Overclocking Intel® Core Processors: Taking Overclocking to the Next Level

Dan Ragland – Overclocking Architect, Intel Corp.

Jayashree Bhargava – Application Engineer, Intel Corp.
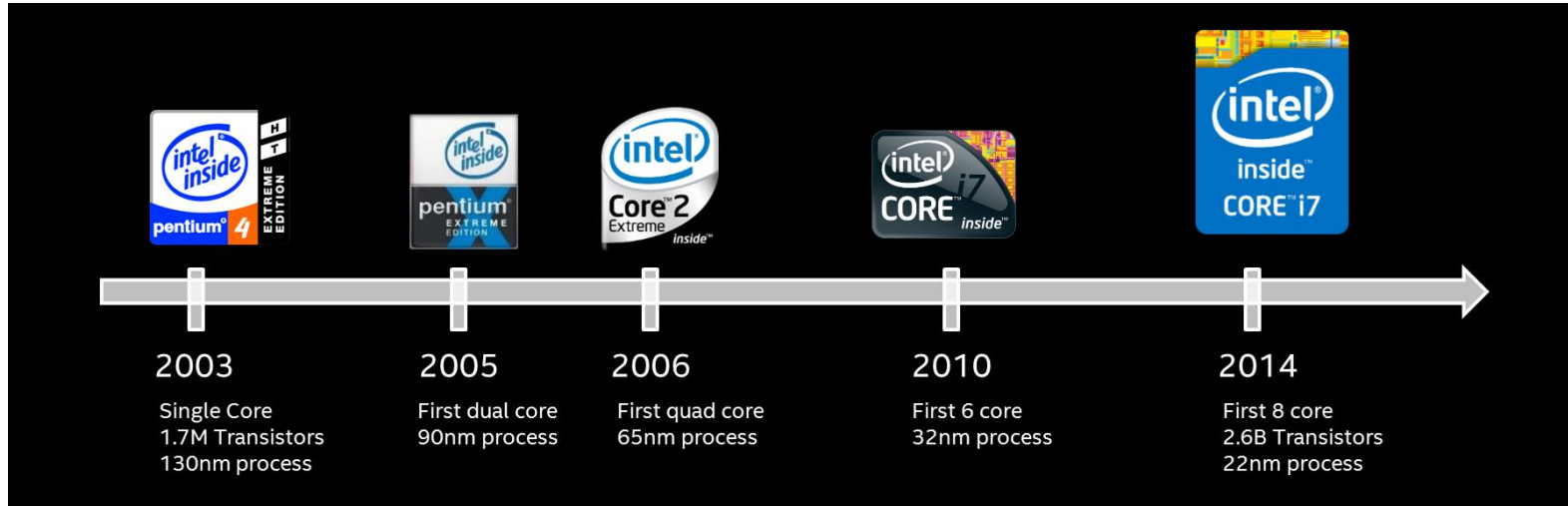
"HiCookie" – Overclocking Guru, GIGABYTE

RPCS006

(intel®)

⚠️ 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

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Over a Decade of Extreme Edition Innovation!

2003
Single Core
1.7M Transistors
130nm process

2005
First dual core
90nm process

2006
First quad core
65nm process

2010
First 6 core
32nm process

2014
First 8 core
2.6B Transistors
22nm process

Our commitment to innovation in overclocking continues!

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Taking Overclocking to the Next Level
in 2014 and beyond

- Intel® Core™ i7-4790K Processor: Enhanced for overclocking

- First unlocked **Intel® Pentium™** SKU for overclockers

- NEW Intel® Core™ i7 Processor Family on LGA 2011-v3 socket with X99 Chipset
  - First **8-Core** overclock-able Intel® processor based desktop
  - First **DDR4** based Intel desktop platform
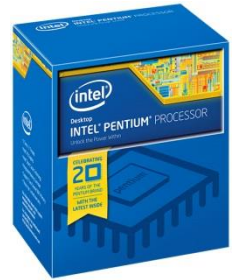
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Agenda

- **Overclocking Theory**

- **High-end Desktop Overclocking Architecture**

- **Desktop Overclocking Architecture**

- **Overclocking Ecosystem**

- **Summary**

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Defining Overclocking

- **What is Overclocking (OC)?**
  - The process of increasing clock rates beyond specification
- **Why Overclock?**
  - Increase performance for compute intensive tasks, e.g., transcode, gaming, rendering
  - Compete, Promote, Socialize
- **How is this done?**
  - Obtain a motherboard optimized for unlocked Intel® processors
  - Change unlocked ratios or platform clock frequency
  - Increase voltage on relevant interfaces
  - Improve cooling on overclocked/overvoltaged components

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Overclocking General Approach

- Apply aggressive cooling to CPU and VRs

- Increase the allowable power and current on the CPU
  - Turbo Power Limits: PL1, PL2
  - IccMax current from the VR

- Select voltages to support frequency on each interface impacted

- Increase frequency
  - Core: Increase your per active core turbo ratios
  - Processor Graphics: Increase your graphics ratios
  - Memory: Increase your memory ratio and associated timings

- Repeat above with different frequency and voltage combinations

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Methods differ for each usage scenario

*Remember: Maximize frequency, minimize voltage and improve cooling to meet specific stability requirements*

What	Why	How
Processor Cores	Rendering, Music, Photo and Video editing, Transcode, Gaming Physics, AI, Compute Intensive	✓ Increase power limits and max current ✓ Raise core voltage ✓ Increase active core ratios
Processor Graphics[†]	Gaming frame rates, Media Transcode	✓ Increase power limits and max current ✓ Raise processor graphics[†] voltage ✓ Raise processor graphics max ratio
Memory	Processor Graphics performance, Sound engineering, Photo and Video editing	✓ Increase memory ratio ✓ Raise memory IO voltage ✓ Change timings ✓ Increase system agent voltage
Platform Base Clock	Affects all of the above	✓ Increase all domain voltages ✓ Reduce weakest domain frequency via ratios

Increasing Complexity

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† Processor graphics used Intel® Iris™ Pro, Intel® Iris , or Intel® HD Graphics

Overclocking Theory:
VR Airflow provides > power out put

AIRFLOW

HEAT

Reduce Thermal Impedance
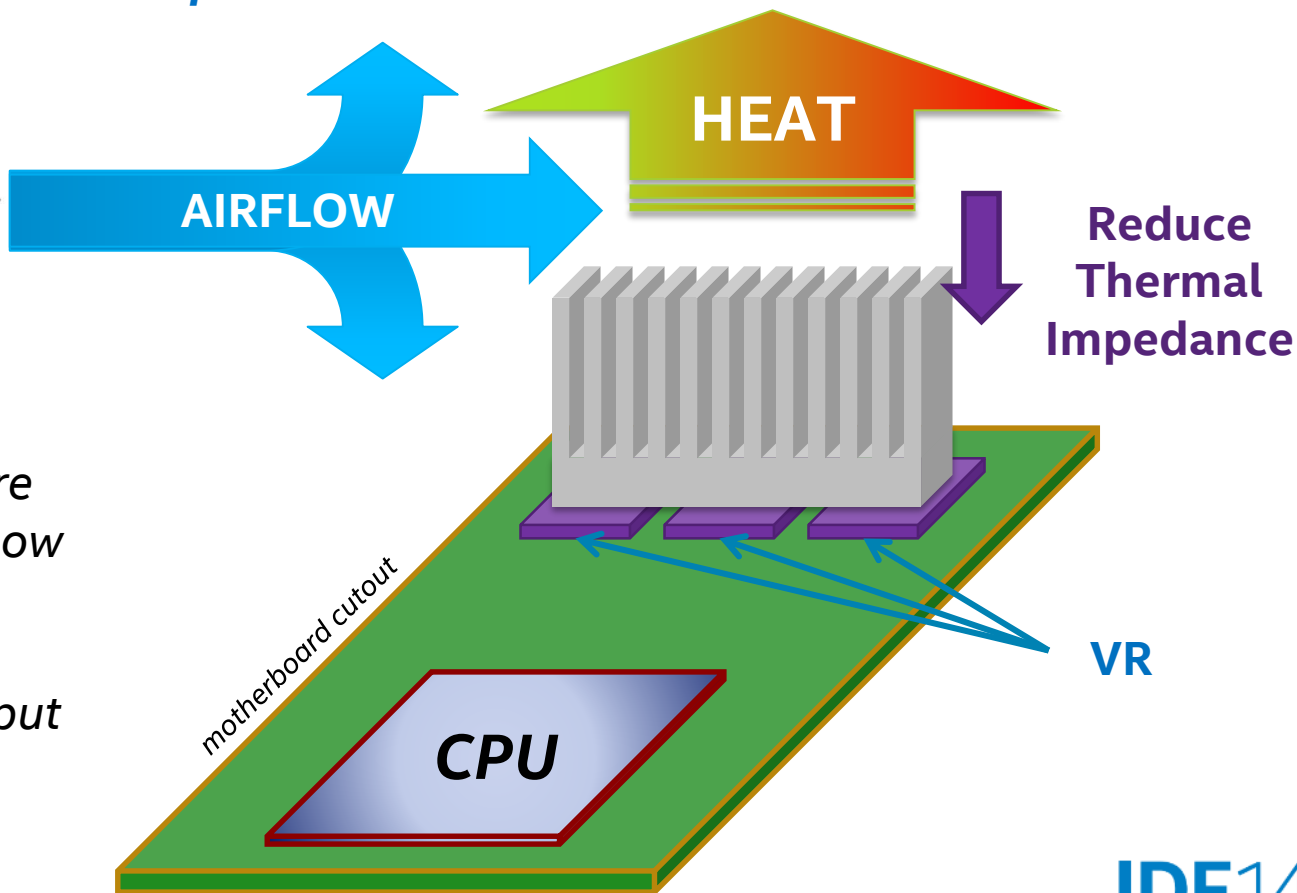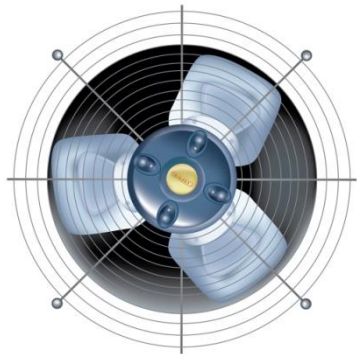
Higher airflow and more efficient heatsink will allow more heat to be dissipated...Enabling increased VR power output capability!

motherboard cutout

CPU

VR

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Intel® Core™ i7-5960X Processor Extreme Edition
## *Overclocking Intel's First 8-Core Desktop Processor*

- **New!** 8 Cores, 16 Threads
- **New!** 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
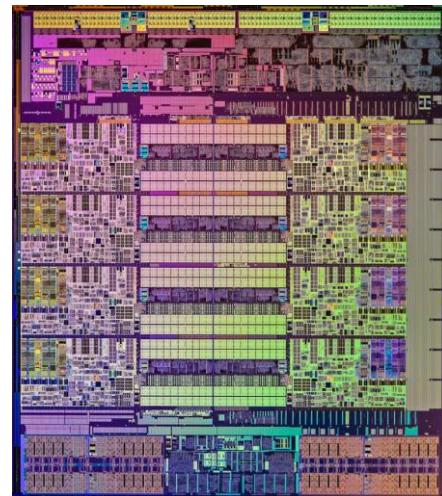
....highest desktop core count and it overclocks amazingly well !!!

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Intel® Core™ i7 Processors for high-end desktop:
Based on Socket LGA 2011-3 with Intel® X99 Express Chipset
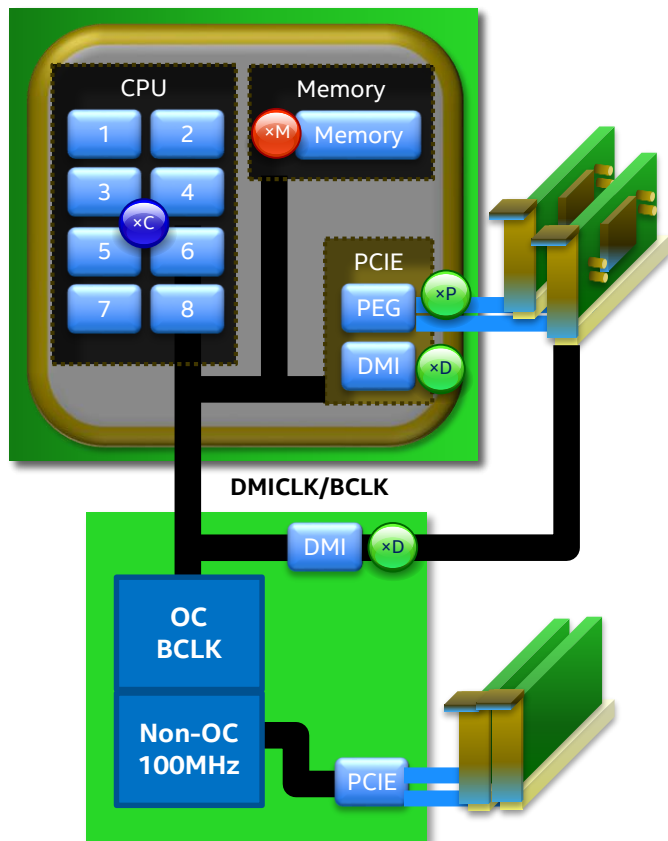
Core Frequency
- Unlocked Intel® Turbo Boost Technology Limits
- Unlocked core ratios up to 80 in 100MHz increments
- Programmable voltage offset and override voltage via iVR

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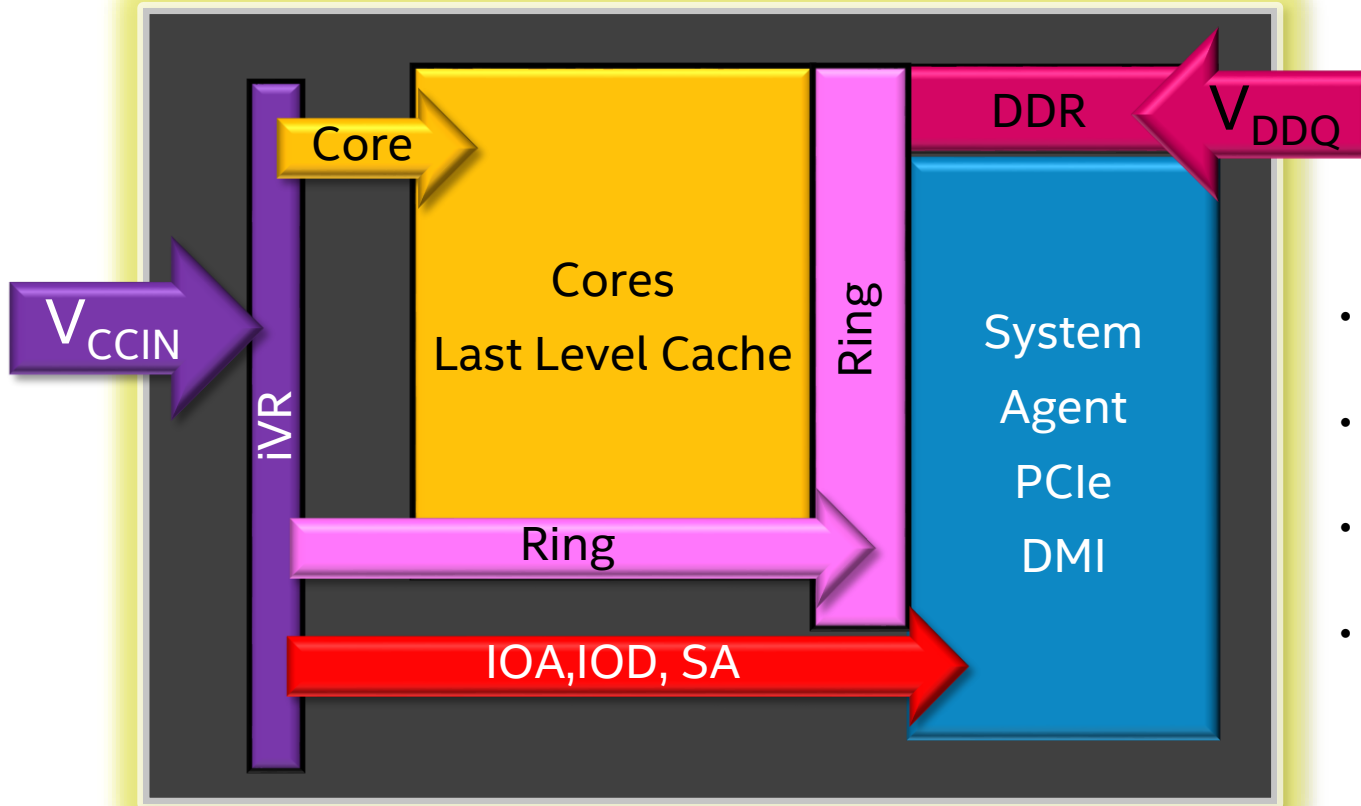- Granularity options for 200 and 266MHz

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

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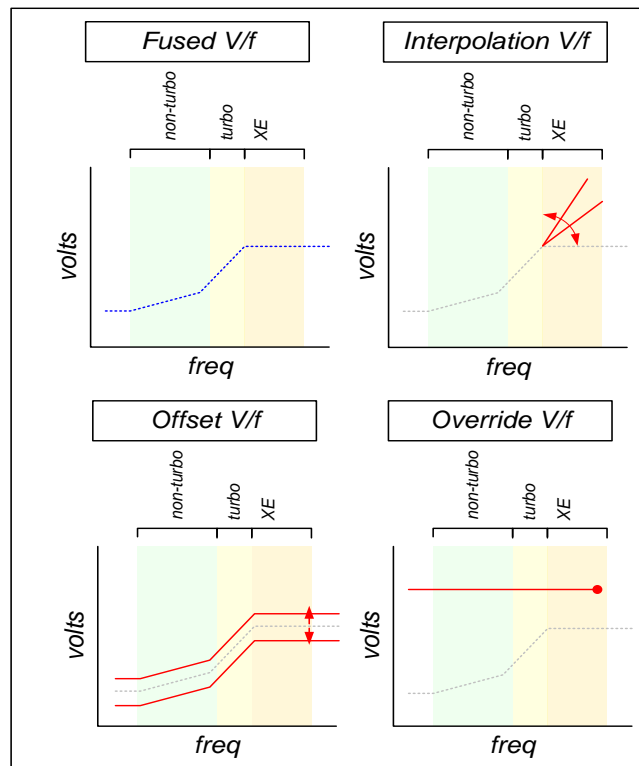- Variable BCKL: PEG/DMI ratios 5:5, 4:5, 3:5, for BCKL@ 100, 125, and 167 MHz

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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

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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.

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Clock Tree: BCLK Tuning
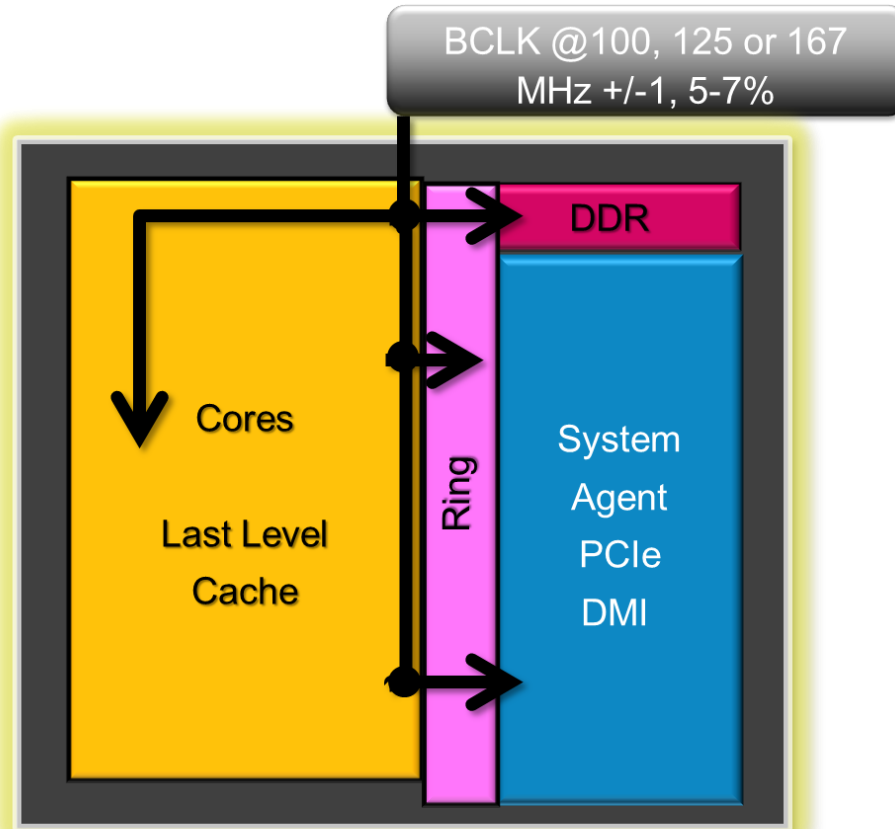
BCLK @100, 125 or 167 MHz +/-1, 5-7%

Cores
Last Level Cache

Ring

DDR

System Agent
PCIe
DMI

- 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*

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Intel® Core™ i7 Processors for Desktop Based on Socket LGA2011 with Intel® X99 Express Chipset

	i7-5960X	i7-5930K	i7-5820K
SKU	i7-5960X	i7-5930K	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[†]	Up to 2667	Up to 2667	Up to 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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Live Demonstration[1] : Overclocking the Intel® Core™ i7-5960X Extreme Edition Processor

[1] Warning: This demonstration is performed by a trained expert. Some of the techniques used may not be suitable for beginners. Risks and required safety measures should be well understood before attempting to replicate.

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4th Generation Intel® Core™ Processors
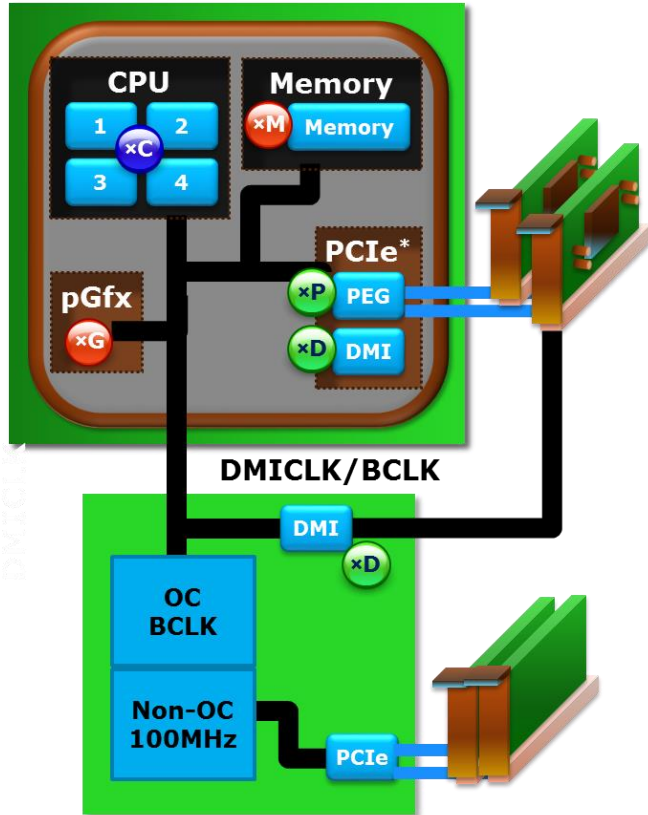
×C Core Frequency
- Unlocked Intel® Turbo Boost Technology limits†
- Unlocked core ratios up to 80 in 100MHz increments†
- Programmable voltage via iVR

×G Processor Graphics Frequency (pGfx)
- Unlocked Intel® HD Graphics limits†
- Unlocked graphics ratios up to 60 in 50MHz increments
- Programmable voltage via iVR

×M Memory Ratio
- Unlocked memory controller
- Options for 200 and 266MHz steps†
- Logical ratios up to 2933MHz†

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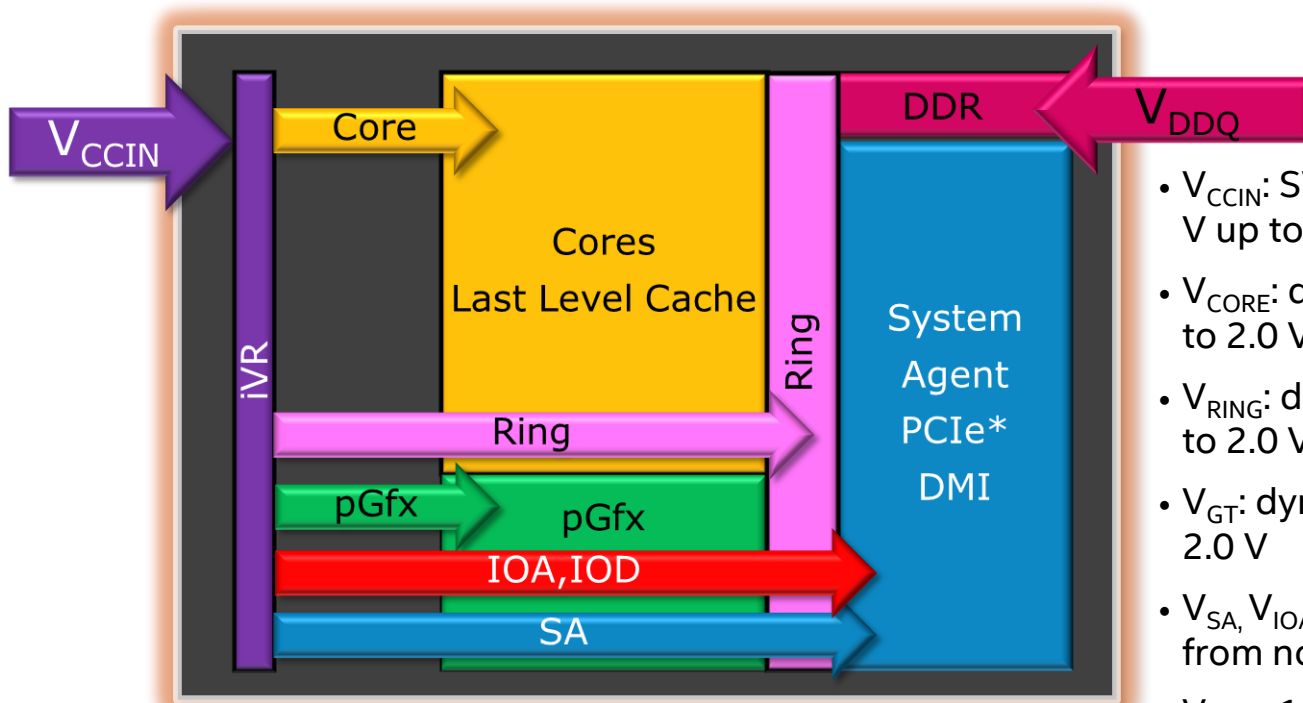 - Unlocked PCH clock controller (1MHz increments upwards of 200MHz)†

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

PCIe = PCI Express*
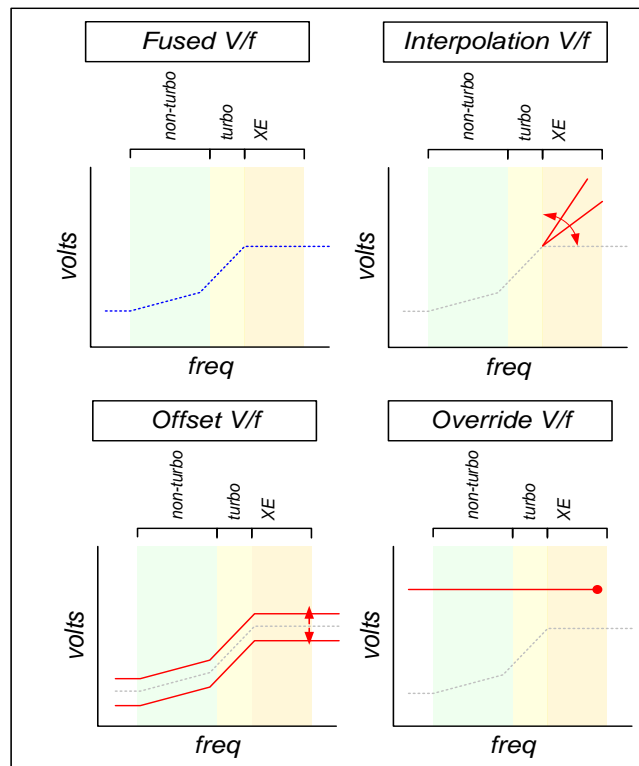† Only some processors enable part or all of these features.

Voltage Planes

- V_{CCIN}: SVID 1.8V Nom up to 2.3V+, static V up to 3.04V
- 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_{GT}: dynamic additional V, static V up to 2.0 V
- $V_{SA,}$ V_{IOA}, V_{IOD}: Up to 500mV Offset V from nominal
- V_{DDQ}: 1.5V Nom for DDR3 or 1.35V Nom for DDR3L
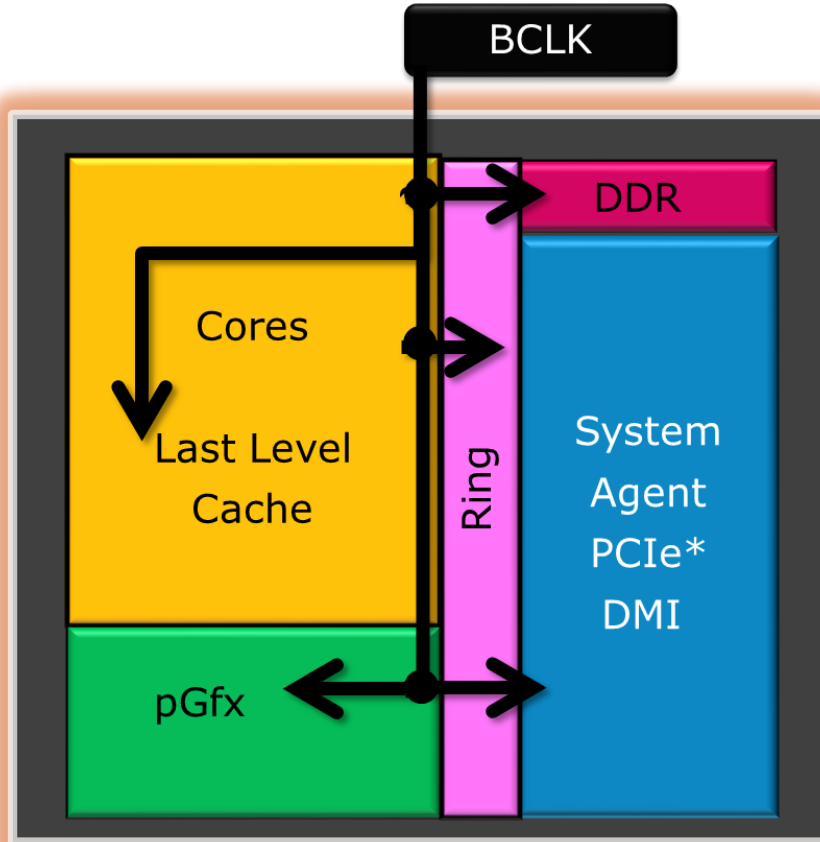
PCIe* = PCI Express*

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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.

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Clock Tree

- 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(GT) = BCLK/2*GT Ratio*

  *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*

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Ratio Tuning Capability Summary

Core Turbo Ratios†

- Core ratios up to 80
- Unlocked Turbo Limits
- Current Limit Override

- Graphics ratios up to 60

pGfx Ratios†

Cores

Last Level Cache

Ring

Graphics

DDR

System Agent PCIe* DMI

PEG DMI Ratios

DDR Ratios

- Steps of 266 or 200 MHz
- Timing Overrides
- Manual or Intel Extreme Memory Profile technology

Ring Ratios†

- Ring Ratios up to 80
- Ring Ratio typically <= Core

PEG, DMI Ratios

BIOS sets based on requested BCLK frequency:
- 100MHz: 80/50   (PEG/DMI Ratios)
- 125MHz: 64/40
- 167MHz: 48/30
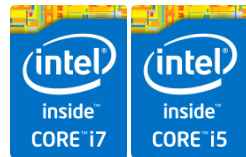
† = Configurable within OS

PCIe* = PCI Express*

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Desktop: 4th Generation Intel® Core™ Processors

Intel® Z97 Express Chipset

Intel H97 Express Chipset

‡Others

Unlocked Processors†	intel inside™ CORE™ i7	intel inside™ CORE™ i5	‡Others
Turbo Ratio Overrides	√		No
DDR Frequency Overrides	√		√
Fine BCLK Overrides	√[1]		√[1]
Coarse BCLK Ratios	√[2]		No
iVR Overvoltage	√		√
PL1, PL2, Tau, ICCMax Overrides	√		√
DDR Timing Overrides	√		√
pGfx Ratio Overrides	√		√

†*Unlocked Processors:*

Intel® Core™
- i7-4790K, i7-4770K
- i5-4690K, i5-4670K

Intel® Pentium™
- G3258

intel inside™ PENTIUM®

‡ This includes all other overclocking locked Intel® Core™ i3, Intel® Pentium™, and Intel® Celeron™

[1] Actual Fine BCLK frequency adjustments will be limited. ~5%

[2] Coarse BCLK Ratios (1.0, 1.25, 1.67) are unlocked with K SKU processors only

Note: Actual overclocking results will vary and capabilities are subject to change.

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Mobile: 4th Generation Intel® Core™ Processor Overclocking†

Summary:
- Core overclocking on select Intel® Core™ i7 SKUs
- Graphics and memory overclocking on all Intel Core i7 and Core i5 based –H, –M, and –U series processors

	Intel Core processor...	Turbo Ratio Overrides	Processor Graphics Ratio Overrides	iVR Over-voltage	BCLK Coarse[1]	BCLK Fine[1]
–H and –M Series	i7-4930MX	Unlimited	√	√	√	√
	i7-4900MQ	6 bins	√	√	√	√
	i7-4950HQ	6 bins	√	√		√
	i7-4800MQ	4 bins	√	√	√	√
	i7-4850HQ	4 bins	√	√		√
	i7-4702MQ	2 bins	√	√	√	√
	i7-4700MQ	2 bins	√	√	√	√
	i7-4750HQ	2 bins	√	√		√
	i5	none	√			√
	i3	none				
–U Series	i7-4600U	4 bins	√	√		
	i7-4650U	4 bins	√	√		
	i7-4558U	4 bins	√	√		
	i5	none	√			
	i3	none				
–Y Series	All	none				

[1] Requires Intel® HM87 or QM87 chipsets and results will vary.
† Actual overclocking results will vary and capabilities are subject to change.

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Live Demo:
Intel® Pentium™ G3258 Overclocking
with Intel® Extreme Tuning Utility

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- **Overclocking Theory**

- **High-end Desktop Overclocking Architecture**

- **Desktop Overclocking Architecture**
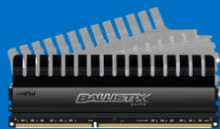
- **Overclocking Ecosystem**

- **Summary**

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Intel® Extreme Memory Profile for DDR4
Intel® Core™ i7 Processor Family for LGA 2011-v3

Quad Channel DDR4 Memory Kits

- Performance-oriented expansion of standard DDR4 memory specification
- Memory DIMM kits certified for four channel mode, ensuring optimal performance
- Designed for ultimate flexibility with predefined and certified memory optimizations
- Intel "Supports" Identifier badge on memory packaging for easy identification in retail

Partial list of Intel® Extreme Memory Profile (Intel® XMP) certified memory vendors. Consult motherboard manufacturers and memory vendors for Intel XMP support details.

Get ready for DDR4 Overclocking!

- **First desktop DDR4 platform launched Aug 29th, 2014**
  - 2,133 MT/s is the supported frequency
- **Amazing overclocking results† on day-1**
  - Ratio based OC up to 2667 MT/s; much higher with BCKL OC'ing
  - Up to 2,800 MT/s **without** voltage increase (1.2v)
  - Modules at 3,200 MT/s and beyond available today!!!
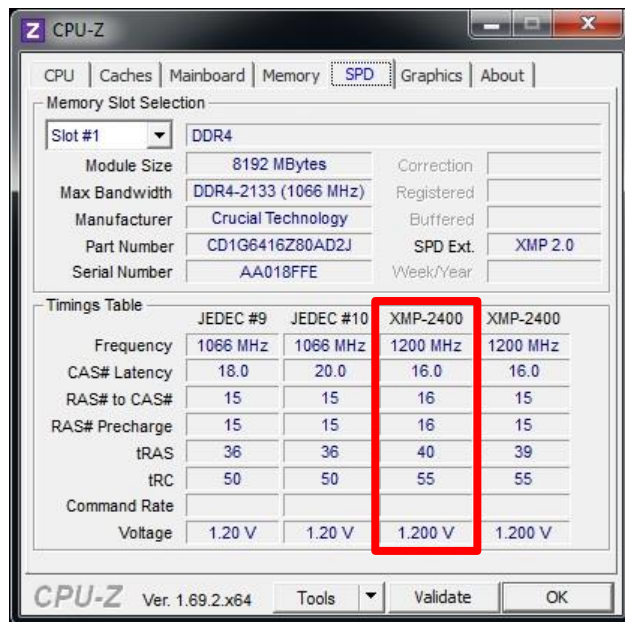- Look for DDR4 Intel® XMP 2.0 certified modules

Intel® Extreme Memory Profile (Intel® XMP)   *† Overclocking results may vary and subject to change.*

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Intel® Extreme Memory Profile (Intel® XMP)

- New Intel ® XMP 2.0 spec released for DDR4

- Enables speeds, latencies above JEDEC specification.
  - Easy, robust, overclocking solution designed to take advantage of the unlocked capability of Intel® Core™ Processors
  - Predefined and tested profiles can be selected in BIOS

- Intel XMP compliant DIMMs available
  - **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**
  - Adata, Corsair*, G.Skill*, Kingston*, Patriot*, Crucial* and others

Certifications posted at:
http://www.intel.com/consumer/game/extreme-memory.htm

CPU-Z

Memory Slot Selection			
Slot #1	DDR4		
Module Size	8192 MBytes	Correction	
Max Bandwidth	DDR4-2133 (1066 MHz)	Registered	
Manufacturer	Crucial Technology	Buffered	
Part Number	CD1G6416Z80AD2J	SPD Ext.	XMP 2.0
Serial Number	AA018FFE	Week/Year	

Timings Table

	JEDEC #9	JEDEC #10	XMP-2400	XMP-2400
Frequency	1066 MHz	1066 MHz	1200 MHz	1200 MHz
CAS# Latency	18.0	20.0	16.0	16.0
RAS# to CAS#	15	15	16	15
RAS# Precharge	15	15	16	15
tRAS	36	36	40	39
tRC	50	50	55	55
Command Rate				
Voltage	1.20 V	1.20 V	1.200 V	1.200 V

CPU-Z Ver. 1.69.2.x64 Tools Validate OK

System boots with highest supported JEDEC defined parameters by default	Select XMP profile via enabled BIOS or tuning app and profile and reset

†CPU must support unlocked memory multiplier and be paired with correct chipset. Intel XMP is overclocking.
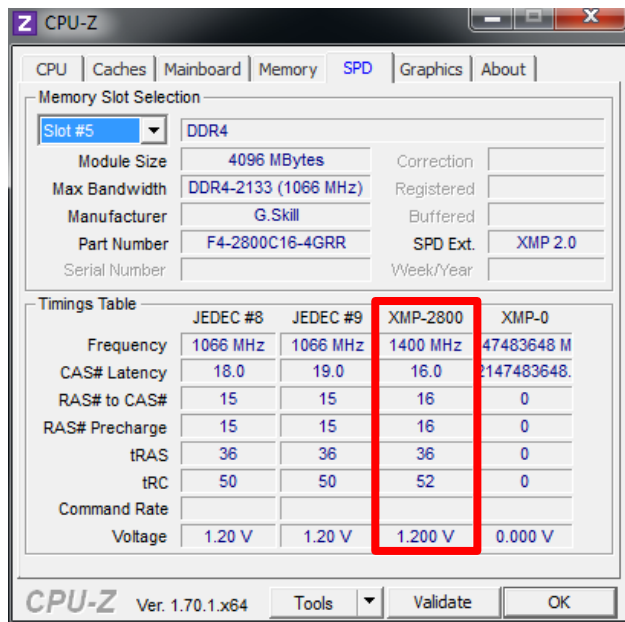
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Certifications posted at:
http://www.intel.com/consumer/game/extreme-memory.htm

CPU-Z

Memory Slot Selection

Slot #1	DDR4
Module Size	4096 MBytes
Max Bandwidth	DDR4-2133 (1066 MHz)
Manufacturer	Corsair
Part Number	CMK16GX4M4A2800C16
Serial Number	

Correction		Registered	
Buffered		SPD Ext.	XMP 2.0
Week/Year			

Timings Table

	JEDEC #7	JEDEC #8	XMP-2800	XMP-2998
Frequency	1066 MHz	1066 MHz	1400 MHz	1499 MHz
CAS# Latency	15.0	16.0	16.0	16.0
RAS# to CAS#	15	15	18	18
RAS# Precharge	15	15	18	18
tRAS	36	36	36	39
tRC	50	50	54	70
Command Rate				
Voltage	1.20 V	1.20 V	1.200 V	1.350 V

CPU-Z   Ver. 1.70.0.x64   Tools   Validate   OK

System boots with highest supported JEDEC defined parameters by default

Select XMP profile via enabled BIOS or tuning app and profile and reset

†CPU must support unlocked memory multiplier and be paired with correct chipset. Intel XMP is overclocking.

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Intel® Extreme Memory Profile (Intel® XMP)

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  - Predefined and tested profiles can be selected in BIOS

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  - **Intel XMP Certified:** Module has passed supplier test and submission process for specific CPU and motherboard **BEST**
  - Adata, Corsair*, G.Skill*, Kingston*, Patriot*, Crucial* and others

Certifications posted at:
http://www.intel.com/consumer/game/extreme-memory.htm

CPU-Z — SPD tab

Memory Slot Selection	Slot #5	DDR4		
Module Size	4096 MBytes		Correction	
Max Bandwidth	DDR4-2133 (1066 MHz)		Registered	
Manufacturer	G.Skill		Buffered	
Part Number	F4-2800C16-4GRR		SPD Ext.	XMP 2.0
Serial Number			Week/Year	

Timings Table	JEDEC #8	JEDEC #9	XMP-2800	XMP-0
Frequency	1066 MHz	1066 MHz	1400 MHz	47483648 M
CAS# Latency	18.0	19.0	16.0	2147483648.
RAS# to CAS#	15	15	16	0
RAS# Precharge	15	15	16	0
tRAS	36	36	36	0
tRC	50	50	52	0
Command Rate				
Voltage	1.20 V	1.20 V	1.200 V	0.000 V

CPU-Z Ver. 1.70.1.x64   Tools   Validate   OK

System boots with highest supported JEDEC defined parameters by default

Select XMP profile via enabled BIOS or tuning app and profile and reset

†CPU must support unlocked memory multiplier and be paired with correct chipset. Intel XMP is overclocking.

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Intel® Extreme Memory Profile (Intel® XMP)

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Certifications posted at:
http://www.intel.com/consumer/game/extreme-memory.htm

CPU-Z

CPU | Caches | Mainboard | Memory | SPD | Graphics | About

Memory Slot Selection

Slot #5 — DDR4

Module Size	4096 MBytes
Max Bandwidth	DDR4-2133 (1066 MHz)
Manufacturer	G.Skill
Part Number	F4-3333C16-4GRK
Serial Number	

Correction	
Registered	
Buffered	
SPD Ext.	XMP 2.0
Week/Year	

Timings Table

	JEDEC #8	JEDEC #9	XMP-3332	XMP-0
Frequency	1066 MHz	1066 MHz	1666 MHz	47483648 M
CAS# Latency	18.0	19.0	16.0	2147483648.
RAS# to CAS#	15	15	16	0
RAS# Precharge	15	15	16	0
tRAS	35	35	36	0
tRC	50	50	52	0
Command Rate				
Voltage	1.20 V	1.20 V	1.350 V	0.000 V

CPU-Z   Ver. 1.70.1.x64   Tools | ▼ | Validate | OK

| System boots with highest supported JEDEC defined parameters by default | Select XMP profile via enabled BIOS or tuning app and profile and reset |

†CPU must support unlocked memory multiplier and be paired with correct chipset. Intel XMP is overclocking.

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Live Demo:
DDR4 Overclocking on
Intel® Core™ i7-5960X Processor

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Intel® Extreme Tuning Utility (Intel® XTU)

- Simple-to-use Windows* application
- Exposes processor & PCH knobs for performance tuning by user
- Real-time adjustment of key settings without rebooting[1]
- Version 5.1 now available for download from Intel or other motherboard suppliers †

http://www.intel.com/go/xtu

† Motherboard BIOS must be configured correctly to work with XTU. Contact your motherboard supplier for more information.
1 Available select 3rd and 4th Generation Intel® Core™ Processor SKUs.

Intel® Extreme Tuning Utility and HWBot.org*

Combined Features

- Upload/Download overclocking settings reliably

- Export/Import Intel XTU overclocking settings

- Compare benchmark scores and configurations with others

- Link other benchmark scores to Intel XTU profiles

- Compete with others for higher scores

- Integrated with existing social networks: Facebook* and Twitter*

Agenda

- **Overclocking Theory**

- **High-end Desktop Overclocking Architecture**

- **Desktop Overclocking Architecture**

- **Overclocking Ecosystem**

- **Summary**

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Summary

- Innovation in overclocking continues a decade long focus

- Intel® Core™ i7 Processors with the Intel® X99 Express Chipset allow increasing Core, DDR, and BCLK frequencies on processors with the highest core count and memory capacity

- 4th Generation Intel® Core™ processors build upon existing overclocking capabilities and new SKUs offer greater OC performance and price points

- We will continue to introduce exciting new overclocking features as demonstrated today!

- Reminder: Intel has not tested, and does not warranty, the operation of the processor beyond its specifications

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Next Steps

- **For designers:** full overclocking documentation is available to you under NDA; you will find all details on all these tuning knobs
  - Contact your Intel field rep. for details
- **For system OEMs:** we encourage you to utilize overclocking while making informed decisions about risks and rewards
  - Use the lowest voltage at the lowest temperature to minimize risk
- **For end users:** check-out the products and tools shown today
  - Our latest 8-Core desktop processors
  - DDR4 Overclocking
  - Intel ® Extreme Tuning Utility

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Additional Sources of Information

- A PDF of this presentation is available 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.

- **Demos at IDF:**
  - Overclocking demos of Intel processors and DDR4 memory
- **Intel Resources:**
  - intel.com/gaming
  - 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.

Legal Disclaimer

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Legal Disclaimer

- Processor Numbering Notice: Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families: Go to: [Learn About Intel® Processor Numbers](#)
- Iris™ Graphics: Iris™ graphics is available on select systems. Consult your system manufacturer.
- Overclocked Memory: Warning: Altering PC memory frequency and/or voltage may (i) reduce system stability and use life of the system, memory 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 assumes no responsibility that the memory, included if used with altered clock frequencies and/or voltages, will be fit for any particular purpose. Check with memory manufacturer for warranty and additional details.
- Overspeed Protection Removed: 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® Turbo Boost Technology requires a system with Intel Turbo Boost Technology. Intel Turbo Boost Technology and Intel Turbo Boost Technology 2.0 are only available on select Intel® processors. Consult your PC manufacturer. Performance varies depending on hardware, software, and system configuration. For more information, visit http://www.intel.com/go/turbo.

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Risk Factors

The above statements and any others in this document that refer to plans and expectations for the second quarter, the year and the future are forward-looking statements that involve a number of risks and uncertainties. Words such as "anticipates," "expects," "intends," "plans," "believes," "seeks," "estimates," "may," "will," "should" and their variations identify forward-looking statements. Statements that refer to or are based on projections, uncertain events or assumptions also identify forward-looking statements. Many factors could affect Intel's actual results, and variances from Intel's current expectations regarding such factors could cause actual results to differ materially from those expressed in these forward-looking statements. Intel presently considers the following to be important factors that could cause actual results to differ materially from the company's expectations. Demand for Intel's products is highly variable and, in recent years, Intel has experienced declining orders in the traditional PC market segment. Demand could be different from Intel's expectations due to factors including changes in business and economic conditions; consumer confidence or income levels; customer acceptance of Intel's and competitors' products; competitive and pricing pressures, including actions taken by competitors; supply constraints and other disruptions affecting customers; changes in customer order patterns including order cancellations; and changes in the level of inventory at customers. Intel operates in highly competitive industries and its operations have high costs that are either fixed or difficult to reduce in the short term. Intel's gross margin percentage could vary significantly from expectations based on capacity utilization; variations in inventory valuation, including variations related to the timing of qualifying products for sale; changes in revenue levels; segment product mix; the timing and execution of the manufacturing ramp and associated costs; excess or obsolete inventory; changes in unit costs; defects or disruptions in the supply of materials or resources; and product manufacturing quality/yields. Variations in gross margin may also be caused by the timing of Intel product introductions and related expenses, including marketing expenses, and Intel's ability to respond quickly to technological developments and to introduce new products or incorporate new features into existing products, which may result in restructuring and asset impairment charges. Intel's results could be affected by adverse economic, social, political and physical/infrastructure conditions in countries where Intel, its customers or its suppliers operate, including military conflict and other security risks, natural disasters, infrastructure disruptions, health concerns and fluctuations in currency exchange rates. Intel's results could be affected by the timing of closing of acquisitions, divestitures and other significant transactions. Intel's results could be affected by adverse effects associated with product defects and errata (deviations from published specifications), and by litigation or regulatory matters involving intellectual property, stockholder, consumer, antitrust, disclosure and other issues, such as the litigation and regulatory matters described in Intel's SEC filings. An unfavorable ruling could include monetary damages or an injunction prohibiting Intel from manufacturing or selling one or more products, precluding particular business practices, impacting Intel's ability to design its products, or requiring other remedies such as compulsory licensing of intellectual property. A detailed discussion of these and other factors that could affect Intel's results is included in Intel's SEC filings, including the company's most recent reports on Form 10-Q, Form 10-K and earnings release.

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