Booting from an NVMe* PCIe* Intel Solid-State Drive

Technology Brief

April 2015

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Introduction

This document serves as a guide for end users who intend to implement NVMe* PCIe* Solid-State Drives as a bootable medium in their desktop PC.

The information in this document is not applicable if the SSD is being used as a secondary storage device rather than the primary boot device. This guide will not cover the physical installation of the device. More information regarding the physical installation of your NVMe PCIe SSD into your system can be found at the Intel Support Website.

The information and instructions in this guide apply only to Intel Solid-State Drive 750 Series. Please verify with your motherboard vendor that you have the latest instructions and compatibility information before attempting to install the 750 Series.

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Table 1: Terminology

Abbreviation	Term	Definition
NVMe	Non-Volatile Memory Express	The next-generation specification used to access SSDs through the PCI Express bus with greater throughput and lower latency.
PCIe	Peripheral Component Interconnect Express	A standard connection found on most systems that supports the high speed of the NVMe SSD.
UEFI	Unified Extensible Firmware Interface	A specification for system firmware, meant to replace legacy BIOS, that provides software layer between the operating system and the system firmware.
CSM	Compatibility Support Module	A UEFI firmware feature that enables legacy BIOS-style booting by emulating a BIOS environment.

Table 2: References

Document	Location
NVMe Specification 1.1b	http://www.nvmexpress.org/wp-content/uploads/NVM_Express_1_1b.pdf
UEFI Specification 2.4 (Errata B)	http://www.uefi.org/sites/default/files/resources/2_4_Errata_B.pdf

Technical Overview

Because NVMe is still a maturing technology, configuring your system to boot from an NVMe SSD can be a confusing task. To better understand the end goal and to troubleshoot more effectively, it is important to have a general understanding of UEFI and the boot process.

Booting from an NVMe PCIe SSD is only supported on a system that supports UEFI, a new system firmware that endeavors to improve upon legacy BIOS and standardize system processes such as booting, loading drivers, and more.

It is important that the operating system installer is booted in UEFI mode to properly configure the operating system to also boot in UEFI mode. Booting in UEFI allows the installer to create an entry in the UEFI boot menu and create an EFI system partition on the boot device which will contain the bootloaders of installed operating systems.

When the system boot process starts, the UEFI boot manager begins loading the UEFI driver imbedded within the firmware of the SSD. This process allows the system firmware to access the SSD, including any partitions residing on the device. The boot manager will continue by searching the EFI system partition for a valid operating system bootloader. This bootloader is then executed to load the operating system.

Determining Compatibility

Booting from an NVMe SSD is not guaranteed to work on every system configuration; specific requirements must be met for a successful boot.

System Compatibility

In order to support the required UEFI NVMe driver, your system's firmware must be based on UEFI 2.3.1 or later.

If your system was purchased after 2012 or shipped with Windows* 8 pre-installed, it most likely supports UEFI. Check with your system vendor to verify.

Operating System Compatibility

In order to successfully use an NVMe PCIe SSD as a boot device, the operating system must support NVMe, either natively or through an additional driver. The operating system must be 64-bit for UEFI support. For best compatibility, Windows* 8.1 is recommended because of its integrated NVMe driver.

Table 3: Windows Compatibility

	Support	Additional Notes
Windows 8.1	Supported	Native NVMe support
Windows 8	Supported	Required additional drivers during installation
Windows* 7	Limited Support	Limited system compatibility and requires additional drivers

Windows 7 Compatibility Notes

Windows 7 does not support native UEFI booting without a Compatibility Support Module. As a result, system compatibility is limited and varies by vendor. In order to properly boot Windows 7 from an NVMe SSD, your system must support loading UEFI drivers when the Compatibility Support Module is enabled. Refer to the first example later in this document for an example of this configuration.

Motherboard Configuration

NVMe is still a new specification, therefore many motherboards are not properly configured (out of the box) to boot from NVMe SSDs. Successful motherboard BIOS configurations vary widely and are heavily dependent on the motherboard manufacturer. There is no specific set of options that will guarantee a successful boot, usually the following setting of a typical motherboard will need to be adjusted.

The first step is to ensure you have the latest UEFI BIOS loaded onto your motherboard. Check your motherboard vendor support website to find the latest UEFI BIOS for your particular motherboard. Second, the system must be configured to boot from UEFI devices. This is often the default on most modern motherboards. For best chance of success disable legacy boot.

The majority of relevant settings are typically found in the Compatibility Support Module (CSM). In general, it's best to leave this enabled or automatic if that option is provided if you are booting into Windows 7. This will allow the firmware to intelligently decide how to best optimize compatibility. However, on certain systems, such as Gigabyte motherboards, the CSM should be disabled for proper support.

In practice, successfully booting from an NVMe device requires trial and error along with patience as you experiment with different combinations of relevant settings. Refer to your system's user manual for information on how to adjust these settings.

As the industry matures, motherboard vendors will continue updating their platforms to support near plug and play compatibility.

Example configurations are listed below for reference. Please note that these required configurations may change as NVMe support matures.

Example: Gigabyte X99-UD4 BIOS Configuration

Specifications

Motherboard: Gigabyte X99-UD4
Chipset: Intel® X99 Chipset
BIOS Revision: F5

Compatibility Notes

With optimized defaults, this motherboard will properly support booting Windows 8.1 from an NVMe SSD. If using Windows 7, the CSM must be configured to load UEFI drivers first in order to successfully boot from PCIe devices. This example can be used as a general guide for other motherboard settings if using a different brand.
There will be similar settings and functions to ensure NVME boot ability with Windows 7.

Required Configuration

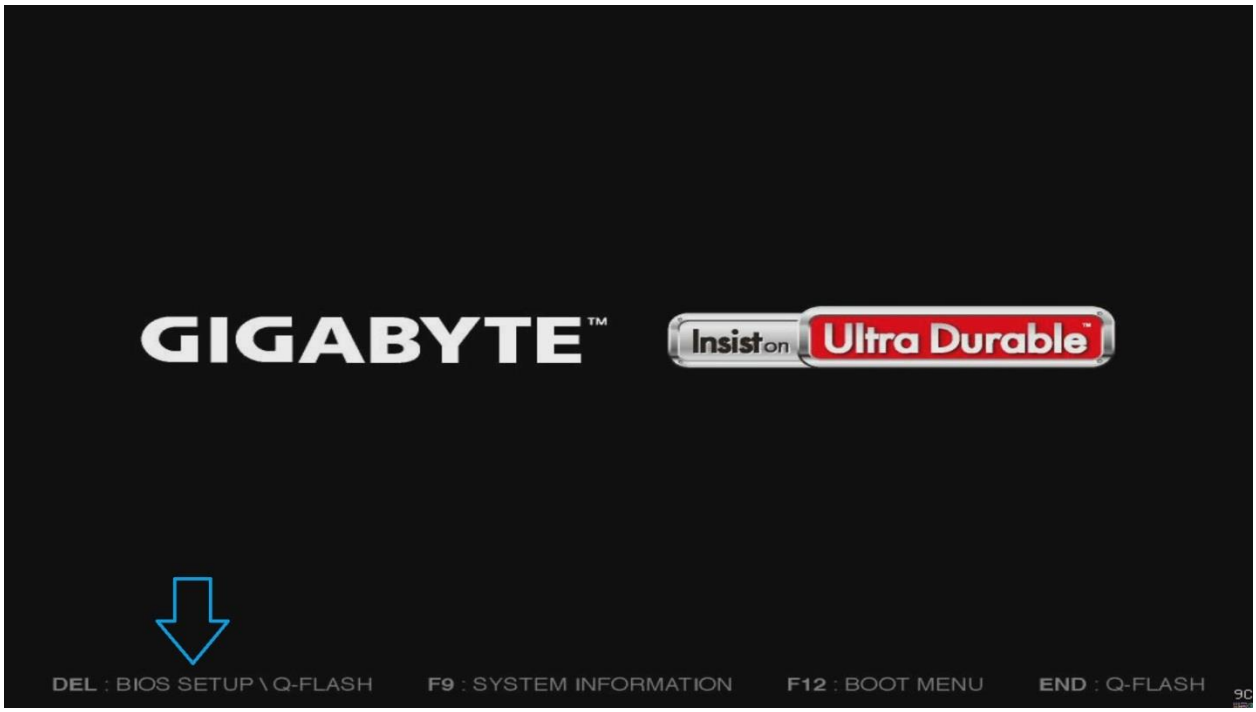
Windows 8 or 8.1

Ensure Windows 8 Features listed under the BIOS Features Tab are set to UEFI for the following Settings:
->Storage Boot Option Control->UEFI; Other PCI Device ROM Priority->UEFI

Windows Guide

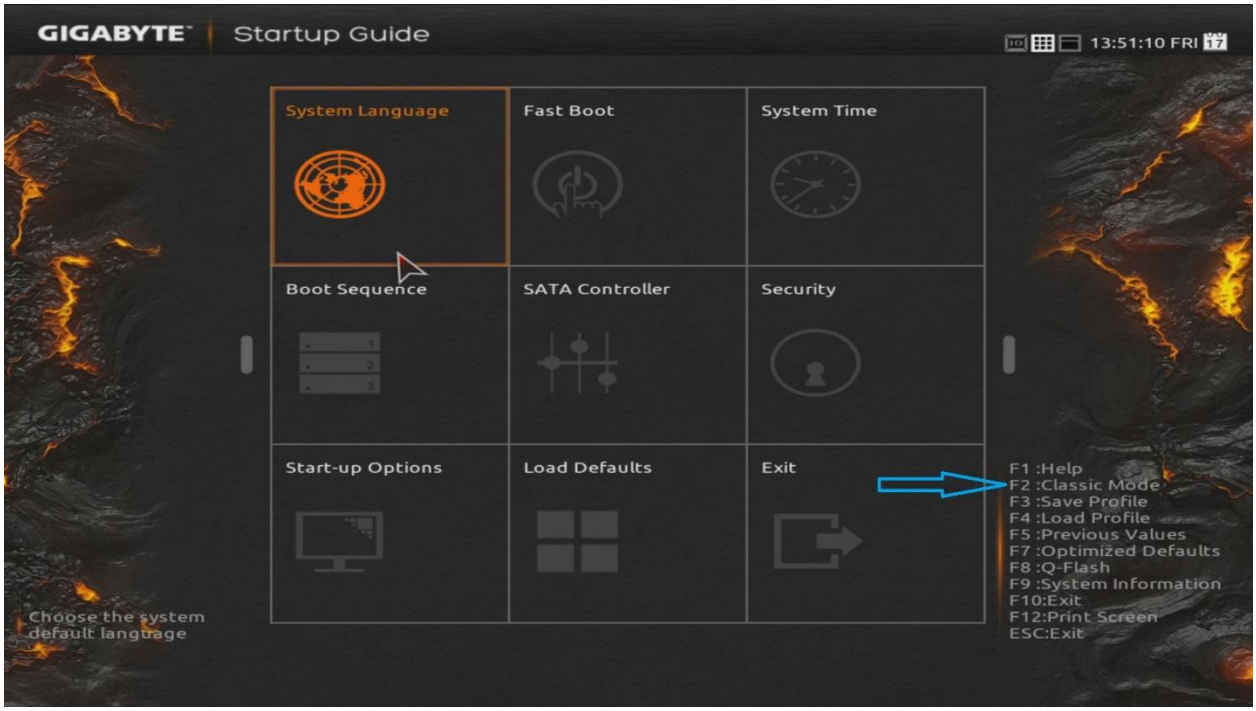
Windows 7

On first boot of the Gigabyte X99 UD4 you will want to ensure that you are starting from the optimized defaults. To ensure that you are running from the optimized defaults press the **Delete** key and enter the BIOS.

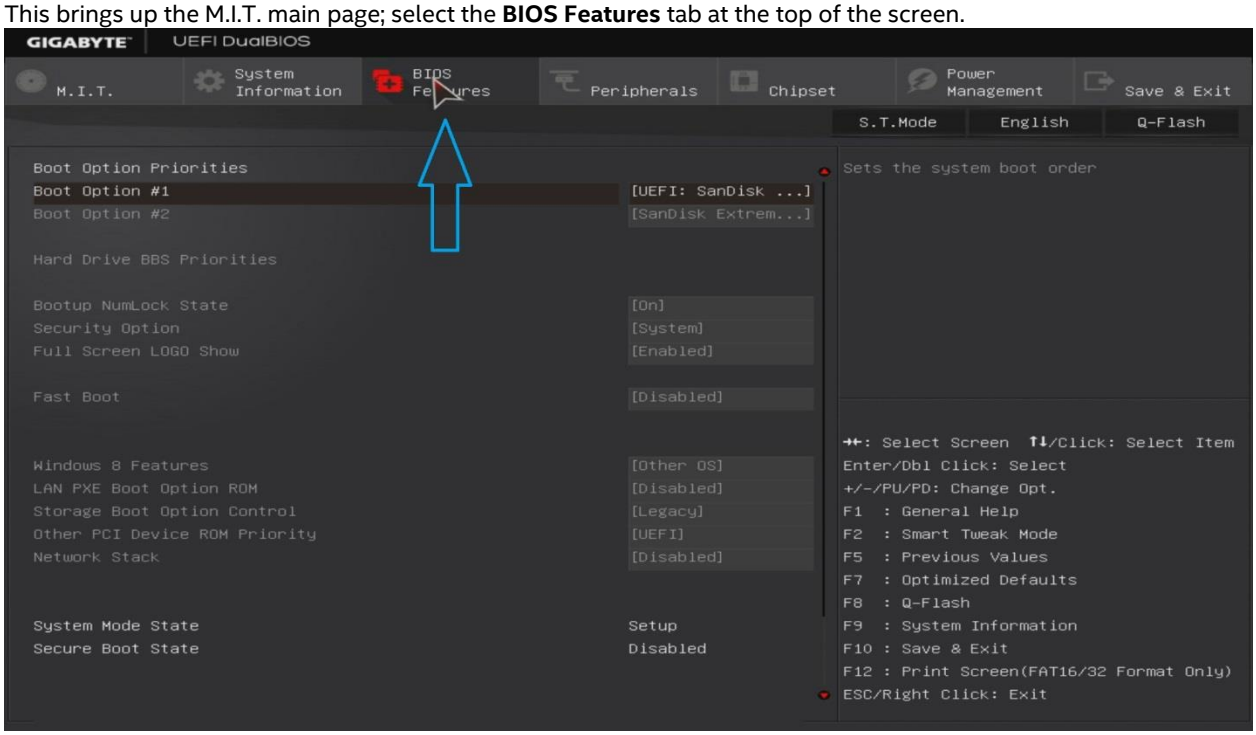


You will be greeted by either the Language selection screen or the 9 space grid. Press the **F7** key and confirm the optimized default selection, then press **F10** to save the settings and reboot.

Once the Startup Guide screen displays Press **F2** to enter **Classic Mode**.

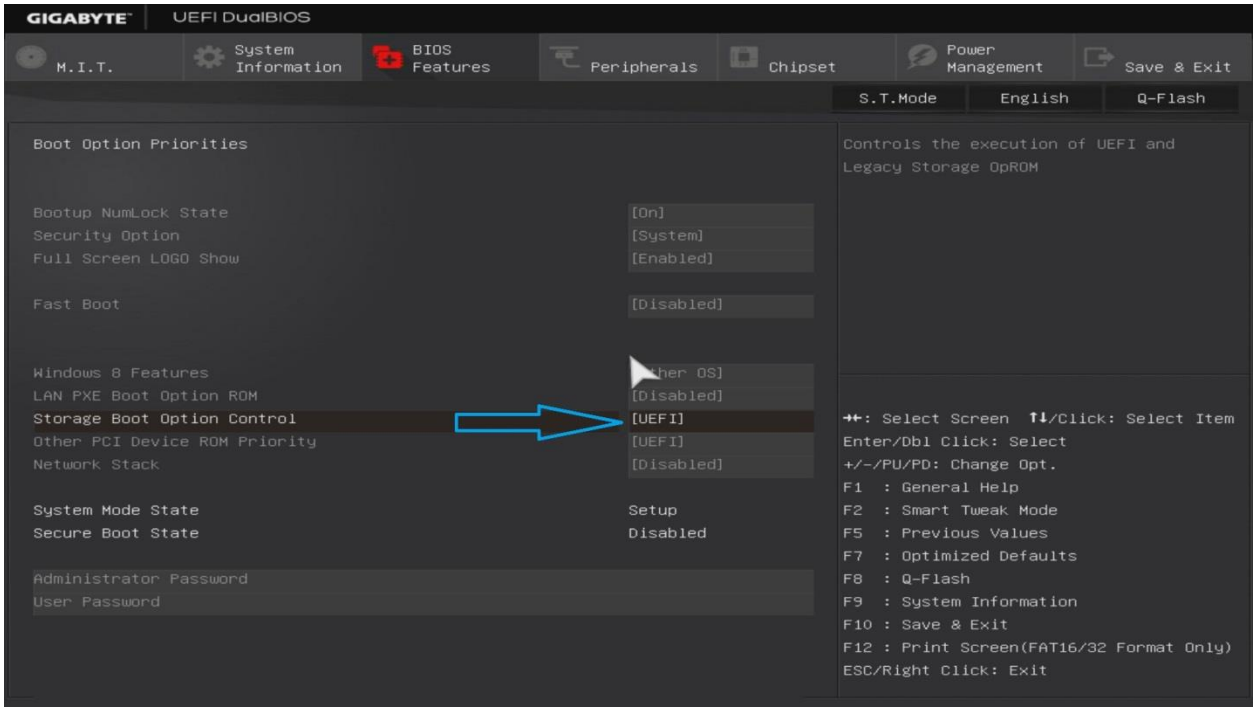


This brings up the M.I.T. main page; select the **BIOS Features** tab at the top of the screen.

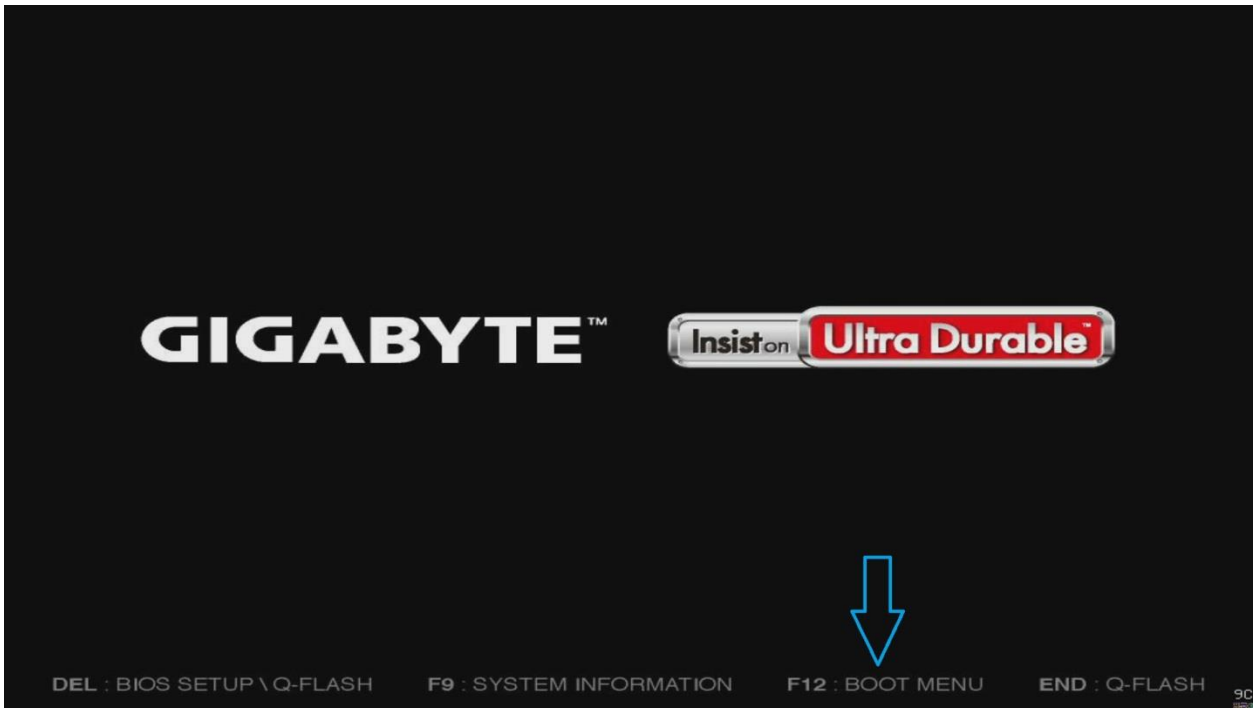


To set the system up to install Windows 7 leave the **Windows 8 Features** on **Other OS**.

On the Storage Boot Option Control change the setting from **Legacy** to **UEFI.**

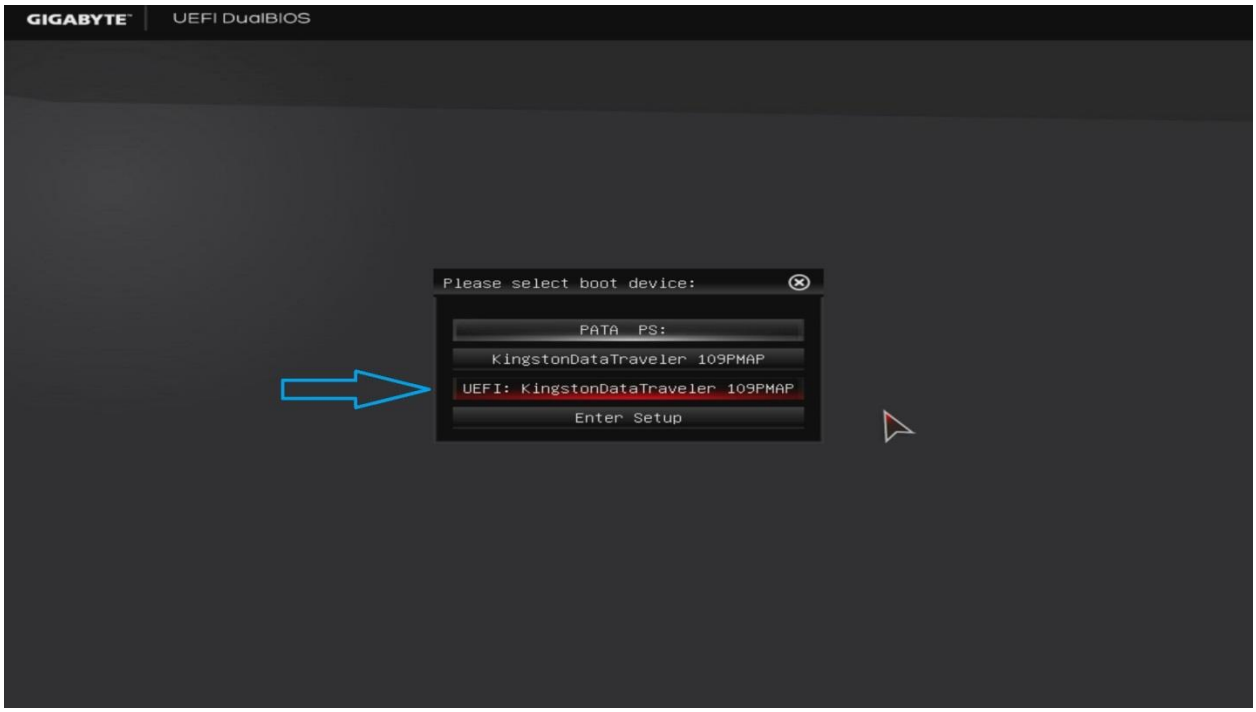


Press **F10** to **Save & Exit**.

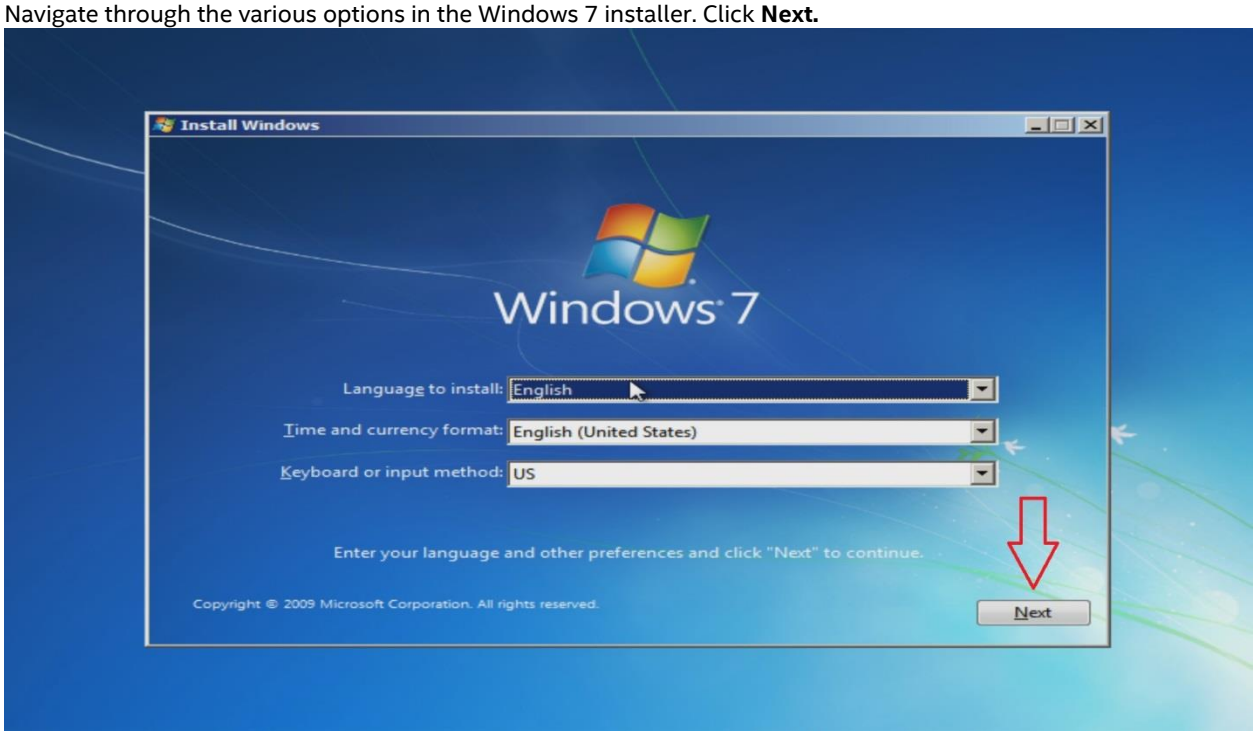


Press **F12** to enter the **Boot Menu** after the system has rebooted.

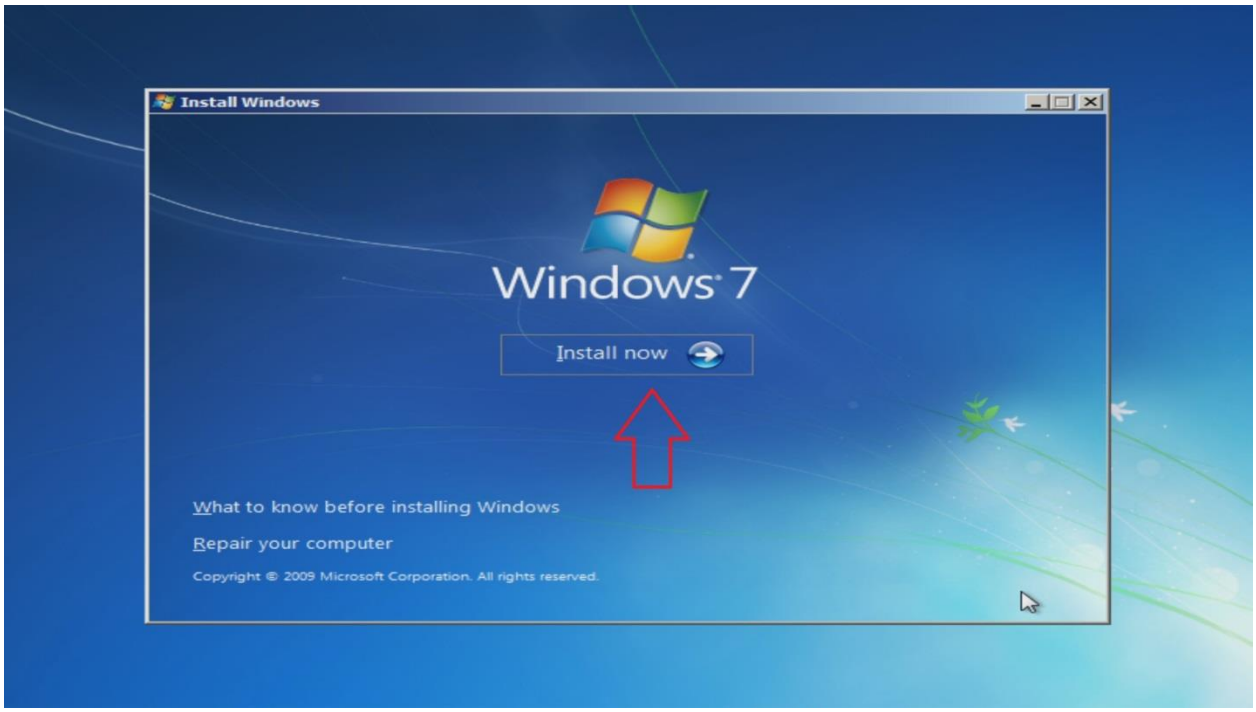
When the boot manager prompt displays on the screen, select the **UEFI: option.**



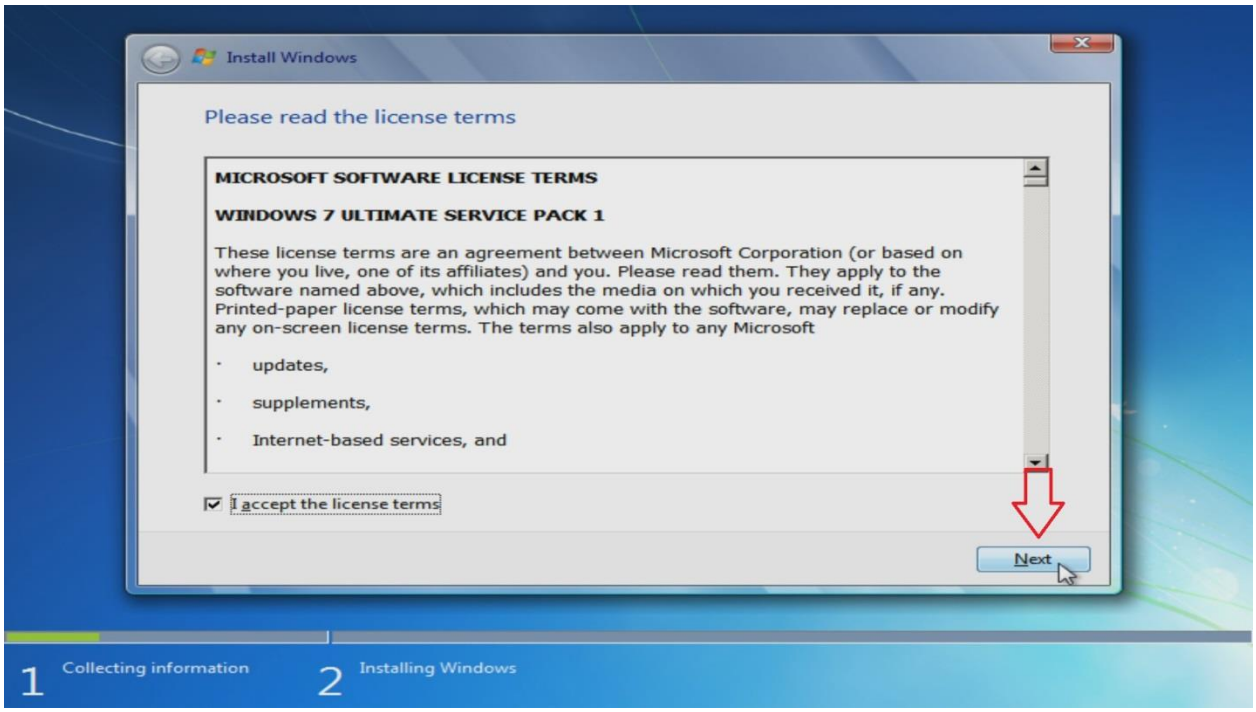
Navigate through the various options in the Windows 7 installer. Click **Next.**



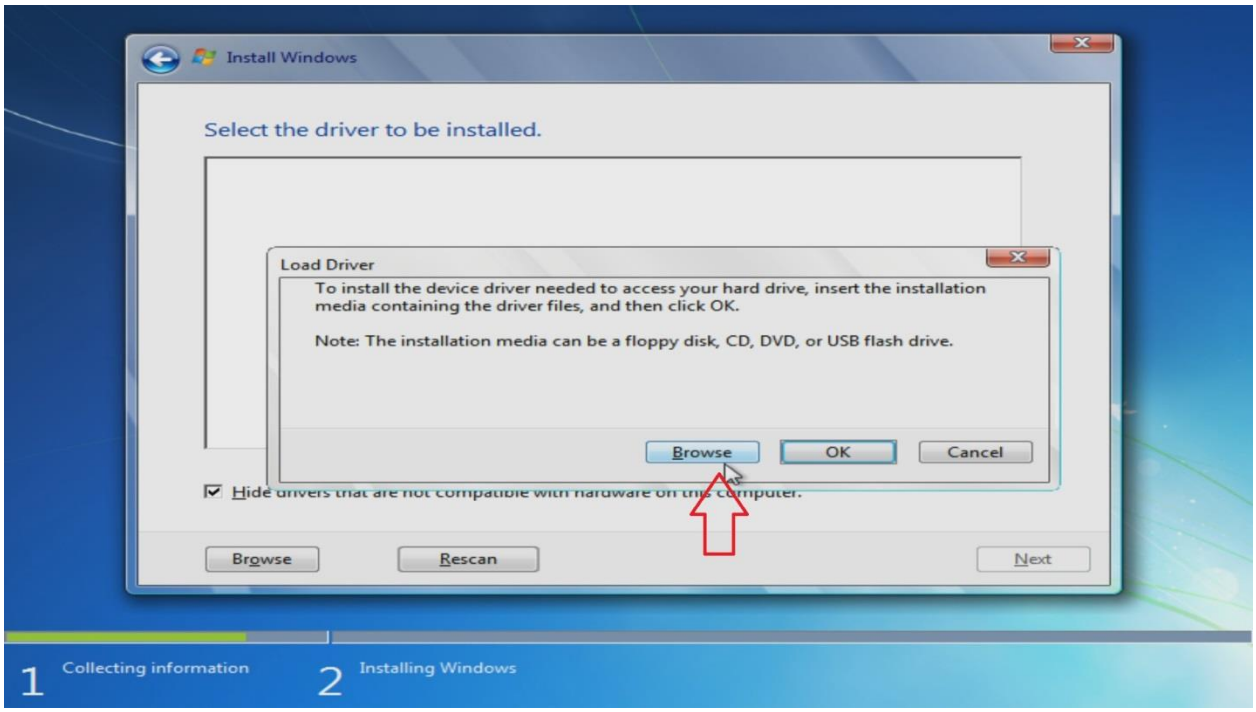
Click **Install now.**



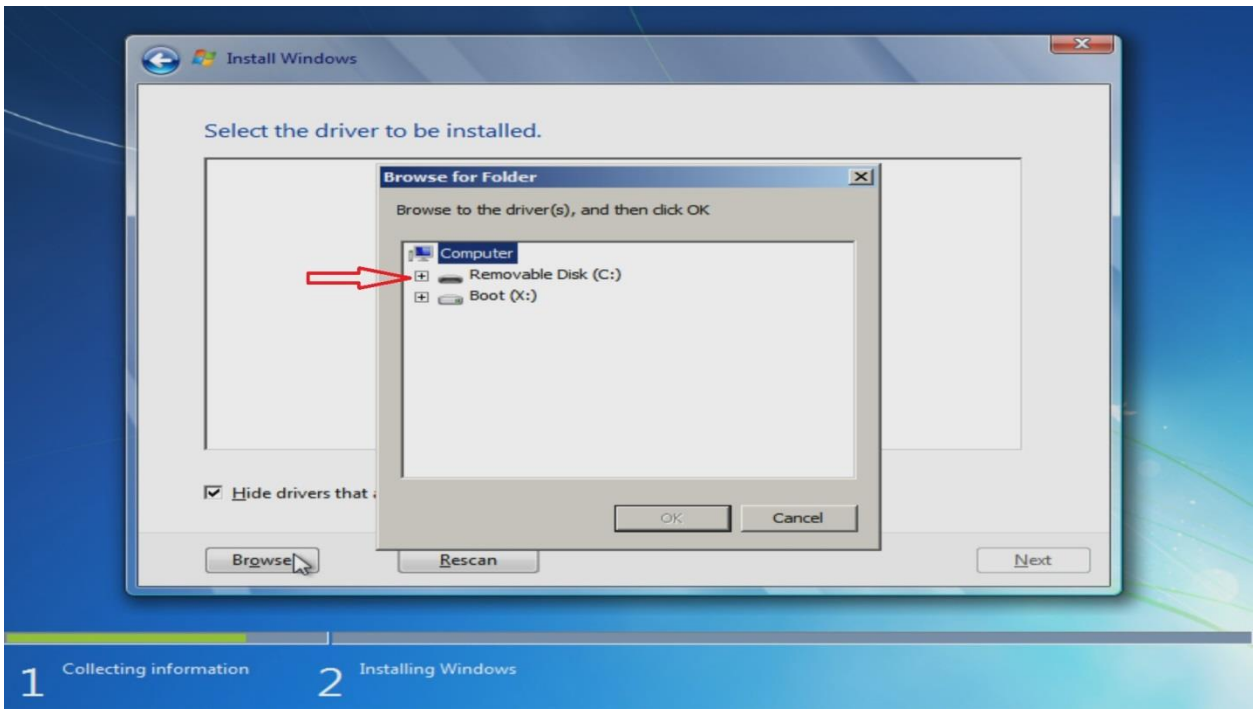
Read through the license terms, accept them and click **Next**.



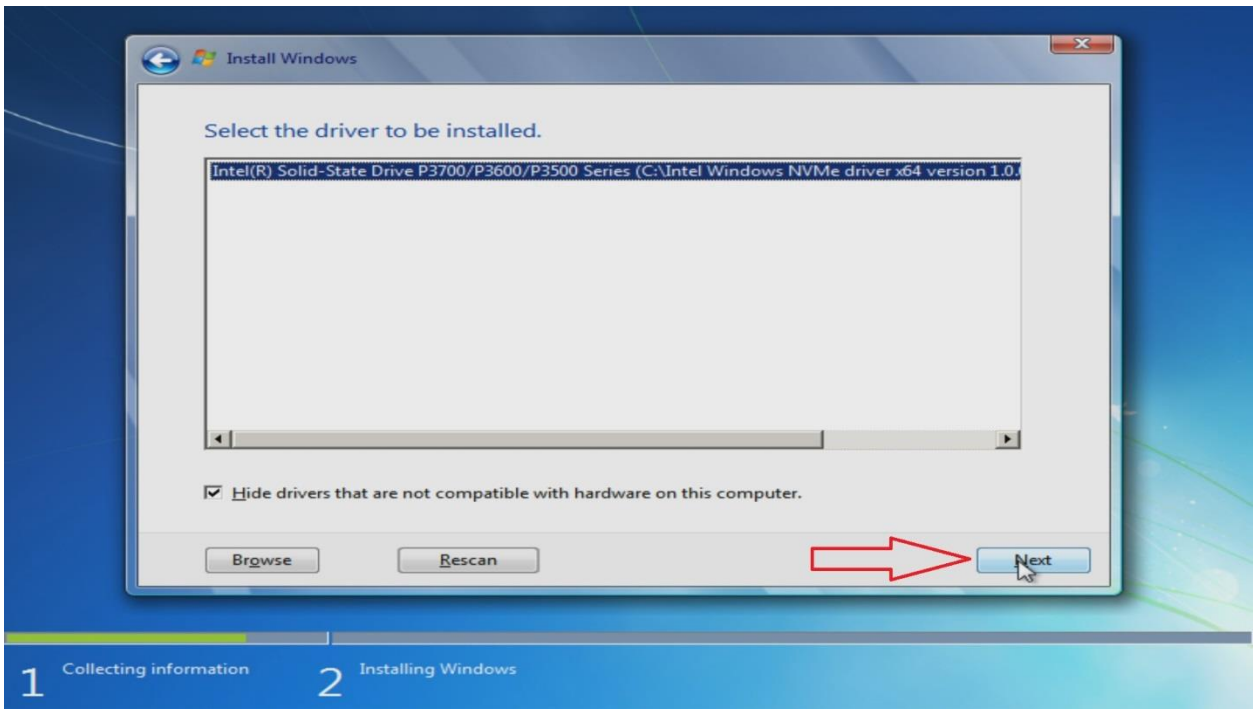
You will be presented with a screen with no visible storage to choose to install to. Select **Load Driver.**



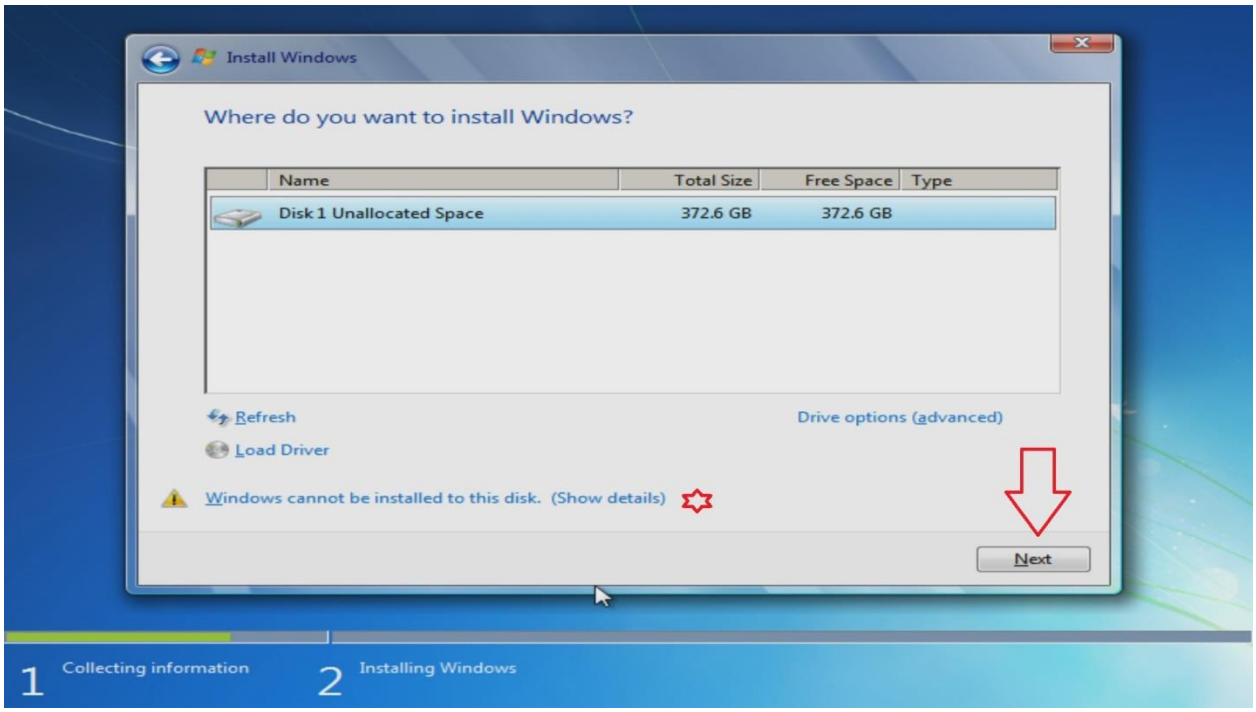
Verify that you have preloaded your CD/DVD/USB with the **Intel 750 Series NVMe Driver** folder.
Select the **Browse** option and select your **Removable Disk/CD/DVD**.



Navigate through “750 Series Driver for Windows pre-installation” and select the driver. When you select the “750 Series Driver for Windows pre-installation” sub folder it may take up to 60 seconds to pre-load the driver into the installation. When it has finished the following screen will display, with the driver auto-selected, click **Next** to continue.



At this stage the disk should be visible in the Installation process. It’s possible that a warning will display stating that “**Windows cannot be installed to this disk**.” Simply hit **Next** and the installation should go forward from this point.



Your installation will now proceed and will have a number of automated reboots after this. This process will end at the Windows 7 customization menu allowing you to finish with the personalization of the OS.

Examples

Example: ASUS Z97 BIOS Configuration

Specifications

Motherboard: ASUS Maximus VII Gene
Chipset: Intel® Z97 Chipset
BIOS Revision: 1002 (7/08/2014)

Compatibility Notes

With optimized defaults, this motherboard will properly support booting Windows 8.1 from an NVMe SSD. If using Windows 7, the CSM must be configured to load UEFI drivers first when booting from PCIe devices.

Required Configuration

Windows 8 or 8.1

No additional configuration is required.

Windows 7

1. Open **CSM (Compatibility Support Module)** under the **Boot** tab
2. Verify that **Launch CSM** is **Enabled**
3. Set **Boot from PCI-E/PCI Expansion Devices** to **UEFI driver first**

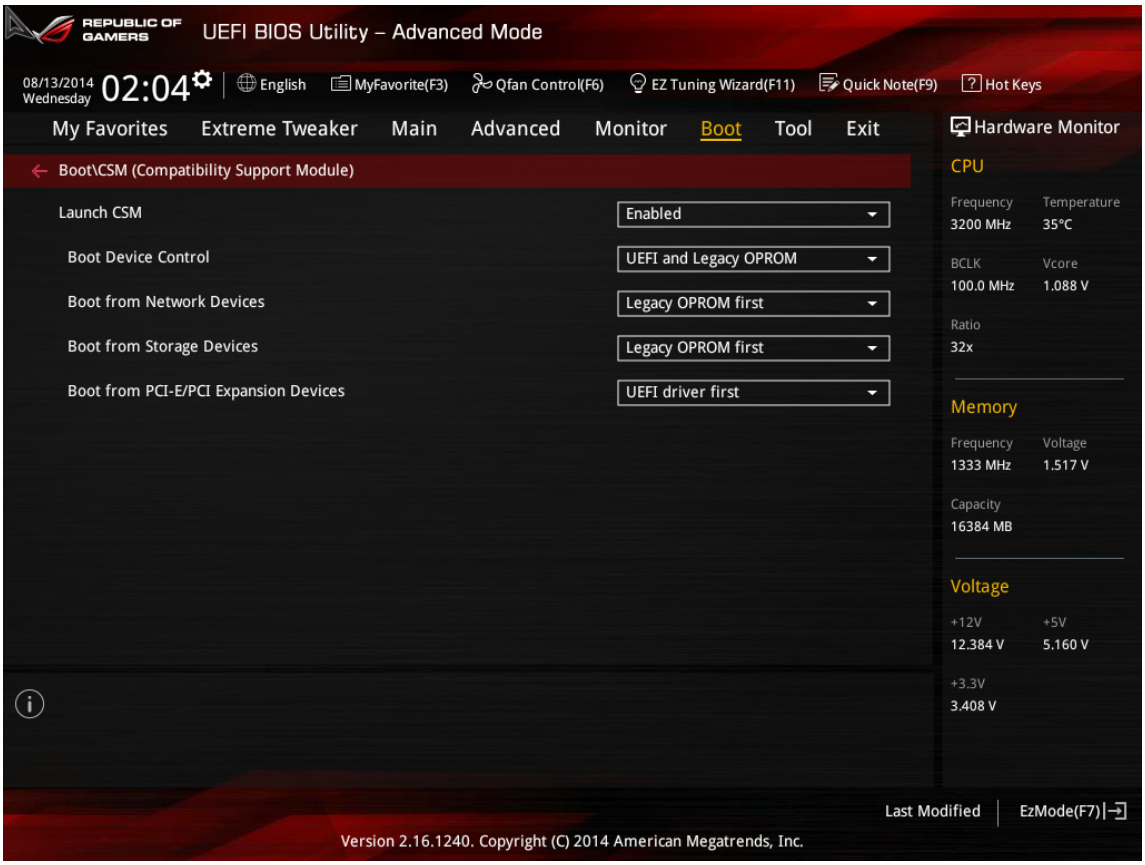


Figure 1: Required configuration for Windows 7 boot support.

Example: Gigabyte Z97 BIOS Configuration

Specifications

Motherboard: Gigabyte GA-Z97X-Gaming 5

Chipset: Intel® Z97 Chipset

BIOS Revision: F5 (5/30/2014)

Compatibility Notes

The default settings on this motherboard are not properly configured for NVMe boot support. The CSM must be disabled in order for NVMe devices to boot successfully. Because the CSM must be disabled, Windows 7 is not supported in this platform.

Required Configuration

Windows 8 or 8.1

1. Set **Windows 8 Features** to **Windows 8**
2. Set **CSM Support** to **Never**

Note: In Smart Tweak mode, the above options can be found with the search function.

Windows 7

Not supported on this motherboard at this time.

Figure 2: Required configuration for Windows 8 or 8.1 boot support.

Example: ASUS Z87 BIOS Configuration

Specifications

Motherboard: ASUS Z87-Expert

Chipset: Intel® Z87 Chipset

BIOS Revision: 1802 (3/14/2014)

Compatibility Notes

The optimized defaults for this BIOS will successfully boot NVMe SSDs; no additional configuration is required. If you are experiencing difficulties, verify that your CSM settings match the image below. These settings will support Windows 7, 8, or 8.1.

Required Configuration

Windows 8 or 8.1

No additional configuration is required.

Windows 7

No additional configuration is required.

Figure 3: Default settings that will properly boot Windows 7, 8, and 8.1

Example: Gigabyte X99 BIOS Configuration

Compatibility Notes

The default settings on this board are not setup for NVME support on either Windows 7 or Windows 8/8.1. The Storage Boot Option Control must be changed from Legacy to UEFI for Windows 7 and the Windows 8 Features must be enabled for Windows 8/8.1. In both cases of installation the Installation media must be configured as UEFI. An instructional guide on how to configure Installation media as UEFI is available at: http://www.eightforums.com/tutorials/15458-uefi-bootable-usb-flash-drive-create-windows.html
Option 1 with Rufus is easiest and will accomplish the quickest results.

Windows 8/8.1

1. Set **Windows 8 Features** to **Windows 8**
2. Set **CSM Support** to **Enabled**

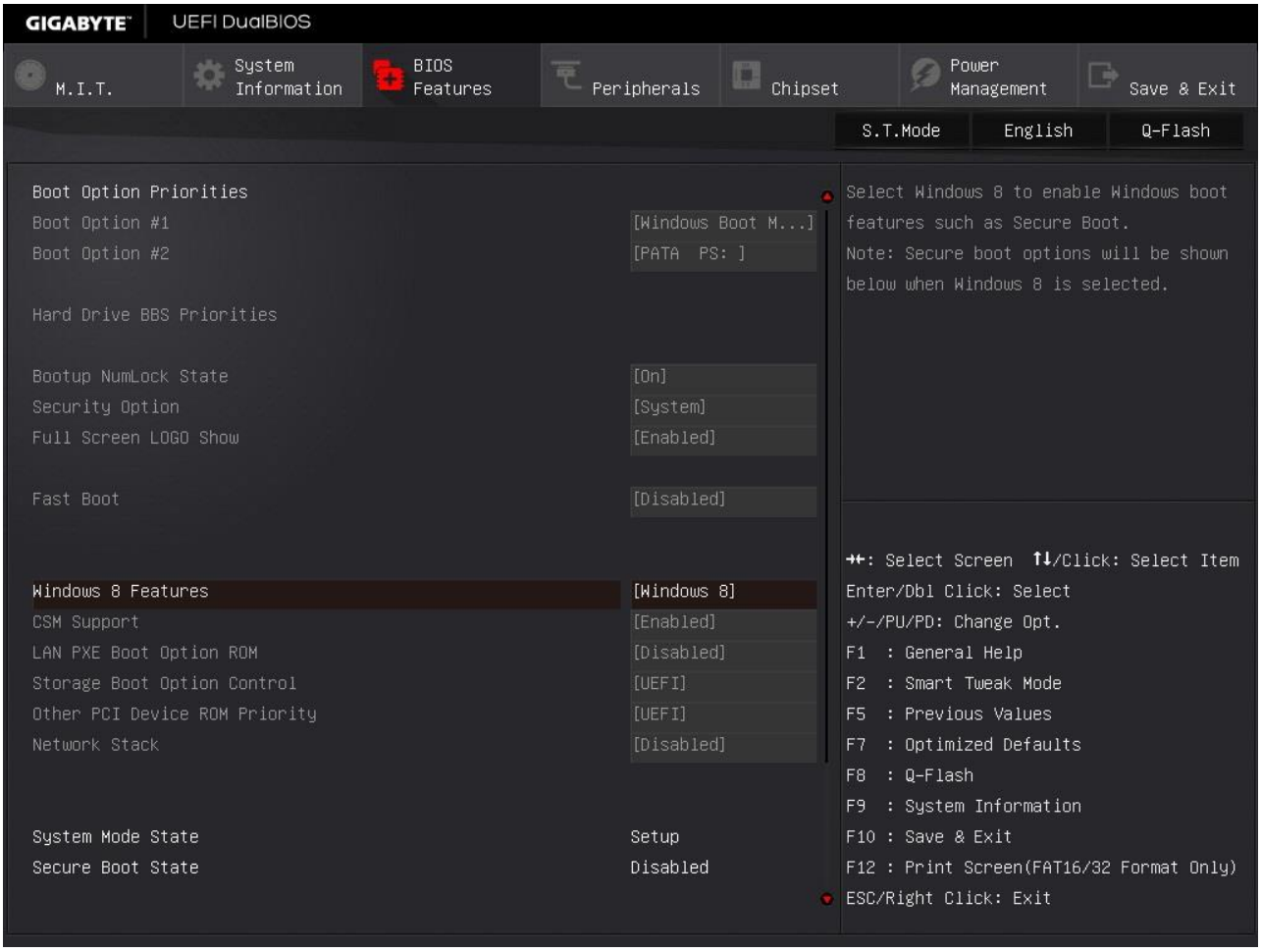


Figure 4: Required configurations for Windows 8 and 8.1

Windows 7

1. Set **Windows 8 Features** to **Other OS**
2. Set **Storage Boot Option Control** to **UEFI**

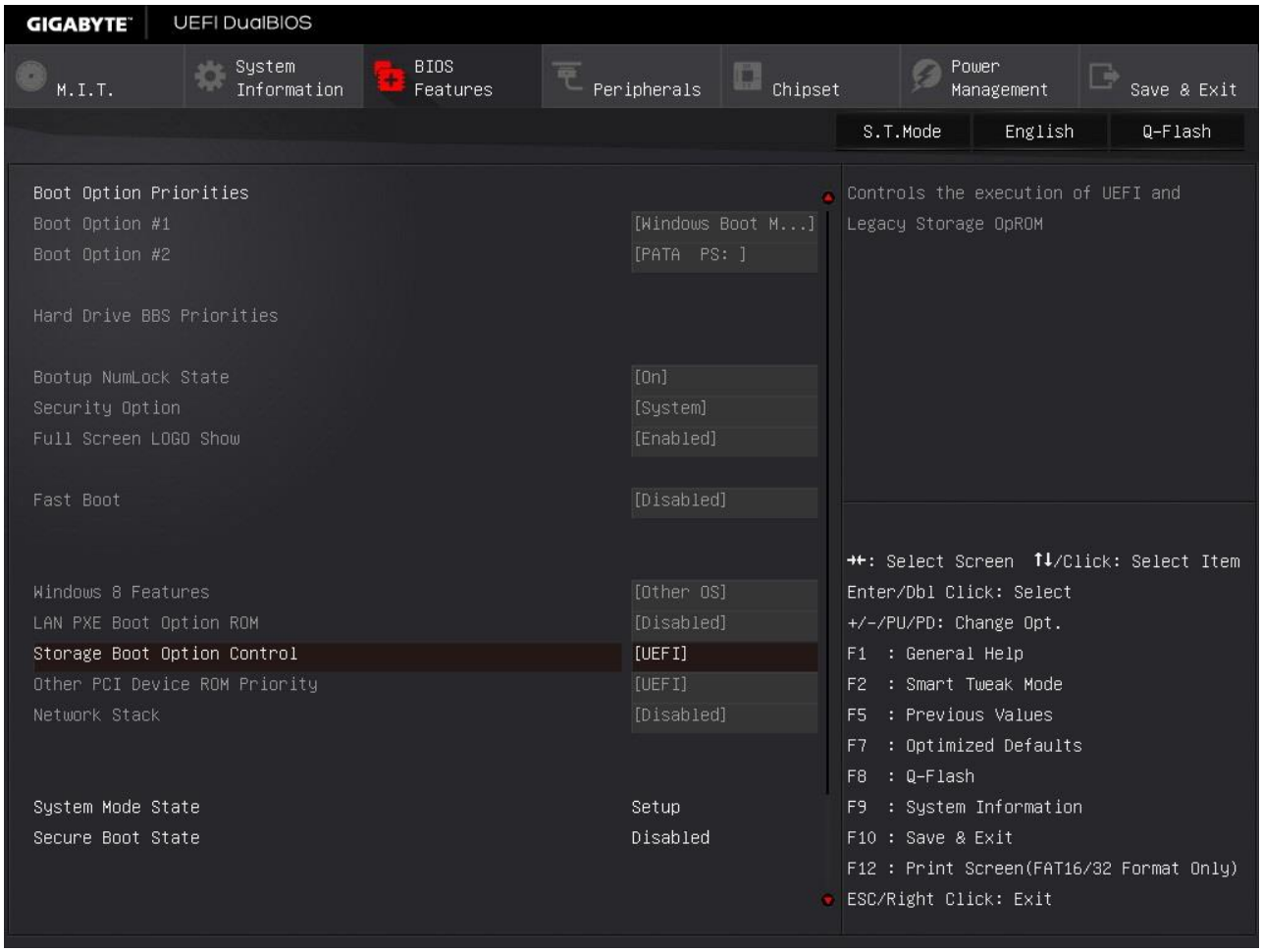


Figure 5: Required configuration for Windows 7 Support.

Example: Intel® H77 BIOS Configuration

Specifications

Motherboard: Intel® Desktop Board DH77DF

Chipset: Intel® H77 Chipset

BIOS Revision: 0110 (5/13/2013)

Compatibility Notes

In this case, the motherboard is slightly older but still supports UEFI booting. By default, the motherboard is configured to boot from both UEFI and legacy devices. While this configuration works as expected for SATA devices, NVMe devices are not listed in the boot list unless legacy booting is disabled.

This motherboard does not support any configuration of the CSM and is not properly configured to load UEFI drivers when booting legacy devices. As a result, Windows 7 cannot be installed on this system.

Required Configuration

Windows 8 or 8.1

1. Open **Advanced Setup**
2. Open **Boot Configuration** under the **Boot** tab
3. Uncheck the **Legacy Boot** option such that it is **disabled**
4. Verify **UEFI Boot** is still **enabled**

Windows 7

Not supported on this motherboard at time of writing.

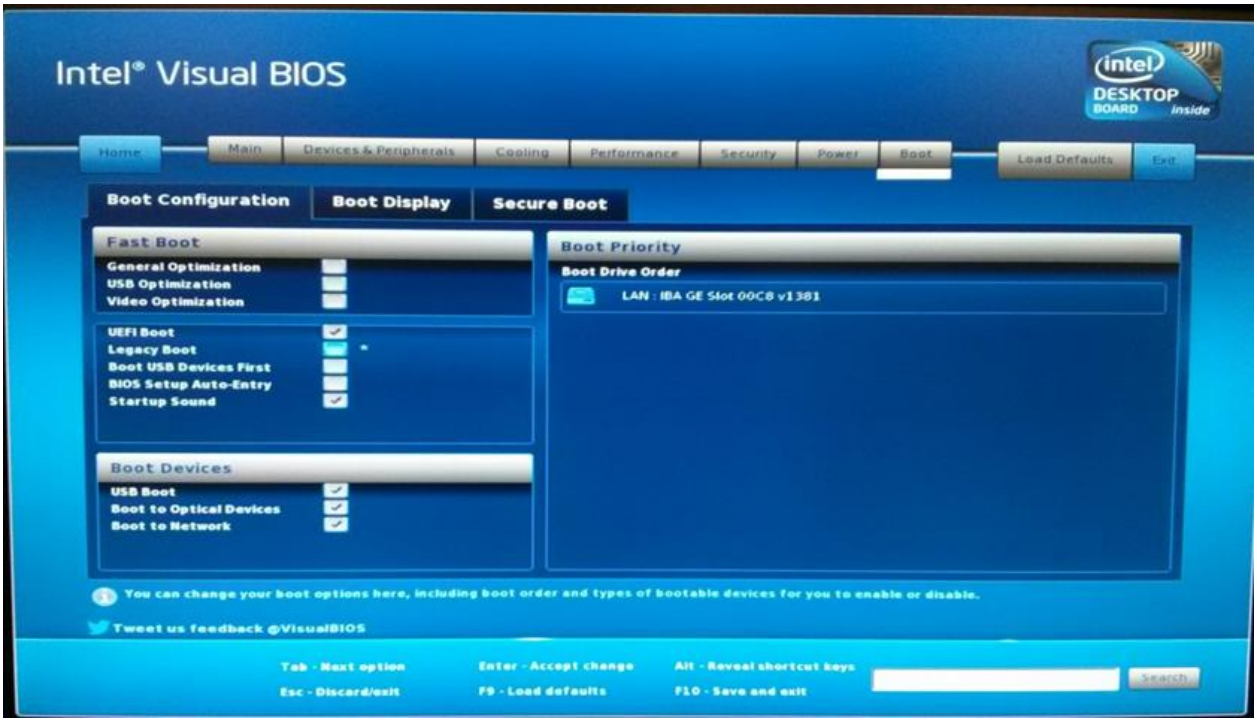


Figure 6: Required configuration for Windows 8 or 8.1 boot support.

Example: ASUS Z97 Deluxe

Specifications

Motherboard: ASUS Z97 Deluxe

Chipset: Intel® Z97 Chipset

BIOS Revision: 1304

Compatibility Notes

This board is not setup for UEFI as default. You will need to change settings in BIOS to UEFI for NVME Bootability for Windows 7, Windows 8 and Windows 8.1.

Required Configuration

Windows 7, 8 or 8.1

1. Open **Advanced Setup**
2. Open **Boot Configuration** under the **Boot** tab
3. **Enable CSM**
4. Set **Boot Device Control** to **UEFI** and **Legacy OPROM**
5. Set **Boot** from **Storage Devices** to **UEFI**
6. Set **Boot from PCIe/PCI Expansion Devices** to **UEFI**

Example: Gigabyte X99-UD4

Specifications

Motherboard: Gigabyte X99-UD4

Chipset: X99

BIOS Revision: Ver. F5

Required Configuration

Windows 7, 8 or 8.1

1. **BIOS** Features Tab->
2. **Enable Windows 8 Features**-> **Windows 8** or **Windows 8 WHQL**
3. **Storage Boot Option Control** -> **UEFI**
4. **Other PCI Device Rom Priority** -> **UEFI**

Example: Republic of Gamers Rampage V Extreme BIOS Configuration

Specifications

Motherboard: ASUS Republic of Gamers Rampage V Extreme

Chipset: X99

Compatibility Notes

The optimized defaults for the factory BIOS will generally successfully boot NVMe SSDs; no setting changes are required. Certain PCIe slots (like slot 3 and 4) require additional configuration. If you are experiencing difficulties, verify that your CSM settings are set to UEFI.

Required Configuration

Windows 7, 8 or 8.1

1. Go to **Boot**->
2. Go to **Boot** -> **CSM**
3. **Boot from storage devices** -> **UEFI**
4. **Boot from PCIe/PCI expansion device** -> **UEFI**

Example: MSI X99 BIOS Configuration

Specifications

Motherboard: MSI X99S Xpower AC

Chipset: X99

BIOS Revision: Ver 1.2

Compatibility Notes

This motherboard required additional and separate configuration setting changes to install and boot Windows 7 and Windows 8.1 in UEFI successfully.

Required Configuration

Settings for Installing Windows 7, 8 or 8.1

1. Go to **Advanced: Disable quick boot**
2. Go to **Boot** -> **UEFI mode only**
    a. Change first boot to **UEFI USB key** and **disable all others**
    b. BBS Hard Disk boot priority: **Disable**
    c. BBS USB Key boot priority: **Enable boot USB**

Settings for Booting Windows 7, 8 or 8.1

1. Go to **Advanced: Disable quick boot**
2. Go to **Boot** -> **UEFI mode only**
    a. Change first boot to **UEFI hard disk** and **disable all others**
    b. BBS Hard Disk boot priority: **Enable windows loader**
    c. BBS USB Key boot priority: **Disable**

Example: EVGA X99 BIOS Configuration

Specifications

Motherboard: EVGA X99 Micro

Chipset: X99

BIOS Revision: Ver 1.03

Compatibility Notes

This motherboard required additional and separate configuration setting changes to install and boot Windows 7 and Windows 8.1 in UEFI successfully.

Required Configuration

Windows 7, 8 or 8.1

1. Go to **Advanced: Disable fast boot**
2. Go to **Boot Mode Select -> UEFI**
3. **CSM** ->
    a. Boot option filer -> **UEFI**
    b. Launch storage oprom -> **UEFI**
    c. Other PCI device ROM priority -> **UEFI**
4. **Advance Settings** ->
    a. **Disabled legacy USB support**

Example: ASUS x99-Deluxe

BIOS Configuration/Windows 7 and 8.1 Installation Guide

Specifications

Motherboard: ASUS x99-Deluxe
Chipset: Intel® x99 Chipset
BIOS Revision: version 0904 (9/24/2014)

Compatibility Notes

Both Windows 7 and Windows 8.1 require changes in the BIOS menu to recognize PCIe drives.

Required Configuration

Windows 7 & Windows 8.1

BIOS Configuration

1. Before installing Windows 7 or 8.1 you must load BIOS, which should happen automatically. If not, reboot and press F2 to load BIOS.
2. By default, BIOS is **in EZ mode,** press F7 to load **advanced mode.**
3. Click on the **Boot** tab located at the top of the screen.
4. Scroll down and click on **CSM (Compatibility Support Module)**.
5. Change the Boot from **PCI-E/PCI expansion devices** to **UEFI driver first**.
6. Click on the **Exit** tab at the top of the screen and click on **Save Changes & Reset**, agreeing to all changes made.

Windows 7

Note: This step may hang upon booting, if it does, simply restart the computer.

1. Insert Windows 7 installer device, press the F8 key to load the boot manager if it doesn't load automatically.
2. Select the UEFI location of your installer and run installation.
    a. On the **Where do you want to install Windows** screen, click on **Load Driver.**
    b. Insert the media containing the **Intel NVME driver,** navigate to the driver location and it will load automatically.
    c. Click **OK** and then **Next.**
    d. The drive should now be visible, finish installing normally.
    Do not unplug the drive containing the NVME driver until installation is completed.

Windows 8.1

1. Insert Windows 8.1 installer device, pressing **F8** to load the boot menu if needed.
2. Select the **UEFI location** of your installer and run installation normally.

Operating System Installation

Installing an operating system onto an NVMe PCIe SSD follows much of the same procedure as a typical installation. However, in some cases, the installation media will need to be modified and additional drivers may be required.

Installation Media: UEFI

In order to get a properly configured UEFI operating system installation, the installation media must be booted in UEFI native mode.

To verify that the installation media is properly formatted, insert the media and enter the boot menu. If the boot menu lists the media with a **UEFI** prefix, the installer is properly configured.

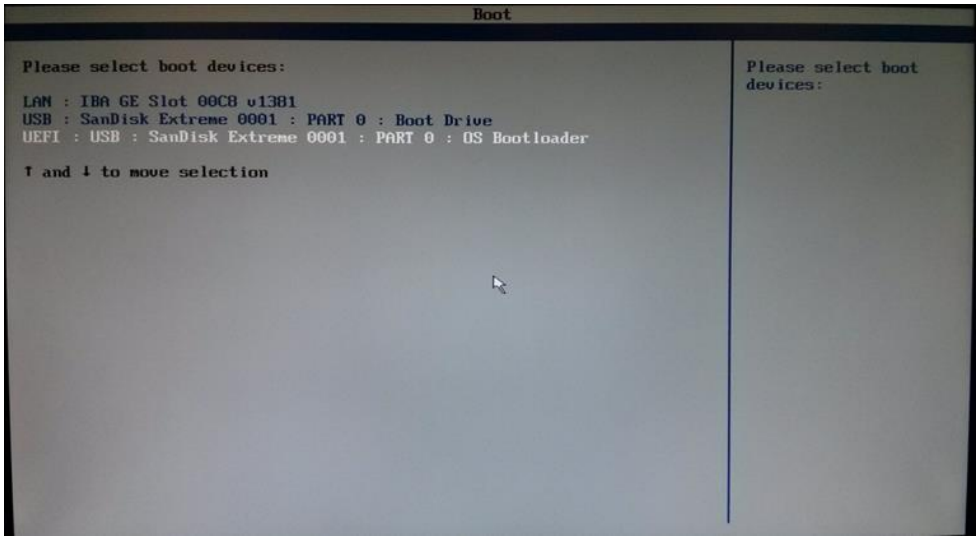


Figure 7: An example of a USB installer properly configured for UEFI support.

If the media does not have the **UEFI** prefix, manually creating a new USB installer is recommended to ensure that it will support a UEFI native installation.

Manually Creating a UEFI USB Installer from an Existing Installer

Note: This is not necessary unless you are unable to boot the installation media in UEFI mode.

Warning: The following procedure is risky and will erase any storage device that is accidently selected.

Use caution and back up all of your data before continuing!

1. Open a new **Command Prompt** as **Administrator**
2. Type **diskpart** and wait for the Diskpart utility to open
3. Type **list disk** and locate the index of your target USB flash drive.
4. Type **select disk X** where X is the identifier of the USB flash drive in the previous step.
5. Type the following commands to format the USB flash drive with a FAT 32 file system:
   a. clean
   b. create partition primary
   c. format fs=fat32 quick
   d. active
   e. assign
6. Locate the appropriate USB flash drive in Windows Explorer and copy all installation files from the existing installation media to the USB flash drive.
7. **Windows 7 Only:**
   a. With 7-zip or any comparable utility, open the **install.wim** in the sources folder on your USB flash drive.
   b. Extract **install.wim\1\Windows\Boot\EFI\bootmgfw.efi** to a temporary location, such as the desktop.
   c. Rename **bootmgfw.efi** to **bootx64.efi** and copy it into the **efi\boot** folder on your USB flash drive.

Injecting Drivers During Installation

Windows 7 and Windows 8 do not include native support for NVMe. When installing these versions of Windows, additional drivers will need to be installed from the Windows installer.

Loading Drivers in Windows Installation

1. On **Where do you want to install Windows?** screen, the NVMe SSD will not be listed. This is because Windows does not have the required drivers.
2. Once you've downloaded the latest NVMe driver. Copy the driver to a separate CD, DVD, or USB flash drive.
3. Click **Load driver**
4. Browse to the driver you copied to the separate media.
5. Select the appropriate driver and click **Next.**
6. The NVMe PCIe SSD should now be listed as an installation target.
7. Continue with the installation.