/products/83358)**	3.5 GHz	3.7 GHz	3.2 GHz	3.6 GHz	15 MB	135 W		$996 / —			up to DDR 2133
	8 (16)		**2630v3 (http://ark.intel.com/products/83356)**	2.4 GHz	3.2 GHz	2.1 GHz	3.2 GHz	20 MB	85 W		$667 / $671			up to DDR 1866
			2630Lv3 (http://ark.intel.com/products/83357)	1.8 GHz	2.9 GHz	1.5 GHz	2.9 GHz		55 W		$612 / —			
	10 (20)		**2628Lv3 (http://ark.intel.com/products/81704)**	2.0 GHz	2.5 GHz	1.7 GHz	2.4 GHz	25 MB	75 W		$1,364 / —			
	4 (8)		**2623v3 (http://ark.intel.com/products/83354)**	3.0 GHz	3.5 GHz	2.7 GHz	3.5 GHz	10 MB	105 W		$444 / —			
	6 (12)		**2620v3 (http://ark.intel.com/products/83352)**	2.4 GHz	3.2 GHz	2.1 GHz	3.2 GHz	15 MB	85 W		$417 / $422			
	8 (16)		**2618Lv3 (http://ark.intel.com/products/83351)**	2.3 GHz	3.4 GHz	1.9 GHz	3.4 GHz	20 MB	75 W		$779 / —			
	6 (6)		**2609v3 (http://ark.intel.com/products/81897)**	1.9 GHz	N/A	1.9 GHz	N/A	15 MB	85 W		$306 / $306			up to DDR 1600
	6 (12)		**2608Lv3 (http://ark.intel.com/products/83350)**	2.0 GHz		1.7 GHz			52 W		$441 / —			up to DDR 1866
	6 (6)		**2603v3 (http://ark.intel.com/products/83349)**	1.6 GHz		1.3 GHz			85 W		$213 / $217			up to DDR 1600
	10 (20)		**2687Wv3 (http://ark.intel.com/products/81909)**	3.1 GHz	3.5 GHz	2.7 GHz	3.5 GHz	25 MB	160 W		$2,141 / $2,145			

Workstation	8 (16)		**1680v3 (http://ark.intel.com/products/82767)**	3.2 GHz	3.8 GHz	2.9 GHz	3.4 GHz	20 MB	140 W		$1,723 / —	DMI 2.0 PCIe 3.0	up to DDR 2133	
			1660v3 (http://ark.intel.com/products/82766)	3.0 GHz	3.5 GHz	2.7 GHz	3.5 GHz				$1,080 / —			
	6 (12)		**1650v3 (http://ark.intel.com/products/82765)**	3.5 GHz	3.8 GHz	3.2 GHz	3.7 GHz	15 MB			$583 / $586			
	4 (8)		**1630v3 (http://ark.intel.com/products/82764)**	3.7 GHz	3.8 GHz	3.4 GHz	3.7 GHz	10 MB			$372 / —			
			1620v3 (http://ark.intel.com/products/82763)	3.5 GHz	3.6 GHz	3.2 GHz	3.5 GHz				$294 / $297			
	4 (4)		**1607v3 (http://ark.intel.com/products/82762/)**	3.1 GHz	N/A	2.8 GHz	N/A				$255 / —		up to DDR 1866	
	4 (4)		**1603v3 (http://ark.intel.com/products/82761)**	2.8 GHz		2.5 GHz					$202 / —			

Haswell E3-12xx v3 SKUs

Target segment	Cores (threads)	Processor branding and model		GPU model	CPU clock rate		Graphics clock rate		L3 cache	GPU eDRAM	TDP	Release date	Release price (USD) tray / box	Soc
					Normal	Turbo	Normal	Turbo						
			1286v3 (http://ark.intel.com/products/80913)	HD P4700 (GT2)	3.7 GHz	4.1 GHz	350 MHz	1.3 GHz	8 MB	N/A	84 W	May 11, 2014	$662 / —	LGA 115
			1286Lv3 (http://ark.intel.com/products/80914)		3.2 GHz	4.0 GHz		1.25 GHz			65 W		$774 / —	
			1285v3 (http://ark.intel.com/products/75465)		3.6 GHz			1.3 GHz			84 W	June 2, 2013	$662 / —	
			1285Lv3 (http://ark.intel.com/products/75466)		3.1 GHz	3.9 GHz		1.25 GHz			65 W		$774 / —	
			1284Lv3 (http://ark.intel.com/products/88045)	Iris Pro 5200 (GT3e)	1.8 GHz	3.2 GHz	750 MHz	1 GHz	6 MB	128 MB	47 W	February 18, 2014	OEM	BGA 136
			1281v3 (http://ark.intel.c											

			om/products/80907)	N/A	3.7 GHz	4.1 GHz	N/A				82 W	May 11, 2014	$612 / —	
			1280v3 (http://ark.intel.com/products/75057)		3.6 GHz	4.0 GHz						June 2, 2013		
			1276v3 (http://ark.intel.com/products/80915)	HD P4600 (GT2)			350 MHz	1.25 GHz			84 W	May 11, 2014	$339 / $350	
			1275v3 (http://ark.intel.com/products/75464)		3.5 GHz	3.9 GHz						June 2, 2013	$339 / $350	
			1275Lv3 (http://ark.intel.com/products/76300)	HD (GT1)	2.7 GHz			1.2 GHz			45 W	May 11, 2014	$328 / —	
	4 (8)		**1271v3 (http://ark.intel.com/products/80908)**	N/A	3.6 GHz	4.0 GHz	N/A				80 W		$328 / $339	
			1270v3 (http://ark.intel.com/products/75056)		3.5 GHz	3.9 GHz						June 2, 2013		
Server		Xeon E3 v3	**1268Lv3 (http://ark.intel.com/products/75467)**	HD P4600 (GT2)	2.3 GHz	3.3 GHz	350 MHz	1 GHz	8 MB	N/A	45 W		$310 / —	
			1265Lv3 (http://ark.intel.com/products/75463)	HD (GT1)	2.5 GHz	3.7 GHz		1.2 GHz					$294 / —	
			1246v3 (http://ark.intel.com/products/80916)	HD P4600 (GT2)	3.5 GHz	3.9 GHz					84 W	May 11, 2014	$276 / $287	LGA 1150
			1245v3 (http://ark.intel.com/products/75462)		3.4 GHz	3.8 GHz						June 2, 2013		
			1241v3 (http://ark.intel.com/products/80909)		3.5 GHz	3.9 GHz					80 W	May 11, 2014	$262 / $273	
			1240v3 (											

			http://ark.intel.com/products/75055)	N/A	3.4 GHz	3.8 GHz	N/A				June 2, 2013		
			1240Lv3 (http://ark.intel.com/products/80912)		2.0 GHz	3.0 GHz				25 W	May 11, 2014	$278 / —	
			1231v3 (http://ark.intel.com/products/80910)		3.4 GHz	3.8 GHz				80 W		$240 / $250	
			1230v3 (http://ark.intel.com/products/75054)		3.3 GHz	3.7 GHz					June 2, 2013		
			1230Lv3 (http://ark.intel.com/products/75053)		1.8 GHz	2.8 GHz				25 W		$250 / —	
	4 (4)		**1226v3 (http://ark.intel.com/products/80917)**	HD P4600 (GT2)	3.3 GHz	3.7 GHz	350 MHz	1.2 GHz		84 W	May 11, 2014	$213 / $224	
			1225v3 (http://ark.intel.com/products/75461)		3.2 GHz	3.6 GHz					June 2, 2013		
			1220v3 (http://ark.intel.com/products/75052)	N/A	3.1 GHz	3.5 GHz	N/A			80 W		$193 / $203	
	2 (4)		**1220Lv3 (http://ark.intel.com/products/75051)**		1.1 GHz	1.5 GHz			4 MB	13 W	September 1, 2013	$193 / —	

SKU suffixes to denote:

- L – low power

Mobile processors

- All models support: *MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, F16C, Enhanced Intel SpeedStep Technology (EIST), Intel VT-x, Intel 64, XD bit (an NX bit implementation)*, and *Smart Cache*.
  - Core i3, i5 and i7 support *AVX, AVX2, BMI1, BMI2, FMA3*, and *hyper-threading (HT)*.
  - Core i3, i5 and i7 except the Core i3-4000M support *AES-NI*.[93]
  - Core i5 and i7 except the Core i5-4410E, i5-4402EC, i7-4700EC, and i7-4702EC support *Turbo Boost 2.0*.
- Platform Controller Hub (PCH) integrated into the CPU package, slightly reducing the amount of space used on motherboards.[94]
- Transistors: 1.3 billion[95]
- Die size: 181 mm^2[95]

The following table lists available mobile processors.

Target segment	Cores (threads)	Processor branding and model	GPU model	Programmable TDP[96]:69–72				CPU Turbo (single core)	Graphics clock rate		
				SDP[97][98]:71	cTDP down[a]	Nominal TDP[b]	cTDP up[c]		Normal	Turbo	
		4940MX (http://ark.intel.com/products/78940)	HD 4600 (GT2)			57 W / 3.1 GHz	65 W / 3.8 GHz	4.0 GHz	400 MHz	1.35 GHz	8
		4930MX (http://ark.intel.com/products/75133)				57 W / 3.0 GHz	65 W / 3.7 GHz	3.9 GHz			
		4980HQ (http://ark.intel.com/products/83503)	Iris Pro 5200 (GT3e)			47 W / 2.8 GHz	N/A	4.0 GHz	200 MHz	1.3 GHz	
		4960HQ (http://ark.intel.com/products/76088)				47 W / 2.6 GHz	55 W / 3.6 GHz	3.8 GHz			6
		4950HQ (http://ark.intel.com/products/76085)				47 W / 2.4 GHz	55 W / 3.4 GHz	3.6 GHz			
		4910MQ (http://ark.intel.com/products/78939)	HD 4600 (GT2)			47 W / 2.9 GHz	55 W / 3.7 GHz	3.9 GHz	400 MHz		
		4900MQ (http://ark.intel.com/products/75131)				47 W / 2.8 GHz	55 W / 3.6 GHz	3.8 GHz			8
		4870HQ (http://ark.intel.com/products/83504)	Iris Pro 5200 (GT3e)			47 W / 2.5 GHz	N/A	3.7 GHz	200 MHz	1.2 GHz	
		4860EQ (http://ark.intel.com/products/76298)				47 W / 1.8 GHz		3.2 GHz	750 MHz	1 GHz	
		4860HQ (http://ark.intel.com/products/76089)				47 W / 2.4 GHz	55 W / 3.4 GHz	3.6 GHz	200 MHz	1.2 GHz	
		4850EQ (http://ark.intel.com/products/76299)				47 W / 1.6 GHz	N/A	3.2 GHz	650 MHz	1 GHz	
		4850HQ									

			(http://ark.intel.com/products/76086)				47 W / 2.3 GHz	55 W / 3.3 GHz	3.5 GHz	200 MHz	1.2 GHz
			4810MQ (http://ark.intel.com/products/78937)	HD 4600 (GT2)			47 W / 2.8 GHz	55 W / 3.6 GHz	3.8 GHz	400 MHz	1.3 GHz
			4800MQ (http://ark.intel.com/products/75128)				47 W / 2.7 GHz	55 W / 3.5 GHz	3.7 GHz		
Performance	4 (8)		**4770HQ (http://ark.intel.com/products/83505)**	Iris Pro 5200 (GT3e)	N/A	N/A	47 W / 2.2 GHz		3.4 GHz	200 MHz	1.2 GHz
			4760HQ (http://ark.intel.com/products/76090)				47 W / 2.1 GHz	55 W / 3.1 GHz	3.3 GHz		
			4750HQ (http://ark.intel.com/products/76087)				47 W / 2.0 GHz	55 W / 3.0 GHz	3.2 GHz		
			4720HQ (http://ark.intel.com/products/78934)	HD 4600 (GT2)			47 W / 2.6 GHz	N/A	3.6 GHz	400 MHz	1.2 GHz
			4712MQ (http://ark.intel.com/products/78933)				37 W / 2.3 GHz	45 W / 3.1 GHz	3.3 GHz		1.15 GHz
			4712HQ (http://ark.intel.com/products/78932)								
		Core i7	**4710MQ (http://ark.intel.com/products/78931)**				47 W / 2.5 GHz	55 W / 3.3 GHz	3.5 GHz		
			4710HQ (http://ark.intel.com/products/78930)								1.2 GHz
			4702MQ (http://ark.intel.com/products/75119)								

							37 W / 2.2 GHz	45 W / 2.9 GHz	3.2 GHz		1.15 GHz
			4702HQ (http://ark.intel.com/products/75118)								
			4700MQ (http://ark.intel.com/products/75117)				47 W / 2.4 GHz	55 W / 3.2 GHz	3.4 GHz		
			4700HQ (http://ark.intel.com/products/75116)								1.2 GHz
			4701EQ (http://ark.intel.com/products/76297)								1 GHz
			4700EQ (http://ark.intel.com/products/75469)								
			4702EC (http://ark.intel.com/products/75556)	N/A			27 W / 2.0 GHz		N/A	N/A	N/A
			4700EC (http://ark.intel.com/products/75555)			43 W / 2.7 GHz	N/A				
			4650U (http://ark.intel.com/products/75114)	HD 5000 (GT3)	N/A	11.5 W / 800 MHz	15 W / 1.7 GHz		3.3 GHz	200 MHz	1.1 GHz
			4610Y (http://ark.intel.com/products/76618)	HD 4200 (GT2)	6 W / 800 MHz	9.5 W / 800 MHz	11.5 W / 1.7 GHz		2.9 GHz		850 MHz
			4610M (http://ark.intel.com/products/80345/)	HD 4600 (GT2)		N/A	37 W / 3.0 GHz		3.7 GHz	400 MHz	1.3 GHz
			4600M (http://ark.intel.com/products/76349/)				37 W / 2.9 GHz	N/A	3.6 GHz		
			4600U (http://ark.intel.com/prod	HD 4400 (GT2)		11.5 W / 800 MHz	15 W / 2.1 GHz		3.3 GHz		1.1 GHz

			ucts/76616/)								
			4578U (http://ark.intel.com/products/83506)	Iris 5100 (GT3)		23 W / 800 MHz	28 W / 3.0 GHz		3.5 GHz	200 MHz	1.2 GHz
			4558U (http://ark.intel.com/products/75992)				28 W / 2.8 GHz		3.3 GHz		1.2 GHz
			4550U (http://ark.intel.com/products/75112)	HD 5000 (GT3)		11.5 W / 800 MHz	15 W / 1.5 GHz		3.0 GHz		1.1 GHz
			4510U (http://ark.intel.com/products/81015)	HD 4400 (GT2)			15 W / 2.0 GHz		3.1 GHz		
			4500U (http://ark.intel.com/products/75460)				15 W / 1.8 GHz	25 W / 3.0 GHz	3.0 GHz		
			4402EC (http://ark.intel.com/products/75554)	N/A	N/A	N/A	27 W / 2.5 GHz		N/A	N/A	N/A
			4422E (http://ark.intel.com/products/79201)	HD 4600 (GT2)		N/A	25 W / 1.8 GHz		2.9 GHz	400 MHz	900 MHz
			4410E (http://ark.intel.com/products/79199)				37 W / 2.9 GHz		N/A		1 GHz
			4402E (http://ark.intel.com/products/76307)				25 W / 1.6 GHz		2.7 GHz		900 MHz
			4400E (http://ark.intel.com/products/76292)				37 W / 2.7 GHz		3.3 GHz		1 GHz
			4360U (http://ark.intel.com/products/75034)	HD 5000 (GT3)		11.5 W / 800 MHz	15 W / 1.5 GHz		3.0 GHz	200 MHz	1.1 GHz
			4350U (http://ar								

			k.intel.com/products/75033)				15 W / 1.4 GHz		2.9 GHz		
			4340M (http://ark.intel.com/products/80344)	HD 4600 (GT2)		N/A	37 W / 2.9 GHz		3.6 GHz	400 MHz	1.25 GHz
			4330M (http://ark.intel.com/products/76750)				37 W / 2.8 GHz		3.5 GHz		
			4310M (http://ark.intel.com/products/80373)	HD 4600 (GT2)			37 W / 2.7 GHz		3.4 GHz	400 MHz	1.25 GHz
			4310U (http://ark.intel.com/products/80343)	HD 4400 (GT2)		11.5 W / 800 MHz	15 W / 2.0 GHz		3.0 GHz	200 MHz	1.1 GHz
			4302Y (http://ark.intel.com/products/76613)	HD 4200 (GT2)		4.5 W / 800 MHz	11.5 W / 1.6 GHz		2.3 GHz	200 MHz	850 MHz
			4300Y (http://ark.intel.com/products/76612)		6 W / 800 MHz	9.5 W / 800 MHz					
			4300M (http://ark.intel.com/products/76347)	HD 4600 (GT2)	N/A	N/A	37 W / 2.6 GHz	N/A	3.3 GHz	400 MHz	1.25 GHz
		Core i5	**4300U (http://ark.intel.com/products/76308)**	HD 4400 (GT2)		11.5 W / 800 MHz	15 W / 1.9 GHz		2.9 GHz	200 MHz	1.1 GHz
			4288U (http://ark.intel.com/products/75991)	Iris 5100 (GT3)		23 W / 800 MHz	28 W / 2.6 GHz		3.1 GHz		1.2 GHz
			4258U (http://ark.intel.com/products/75990)				28 W / 2.4 GHz		2.9 GHz		1.1 GHz
			4308U (http://ark.intel.com/products/83507)				28 W / 2.8 GHz		3.3 GHz		1.2 GHz

Mainstream	2 (4)		**4260U (http://ark.intel.com/products/75030)**	HD 5000 (GT3)	6 W / 800 MHz	11.5 W / 800 MHz	15 W / 1.4 GHz	25 W / ?	2.7 GHz	200 MHz	1 GHz	3
			4250U (http://ark.intel.com/products/75028)				15 W / 1.3 GHz		2.6 GHz			
			4210H (http://ark.intel.com/products/78929)	HD 4600 (GT2)		N/A	47 W / 2.9 GHz		3.5 GHz	400 MHz	1.15 GHz	
			4210M (http://ark.intel.com/products/81012)				37 W / 2.6 GHz		3.2 GHz			
			4210U (http://ark.intel.com/products/81016)	HD 4400 (GT2)		11.5 W / 800 MHz	15 W / 1.7 GHz		2.7 GHz	200 MHz	1 GHz	
			4220Y (http://ark.intel.com/products/81020)	HD 4200 (GT2)	6 W / 800 MHz	9.5 W / 800 MHz	11.5 W / 1.6 GHz		2.0 GHz		850 MHz	
			4210Y (http://ark.intel.com/products/76611)				11.5 W / 1.5 GHz		1.9 GHz			
			4202Y (http://ark.intel.com/products/76610)		4.5 W / 800 MHz		11.5 W / 1.6 GHz		2.0 GHz			
			4200Y (http://ark.intel.com/products/75802)		6 W / 800 MHz		11.5 W / 1.4 GHz		1.9 GHz			
			4200U (http://ark.intel.com/products/75459)	HD 4400 (GT2)		11.5 W / 800 MHz	15 W / 1.6 GHz	25 W / ?	2.6 GHz		1 GHz	
			4200H (http://ark.intel.com/products/75027)	HD 4600 (GT2)		N/A	47 W / 2.8 GHz		3.4 GHz	400 MHz	1.15 GHz	
			4200M (http://ark.intel.com/products/763				37 W / 2.5 GHz		3.1 GHz			

		48)								
	Core i3	**4158U (http://ark.intel.com/products/75989)**	Iris 5100 (GT3)	N/A	23 W / 800 MHz	28 W / 2.0 GHz		200 MHz	1.1 GHz	
		4120U (http://ark.intel.com/products/81017)	HD 4400 (GT2)		11.5 W / 800 MHz	15 W / 2.0 GHz			1 GHz	
		4112E (http://ark.intel.com/products/79198)	HD 4600 (GT2)		N/A	25 W / 1.8 GHz		400 MHz	900 MHz	
		4110E (http://ark.intel.com/products/79197)				37 W / 2.6 GHz				
		4102E (http://ark.intel.com/products/76294)				25 W / 1.6 GHz				
		4100E (http://ark.intel.com/products/76293)				37 W / 2.4 GHz				
		4110M (http://ark.intel.com/products/77483)				37 W / 2.6 GHz			1.1 GHz	
		4100M (http://ark.intel.com/products/76346)				37 W / 2.5 GHz				
		4100U (http://ark.intel.com/products/75110)	HD 4400 (GT2)		11.5 W / 800 MHz	15 W / 1.8 GHz			1 GHz	
		4030Y (http://ark.intel.com/products/81021)	HD 4200 (GT2)	6 W / 800 MHz	9.5 W / 800 MHz	11.5 W / 1.6 GHz			850 MHz	
		4020Y (http://ark.intel.com/products/76609)				11.5 W / 1.5 GHz				
		4012Y (http://ark.intel.c		4.5 W / 800 MH	N/A					

		om/products/76608)		4.5 W / 800 MHz	N/A					
		4010Y (http://ark.intel.com/products/75988)		6 W / 800 MHz	9.5 W / 800 MHz	11.5 W / 1.3 GHz			200 MHz	
		4030U (http://ark.intel.com/products/81018)	HD 4400 (GT2)	N/A	11.5 W / 800 MHz	15 W / 1.9 GHz	N/A	N/A		1 GHz
		4025U (http://ark.intel.com/products/81019)								950 MHz
		4010U (http://ark.intel.com/products/75107)				15 W / 1.7 GHz				1 GHz
		4005U (http://ark.intel.com/products/75105)								950 MHz
		4000M (http://ark.intel.com/products/75104)	HD 4600 (GT2)			37 W / 2.4 GHz			400 MHz	1.1 GHz
	Pentium	**3561Y (http://ark.intel.com/products/78946)**		6 W / 800 MHz		11.5 W / 1.2 GHz			200 MHz	850 MHz
		3560Y (http://ark.intel.com/products/76622)								
		3558U (http://ark.intel.com/products/78945)		N/A		15 W / 1.7 GHz				1 GHz
		3556U (http://ark.intel.com/products/76621)								
		3560M (http://ark.intel.com/products/81013)				37 W / 2.4 GHz			400 MHz	1.1 GHz
		3550M (								

			http://ark.intel.com/products/77404)			N/A	37 W / 2.3 GHz					
	2 (2)	Celeron	**2981U (http://ark.intel.com/products/78944)**	HD Graphics	N/A		15 W / 1.6 GHz			200 MHz	1 GHz	2
			2980U (http://ark.intel.com/products/76620)									
			2957U (http://ark.intel.com/products/78942)				15 W / 1.4 GHz					
			2955U (http://ark.intel.com/products/75608)									
			2970M (http://ark.intel.com/products/81014)				37 W / 2.2 GHz			400 MHz	1.1 GHz	
			2950M (http://ark.intel.com/products/77403)				37 W / 2.0 GHz					
			2961Y (http://ark.intel.com/products/78943)		6 W / 800 MHz		11.5 W / 1.1 GHz			200 MHz	850 MHz	

a. When a cooler or quieter mode of operation is desired, this mode specifies a lower TDP and lower guaranteed frequency versus the nominal mode.[96]:71–72
b. This is the processor's rated frequency and TDP.[96]:71–72
c. When extra cooling is available, this mode specifies a higher TDP and higher guaranteed frequency versus the nominal mode.[96]:71–72

SKU suffixes to denote:

- M – mobile processor (Socket G3)
- Q – quad-core
- U – ultra-low power (BGA1168 packaging)
- X – "extreme"
- Y – extreme low-power (BGA1168 packaging)
- E / H – BGA1364 packaging

See also

- LGA 1150: Original Haswell chipsets
- List of Intel chipsets
- List of Intel CPU microarchitectures

Notes

a. Implemented as eDRAM and serving primarily to increase the performance of integrated GPU, while being shared with the CPU.

b. Maximum QPI speed depends on the CPU model.
c. Unconfirmed details may differ from surrounding models

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