Ryzen 3000 Series
Memory Overclocking Guide

DDR4 on X570 Platform

For more information, visit www.corsair.com
Introduction
When you first install your new CORSAIR memory modules, you may notice them not running at the advertised speed – because the system wants to make sure it boots without any hiccups. For Ryzen 3000 series CPUs, peak system performance is observed between 3,200 and 3,600MHz, so how do we get there? It should be noted that anything over 2,133MHz is technically considered “overclocked,” but don’t worry; all our memory goes through a meticulous screening process to ensure that it’s stable at the advertised speed. Be sure to check out the “Additional Resources” section for further assistance, including a DRAM calculator which helps you find the best values for your DRAM. Lastly, while some terminology differs between different motherboard manufacturers, with a reference table at the end of this guide.

Specifications for system used in this article:
CPU: AMD Ryzen 3800X
CPU Cooler: CORSAIR H100i PRO CPU Cooler
GPU: Nvidia GTX 1070
Motherboard: Gigabyte AORUS Master X570
  • BIOS Version: F4
  • Revision Date: 06/13/2019
Operating System: Windows 10 Pro
  • Version: 1809
  • Build: 17763.615
PSU: CORSAIR RM750
RAM: 16GB (2x8GB) 4000MHz VENGEANCE RGB PRO
System Drive: CORSAIR NEUTRON NX500 – 480GB
System Housing: Open test bench
Basic Setup – Enabling XMP/DOCP Profile

On most motherboards, you can usually get by with simply enabling built-in “overclocking” profiles, which will show up as an “XMP” (Extreme Memory Profile) or “DOCP” (DRAM Overclocking Profile) setting. In essence, XMP and DOCP are the same thing.

To enable the built-in memory profiles, first boot into your system’s BIOS by turning your computer on, and when you see the logo splash screen, press the DEL key on your keyboard.

- Tip: You don’t have to wait until prompted, you can press DEL repeatedly until you see the BIOS screen pop up

Once in your system’s BIOS, use the left/right arrow keys on your keyboard to navigate to the “Tweaker” tab. Here, you’ll see a lot of options for overclocking your CPU, memory, and more. Since we’re only worried about overclocking memory, find the “Extreme Memory Profile (X.M.P)” option. By default, it’s disabled, as shown below.

To enable the profile, use the up/down arrows to navigate to the XMP setting, then press the “Enter” key. A small window will pop up with profile options. Again, using the up/down arrows, navigate to desired option and press the “Enter” key once again; in the image below, “Profile 1” was selected.
Once the “Enter” key is pressed, the small window will close and you’ll see your memory kit’s speed, timings, and voltage settings in the right column.

Note: A 4000MHz memory kit was used for these screenshots. XMP settings will display the speed of the memory in your system.

To save your settings and exit the BIOS, use the left/right arrow keys to navigate to the “Save & Exit” tab and press the “Enter” key. Your system will ask if you want to save the changes you’ve made; confirm this by navigating to the option with the arrow keys, then use “Enter” to select. Your system will now reboot with the new settings.

This is an incredibly quick and easy method, and if the system boots up like it should, you’re all set! There may be times when you want or need to manually change settings to improve system stability, and the next section will show you how.
ADVANCED SETUP – RECOMMENDED SETTINGS

In this section, we’ll walk you through manually configuring your CORSAIR memory. We’ll also assume you know how to navigate the BIOS using the arrow keys, make selections with the “Enter” key, etc.

MEMORY SPEED ADJUSTMENT – System Memory Multiplier

We stated earlier that the memory speed sweet spot for the Ryzen 3000 & X570 platform was between 3200 and 3600MHz, so we’re going to go with the latter and set our system our memory to 3600MHz. The first setting you’ll want to change under the “Tweaker” tab is the “System Memory Multiplier.” This is the number you’ll multiply with the “BCLK” (Base Clock) which Gigabyte calls “CPU Clock Control.” In the image below, you’ll see it has a value of 100.00MHz. To determine the value for the System Memory Multiplier, use the following formula:

\[
\text{System Memory Multiplier} = \frac{\text{Target Memory Speed}}{\text{BCLK (Base Clock)}}
\]

Substituting our known values for “Target Memory Speed” and “BCLK”

\[
\text{System Memory Multiplier} = \frac{(3600\,\text{MHz})}{(100.37\,\text{MHz})} \approx 36.00
\]

If the “System Memory Multiplier” line is highlighted, you can simply start typing the numbers, then press enter to confirm your input.
INFINITY FABRIC – Infinity Fabric Clock Speed (FCLK)

On Ryzen systems, the latency and available bandwidth for all connected components like the DRAM controller, PCIe bus, etc. is based off the Infinity Fabric speed (FCLK). All of this occurs in an interconnect AMD calls “Infinity Fabric.” The Infinity Fabric clock speed (FCLK) is configurable and directly relates to the memory clock (MCLK). For Ryzen 3000 CPUs, most will run a 1:1 ratio between FCLK and MCLK, which can be considered “synchronous” operation, up to 1,800MHz. There may be instances where the FCLK may be set to operate in an “asynchronous” mode (not a 1:1 ratio), which may introduce increased latency, thus negating any performance benefit. However, for extremely high MCLK values (> 3,600MHz), asynchronous operation may actually increase overall performance, at the cost of stability.

Previously, we defined the “System Memory Multiplier” to be 36.00, which gave us our target effective memory clock speed of 3,600MHz. However, since the system memory is “DDR” (Double Data Rate) the actual memory clock speed of the RAM (MCLK) is 1,800MHz. Why is that? Double data rate defines the way data is sent with every clock cycle; clock cycles have both a rising and falling edge. Older Single Data Rate memory (SDR) would only send data signals on the rising edge, but DDR sends data signals on both the rising and falling edge, effectively doubling the rate in which data is transmitted, and this gives us our effective memory clock speed of 3,600MHz.

![Figure 1: Single Data Rate vs. Double Data Rate (Source: Wikipedia)](image)

For FCLK adjustment, we’re only interested in MCLK, or the actual memory clock speed – 1,800MHz.

To access FCLK adjustment, navigate to:
*Settings > AMD Overclocking*
Accept the warning, then select **DDR and Infinity Fabric Frequency/Timing**

Choose “Infinity Fabric Frequency and Dividers” and you’ll see the option to configure the Infinity Fabric Frequency. If left on “Auto,” the system will do its best to achieve FCLK = MCLK, which is what we’re aiming to achieve in this guide. However, knowing how to manually set the values will give more flexibility for future overclocking endeavors.

*Note: DDR timing adjustments will be made under the “Tweaker” tab*
Recall that for this guide, we wanted the FCLK to equal MCLK for the best overall performance. Our actual MCLK value was 1,800MHz, so that’s what we’ll choose here. Highlight the desired value, then press the Enter key to select. Your FCLK is now manually set.

**VOLTAGE ADJUSTMENT**

Under the “Tweaker” tab, navigate to “DRAM Voltage.” Once highlighted, change the value to 1.35V.
TIMINGS

Now, navigate to “Advanced Memory Settings” and press “Enter.”

You’ll be presented with two options: “Memory Subtimings” and “SPD Info.” Select the “Memory Subtimings” option.

You’ll be presented with the screen below. By default, all the options are set to Auto.
However, we need to manually set CAS Latency, tRCDRD, tRCDWR, tRAS and tRAS. For our 3,600MHz speed, for this kit, we used the following timings:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS Latency</td>
<td>16</td>
</tr>
<tr>
<td>tRCDRD</td>
<td>18</td>
</tr>
<tr>
<td>tRCDWR</td>
<td>18</td>
</tr>
<tr>
<td>tRAS</td>
<td>36</td>
</tr>
</tbody>
</table>

To input these values, simply highlight each line, then type the associated value as shown in the table.

If you have a 3,600MHz C18 kit, the timings you’ll want to use are as follows:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS Latency</td>
<td>18</td>
</tr>
<tr>
<td>tRCDRD</td>
<td>22</td>
</tr>
<tr>
<td>tRCDWR</td>
<td>22</td>
</tr>
<tr>
<td>trP</td>
<td>22</td>
</tr>
<tr>
<td>tRAS</td>
<td>42</td>
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</table>

**ADDITIONAL SETTINGS**

There are other settings which are generally fine to be left on “Auto” but there may be instances where you encounter instability, even with the recommended values. The options we’re looking at are: **Command Rate, Gear Down Mode, and ProcODT**.

**Command Rate** (Command Per Clock): This value can be defined as the delay, in clock cycles, between the memory controller latching onto an available memory bank, a process which is known as “Chip Select.” Common values for this are 1T and 2T.

- For example, with the most commonly used 2T value, it will take two clock cycles to find an available memory chip for the memory controller to communicate with. Reducing this to 1T can improve performance but with the possibility of instability in the system; the memory controller may not properly find a memory chip to latch onto, thus introducing errors.

**Gear-Down Mode**: This is reliability, availability, and serviceability (RAS) function for high speed RAM, only for RAM speeds in excess of 2,666MHz. During normal operation (½ rate), DRAM Address, Command, and Control use every rising edge of the clock signal, but with Gear-Down these are pushed to every other rising edge to ensure maximum compatibility and stable operation (¼ rate).

- This setting isn’t necessary if you can achieve stable overclocking on your system memory.
- Use this mode if your overclock settings are causing instability.
**ProcODT (Processor On-Die Termination):** This setting determines when the memory signal is terminated, and values between 40Ω and 60Ω have been shown to help increase stability when overclocking system memory.

- The symbol “Ω” is the Greek capital letter omega. This is used to show that a value’s unit of measurement is “Ohms,” a measure of electrical resistance. If you add more electrical resistance, more heat will be produced, so unless you’re cooling your system memory with a custom solution, stick between 40Ω and 60Ω.
- You can freely play with this value between those bounds until you find what works best for your system configuration.

When you’re all done with these configurations, save the settings and exit the BIOS.

Overclocking system memory isn’t an exact science, and there may be times where some values may need to be adjusted, but with the information provided here, you should be able to get your system memory performing at its best in no time.

**ADDITIONAL INFORMATION**

**Memory Controller Limitations:** While AMD’s Ryzen 3000 platform is beastly and supports extremely high memory speeds, the memory controller does still have limitations, and those limitations become noticeable when populating all four DIMM slots with either single or dual rank memory.

- A memory’s “rank” is determined by how many sets of memory chips are present that are read/written from/to; ultimately, the higher the rank, the longer the read/write process takes
  - Single-rank only has one set of memory chips.
  - Dual-rank has two sets of memory chips, but only one may be accessed at a time.
- Table of potentially achievable speeds for various RAM configurations:

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<th>Configuration</th>
<th>Max Safe Speed (Up to)</th>
<th>OC Speed (Up to)</th>
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</thead>
<tbody>
<tr>
<td>2 x 1 Rank</td>
<td>3600MHz</td>
<td>4400MHz</td>
</tr>
<tr>
<td>2 x 2 Rank</td>
<td>3600MHz</td>
<td>4000MHz</td>
</tr>
<tr>
<td>4 x 1 Rank</td>
<td>3600MHz</td>
<td>4000MHz</td>
</tr>
<tr>
<td>4 x 2 Rank</td>
<td>2933MHz</td>
<td>3600MHz</td>
</tr>
</tbody>
</table>

Disclaimer: The figures listed here represent observed speeds in our own testing; variations in system specifications or environment may reduce overall performance.
**SoC (System-on-Chip) Voltage**: SoC voltage is the voltage supplied to supplementary components like the, known as “System-on-Chip.” Most motherboards will automatically adjust SoC Voltage to accommodate overlocks on DRAM. This value can be manually adjusted.

- You must be very careful with adjustment of these values, due to potential inaccuracies in how voltage is being measured and reported; while you may set the SoC voltage to a safe level, variations that exceed the upper limit could irreparably damage your CPU or other components.
- 1.2V is generally considered the upper limit of safe SoC voltages, particularly on Ryzen 3000 CPUs.
- Many motherboards will automatically adjust SoC voltage to suit other overclocking settings you’ve changed.

**ADDITIONAL RESOURCES**

**Ryzen DRAM Calculator** by 1usmus
- [https://www.techpowerup.com/download/ryzen-dram-calculator/](https://www.techpowerup.com/download/ryzen-dram-calculator/)
- This tool will help tailor your DRAM configuration for stable overlocks with your specific system memory.

**CORSAIR Community Forums**
- [http://forum.corsair.com](http://forum.corsair.com)
- Community driven, CORSAIR supported.
### Reference Guide for Manufacturer Differences in Terminology and Configuration Locations

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<th>ASUS</th>
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<td>OC section (in Advanced Mode)</td>
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<td>“FCLK Frequency”</td>
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<td>“Ai Overclock Tuner”</td>
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<td>“A-XMP”</td>
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<td>Tweaker tab</td>
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