

Intel® Solid State Drives with PCIe NVMe

*Boot Installation Guide
August 2020*



Ordering Information

Contact your local Intel sales representative for ordering information.

Revision History

Revision Number	Description	Revision Date
001	<ul style="list-style-type: none">Initial release	February 2018
002	<ul style="list-style-type: none">Section 4.2.4, added note re: 3rd party tool capability through a GUI.	June 2018
003	<ul style="list-style-type: none">Minor formatting changes and added reference to Intel® Memory and Storage Tool in Section 5	August 2020

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1 Overview

This guide explains how to install the Windows operating system into Intel® SSDs, that utilize the PCIe NVMe interface, as a bootable medium in the computing platform.

Note: Datacenter usage, workloads, or environments are not supported and will invalidate the warranty for client Intel® SSDs.

The information in this document is intended to assist in the setup and preparation of the Intel® SSD as the primary boot device, not a secondary storage device.

Non-Volatile Memory Express (NVMe) is a scalable non-volatile memory host interface that can help increase efficiency and reduce latency, while delivering high speed access to storage media connected through the PCIe bus, thus resulting in increased overall bandwidth. This high bandwidth bus technology is a data transport feature that has become an industry standard for a wide range of motherboard vendors today.

Table 1: Terminology

Abbreviation	Term	Definition
CSM	Compatibility Support Module	A UEFI firmware feature that enables legacy BIOS-style booting by emulating a BIOS environment.
NVMe	Non-Volatile Memory Express	The next-generation specification used to access SSDs through the PCI Express bus.
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.



2 System Requirements

2.1 Software

2.1.1 Determining Compatibility

The information and instructions in this guide apply to Intel® SSD's that utilize the PCIe with NVMe Interface. Check that you have the latest instructions and compatibility information before attempting to install the Intel® SSD as the boot drive.

Setting up the NVMe SSD as the boot drive is not supported on every system configuration. Specific requirements must be met for a successful boot. To support the required UEFI NVMe driver, your system's firmware must be based on UEFI 2.3.1 or later. For Specific details about UEFI support and NVMe driver support in the OS, please see Sections 2.1.2 and 2.1.3.

If your system was purchased after 2012 or shipped with Windows 8.1 or Windows 10 pre-installed, it most likely supports UEFI. Check with your system vendor to verify.

2.1.2 UEFI BIOS Compatibility

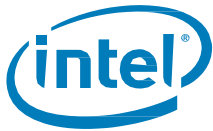
Booting from an NVMe PCIe SSD is only supported on systems that support UEFI. UEFI is a system firmware that endeavors to improve upon legacy BIOS and standardize system processes, such as booting, loading drivers, and more.

It is important that the operating system installer is booted in UEFI mode. Booting in UEFI enables the installer to create an entry in the UEFI boot menu and create a UEFI system partition on the boot device which will contain the bootloaders of installed operating systems. Upon start up, the boot manager will search the UEFI system partition for a valid operating system bootloader. This bootloader is then executed to load the operating system.

Windows 7 does not support native UEFI booting without a Compatibility Support Module. As a result, system compatibility is limited and varies by vendor.

To properly boot Windows 7 from an NVMe SSD, your system must support loading UEFI drivers when the Compatibility Support Module is enabled. To determine if your system is supported, check the following:

- Verify that the system BIOS Boot motherboard settings are configured to boot from UEFI devices. This is often the default on most modern motherboards. For the best chance of success, disable the legacy boot and select UEFI.
- Consult your motherboard vendor's support website to find the latest UEFI BIOS for your particular motherboard.



2.1.3 Operating System Compatibility

Operating System compatibility is dependent on the availability of the NVMe driver. The most recent Windows operating systems contain native NVMe driver support, see the table below for more information. Windows 10 is recommended as it offers the most feature support.

Table 2: Windows Compatibility

OS	Support	Additional Notes
Windows 10	Supported	Native NVMe support with Microsoft 'in-box' drivers
Windows 8.1	Supported	Native NVMe support with Microsoft 'in-box' drivers
Windows 7	Limited Support	Limited system compatibility and features. Requires additional drivers

As an alternative to the Windows native inbox NVMe driver, Intel also offers NVMe drivers for some products. Consult the [Intel Support site](#) to see if your Intel® SSD is supported.

2.2 Hardware

NVMe hardware support has become an industry standard specification, but there may still be motherboards on the market that are not properly configured 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. It is common that the BIOS settings of a typical motherboard will need to be adjusted. See the Motherboard vendor's user manual for further specific instructions on NVMe hardware compatibility.

2.2.1 Hardware Installation

Intel® SSDs that utilize the PCIe NVMe interface are available in multiple form factors, depending on the product line.

Consult your motherboard/system vendor's user and installation guide for the proper connections. Carefully note the proper PCIe NVMe connectors available.

For help in the proper handling and installation of the hardware, please see below for some tips and guidance:

M.2 Form Factor: [Proper Handling Techniques and Precautions for your M.2 Device](#)

AIC (Add-in Card) or U.2 (2.5 inch) Form Factors: [Physical Installation Instructions for PCIe NVMe U.2 and Add-In Card Solid State Drives](#)

3 UEFI Configuration and Setup

3.1 Enabling the Compatibility Support

This is an example of how to configure the BIOS for CSM support in addition to configuring the boot options to enable UEFI.

Consult your specific motherboard vendor's User Guide or support site for the proper settings

Example

ASUS Prime Z270-A BIOS Configuration

Specifications

Motherboard	ASUS Prime Z270-A
Chipset	Intel® Z270 Chipset
BIOS Revision	0906 (3/24/2017)

Compatibility Notes

UEFI is a requirement across all windows installations and CSM needs to be enabled for the Windows 7 operating system.

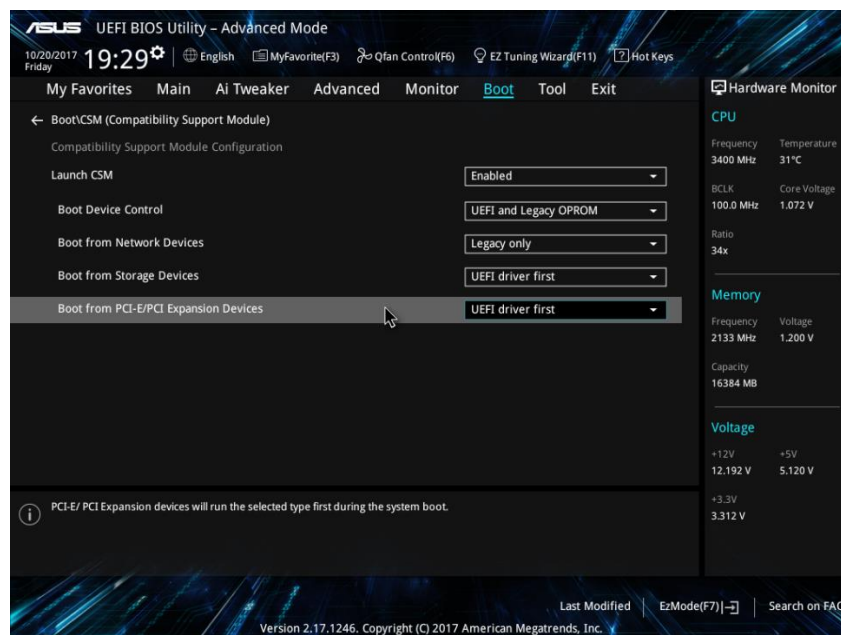
Windows 8.1/10

Boot options must be configured to UEFI.

Windows 7

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

Figure 1: Required Configuration for Windows 7 Boot Support



4 Windows Install Process

4.1 Windows 8.1 and Windows 10

The Windows 8.1 and Windows 10 operating systems offer native support for Intel® SSDs that utilize the PCIe with NVMe interface and have a standard installation process. Follow these steps for proper installation:

1. Ensure that your BIOS is configured to UEFI. (See [section 2.1.2](#))
2. Boot from the Windows OS installation media. (DVD or USB Key)
Note: Follow the instructions from the board/system manufacturer to adjust the Boot Priority in the system BIOS for the Installation Media as required.
3. Follow the steps to install the OS to the Intel® SSD
Note: If the Intel® SSD does not appear in the list of drives during the installation process, check your BIOS settings:
 - If Intel® Rapid Storage Technology (Intel® RST) is enabled with remapping you will have to install the Intel RST driver during OS installation to see the drive (see the BIOS section in 4.2.2).
 - If your system does not have Intel® RST Enabled currently and you still do not see the drive during Windows OS installation, it is suggested to contact your board/system manufacturer for the proper BIOS settings to enable support for NVMe drives.
4. Boot the Windows operating system using the Intel® SSD.
5. **[Optional]** At this time it is recommended to install the Client NVMe Microsoft Windows Driver for Intel® SSDs available here: <https://downloadcenter.intel.com/download/27396/Client-NVMe-Microsoft-Windows-Drivers-for-Intel-SSDs?v=t>

Note:

- a. Not all Intel® SSDs that utilize the PCIe NVMe interface are supported by the Intel® NVMe™ Windows driver, so confirm at the link above.
- b. If your device is not supported, it is proper to stay with the Windows inbox driver

4.2 Windows 7

For the Windows 7 OS, support for SSDs that utilize the PCIe with NVMe interface was added at a later time, as a Windows Update. As a result, the Windows 7 installation media will not detect the SSD. During installation an NVMe driver must be added in order for the OS to detect the drive properly.

First you must ensure that your BIOS is configured to CSM Enabled with UEFI ([Section 3](#)) support for Storage devices.

During OS installation an NVMe driver will need to be loaded for drive recognition. Below 3 options are described, select the driver with support for NVMe devices that best suits your needs.

Method 1: Client NVMe Microsoft Windows Drivers for Intel® SSDs

Note: Driver does not support all Intel® SSDs, confirm compatibility here before proceeding

Method 2: Intel® Rapid Storage Technology (Intel® RST)

Note: Make sure to confirm with your system provider or user manual if Intel® RST is supported on your platform before proceeding

Method 3: Windows 7 installation using DISM with Windows Hotfix

Note: Utilize this option if your platform does not support Intel® RST and SATA port remapping and is not supported by the Client NVMe Microsoft Windows Drivers for Intel® SSDs

Disclaimer: Any links provided for third party tools or sites are offered for your convenience and should not be viewed as an endorsement by Intel of the content, products, or services offered there. Intel does not offer support for any third party tool mentioned here.



4.2.1 Method 1: Windows 7 Installation with the Client NVMe Microsoft Windows Drivers for Intel® SSDs

Make sure to confirm the Intel® SSD being used is supported by the Client NVMe Microsoft Windows Drivers [here](#) before proceeding

1. Inject the USB 3.0 drivers into the Windows 7 installation image files on the installation media as described in [Section 4.2.3](#)
2. Download the [Client NVMe Microsoft Windows Drivers for Intel® SSDs](#) and place on the Windows 7 installation media, or other USB drive.
3. Boot from the Windows 7 installation media (Making sure to have the UEFI Boot media as Priority 1 in the System BIOS)
Note: You will not be able to see the SSD in the drive list. This is because Windows does not have the required drivers.
4. Click **Load driver**
5. Browse to the driver you copied to the separate media
6. Select the appropriate driver and click **Next**
The SSD should now be listed as an installation target
7. Continue with the installation

4.2.2 Method 2: Windows 7 Installation with the Intel® Rapid Storage Technology (Intel® RST) Driver

This installation requires the Intel® 6th Generation platform and newer with the PCIe storage remapping option.

Note: If your platform does not meet all requirements for this method, use the Client NVMe Microsoft Windows drivers for Intel® SSDs as described in Section 4.2.1 (if your device is supported) or the Windows Hotfix NVMe drivers defined in Section 4.2.3.

4.2.2.1 Resources needed for the Intel® RST Driver Installation

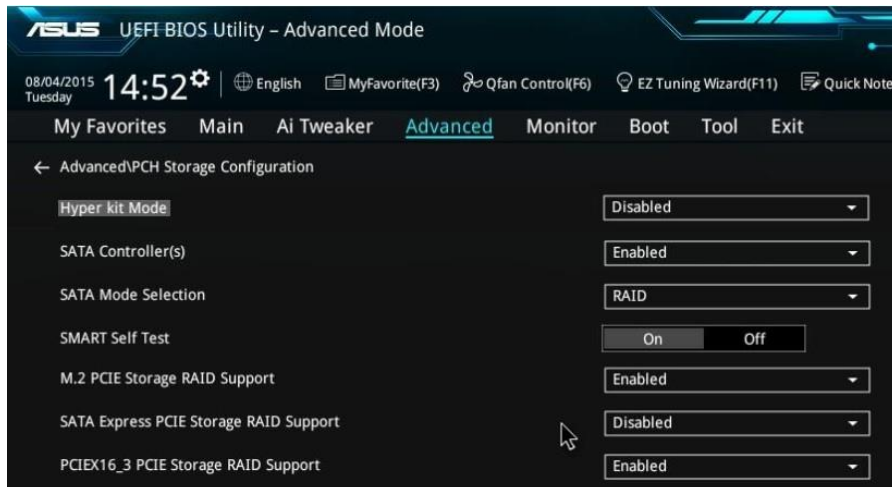
- Windows 7 SP1 x64.iso
Use the current Windows 7 ISO downloaded image or install files from original installation DVD.
- Attain a tool to zip and unzip files.
7-Zip tool link located at <http://www.7-zip.org>
- Intel® RST F6 Drivers for your platform downloaded and placed on USB media for use during OS installation
<https://downloadcenter.intel.com/product/55005/Intel-Rapid-Storage-Technology-Intel-RST->
- USB Drivers
<https://downloadcenter.intel.com/product/65855/Intel-USB-3-0-eXtensible-Host-Controller-Driver>

4.2.2.2 BIOS Setup

Intel® RST requires the PCIe storage remapping option. It is limited to the Intel 6th Generation platform and newer, so be sure to check with your motherboard vendor or user manual before applying this method. Changing ports with RST PCIe storage remapping option will allow NVMe to be properly utilized. You will get boot ability after the ports are properly remapped.

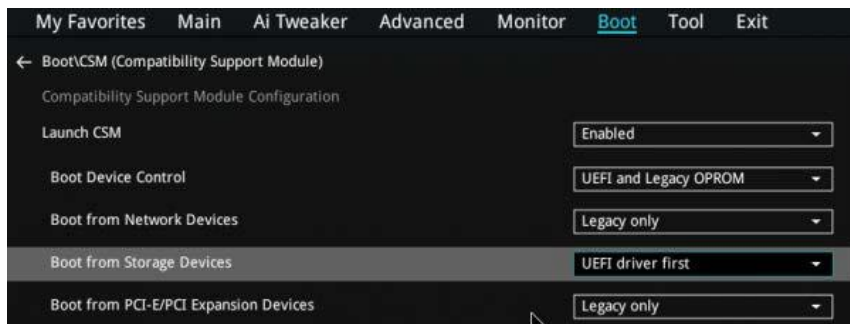
Figure 2 shows the UEFI BIOS advanced settings' additional options that are specific to the Intel RST platform. By toggling the RAID support controls, it diverts control of the connected device over to RST.

Figure 2: Intel® RST BIOS: Advanced Example



In Figure 3, the Intel boot settings are selected to have UEFI driver first. This is important for booting the Intel SSD as your primary bootable device.

Figure 3: Intel® RST BIOS: UEFI Boot



4.2.2.3 Installation

1. Inject the USB Driver in the Windows 7 ISO image. For more information, see [USB 3.0 Driver Inject](#).
2. To boot to the Windows installer, use the Windows ISO via either of these methods:
 - USB install key and copy Windows DVD installer files, or
 - The DVD installer media.

After the Windows installer boots, you will be prompted to locate additional drivers.

3. Browse to your USB flash drive or optical drive with Intel RST F6 drivers on it.

After the driver is installed, the SSD should show as a drive option to install Windows.

4. Install Windows as normal and update all drivers with motherboard disk, or download from vendor's site.



4.2.3 Method 3: Windows 7 Installation using DISM with Windows Hotfix

4.2.3.1 Resources

- Windows 7 SP1 x64.iso
 - Use the current Windows 7 ISO downloaded image or install files from original installation DVD.
- Windows 10.iso
 - <https://www.microsoft.com/en-us/software-download/windows10>
- Microsoft Hotfixes
 - <https://support.microsoft.com/en-us/kb/2990941>
 - <https://support.microsoft.com/en-us/kb/3087873>

Microsoft update solution will be emailed once requested through the links noted above.

- Follow the DISM commands in the command line to mount the required files.
 - To use the DISM process, acquire the Windows 8.1 ADK or later.
 - Intel recommends using the DISM commands within the Command Prompt (see section 4.2.3.3).
 - For the GUI method, you can use third party applications, such as Ntlite (<https://www.ntlite.com/download/>)
 - Attain a tool to zip and unzip files (7 zip tool link located below for reference) 7-Zip at <http://www.7-zip.org>

4.2.3.2 Preparing Windows 7 Install Key

First you must create the bootable media to start the process of installing Windows 7 into the SSD. The main item needed is a Windows 7 ISO, which can be downloaded from Microsoft or properly extracted using an existing Windows 7 DVD install disk.

Downloaded Windows 7 ISO

1. Prepare the USB key as a bootable key.
2. Extract the ISO files to the prepared USB install key.

DVD Media

1. Prepare the USB key as a bootable key.
2. Copy files from the DVD to the prepared USB install key.

4.2.3.3 Modify Windows 7 Install Files using DISM Utility

1. Create a temporary working directory, such as C:\Win7USB.
2. In your working directory, make two sub-directories called "Hotfix" and "Mount."
3. Extract your Hotfix files into your "Hotfix" subdirectory. You should have the following files:

Windows6.1-KB2990941-*-*x64.msu

Windows6.1-KB3087873-*-*x64.msu

4. From your Windows 7 install key, copy the "install.wim" file from the "sources" directory on your install key to the working directory C:\Win7USB.

5. Open a command prompt as administrator, and change to your working directory. For example: `cd C:\Win7USB`
6. Based on the version of Windows 7 you have available, determine which index number to modify.

Choose the index that matches the Windows 7 version you have. To determine the index, run the command:

```
dism /get-wiminfo /wimfile:install.wim
```

Using index 3 for this example:

```
C:\Win7USB>dism /get-wiminfo /wimfile:install.wim
Deployment Image Servicing and Management tool
Version: 6.1.7600.16385

Details for image : install.wim

Index : 1
Name : Windows 7 HOMEBASIC
Description : Windows 7 HOMEBASIC
Size : 11,710,161,360 bytes

Index : 2
Name : Windows 7 HOMEPREMIUM
Description : Windows 7 HOMEPREMIUM
Size : 12,222,587,449 bytes

Index : 3
Name : Windows 7 PROFESSIONAL
Description : Windows 7 PROFESSIONAL
Size : 12,131,063,436 bytes

Index : 4
Name : Windows 7 ULTIMATE
Description : Windows 7 ULTIMATE
Size : 12,285,492,779 bytes

The operation completed successfully.
C:\Win7USB>
```

7. Modify the "install.wim" file by running the following commands:
`dism /mount-wim /wimfile:install.wim /index:3 /mountdir:mount`
`dism /image:mount /add-package: [Path of the hotfix files]`
i.e. `C:\Win7USB\Hotfix`
`dism /get-packages /image:mount`
`dism /unmount-wim /mountdir:mount /commit`
8. Copy the updated "install.wim" in the working directory back to the "sources" directory on your install key.

4.2.3.4 Extracting Necessary Windows 10 Files

1. Open win 10 ISO with zip tool.
2. Extract the "boot.wim" and "setup.exe" files from the "sources" directory to the Windows 7 "sources" directory on your USB install key.

When prompted to overwrite, be sure to replace Windows 7 files with Windows 10 files.

Your windows 7 USB key is now configured properly for windows installation.



4.2.4 USB 3.0 Driver Inject

Note: USB 3.0 drivers are backward compatible with USB 2.0.

Intel recommends using the DISM commands within the Command Prompt.

Note: This process can also be done through some 3rd party tools that offer this capability through a GUI.

Using the DISM commands, the provided USB drivers must be injected into the windows 7 ISO image. The following steps are vital in order to see the NVMe driver directories on the USB install key.

1. Create a temporary working directory, such as C:\Win7USB
2. In your working directory, create two sub-directories called "USBDriver" and "Mount"
3. Extract your USB driver files into your "USBDriver" subdirectory
4. From your Windows 7 install key, copy the "install.wim" and "boot.wim" files from the "sources" directory on your install key to the working directory C:\Win7USB.
5. Open a command prompt as administrator, and change to your working directory.
For Example: cd C:\Win7USB
6. Based on the version of Windows 7 you have available, determine which index number to modify.

Choose the index that matches the Windows 7 version you have. To determine the index, run the following command:

```
dism /get-wiminfo /wimfile:install.wim
```

To modify "boot.wim" after modifying "install.wim" run the following command and follow subsequent steps:

```
dism /get-wiminfo /wimfile:boot.wim
```

Using index 3 for this example:

```
C:\Win7USB>dism /get-wiminfo /wimfile:install.wim
Deployment Image Servicing and Management tool
Version: 6.1.7600.16385

Details for image : install.wim

Index : 1
Name : Windows 7 HOME BASIC
Description : Windows 7 HOME BASIC
Size : 11,710,161,360 bytes

Index : 2
Name : Windows 7 HOME PREMIUM
Description : Windows 7 HOME PREMIUM
Size : 12,222,587,449 bytes

Index : 3
Name : Windows 7 PROFESSIONAL
Description : Windows 7 PROFESSIONAL
Size : 12,131,063,436 bytes

Index : 4
Name : Windows 7 ULTIMATE
Description : Windows 7 ULTIMATE
Size : 12,285,492,779 bytes

The operation completed successfully.
C:\Win7USB>
```

7. Modify the "install.wim" file by running these commands:


```
dism /mount-wim /wimfile:install.wim /index:3 /mountdir:mount
dism /image:mount /add-package: [Path of the USBDriver files] i.e C:\Win7USB\USBDriver
dism /get-packages /image:mount
dism /unmount-wim /mountdir:mount /commit
```



8. Modify the "boot.wim" file by running these commands

```
dism /mount-wim /wimfile:boot.wim /index:3 /mountdir:mount
dism /image:mount /add-driver:C:\Win7USB\USB3 /recurse
dism /get-drivers /image:mount
dism /unmount-wim /mountdir:mount /commit
```
9. Now take your updated "install.wim" and "boot.wim" in the working directory and copy it back to the "sources" directory on your install key.

Note: If you are unable to see the drive directory on the USB key install after injecting the USB drivers into the windows 7 ISO image via DISM commands, please consult your motherboard manufacturer to obtain the necessary USB drivers and perform the injection process with the appropriate USB drivers.

§



5 Installation System Confirmation

After the drive boots on its own, then it is confirmed that the drive will boot as a bootable medium.

For further management, SSD utility software tools are provided.

- **Intel® Memory and Storage Tool**

The Intel® Memory and Storage Tool (Intel® MAS) is drive management software that allows you to view current drive information for Intel® Solid State Drives (Intel® SSDs). The tool can be used to assess the drive health, update the firmware, check SMART attributes, and more.

<https://downloadcenter.intel.com/download/29704?v=t>

- **CrystalDiskInfo**

CrystalDiskInfo is a software tool for SSDs that provides a complete report of SMART data, as well as a current temperature and health status. This tool can also be utilized to gather basic information such as buffer size, firmware, and serial numbers. More advanced options such as command time out, end-to-end error reads, and relocation event count can be utilized for determining drive endurance and enabling analysis over the life of the drive.

<https://crystalmark.info/?lang=en>

- **CrystalDiskMark**

CrystalDiskMark is a benchmark software tool that allows you to measure sequential reads/writes as well as other benchmarking options for further management. This tool is useful because it allows you check if your drive is running at optimal levels, displaying the results in a user-friendly graph interface, and refers to common benchmarking figures such as MB/s and IOPS. This is an essential tool for testing key features, such as read/write speeds for large files up to 512KB and requires minimal configuration.

<https://crystalmark.info/?lang=en>