

ADRUS Z390 DESIGN FOR

All Cores at 5GHz+ and other results may vary by CPU and cooling solution.

Features may vary by model.

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Z390 Overclocking Guide GIGABYTE

GIGABYTE AORUS Z390 Guide to Overclocking Intel 9000 series CPUs to 5GHz+

Chapter 1: Intro

Intel i9-9900K Overclocks to 5GHz on Z390 AORUS Boards

The core counts keep going up and this time Intel has come up with an 8 core, 16 thread processor. Along with it, Intel launched a mainstream chipset which supports this new generation of CPUs, the Z390. The best part is that there's backwards compatibility with the last chipset generation! Gaming and overclocking are better than ever without compromises! Yes, 5 GHz and 8 cores is now reality!!!

Beginner FAQ

What is overclocking?

Overclocking refers to pushing your computer components harder and faster than the manufacturer designed them to go. CPUs, video cards, and memory often have the capability to run faster than their rated speeds and overclocking takes advantage of that.

Why overclock?

Overclocking your CPU, VGA, and/or memory can result in higher frames per second in games, increase benchmark scores and provide better overall performance of your PC. There are three big reasons to consider overclocking: free performance, reducing FPS dip/stutter and unlocking full performance of high end GPUs.

One of the key areas where overclocking helps gaming is boosting the low/minimum FPS in games. It's those demanding moments in games with lots of action and textures that can cause a PC to momentarily slow down with FPS dipping to low digits under heavy load where CPU often needs to work very hard as running at faster speeds will improve FPS and the gaming experience. The second important aspect of overclocking is combining a fast CPU with a high end GPU. After a high end GPU is bottlenecked in games such as PUBG, a good example of this type of behavior, having a fast CPU combined with a decent graphics card will leave you fragging without FPS dips. Overclocking gives you a free performance boost, why not give it a shot!

Is my notebook processor comparable to my desktop processor?

Desktops have much higher power requirements and better heat dissipation capabilities compared to notebooks. The same model processor in a desktop performs better than the mobile equivalent. CPU speed can have an impact on graphics performance and desktop CPUs will have superior performance because of that.

What can I overclock?

The most often overclocked components are the CPU, video card and memory. In this guide our focus is CPU overclocking.

Disclaimer: Overclock at your own risk!

Overclocking your CPU voids your warranty and it can also damage your CPU, especially if done incorrectly.

Chapter 2: How to Overclock Your Intel i9-9900K

For reference we are using a GIGABYTE Z390 AORUS MASTER motherboard and an Intel i9-9900K CPU. Based on our testing many Intel i9-9900Ks can hit 5GHz using water-cooling and around 1.3-1.35Vcore. This is our experience with the CPUs we've tested. You may find that your CPU will overclock better (or worse) than our samples so keep that in mind when doing the testing.

Step 1: Enter the BIOS by pressing the "delete" button

If you have never been inside your BIOS before, welcome! There is no need to worry, we will guide you step by step with screenshots.

Step 2: Load your Extreme Memory Profile (X.M.P.)

Enter "Advanced Frequency Settings"

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ADRUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	
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Here you see the "Extreme Memory Profile (X.M.P.)" option. Change it to "Profile 1". Depending on your RAM you might see a second X.M.P. profile.

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- Hody	Save & Exit	Power	Chipset	Peripherals	BIOS	System	M.I.T.	ADRUS
	MHz	100.00	Auto				Base Clock	CPL
			100.00MH			2	t Clock Value	Hos
		30.00	Auto			itio	phics Slice Ra	Gra
Alt		30.00	Auto			Ratio	phics UnSlice	Gra
**			Auto				Upgrade	CPL
			Enabled		nce	Core Performa	anced Multi-	Enh
			🌟 5000MHz				Clock Ratio	CPL
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			1GHz		r On	for Early Powe	K Frequency	FCL
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			Profile1			y Profile(X.M.P.	eme Memory	Ext
	3200	DDR4-	🌟 Auto			Multiplier	em Memory	Sys
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			Auto		200/266)	tio (100/133 or	nory Odd Ra	Mer
	IHz	2133M	3200MHz			ncy(MHz)	nory Frequer	Mer

X.M.P. profiles are a quick way to get optimal performance for your memory without having to tweak the settings manually. These settings are verified by the memory manufacturer so you don't have to worry about stability.

Step 3: Change your CPU Multiplier

The formula to calculate the frequency of your CPU is: CPU Base Clock * CPU Clock Ratio. The Intel i9-9900K CPU has a Base Clock of 100 and CPU Clock Ratio of 47 for a frequency of 100 * 47 = 4700MHz. In this guide we will be overclocking to 5GHz for a 300MHz increase. Set your CPU Clock Ratio to "50".

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AURUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	
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CPU Enl CPU FCU ■ Ad	U Upgrade hanced Multi- U Clock Ratio U Frequency LK Frequency vanced CPU C	Core Performa for Early Powe fore Settings	ince er On		Auto Disabled 5000MH 5.00GHz 1GHz	j z 3.60G	Hz	«« •

Step 4: Disable Power Management & VT-d settings

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UKUS	M.I.T.		BIO2			Power		
CPL	J Base Clock				Auto	100.00	0MHz	í l
Hos	t Clock Value				100.00M	Hz		
Gra	phics Slice Ra	tio			Auto	30.00		_
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CPL	l Upgrade				Auto			**
Enh	anced Multi-	Core Performa	nce		Disabled			
CPL	Clock Ratio				🜟 5000MH:	z		
CPL	J Frequency				5.00GHz	3.60G	Hz	
FCL	K Frequency l	for Early Powe	r On		1GHz			
Adv	anced CPU Co	ore Settings						

These power management settings may decrease the stability of your system. You can keep them enabled if you think you really need them but we suggest you disable them.

Disable the following power management settings: Intel[®] Speed Shift Technology, CPU Enhanced Halt (C1E), C3 State Support, C6/C7 State Support, C8 State Support and C10 State Support.

Intel(R) Speed Shift Technology	Disabled	
CPU Enhanced Halt(C1E)	Disabled	
C3 State Support	Disabled	
C6/C7 State Support	Disabled	
C8 State Support	Disabled	
C10 State Support	Disabled	
Package C State limit	Auto	
CPU Thermal Monitor	Auto	
Ring to Core offset (Down Bin)	Disabled	Auto: This Option will honor
CPU EIST Function	Disabled	the Silicon default values;
Race To Halt (RTH)	Disabled	DISABLE - Mobile SKUS,
Energy Efficient Turbo	Disabled	other than Mobile
Voltage Optimization	Disabled	
Hardware Prefetcher	Auto	
A Carl all the restanded for the		Easty Mode (E2) L O Ela
Back		Lasy Mode (F2) Q-Fla

*Note: Alternatively, instead of disabling all these options you can simply just disable the "Enhanced Multi-Core Performance" under Advanced Frequency Settings.

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AURUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	
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CPI	J Upgrade		000		Auto	30.00		
CPI CPI FCI	J Clock Ratio J Frequency K Frequency	for Early Powe	r On		5.00GHz 1GHz	3.60GI	Hz	

Step 5: Change Uncore Frequency

The formula for Uncore frequency is CPU Base Clock * Uncore Ratio = Uncore Frequency.

Uncore frequency is the frequency of the non-core parts of the CPU- IE cache, memory controller, etc. To start, set your uncore to 47 and continue on with the guide. After you have determined your CPU's highest overclock you can re-visit your uncore settings. In general higher uncore values do not produce meaningful performance differences, but they may improve benchmark score. Set CPU Uncore to "47".

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ADRUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	
CPI	J Clock Ratio				5000MHz			T
CPU	J Frequency				5.00GHz	3.60G	Hz	
FCL	K Frequency	for Early Powe	rOn		1GHz			
AV	X Offset				Auto			Alt
TjM	IAX Temperal	ture			110°C			
Un	core Ratio				4700MHz			« «
Une	core Frequen	су			4.70GHz	4.70G	Hz	

*Note: You may find that you lose stability at 5GHz CPU clocks if you raise the uncore frequency really high. Start with uncore at 4.7GHz and if your system is stable then raise it to a higher frequency.

**Note: Please disable the "Ring to Core offset (Down bin)" under the Advanced CPU Core Settings. Under the "Chipset" tab disable VT-d.

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AORUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	
VT- Inte Auc Abc	d ernal Graphic dio Controller ove 4G Decod	s r ling			Disabled Auto Enabled Disabled			Ait
PCH	LAN Contro	ller			Enabled			**
Wa	ake on LAN E	nable			Enabled			*
IOA	PIC 24-119 E	ntries			Enabled			

Here you can disable settings or features which may not be necessary in your daily operation. VT-d is used for virtualization. If you don't plan on using any virtual machines you can disable it. The same stands for the Internal Graphics.

Step 6: Adjust Your Voltage Settings

Now that we have set our memory XMP profile, Uncore, and CPU multiplier we must also adjust the CPU voltage (Vcore). In order for the CPU to operate at higher frequencies more voltage will be required.

Go to the starting BIOS page (M.I.T.) and select the "Advanced Voltage Settings" option.

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Sm	art Fan 5 Set	tings						le la

Select the "Advanced Power Settings" Option



(Optional) CPU Vcore Loadline Calibration

AORUS Z390 motherboards are already optimized to reduce voltage fluctuation. These voltage fluctuations are built into standard voltage management to reduce power consumption but can also have adverse effects during overclocking as you need a stable fixed voltage to ensure consistency in power delivery. To begin leave LLC on AUTO. If you experience any shutdowns while stress testing set LLC to "Turbo" and test again. If you still experience shutdowns set LLC to "Extreme". Make sure you also keep an eye out on the CPU load temperature to prevent overheating.

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CPU	J Internal AC/ J Vcore Loadi	/DC Load line line Calibration			Auto Turbo	1111111		Ait

Step 7: Change CPU Vcore Settings

Go back one page (ESC) or from the main BIOS page (M.I.T) select "Advanced Voltage Control" Select "CPU Core Voltage Control"

ADRUS	М.І.Т.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	^{09/21/2018} 17:13
Adv CPI Chi DR Inte	vanced Powe J Core Voltag pset Voltage AM Voltage C ernal VR Cont	r Settings je Control Control Control crol			11111			Alt .
ADRUS	М.І.Т.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	^{09/21/2018} 17:13 Friday
CPI Dyr BC	<mark>J Vcore</mark> namic Vcore(I LK Adaptive V	DVID) /oltage			t.300V Auto Auto	1.195\ +0.000	X VV	
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VC VC CPI RIN GT	CPLL CPLL OC U Core PLL OV IG PLL Overvo PLL Overvolt	vervoltage (+m\ bltage (+mV) age (+mV)	v)		Auto Auto Auto Auto Auto	1.020\ 1.250\ - -	1	

CPU Vcore: Raising this helps keeps the system stable at higher CPU frequencies. However, it also increases the amount of heat your CPU produces. We suggest you keep Vcore under 1.35V depending on your CPU cooling solution. Most CPU's should be able to overclock to 5GHz on all the cores at this voltage, however CPUs are not all created equally. Some may need more voltage, some less.

Set Vcore to "1.30" to start. If you system is not stable raise the voltage in increments of .01 with a maximum of 1.40V.

*Note that changing Vcore voltage also changes your Uncore voltage since they share the same power rail.

(Optional) Advanced Settings

The following are settings are optional and might sometimes be needed when overclocking on air or water. There are additional voltages settings not covered here—they are used mostly when trying to hit overclocking records while using liquid nitrogen.

CPU VCCIO and CPU System Agent Voltage: Both of these settings help with DRAM frequency overclocking. Values up to 1.3-1.35V are high but they are ok if you are using aircooling. Since we used X.M.P. profiles for our memory these voltages will be automatically set. BCLK Adaptive Voltage: This setting helps when you raise the "CPU Base Clock" frequency. You should not need to adjust it because we left "CPU Base Clock" at the default value of 100.

Step 8: Save Your Settings

Before rushing off to test your new overclock we suggest saving your profile. You will find this option on the last page of the BIOS named "Save & Exit".

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ADRU5	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	
Sav	ve & Exit Setu	р						Í
Exi	t Without Sav	ving						
Loa	ad Optimized	Defaults		Save P	rofiles	8		Alt
Во	ot Override			Profile 1 :	9900K 5G			**
Say	e Profiles			Profile 2	: Empty			¢.
Loa	ad Profiles			Profile 3	: Empty			
Pre	eferred Operal	ting Mode		Profile 4	: Empty			
	liened operation	ing mode		Profile 5	: Empty			
				Profile 6	: Empty			
				Profile 7	: Empty			
				Profile 8	: Empty			
				Select File in H	IDD/FDD/U	SB		

Select the option "Save Profiles" and select and name the profile.

ADRUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	^{09/21/2018} 17:15 [®] Friday
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Pre	ferred Opera	ting Mode		Profile 1 :	9900K 5G			
· · · · · · · · · · · · · · · · · · ·				Boot Record : La	ist Known Go	bod		
				Select File in H	IDD/FDD/USI	3		

Using the "Load Profiles" option you can load the profiles you've previously saved.

This is very useful when you need to clear the CMOS due to an overly aggressive overclock in which you've lost all of your previous settings.

Step 9: Save & Exit

Last step is to select the "Save & Exit Setup" and click yes on the pop-up window. This will reboot your motherboard and apply all the settings that you have changed.

				09/21/2018 17:5 Friday
Save & Exit Setup				
Exit without saving				
	Save & rese			Alt
Load Optimized Deraults	2	and the second		Ait
Proch Ourseide	Save configurati	on and reset?		11
Boot Overnde				
Saua Drafilar	Yes	No		
Save Profiles				
Load Promes	Last Modifie	d		
Preferred Operating Mode	CPU Vcore Loadline Calibration	[Auto] → [Turb	o]	
referred operating mode	CPU Vcore	[Auto] → [1.300	DV]	
	Enhanced Multi-Core Performance	[Auto] → [Disal	bled]	
	CPU Clock Ratio	$[Auto] \rightarrow [5000$	MHZ]	
	Incore Patio	$[Auto] \rightarrow [110]$		
	Intel(R) Speed Shift Technology	$[Auto] \rightarrow [Disal]$	bled]	
	CPU Enhanced Halt(C1E)	[Auto] → [Disal	bled]	
	C3 State Support	[Auto] → [Disal	bled]	
	C6/C7 State Support	[Auto] → [Disal	bled]	
	CR State Support	[Auto] -> [Dical	hlod1	
			Exit BIOS savin	ig all changes
			maue.	

Chapter 3: Stability Testing

Congratulations! You are now running at 5GHz, which is nothing to scoff at. Now it's time to make sure that it's stable. We're going to use the software below to monitor our system, test stability, and adjust our overclocks.

Prime95 Version 27.9 Build 1— This is used to stress test our CPU in order to ensure that it's stable in the most taxing of conditions. This particular version of Prime95 uses AVX instructions which push our CPU to the absolute max.

CPU-Z— Used to monitor our CPU frequencies and Vcore settings.

CoreTemp— Used to monitor idle, load, and loading temperatures.

How to Stability Test

Step 1: Open up CPU-Z, CoreTemp, and Prime95. Make sure Prime95 is configured. Click the "Small FFTs" preset and then press OK to start.

Run a Torture Test	\times
Small FFTs (maximum heat, FPU stress, data fits in L2 cache, RAM not tested much)	ок
 In-place large FFTs (maximum power consumption, some RAM tested) Blend (tests some of everything, lots of RAM tested) 	Cancel
C Custom	
Number of torture test threads to run: 16	
Torture test settings Min FFT size (in K): 8 Max FFT size (in K):	
Run FFT's in-place Memory to use (in MB): 0	

Step 2: Start Prime95 and look at "CPU Load" in the CoreTemp app. If one of your cores is not at 100%, your system gets the blue screen of death or just freezes, that means your settings were too aggressive and your CPU has failed the stability test. We normally test for 1 hour. You can keep it running overnight for increased assurance.

🗱 Core Ten File Option	np 1.12.1 ns Tools	Help	-			×	
Select CPU:	Processor #	=0 9	Core(s))	16	Thread(s)	
Processor In	formation	Chec	k for Inte		river	<u>Updates</u>	
Model:	Intel Core is	9900K (Cof	fee Lake))		1	
Platform:	LGA 1151 (S	ocket H4)					
Frequency:	5000.00MH;	z (100.00 x 5	50.0)			i i i	
VID:	1.2112 v	P	Iodulatio	n;			
Revision:		Lit	thograph	y:	14 nm		
CPUID:	0x906EC		TD	P:	95.0	Watts	
Processor #0): Temperatu	re Readings					
Power:	250.2W	243.5W	N/A	6	.7W	N/A	
Tj. Max:	115°C		Min.	Max.		Load	
Core #0:	91°C		35°C	9	3°C	100%	
Core #1:	86°C		35°C	8	8°C	100%	
Core #2:	97°C		36°C	9	7ºC	100%	
Core #3:	89°C		35°C	9	2°C	100%	
Core #4:	94°C		35°C	9	5°C	100%	
Core #5:	89°C		34°C	9	3°C	100%	
Core #6:	91°C		35℃	9	3°C	100%	
Core #7:	85°C		34°C	8	8°C	100%	

Step 3a (If Prime95 Fails): Close Prime95 by right clicking the Prime95 icon on the tray bar in the lower right side of your screen and selecting "Exit". This closes Prime95.

Step 3b (If Prime95 Fails): Now it's time to adjust your frequency or voltage settings. You can do this either through the BIOS or using EasyTune which is available through the GIGABYTE App Center. You have two options: Either increase CPU Vcore or decrease CPU Clock Ratio. We recommend you to keep CPU Vcore below 1.35 volts if possible. After making an adjustment, go back to Step 1. If it continues to fail, dial down your CPU Clock Ratio until you pass stability testing.

Step 3C (If Prime95 Fails): If you aren't stable at 5GHz on Prime95 you can try setting AVX offset to "2". This will lower your CPU multiplier by 2x when running AVX instruction sets. For instance if your CPU is set go 5GHz it will run at 4.8GHz during Prime95.

AVX Offset: AVX Offset ranges from 0 to 31. When you set an AVX offset it will reduce the multiplier by 1-31 (whatever you set it to) when running AVX instruction sets. You can find this setting under "M.I.T" -> "Advanced CPU Core Settings"

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ADRU5	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	Tuesday
CPU	l Clock Ratio				Auto			т
CPU	Frequency				3.60GHz	3.60GH	Ηz	
FCL AV2	K Frequency Offset	for Early Powe	r On		1GHz 2	11111		Alt

Step 4 (Success): Congratulations, your current overclock is stable. You may want to try for a higher frequency. To do so, experiment with raising your CPU Clock Ratio and CPU Vcore settings either in BIOS or EasyTune and go back to Step 1 to ensure that it's stable.

Example of a 5GHz i9-9900K on water-cooling:

		CPU-Z - X					
		miles has deed and an internal	HW/iNFO64 v5.87-3500 Sensor Status				×
24 Prime95	- 🗆 X	CPU Caches Mainboard Memory SPU Graphics Bench About	Sensor	Current	Minimum	Maximum	^
Test Edit Advanced Options Window Help		Name Intel Core I9 9900K	RING: Package-Level RAPL/PBM PL1	No	No	No	
Main thread		Code Name Coffee Lake Max TDP 95.0 W	RING: Package-Level RAPL/PBM PL2,PL3	No	No	No	
Main thread Aug 29 17:011 Optimizing for CPU architecture: Core i3	//5//7, L2 cache size: 256 KB, L3 cache size: 16 MB	Tachadaaa 14 mm Case Voltage 1 204 V	GIGABYTE Z390 ACRUS MASTER-CF (Int				
[Main thread Aug 29 17:01] Starting workers.		Technology 14mm Core vortage 1.204 v	PCH Temperature	41.0 °C	35.0 °C	43.0 °C	
		Specification Intel® Core ** 19-9900K CPU @ 3.60GHz (ES)					
Vorker #2 - Self-Test		Parminy 6 Model E Stepping C	GIGABYTE Z390 AORUS MASTER-CF (ITE				A
		Testurfeers NWY CCE CCE2 CCE3 CCCE3 CCCE4 1 CCE4 2 EM64T VT.v	Temperature 1	33 °C	28 °C	33 °C	
24 Worker #3 - Seff-Test		AES, AVX, AVX2, FMA3, TSX	Temperature 2	30 °C	30 °C	30 °C	
		Clocks (Core #0) Cache	Temperature 4	41 °C	31.90	43.90	
Worker #4 - Self-Test		Core Speed 5003.65 MHz L1 Data 8 x 32 KBytes 8-way	Temperature 5	93 °C	32 °C	93 °C	
		Multipler x 50.0 (8 - 50) L1 Inst. 8 x 32 KBytes 8-way	Ø Vcore	1.296 V	1.260 V	1.488 V	
Worker 25 - Self-Text		Bus Speed 100.07 MHz Level 2 8 x 256 KBytes 4-way	Vccp2	1.836 V	1.824 V	1.968 V	
		Rated FSB Level 3 16 MBytes 16-way	9 +3.3V	1.956 V	1.956 V	2.004 V	
Marker H. C.W.Test			9 +5V	3.145 V	3.145 V	3.286 V	
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			G 2000	2.360 V	2.352 V	2.336 1	
24 vvorker#7+ ben+ lest		🗟 CPU-Z — 🗔 🗙	U VBAT	3.144 V	3.144 V	3.144 V	
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24 Worker = 5 - Self- (#St		General	Chassis Intrusion	Yes	Yes	Yes	
Worker 29 - Grill Tert		Type DDR4 Channel # Dual					
		Size 16 GBytes DC Mode	Temperature 1	34.97	28.90	34.97	
Markey 210 - Salt Tair		NB Frequency 4701.1 MHz	Temperature 3	32 °C	27 °C	32 %	
TSURMUTING TO THE	ment internet	Timings	Ø Vcore	1.287 V	1.276 V	1.485 V	
Water attachment	Core lemp (.12.) — L X	DRAM Prequency 1600.5 MHz	Vccp2	0.671 V	0.660 V	0.671 V	
	File Options Tools Help	FSB:DRAM 1:24	¥3.3V	1.056 V	1.045 V	1.056 V	
Washing #17 Call Tart	Select OPU: Processor #0 - 8 Core(s) 16 Thread(s)	CAS#Latency (CL) 16.0 dods	y AVCC3	3.388 V	3.366 V	3.388 V	
Mound are apprending	Processor Information Check for Intel Driver Updates	RAS# to CAS# Delay (RCD) 18 docks	G VINE	4.796 V	1.520 V	4.790 ¥	- 10
Manager #11 - East Test	Model: Intel Core /9 9900K (Coffee Lake)	Ovie Time (IRAS) 38 dorks	0 3V58	3.366 V	3.366 V	3.388 V	
24 Worker +13 - Self-rest	Platform: IGA 1151 (Socket Hd)	Row Refresh Cycle Time (IREC) 560 clocks	0 VBAT	3.256 V	3.256 V	3.256 V	
	Frequency: 5000.00MHz (100.00 x 50.0)	Command Rate (CR) 2T	Chassis Intrusion	Yes	Yes	Yes	
54 MouxeLate - 261-161	MD: 1.2250 v Modulation	DR 6M Jdle Timer					
	Danistony Lithographic 14 pp	🗟 CPU-Z — 🗀 🗙	GIGABYTE 2390 ACRUS MASTER-CF (DR				
24 Worker = 10 - bert-test		CRU Carban Mainboard Manoru SED Grantice Banch About	& VRT1	91.0 °C	32.0 °C	91.0 ℃	
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24 Worker #10 - Self-Test	Processor #0: Temperature Readings	Manufacturer Globbyte Technology Co. 1td.	U VE VIN	11.000 V	10.938 V	11.553.9	1
For Help, press F1	Power: 244.8W 238.1W N/A 6.7W N/A	Model Z390 AORUS MASTER-OF X.X	Gurrent (IOUT)	191.750 A	33.500 A	195.250 A	1
	Tj. Max: 100°C Min. Max. Load	Chinest Intel CoffeeLake Perr 05	Current (IIN)	15.969 A	4.313 A	15.969 A	
	Core #0: 90%C 32%C 91%C 100%6	Contectante Contectante Rev. 04	Power (POUT)	234.000 W	48.500 W	237.500 W	2
	Core #1: 83°C 32°C 84°C 100%		Power (Input)	175.500 W	49.500 W	178.500 W	1
	Core #2: 94°C 33°C 96°C 100%	Deto The Troopo					
naphsot0014	Core #3: 88 31°C 88°C 100%	BIOS	GIGABYTE 2390 AORUS MASTER-CF (IR	00.0.07	21.0.00	00.0.00	
	Core #4: 92% 32°C 95°C 100%	Brand American Megatrends Inc.	1 10 17	91.0.90	32.0 %	91.0.90	
	Core #5: 101% 319C 899C 100%	Version F4	UR VOLIT	0.004 V	0.004 V	0.004 Y	
	Core #6: 00% 31% 91% 100%	Date 08/24/2018	VR VIN	11.000 V	10.969 V	11.563 V	
	Core #7: 84% 30% 85% 100%	Graphic Interface					~
naphsot0015	interiore para la compara a	Version PCI-Express	¢				>
		Link Width x16 Max. Supported x16			0	0001	-
		Side Band Addressing	44 10 10 10 10 10 10 10 10 10 10 10 10 10	1:04:25		22 3	K
					and the second s	in the second second second	

Thermals

As you can tell from the last screenshots, the CPU temperature of an overclocked i9-9900k is quite high. This is something that we've noticed on many of the processors.

If you concern for high CPU temperature we suggest you to use a custom water-cooling or a high-end AIO and adjust the TjMAX Temperature to 110°C.

You will find the "TjMAX Temperature" option under the Advance CPU Core Settings submenu in M.I.T tab.

C								09/21/2018 17:14
ADRUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	
CPU CPU FCL AV2 TjM	J Clock Ratio J Frequency K Frequency X Offset IAX Tempera	for Early Powe	er On		5000MHz 5.00GHz 1GHz Auto 110°C	3.60GI	Hz	Ait
Und	core Ratio core Frequen	cy			4700MHz 4.70GHz	4.70G	Hz	<i>~~</i>

Results

We've increased frequency from 4.7GHz to 5GHz—a 300MHz increase! The results of our overclocks can be seen in the Intel[®] Extreme Tuning Utility benchmark below.

Intel Core i9-9900K	Intel Core i9-900K	Intel Core i9-900K			
Default Settings	@ 5GHz	@ 5.2GHz			
3233 Marks Con	3450 Marks	3524 Marks			
Share, compare, and	Share, compare, ar	Share, compare, an			
Intel® XTU users in	Intel® XTU users ir	Intel® XTU users in			
Maximum Processor Frequency 4.91 GHz	Maximum Processor Frequency 5.00 GHz	Maximum Processor Frequency 5.20 GHz			
Highest CPU Temperature 72 °C	Highest CPU Temperature 99 °C	Highest CPU Temperature 83 °C			

From stock to 5GHz we jump 217 marks from 3233 to 3450. From 5GHz to 5.2GHz we gain an additional 74 Marks.

Chapter 5: Pushing Past 5GHz

Although, 5GHz was our initial target some CPUs can reach a higher frequency and still be stable. Here is an example on an i9-9900K tuned for 5.1GHz. Keep in mind that the CPU temperature is going to be even higher than before and that's something you should take into consideration before you start trying to increase CPU clocks.

We recommend using a custom water-cooling build for the best results. Even some AIOs are not capable of dissipating the high temperature that the CPU produces under AVX load.

For the specific steps please refer to the overclocking guide above. The specific settings for a 5GHz overclock are listed below.

Step 1: Adjust CPU Clock Ratio

Previously we set our CPU Clock Ratio to 50 and now it's a simple adjustment to 51. Since this overclock is more difficult than the previous 5GHz overclock, we suggest you change these settings through the BIOS.

C		1. Notes				-//	1011	09/25/2018 14:42
ADRU5	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	
C H G	PU Base Clock ost Clock Value raphics Slice Ra raphics UnSlice	itio Ratio			Auto 100.00MI Auto Auto	100.00 Hz 30.00 30.00	0MHz	
C	PU Upgrade nhanced Multi-	Core Performa	ince		Auto Disabled			
C F	PU Clock Ratio PU Frequency CLK Frequency	for Early Powe	er On		5.10GHz 1GHz	3.60G	Hz	

Step 2: Adjust CPU Vcore

Just like before we will set the Vcore at 1.3V. Aiming for higher frequency means you might have to increase the Vcore. Depending on how lucky you were in the CPU lottery the CPU Vcore setting can range from 1.3V to 1.35V. Our particular CPU needed 1.3V to be stable.

1	923	11 17 17				11	/0//	09/21/2018 17.1	৾
ADRUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	Friday ••••	
									1
	CPU Vcore				🗯 1.300V	1.195	v []]]		
	Dynamic Vcore(DVID)			Auto	+0.00	0V		
	BCLK Adaptive \	/oltage			Auto				
	SVID offset				Disabled			Alt	
	CPU Graphics Vo	oltage (VAXG)			Auto	1.200	V		
	CPU VCCIO				Auto	0.950	V	11	
	CPU System Age	ent Voltage			Auto	1.050	V		•
	VCC Substained				Auto	1.020	V		
	VCCPLL				Auto	1.020	V		
	VCCPLL OC				Auto	1.250	V		
	CPU Core PLL Ov	vervoltage (+m)	/)		Auto				
	RING PLL Overvo	oltage (+mV)			Auto				
	GT PLL Overvolt	age (+mV)			Auto				
	SA PLL Overvolt	age (+mV)			Auto		Adjust the CPU V	core	
	MC PLL Overvolt	age (+mV)			Auto	-	voltage. Auto = BIOS auto	matically	

Step 3: Change CPU Vcore Loadline Calibration

In order to reduce any possible Vdroop that interferes with our stability when overclocking set LLC to "Turbo". If the system is not stable or you're experiencing shut downs set the LLC to "Extreme".

1.						-//		^{09/21/2018} 17:13
ADRUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	
CPL CPL	J Internal AC, J Vcore Load	/DC Load line line Calibration			Auto Turbo			Alt KK

Step 4: Stability Testing

Test the stability of these new settings by following the steps under "How to Stability Test".

Below is an example of an Intel Core i9-9900K using a Bitspower water-cooling kit.

Prime95	- 0 ×	🙆 CPU-Z — 🗌 🗙	HWINF064 v5.88-3510 Sensor Status		1.5	
Test Edit Advanced Options Window Help		CPU Caches Mainboard Memory SPD Graphics Bench About	Sensor	Current	Minimum	Maximum A
		Processor	GIGABYTE Z390 AORI /S MASTER-CE (Int		- a a dan	- water date
24 Main thread		Name Intel Core I9 9900K	PCH Temperature	44.0 °C	41.0 °C	46.0 °C
[Main thread Sep 11 15:20] Optimizing for CPU architecture: Core i3/i5/i7, L2	cache size: 256 KB, L3 cache size: 16 MB	Code Name Coffee Lake Max TDP 95.0 W				
Imain urcau sep 11 15.20] starting workers.		Technology 14mm Crue Violane 1,264 X-series	GIGABYTE 2390 AORUS MASTER-OF (ITE			
and the second			Temperature 1	35 °C	34 %	35 °C
Z4 Worker #2 - Self-Test		Spedification Intel® Core 7 9-9900K CPU @ 3.60GHz (ES)	Temperature 2	39 °C	3/ 90	39 °C
		Pamey 6 Model E Stepping C	Temperature 4	46.90	44.90	47.10
24 Worker #3 - Se8-Test		Ext. Party 6 Ext. Mode ye Revision P0	Temperature 5	94 °C	77 °C	95 °C
		AES, AVX, AVX2, FMA3, TSX	Vcore	1.296 V	1.284 V	1.416 V
24 Worker #4 - SeN-Test		Clarke (Care 20) Carks	Vccp2	1.800 V	1.788 V	1.956 V
		Crus Speed 5100.00 MHz 11 Data 8 x 32 KRytee Sway	¥ +3.3V	1.956 V	1.956 V	2.004 V
Worker #5 - Self-Test		Multipler x S1.0 (8-50) 11 Inst. 8 x 32 KBytes 8-way	¥ +5V	3.125 V	3.105 V	3.286 V
		Bus Speed 100.00 MHz Level 2 8 x 256 KBytes 4-way	VINS	1.308 V	1.296 V	1.308 V
Worker #8 - Self-Test		Rated FSB Level 3 16 MBytes 16-way	2 DUCE	1.344 V	2.332 V	1.356 V
			g upat	3.360 V	3.300 V	3.304 Y
Worker #7 - Net running		Selection Societ #1 - Cores 8 Threads 16	J AVC3	3.072 V	3.072 V	3.072 V
			O Chassis Intrusion	Yes	Yes	Yes
Worker #1 - Self-Test		😅 CPU-Z - 🗇 🗙				
		CPU Caches Mainboard Memory SPD Graphics Bench About	GIGABYTE 2390 ADRUS MASTER-CF (ITE			
Manhar Ris Call Tark		General	Temperature 1	37 °C	35 °C	38 °C
		Type DDR4 Channel # Dual	Temperature 3	34 °C	32 °C	34 °C
Contraction of the second seco		Size 16 GBytes DC Mode	Vcore	1.287 V	1.276 V	1.408 V
A ALONG A IN - SON- IGI		NB Frequency 4698.9 MHz	y vccpz	0.660 V	0.660 V	0.671 V
		(Turious	d awora	1.036 V	2.034 V	1.030 V
24 Worker #11+ Self-Test		DRAM Frequency 1599.3 MHz	+120	4.752 V	4.708 V	4.796 V
		FSE:DRAM 1:24	VINS	1.529 V	1.518 V	1.529 V
24 Worker #12 - Self-Test		CAS# Latency (CL) 16.0 dools	💡 3VSB	3.366 V	3.344 V	3.388 V
	Core Temp 1.12.1	RAS# to CAS# Delay (IRCD) 18 docks	VBAT	3.234 V	3.234 V	3.234 V
24 Worker #13 - Sell-Test	File Options Tools Help	RAS# Precharge (tRP) 18 docks	Chassis Intrusion	Yes	Yes	Yes
	and the second sec	Cyde Time (IRAS) 38 docks				, v
Voter #14 - Self-Test	Select CPU: Processor #3 8 Core(s) 16 Thread(s)	Row Refresh Cycle Time (IRFC) 560 docks				'
	Processor Information Check for Intel Driver Updates	Command Rate (CR) 2T	and shall the	1:00:24 ED	3	31 11
Worker #15 - Sell-Test	Model: Intel Core I9 9900K (Coffee Lake)	0 CPU-Z - X		test		A .
	Platform: LGA 1151 (Socket H4)	CRU Carbos Manhoard Memory SED Granhirs Bench About				
24 Worker #16 - Sell-Test	Frequency: 5101.22MHz (100.02 x 51.0)	Motherboard				
	VID: 1.2372.v Modulation	Manufacturar Goshyte Technology Co. Ltd.				
For Help, press F1	Revision: Uthography: 14nm	Model Z390 ACRUS MASTER-CE X.X				
	CPUID: 0x906EC TDP: 95.0 Watts	Chinese Intel Configuration Intel Con				
	Province and Terrarely or Province	Crusting Intel Correctage Rev. 04				
	Processor #0: Temperature Readings	2000 Kinge and 2000 Key, 10				
	Power: 236.4W 230.3W N/A 6.1W N/A	D-G0 110 110088				
	Tj. Max: 110°C Min. Max. Load	BIOS				
inaphsot0018 snaphsot0026	Core #0: 88°C 36°C 89°C 100%	Brand American Megatrends Inc.				
	Core #1: 81°C 36°C 82°C 100%	Version F5a				
	Core #2: 94°C 37°C 96°C 100%	Date 09/05/2018				
	Core #3: 83°C 34°C 88°C 54%	Graphic Interface				
	Core #4: 95% 35% 96% 100%	Version PCI-Express				
inaphsot0019 snaphsot0027	Core #5: 87*C 34*C 88*C 100%	Link Width x16 Max. Supported x16				
	Core #6: 91°C 34°C 92°C 100%	Side Band Addressing				
	Core #7: 83°C 34°C 85°C 100%					

AVX Offset: AVX Offset ranges from 0 to 31. When you set an AVX offset it will reduce the multiplier by 0-31 (whatever you set it to) when running AVX instruction sets.

If you aren't stable at 5.1GHz on Prime95 you can try setting AVX offset to "2". This will lower your CPU multiplier by 2x. For instance if your CPU is set at 5.1GHz it will run at 4.9GHz during Prime95.

AVX offset is found under M.I.T -> Advanced

1º							////	09/25/2018 Tuesday 13:06
ADRUS	M.I.T.	System	BIOS	Peripherals	Chipset	Power	Save & Exit	Tuesday
CPU CPU FCL	Clock Ratio Frequency K Frequency	for Early Powe	r On		Auto 3.60GHz 1GHz 2	3.60Gł	Hz	Alt

*Note: The processors can be stable at higher frequencies if the load applied doesn't have AVX extensions. For example this specific CPU is stable at 5.3GHz without AVX load. That means in this case we have 2 options. Either we overclock the CPU at 5.1GHz for all types of loading or we overclock it at 5.3GHz with the AVX option at 2.

Prime95	- 🗆 X	🔯 CPU-Z 🖂 🗶 🗃 k	HWINFO64 v5.88-3510 Sensor Status		- 🗆 X
Test Edit Advanced Options Window Help		CPU Caches Manboard Memory SPD Graphics Bench About Senso	Y	Current Me	mum Maximum A
		Processor	IGARINTE 7 800 4/00/ IS MASTER //E /Int		
24 Meet Streas [Main thread Sep 12 13:44] Optimizing for CPU architecture: Unknown Intel, L2 cache size; 2 [Main thread Sep 12 13:44] Logical CPUs 1.2 form one physical CPU.	56 KB, L3 cache size: 16 MB	Name Intel Core I9 9900K Code Name Coffee Lake Max TDP 95.0 W Padage Socket 1151 LGA CORE I9	CH Temperature	42.0 °C 40	0 °C 44.0 °C
Main thread Sep 12 13:44 Logical CPUs 3,4 form one physical CPU.		Technology 14mm Core Voltage 1.428 V	mperature 1	34 °C	33 °C 34 °C
Main thread Sep 12 13:44 Logical CPUs 5,6 form one physical CPU.		Specification Intel® Core™ 19-9900K CPU @ 3.60GHz (ES)	enperature 2	37 °C	35 °C 37 °C
		Pamily 6 Model E Stepping C	imperature 3	94 °C	26 °C 95 °C
Worker #2 - Self-Test		Ext. Family 6 Ext. Model 9E Revision P0	imperature 4	42 °C	38 °C 42 °C
ISen 12 13:45 Worker starting		Instructions MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, EM64T, VT-K,	imperature 5	76 °C	49 °C 76 °C
		AES, AVX, AVX2, FMA3, TSX	ore	1.428 V 1.	404 V 1.440 V
Worker 21 - Sell-Led		Clocks (Core #0) Cache	xp2	1.800 V 1.	200 V 1.956 V
Reg 12 12:45 Werker stadios		Core Speed 5301.27 MHz L1 Data 8 x 32 KBytes 8-way	3.3V	1.936 V 1	756 V 2.004 V
Joep 12 13.40 Worker starting		Multiplier x 53.0 (8 - 50) L1 Inst. 8 x 32 KBytes 8-way	NS	1.308 V 1.	296 V 1.308 V
		Bus Speed 100.02 MHz Level 2 8 x 256 KBytes 4-way	Nő	1.344 V 1	344 V 1.156 V
Worker +4 - Self-Test		Rated FSR Level 3 16 MBytes 15-way	ISB	3,360 V 3.	360 V 3.384 V
Sep 12 13:45 Worker starting		g ve	MAT	3.120 V 3.	120 V 3.120 V
		Selection Societ #1	/0C3	3.072 V 3.	072 V 3.072 V
21 Worker #3 - Self-Test		Oc	hassis Intrusion	Yes	Yes Yes
[Sep 12 13:45] Worker starting					
		CPU Caches Mainboard Memory SPD Graphics Bench About	IGABITE 2390 ACRUS MASTER-OF (ITE	15.9*	11.57 15.57
Worker #0 - Sed - IEE		General	mperature 3	34 90	31 % 34 %
[Sep 12 13:45] Worker starting		Type DDR4 Channel # Dual	we	1.430 V 1.	397 V 1.441 V
		Size 32 GBytes DC Mode	m2	0.671 0.	660 V 0.671 V
		NB Frequency 4697.7 MHz 9 +	3.3V	1.045 V 1.	045 V 1.056 V
A AADLAD & 13 - 2410 (101		Timings	/0C3	3.388 V 3.	388 V 3.388 V
Worker #14 - Self-Test	0 0 2	DRAM Prequency 1600.5 MHz 2 +	127	4.796 V 4.	752 V 4.796 V
	Contract Indexed Contract	FSB:DRAM 1:24	N5	1.529 V 1.	529 V 1.529 V
Worker #15 - Self-Tect		CAS#Latency (CL) 16.0 dods	/SB	3.366 V 3.	366 V 3.366 V
	Cont Terms 1121 - X	RAS# to CAS# Delay (IRCD) 18 dools	MT	3.2348 3.	234V 3.234V
Monxer #10+Self-Test	Elle Outliner Task Hale	RAS#Precharge (SRP) 18 000/3		10	v is
(For Help, press F1	File Options room Help	Cycle Time (BCAS) 38 0003			
	Select OPU: Processor #0	Command Bate (CD) 2T		(T)	ST CON LAN
rcue - snaprisotour snaprisotoure snaprisotoure arcue - rcue	Processor Information Check for Intel Driver Lodates Model: Intel Core IB 9900K (Coffee Lake)	CPU-Z - X	· · · · · · · · · · · · · · · · · · ·	07:49	
	Platform: LGA 1151 (Socket H4)	CPU Caches Mainboard Memory SPD Graphics Bench About			
	Frequency: 5298,734Hz (99,98 x 53,0)	Motherboard			
	VID: 1.2996 v Modulation	Manufacturer Gigabyte Technology Co. Ltd.			
Temp snaphsot0006 snaphsot0017 snaphsot0025 4.7 XTU	Revision Uthor aphy: 14 pm	Model Z390 AORUS MASTER-CF X.X			
	CRUTD: D-005EC TTO: S5 0.Watte	Chipset Intel Coffee Lake Rev. 0A			
	Croid-Jackware Inter-Jacomana	Southbridge Intel Z390 Rev. 10			
	Processor #0: Temperature Readings	LPCIO ITE IT8688			
	Power: 229.2W 223.0W N/A 6.2W N/A	and .			
ishot snaphsot0008 snaphsot0018 snaphsot0026 4.7 CBR15	Tj. Max: 110°C Min. Max. Load	BUO			
	Core #0: 57% 35°C 98°C 100%	Brand (America) Pegaliterica and			
	Core #1: 91°C 35°C 92°C 100%				
	Core #2: 20% 36°C 106°C 100%	Care Indextee a			
	Core #3: 98*C 34*C 98*C 300%	Graphic Interface			
at0001 coachrot0009 coachrot0019 coachrot0027 47 Aida64	Core #4: 00% 35°C 105°C 100%	Version PCI-Express			
	Core #5: 99*C 33*C 99*C 100%	Link Width X16 Max. Supported X16			
	Core #6: 96°C 34°C 97°C 100%	Side Band Addressing			
	Core #7: 93°C 34°C 95°C 100%				