

# Intel Virtual RAID On CPU (VROC) Storage Configurator

Lenovo ThinkStation PX, P7, P5



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## Overview

The ThinkStation PX, P7, and P5 workstations offer an enterprise RAID solution through Intel's Virtual RAID On CPU (VROC) hardware upgrade key. The Intel VROC solution supports multiple Volume Management Devices (VMDs) to be able to RAID a vast number of PCIe NVMe solid state drives as well as SATA drives. The following document provides detailed guidance for users to optimally configure their onboard Intel RAID storage options in the ThinkStation PX, P7, and P5 platforms.

# Section 1 – Intel Virtual RAID On CPU (VROC)

There are two types of Intel VROC modules supported on the Lenovo ThinkStation PX, P7, and P5 platforms. Table 1 below shows the available Intel VROC options that can be utilized on each of these ThinkStation platforms.

Table 1 - Intel VROC Options

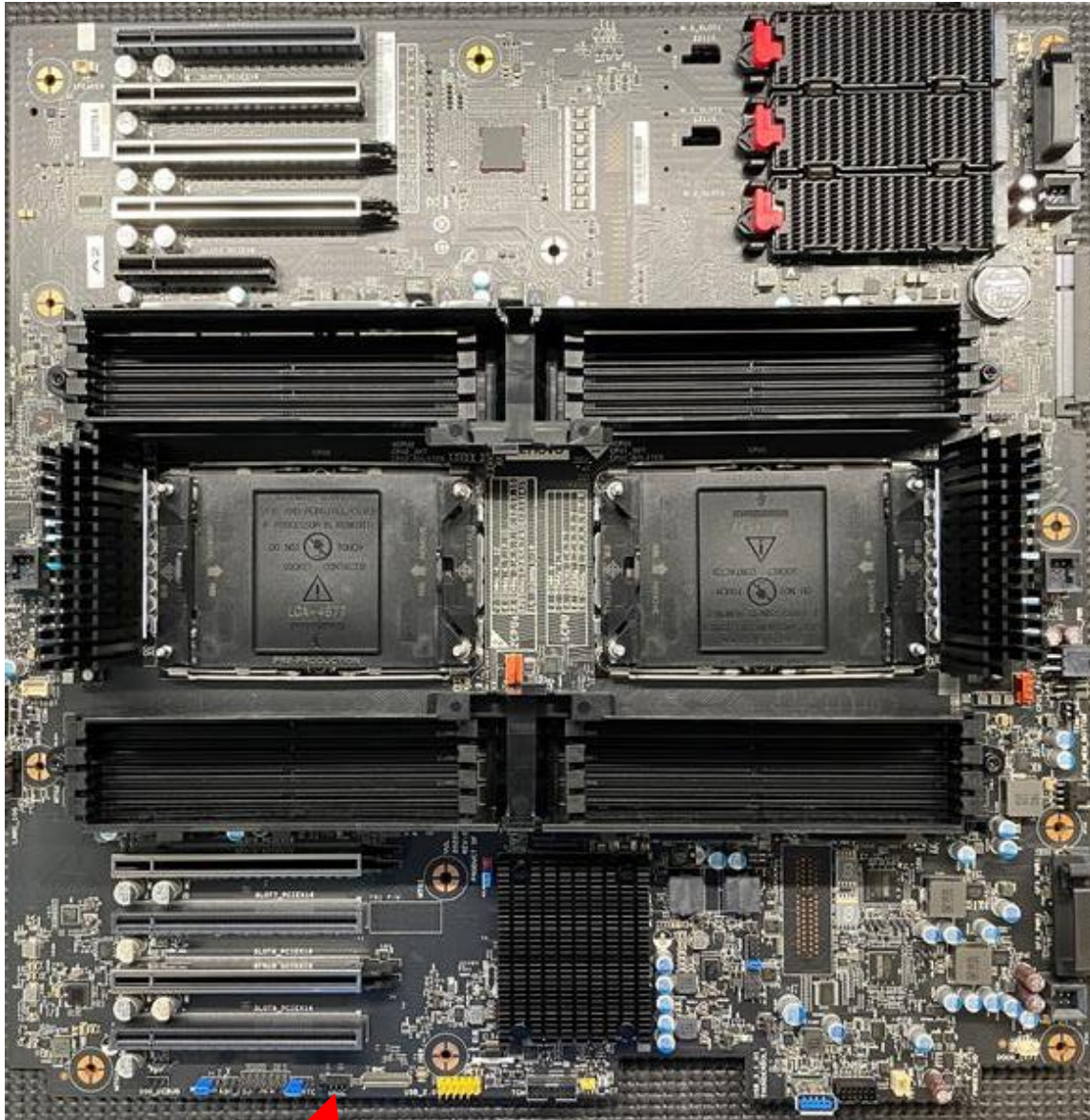
Intel Virtual RAID on CPU (VROC)	Picture	RAID Types Supported
<p><b>Basic</b>            (FRU: 00FC973)            (Lenovo Option: N/A)</p>		<p>RAID 0, 1, and 10</p>
<p><b>Premium</b>            (FRU: 00FC974)            (Lenovo Option: 4XH0Q89603)</p>		<p>RAID 0, 1, 5, and 10</p>

Note: Only one Intel VROC module can be installed per system.

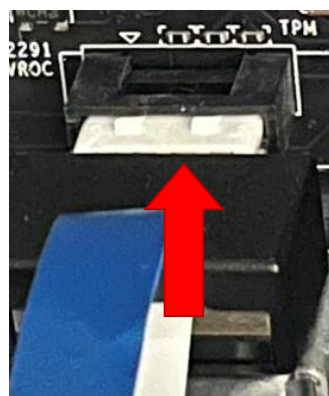
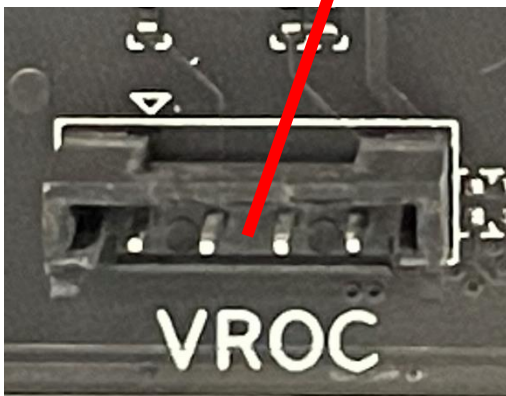
## ThinkStation PX – VROC Header Location

The figure below shows the Intel VROC header location on the ThinkStation PX motherboard. The VROC module should latch into the header when fully inserted.

Figure 1 – PX motherboard showing VROC header location



Front of System

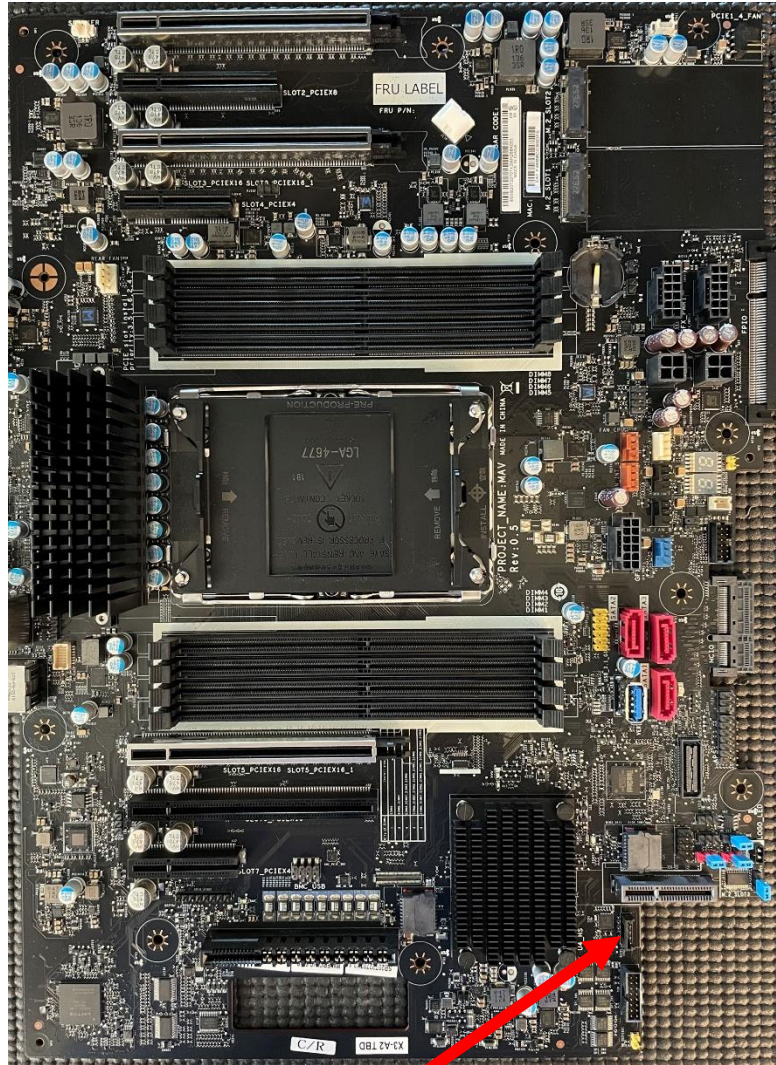




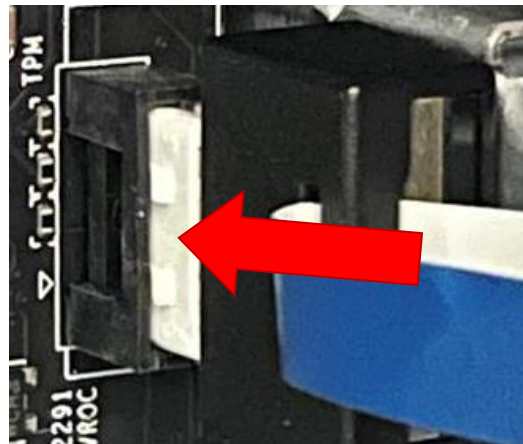
## ThinkStation P7 – VROC Header Location

The figure below shows the Intel VROC header location on the ThinkStation P7 motherboard. Note, removing the power supply is suggested for easy access to the VROC header on the motherboard. The VROC module should latch into the header when fully inserted.

Figure 2 - P7 motherboard showing VROC header location



Front of System

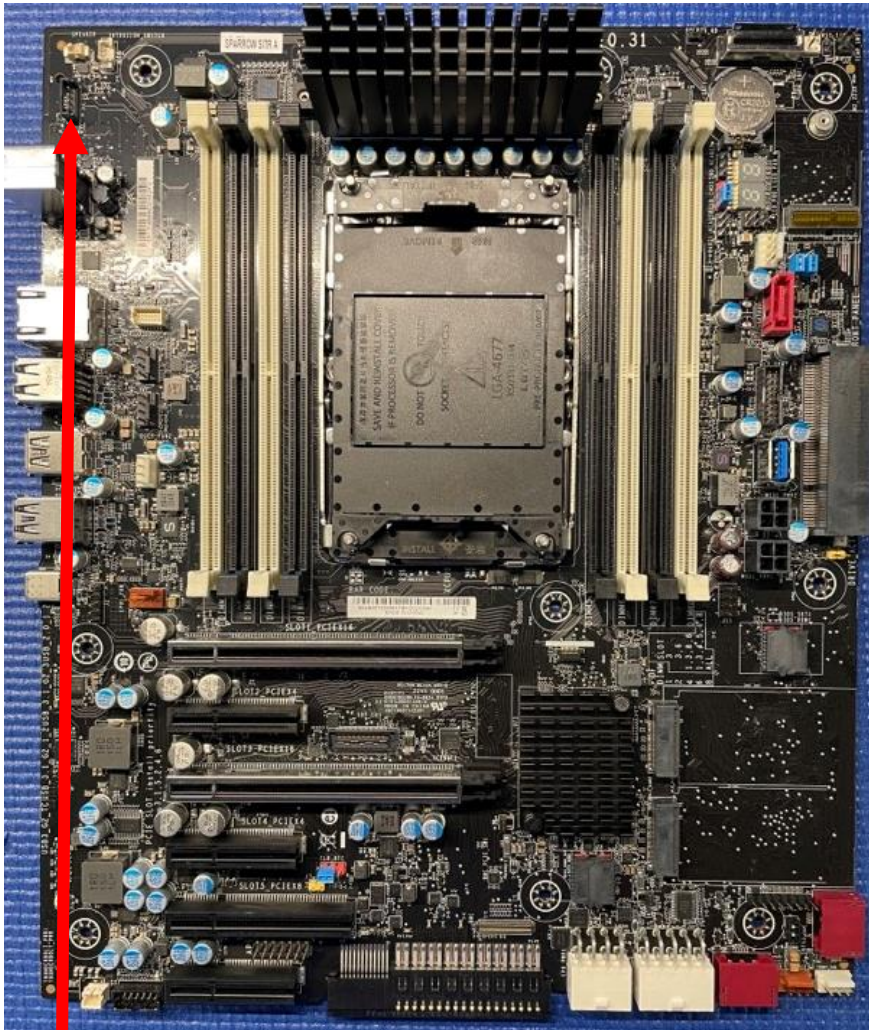




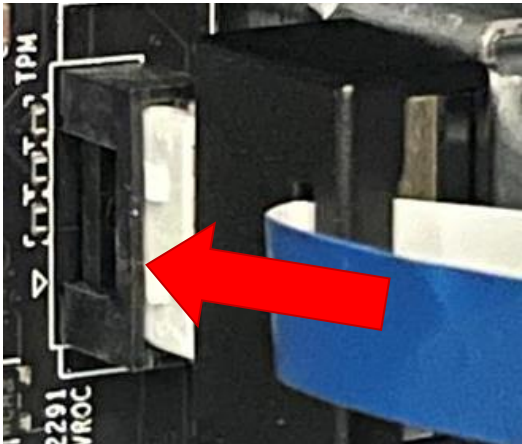
### ThinkStation P5 – VROC Header Location

The figure below shows the Intel VROC header location on the ThinkStation P5 motherboard. Note, the memory duct and rear memory duct fans need to be removed to access the VROC header on the motherboard. The VROC module should latch into the header when fully inserted.

Figure 3 - P5 motherboard showing VROC header location



Front of System



## Section 2 – Levels of Support

The ThinkStation PX, P7, and P5 platforms all support Intel VROC 8.0 or later. The below table highlights supported features for the Intel VROC controller.

Figure 4 - Levels of Support

Features	Support
<b>BIOS Version</b>	PX: S09KT0CA or later P7: S0DKT0BA or later P5: S0CKT0BA or later
<b>Prerequisites</b>	VROC Key Header required on motherboard
<b>Drive Types</b>	NVMe M.2 / E1.S / U.2 / U.3 / E3.S NVMe PCIe Add-in card SATA
<b>Maximum Number of VMDs</b>	Refer to VMD Mapping below for each platform
<b>Maximum Number of drives per VMD</b>	4
<b>RAID 0 / RAID 5</b>	≥ 2 drives
<b>RAID 10</b>	4 drives
<b>RAID 1</b>	2 drives
<b>Bootable Support</b>	Yes, across a single VMD
<b>Data-only Support</b>	Yes, can span across multiple VMDs
<b>UEFI Support</b>	Yes (Legacy support not available)
<b>Spanning VMDs across CPUs (PX only)</b>	Yes, though could result in performance degradation
<b>Linux Support</b>	RHEL 9.2 Ubuntu 22.04 LTS
<b>Toolless VROC Installation</b>	Yes

Notes:

1. Levels of support vary based on platform.
2. Mixing different drive types and capacities is not recommended.
3. Please be sure to backup all data before proceeding! Switching between PCIe versus VMD mode or AHCI versus RAID mode may lead to data loss on the drives (including the operating system).

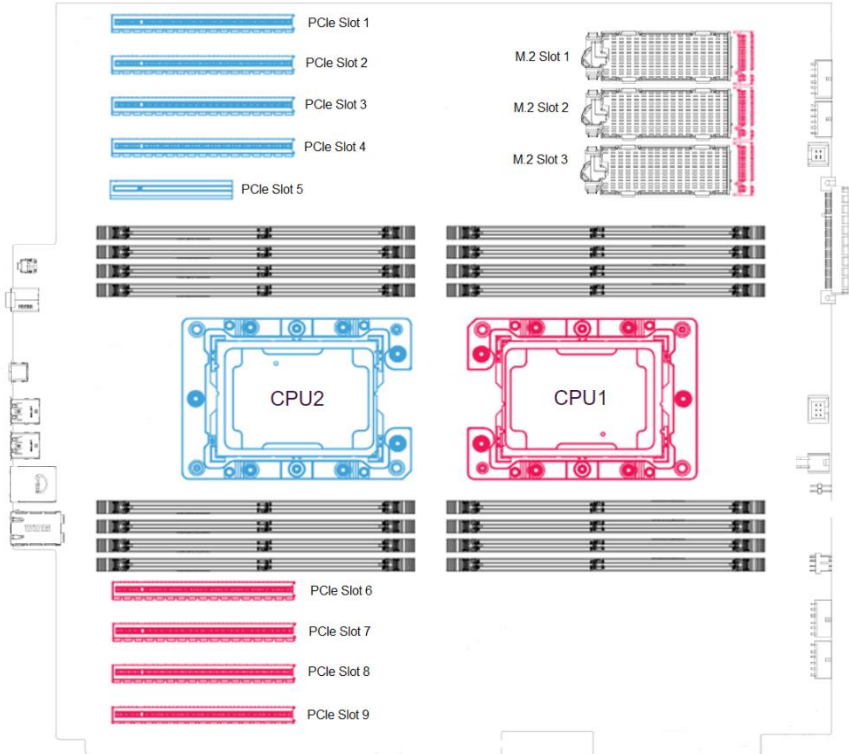


# Section 3 – VMD Mapping

Here is a general overview of the Intel Volume Management Device (VMD) mappings for the ThinkStation PX, P7, and P5 workstations.

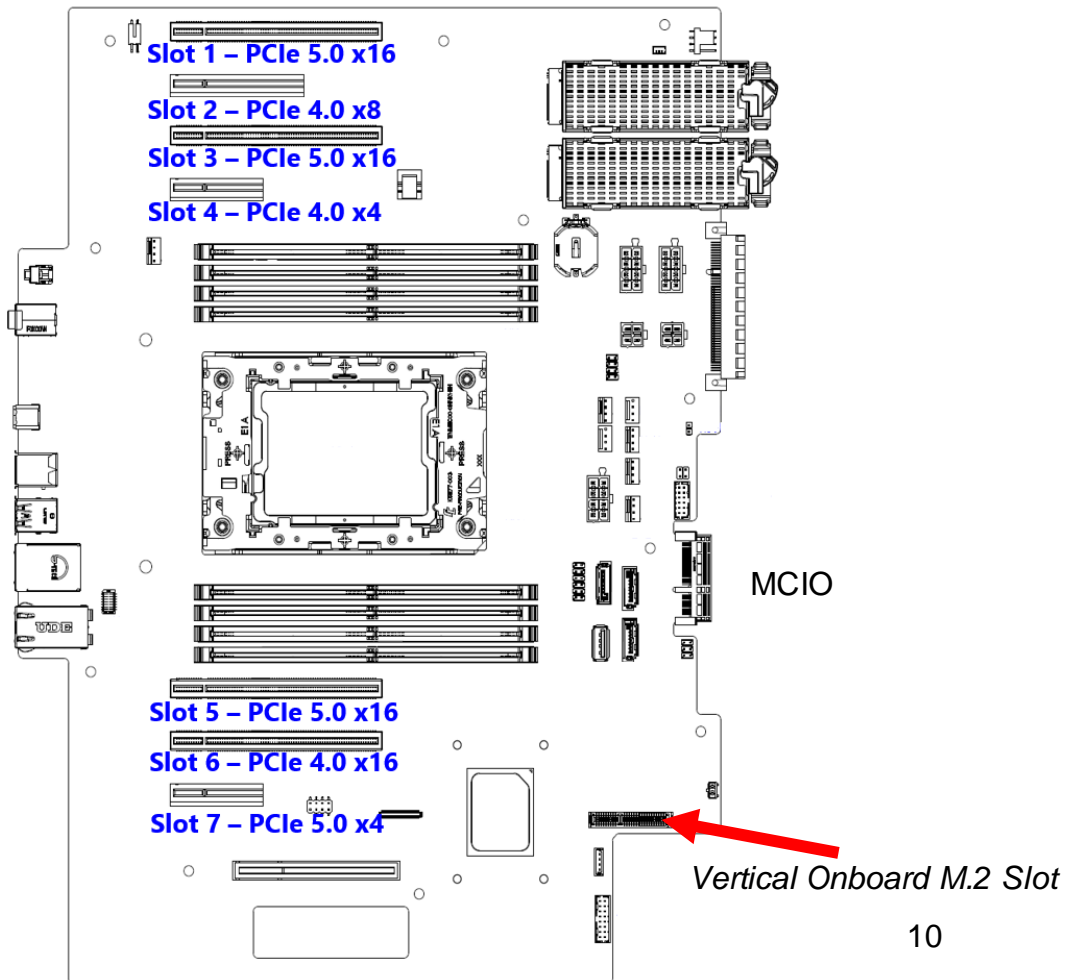
ThinkStation PX – VMD Mapping Implementation			
<u>CPU2</u>		<u>CPU1</u>	
<b>VMD0</b>	PCIe Slot 1	<b>VMD0</b>	PCIe Slot 7
<b>VMD1</b>	MCIO1 Slot 1 (Front Storage Bay 2)	<b>VMD1</b>	PCIe Slot 6
	MCIO1 Slot 2 (Front Storage Bay 2)	<b>VMD2</b>	PCIe Slot 8
	MCIO2 Slot 1 (Front Storage Bay 3)	<b>VMD3</b>	PCIe Slot 9
	MCIO2 Slot 2 (Front Storage Bay 3)	<b>VMD4</b>	Onboard M.2 Slot 1
<b>VMD2</b>	PCIe Slot 4		Onboard M.2 Slot 2
<b>VMD3</b>	PCIe Slot 3		Onboard M.2 Slot 3
<b>VMD4</b>	PCIe Slot 2		
<b>VMD5</b>	PCIe Slot 5		

Note: MCIO slots are located under the motherboard.



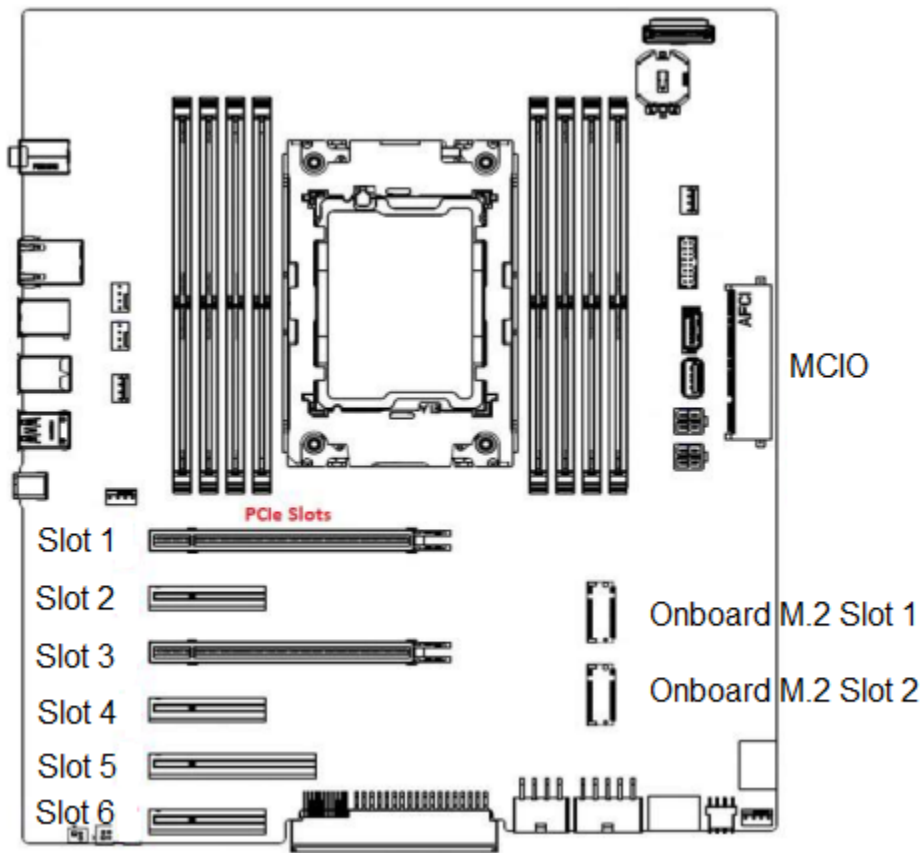
## ThinkStation P7 – VMD Mapping Implementation

<u>CPU</u>	
<b>VMD0</b>	PCIe Slot 7
	MCIO (Front Storage Bay or Internal NVMe Storage Trays)
<b>VMD1</b>	Onboard M.2 Slot 1
	Onboard M.2 Slot 2
	Onboard M.2 Slot 3 (Vertical)
<b>VMD2</b>	PCIe Slot 3
<b>VMD3</b>	PCIe Slot 1
<b>VMD4</b>	PCIe Slot 6
<b>VMD5</b>	PCIe Slot 5
<b>VMD6</b>	PCIe Slot 4
	PCIe Slot 2



## ThinkStation P5 – VMD Mapping Implementation

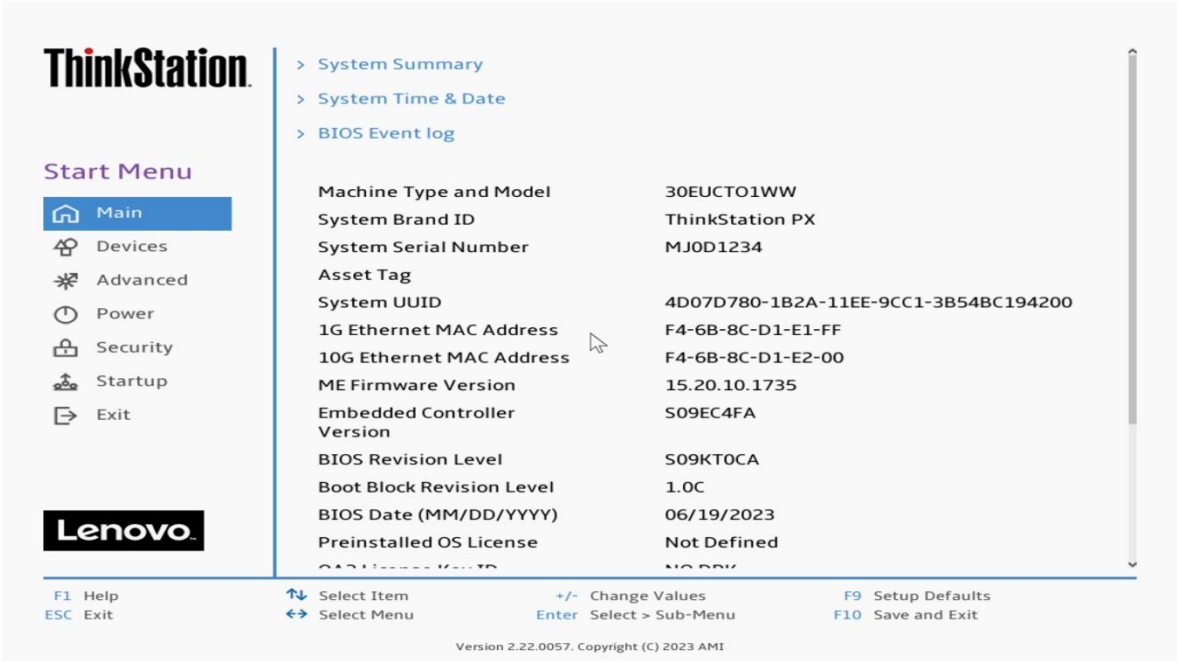
<u>CPU</u>	
<b>VMD0</b>	PCIe Slot 3
<b>VMD1</b>	PCIe Slot 1
<b>VMD2</b>	PCIe Slot 5
	Onboard M.2 Slot 1
<b>VMD3</b>	Onboard M.2 Slot 2
	MCIO (Front Storage Bay)



# Section 3 – How to Enable NVMe RAID

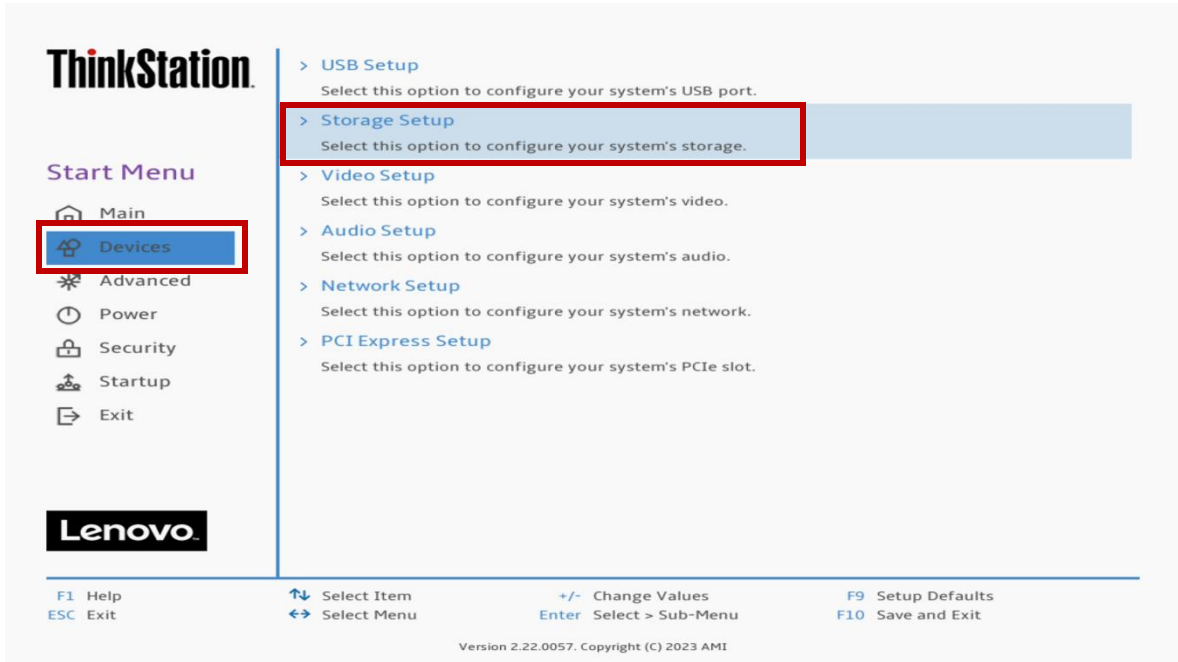
In order to setup and configure NVMe RAID, BIOS must be set to VMD mode first. Refer to the steps below on how to configure BIOS in VMD mode.

1. Power on the system and press the function F1 key at the Lenovo splash screen to enter BIOS setup.



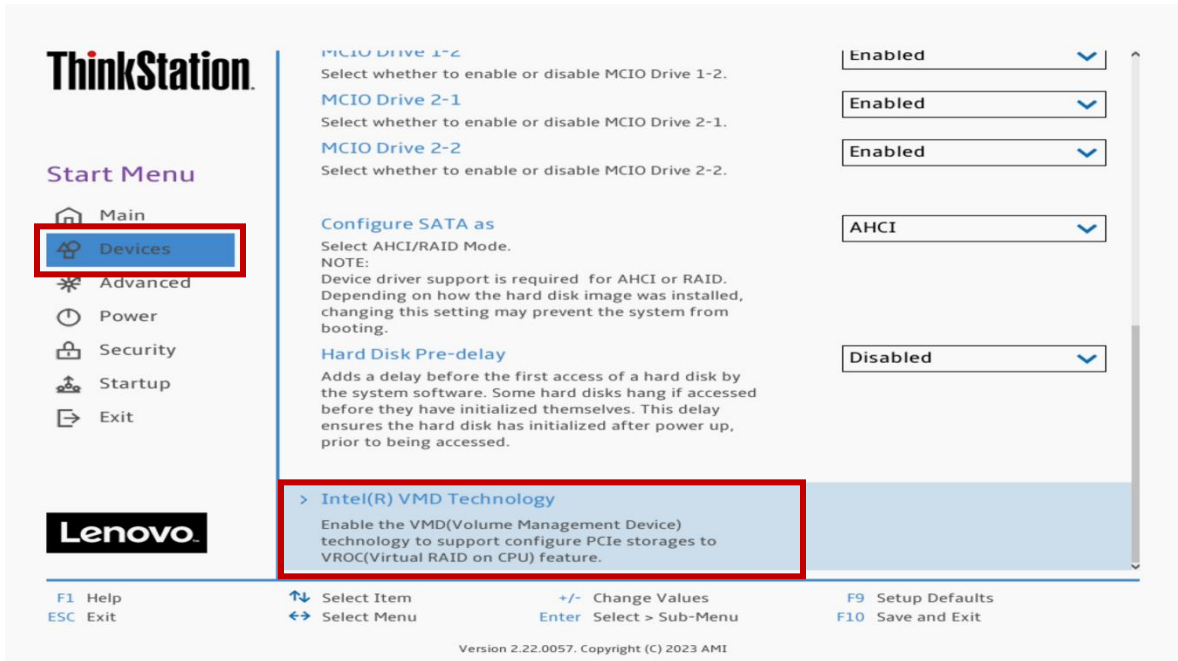


- From within the BIOS setup screen, select the “Devices” menu option from the left-side menu options and ‘Storage Setup’ from the middle menu options.

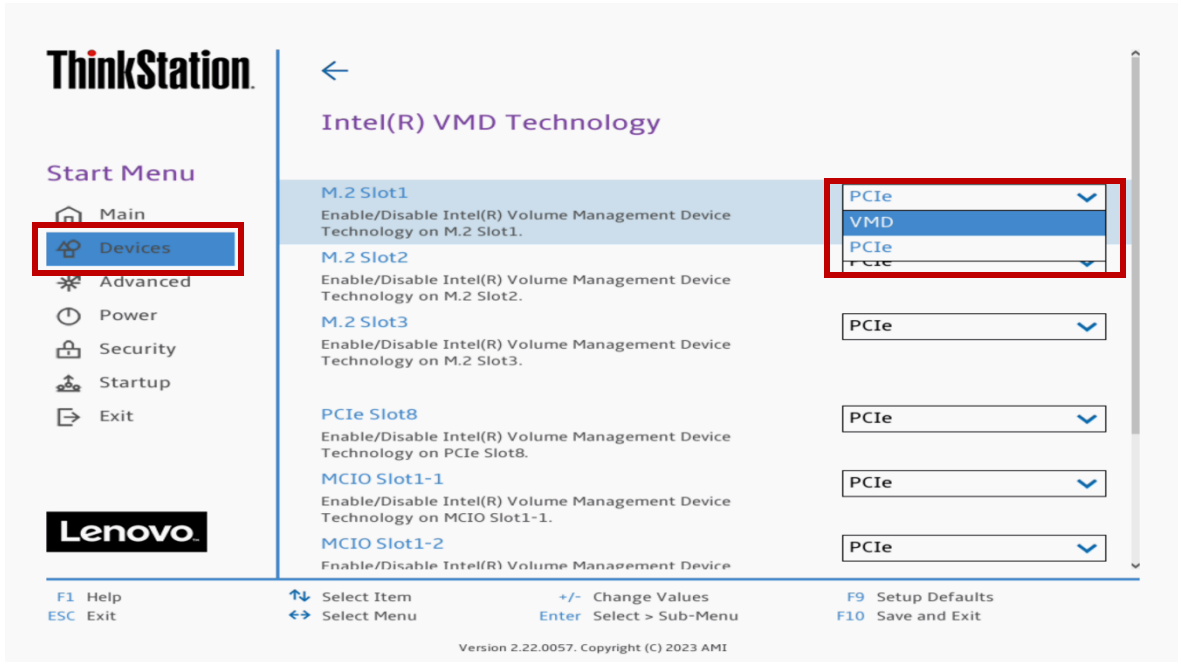


- Navigate toward the bottom of the list and select “Intel® VMD Technology”.

*Note: If this option does not show up here, please check the system BIOS version and consider upgrading to the latest available BIOS.*



- 4. Under the “Intel® VMD Technology” menu, select the appropriate drives to RAID across and switch the drop-down menu from “PCIe” to “VMD”.



In the ThinkStation PX, here is a brief description of what each of these line items mean within the “Intel® VMD Technology” menu. The ThinkStation P5 and P7 have the same concept but with reduced complexity.

Figure 5 below shows how to enable “VMD” across the onboard M.2 slots.

Figure 5 - Onboard M.2 Slots

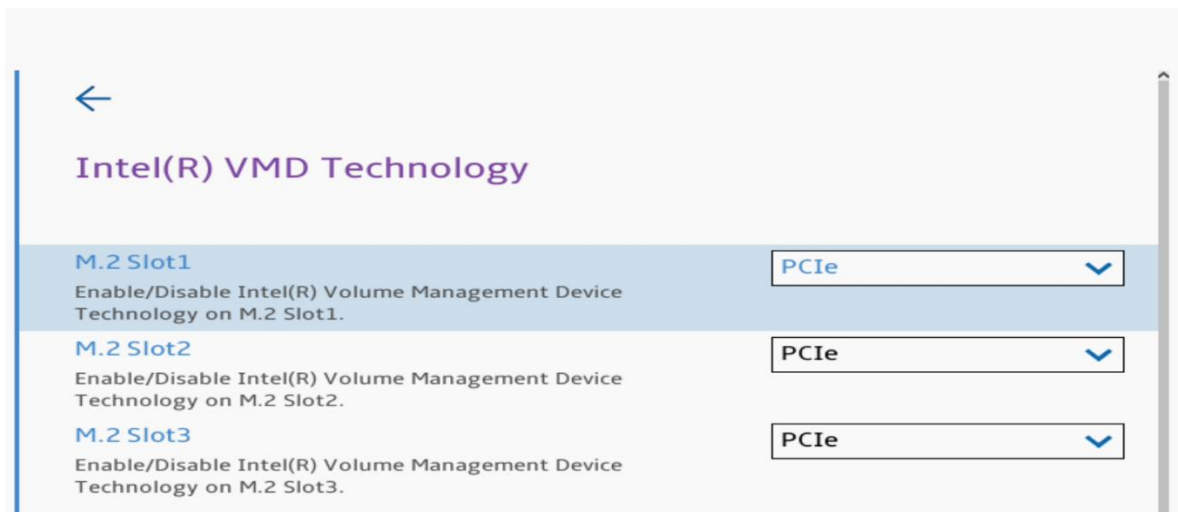


Figure 6 below shows how to enable “VMD” across the front accessible M.2 drives.

Figure 6 - Front NVMe Drives



Table 2 below shows the representation for the front accessible M.2 drives across the different platforms.

Table 2 - MCIO

PX	P7	P5
Front M.2 Bay 1 → MCIO Slot 1-1 → MCIO Slot 1-2	Front M.2 Bay 1 or 3 <sup>rd</sup> Onboard M.2 → MCIO Slot 1-1	Front M.2 Bay 1 → MCIO Slot 1-1
Front M.2 Bay 2 → MCIO Slot 2-1 → MCIO Slot 2-2	M.2 drives installed in internal 3.5" bays → MCIO Slot 1-1 → MCIO Slot 1-2	

Figure 7 below shows how to enable “VMD” across PCIe add-in adapters.

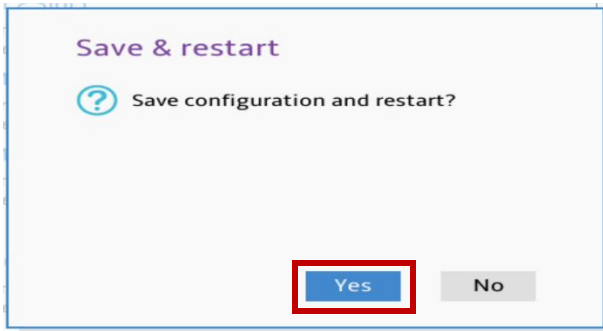
Figure 7 - PCIe NVMe Add-in Adapters



Note: Depending on the number of PCIe NVMe Add-in Adapters installed in the system will depend on how many of these items show up here.

PCIe Slot $X$  → correlates to the PCIe slot to where the PCIe add-in adapter is installed.

5. Select the function key F10 to 'Save and Exit' BIOS setup.

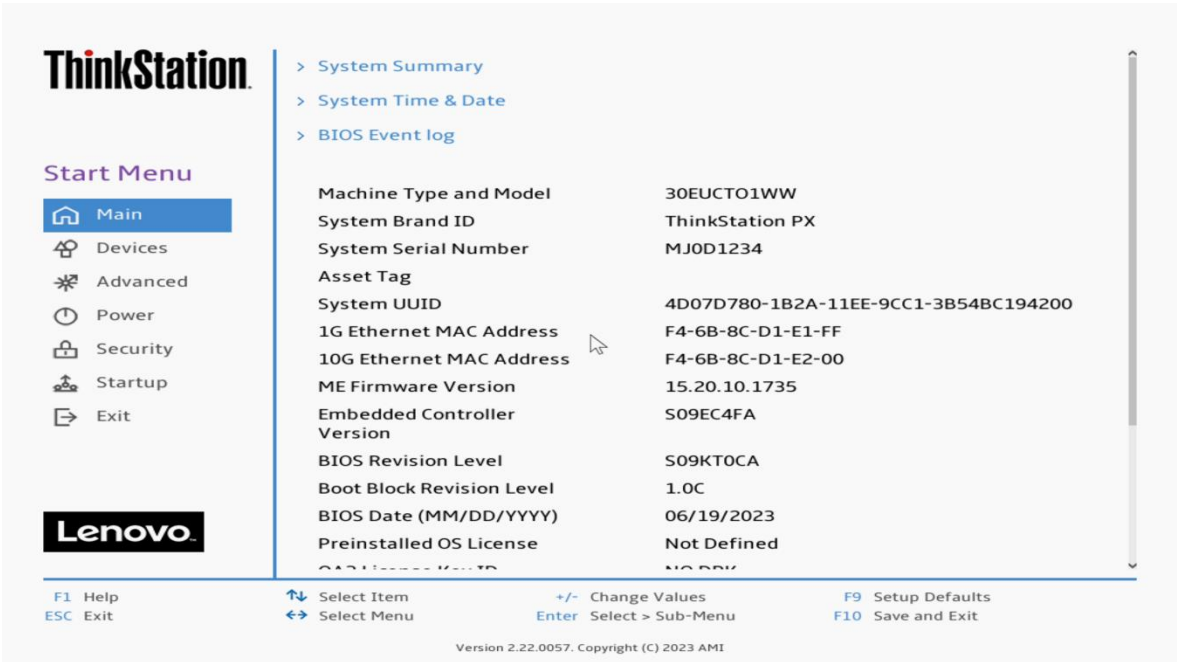




# Section 4 – How to Create NVMe RAID

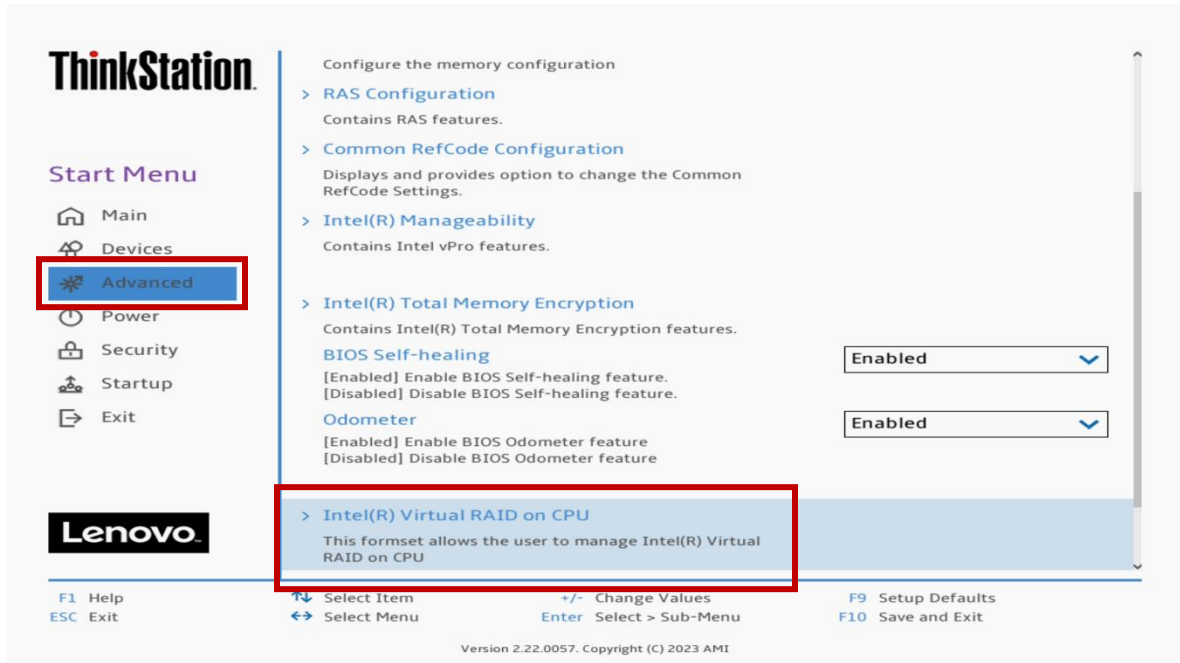
Refer to the steps below on how to create an NVMe RAID array. Please be sure to have the Intel VROC module installed per 'Section 1' above.

1. Power on the system and press the function F1 key at the Lenovo splash screen to enter BIOS setup.



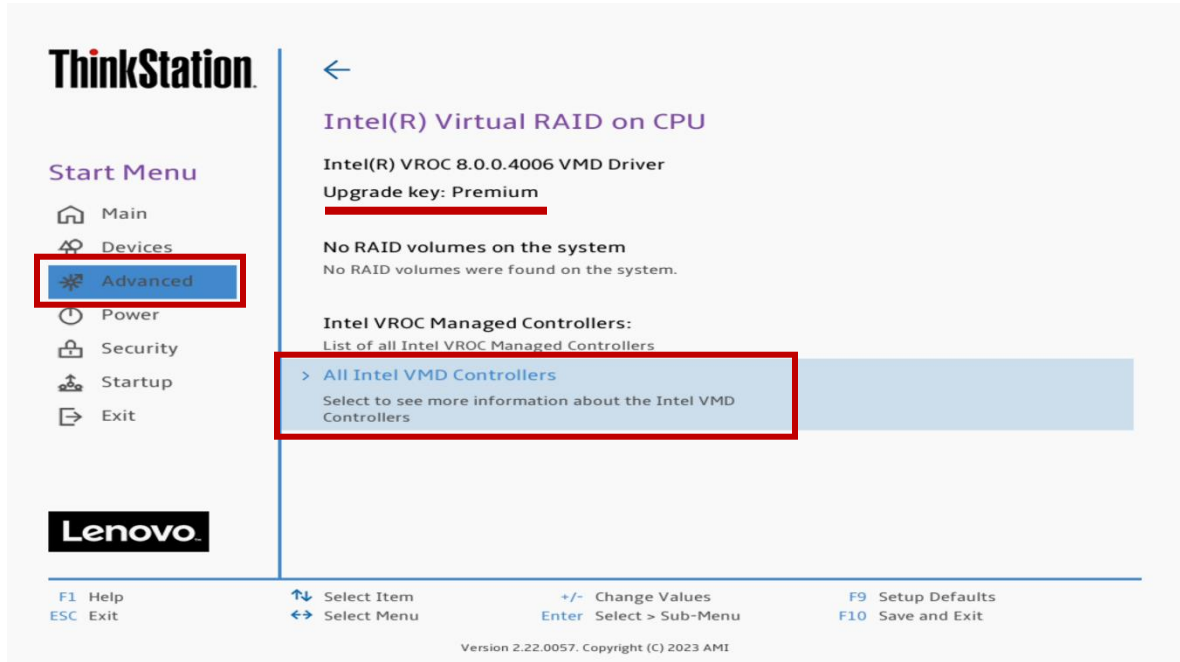
- From within the BIOS setup screen, select the “Advanced” menu option from the left-side menu options and “Intel® Virtual RAID on CPU” from the middle menu options.

*Note: If this option does not show up here, please check the system BIOS version and consider upgrading to the latest available BIOS.*

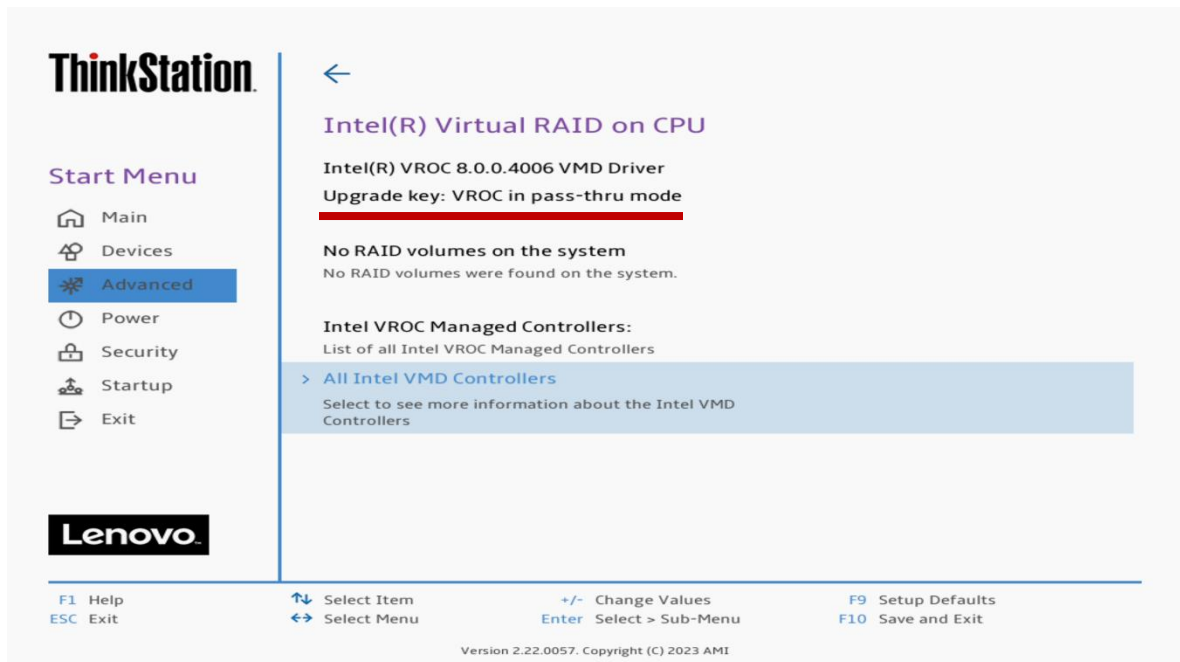


3. Select “All Intel VMD Controllers”.

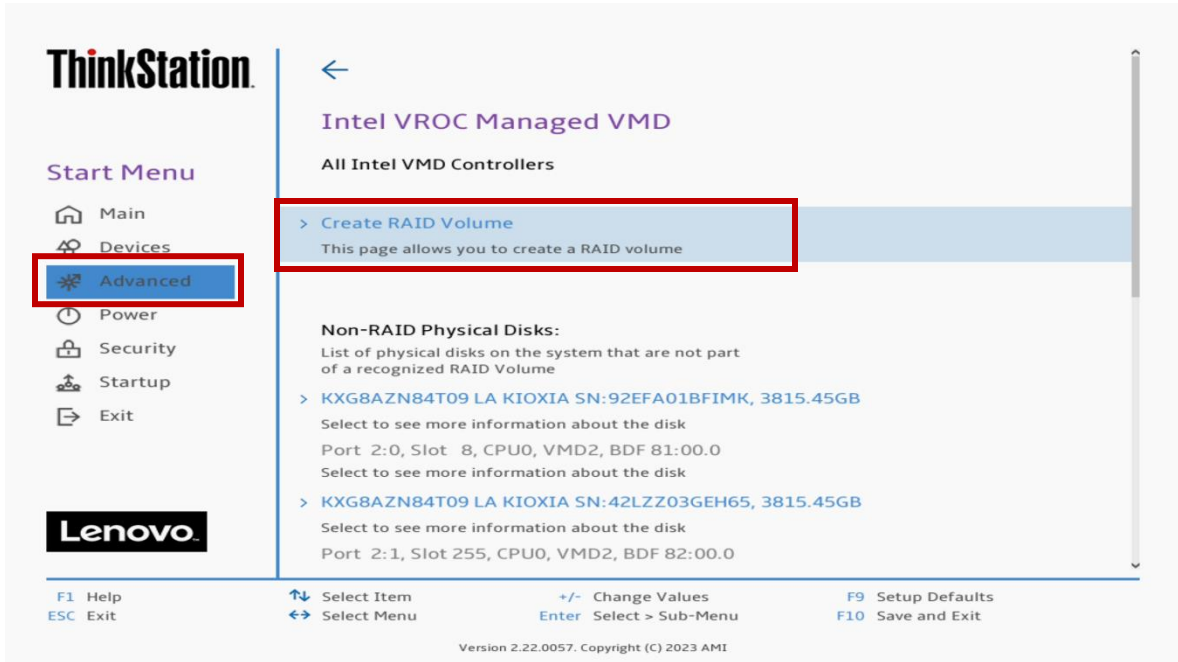
*Note: “Upgrade key” underlined below will either read “Premium” or “Basic” depending on what is installed in the system.*



*Note: If the system does not detect a VROC module installed, then the “Upgrade key” will show up as “VROC in pass-thru mode”.*



4. Select “Create RAID Volume”.

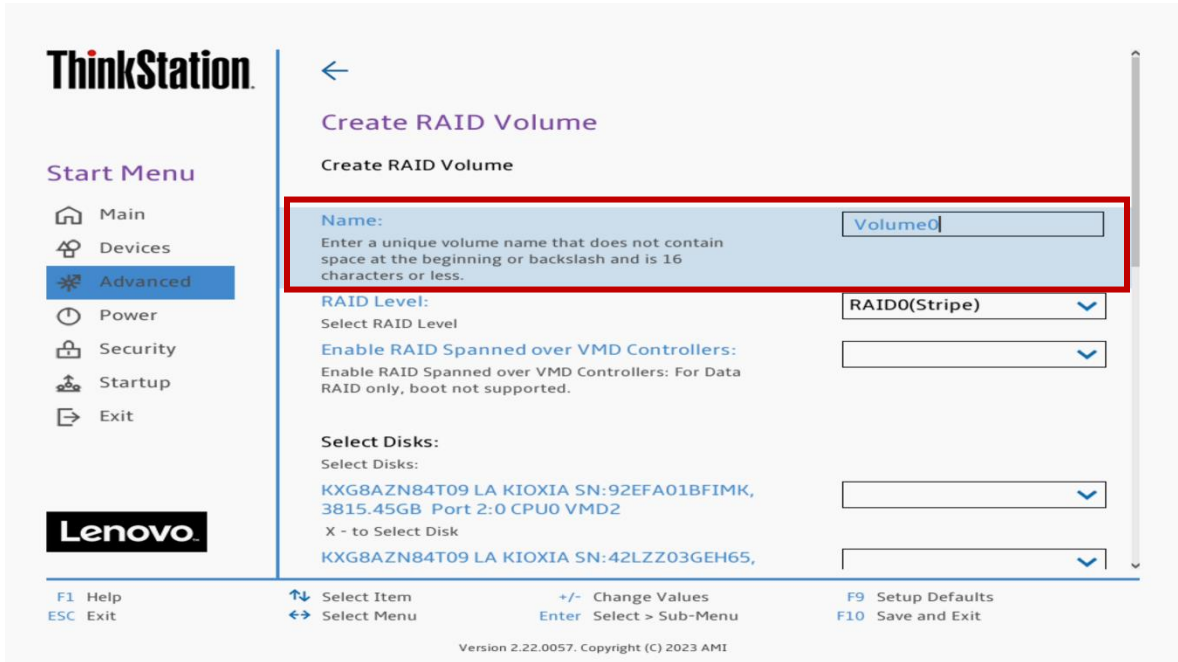


*Note: If the system does not detect a VROC module, there will be no option to create a RAID volume.*



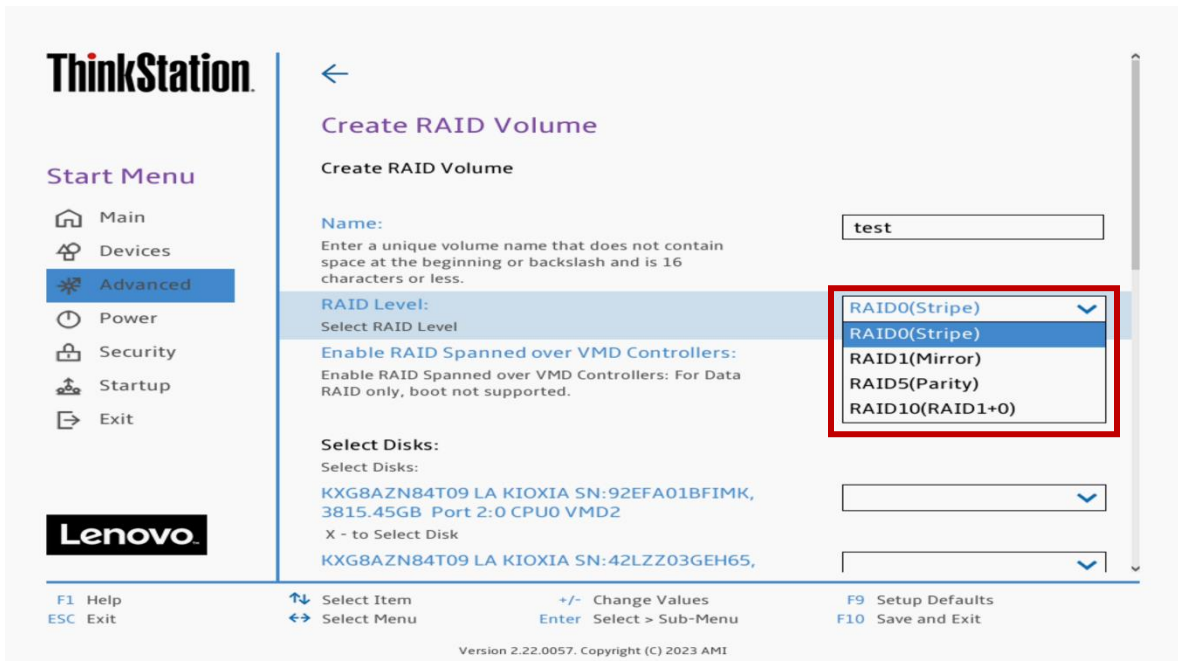


5. Within the “Create RAID Volume” menu, select a unique name for the RAID volume.



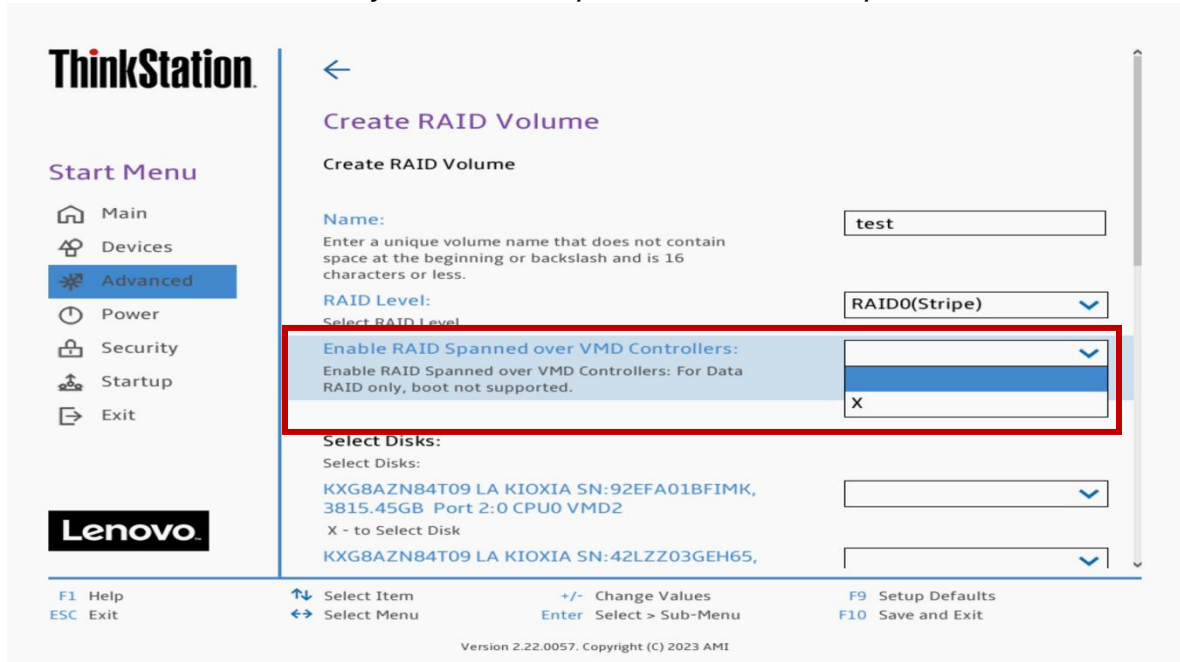
6. Select a RAID Level from the drop-down menu.

*Note: Only available RAID options depending on the type of VROC module and number of NVMe drives detected will show up here.*

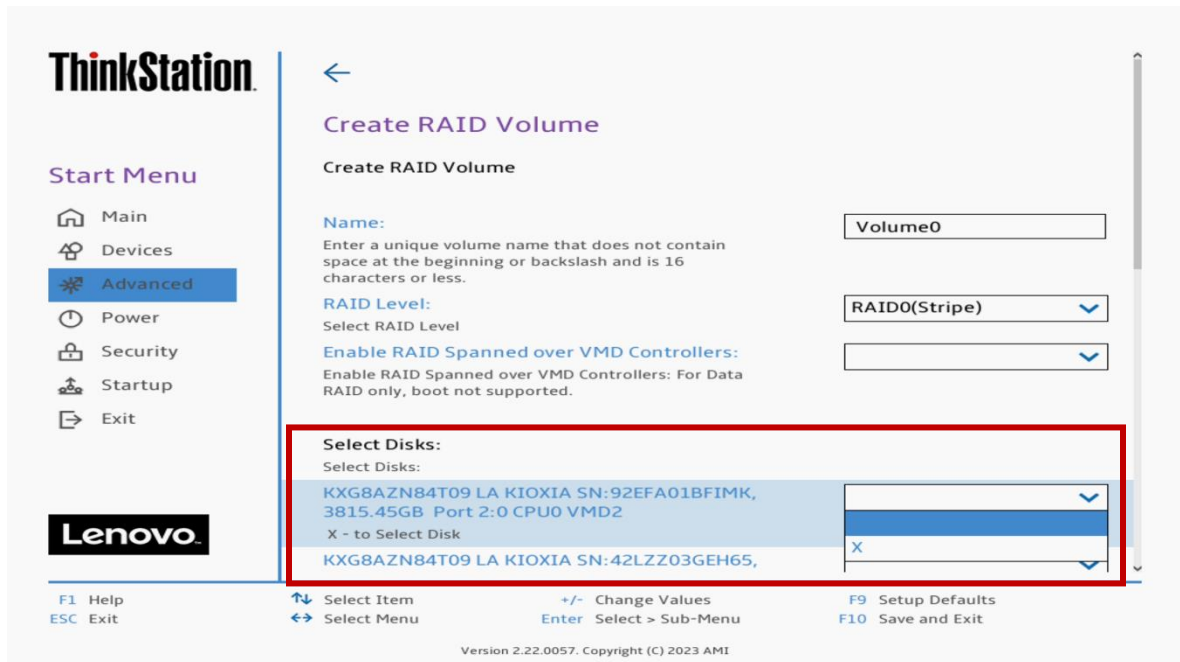


- 7. Select whether to enable RAID to be spanned across multiple VMD controllers. Only applies to ThinkStation PX with dual CPUs.

*Note: Bootable RAID arrays cannot be spanned across multiple VMDs.*



- 8. Select the drives to use in the RAID array by selecting the "X" from each drop-down menu.



- 9. The "Strip Size" and "Capacity" will automatically populate values here depending on the RAID type and drives selected.

**ThinkStation**

**Start Menu**

- Main
- Devices
- Advanced**
- Power
- Security
- Startup
- Exit

**Lenovo**

... TO SELECT DISK

KXG8AZN84T09 LA KIOXIA SN:42LZZ03DEH65, 3815.45GB Port 2:2 CPU0 VMD2  
X - to Select Disk

KXG8AZN84T09 LA KIOXIA SN:92EFA031FIMK, 3815.45GB Port 2:3 CPU0 VMD2  
X - to Select Disk

KXG8AZN84T09 LA KIOXIA SN:42LZZ03BEH65, 3815.45GB Port 4:0 CPU0 VMD4  
X - to Select Disk

KXG8AZN84T09 LA KIOXIA SN:42LZZ038EH65, 3815.45GB Port 4:1 CPU0 VMD4  
X - to Select Disk

KXG8AZN84T09 LA KIOXIA SN:42LZZ036EH65, 3815.45GB Port 4:2 CPU0 VMD4  
X - to Select Disk

**Strip Size:** 128KB  
Strip size help

**Capacity (GB):** 10874.01  
Capacity is an approximation in GB. Enter desired volume size. 0 will be treated as Maximum Size. Approximate Maximum size=11446.33. Default Capacity is approximately 95% of Maximum size.

F1 Help    ESC Exit    Select Item    Select Menu    +/- Change Values    Enter Select > Sub-Menu    F9 Setup Defaults    F10 Save and Exit

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- 10. Select "Create Volume".

**ThinkStation**

**Start Menu**

- Main
- Devices
- Advanced**
- Power
- Security
- Startup
- Exit

**Lenovo**

... TO SELECT DISK

KXG8AZN84T09 LA KIOXIA SN:92EFA031FIMK, 3815.45GB Port 2:3 CPU0 VMD2  
X - to Select Disk

KXG8AZN84T09 LA KIOXIA SN:42LZZ03BEH65, 3815.45GB Port 4:0 CPU0 VMD4  
X - to Select Disk

KXG8AZN84T09 LA KIOXIA SN:42LZZ038EH65, 3815.45GB Port 4:1 CPU0 VMD4  
X - to Select Disk

KXG8AZN84T09 LA KIOXIA SN:42LZZ036EH65, 3815.45GB Port 4:2 CPU0 VMD4  
X - to Select Disk

**Strip Size:** 128KB  
Strip size help

**Capacity (GB):** 10874.01  
Capacity is an approximation in GB. Enter desired volume size. 0 will be treated as Maximum Size. Approximate Maximum size=11446.33. Default Capacity is approximately 95% of Maximum size.

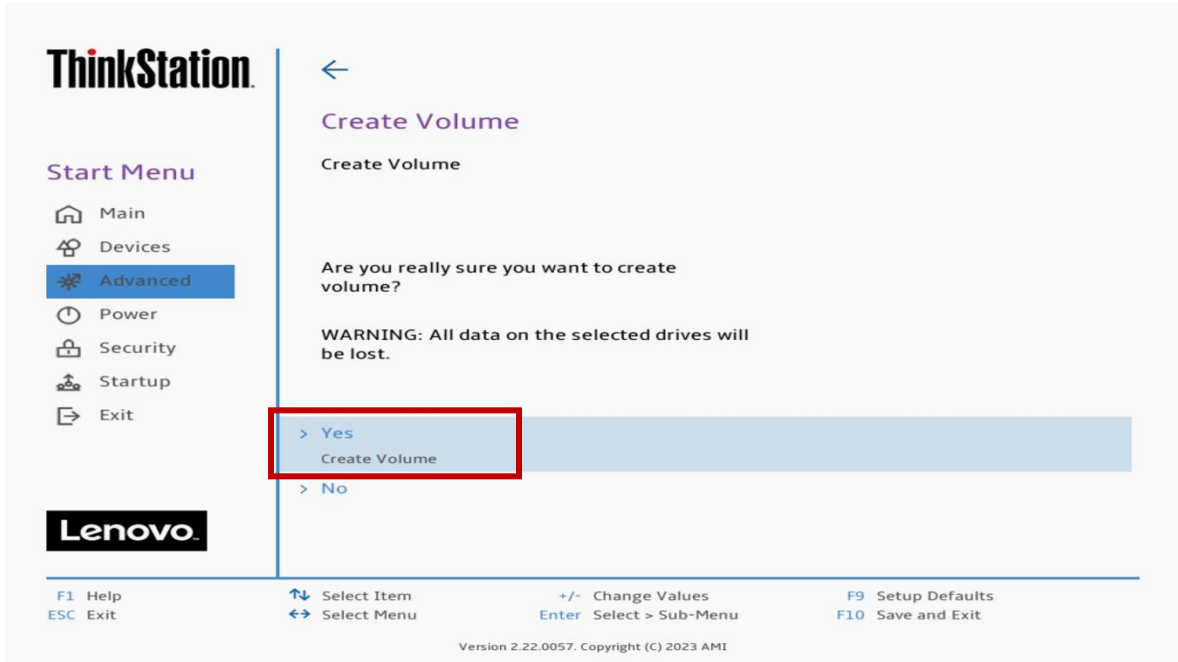
**> Create Volume**  
Create a volume with the settings specified above

F1 Help    ESC Exit    Select Item    Select Menu    +/- Change Values    Enter Select > Sub-Menu    F9 Setup Defaults    F10 Save and Exit

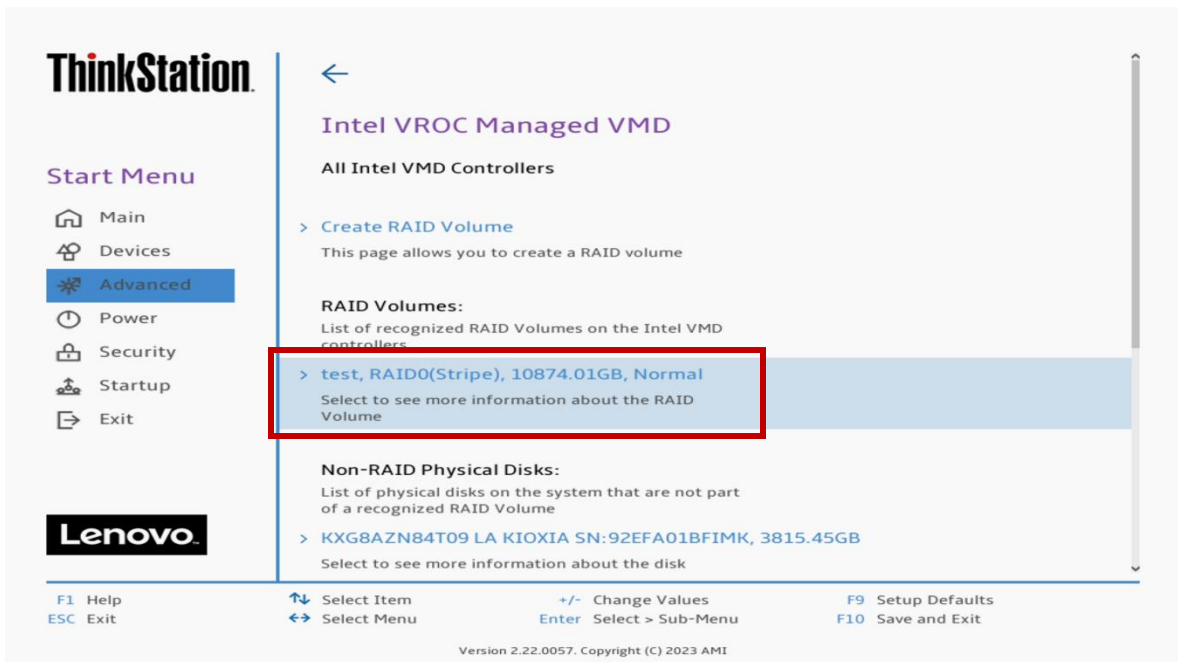
Version 2.22.0057. Copyright (C) 2023 AMI

11. Select “Yes” to confirm creating the RAID volume.

*Note: All data on the select drives will be lost.*

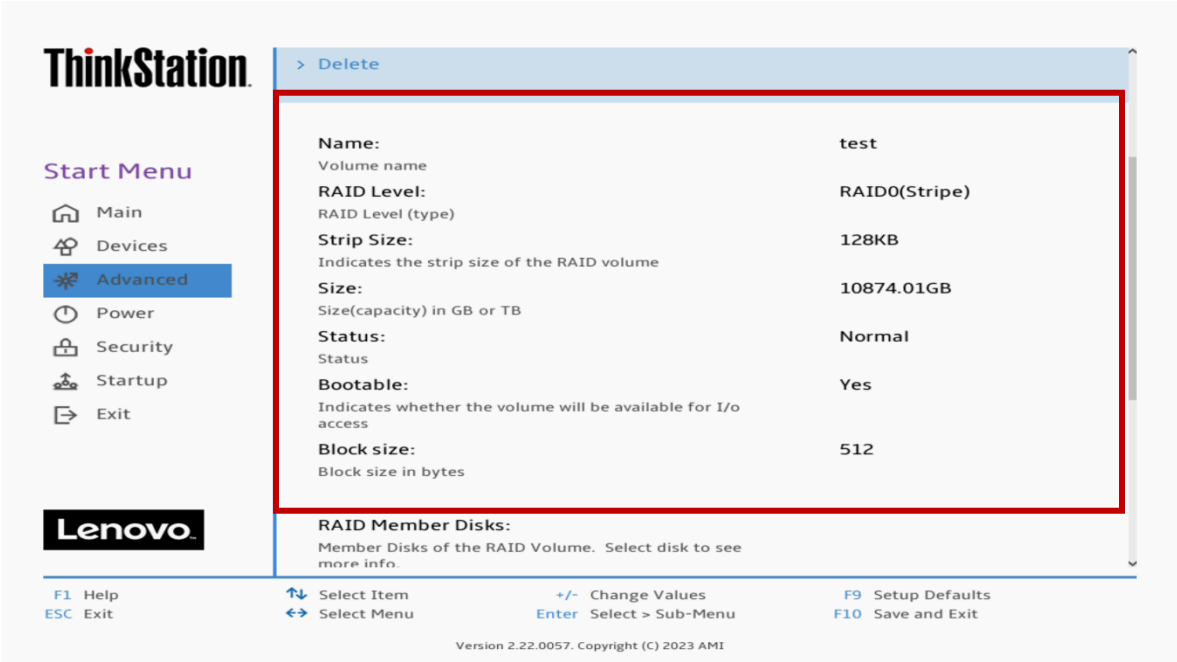


12. The created RAID arrays will show up under the root menu for “Intel VROC Managed VMD”.

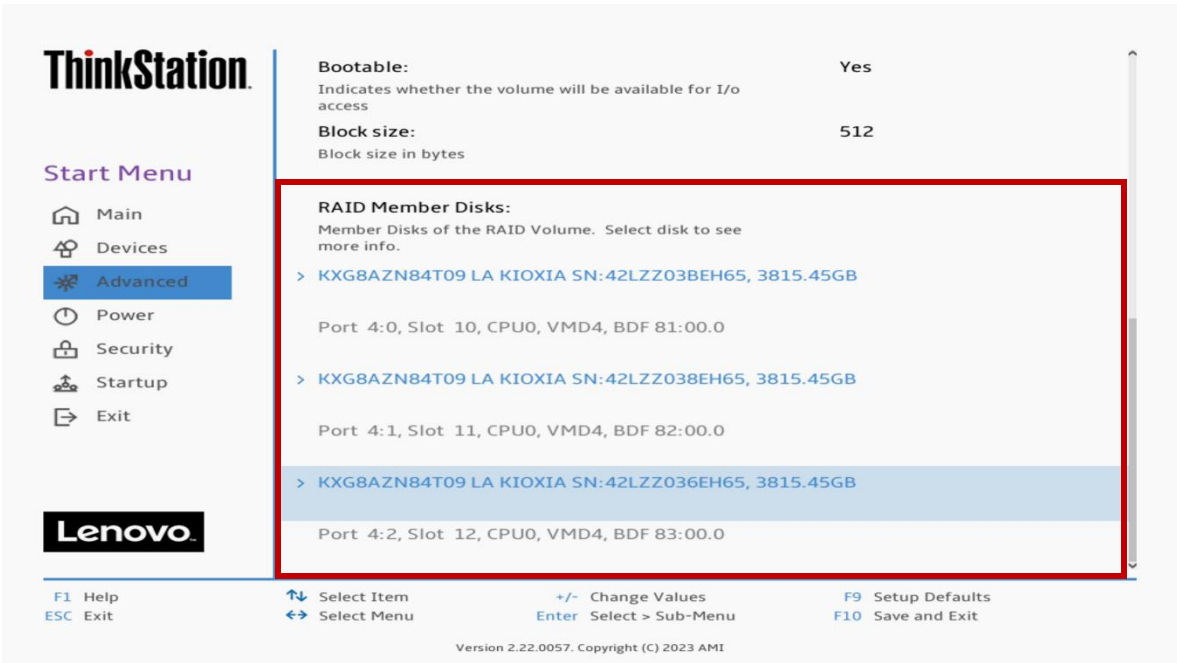




13. To view the RAID volume information, select the RAID volume from the previous step.

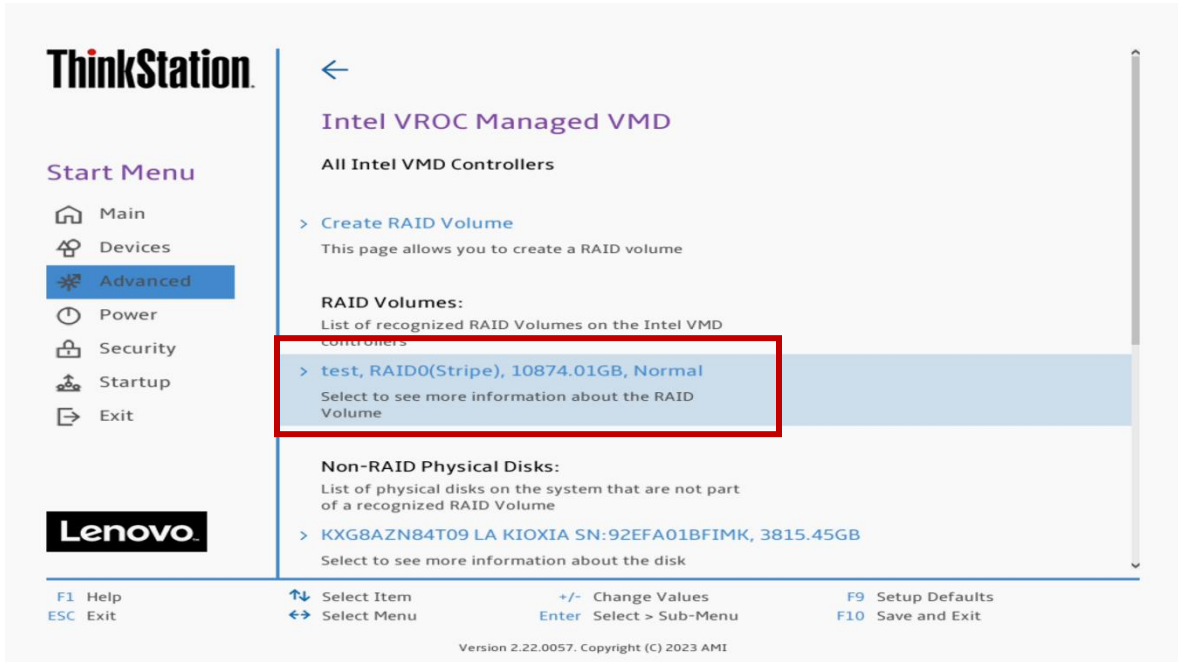


Scrolling down the “RAID Volume Info” screen will show the drives associated with the RAID volume.

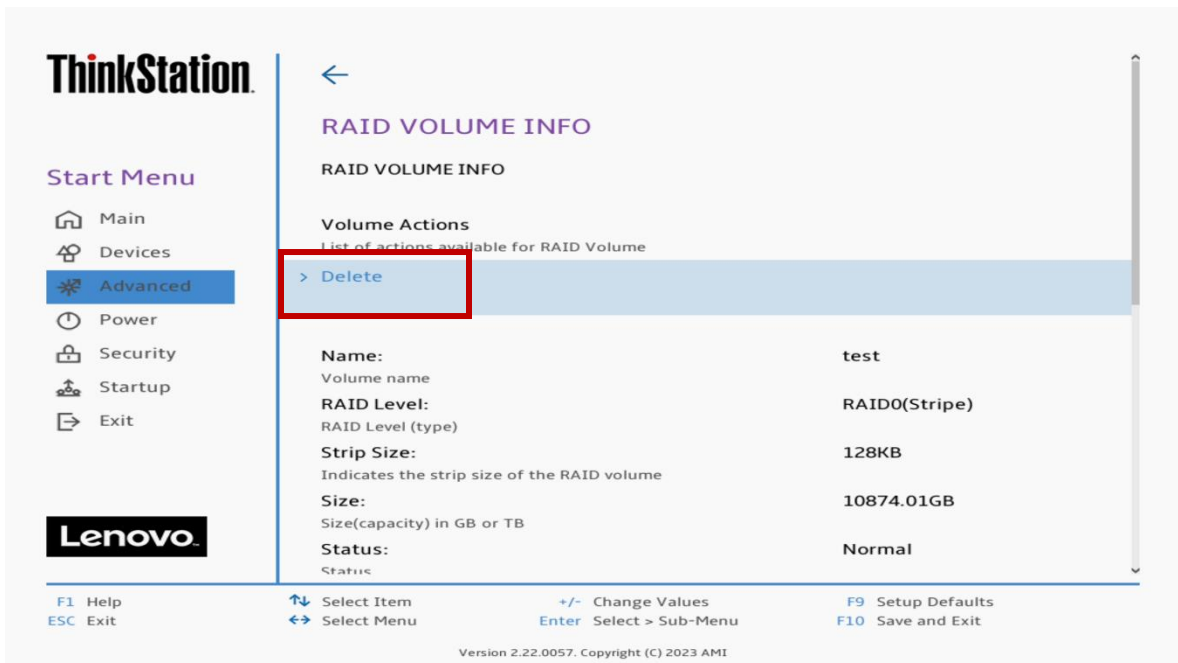


14. To delete the RAID, select the RAID volume from the previous step.

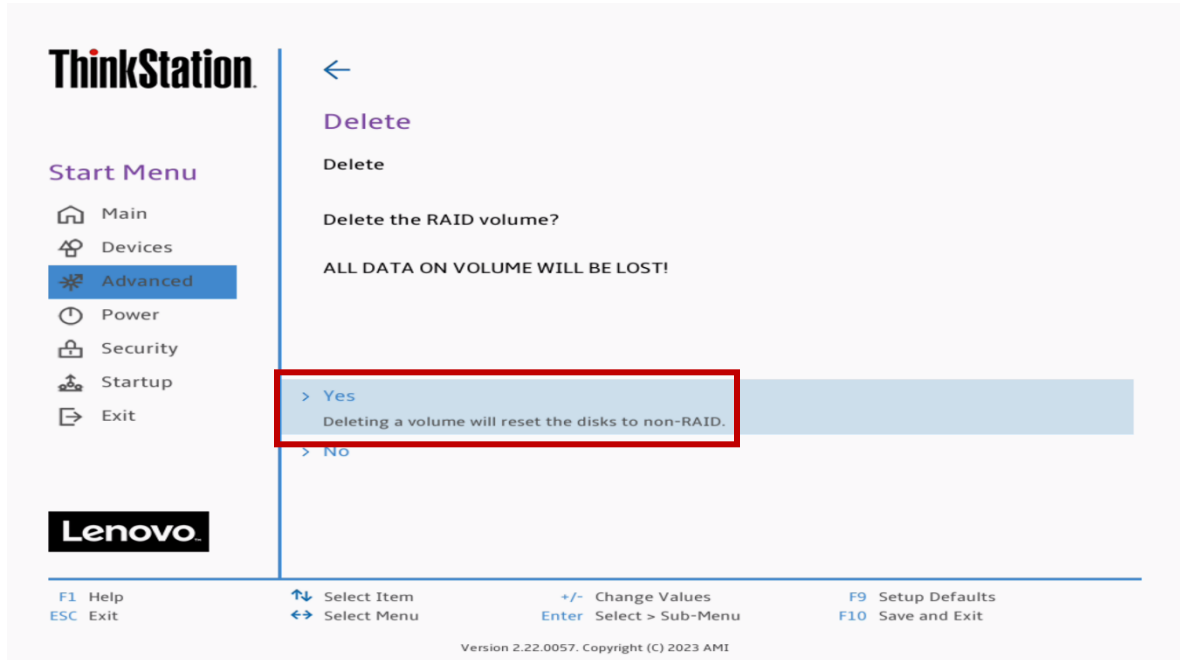
*Note: This is destructive and will not be able to recover the RAID array and all data stored on the drives.*



15. Select "Delete".



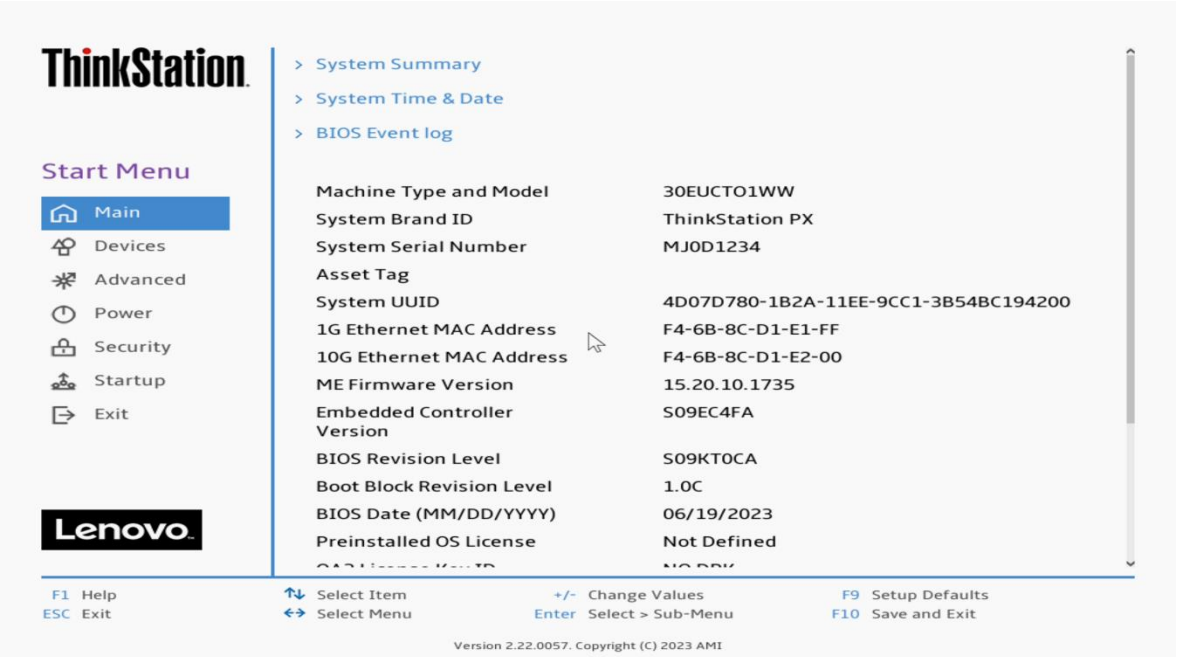
16. Select "Yes".



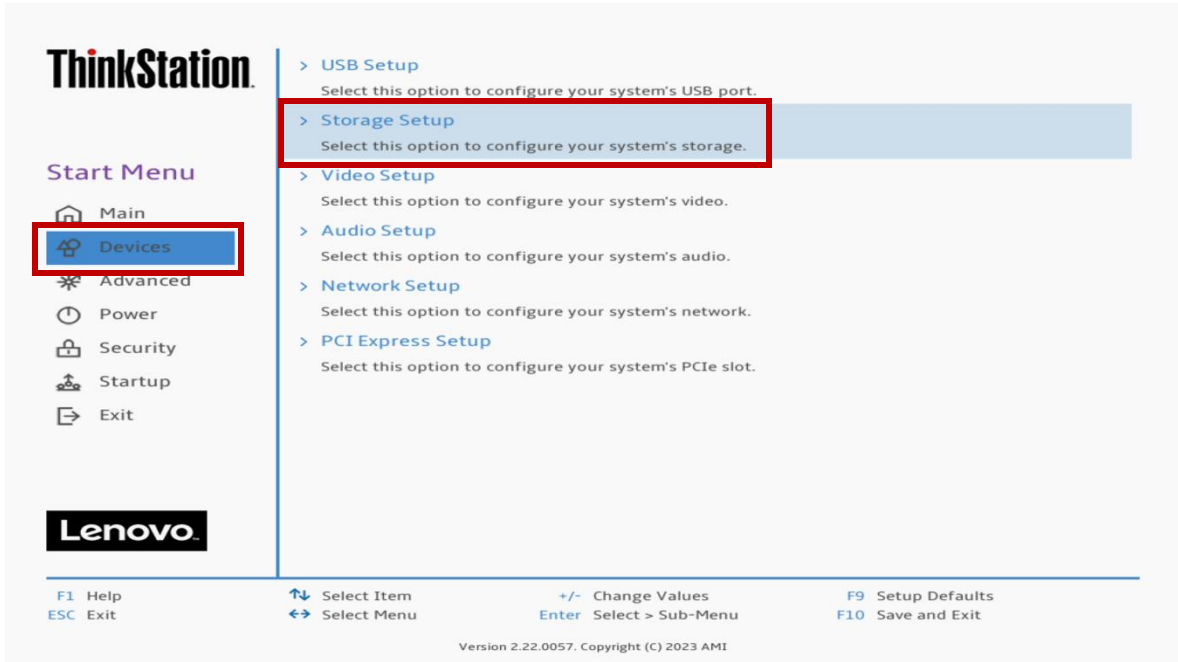
# Section 5 – How to Enable SATA RAID

In order to setup and configure SATA RAID, BIOS must be set to RAID mode first. Refer to the steps below on how to configure BIOS in RAID mode.

1. Power on the system and press the function F1 key at the Lenovo splash screen to enter BIOS setup.

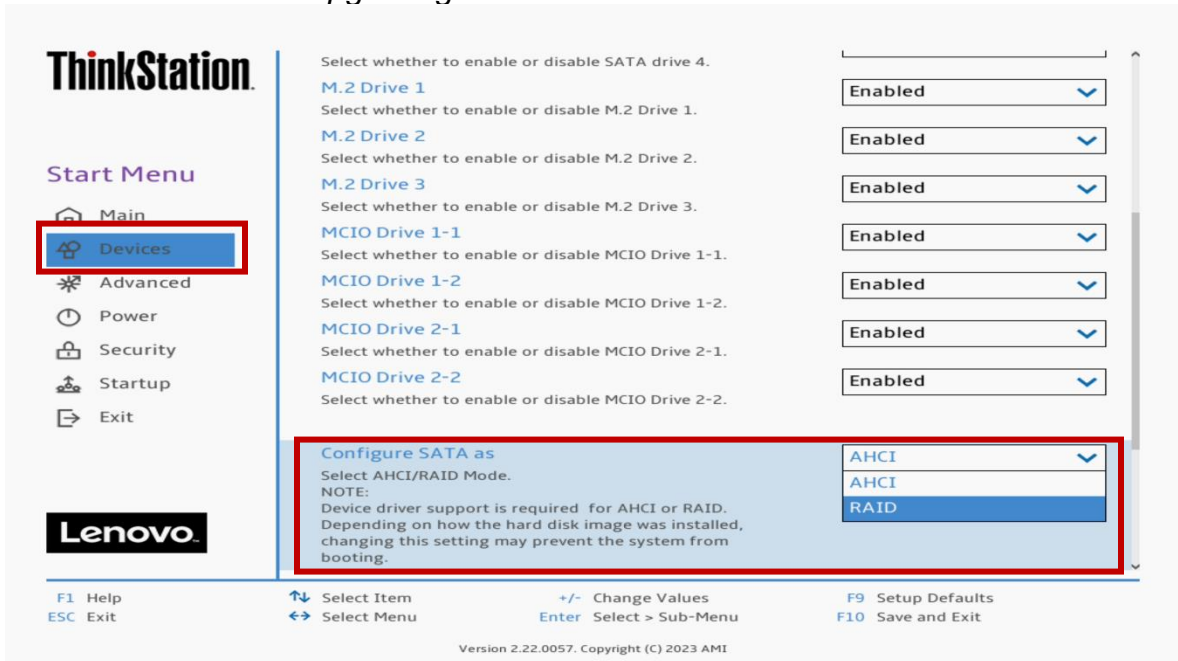


- From within the BIOS setup screen, select the “Devices” menu option from the left-side menu options and “Storage Setup” from the middle menu options.



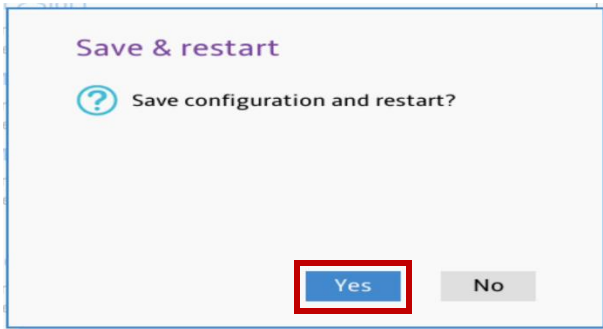
- Navigate toward the middle of the list and select “Configure SATA as” and change the dropdown menu from “AHCI” to “RAID”.

*Note: If this option does not show up here, please check the system BIOS version and consider upgrading to the latest available BIOS.*





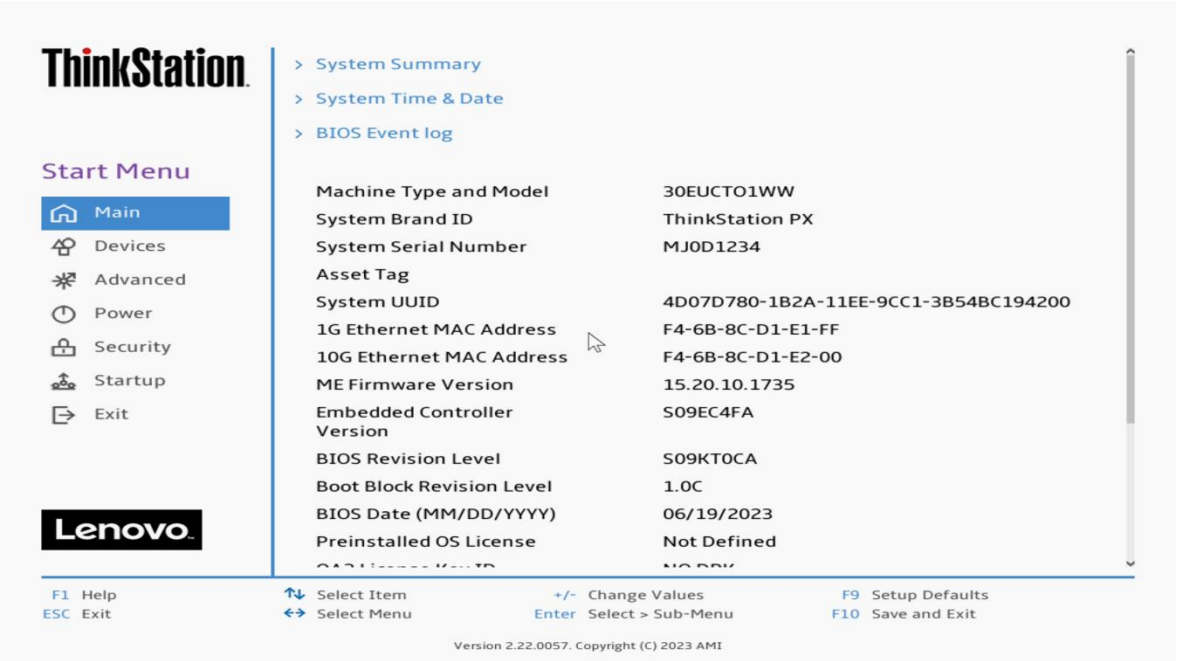
4. Select the function key F10 to “Save and Exit” BIOS setup.



# Section 6 – How to Create a SATA RAID

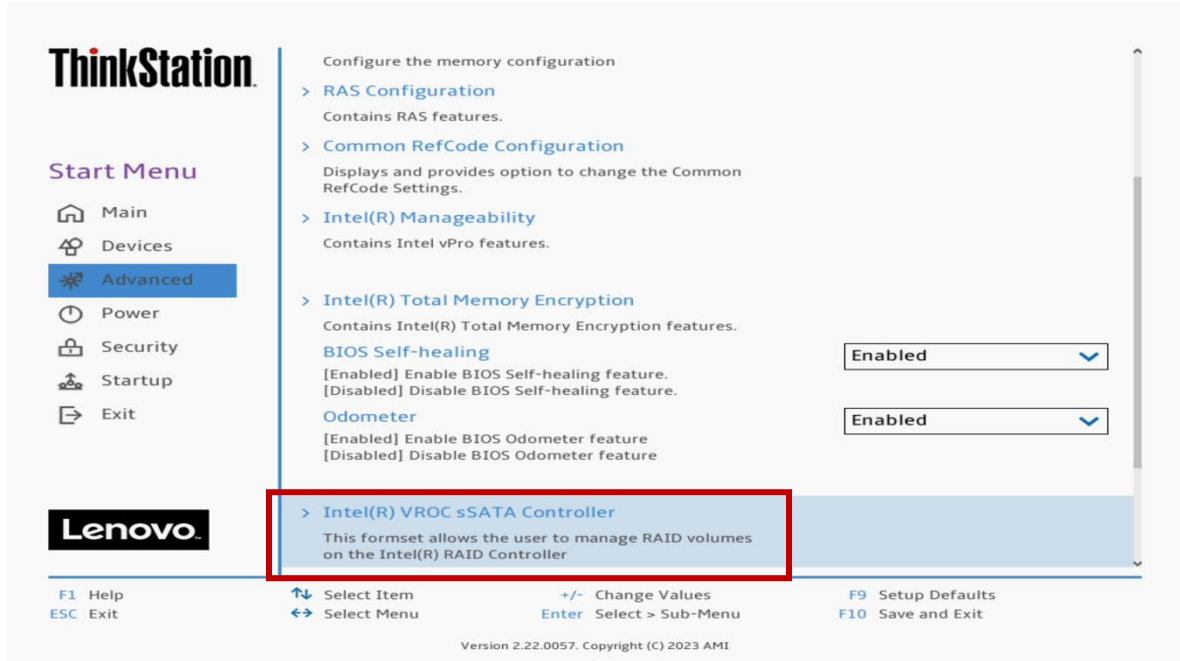
Refer to the steps below on how to create a SATA RAID array. Note, an Intel VROC module is not necessary to complete these steps below.

1. Power on the system and press the function F1 key at the Lenovo splash screen to enter BIOS setup.



- From within the BIOS setup screen, select the “Advanced” menu option from the left-side menu options and “Intel® VROC sSATA Controller” from the middle menu options.

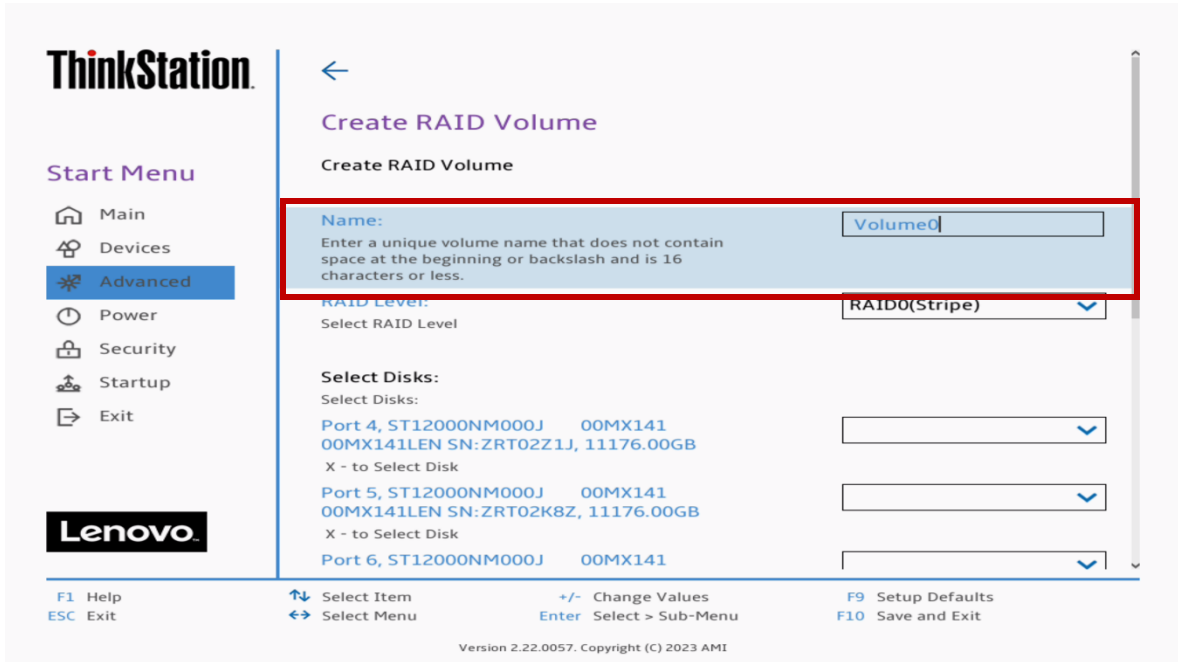
*Note: If this option does not show up here, please check the system BIOS version and consider upgrading to the latest available BIOS.*



- Select “Create RAID Volume”.

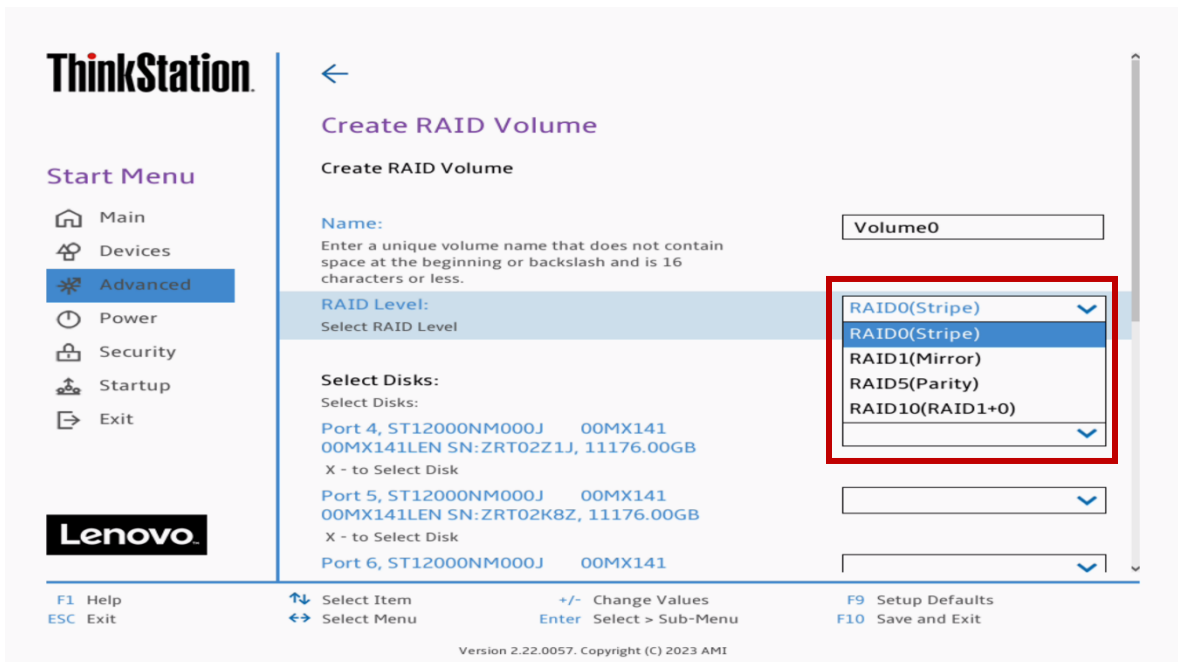


- 4. Within the “Create RAID Volume” menu, select a unique name for the RAID volume.

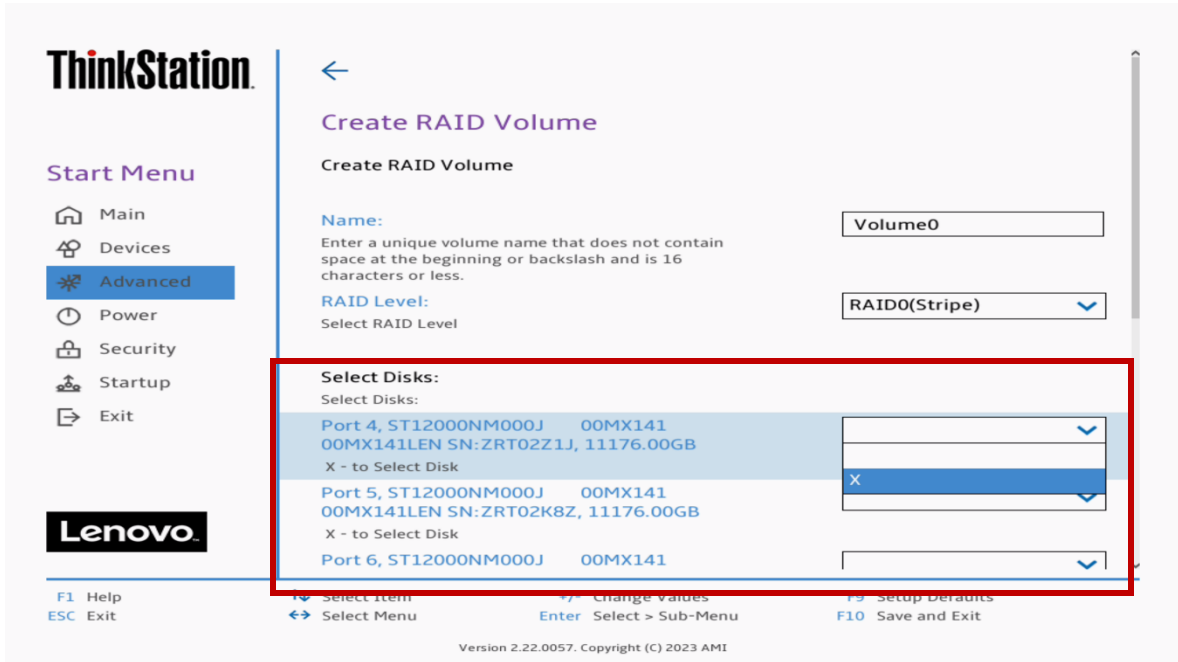


- 5. Select a RAID level from the drop-down menu.

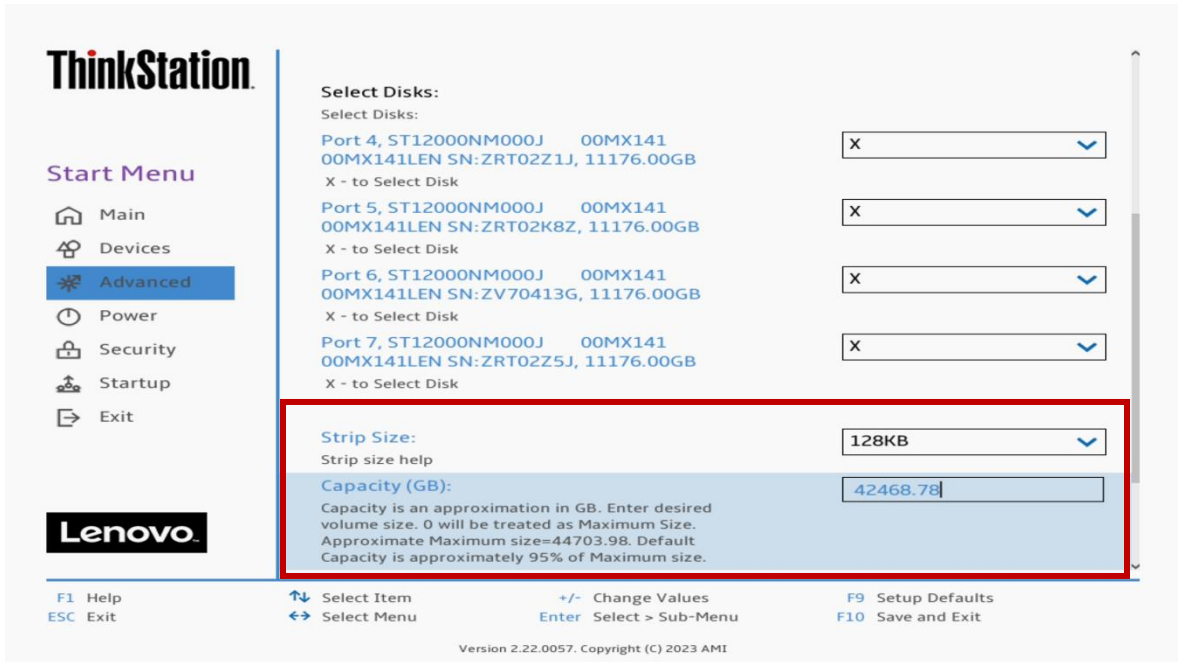
*Note: Only available RAID options depending on the number of SATA drives detected will show up here.*



- 6. Select the drives to use in the RAID array by selecting the “X” from each drop-down menu.



- 7. The “Strip Size” and “Capacity” will automatically populate values here depending on the RAID type and drives selected.



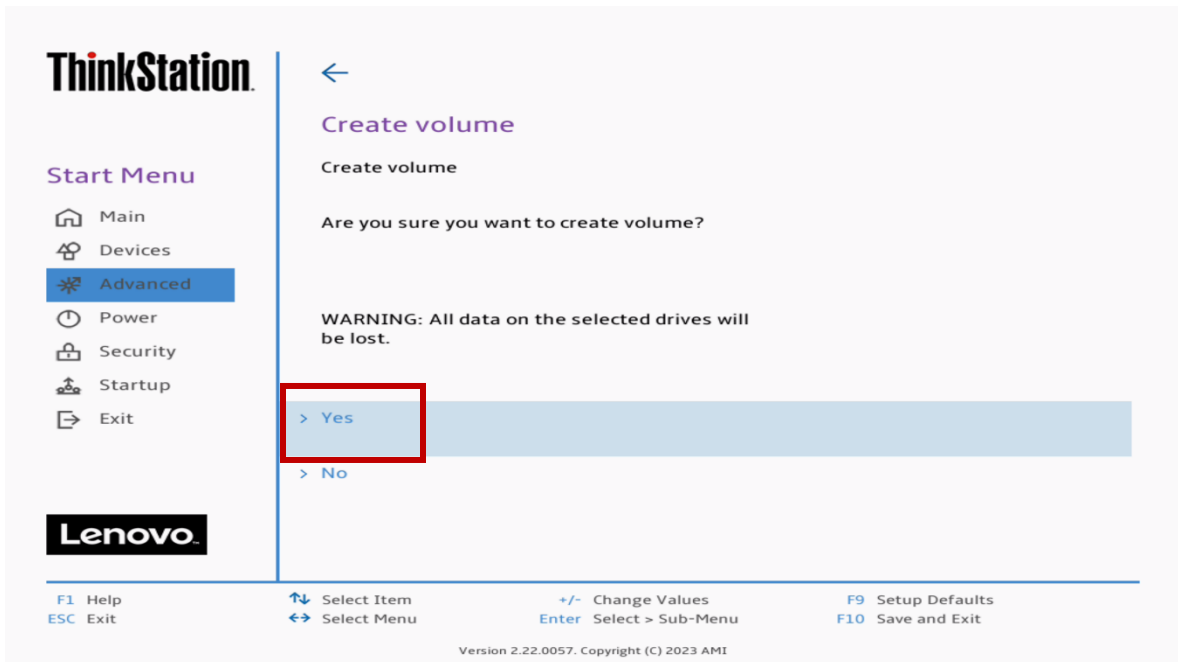


8. Select “Create Volume”.

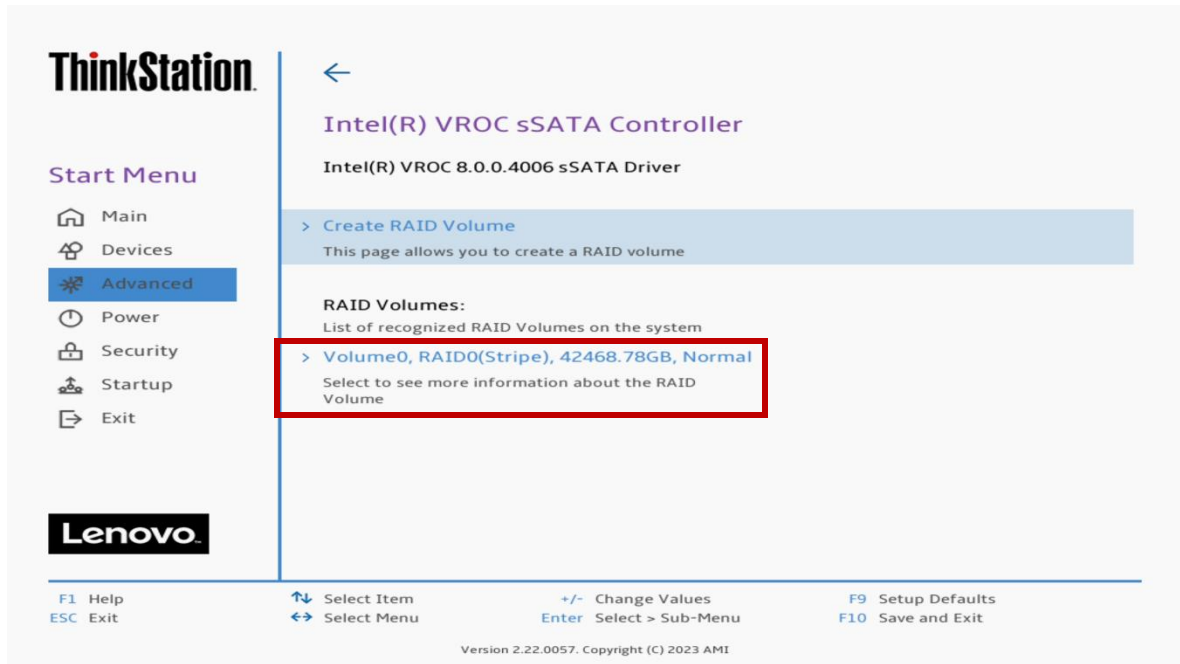


9. Select “Yes” to confirm creating the RAID volume.

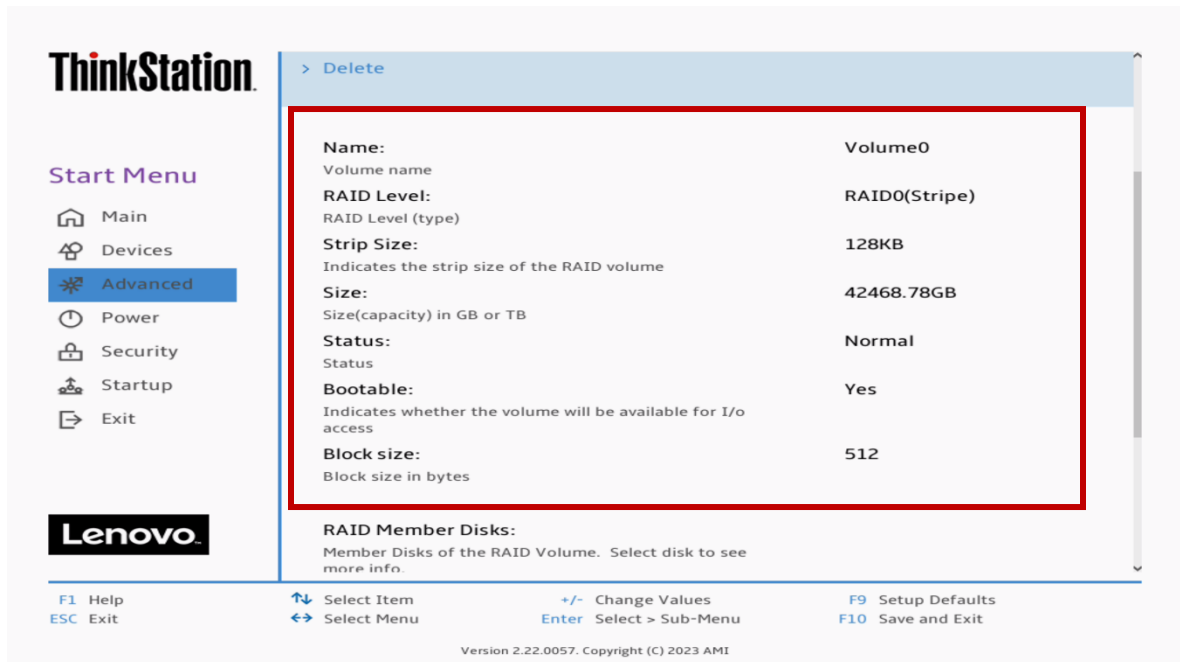
*Note: All data on the selected drives will be lost.*



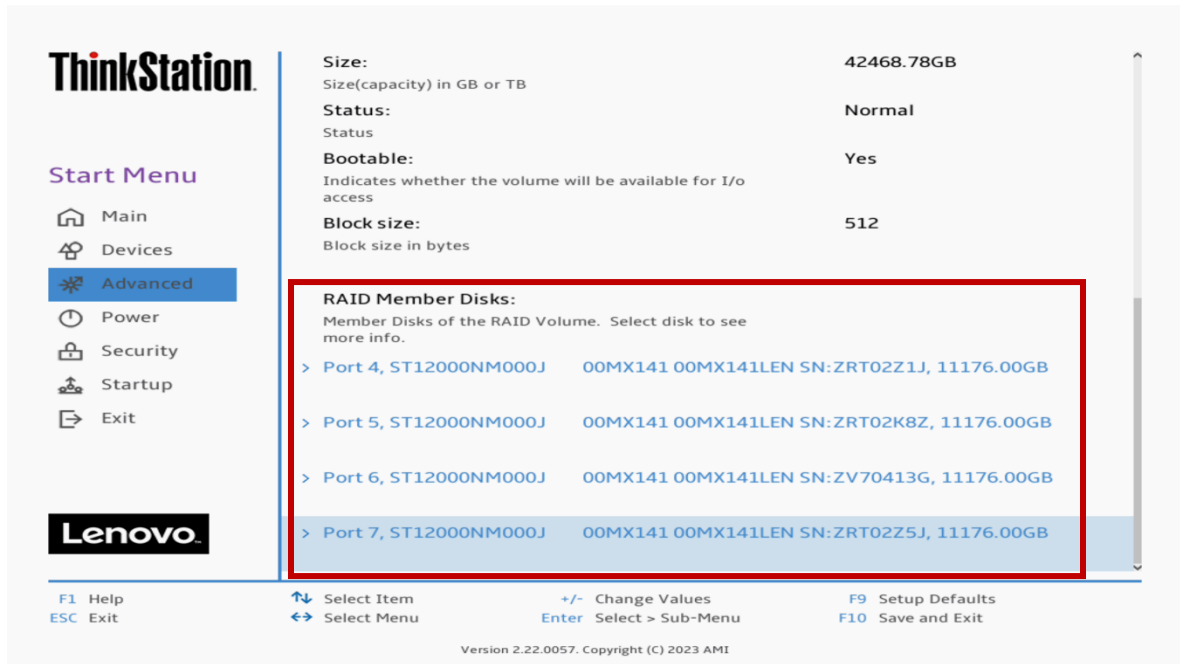
10. The created RAID array will show up under the root menu for “Intel VROC sSATA Controller”.



11. To view the RAID volume information, select the RAID volume from the previous step.

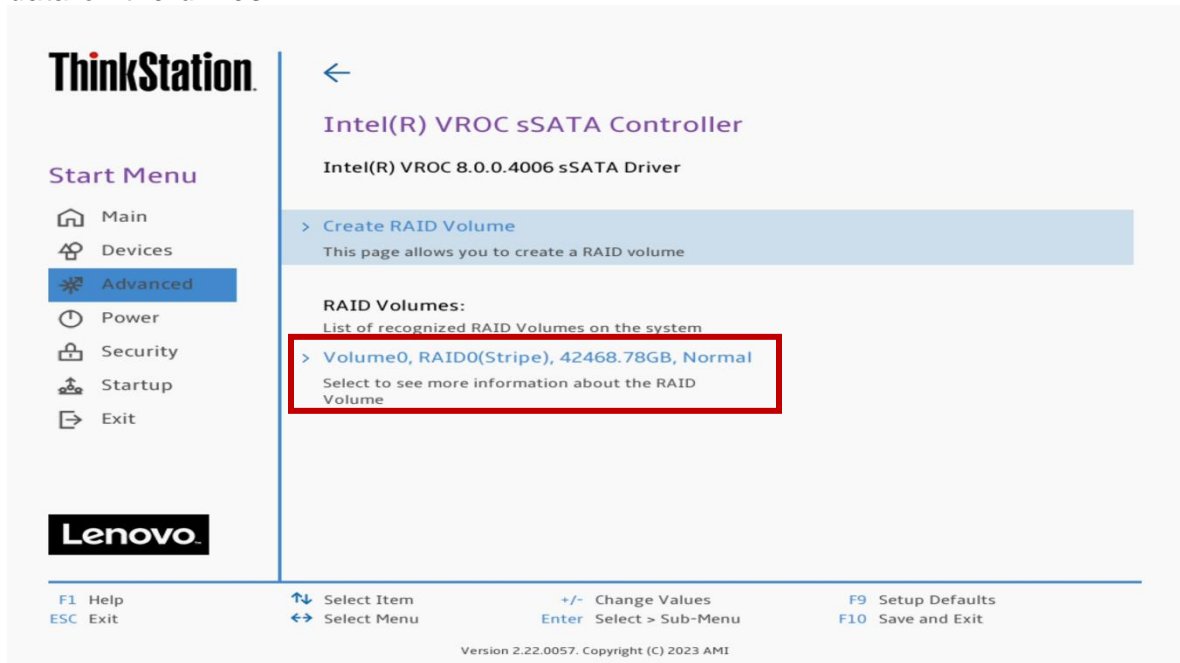


12. Scrolling down the “RAID Volume Info” screen will show the drives associated with the RAID volume.

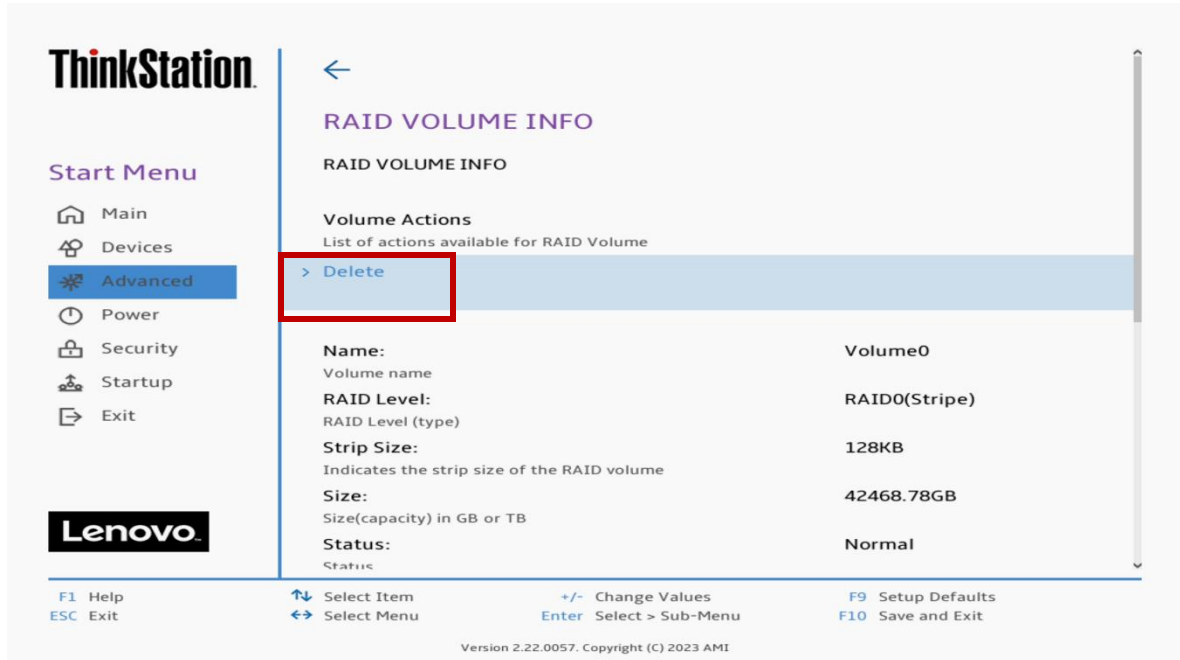


13. To delete the RAID, select the RAID volume from the previous step.

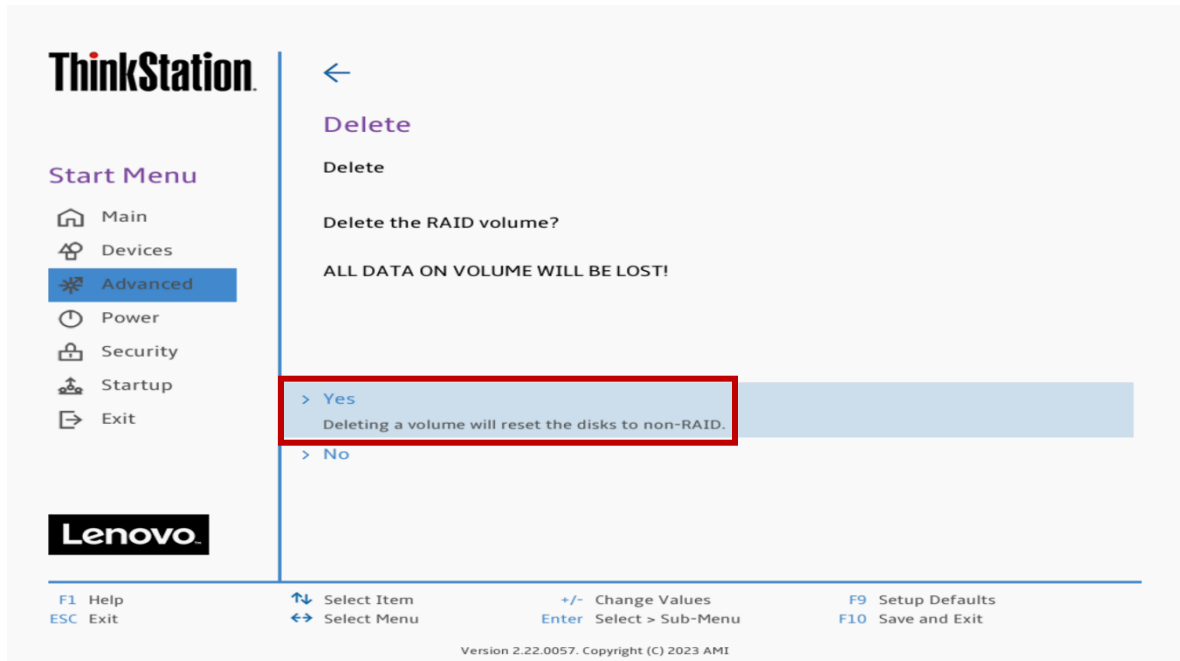
*Note: This is destructive and will not be able to recover the RAID array or data on the drives.*



14. Select "Delete".



15. Select "Yes".





# Revision History

Version	Date	Author	Changes/Updates
1.0	9/18/2023	Jason M.	Initial draft.