IDF15
INTEL DEVELOPER FORUM

Overclocking 6th Generation Intel® Core™ Processors!

Dan Ragland – Overclocking System Architect, Intel Corporation
Nick Shih – Overclocking Guru, ASRock
Colin Brix – Director of Technical Marketing and PR, Corsair

RPCS001

intel
experience what's inside™

WARNING: Altering clock frequency and/or voltage may: (i) reduce system stability and useful life of the system and processor; (ii) cause the processor and other system components to fail; (iii) cause reductions in system performance; (iv) cause additional heat or other damage; and (v) affect system data integrity. Intel has not tested, and does not warranty, the operation of the processor beyond its specifications. Intel assumes no responsibility that the processor, including if used with altered clock frequencies and/or voltages, will be fit for any particular purpose.

For more information, visit:

http://www.intel.com/consumer/game/gaming-power.htm

Agenda

- Overclocking (OC) Architecture: Intel® Core™ i7-6700K processor with Intel® Z170 Chipset
- Live Overclocking Demonstration!
- Motherboard Technology for OC
- OC Architecture: 8-Core OC on Intel® X99 Chipset
- Tools and Technology for OC
- OC Extended Ecosystem
- Summary and Q&A

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Overclocking SKU Options: for 6th Generation Intel® Core™ Processors

Overclocking Capabilities

Intel® 100 Series Chipset	Intel® Core™ i7-6700K Intel Core i5-6600K
Intel Z170 Chipset	• Unlocked BCLK Frequency • Unlocked Processor Ratios • Unlocked Memory Ratio • Unlocked Processor Graphics Ratio • Unlocked Voltage controls

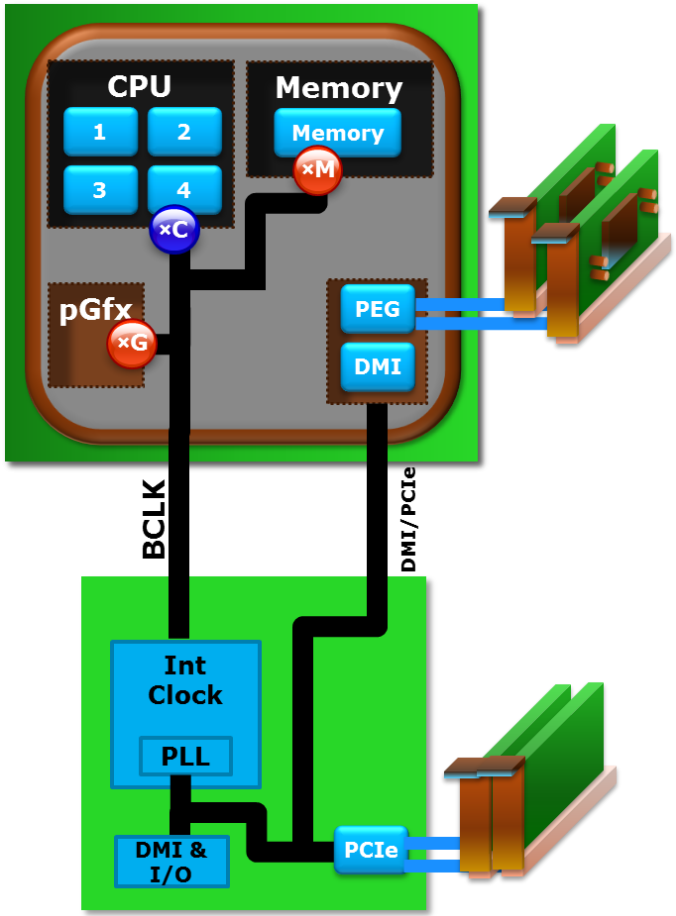
Overclocking Feature Comparison

	Intel® Core™ i7-3770K processor	Intel® Core™ i7-4790K processor	Intel® Core™ i7-6700K processor
Δ Available Core Ratio Overrides	Up to 63	Up to 80	Up to 83
Real-time Core Ratio, PL, IccMax Control	√	√	√
Δ BCLK Overclocking	Limited	Coarse Ratio 100, 125, 167MHz	100 to >200MHz in 1MHz increments
Δ MSR Voltage Control	SVID Extra Voltage (Cores, GT)	FIVR: SVID Extra Voltage, Voltage Override, Interpolative	SVID Extra Voltage, Voltage Override, Interpolative
Δ Processor Graphics Overclocking	All chipsets	All chipsets	Z170 only
Δ Available DDR Ratio/Frequency Overrides and MRC	Up to 2667	Up to 2667	Up to 4133
Δ DDR Granularity Steps	200/266 MHz	200/266 MHz	100/133 MHz
Δ XMP Memory Reference Code	1.3	1.3	2.0

Δ = New or significant change for this generation.

Features are subject to change. Features shown are available in select SKUs. Overclocking results not guaranteed.

Overclocking Architecture Overview



×C **Core Frequency**
- Unlocked core ratios up to 83 in 100MHz increments†
- Complete Turbo overrides for Voltage, Power Limits, IccMax

×G **Graphics Frequency (pGfx)**
- Unlocked graphics ratios up to 60 in 50MHz increments†
- Turbo Voltage controls

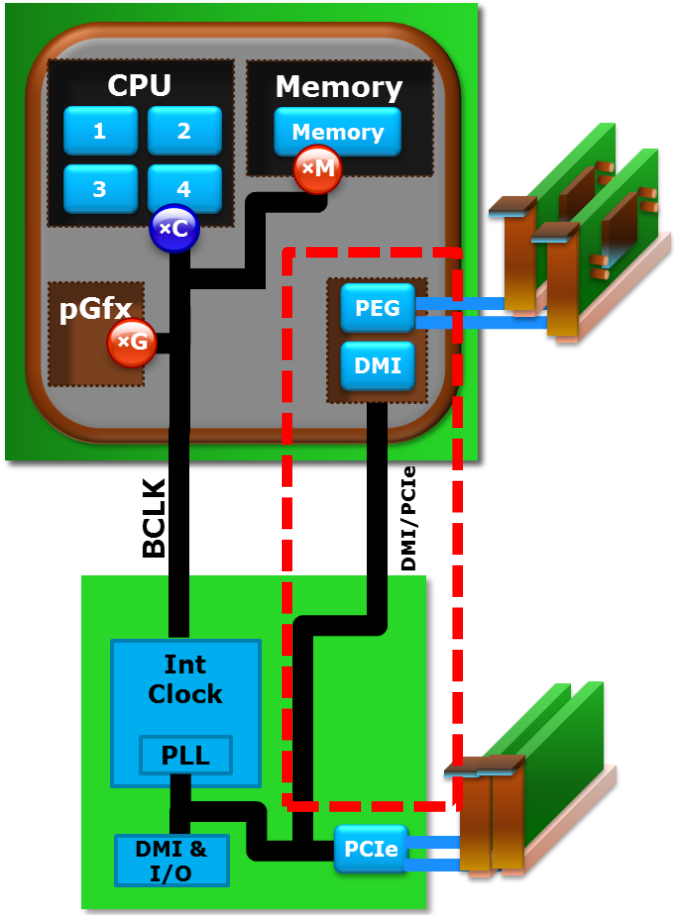
×M **Memory Ratio**
- Options for 100 and 133 MHz steps†
- Logical ratios up to at least 4133 MHz†

BCLK
- PCH clock controller
- 1MHz increments
- Up to 200 MHz or higher†
- Note: Discrete clocking solutions exist which enable finer than 1MHz increments and ranges far >250MHz †

PCIe = PCI Express® pGfx = Intel® Processor Graphics

† Subject to change at any time. Overclocking results not guaranteed.

Clocking Options (BCLK)

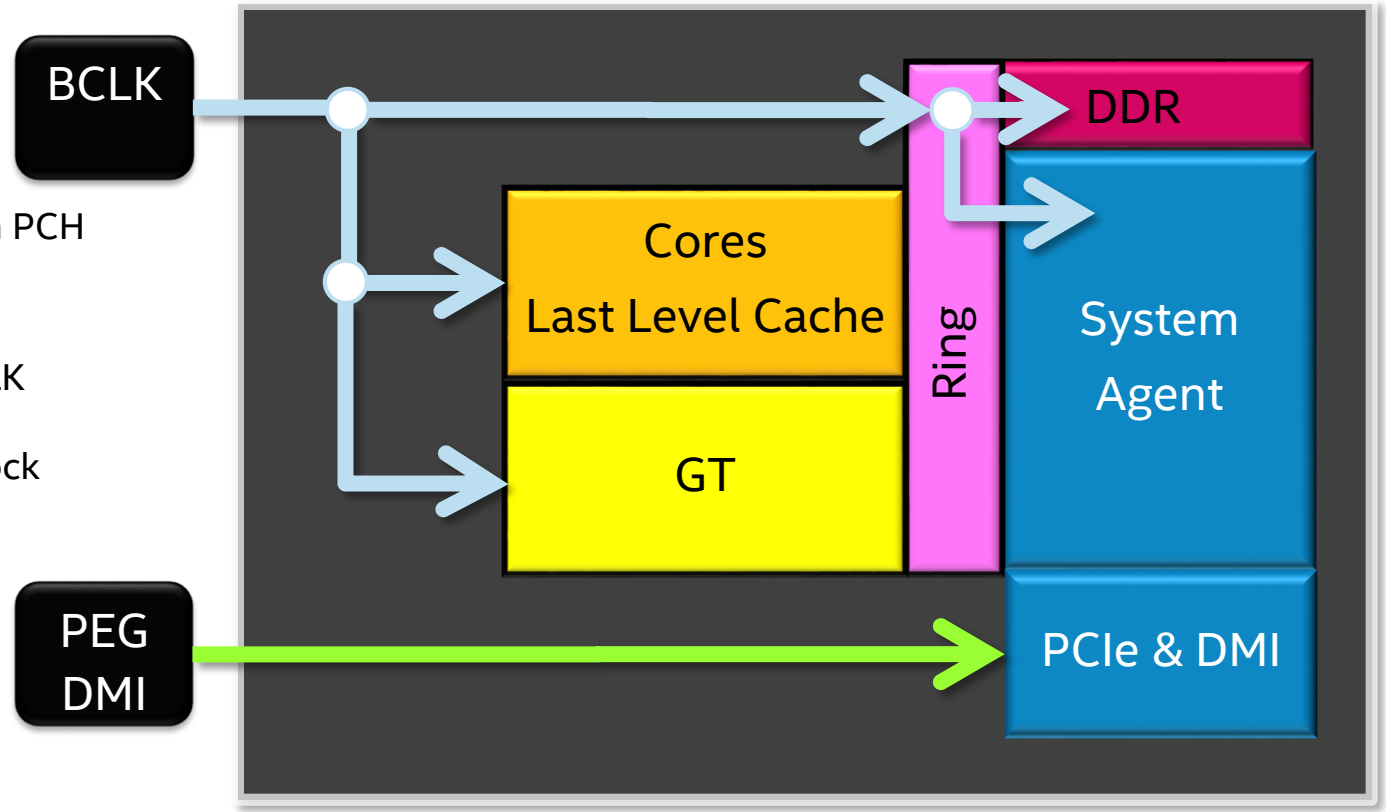


- No more PEG/DMI ratios required! (125/16)
- BCLK has full fine grain overclocking capability
- Option for Discrete BCLK or Integrated (PCH)
- PEG/DMI domain has isolated 100 MHz clock

Motherboard ODMs may offer discrete BCLK control for extreme overclocking results!

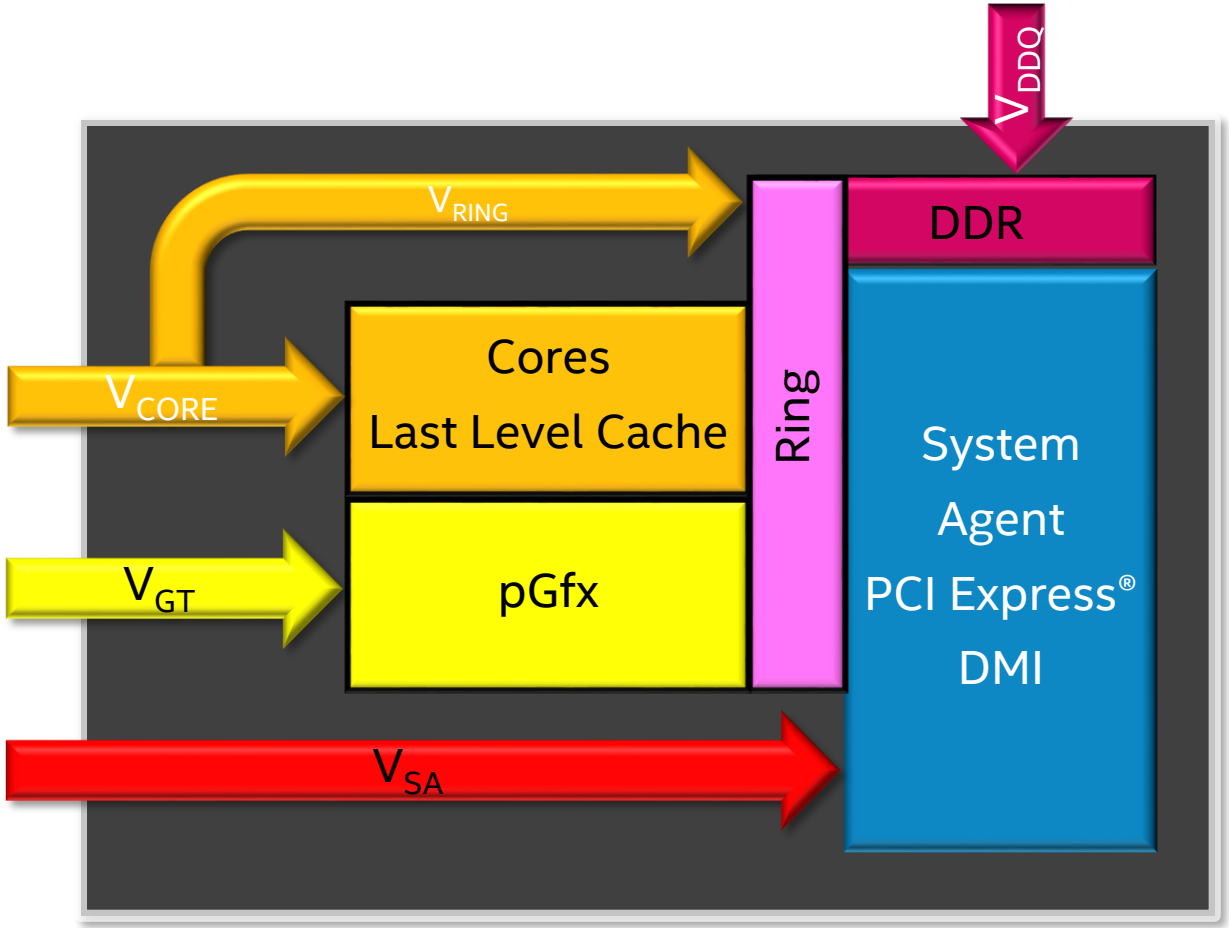
Clock Tree: BCLK Tuning

- BCLK input comes from PCH in 1 MHz steps
- PCI Express® (PCIe) BCLK (100MHz SSC) has a dedicated reference clock



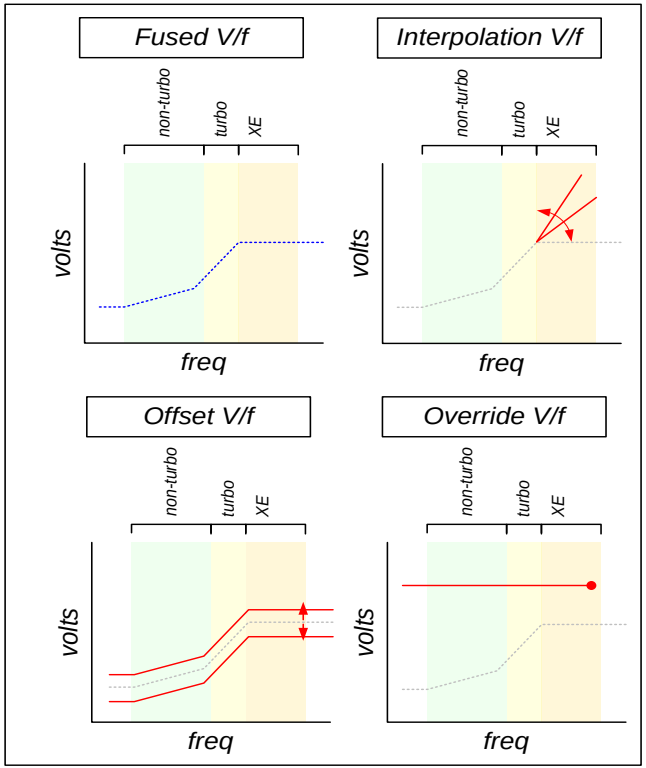
Voltage Planes

- V_{CORE} & V_{RING}: dynamic VR up to 1.52V (SVID) plus "Vboost" offset
- V_{GT}: dynamic VR up to 1.52V (SVID) plus offset
- V_{DDQ}: 1.2V Nom for DDR4



Processor Core Voltage Control Modes

- Default Voltage/Freq curve
- Offset (+/-) is applied to the entire curve and can be combined with Override or Interpolation



- Interpolation (adaptive) in the overclocking region: Target Based
- Override applied to the entire curve. Used for extreme OC Tradeoff: higher power and lower reliability.

Intel® Microarchitecture Codename Skylake was Designed for Overclocking!

1. **Core Overclocking performance improvements**
   - ✓ Overclock-ability of CPU cores is great!
   - ✓ Instructions per clock (IPC) improvements
2. **Significant BCLK base-clock Overclocking enhancements**
   - ✓ BCKL granularity now 1MHz increments (was coarse ratios 125/167 on prior gen)
   - ✓ Up to 2X BCLK frequency gain, over i7-4790K, with reports at >400MHz in LN2†
3. **Amazing DDR4 Overclocking**
   - ✓ Ratios up to 4133MHz† and improved granularity (100/133)
   - ✓ Intel Memory Reference Code support for overclocking

† Overclocking capabilities are subject to change at any time. Overclocking results not guaranteed.

Extreme Overclocking Achievements

Achieved on launch day†

SKYLAKE LAUNCH: 7 WORLD RECORDS, 10 GLOBAL FIRST PLACES

	BENCHMARK		SCORE	OVERCLOCKER	MOTHERBOARD	MEMORY
WR	PiFast		9,47	dRweEz	ASUS Maximus VIII Extreme	G.SKILL Ripjaws 4
WR	3DMark05		78917	Dancop	ASUS Maximus VIII Extreme	G.SKILL Ripjaws 4
WR	3DMark06		61613	der8auer	ASUS Maximus VIII Extreme	G.SKILL Ripjaws 4
WR	3DMark2001 SE		199091	elmor	ASUS Maximus VIII Gene	G.SKILL Ripjaws 4
WR	Aquam			Dancop	ASUS Maximus VIII Ex	KILL Ripjaws 4
WR	3DMark03		30765	der8auer	ASUS Maximus VIII eme	G.SKILL Ripjaws 4
WR	Unigine Heaven - me Preset		916	Dancop	ASUS Maximus VIII reme	G.SKILL Ripjaws 4
GFP	3DMark03	1xGP	29 3	Dancop	ASUS Maximus VIII reme	G.SKILL Ripjaws 4
GFP	Cinebench - R	4xC	15,83	der8auer	ASUS Maximus VIII eme	G.SKILL Ripjaws 4
GFP	Cinebench -	4xCP	4410	dRweEz	ASUS Maximus VIII E	KILL Ripjaws 4
GFP	Geekbench3 - Multi Core	4xCPU	27271	dRweEz	ASUS Maximus VIII Extreme	G.SKILL Ripjaws 4
GFP	GPUPI for CPU - 1B	4xCPU	241,055	Dancop	ASUS Maximus VIII Extreme	G.SKILL Ripjaws 4
GFP	HWBOT Prime	4xCPU	7675,29	Dancop	ASUS Maximus VIII Extreme	G.SKILL Ripjaws 4
GFP	wPrime - 1024m	4xCPU	98,967	der8auer	ASUS Maximus VIII Extreme	G.SKILL Ripjaws 4
GFP	wPrime - 32m	4xCPU	3,152	der8auer	ASUS Maximus VIII Extreme	G.SKILL Ripjaws 4
GFP	XTU	4xCPU	1731	FUGGER	ASUS Maximus VIII Gene	HyperX Predator
GFP	Unigine Heaven - Xtreme Preset	1xGPU	7619,562	Dancop	ASUS Maximus VIII Extreme	G.SKILL Ripjaws 4

(Table as of August 5, 2015. Source: hwbot.org database)

7 & 10

†Source: HWBOT article dated 2015-08-07
http://hwbot.org/newsflash/2983_skylake_the_day_after_7_world_records_and_10_global_first_places

Frequency Standings using Liquid Nitrogen†

- 4-Core @ 6.8 GHz
- DDR4 @ 4,795MT/s
- BCLK @ 552 MHz

Disclaimer: These overclocking results are not typical. Scores were achieved by extreme overclockers using LN2 and other advanced techniques not commonly available to average consumers. Overclocking results are not guaranteed nor covered by warranty. Extreme risk taking!

Rankings change regularly. Visit HWBOT's website for the latest http://hwbot.org

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Live Overclocking Demo!

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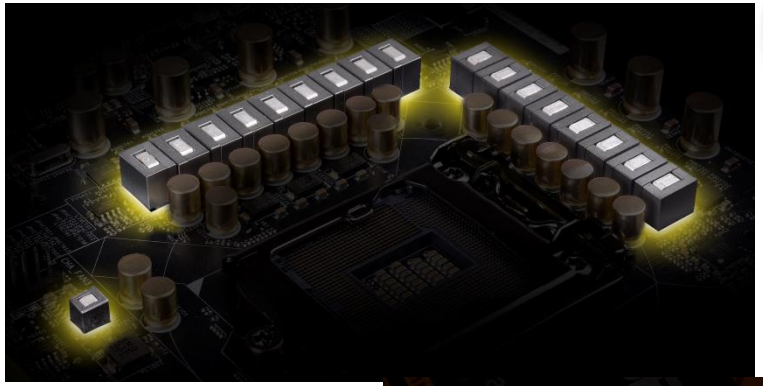
ASRock* Intel® Z170 Chipset OC Formula

CPU	Supports 6th Generation Intel® Core™ Processors
Memory	DDR4 – 4 slots
Expansion Slot	4 x PCI Express® (PCIe) 3.0 x16, 1 x PCIe 3.0 x1, 1 x PCIe 2.0 x1, 1 x Vertical Half-size mini-PCIe
Audio	7.1 CH (Realtek* ALC 1150), Purity Sound* 3
LAN	Intel GbE LAN
Storage	3 x Ultra M.2, 10 x SATA3, 3 x SATA* Express
USB 3.1	1 x Type-A 1 x Type-C

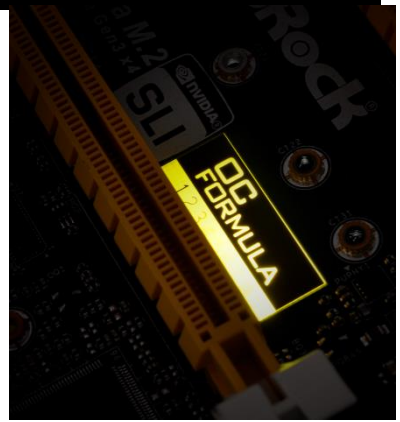
Slide provided by ASRock.

Power Phase and PCB Design



18 Power Phase Design

This flagship motherboard boasts a whopping 18 Power Phase Design. Offering unmatched overclocking capabilities and enhanced performance with the lowest temperature.



8 Layer, 4 x 2 OZ PCB

The 8 Layer PCB comes with 4 sets of 2 ounce copper inner layers, delivering lower temperature and higher energy efficiency for overclocking.

Slide provided by ASRock.

OC Formula Kit

Manually raise or lower the system's CPU ratio, BCLK frequency or CPU Vcore voltage.

Toggle Slow Mode for forcing your CPU to run at its lowest frequency.

Enable or disable the PCI Express® slots.

Reduce 23% power loss and decrease the connector's temperature up to 22℃.

Activate LN2 Mode to disable the CPU's thermal protection.

Learn a few tricks from the champion.

Slide provided by ASRock.

Intel® Extreme Memory Profile Switch

Intel XMP Switch

A convenient onboard switch for loading Extreme Memory Profile (Intel® XMP) profiles without having to enter the BIOS.

DDR4-
2400, 2666, 2800, 2933, 3000, 3200, 3300, 3333 or Higher!

Slide provided by ASRock.

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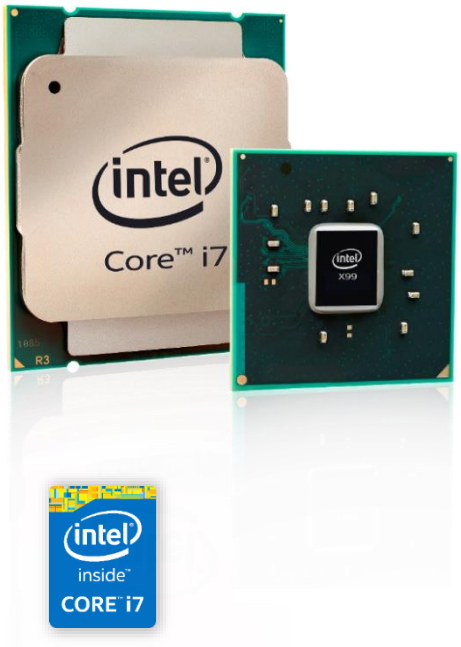
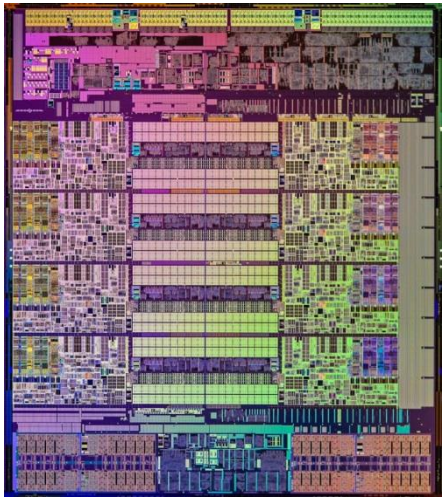
Intel® Core™ i7-5960X Processor Extreme Edition

Overclocking Intel's First 8-Core Desktop Processor

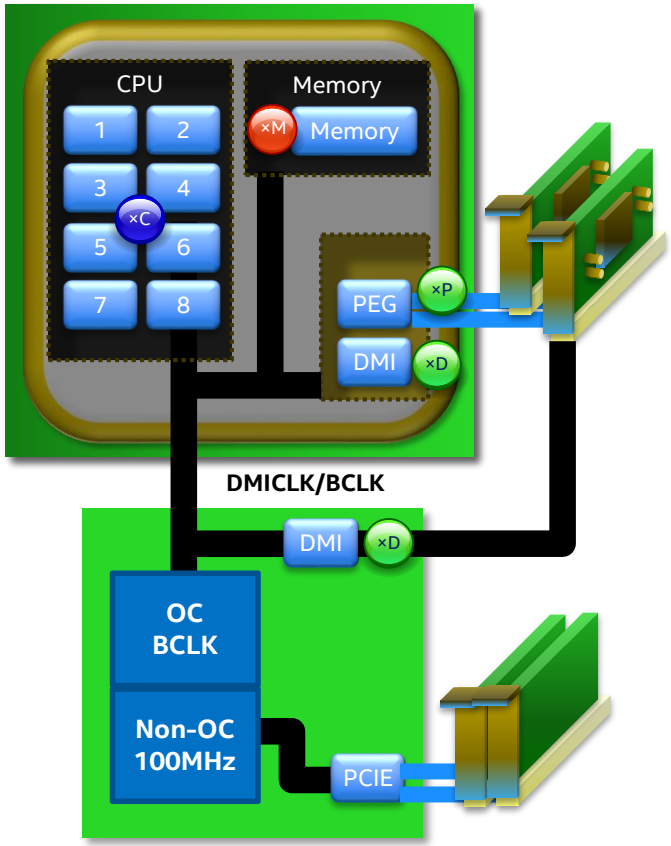


- 8 Cores, 16 Threads
- 4 channel DDR4-2133 memory support
- 3.0 GHz base frequency
- Up to 3.5 GHz Turbo frequency
- Fully unlocked for performance tuning
- 20 MB Intel® Smart Cache
- Intel® Turbo Boost Technology 2.0
- Intel® Hyper-Threading Technology
- Supports LGA 2011-v3 socket
- 40 PCI Express® 3.0 lanes



....highest desktop core count and great overclocking

Intel® Core™ i7 Processors for High-end Desktop:
Based on Socket LGA 2011-3 with Intel® X99 Express Chipset



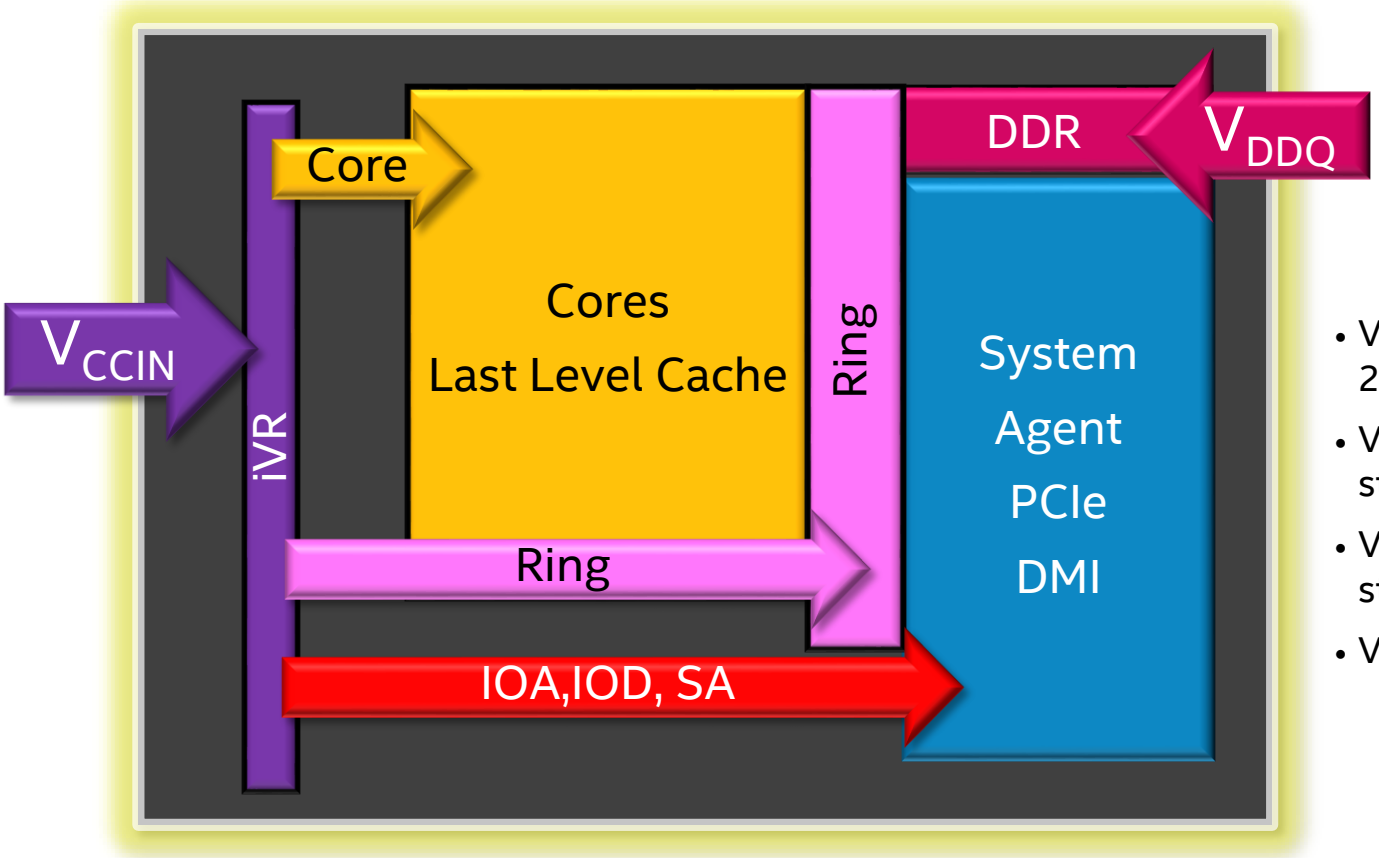
×C Core Frequency
- Unlocked Intel® Turbo Boost Technology Limits
- Unlocked core ratios up to 80 in 100MHz increments
- Programmable voltage offset and override voltage via iVR

×M Memory Ratio
- Unlocked memory controller Unlocked memory controller voltage levels
- Granularity options for 200 and 266MHz

- **DMICLK (aka BCLK)**
  - Unlocked PCH clock controller (<1MHz increments upwards of 200MHz)

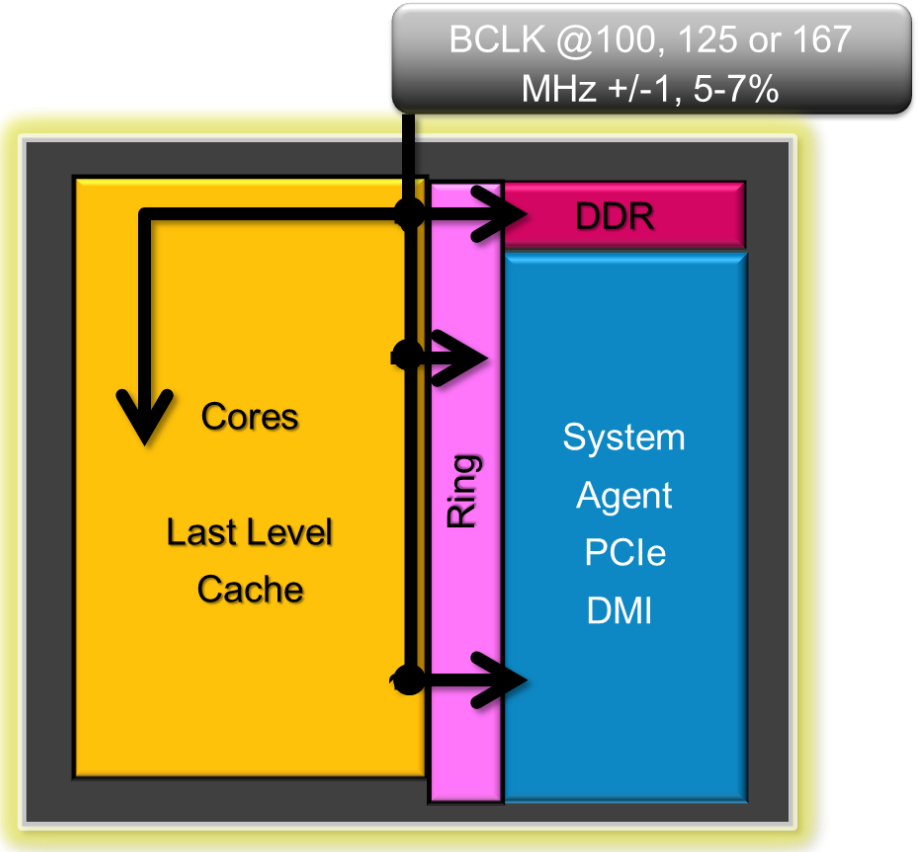
×P ×D PEG and DMI Ratios
- Variable BCKL: PEG/DMI ratios 5:5, 4:5, 3:5, for BCKL@ 100, 125, and 167 MHz

Voltage Planes



- V_{CCIN}: SVID 1.8V Nom up to 2.3V+, static V up to 3.0V
- V_{CORE}: dynamic additional V, static V up to 2.0 V
- V_{RING}: dynamic additional V, static V up to 2.0 V
- V_{DDQ}: 1.2V Nom for DDR4

Clock Tree: BCLK Tuning



- Single BCLK input comes from PCH in <1MHz steps
- Acceptable input to CPU limited by PCI Express® (PCIe) and DMI PLL interface:

  100MHz x ±5-7% PEG/DMI @ 5:5

  125MHz x ±5-7% PEG/DMI @ 5:4

  167MHz x ±5-7% PEG/DMI @ 5:3
- Frequency Relationships

  *f(Core) = BCLK*Core Ratio*

  *F(Ring) = BCLK*Ring Ratio*

  *f(DDR) = BCLK*1.33*DDR Ratio*

  -or-

  *f(DDR) = BCLK*1.00*DDR Ratio*

Desktop Processors for Intel® X99 Chipset Based Systems

SKU	Intel® Core™ i7-5960X	Intel® Core™ i7-5930K	Intel® Core™ i7-5820K
Cores	8	6	6
Clock Speed / Max Turbo Frequency	3.0 GHz / 3.5 GHz	3.5 GHz / 3.7 GHz	3.3 GHz / 3.6 GHz
Cache / PCI Express® Lanes	20 MB / 40 lanes	15 MB / 40 lanes	15 MB / 28 lanes
Turbo Ratio Overrides	Up to 80	Up to 80	Up to 80
PL1, PL2, Tau, ICCMax Overrides	√	√	√
Real-time Core Overclocking (in OS)	Yes	Yes	Yes
DDR Frequency Ratio Overrides†	>2667	> 2667	> 2667
DDR Timing Overrides	√	√	√
Coarse BCLK Ratios	1.0, 1.25, 1.67	1.0, 1.25, 1.67	1.0, 1.25, 1.67

†Memory ratio capabilities above 2667 via ratio not tested; use BCLK for highest frequencies.

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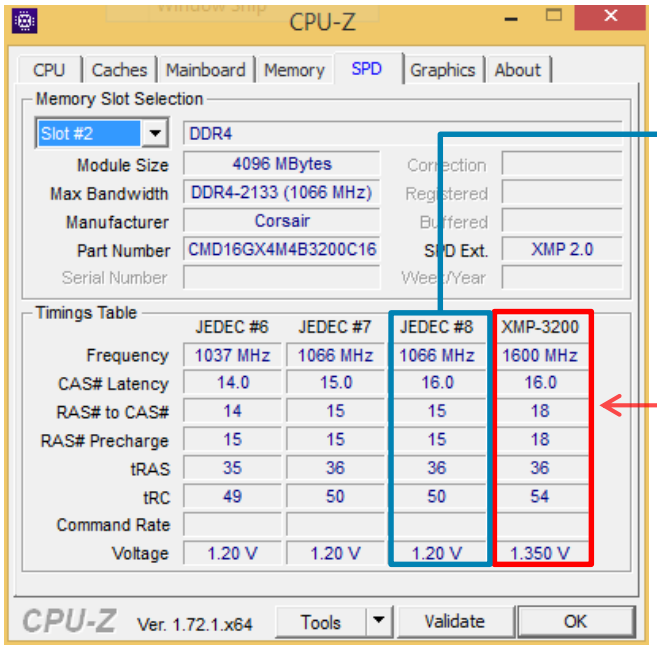
Intel® Extreme Memory Profile (Intel® XMP) for DDR4

- DDR4 is now the focus of Intel's XMP and memory overclocking efforts
- First desktop DDR4 platform launched in Q3'2014 with X99 based platforms
- DDR4 Overclocking modules are available today!
- The lower the voltage, at a given frequency, the better the quality

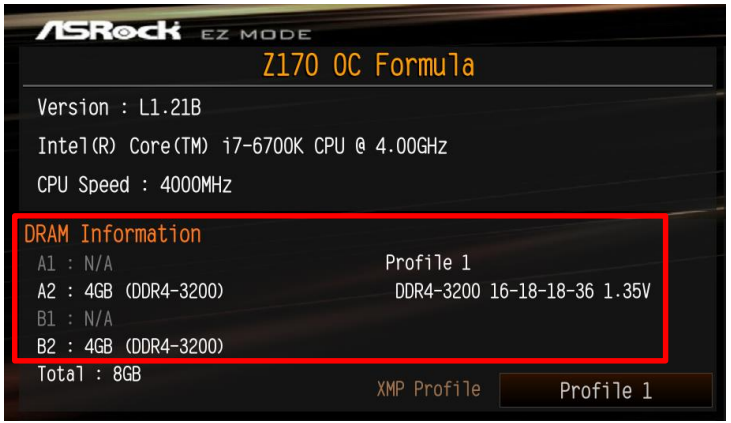
Partial list of Intel® Extreme Memory Profile (Intel® XMP) certified memory vendors.

Intel® Extreme Memory Profile (Intel® XMP)

An Intel XMP enabled BIOS reads the DIMM's SPD chip at power-on: determines if XMP is supported



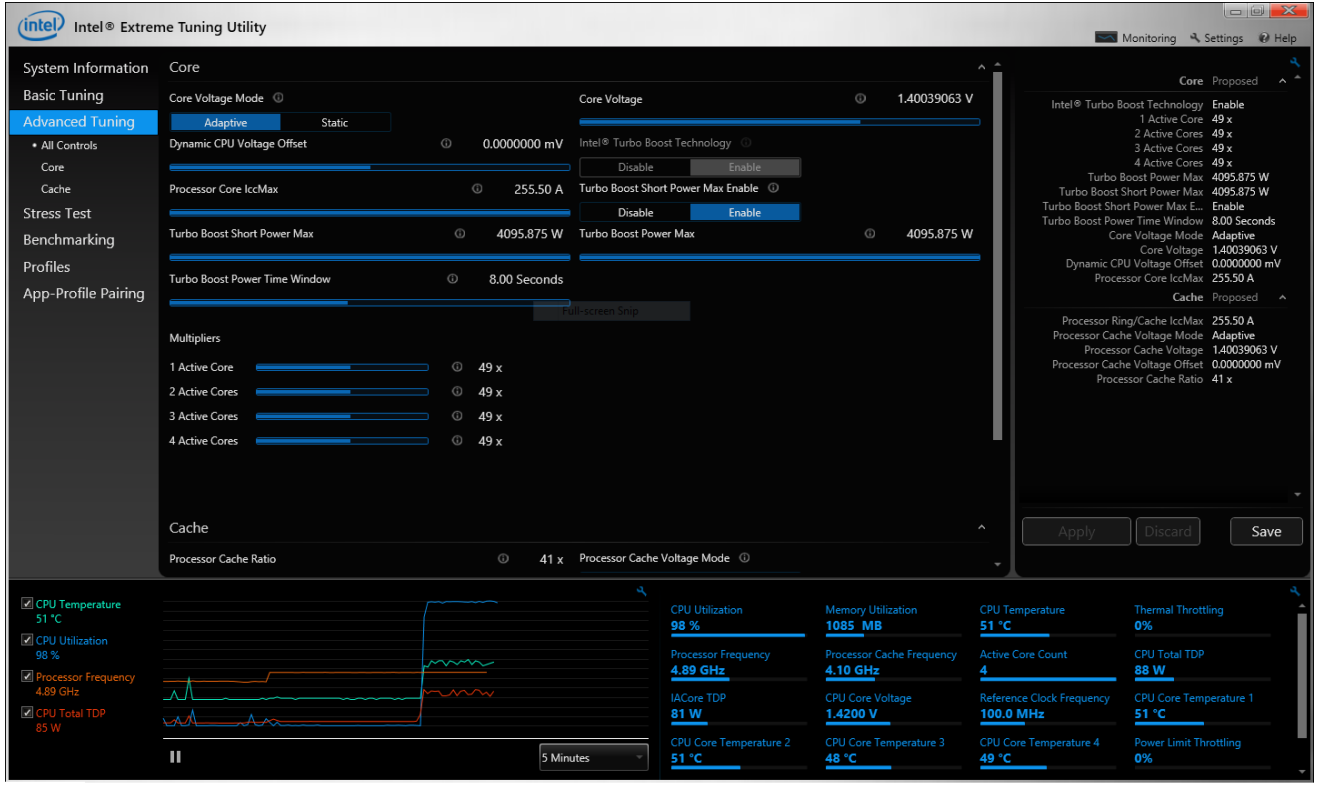
1. System boots with highest supported JEDEC defined parameters
2. XMP profile can be selected by the end user through BIOS setup
3. Reboot to apply



- **Intel XMP Ready:** Module has been programmed with an uncertified profile **GOOD**†
- **Intel XMP Certified:** Module has passed supplier test and submission process for specific CPU and motherboard **BEST**†

†Good and Best refer to the level of testing involved in XMP modules.

Intel® Extreme Tuning Utility (Intel® XTU)



- Overclocking Software
- Real-time tuning
- Monitoring of system performance

- Profile Management
- App-Profile Pairing
- Benchmarking
- Stress Testing
- HWBOT benchmark result submittals

Version 6.0 now available for download: http://www.intel.com/go/xtu

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20 Years of Enabling Enthusiasts

CORSAIR

- PC memory
- Power supplies (PSUs)
- Cases
- Liquid CPU coolers
- Cooling fans
- Keyboards, mice, headsets

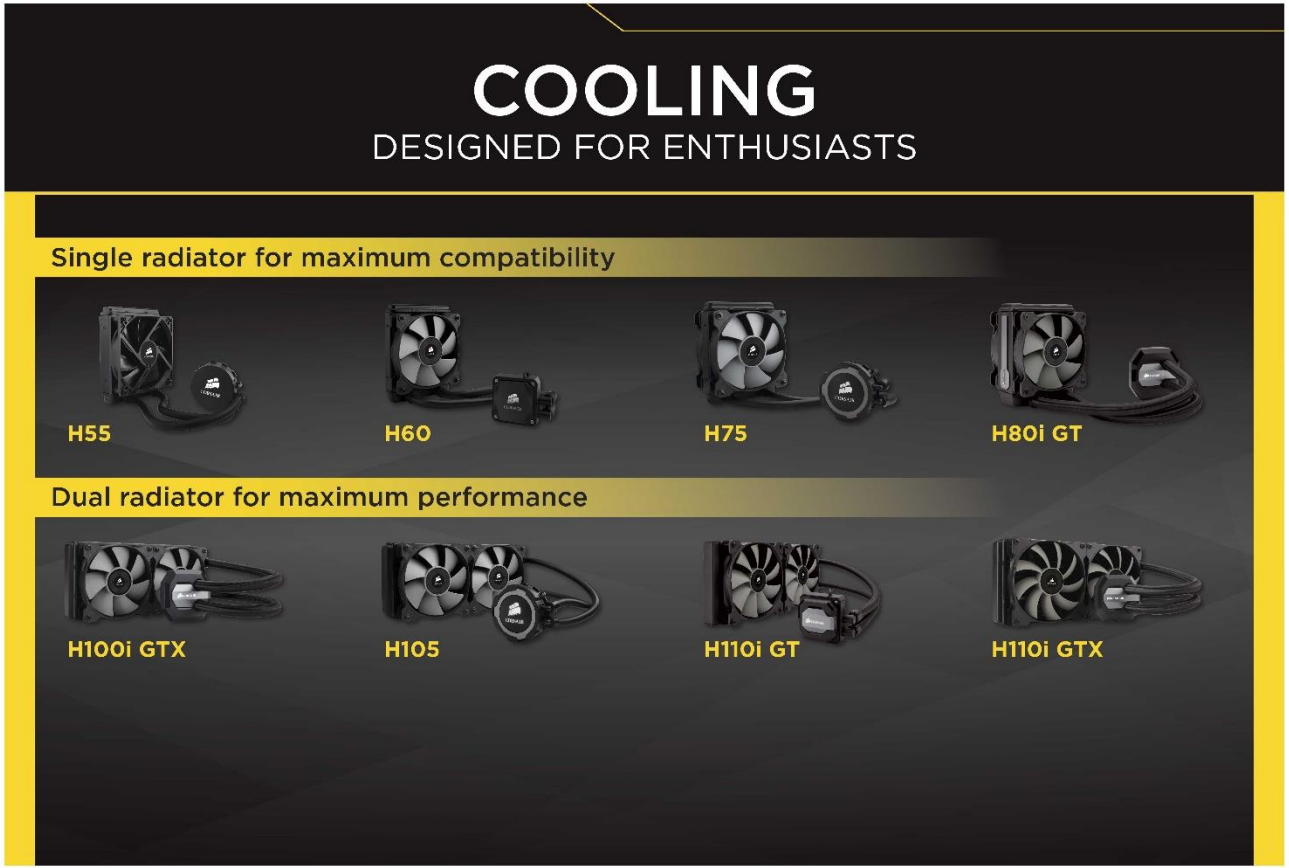
Slide provided by Corsair.

Overclocking Power Supplies

Virtually all of our power supplies support the low-power modes provided by the new generation of processors. These low power modes have been in place since the release of 4th generation Intel Core, so if your power supply works with your 4th or 5th generation based system, it will work with the new motherboards, too.

Slide provided by Corsair.

Cooling Solutions for Overclocking



- The mounting mechanism for 6th generation processors hasn't changed from previous version.
- All of our Intel-compatible Hydro Series liquid CPU coolers will work with your new motherboard, with no adapter necessary.

Slide provided by Corsair.

AIO Water Cooling 101

Radiator – the external heat exchanger. In general, the larger the radiator (both in area and thickness) , the easier it is to dissipate heat

Integrated pump. Cooled fluid from the radiator is pumped in and after the liquid takes on heat from the CPU, it gets pumped out to the radiator to expel the heat

Cold plate – this is the direct heat exchange contact point with the processor much like a traditional heatsink. Material, finish (smoothness), and QC (flatness) contribute to efficiency

Slide provided by Corsair.

CORSAIR

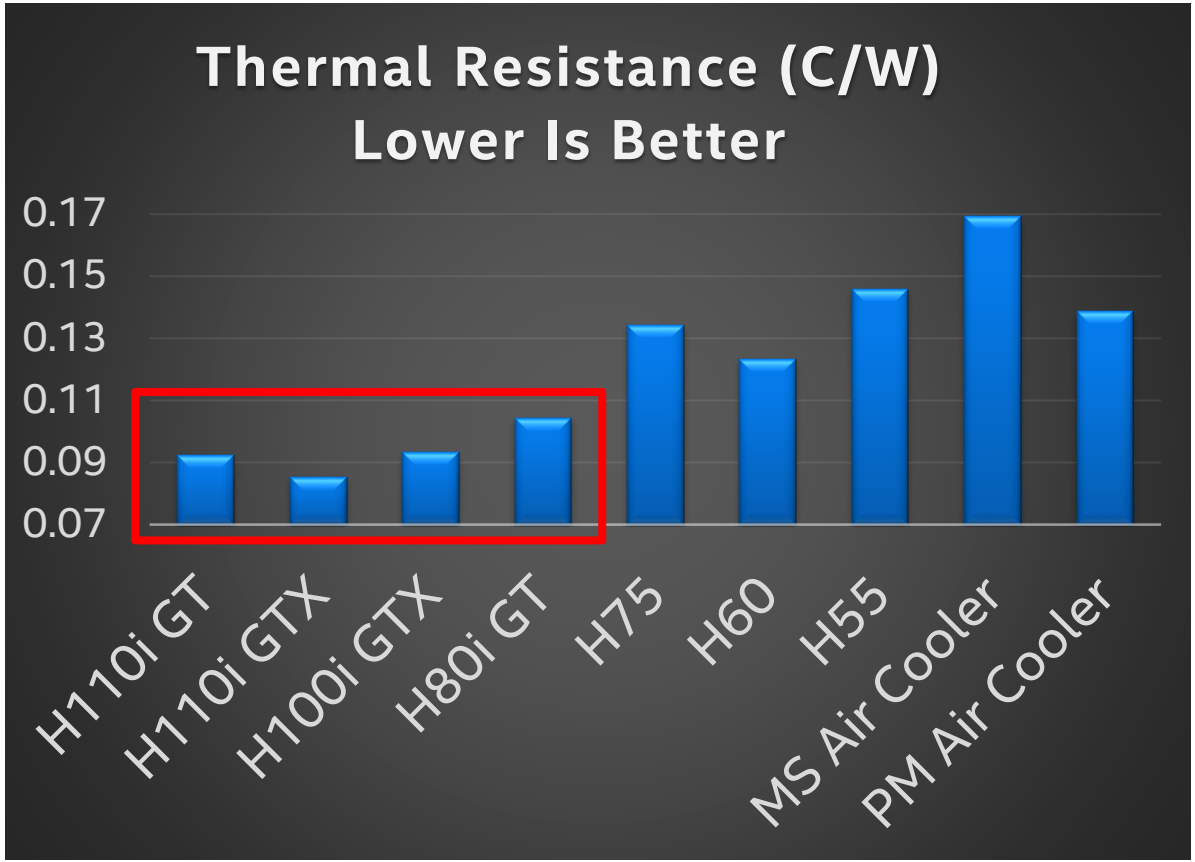
Why Liquid Cool?

VS

- Corsair* Hydro* liquid CPU coolers are quieter because fans don't have to run as fast
- Hydro coolers are completely self-contained, with no filling or maintenance needed
- Hydro liquid coolers are more effective than stock CPU heat sink fans
- Water cooling efficiency over air cooling is simple physics. Do not argue with physics.

Slide provided by Corsair.

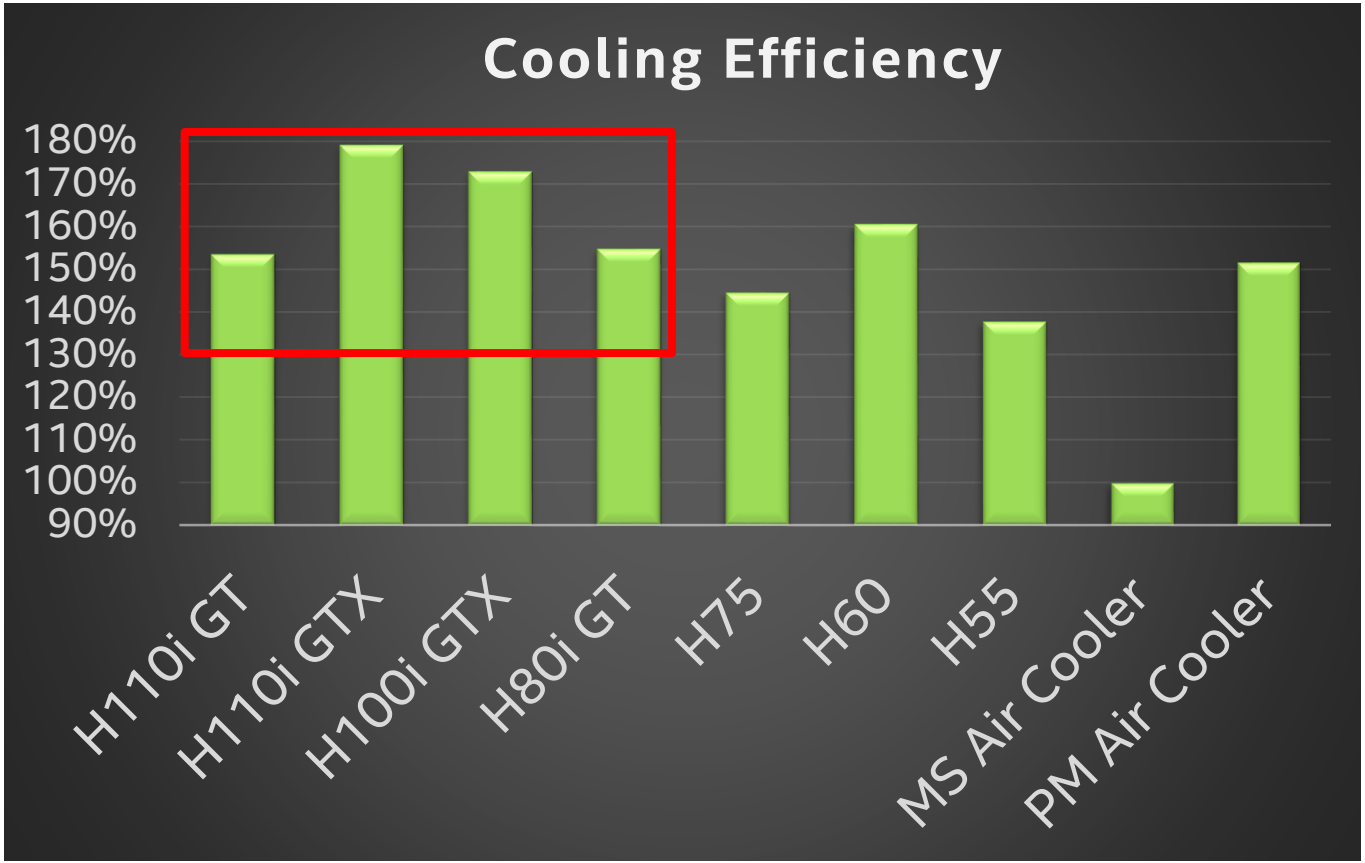
Liquid Cooling vs. Air Cooling



- Lower thermal resistance allows better heat dissipation

Slide and data provided by Corsair.

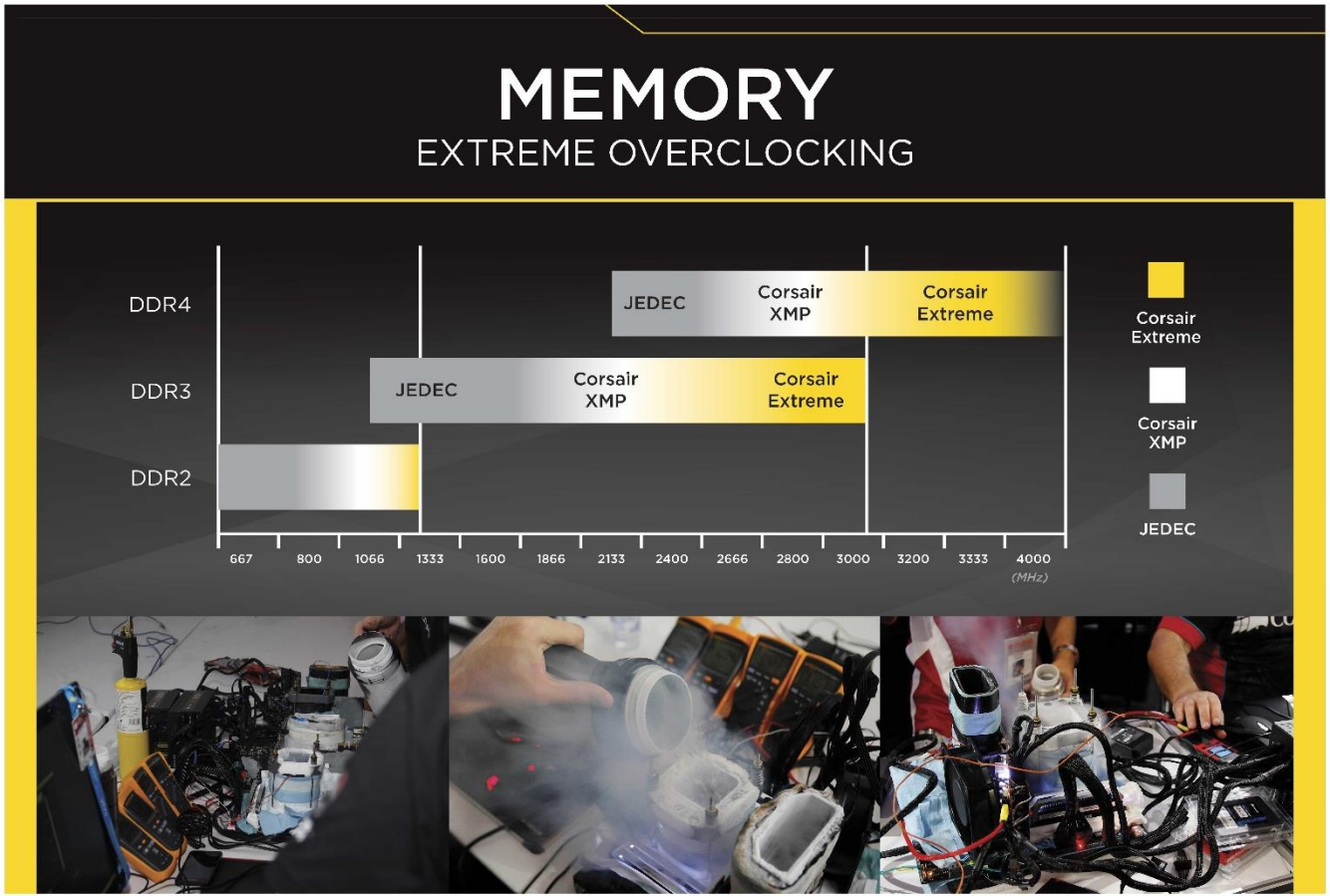
Superior Efficiency of Liquid Cooling



- Corsair Hydro series liquid cooling offers more efficient and quieter performance than air cooling

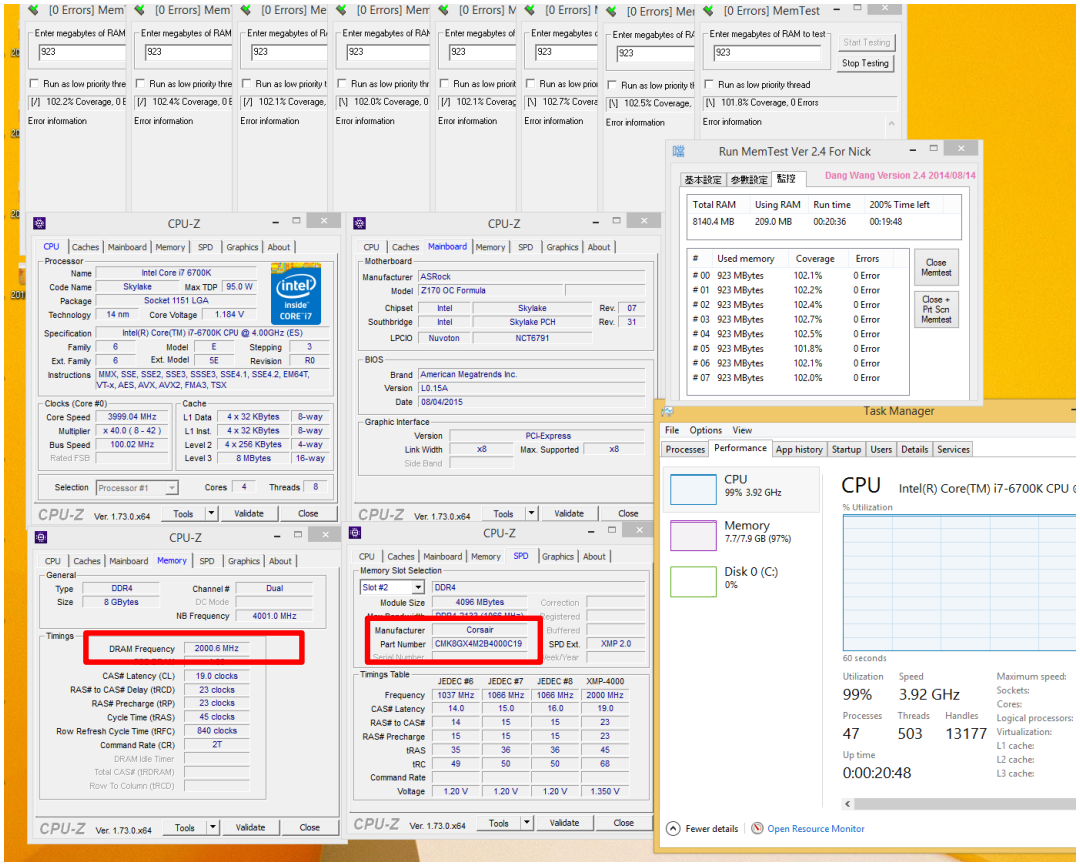
Slide and data provided by Corsair.

More Headroom, Faster Performance



Slide provided by Corsair.

Amazing DDR4 Performance!



DDR4 – 4,000 MT/s Dual Channel (two sticks) with Corsair DDR4 Vengeance LPX memory and ASRock* OC Formula

Slide and data provided by Corsair.

CORSAIR

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Summary and Next Steps

- **The best keeps getting better, with 6th Generation Intel® Core™ processors!**
  - BCLK is back and better than ever!
  - Amazing DDR4 Overclocking!
  - The CPU core performance we've all come to expect!
- **Overclocking system innovation opportunities are abundant**
  - Design differentiation opportunities
  - Form factor and price point scalability

- **The Overclocking Ecosystem is growing and ready for the 6th Generation Intel Core i7-6700K processor**
  - Intel's Overclocking Software and Technologies provide the baseline
  - Ecosystem partners provide options from memory to cooling to chassis…

Additional Sources of Information

- A PDF of this presentation is available from our Technical Session Catalog: www.intel.com/idfsessionsSF. This URL is also printed on the top of Session Agenda Pages in the Pocket Guide.
- **IDF Demos**
  - See the Overclocking Demos on the 2nd floor
    - LN2 Overclocking at noon on Wed and Thurs
- **Intel Resources:**
  - intel.com/go/xtu
  - intel.com/content/www/us/en/gaming/extreme-memory-profile-xmp.html
- **Overclocking forums[1]:**
  - hwbot.org
  - xtremesystems.org

[1] These are examples and do not constitute endorsements from Intel.

Other Technical Sessions

Session ID	Title	Day	Time	Room
MEGA002	Mega Session: The “Game” Changer	Tue	4:00 PM	Level 3 Keynote
SPCS007	Memory Plans for Intel® Architecture Based Client and Enterprise Platforms	Wed	11:00 AM	2006

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