

# Overclocking with Intel® XTU

Overclocking with Unlocked Intel® Core™ Desktop Processors Part 2

REVISED 06/07/2021

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*Overclocking Guides:*

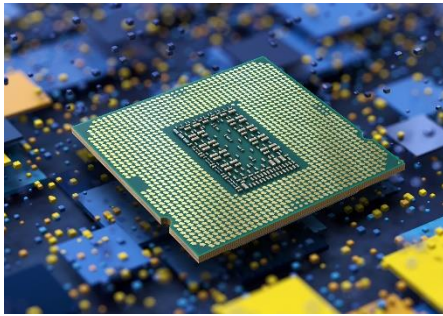
*Getting Started and Core Concepts of Overclocking – OC Guide Part 1*

*Overclocking with Intel® XTU - OC Guide Part 2*

*Overclocking Features and Technologies - OC Guide Part 3*

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## Getting Started

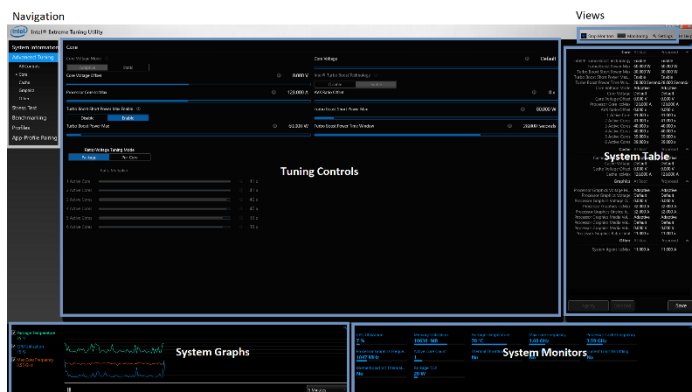
Part 2 of this guide will cover how to use the Intel® Extreme Tuning Utility (XTU) to overclock your system. Intel® XTU is a software utility provided free from Intel®, created to assist you in overclocking your system. Intel® XTU can change settings, monitor your system, and even test its stability. XTU is designed for all levels of overclocking experience from the beginner to an expert. Part 1 of this guide lays the foundation of the process. If you have not read it yet, it is recommended to do so before continuing.

XTU is a free, streamlined, and user-friendly alternative to the manual process of overclocking through the motherboard BIOS. It will work with most Intel®-based motherboard brands and models.

You can download [Intel® XTU for free here](#).

## 1. Main Interface

XTU has five main sections. Those sections are Navigation and Views, Tuning Controls, System Table, System Graphs and System Monitors.



### 1.1. Navigation and Views

The navigation area lists all the major functions of Intel® XTU. You can see the details about your system in **system information**, change system settings free form in **advanced tuning**, and test the stability of your system in **stress test**. Additionally, you can analyze and compare your system's performance against other system profiles in **benchmarking** and manage custom sets of system settings in **profiles**.

Intel XTU has two views: full view and monitoring view. The toggle on the top-right corner of the window switches between these two views. You can also resize each the sections for tuning controls, the system table, the system graphs, and the system monitors by dragging their borders around.

### 1.2. Tuning Controls

This area of the user interface displays the controls for changing the system settings in advanced tuning. For stress tests and profiles, this area will display the settings for these features.

### 1.3. System Table

The system table displays information about the current system settings and a summary of your changes. The system table is customizable. You can add or remove items and columns based on your overclocking strategy in the system table preferences.

### 1.4. System Graphs

The system graphs area shows measured system values over a period of time. The system graphs update live as changes are detected in the system. You can customize the system graphs to show the data you need for your overclocking strategy in the system graphs preferences.

### 1.5. System Monitors

The system monitors area is a dedicated view of selected system values. It displays the value, averages, and the current value. The monitors change color if the monitored values fall into warning or critical zones.

## 2. Interface Details

As covered in part 1 of this guide, monitoring your system is important to achieving a stable overclock. Here are details of the parts of XTU that will help do that.

### 2.1. Understanding the System Table

The system table area is an overview of the hardware settings on your system. It will help you track changes to the system as you make them. When you change a system setting, either through manual tuning or through profiles, the system table highlights the changed system setting(s) and any other values, which are derived from that setting, with a different color. This allows you to quickly scan the system table to see which system settings have been affected by the changes you made.

Each line displays the name of a particular setting and its values at different points in time. By default, the System Defaults and Proposed Values are shown. The system settings in the system table are grouped by features, like the sections used in advanced tuning. You can temporarily hide the sections by clicking the fold arrows at the end of each section header. You can also resize the system table by dragging its border horizontally.

#### 2.1.1. Customizing the System Table

You can customize how information is presented in the system table by clicking the wrench icon on the top-right corner. You can add or remove system settings to the table and reorder them. To reorder an item, move your mouse over the item. Two arrows will appear by the item that will allow you to move the item up or down in the list. You can also show or hide the columns in the

table. The descriptions of the columns are provided in Table 1 below.

Table 1

Value	Description
System Defaults	The default values are the settings that your system manufacturer recommends. When you choose to take your system back to defaults, those values will be used.
Last Boot Values	The values that were active when your computer booted last.
Active Values	The currently active values on the hardware.
Proposed Values	The new values that are proposed either by using the controls in manual tuning, or by selecting a profile.
Percent of Change	The difference between two values. By default, this field shows the difference between active values and proposed values to give you a sense of how aggressive your changes are. The values in this column will be reset when you apply settings or reboot.

Once you have customized the system table to meet your needs, you can close the settings windows. Your changes are automatically saved.

## 2.2. Understand System Graphs

The system graphs offer a visual way to examine the recent trends in the values measured on the system by Intel XTU. They are designed to show the behavior of components over time and help you find correlations between controls and their effects on the system. You can use system graphs to examine the behavior over a period time for multiple monitored values. This gives you the ability to draw similarities between the behavior of the components, see the impact of your system setting changes across your system, and diagnose stability issues.

The system graphs area consists of two sections. The left section lists the currently visible graphs. You can hide the graph temporarily by unchecking the check box by its name. This section also displays the numeric values for each graph. The right section displays graph lines for the currently visible items. The graph starts to fill as time passes and scrolls to the left side of the screen. You can control the scrolling anytime by using on the play/pause button at the bottom of the graph area.

You can also look at graphs of older data or zoom into more recent data using the time range control. This control allows you to pick the range over which the data is displayed in the graphs area. You can choose "1 minute" to see the most recent data or you can choose up to "1 hour" to see a longer trend over time.

You can examine the values of graph lines by moving your mouse cursor over them. The values under your mouse are shown on the left section, under the names of the graphed values. To go back and show the current values, simply move

your mouse away from the graph lines. You can also view statistical data about a particular line by moving your mouse over a graph line on the left and briefly pause. After a short wait, a small window will display the current value, the range, the minimum, the maximum, and the average for the graph line under your cursor. To dismiss this window, simply move your mouse away from the left section.

### 2.2.1. Customizing the System Graphs

You can customize which graph lines are displayed in the system graphs by clicking the wrench icon in that section. The settings window that opens, lists all the available graphs lines on your computer. You can add or remove graph lines by toggling the check boxes on each line. To change the order of the graph lines, move your mouse over the list of items. Two arrows will appear by the item that will allow you to move the item up or down in the list. You can also customize the line color by using the drop-down list on each line.

Once you have customized the system graphs to meet your needs, you can close the settings window. Your changes are automatically saved.

## 2.3. Understanding System Monitors

The system monitors provide a dashboard of values measured from the system. They are designed as prominent displays of data that can provide useful information at a glance. You can use the system monitors to get a prominent at-a-glance summary of values that are of interest to you or use them as immediate warning indicators when you are changing system settings.

Each system monitor consists of the name of the measured value, the current value, and a bar that shows the range of the measurement. The values in system monitors update real-time. You can view statistical data about a particular monitor by moving your mouse over it and briefly pause. After a short wait, a small window will display the current value, the range, the minimum, the maximum, and the average for the monitor under your cursor.

System monitors allow you to be aware of possible issues in your system by displaying warning colors in real-time. If the measured value for a monitor falls into a warning zone or a critical zone, the monitor glows with a distinct color to draw attention. Each monitor has its own zones defined for its particular purpose.

### 2.3.1. Customizing the System Monitors

You can add, remove, and reorder system monitors based on your monitoring needs. To organize the system monitors area, click the wrench icon in the section. The settings window that opens lists all available system monitors on your computer. You can add or remove system monitors by toggling the check boxes on each line. To change the order of the system monitors, move your mouse over the list of items. Two arrows will appear by each monitor. Use the arrows to move the item up or down in the list.

You can also change the colors for the default zone, the warning zone, and the critical zone. Note that changes made to the colors applies to all system monitors.

Once you have customized the system monitors to meet your needs, you can close the settings window. Your changes are automatically saved.

## 2.4. System Information

The system information screen shows the technical properties on your system. Intel® XTU queries your hardware and tabulates the values it reads from the system. The values are grouped based on the capabilities of your processor, your motherboard, and the other components in your computer. Many of these groups have corresponding controls in the manual tuning area. Such sections have blue arrows that allow you to jump to controls for that feature, under manual tuning.

The system information screen is for examining the state of the system settings that are relevant to performance. For this reason, the values shown in the system information do not update in real-time. For monitoring live data read from the system, you can use system graphs and system monitors.

## 2.5. Monitoring View

The monitoring view hides the top portion of the user interface to optimize the Intel XTU window for monitoring your system. In the monitoring view, you can use the system graphs and the system monitors to keep an eye on your system status. The smaller window makes it easy to find a space on your desktop.

To go back to the full view, click the Show All toggle on the top-right corner of the window.

## 3. Actively Monitoring the System

XTU provides several methods to be able to monitor the performance of the system. From the above descriptions, we can see that we can monitor everything from heat, utilization, frequency, to voltages.

### 3.1. Letting you Know

XTU visually indicates that a value has a warning, for either being triggered (on vs off) or has reached a higher than normal value, by changing the color of the value. The default changes the normal blue color to red or yellow, depending on the light, dark or custom color scheme.

### 3.2. Monitoring Your System

Choose one or more of the monitoring software solutions to use on your system. You will want to get familiar with the software to understand its options and capabilities. You will possibly use this software during stress tests and benchmarking.

#### 3.2.1. Key Items to Monitor

Monitoring the system during the first few times benchmarks are run will allow. Table 2 shows some of the key items to monitor.

The monitoring software may call a value something different, but it should be similar.

Table 2

Value	Description
CPU Temperature	What is the maximum temperature of the CPU during the benchmark/stress test runs?
Vcore (CPU Voltage)	What is the voltage of the CPU during the benchmark/stress test runs?
CPU Power (Package TDP)	What is the power consumption of the CPU?

### 3.2.2. Find and Resolve Problems

Monitoring the system during the first few times benchmarks are run, will allow you to quickly identify initial problem areas. These problems could be overheating or power problems. Addressing them prior to proceeding further will allow for a more stable and potentially higher overclock.

### 3.3. Stock Performance

Before attempting an overclock, documenting the performance of the base system is an important step. By having this baseline performance information, you will be able to see if improvements are being made or if the performance has decreased. Choose one or two key benchmarks to measure performance with and use them to generate the baseline for your system. Continue to use those benchmarks as you overclock the system.

### 3.4. Benchmarking BKM's

#### 3.4.1. Keeping track

Overclocking involves tracking many different numbers and values. If you have trouble remembering these measurements, track the numbers in a simple worksheet, or go low-tech and write them down on a piece of paper. Having a record of what you change and what the results are, will make understanding what is working and not working easier.

#### 3.4.2. Multiple Runs

To help eliminate variables, best practice is to run your benchmarks several times. Make sure to allowing time between runs for the system to cool down and normalize again. Scores may vary due to background tasks, ambient temperature changes, etc. By having multiple runs results to compare, you can see the range of performance and eliminate any outliers for a better indicator.

## 4. The Basics of Overclocking

At the most basic level, overclocking is modifying the system settings to allow the CPU to run at frequency above the stock specifications. Because the CPU frequency heavily influences the performance of the system, the main goal of overclocking is to



increase the frequency of the CPU, thereby increasing the performance of the system.

#### 4.1. Main “Knobs” for Overclocking

The three main “knobs” we can adjust to overclock a CPU:

- **BCLK:** The base clock speed or base frequency of the CPU. BCLK is usually measured in MHz (megahertz). Most systems today use a standard 100MHz BCLK
- **Core Multipliers:** Several different multipliers available are applied to the BCLK frequency, resulting in the core frequency, which is measure by GHz (gigahertz)
- **Vcore:** Core voltage is the main input voltage for the CPU. In general, higher frequency speeds will require more power to be stable. However, more power also results in more heat, which can also cause instability. It is a balancing act between the two, to achieve reliable, maximum performance. Vcore is measure in Volts or Millivolts.

Simply put:  $BCLK * Multiplier = Core Frequency$

E.g., 100MHz (BCLK) \* 50 (Multiplier) = 5.0GHz frequency. This GHz frequency is the number most often talked about, when looking at CPU performance or specifications.

#### 4.2. Increasing Frequency

With BCLK and multipliers in mind, to overclock, we simply increase the multiplier by a small increment (+1 for example) to increase the frequency by 100MHz. Then we run benchmarks to verify the stability of the system, measure the performance and compare it to the baseline

#### 4.3. Increasing Voltage

At some point, while increasing the multiplier, the system will become unstable. When that point is reached, increasing the Vcore could help stabilize the OC. After increasing the Vcore a small amount (e.g. 5 -10 mV), rerun the benchmarks and see if they are now stable.

#### 4.4. Make Small Changes

To help eliminate confusion, we recommended to only make small changes, one item at a time. If too many changes are made at the same time, it could be difficult to figure out what change caused instability and what could be done to improve stability

#### 4.5. Playing it Safe

Modern PC hardware is designed with safeguards to protect the system from potential damage due to power fluctuations or excess voltage and other events.

When overclocking, you may encounter these integrated safeguards, which are enabled in the power supply of the system. You may be able to disable or modify the parameters of these safeguards. However, it is not recommended unless you are confident in how to proceed, as you could potentially damage the hardware.

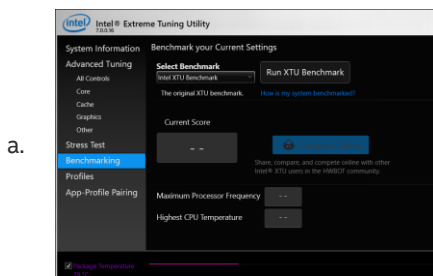
Here are some of the safeguards you might encounter:

- **Over Temperature Protection (OTP):** This limits the CPU temperature to a pre-established maximum. If the CPU temperature is too high, the CPU will throttle the frequency to bring temperatures back to safe levels. If this throttling still is not enough to sufficiently reduce temperatures, the system will automatically shut down.
- **Over Power Protection (OPP):** Motherboards are designed to sustain a certain level of power throughput. If your CPU's power consumption is too high, your system will activate this safeguard. Like OTP, when triggered it will reduce the system frequency to reduce temperatures. OPP will eventually shut down the system if lowering the frequency is not successful.
- **Overcurrent Protection (OCP):** Another safeguard present in all PCs. Current increases inside your CPU as voltage and frequencies go up. With certain motherboards, there is an option to change this value. (In Intel® XTU it can be done though the “Processor Core IccMax” setting. You will most likely have the same option in the BIOS.)
- **Over Voltage Protection (OVP):** Activates when the CPU input voltage is too high.
- **Under Voltage Protection (UVP):** The functional opposite of OVP. Here, your system will shut down if the CPU voltage is too low.
- **Short Circuit Protection (SCP):** SCP Activates when the motherboard detects a short. You should not deactivate this safeguard.

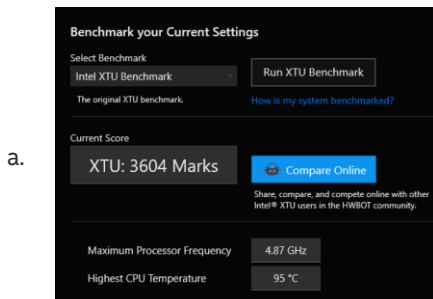
## 5. Let's Overclock!

There are many different methods to overclock. In this guide, we will be using XTU to overclock the system. XTU provides all the tools we will need to modify, test system stability, and benchmark the system.

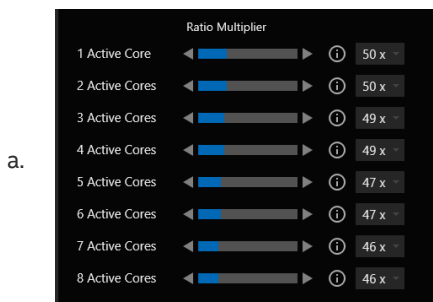
1. First, make sure your system has XTU installed and launched.
2. Setup up the different XTU monitors in the System Graphs and System Monitors of your choosing. Make sure Core Voltage, any "Throttle" indicators and all the core temps are showing
3. Next, go to Benchmarking section of the Navigation area and "Run XTU Benchmark"



4. After the benchmark has completed, note the score, maximum frequency, and highest temp for future reference



5. Select the Advanced Tuning section and scroll the window until you can see the Ratio Multiplier adjustments



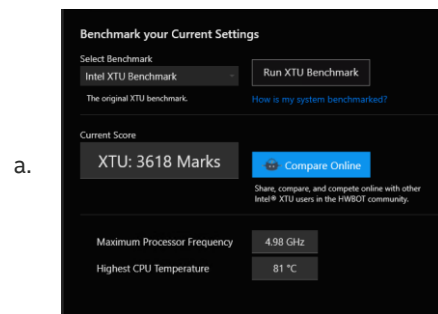
- b. Note: The multiplier for a larger "Active Cores" can never be higher than the multiplier of a lower number of Active Cores. E.g., if 6 Active Cores has a multiplier of 47, 7 and 8

Active Cores can only have a multiplier equal to or lower than 47

6. Next, change the highest Active Core setting to be equal to the next higher Active Core multiplier, by either moving the slider, selecting the multiplier and choosing a new value, or by clicking the left or right arrow around the slider. In this case, we will adjust to 47. The values should change color.



7. Select Apply and return to Benchmarking and re-run the benchmark. If the system is stable, you should have a new, higher score. Take note of the frequency and temperature.

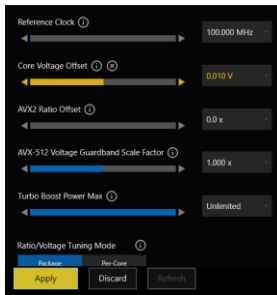


8. Though we only made a small change, the benchmark score did increase a small amount.
9. At this point, we keep increasing the lowest frequency multiplier by one and re-running the benchmark until the system is no longer stable: System crashing or blue screen, freezing, screen corruption or thermal throttling are all possible signs of instability

- a. If the system is thermal throttling, you may not be able to overclock the system further. Overclocking without improving the thermals of the system will only generate more heat and possibly damage the system. Solving thermal throttling mainly involves upgrading the CPU cooler but it can also be affected by poor overall thermals of the system
- b. After a system crash or other instability, you may need to reboot the system and re-apply the last multiplier setting that was used.

10. If the system is unstable but not thermal throttling, you can try to stabilize it by increasing the Core Voltage Offset by a small amount like 10 mV to 20mV. You can find Core Voltage Offset in the Advanced Tuning section, above the multipliers we adjusted before. Add a small amount and apply the settings.

a.

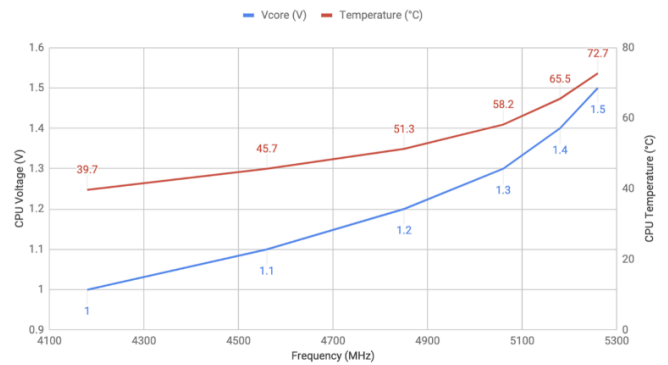


11. Once the setting is applied, re-run the benchmark, and see if the system is not stable. If it is not, you can continue to try to add additional small amounts to Core Voltage Offset until the system is stable again.
12. Once the system is stable again, we repeat the process:
  - a. Increase the multiplier and run the benchmark until the system is unstable
  - b. Add more voltage until the system is stable
  - c. repeat
13. At some point, the system will no longer be stable no matter how much additional voltage is applied or the system thermal throttles. Increasing the voltage will

always increase the amount of heat generated (see Table 3)

Table 3

Scaling of Voltage, Temperature and Frequency



### 5.1. Recovering from System Instability

When overclocking, we push the limits of the system. At some point, the system will become unstable. The most likely outcome is the system freezing or locking up. In those cases, you can usually restart the system using the reset button. If the system is not responding to the reset button (or if you do not have a reset button), you can use the power button.

In some cases, the system will not restart correctly. You may need to reset the BIOS CMOS to clear any corrupt settings to get the system to boot. Note that any setting previously set in the BIOS may need to be re-applied.



## 6. References & Disclaimers

Performance varies by use, configuration, and other factors. Learn more at [www.Intel.com/PerformanceIndex](http://www.Intel.com/PerformanceIndex).

Performance results are based on testing as of dates shown in configurations and may not reflect all publicly available updates. See backup for configuration details. No product or component can be absolutely secure.

Altering clock frequency or voltage may void any product warranties and reduce stability, security, performance, and life of the processor and other components. Check with system and component manufacturers for details.

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R1.0 05/15/2021	Original Release
R1.1 05/17/2021	Formatting Corrections
R1.2 06/07/2021	Table Fixes and Grammar Corrections