

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

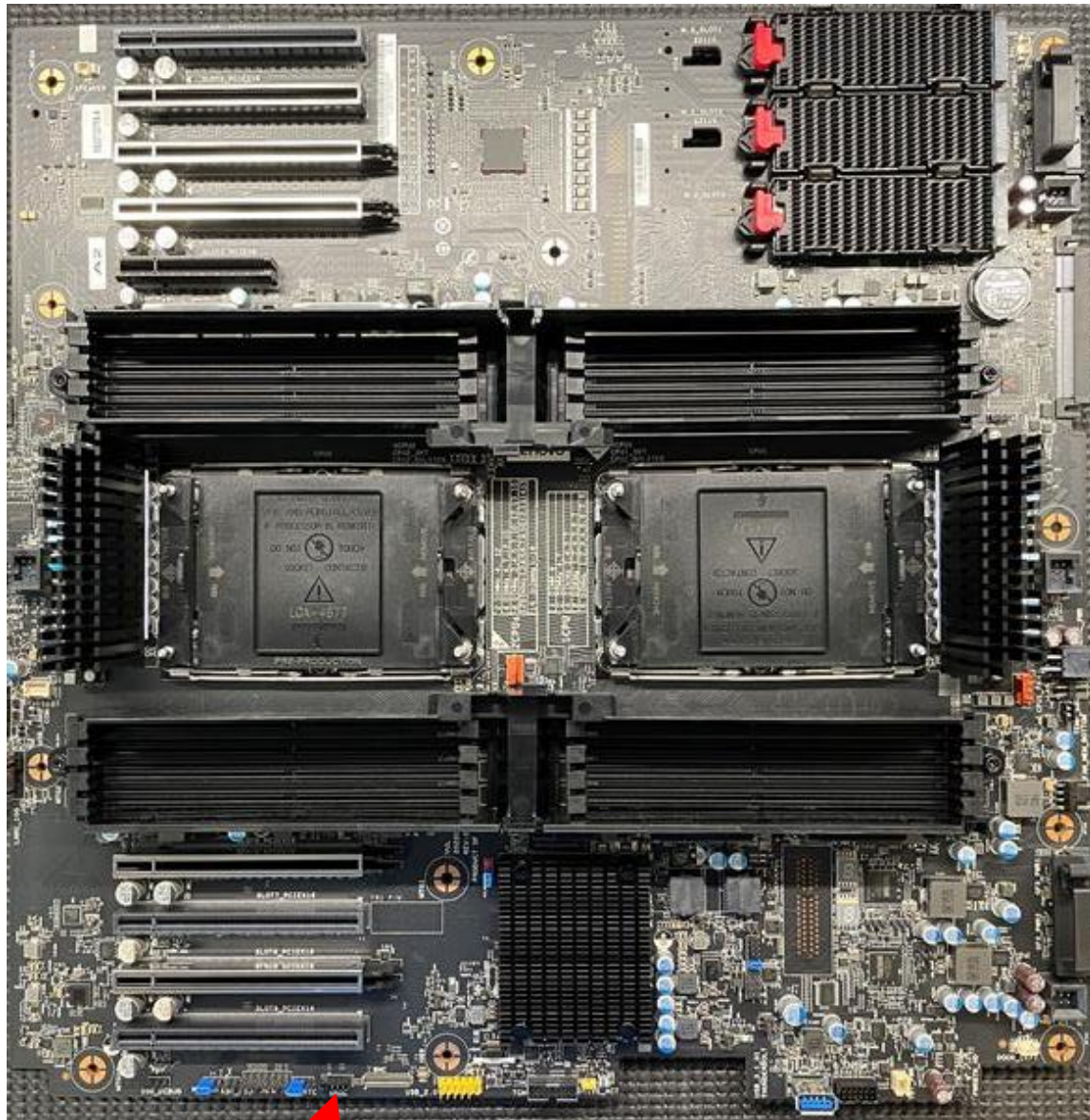
Intel Virtual RAID on CPU (VROC)	Picture	RAID Types Supported
Basic (FRU: 00FC973) (Lenovo Option: N/A)	 A photograph of the Intel VROC Basic module. It is a small, rectangular, gold-colored component with a blue ribbon cable attached. The label on the module reads "VROCSTANMOD" and "1733".	RAID 0, 1, and 10
Premium (FRU: 00FC974) (Lenovo Option: 4XH0Q89603)	 A photograph of the Intel VROC Premium module. It is a small, rectangular, gold-colored component with a blue ribbon cable attached. The label on the module is red and reads "VROCPRMAMOD" and "1709".	RAID 0, 1, 5, and 10

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

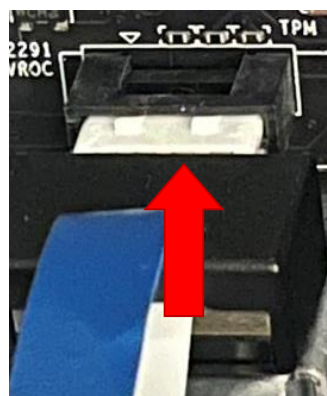
ThinkStation PX – VROC Header Location

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



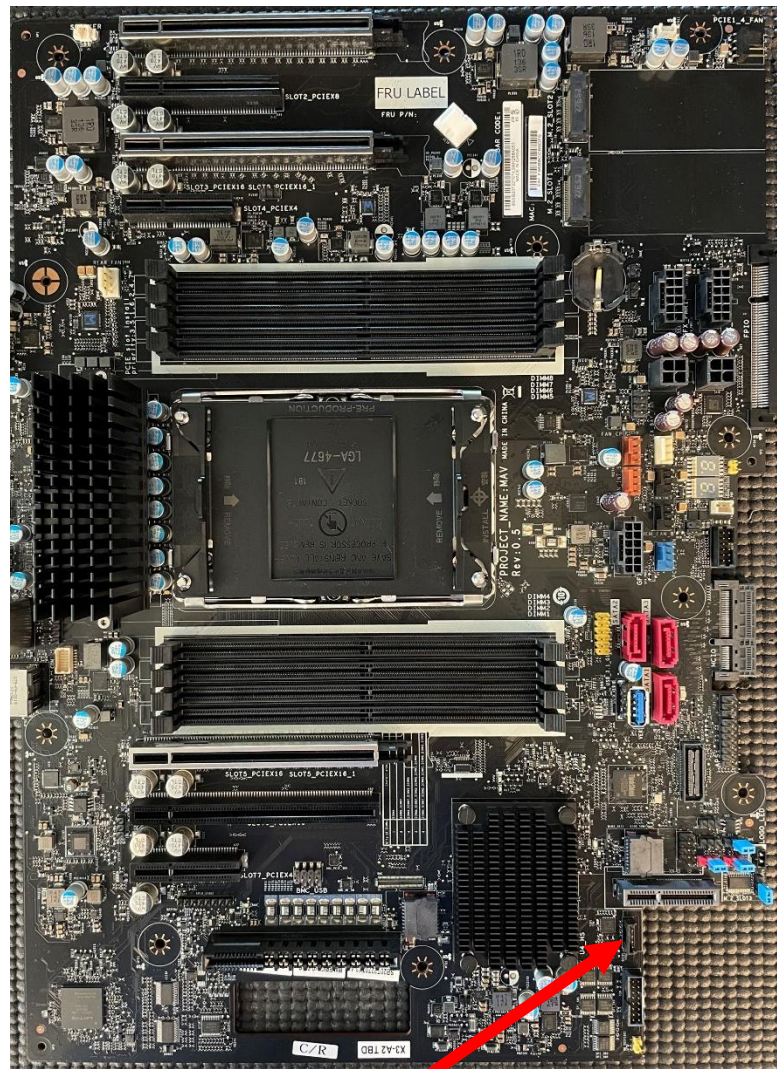
Front of System



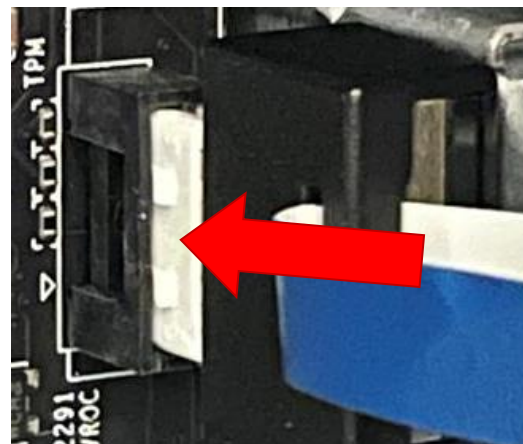
ThinkStation P7 – VROC Header Location

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



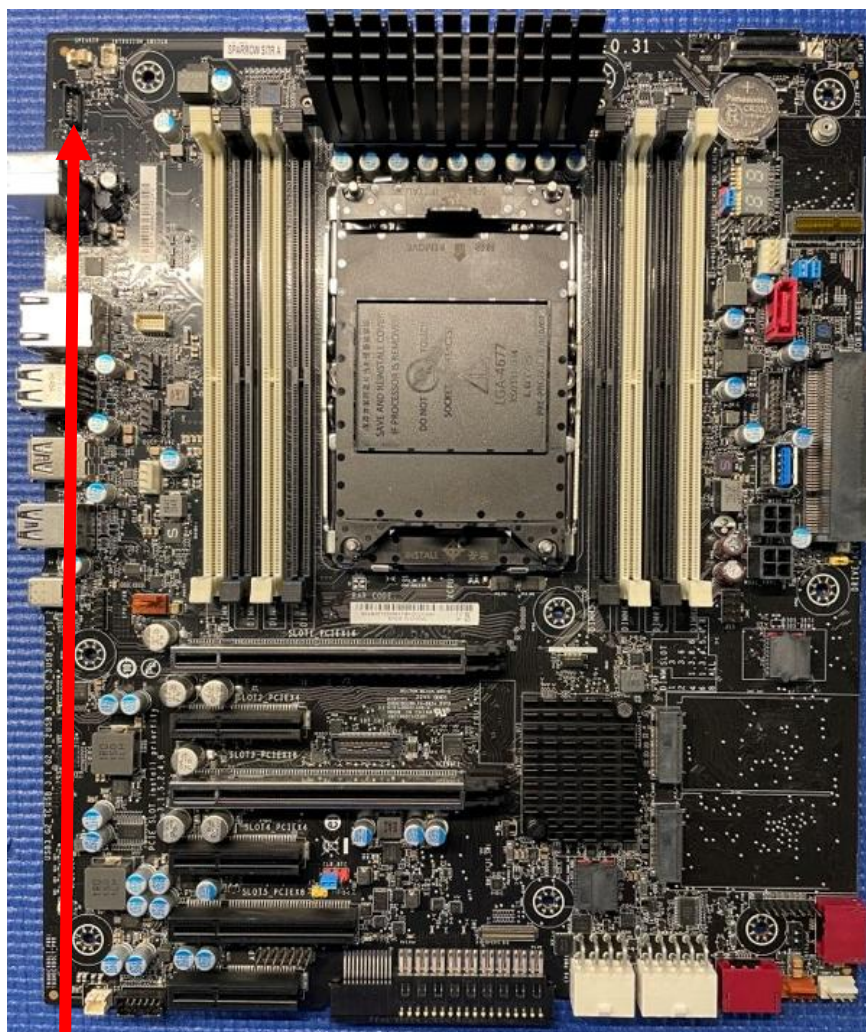
Front of System



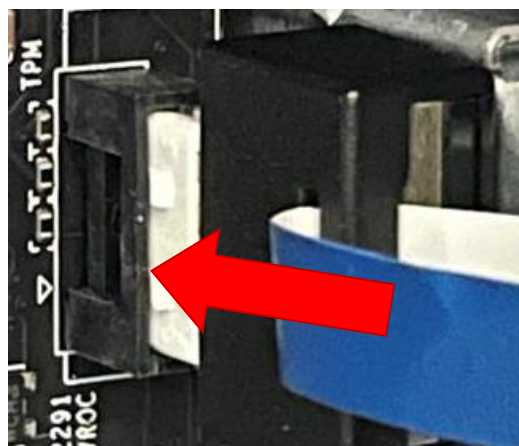
ThinkStation P5 – VROC Header Location

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

Notes:

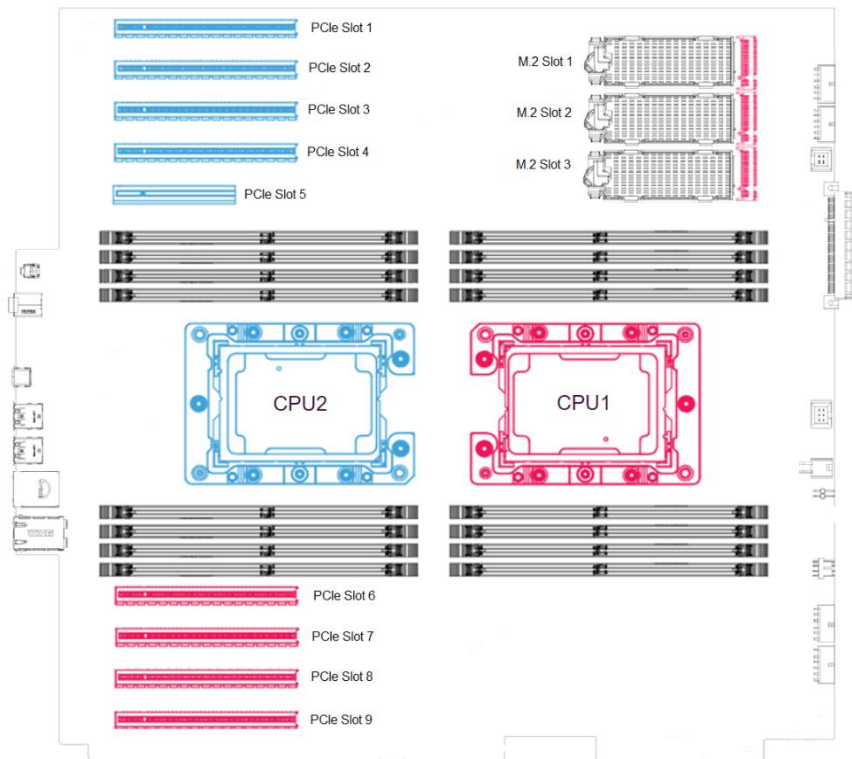
1. Levels of support vary based on platform.
2. Mixing different drive types and capacities is not recommended.
3. Please be sure to backup all data before proceeding! Switching between PCIe versus VMD mode or AHCI versus RAID mode may lead to data loss on the drives (including the operating system).

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.

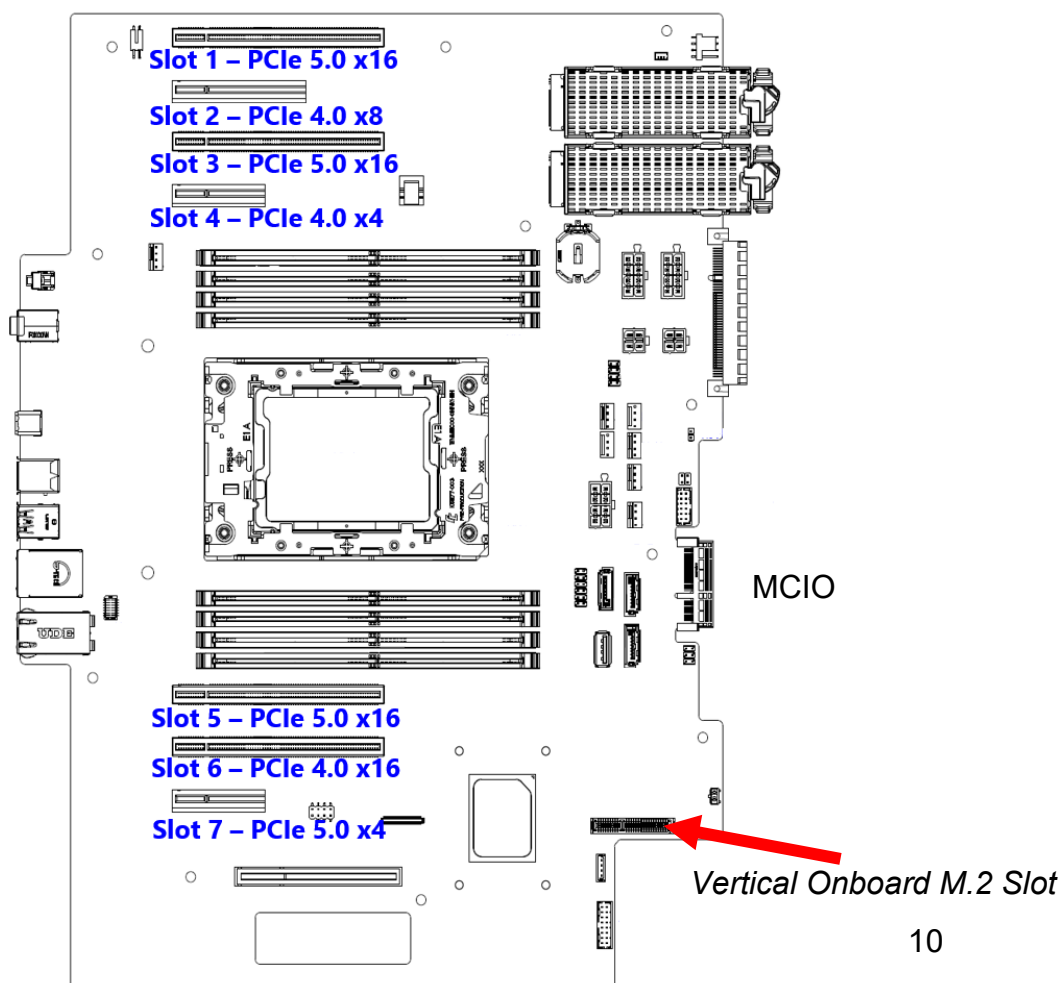
ThinkStation PX – VMD Mapping Implementation			
CPU2		CPU1	
VMD0	PCIe Slot 1	VMD0	PCIe Slot 7
VMD1	MCIO1 Slot 1 (Front Storage Bay 2)	VMD1	PCIe Slot 6
	MCIO1 Slot 2 (Front Storage Bay 2)	VMD2	PCIe Slot 8
	MCIO2 Slot 1 (Front Storage Bay 3)	VMD3	PCIe Slot 9
	MCIO2 Slot 2 (Front Storage Bay 3)	VMD4	Onboard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

Note: MCIO slots are located under the motherboard.



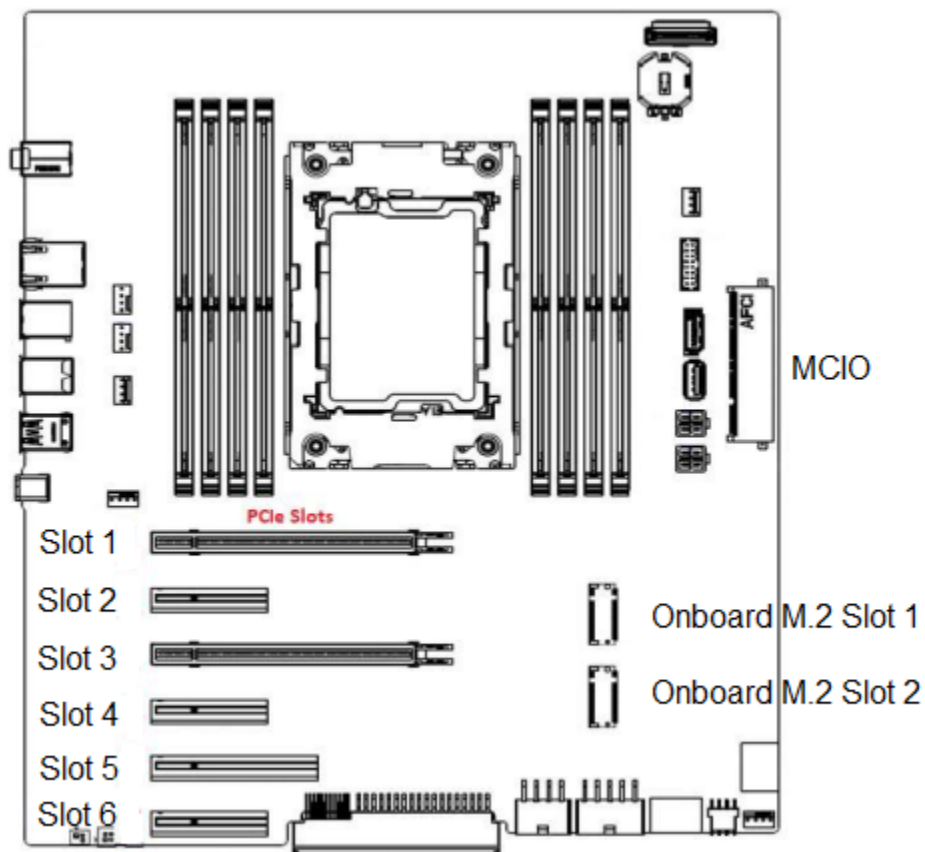
ThinkStation P7 – VMD Mapping Implementation

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



ThinkStation P5 – VMD Mapping Implementation

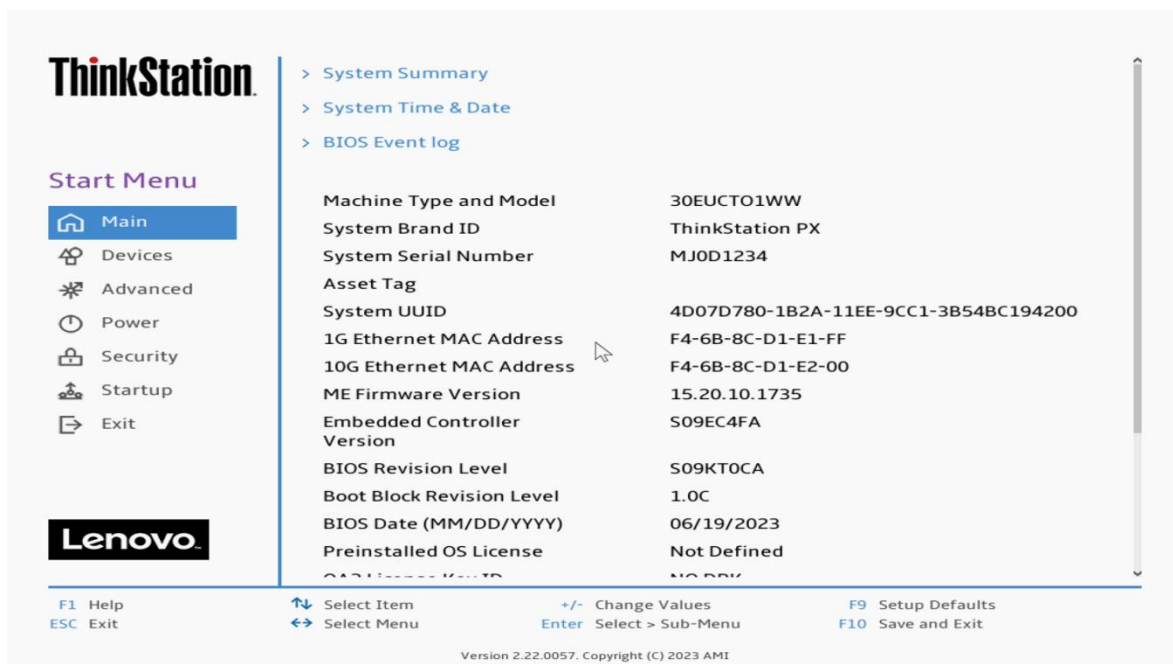
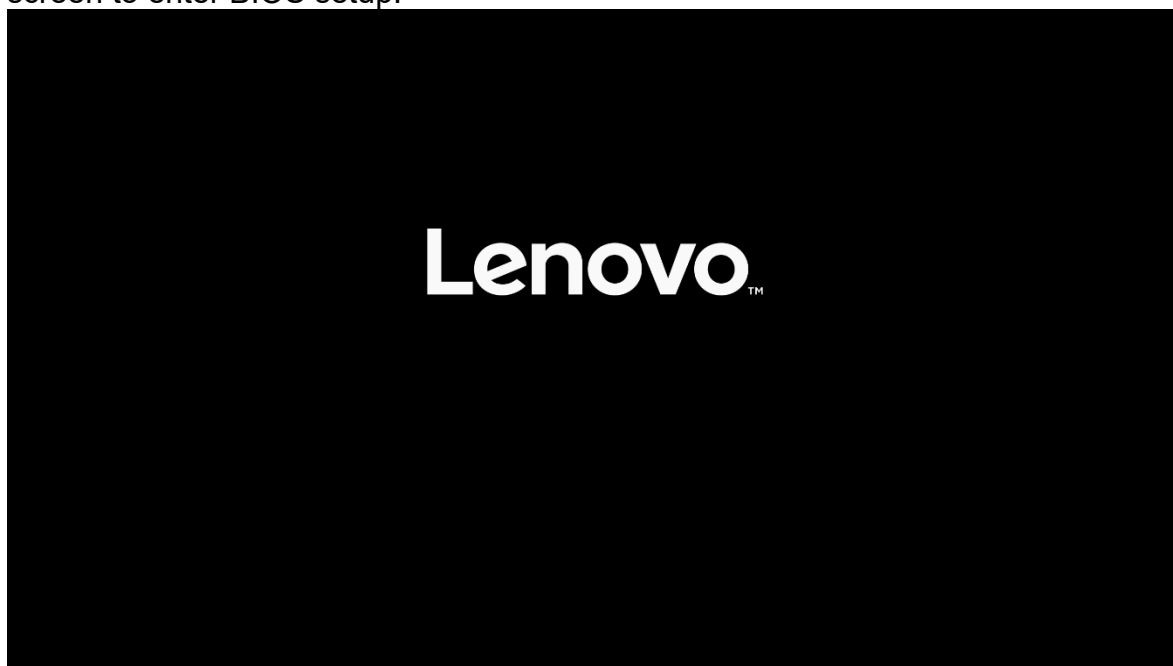
<u>CPU</u>	
VMD0	PCIe Slot 3
VMD1	PCIe Slot 1
VMD2	PCIe Slot 5
	Onboard M.2 Slot 1
	Onboard M.2 Slot 2
VMD3	MCIO (Front Storage Bay)



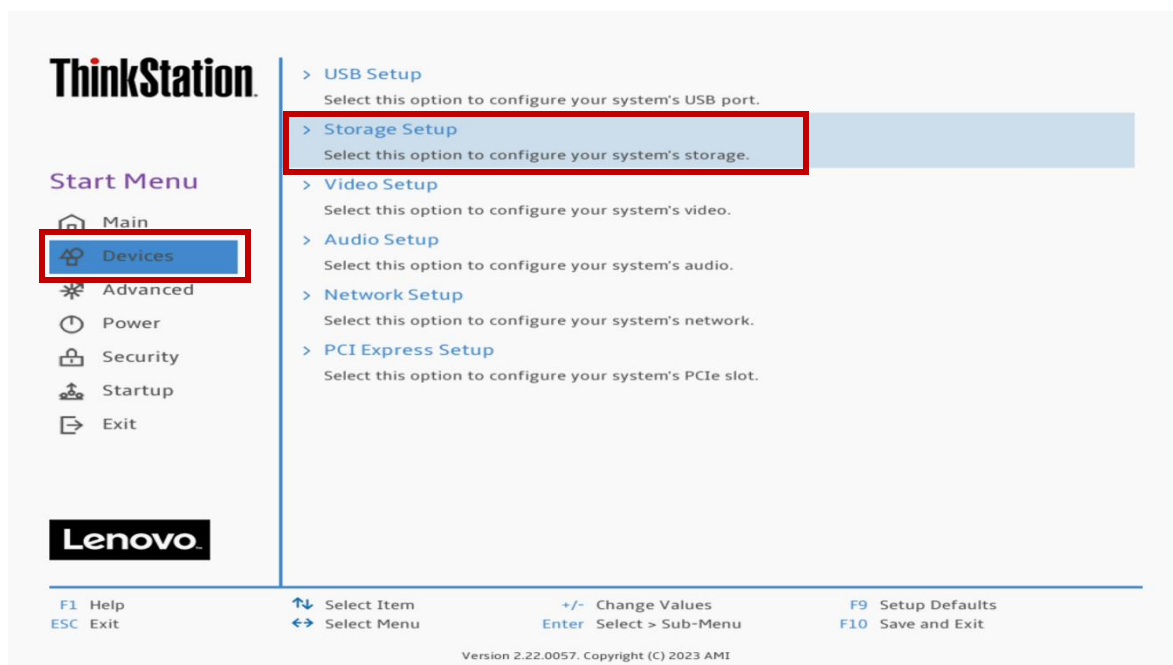
Section 3 – How to Enable NVMe RAID

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.

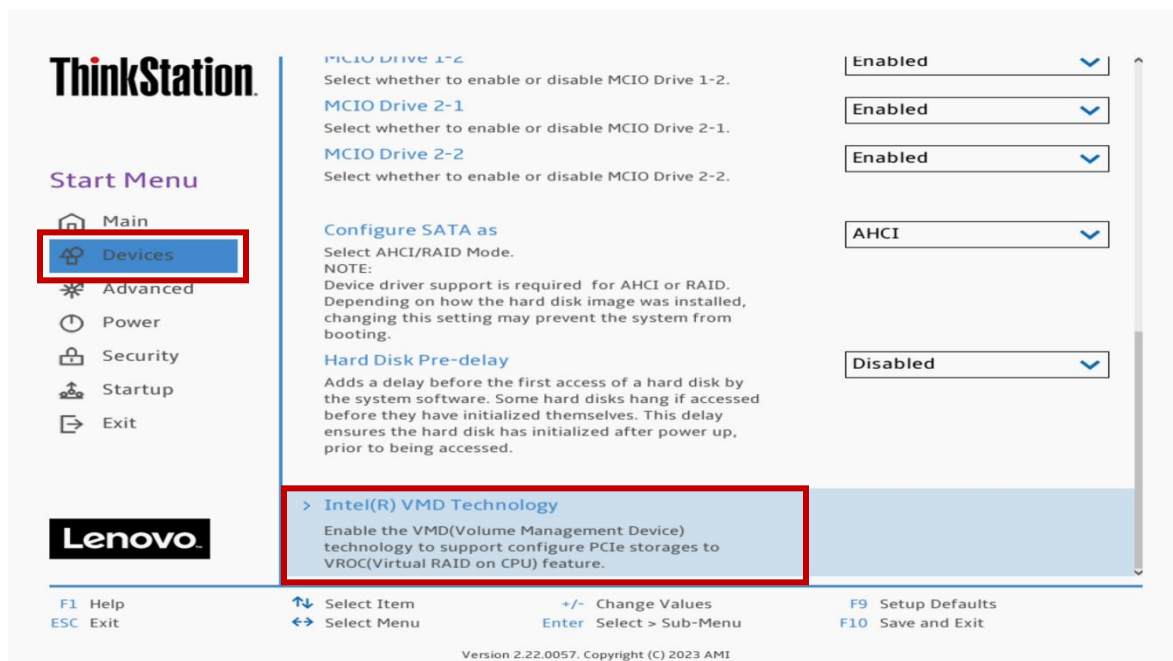


- From within the BIOS setup screen, select the “Devices” menu option from the left-side menu options and ‘Storage Setup’ from the middle menu options.

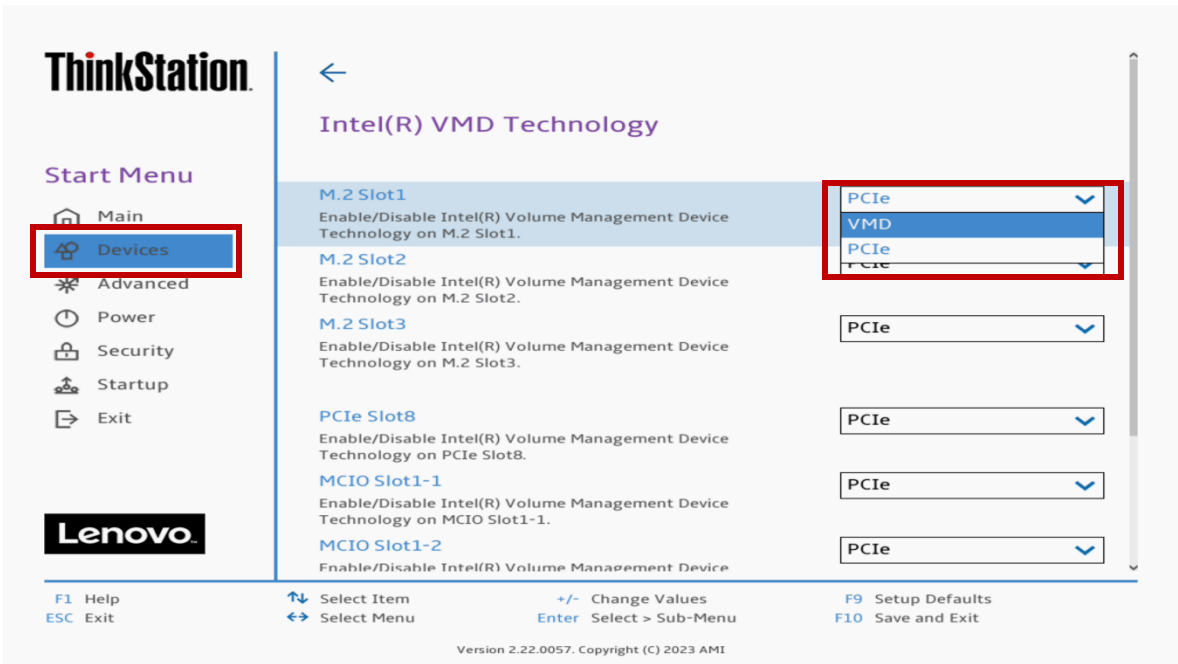


- Navigate toward the bottom of the list and select “Intel® VMD Technology”.

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



- 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

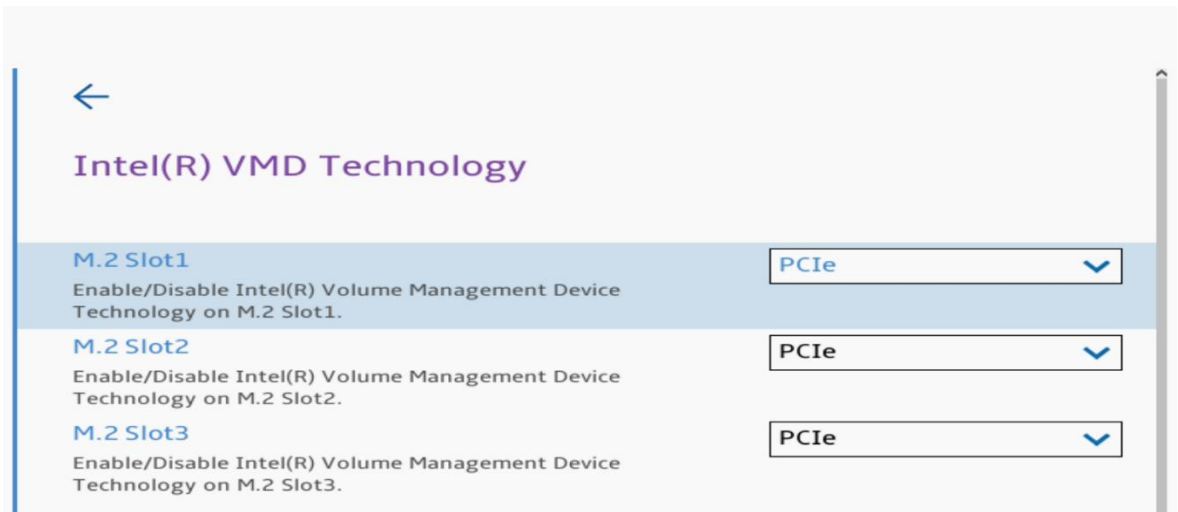


Figure 6 below shows how to enable “VMD” across the front accessible M.2 drives.

Figure 6 - Front NVMe Drives



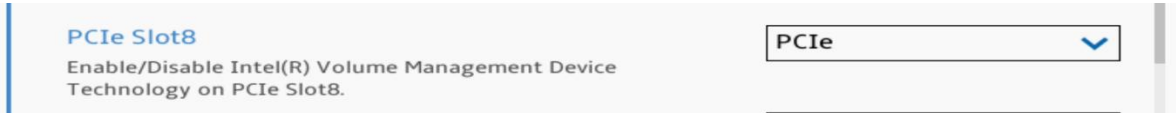
Table 2 below shows the representation for the front accessible M.2 drives across the different platforms.

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 rd 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.

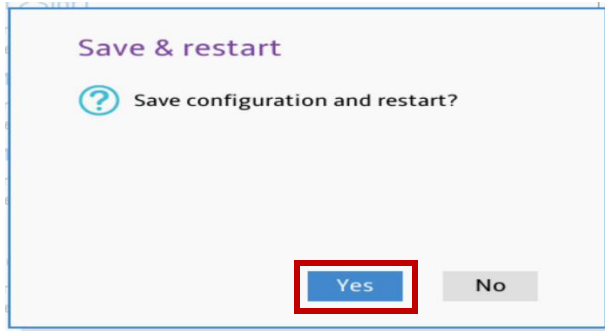
Figure 7 - PCIe NVMe Add-in Adapters



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 SlotX → correlates to the PCIe slot to where the PCIe add-in adapter is installed.

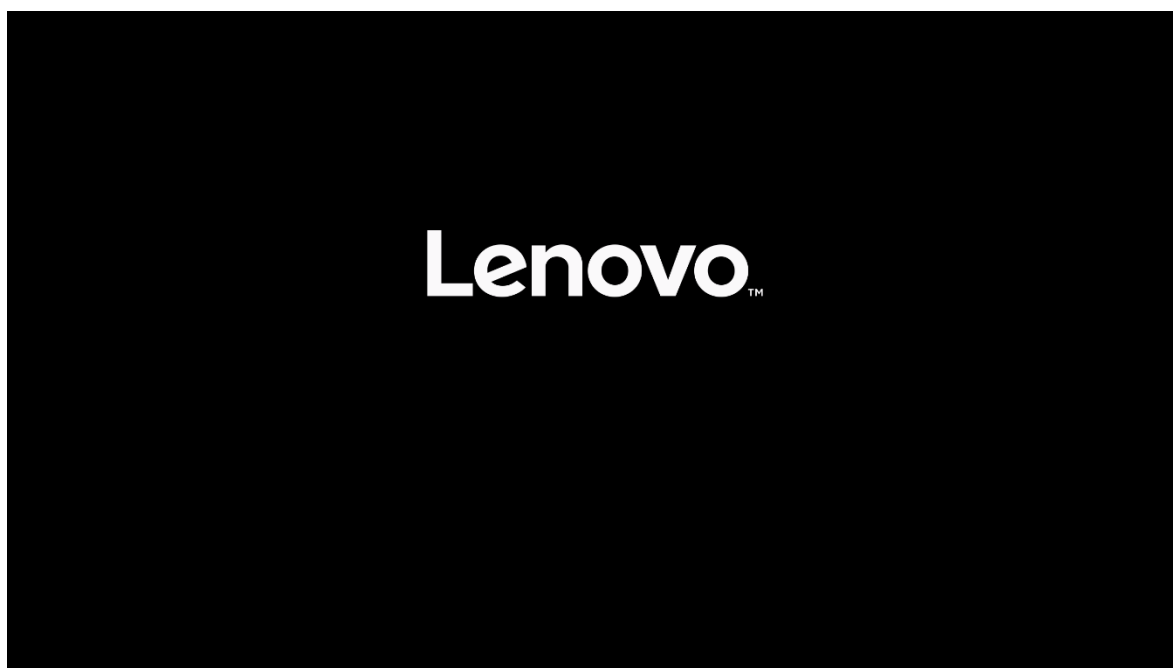
5. Select the function key F10 to 'Save and Exit' BIOS setup.



Section 4 – How to Create NVMe RAID

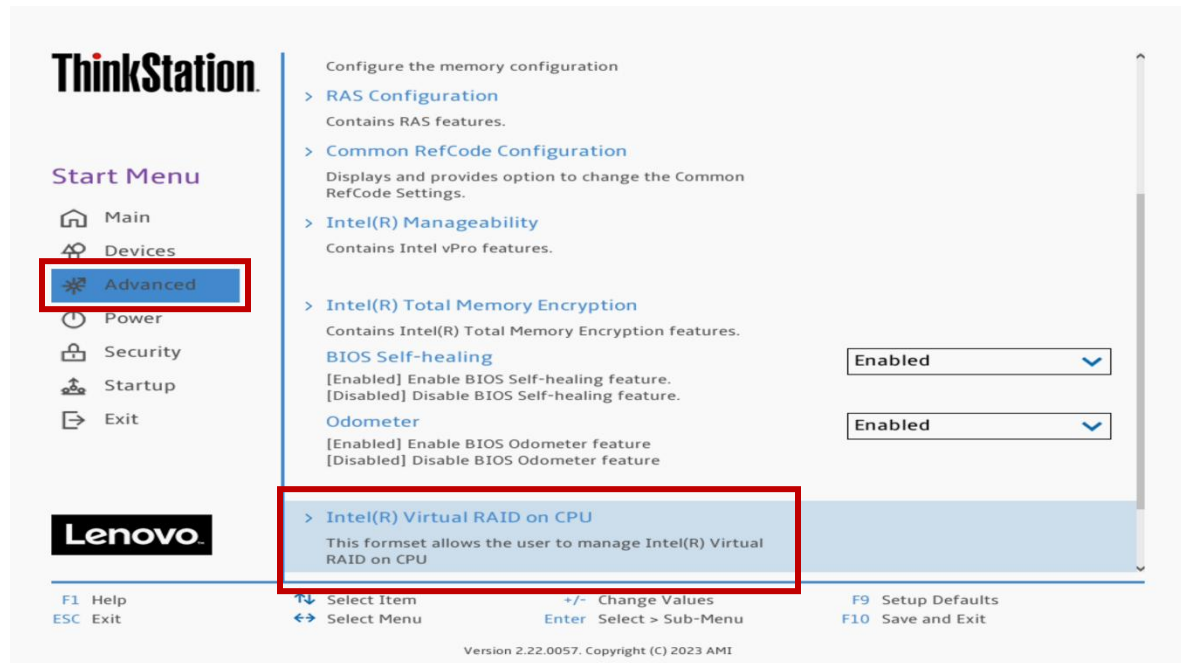
Refer to the steps below on how to create an NVMe RAID array. Please be sure to have the Intel VROC module installed per 'Section 1' above.

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



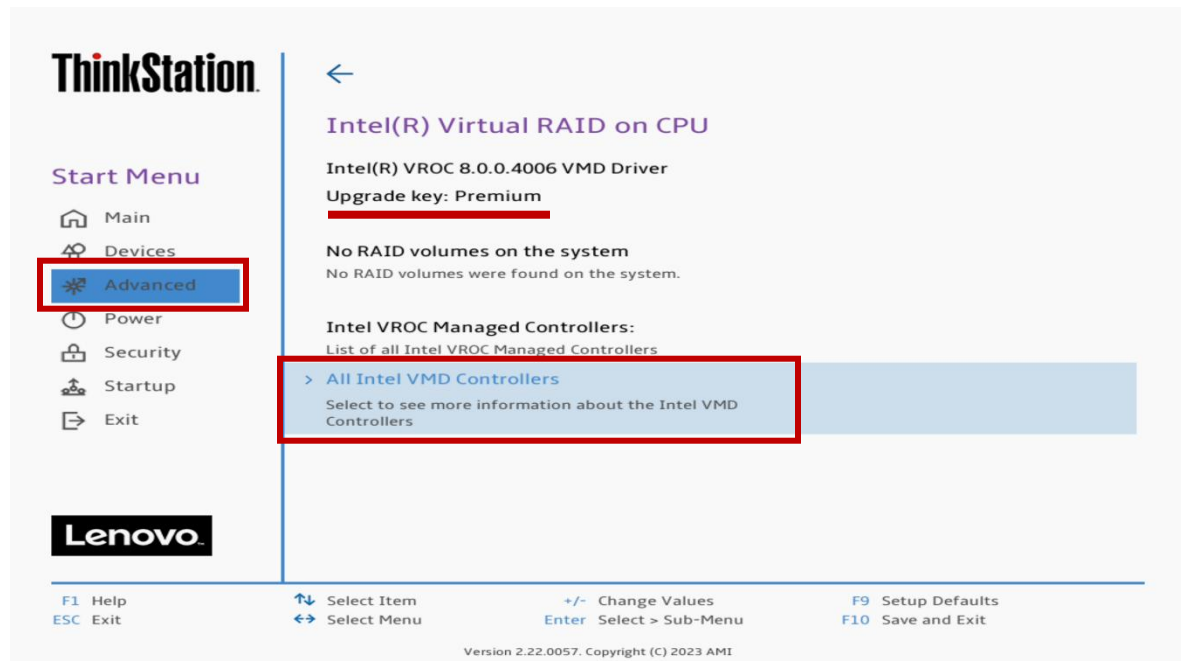
- From within the BIOS setup screen, select the “Advanced” menu option from the left-side menu options and “Intel® Virtual RAID on CPU” from the middle menu options.

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

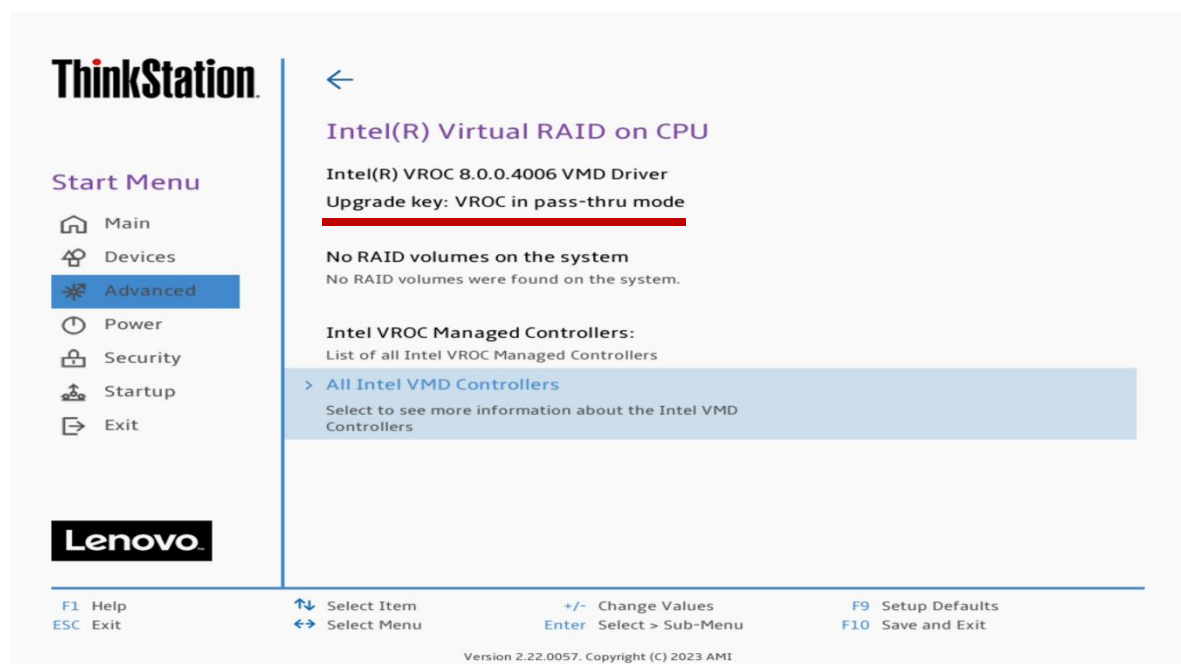


3. Select “All Intel VMD Controllers”.

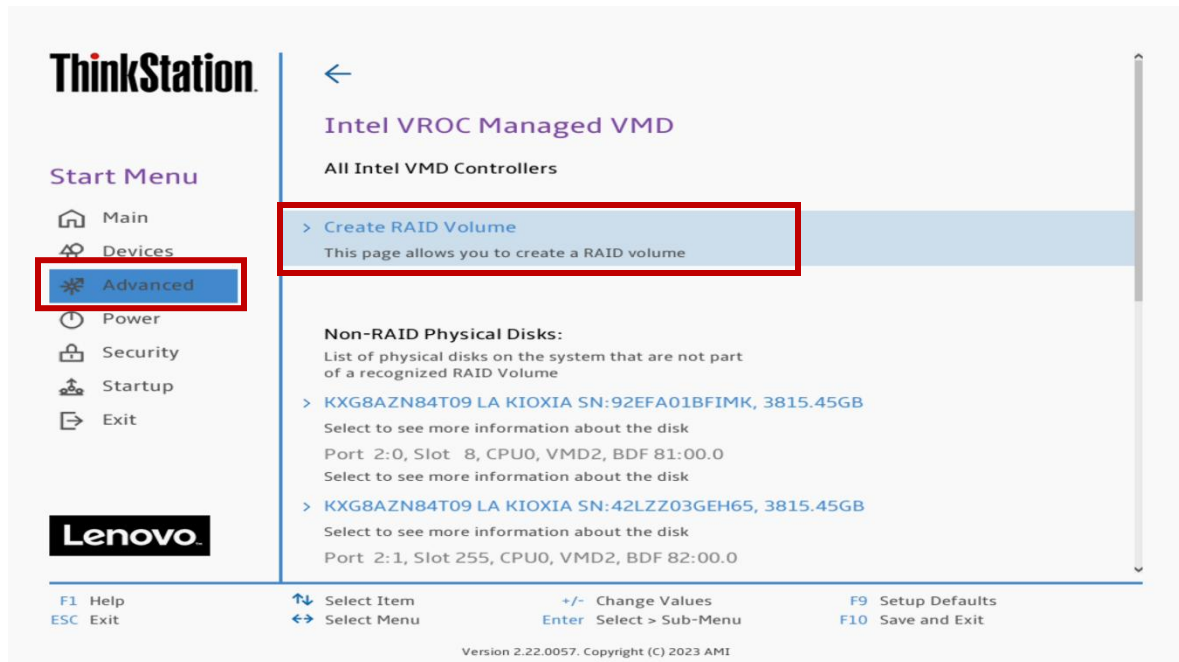
Note: “Upgrade key” underlined below will either read “Premium” or “Basic” depending on what is installed in the system.



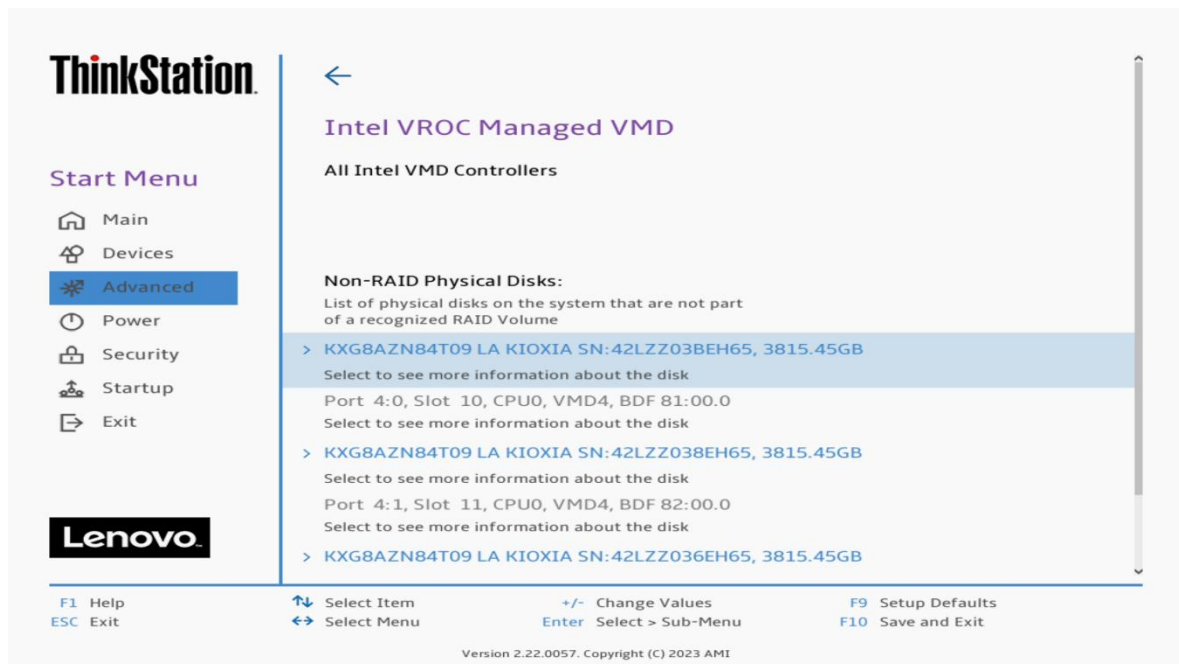
Note: If the system does not detect a VROC module installed, then the “Upgrade key” will show up as “VROC in pass-thru mode”.



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.



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

ThinkStation

Create RAID Volume

Create RAID Volume

Name:
Enter a unique volume name that does not contain space at the beginning or backslash and is 16 characters or less.

RAID Level:
Select RAID Level

Enable RAID Spanned over VMD Controllers:
Enable RAID Spanned over VMD Controllers: For Data RAID only, boot not supported.

Select Disks:
Select Disks:

KXG8AZN84T09 LA KIOXIA SN:92EFA01BFIMK, 3815.45GB Port 2:0 CPU0 VMD2

X - to Select Disk

KXG8AZN84T09 LA KIOXIA SN:42LZZ03GEH65,

Start Menu

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

Lenovo

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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- 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.

ThinkStation

Create RAID Volume

Create RAID Volume

Name:
Enter a unique volume name that does not contain space at the beginning or backslash and is 16 characters or less.

RAID Level:
Select RAID Level

Enable RAID Spanned over VMD Controllers:
Enable RAID Spanned over VMD Controllers: For Data RAID only, boot not supported.

Select Disks:
Select Disks:

KXG8AZN84T09 LA KIOXIA SN:92EFA01BFIMK, 3815.45GB Port 2:0 CPU0 VMD2

X - to Select Disk

KXG8AZN84T09 LA KIOXIA SN:42LZZ03GEH65,

Start Menu

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

Lenovo

F1 Help
ESC Exit

↑ Select Item
↔ Select Menu

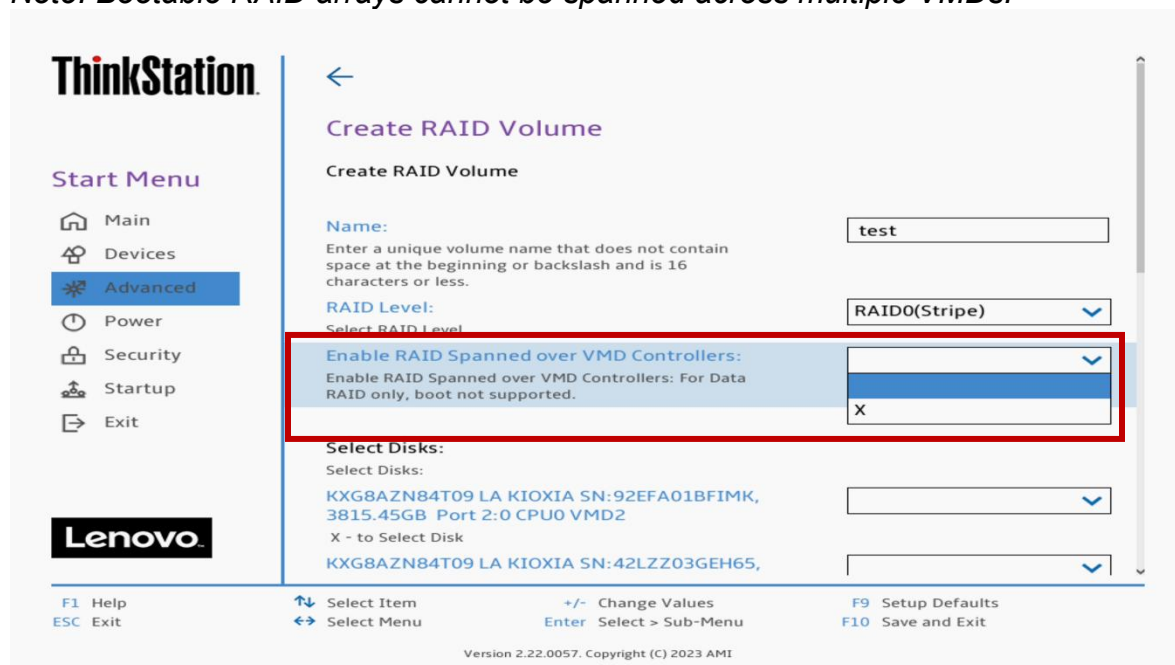
+/- Change Values
Enter Select > Sub-Menu

F9 Setup Defaults
F10 Save and Exit

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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.



ThinkStation

Create RAID Volume

Create RAID Volume

Name: test

RAID Level: RAID0(Stripe)

Enable RAID Spanned over VMD Controllers: X

Select Disks:

KXG8AZN84T09 LA KIOXIA SN:92EFA01BFIMK, 3815.45GB Port 2:0 CPU0 VMD2

KXG8AZN84T09 LA KIOXIA SN:42LZZ03GEH65,

F1 Help
ESC Exit

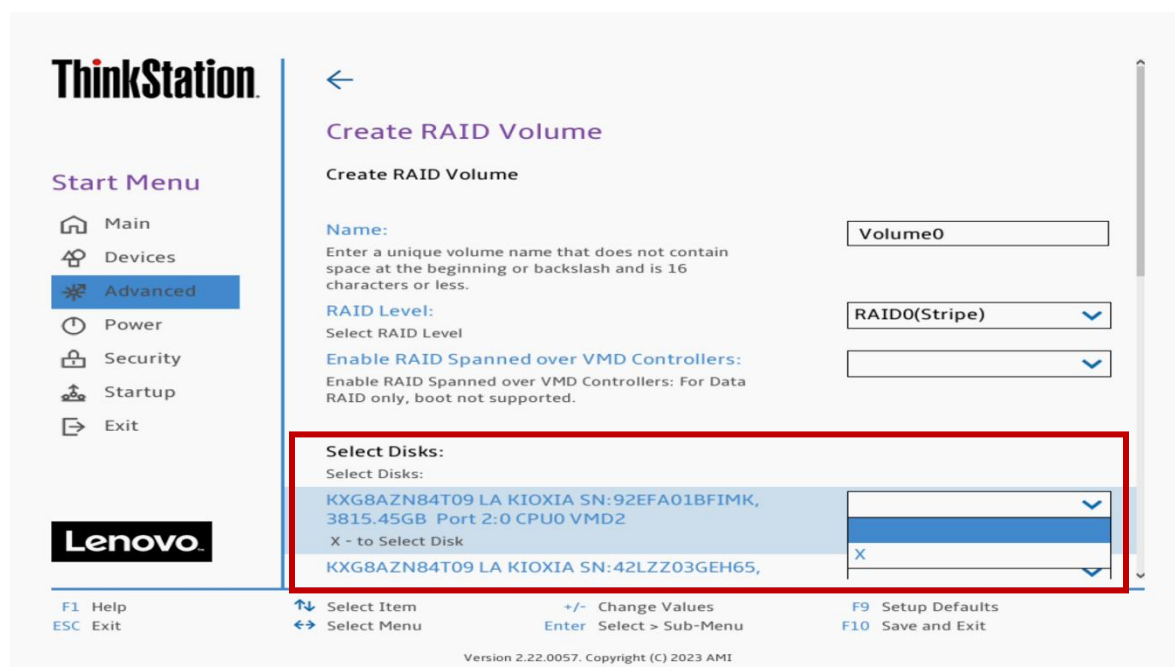
Select Item
Select Menu

+/- Change Values
Enter Select > Sub-Menu

F9 Setup Defaults
F10 Save and Exit

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



ThinkStation

Create RAID Volume

Create RAID Volume

Name: Volume0

RAID Level: RAID0(Stripe)

Enable RAID Spanned over VMD Controllers:

Select Disks:

KXG8AZN84T09 LA KIOXIA SN:92EFA01BFIMK, 3815.45GB Port 2:0 CPU0 VMD2

KXG8AZN84T09 LA KIOXIA SN:42LZZ03GEH65,

F1 Help
ESC Exit

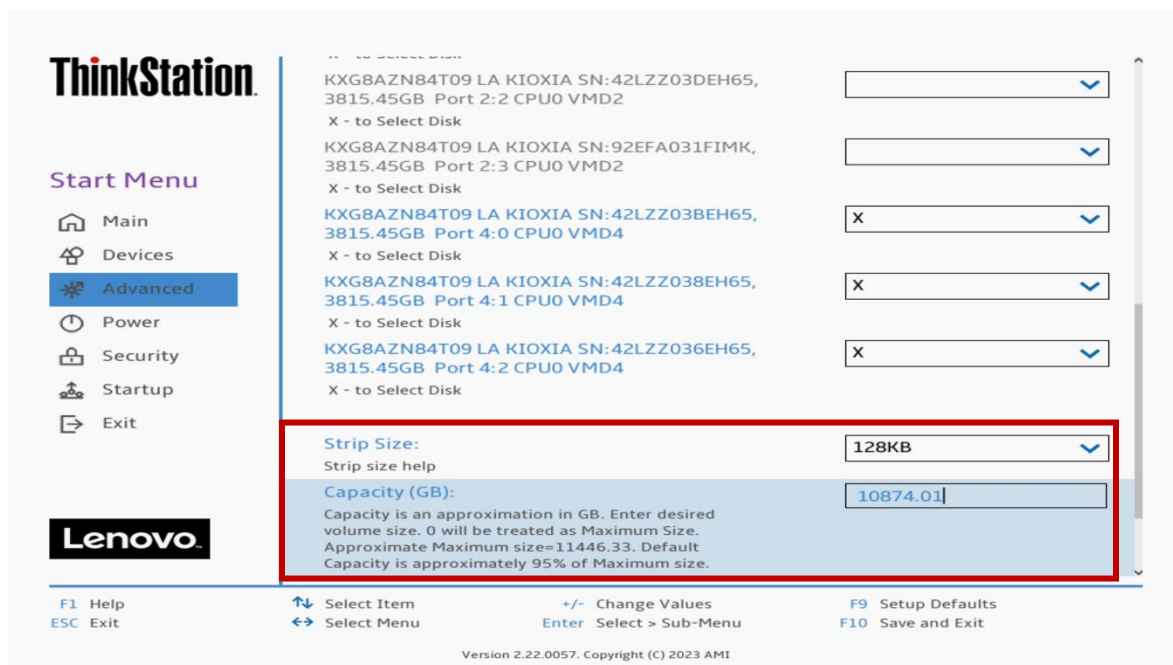
Select Item
Select Menu

+/- Change Values
Enter Select > Sub-Menu

F9 Setup Defaults
F10 Save and Exit

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- 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

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

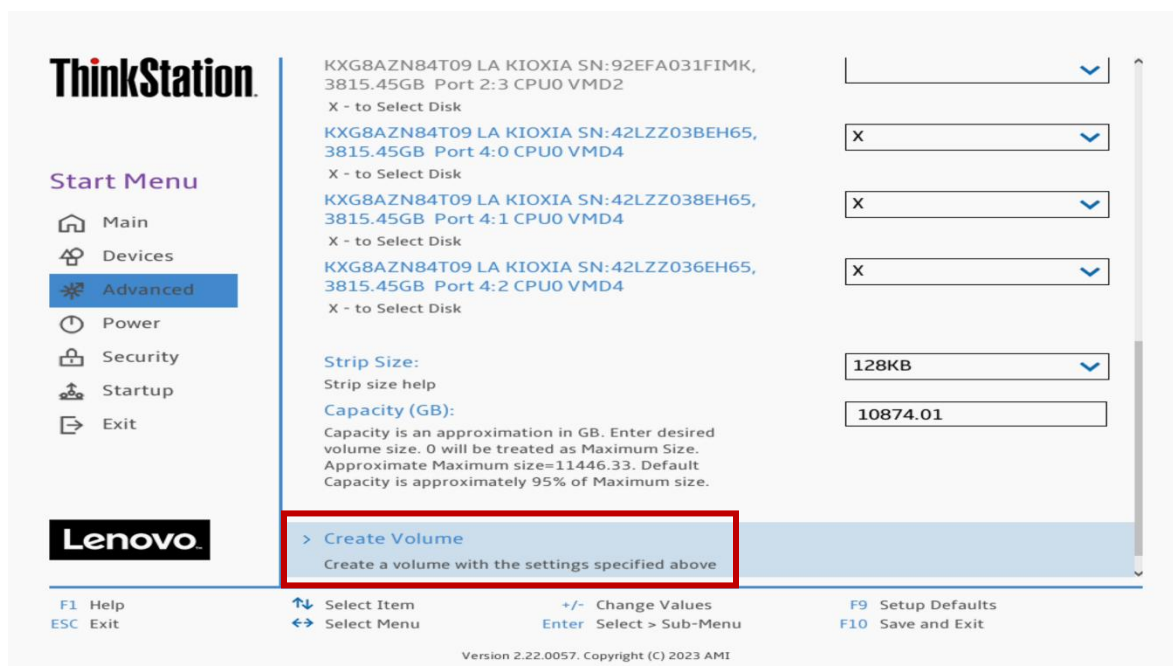
↑ Select Item
← Select Menu

+/- Change Values
Enter Select > Sub-Menu

F9 Setup Defaults
F10 Save and Exit

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- Select "Create Volume".



ThinkStation

Start Menu

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

Lenovo

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

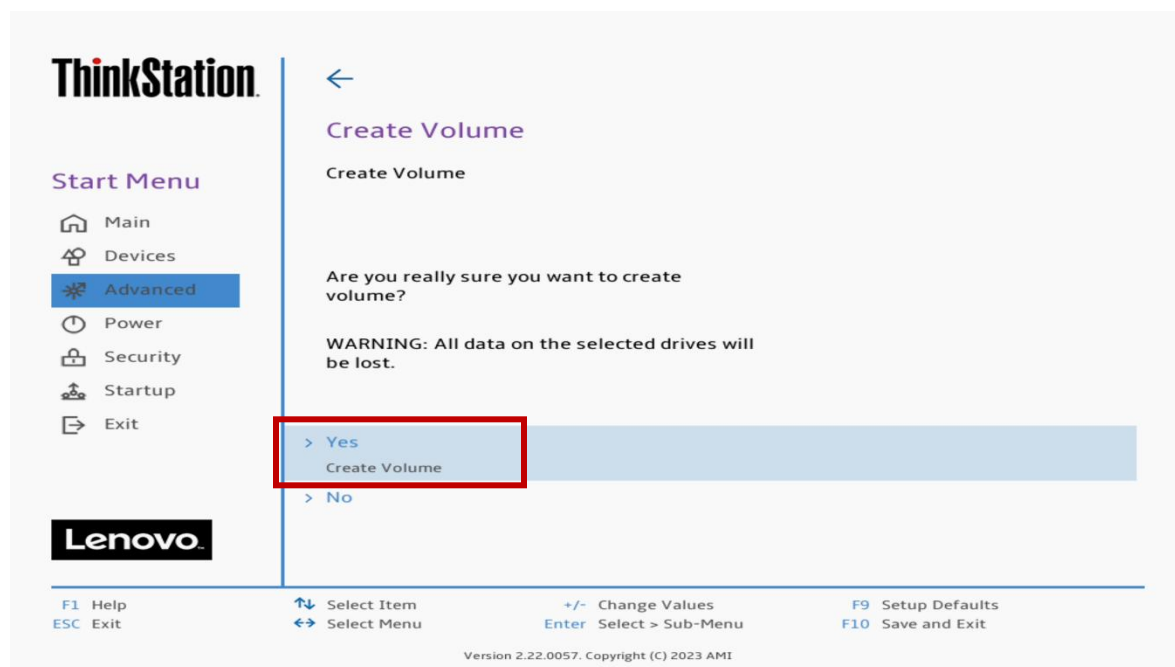
+/- Change Values
Enter Select > Sub-Menu

F9 Setup Defaults
F10 Save and Exit

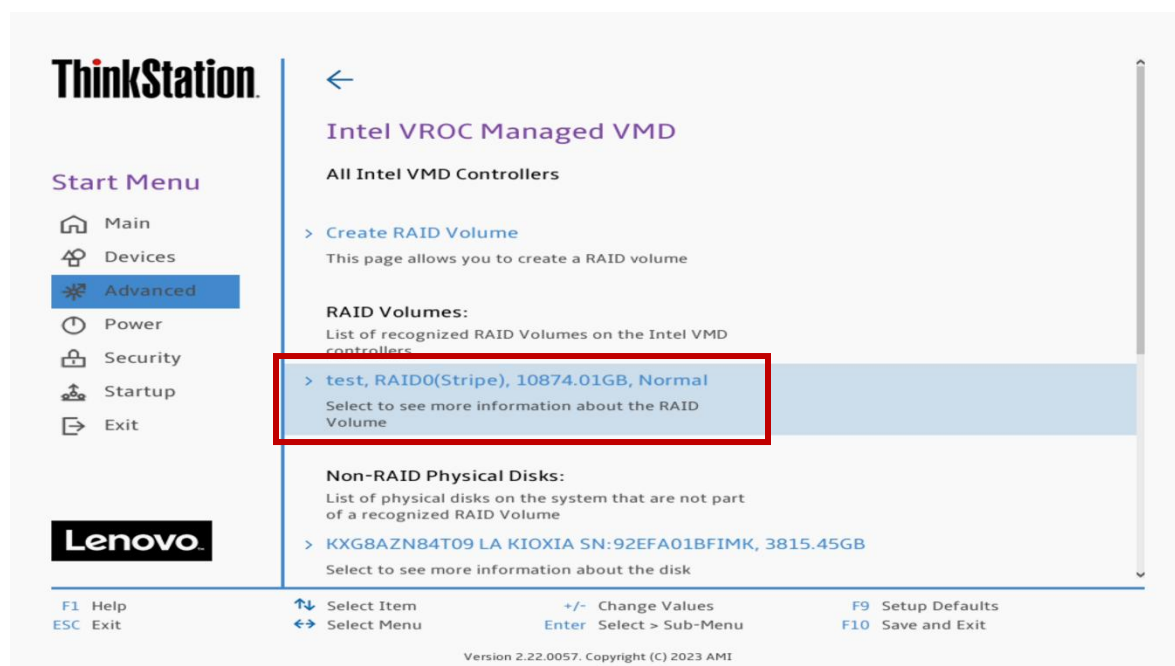
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11. Select “Yes” to confirm creating the RAID volume.

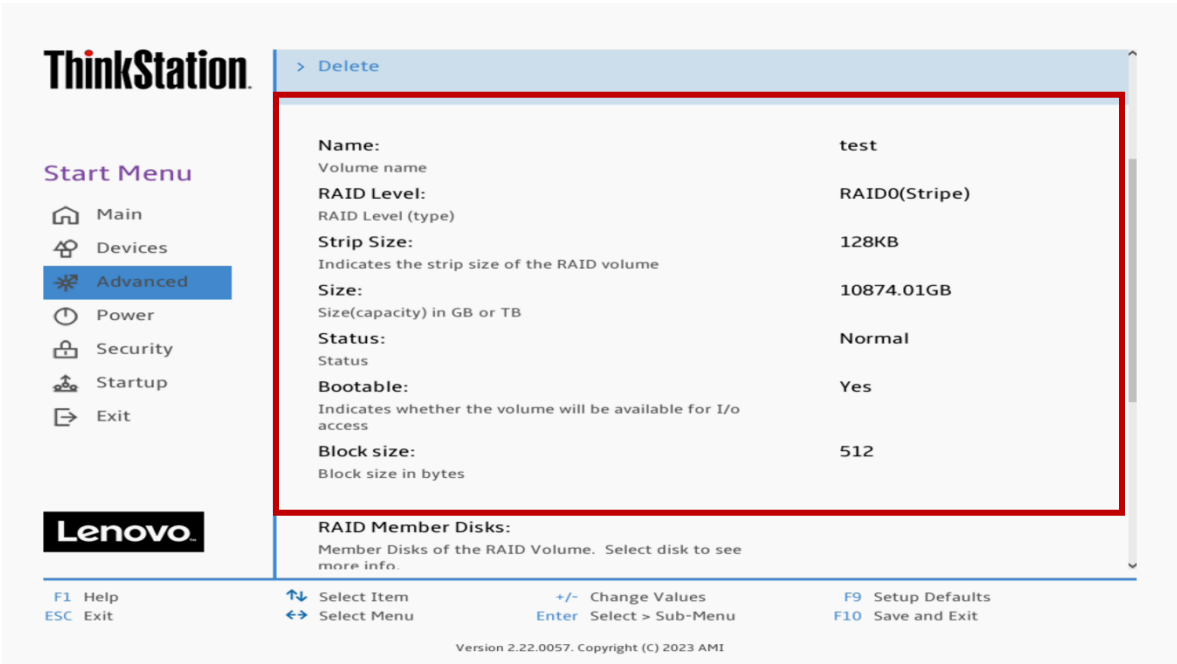
Note: All data on the select drives will be lost.



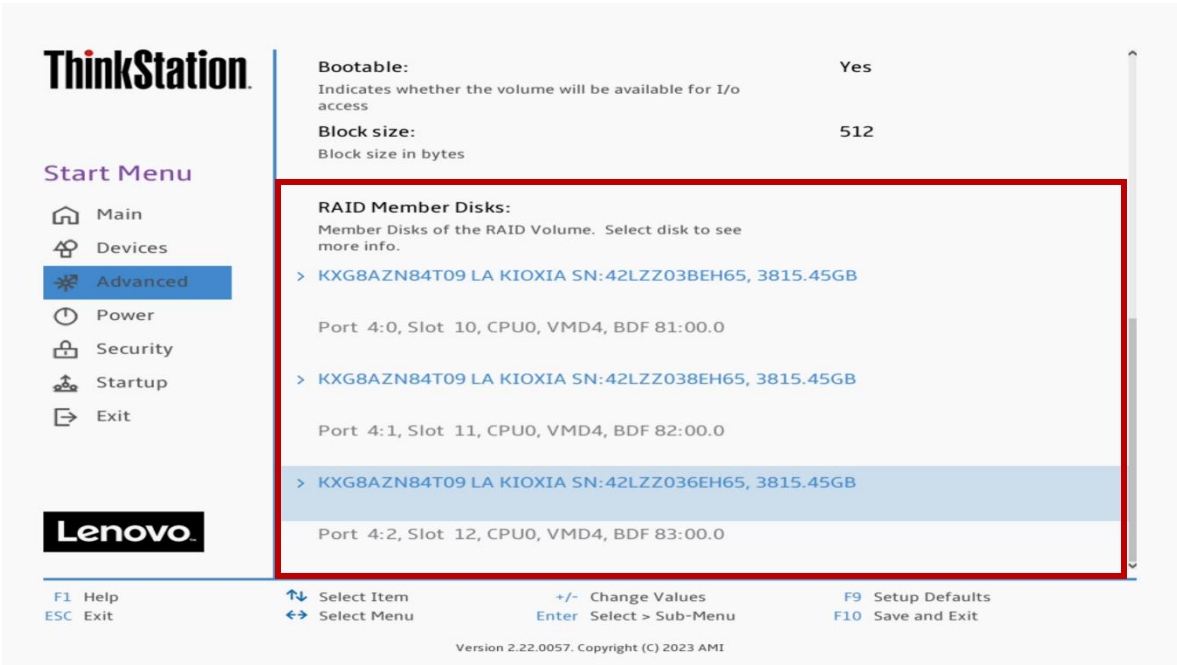
12. The created RAID arrays will show up under the root menu for “Intel VROC Managed VMD”.



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

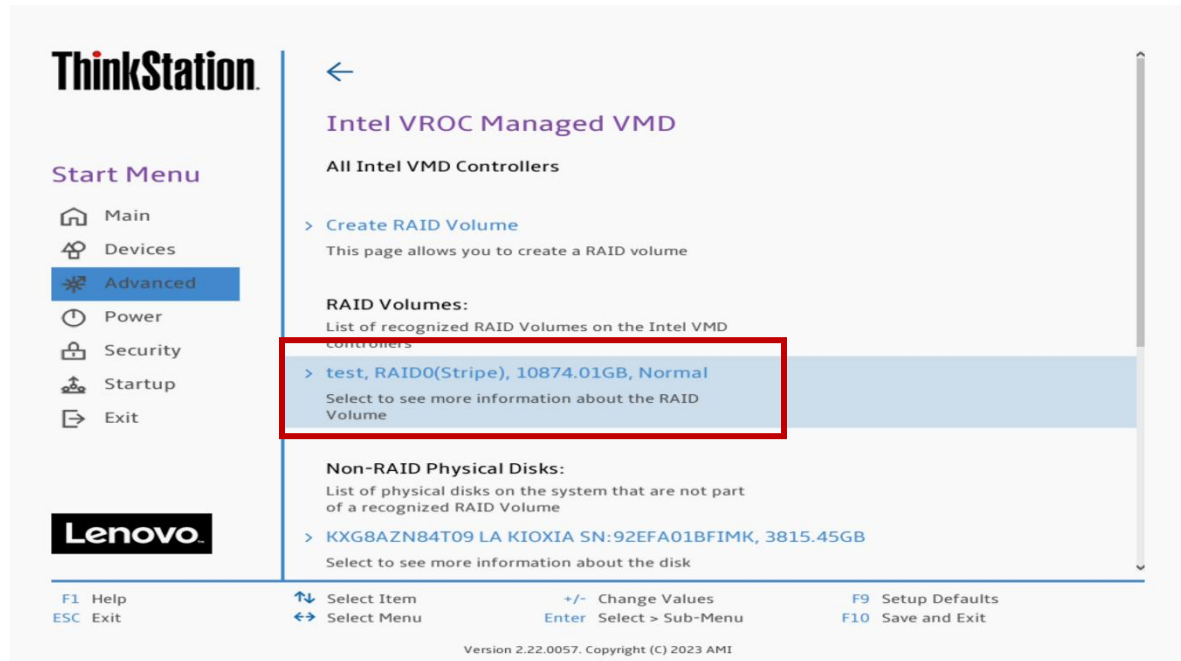


Scrolling down the “RAID Volume Info” screen will show the drives associated with the RAID volume.

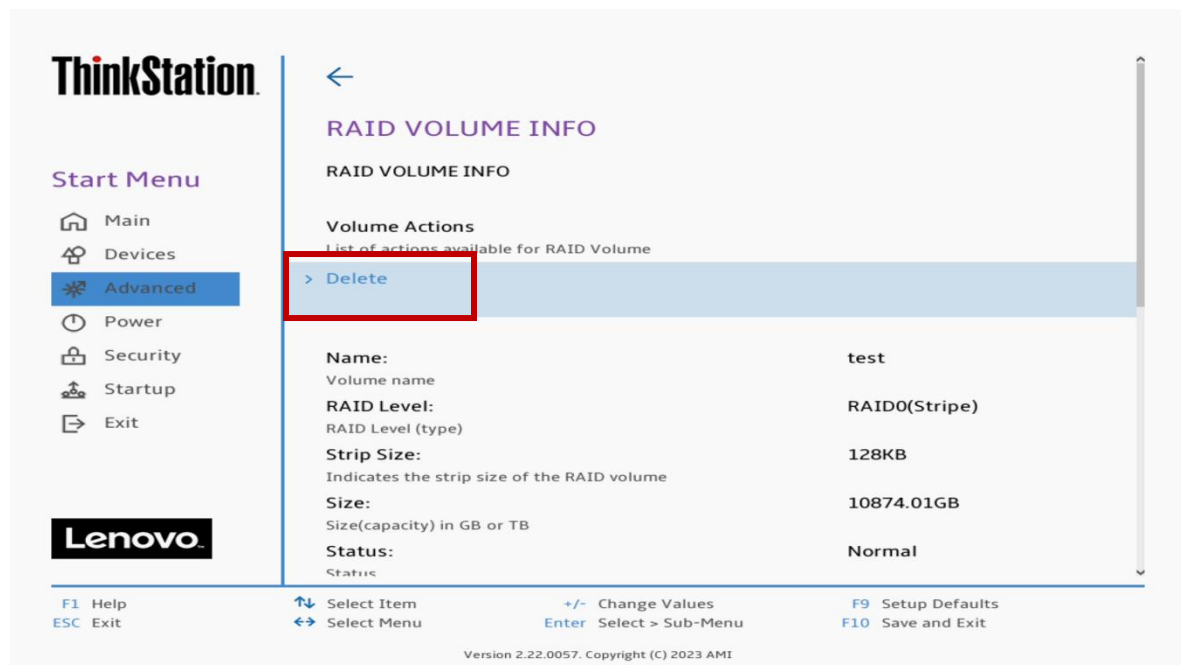


14. To delete the RAID, select the RAID volume from the previous step.

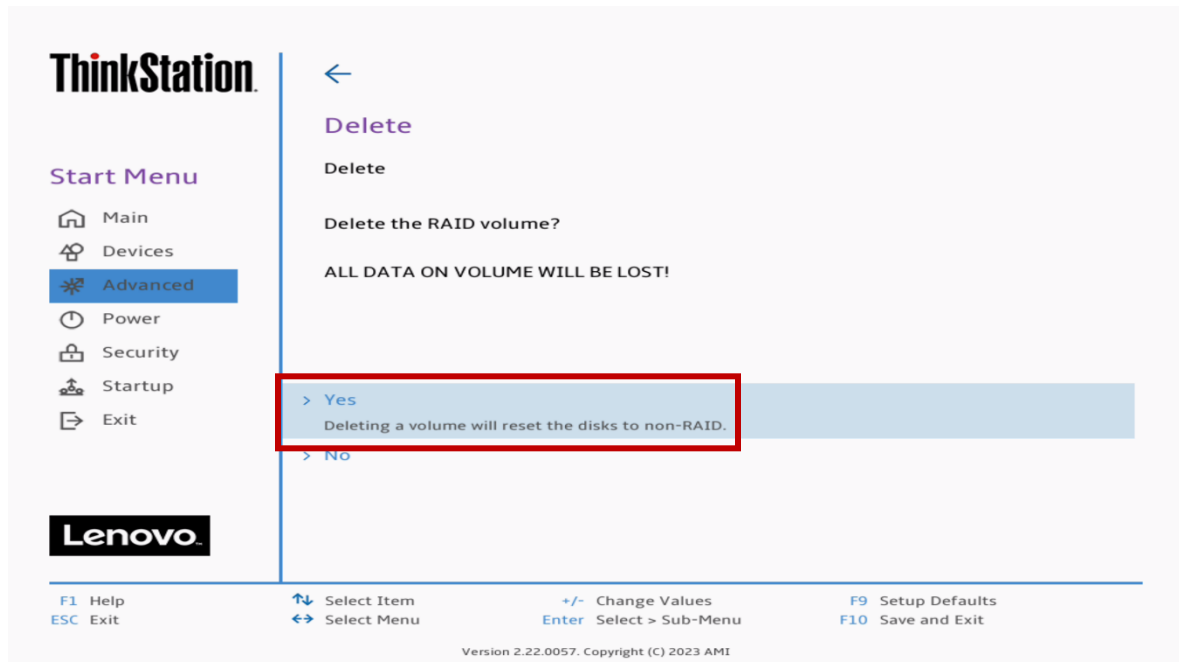
Note: This is destructive and will not be able to recover the RAID array and all data stored on the drives.



15. Select "Delete".



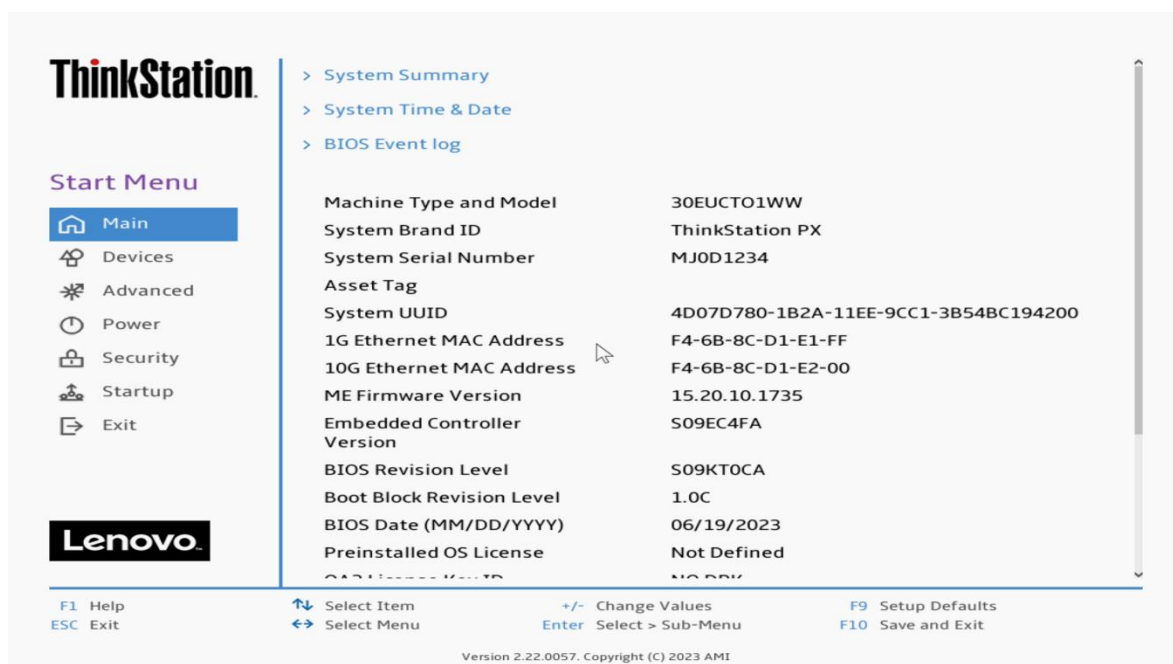
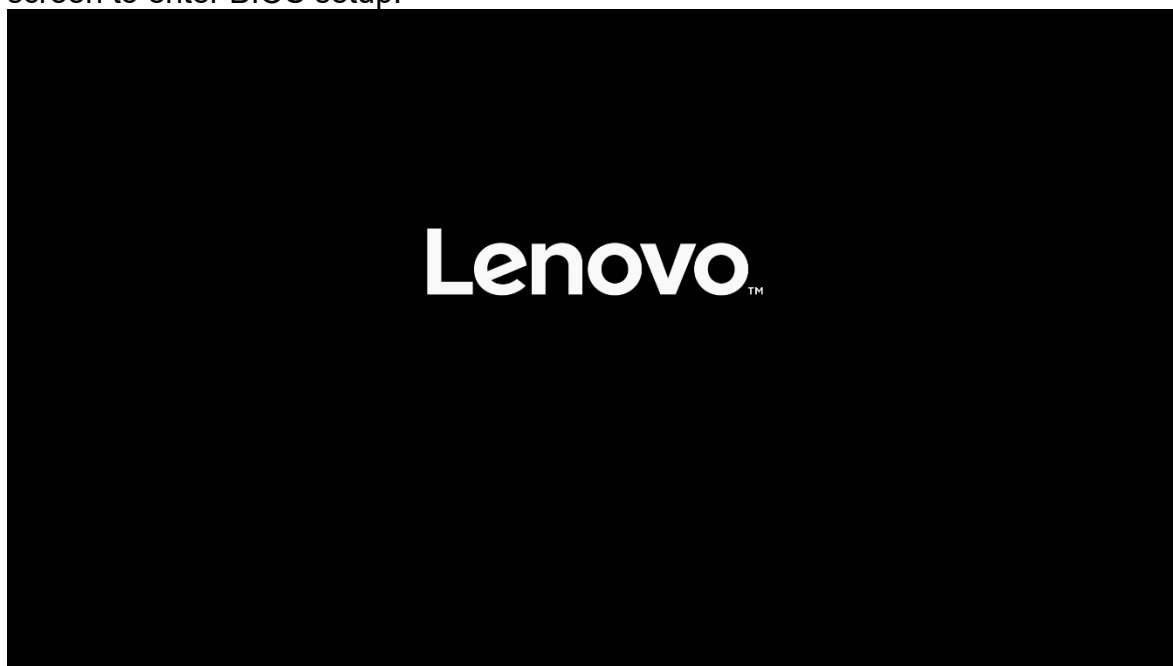
16. Select "Yes".



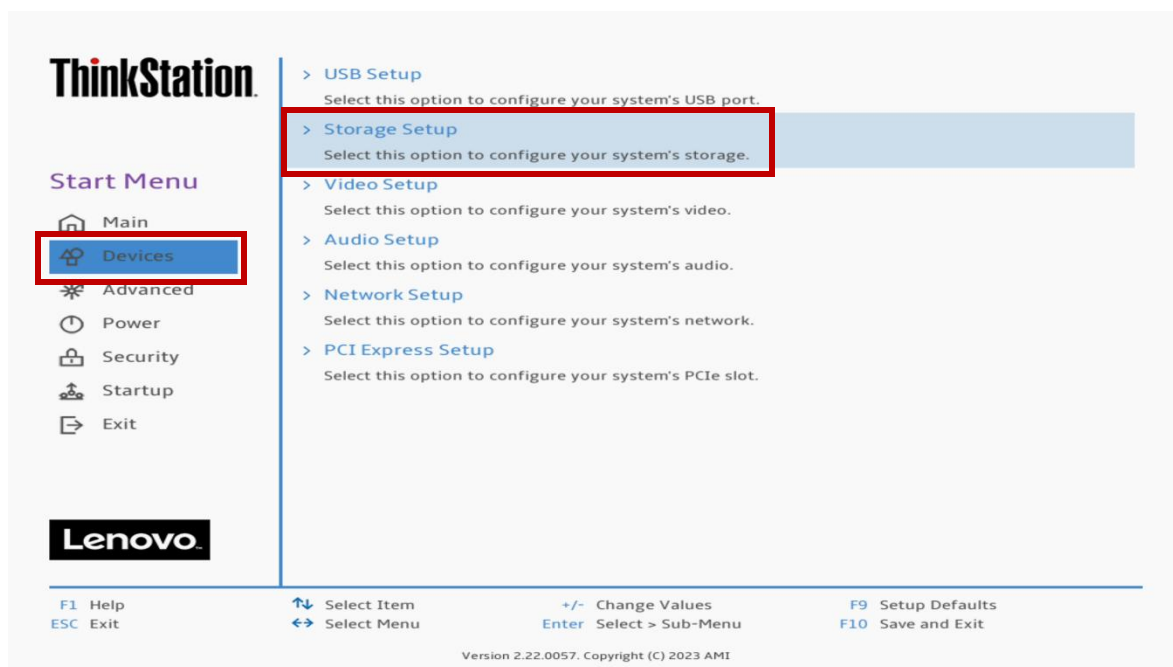
Section 5 – How to Enable SATA RAID

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.

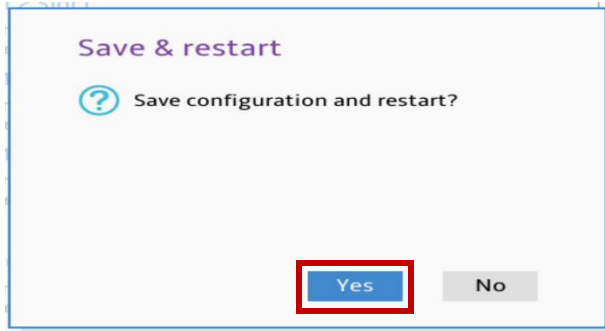


- Navigate toward the middle of the list and select “Configure SATA as” and change the dropdown menu from “AHCI” to “RAID”.

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



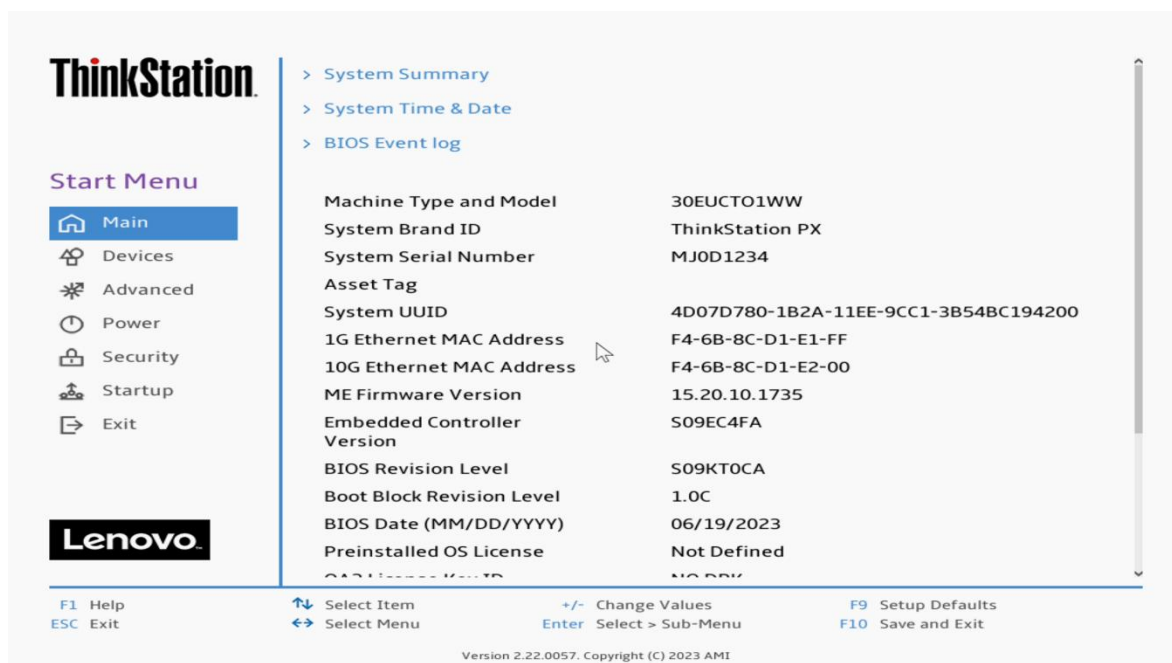
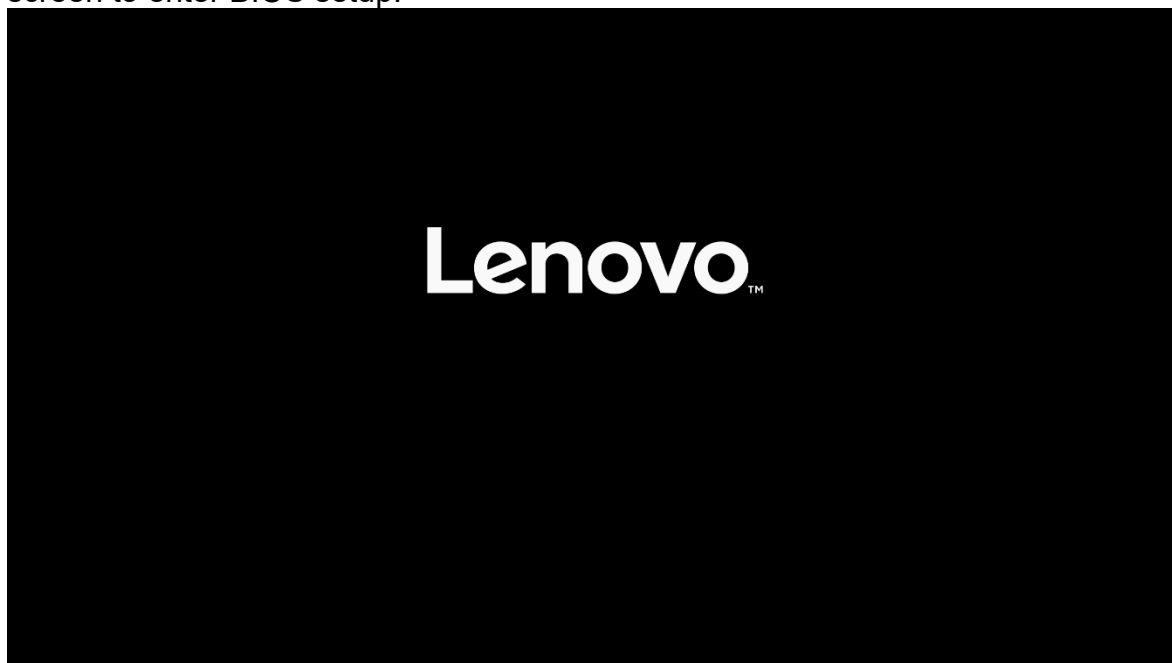
4. Select the function key F10 to “Save and Exit” BIOS setup.



Section 6 – How to Create a SATA RAID

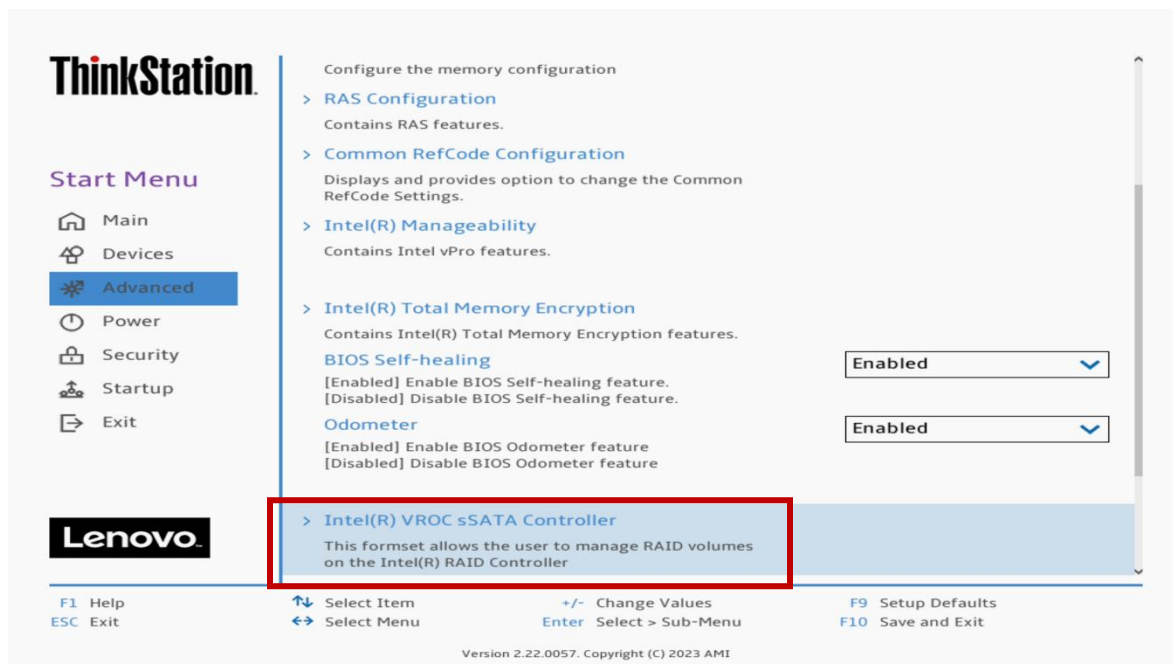
Refer to the steps below on how to create a SATA RAID array. Note, an Intel VROC module is not necessary to complete these steps below.

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

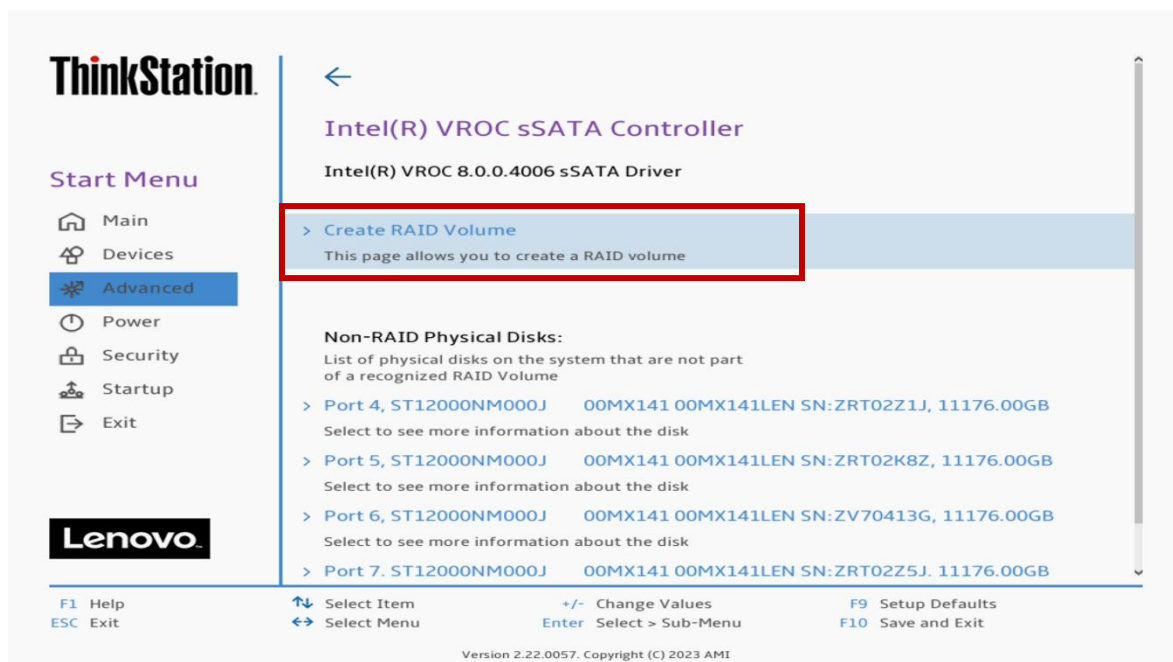


- From within the BIOS setup screen, select the “Advanced” menu option from the left-side menu options and “Intel® VROC sSATA Controller” from the middle menu options.

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.

ThinkStation

Create RAID Volume

Create RAID Volume

Name:
Enter a unique volume name that does not contain space at the beginning or backslash and is 16 characters or less.

Volume0

RAID Level:
Select RAID Level

RAID0(Stripe)

Select Disks:
Select Disks:

Port 4, ST12000NM000J 00MX141
00MX141LEN SN:ZRT02Z1J, 11176.00GB
X - to Select Disk

Port 5, ST12000NM000J 00MX141
00MX141LEN SN:ZRT02K8Z, 11176.00GB
X - to Select Disk

Port 6, ST12000NM000J 00MX141

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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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.

ThinkStation

Create RAID Volume

Create RAID Volume

Name:
Enter a unique volume name that does not contain space at the beginning or backslash and is 16 characters or less.

Volume0

RAID Level:
Select RAID Level

RAID0(Stripe)
RAID0(Stripe)
RAID1(Mirror)
RAID5(Parity)
RAID10(RAID1+0)

Select Disks:
Select Disks:

Port 4, ST12000NM000J 00MX141
00MX141LEN SN:ZRT02Z1J, 11176.00GB
X - to Select Disk

Port 5, ST12000NM000J 00MX141
00MX141LEN SN:ZRT02K8Z, 11176.00GB
X - to Select Disk

Port 6, ST12000NM000J 00MX141

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

ThinkStation

Create RAID Volume

Create RAID Volume

Name: Volume0

RAID Level: RAID0(Stripe)

Select Disks:

Select Disks:

Port 4, ST12000NM000J 00MX141 00MX141LEN SN:ZRT02Z1J, 11176.00GB X - to Select Disk	X
Port 5, ST12000NM000J 00MX141 00MX141LEN SN:ZRT02K8Z, 11176.00GB X - to Select Disk	X
Port 6, ST12000NM000J 00MX141	

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

ThinkStation

Create RAID Volume

Create RAID Volume

Name: Volume0

RAID Level: RAID0(Stripe)

Select Disks:

Select Disks:

Port 4, ST12000NM000J 00MX141 00MX141LEN SN:ZRT02Z1J, 11176.00GB X - to Select Disk	X
Port 5, ST12000NM000J 00MX141 00MX141LEN SN:ZRT02K8Z, 11176.00GB X - to Select Disk	X
Port 6, ST12000NM000J 00MX141 00MX141LEN SN:ZV70413G, 11176.00GB X - to Select Disk	X
Port 7, ST12000NM000J 00MX141 00MX141LEN SN:ZRT02Z5J, 11176.00GB X - to Select Disk	X

Strip Size: 128KB

Strip size help

Capacity (GB): 42468.78

Capacity is an approximation in GB. Enter desired volume size. 0 will be treated as Maximum Size. Approximate Maximum size=44703.98. Default Capacity is approximately 95% of Maximum size.

F1 Help
ESC Exit

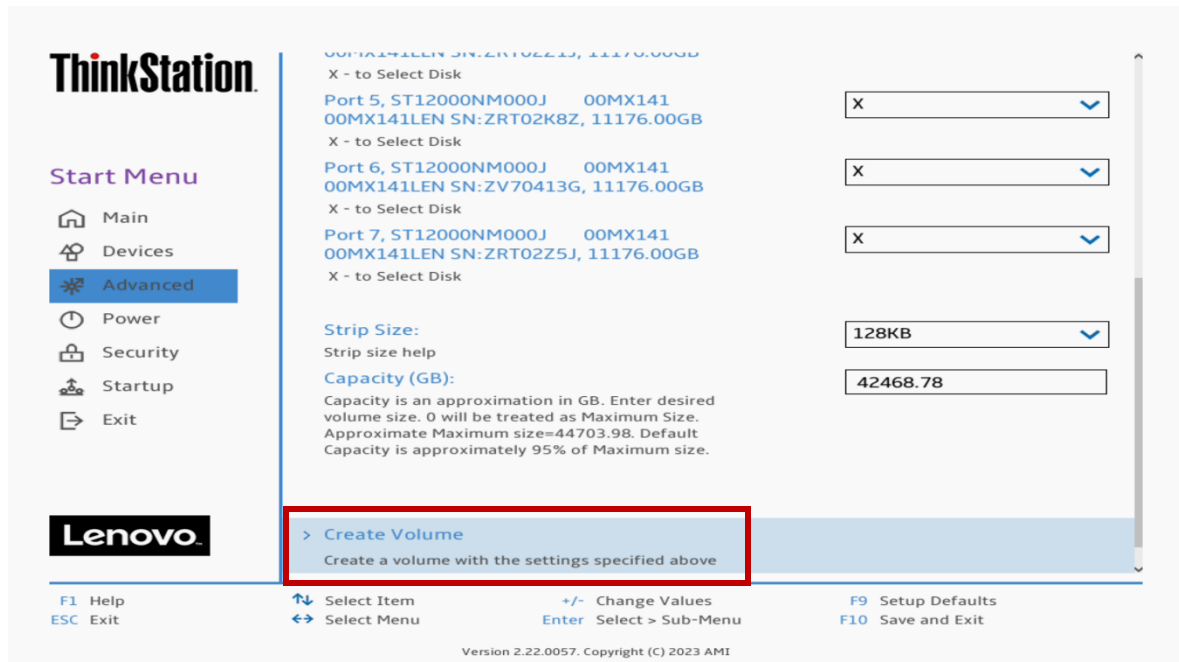
Select Item
Select Menu

+/- Change Values
Enter Select > Sub-Menu

F9 Setup Defaults
F10 Save and Exit

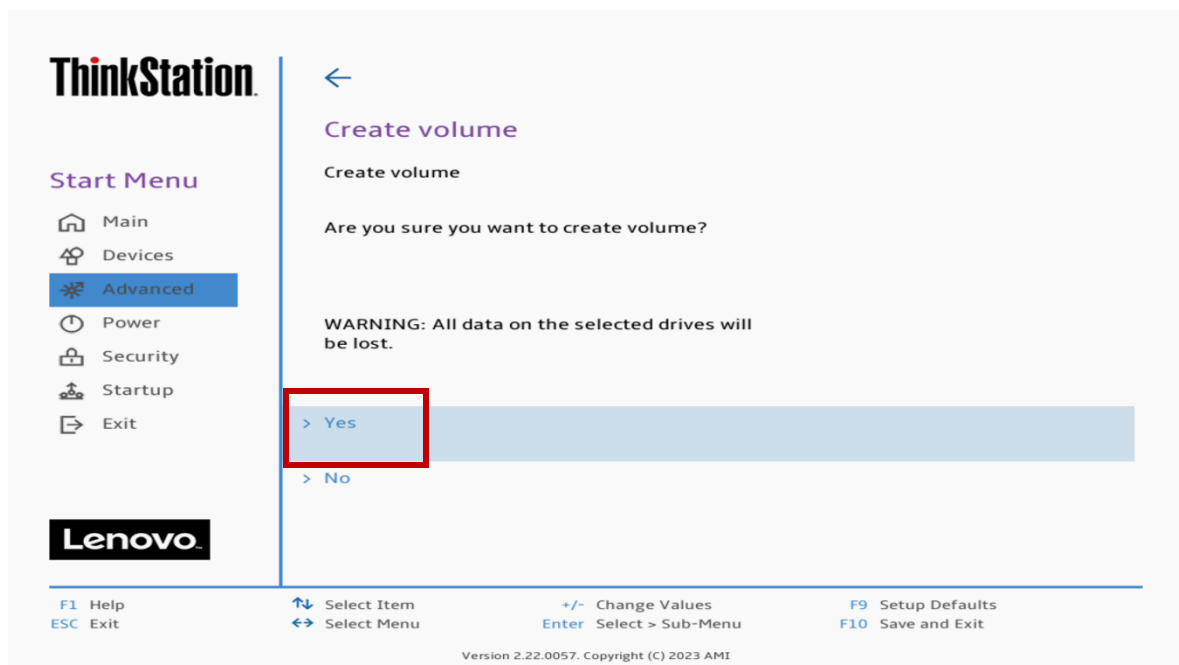
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8. Select “Create Volume”.

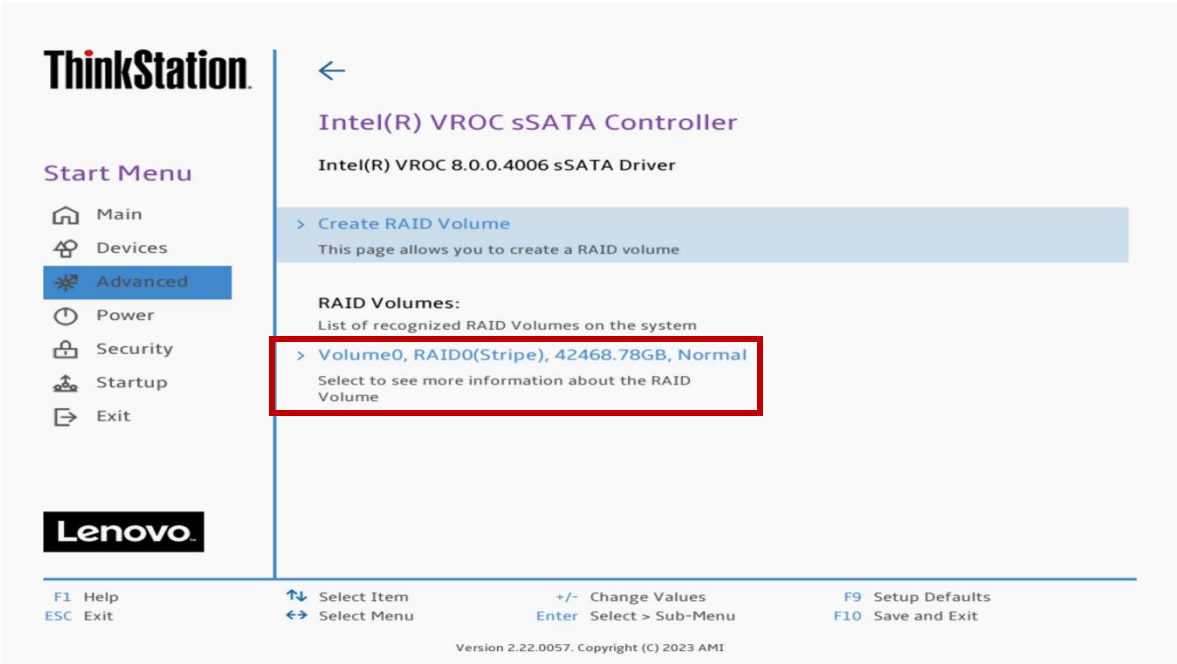


9. Select “Yes” to confirm creating the RAID volume.

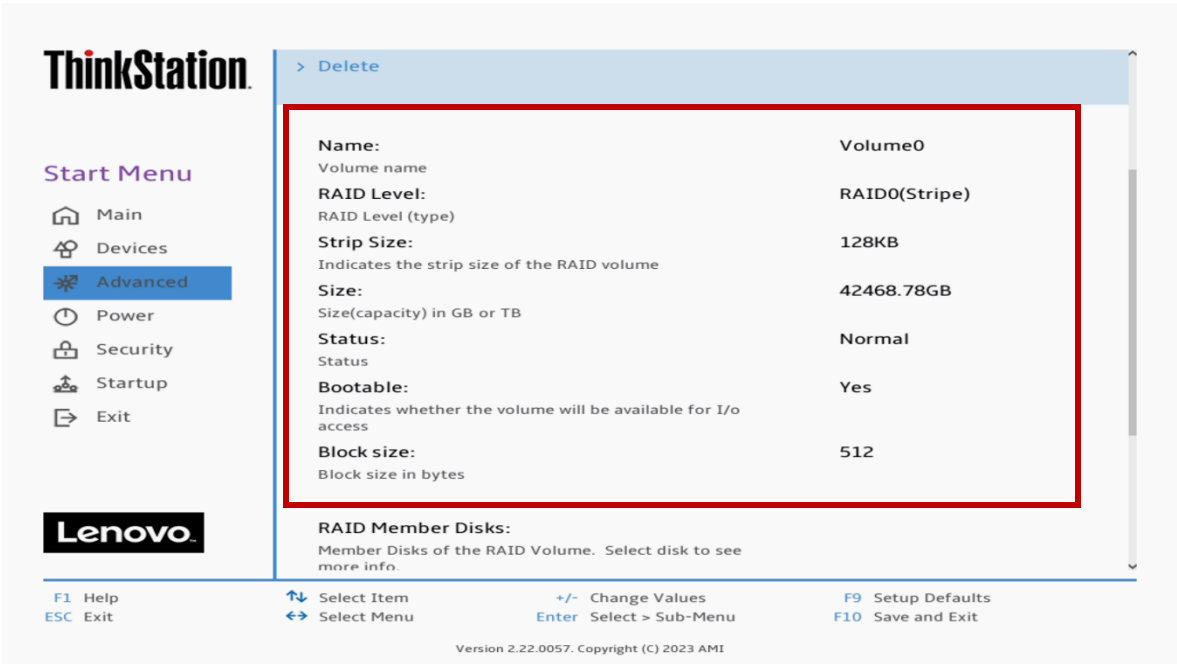
Note: All data on the selected drives will be lost.



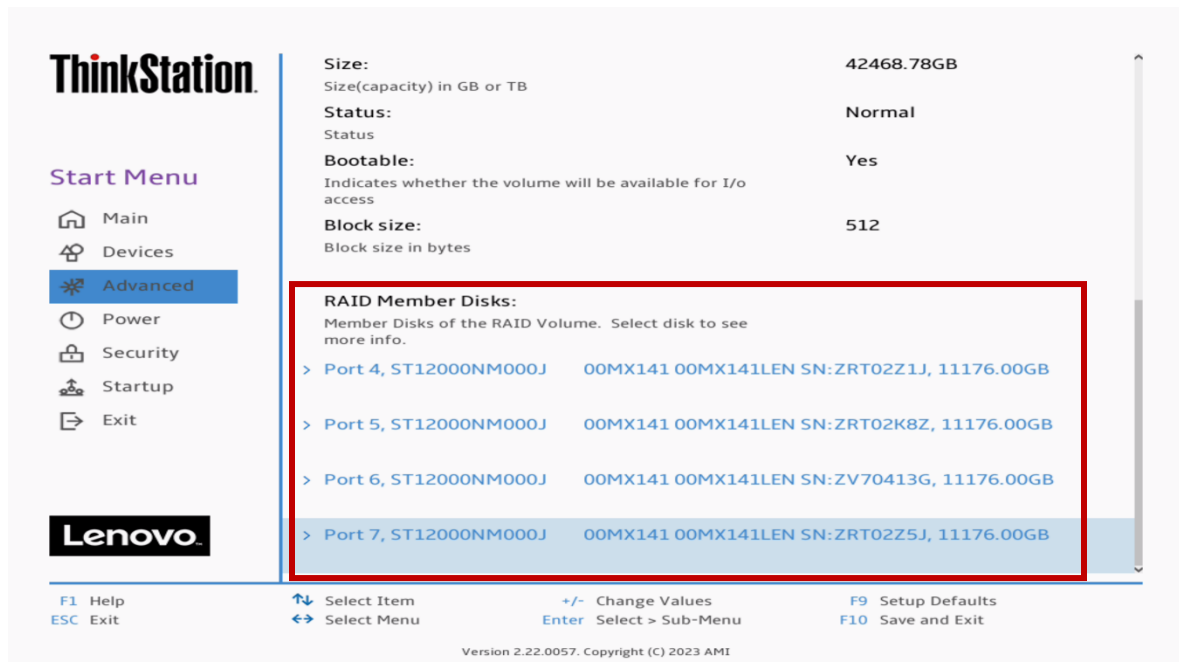
10.The created RAID array will show up under the root menu for “Intel VROC sSATA Controller”.



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

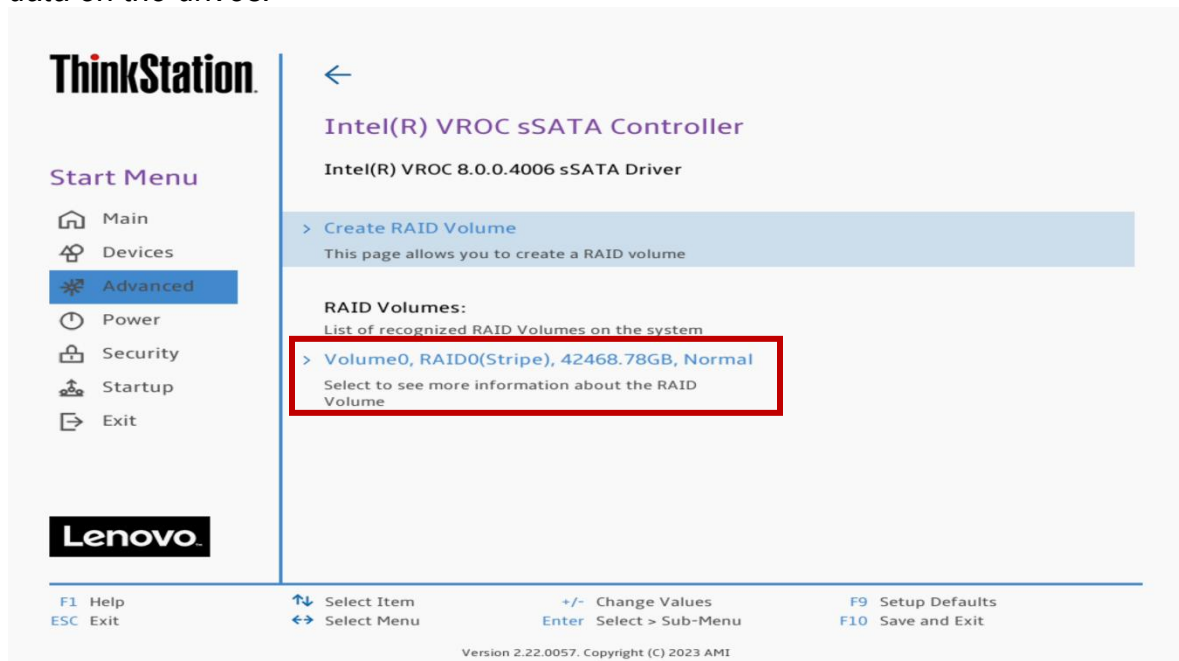


12. Scrolling down the “RAID Volume Info” screen will show the drives associated with the RAID volume.



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

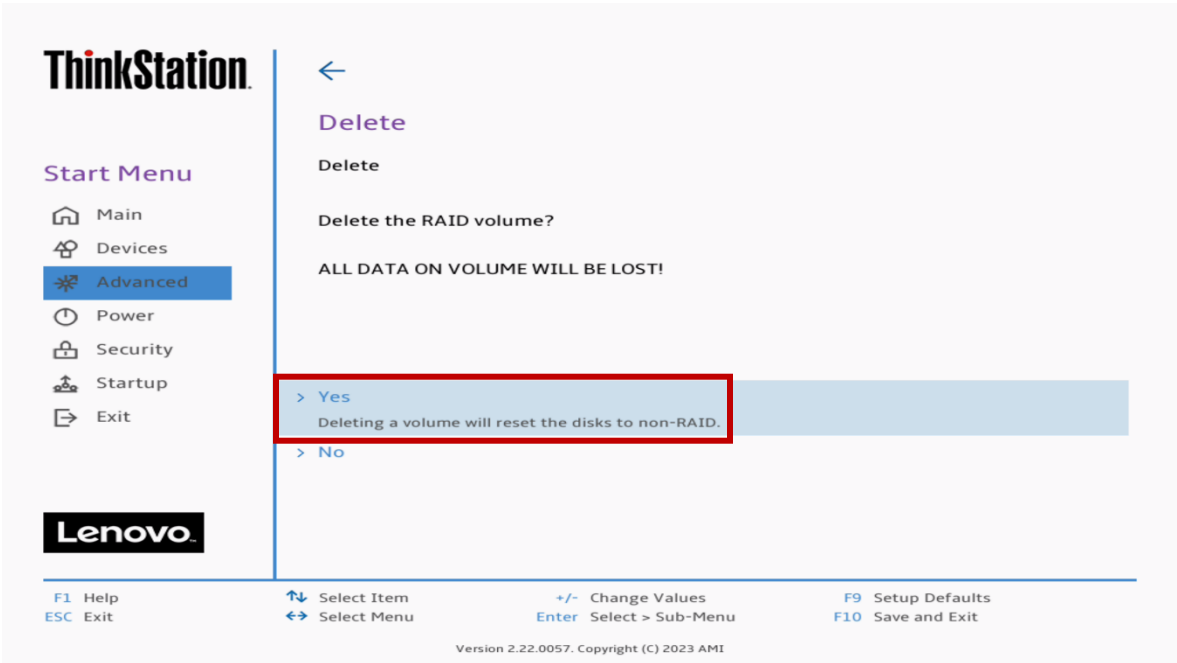
Note: This is destructive and will not be able to recover the RAID array or data on the drives.



14. Select “Delete”.



15. Select “Yes”.



Revision History

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