Intel® VROC (*VMD NVMe RAID)*

Quick Configuration Guide for the Intel® Server M50CYP Family

A QuickStart guide detailing configuration rules and procedures.

Rev 1.2

Feb 2023

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Document Revision History

Date Published	Revision	Changes
August 2022	1.0	Initial release
December 2022	1.1	Added note in red on figure 3. Corrected server board description and backplane port numbering on figure 7. Corrected cable descriptions on figure 8. Section 1.3 added.
February 2023	1.2	Section 2.5.3.2 added.

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System power on/off: The power button DOES NOT turn off the system AC power. To remove all power from the system, you must unplug the AC power cord from the wall outlet. Make sure the AC power cord is unplugged before you open the chassis, add, or remove any components.

Hazardous conditions, devices, and cables: Hazardous electrical conditions may be present on power, telephone, and communication cables. Turn off the server and disconnect the power cord, telecommunications systems, networks, and modems attached to the server before opening it. Otherwise, personal injury or equipment damage can result.

Installing or removing jumpers: A jumper is a small plastic-encased conductor that slips over two jumper pins. Some jumpers have a small tab on top that you can grip with your fingertips or with a pair of fine needle nosed pliers. If your jumpers do not have such a tab, take care when using needle-nosed pliers to remove or install a jumper; grip the narrow sides of the jumper with the pliers, never the wide sides. Gripping the wide sides can damage the contacts inside the jumper, causing intermittent problems with the function controlled by that jumper. Take care to grip with, but not squeeze, the pliers or other tool you use to remove a jumper, or you may bend or break the pins on the board.

Electrostatic discharge (ESD) and ESD protection: ESD can damage disk drives, boards, and other parts. We recommend that you perform all procedures in this chapter only at an ESD workstation. If one is not available, provide some ESD protection by wearing an anti-static wrist strap attached to chassis ground, any unpainted metal surface on your server when handling parts.

ESD and handling boards: Always handle boards carefully. They can be extremely sensitive to ESD. Hold boards only by their edges. After removing a board from its protective wrapper or from the server, place the board component side up on a grounded, static-free surface. Use a conductive foam pad if available but not the board wrapper. Do not slide board over any surface.

Preface

Introduction

This guide provides concise instructions for creating RAID configurations using the VROC HII Configuration Utility. The utility runs prior to loading the operating system (OS) and can be used to prepare a RAID volume before an OS is loaded onto it.

Guide Organization

This guide includes the following:

Section 1 - Product Overview

Provides the product overview, supported hardware and operating systems.

Section 2 - Preparing the server hardware and drivers

Provides the steps required to prepare the system to support Intel® VROC RAID configurations.

Section 3 - Intel® Volume Management Devices (Intel® VMD 2.0)

Provides definition of the Intel® VMD feature and instructions to enable it.

Section 4 - Creating Intel® VROC (VMD NVMe RAID) volumes

Step by step guide and screenshots to create Intel® VROC RAID configurations.

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1. Overview

Intel® VROC (VMD NVMe RAID) is a powerful, reliable, and affordable hybrid RAID solution that uses the built-in processor's Volume Management Devices (VMD) and Intel® VROC drivers to create and manage RAID configurations. Although the VROC RAID solution supports both, SATA and NVMe drives, this guide only centers on the NVMe type drives.

Intel® VROC (VMD NVMe RAID) is only available when the system is configured for UEFI boot mode. To enable Intel® VROC, a hardware key must be inserted onto the server board, and the appropriate processor Virtual Management Devices must be enabled in BIOS Setup.

Intel® VROC provides added performance and reliability for supported systems equipped with NVM Express* (NVMe*) drives to enable an optimal enterprise storage solution. Intel® VROC offers data protection by enabling RAID in a pre-boot environment that can be used in operating systems like Microsoft Windows*, Red Hat Linux* and SUSE Linux*.

1.1 Supported Hardware

This guide covers server products and solutions based on the following Intel® Server product families:

Intel® Server M50CYP Family

The guide supports RAID configurations created using validated U.2 NVMe* drives connected through a supported backplane, as well as M.2 NVMe drives. To increase the number of supported U.2 NVMe* drives, approved PCIe* switches and re-timers are also supported.

Note: For a list of supported devices, consult the Server Compatibility Options.

1.2 Supported Operating Systems*

The Intel® VROC (VMD NVME RAID) solution supports the following Operating Systems, either with in-box drivers or out of the box drivers:

- Microsoft Windows Server 2012* R2
- Microsoft Windows Server 2016*
- Microsoft Windows Server 2019*
- Microsoft Windows Server 2022*
- Red Hat Enterprise Linux* 7.8
- Red Hat Enterprise Linux* 7.9
- Red Hat Enterprise Linux* 8.1
- Red Hat Enterprise Linux* 8.2
- SUSE Linux Enterprise Server 12* SP5
- SUSE Linux Enterprise Server* 15 SP2
- VMWare* EXi 6.5 (only boot volumes, no data RAID is supported)
- VMWare EXi 6.7 (only boot volumes, no data RAID is supported)
- VMWare EXi 7.0 (only boot volumes, no data RAID is supported)

Note: Some of these Operating Systems might not be supported on a particular server system. The following link contains the OSs tested for the system:

- Server Compatibility Options Select your system, and then scroll down the category until Operating System.

1.3 RAID levels and maximum drive count

Intel® VROC (VMD NVMe RAID) supports the following RAID levels: RAID 0, RAID 1, RAID 10 and RAID 5. The enablement of these levels depends on the RAID key used. The below table shows these configurations along with the drive limits.

RAID level	RAID key required	Drive limit
RAID 0	Standard or Premium	As many as the backplane can accept *
RAID 1	Standard or Premium	2
RAID 10	Standard or Premium	4
RAID 5	Premium only	As many as the backplane can accept *

The Intel part number for the standard key is VROCSTANMOD.

The Intel part number for the premium key is VROCPREMMOD

* PCIe Switches and/or re-timers may be required.

2. Preparing Server Hardware and Drivers

2.1 Server System

Intel recommends that the server system has installed the latest firmware package that includes the BIOS, ME, FD, BMC, and FRUSDR utility. The best way to achieve this is to download and install the latest published System Update Package (SUP) corresponding to the server board being used, which may be found at the Intel® Server BIOS Support Central.

2.2 Intel VROC Hardware Key

To enable Intel® VROC, a Hardware Key must be installed on the Intel® server board. There are the three separate keys supporting different RAID levels:

- **Intel® VROC Standard (MM#951605)**: Enables RAID levels 0, 1 and 10. Different NVMe* drive manufacturers are supported.
- **Intel® VROC Premium (MM#951606)**: RAID levels 0, 1, 10 and 5. Different NVMe drive manufacturers are supported.
- **Intel® VROC Intel SSD Only (MM#956822)**: Enables RAID levels 0, 1, 10 and 5 but only Intel® NVMe SSDs are supported.

Refer to the corresponding system TPS document of your system for the VROC Hardware Key installation instructions. The system TPS for a particular M50CYP system can be found by consulting the Support for Intel® Server M50CYP Family from the Intel web site.

2.3 NVMe* drives

Intel® VROC (VMD NVMe RAID) supports the U.2 form factor and the M.2 form factor NVMe drives.

The U.2 form factor NVMe drives must be connected through a supported backplane. The M.2 form factor NVMe drives must be connected on the M.2 slots on the server board.

Intel recommends that the drives are at the latest firmware version, making available the

Solidigm* Storage Tool (Intel® branded NAND SSDs). This utility is only for Intel® and Solidigm* branded drives, other NVMe drive vendors provide similar tools.

2.4 PCIe switches and re-timers

Intel® VROC (VMD NVMe RAID) supports the U.2 NVMe drives directly attached to the server board, but it also supports using PCIe switches and re-timers to increase the number of supported drives. Refer to Section 2.5 for details on connecting and cabling such devices.

2.5 Connecting the drives

As mentioned before, the VROC RAID solution supports either U.2 drives connected to a supported Hot Swap Back Plane (HSBP) or M.2 drives. The PCIe* ports designed for the U.2 drives are PCIe* Gen 4.0 and they are directly connected to the system CPU(s), while the M.2 PCIe* ports are Gen 3 and they go through the system PCH.

This section explains how the connect the cables to connect the drives.

Note: Changing the configuration of the drive interface cables to something other than what is shown in this guide, may cause drive numbering and LED management issues.

2.5.1 NVMe* drives directly connected to the server board PCIe ports.

The system server board provides PCIe* Gen 4.0 ports specifically designed for connecting NVMe drives installed in a backplane, these ports, 4 per CPU, are named A, B, C, and D. Each port is 4-lane wide and by connecting 4-lane NVMe drives a full bandwidth can be obtained. Up to 8 NVMe drives can be connected this way. The following figures show the port location and cable connection details.

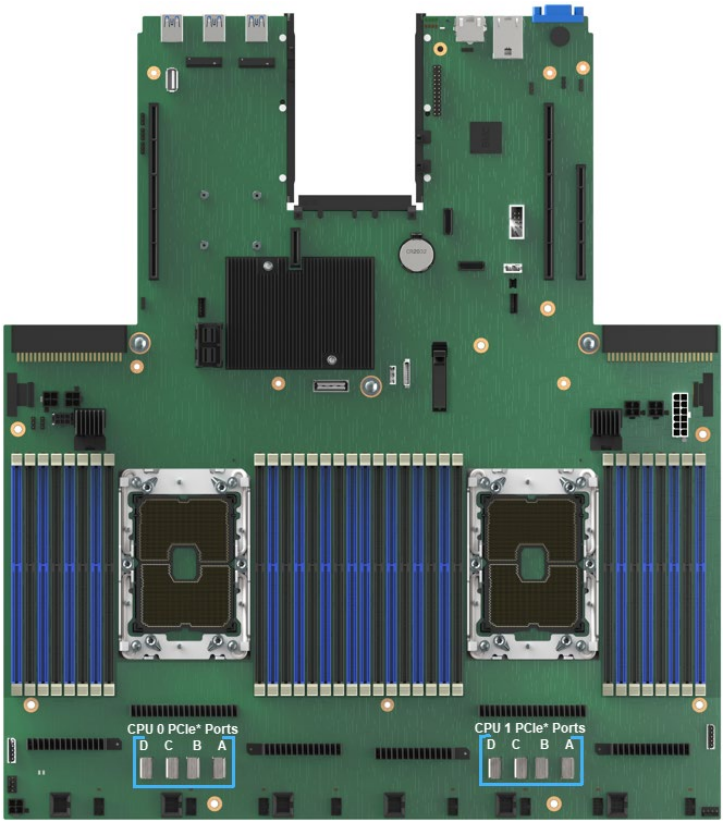

Figure 1. On board PCIe* port locations

See the following figures that show how to connect the backplane to the server board for the different M50CYP systems. The cable ends are labeled to properly connect to the server board connectors. The order shown must be maintained to ensure drive numbering and LED management.

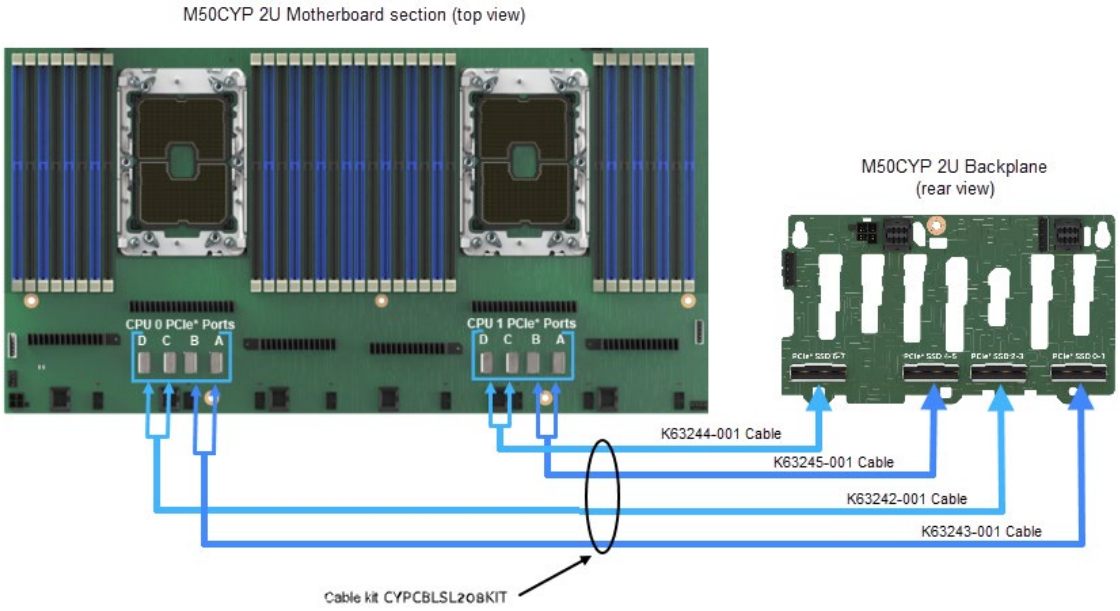

Figure 2. Data cable connections for connecting the HSBP directly to the server board on an M50CYP2UR208 system.

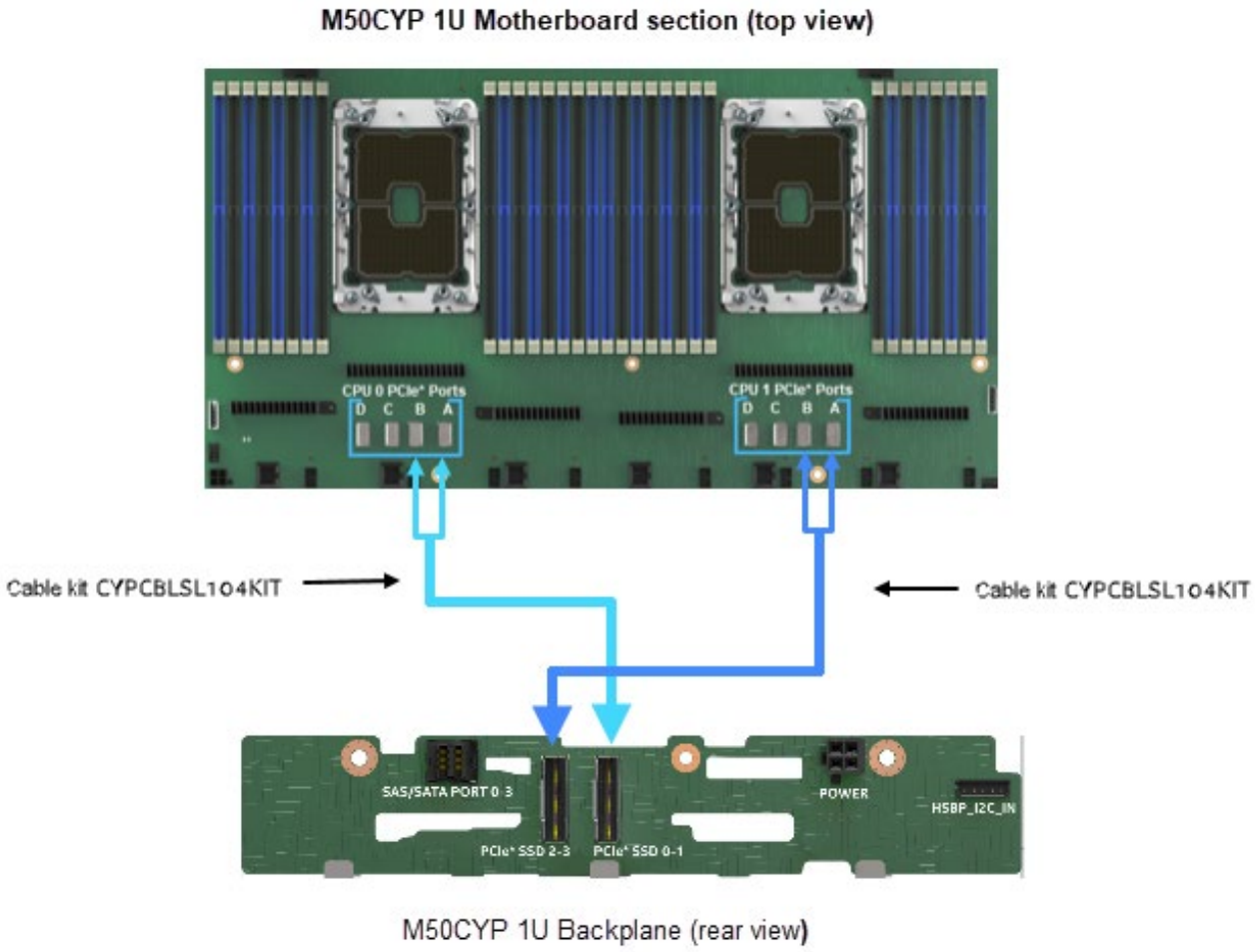

Figure 3. Data cable connections for connecting the HSBP directly to the server board on an M50CYP1UR204 system.

2.5.2 NVMe drives connected to PCIe* re-timers.

The Intel® Server System M50CYP Family support re-timer devices to increase the number of PCIe ports for additional NVMe drives. Each re-timer provides 4 PCIe Gen 4.0 ports to provide full bandwidth for up to 4 drives.

The 2U version of the system supports two re-timers: **CYP2URISER1RTM**, that installs on riser 1, and **CYPRISER3RTM**, that installs on riser 3. The 1U version of the system supports only the CYPRISER3RTM, that installs on riser 3.

The following figures show where on the Intel® server board the re-timers are installed.

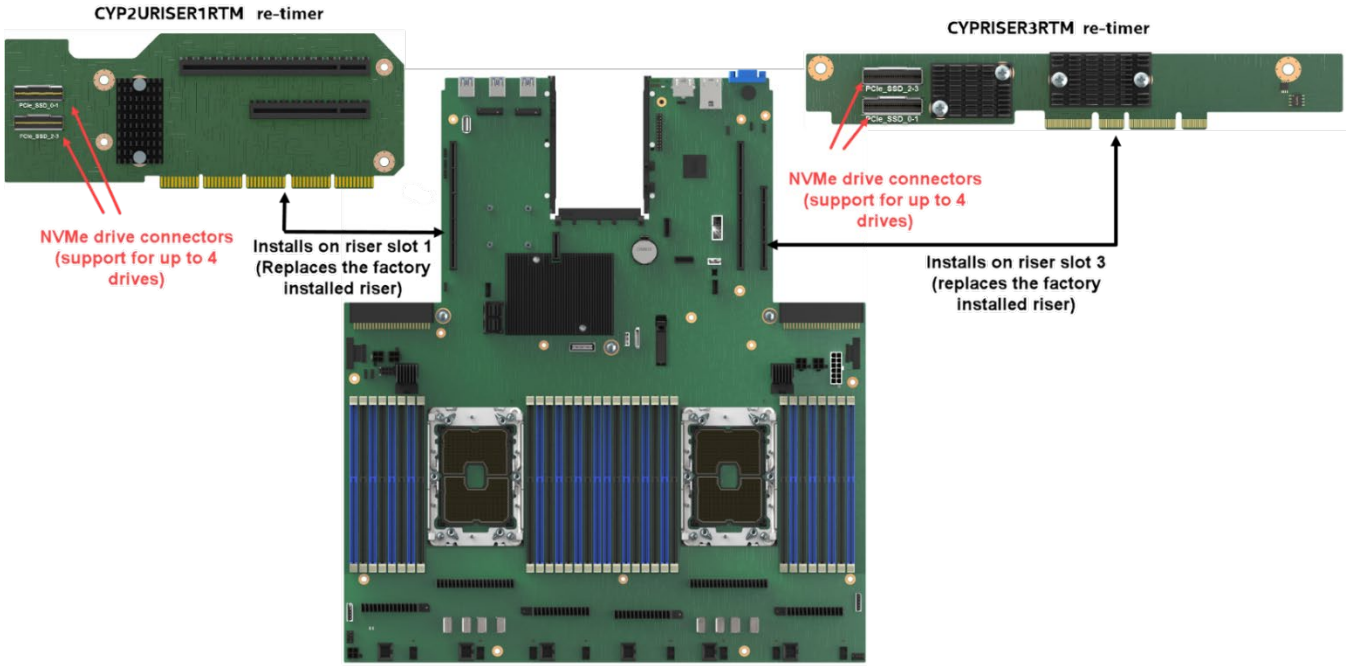

Figure 4. M50CYP2UR208 re-timer options.

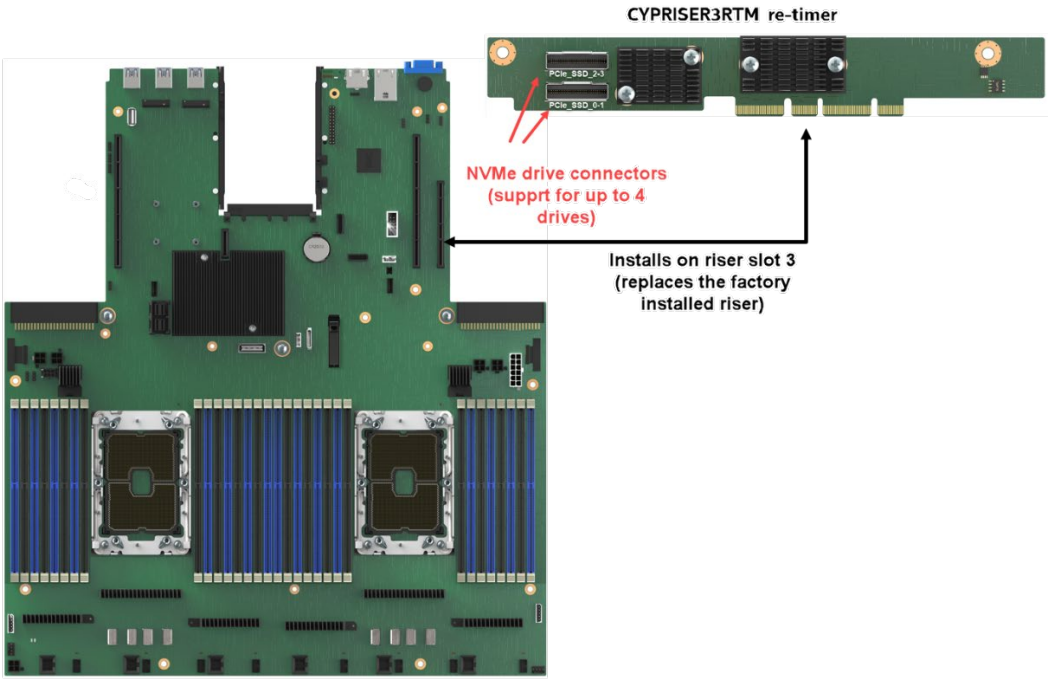

Figure 5. M50CYP1UR212 re-timer option.

By using the re-timers plus the on-board connectors, it's possible to connect up to 16 NVMe drives at full bandwidth (4 PCIe 4.0 lanes each) on the M50CYP2UR208 system and up to 12 NVMe drives on the M50CYP1UR212 system. The next figure shows how the drives must be cabled to achieve this support.

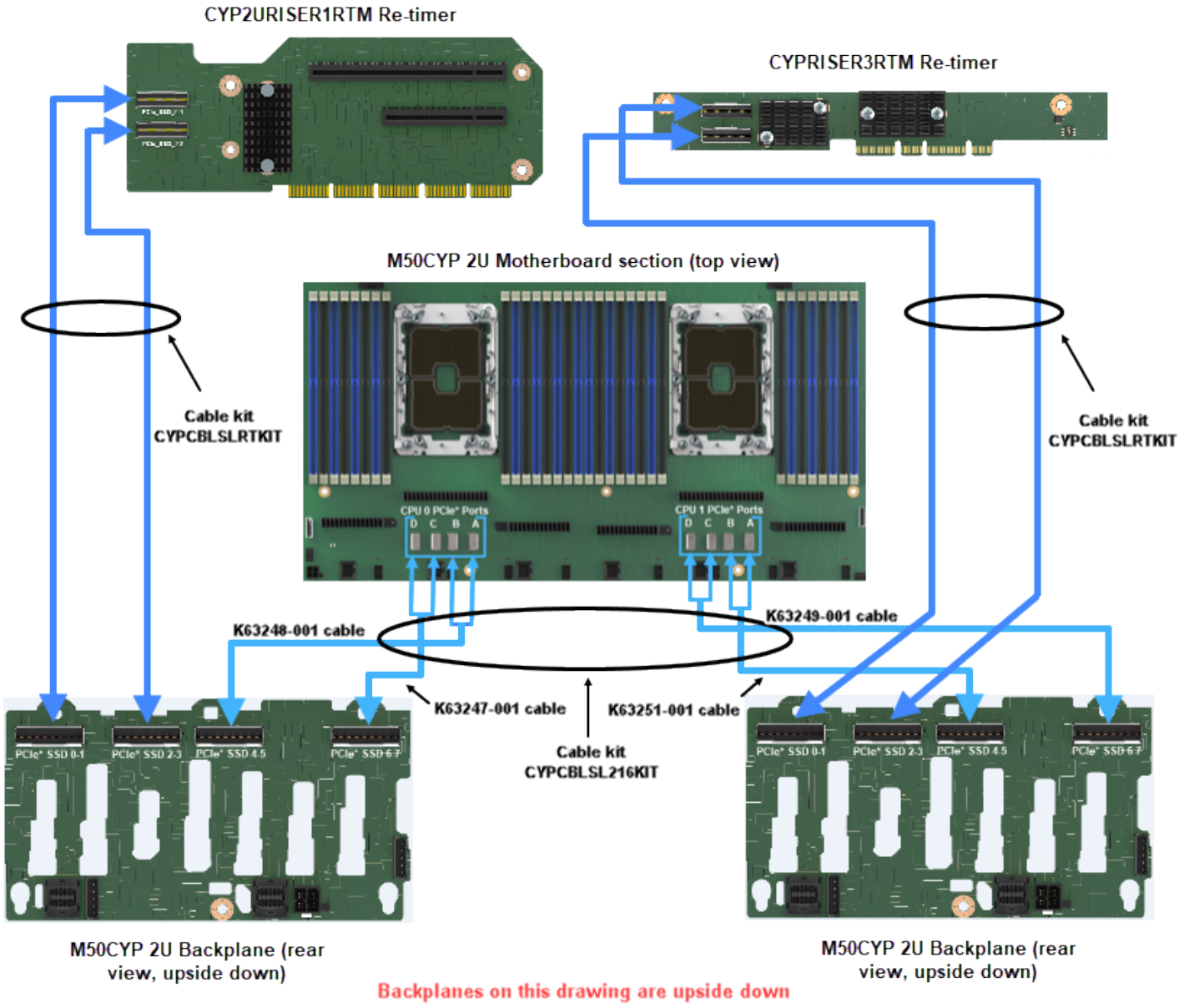

Figure 6. Data cable connections for re-timer support on an M50CYP2UR208 system.

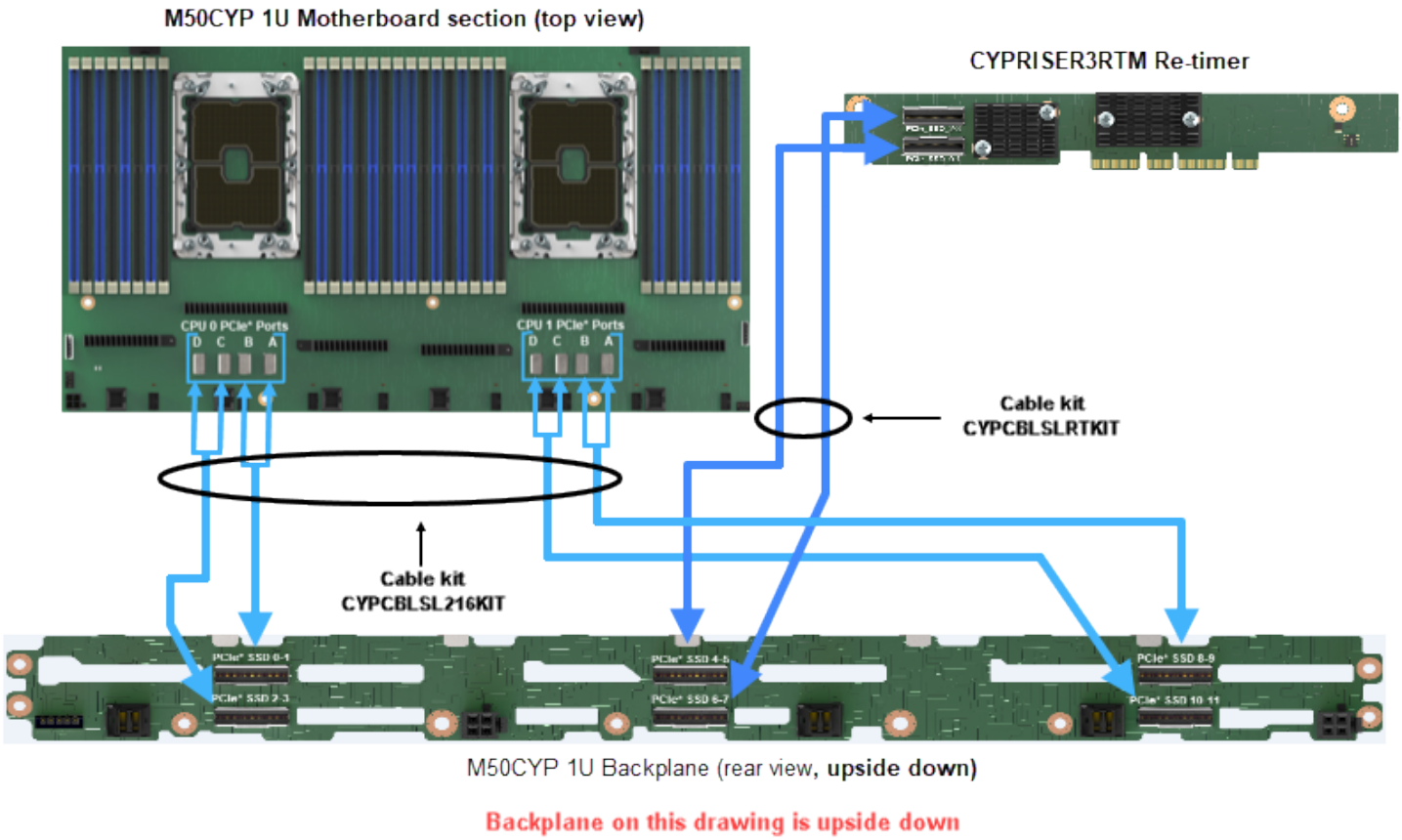

Figure 7. Data cable connections for re-timer support on an M50CYP1UR212 system.

2.5.3 NVMe drives connected through PCIe* switches.

The CYPSWITCHMP PCIe* 4.0 switch is a device that allows to share PCIe* lanes among different NVMe* drives. By using the CYPSWITCHMP, also called Mid-Plane switch, it's possible to increase the number of supported NVMe drives. There are two different switch configurations: x4 and x2.

2.5.3.1 X4 Mid-Plane switch configuration.

On this configuration, each drives uses 4 PCIe* lanes, allowing up to 12 drives per switch. Regular 4-lane common clock NVMe drives are used for this configuration, which are the most common ones in the market.

By installing two Mid-Plane switches on the M50CYP2UR208 system it's possible to install up to 24 NVMe drives, with limited bandwidth. This configuration requires the CYPSWITCHMP switch, the data cable kit CYPCBLSLMIDPIN and the required number of CYPCBLSLMIDPOUT cables (typically 6), for each switch device installed. It also requires the I2C cables, but they are included with the CYPSWITCHMP switch card.

A special firmware must be installed on the Mid-Plane switch to allow this support model, the firmware package has detailed installation instructions and it can be found in the following link: ***https://www.intel.com/content/www/us/en/download/766822***.

The following two figures show how to install the data cables as well as the I2C cables for this support.

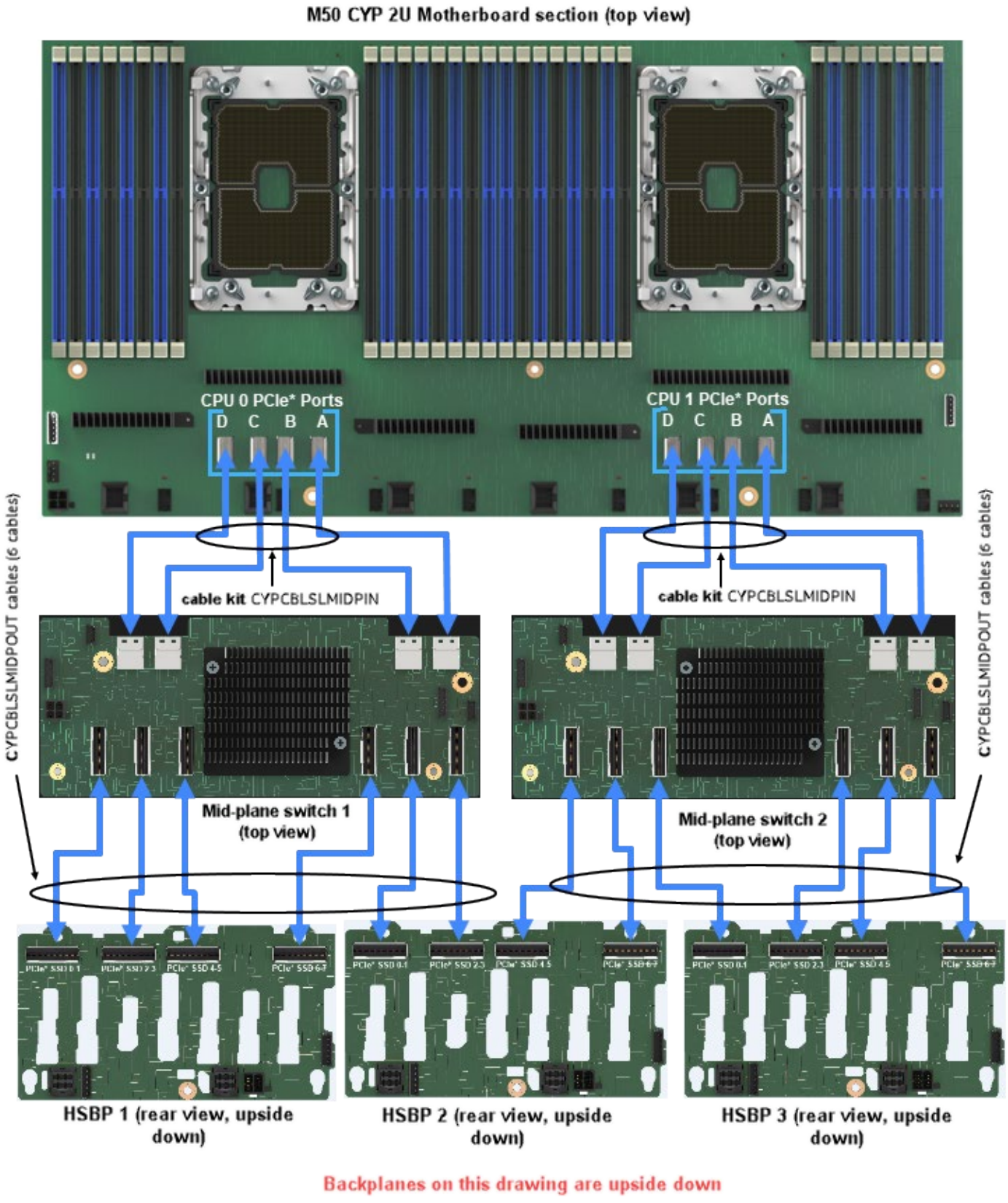

Figure 8. Data cable connections for a mid-plane switch support on an M50CYP2UR208 system, with x4 connections

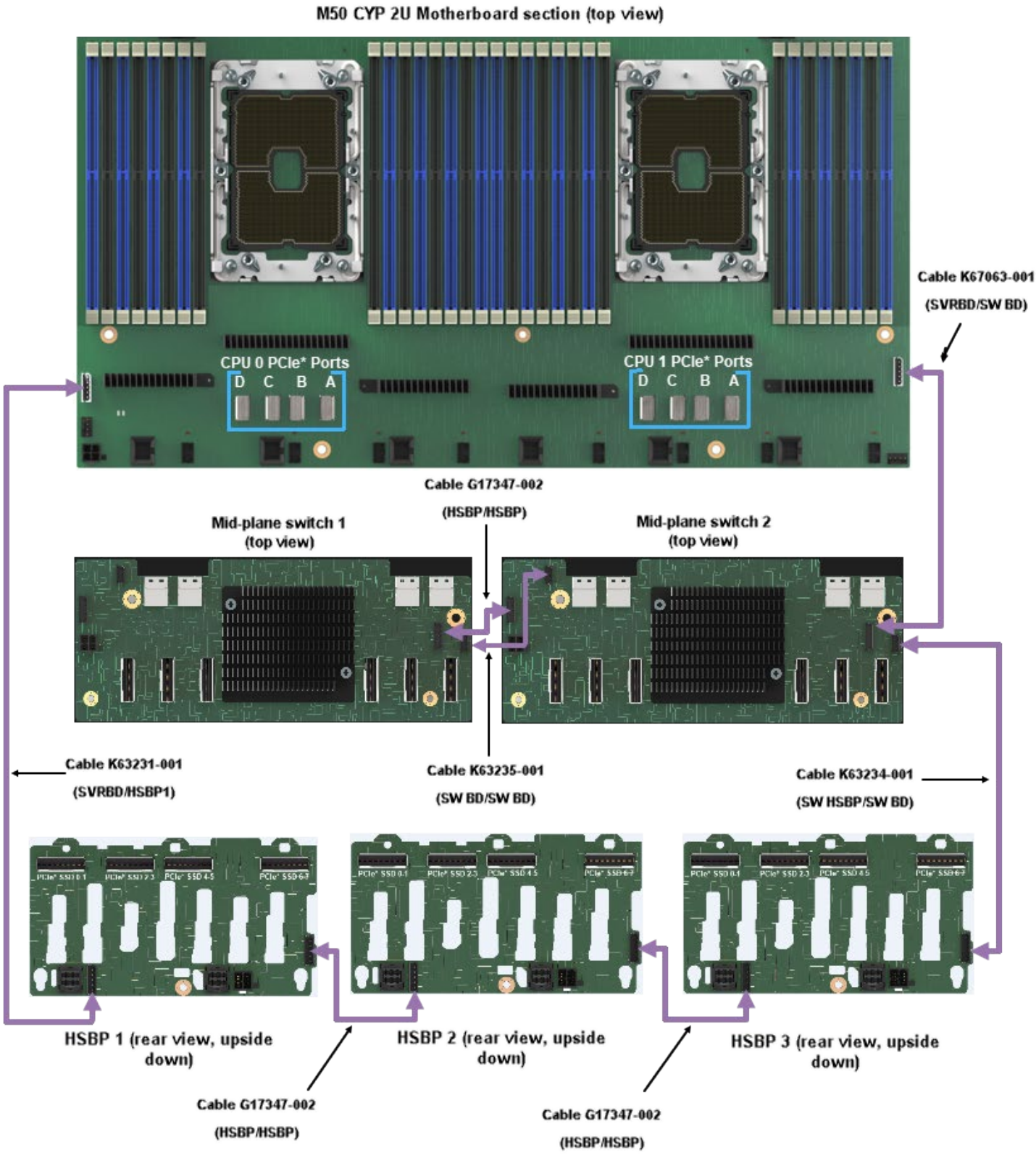

Figure 9. I2C cable connections for a mid-plane switch support on an M50CYP2UR208 system

2.5.3.2 X2 Mid-Plane switch configuration.

On this configuration, each drives uses 2 PCIe* lanes, allowing up to 24 drives per switch. SRIS capable drives MUST be used for this configuration. Consult the Server Compatibility Options page to find drive models that are compatible with this configuration. By installing one single Mid-Plane switch on the M50CYP2UR208 system it's possible to install up to 24 NMVe* drives, with limited bandwidth.

A special firmware must be installed on the Mid-Plane switch to allow this support model, the firmware package has detailed installation instructions and it can be found in the following link: ***https://www.intel.com/content/www/us/en/download/766822*.**

The following two figures show how to install the data cables as well as the I2C cables for this support.

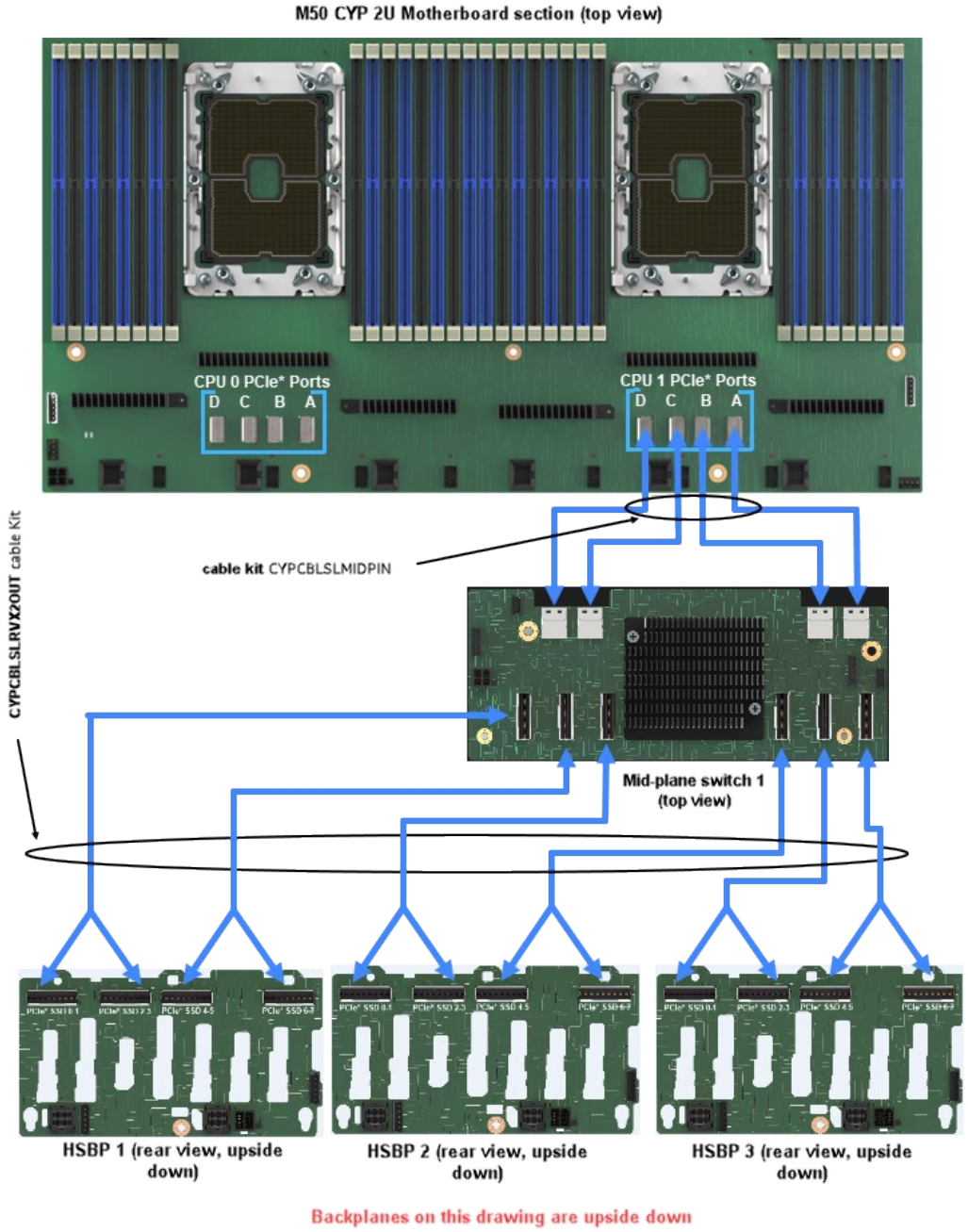

Figure 10. Data cable connections for a mid-plane switch support on an M50CYP2UR208 system, with X2 connections

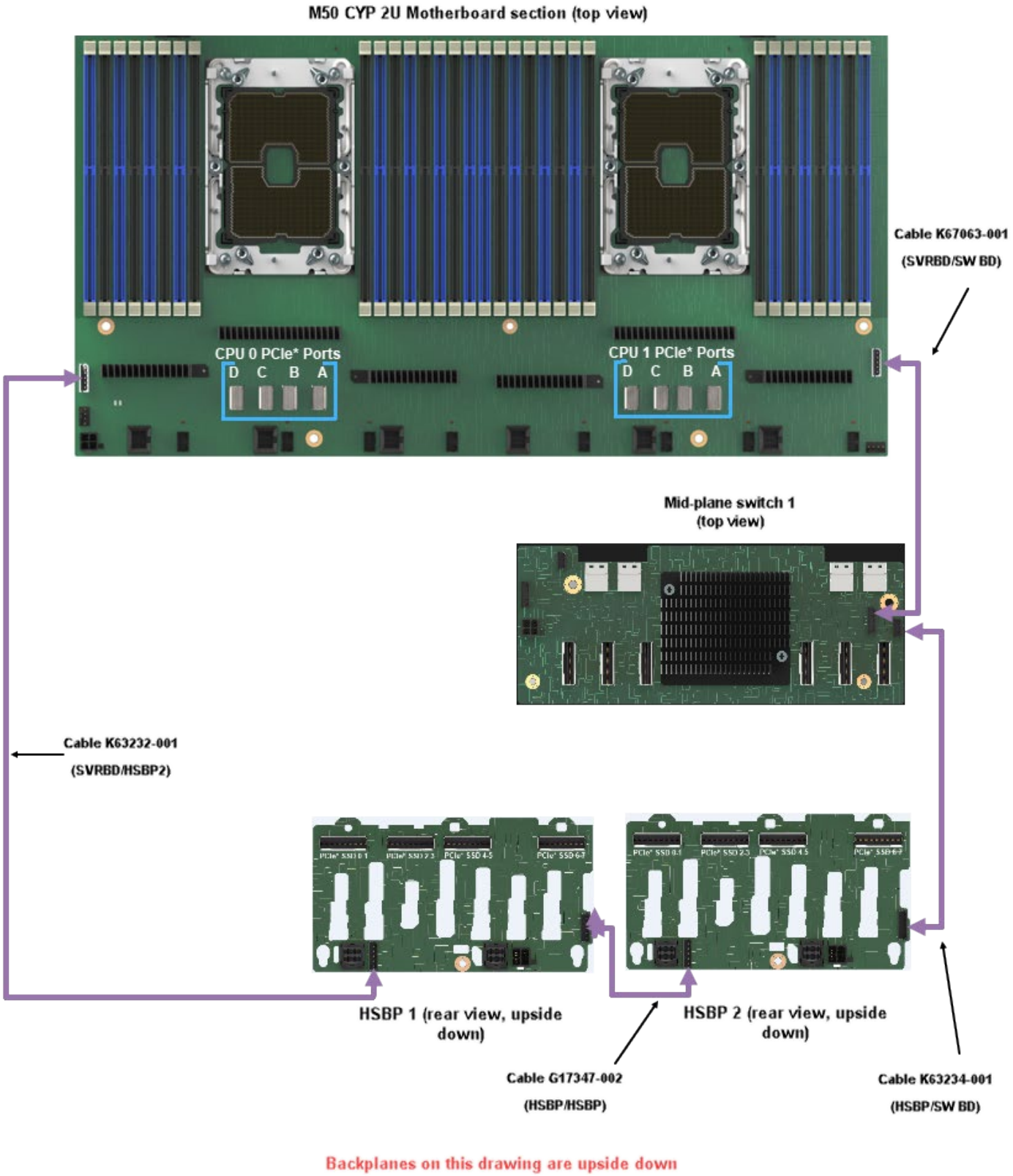

Figure 11. I2C cable connections for a mid-plane switch support on an M50CYP2UR208 system, using one single switch.

2.6 Verify drive list and identify slots

It is a good practice to make sure that all the installed drives are properly recognized by the system before proceeding with the configuration. For that, enter the system BIOS setup, navigate to Advanced → PCI Configuration → UEFI Option ROM Control. At this point the drive list should be visible, showing each drive along with its slot number. Make sure the drive count is accurate. All VMD ports must be disabled for the drives to appear in this list.

2.7 Intel® VROC Drivers.

The Intel® VROC solution has two driver components: the pre-boot, or UEFI driver, and the OS driver. The UEFI driver is embedded in the system BIOS and is referred to as the *VMD VROC UEFI driver*, while the OS driver must be loaded at the OS installation time* and is referred to as the *OS VROC driver;* both contain version numbers. The *OS VROC driver* version can be equal or newer than the *VMD VROC UEFI driver* version but not vice versa, except for the Linux OS. Attention must be paid when updating the system BIOS, if the embedded *VMD VROC UEFI driver* version in the new SUP package is newer than the *OS VROC driver* version, update the *OS VROC driver* prior installing the SUP package.

* Most of the supported Linux distros and versions have the Linux OS VROC driver in-boxed, meaning that the driver is integrated in the OS and there is no need to load any additional drivers

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Note: On a system with the Windows* OS installed and an Intel® VROC virtual drive present, the *OS VROC driver* version must equal or greater than the *VMD VROC UEFI driver* version, otherwise unexpected behavior may happen.

The *OS VROC* driver can be found on the Intel® RAID Support Central.

The *VMD VROC UEFI driver* version embedded in the BIOS is documented in the BIOS Release Notes for the corresponding SUP Package, look at the “BIOS COMPONENTS/CONTENTS” section.

The following is an example of how the *VMD VROC UEFI driver* version is documented in the Release Notes file.

```
================================================================================
                                                    BIOS COMPONENTS/CONTENTS
================================================================================
Processors supported:
                Intel(R) Xeon(R) Scalable Processors 3rd Generation

Microcode versions:
                CPUID                   Version                 Status
                606a4                   0x0b000280              (ICX-SP HCC L0)
                606a5                   0x0c0002f0              (ICX-SP XCC C0)
                606a6                   0x0d000375              (ICX-SP XCC D0/D1/D2 & HCC M1)


SATAAHCI:
                v2.00i
VROCSataEfi:
                v7.7.6.1004
VROCsSataEfi:
                v7.7.6.1004
BIOSACM:
                Production,v1.1.0_20211117_LBG
SINIT:
                Production,v1.1.0_20211117_LBG
NvmDimmDriver:
                v02.00.00.3886
NvmDimmHii:
                v02.00.00.3886
ASTVBIOS:
                v1.09
VMDVROC2:
                v7.7.6.1004
VMDVROC1:
                v7.7.6.1004
SPS:
                04.04.04.202
PCH PFR SVN:
                02
--------------------------------------------------------------------------------
```

Figure 12. *VMD VROC UEFI driver* as it is documented in the BIOS release notes

3. Intel® Volume Management Device (Intel® VMD) 2.0

Intel® VMD 2.0 is a feature present on the 3rd Generation Intel® Xeon® Scalable Processors. This feature provides RAID support for NVMe* drives directly connected to the processor's PCIe* lanes. This section describes how to enable and configure this functionality.

Each member of the Intel® Xeon® processor Scalable family has four Intel® VMD domains (numbered one, two, three and four). Each Intel® VMD domain manages 16 PCIe* lanes divided into four Intel® VMD ports (named A, B, C, and D) consisting of four PCIe* lanes each. Some of these Intel® VMD ports are routed to specific VMD ports on the server board, while others are routed to specific chipset uplinks. This routing is fixed (non-configurable); please refer to the system Technical Product Specification for details on this routing.

There are three different ways to connect NVMe drives to Intel® VMD ports:

1. **Direct attach**. Up to 16 U.2 NVMe* drives can be connected directly to 16 VMD ports. Each NVMe drive uses four dedicated PCIe* lanes, providing full bandwidth for each drive.
    - 8 VMD ports are provided by the system server board.
    - 4 VMD ports are provided by a re-timer on riser 1.
    - 4 VMD ports provided by a re-timer on riser 3.

2. **Through Mid-plane switch.** Up to 24 U.2 NVMe drives can be connected to eight VMD ports by using two PCIe* mid-plane switches.
   The mid-plane switch provides a 1:3 fan-out allowing to share each 4-lane VMD port among 3 NVMe drives, this solution provides limited bandwidth for each drive. There's option to use 4 or 2 PCIe lanes per drive (SRIS capable drives are required to use 2 PCIe lanes).

3. **M.2 NVMe drives.** Up to two M.2 NVMe PCIe Gen 3.0 drives can be connected to the on-board M.2 SSD connectors. These drives use the system PCH to allow connection to the system processor.

A RAID volume can be used as a bootable drive only if all drives in the RAID volume are connected to a single Intel® VMD domain. It is possible to create RAID volumes spanning multiple Intel® VMD domains, however such RAID configurations cannot be made bootable.

3.1 Slot number versus VMD port mapping

To balance the loads between the CPUs, it's important to know how the drives are connected to the different CPUs and VMD domains. Each drive uses a slot number, and each slot group is connected to a VMD domain. See the below table to know how the drive slot numbers are mapped to the different CPU and VMD domains.

Table 1. NVMe Slot number vs VMD port mapping

Location	Drive Slot #	I/O Unit	PCIe* Gen	CPU/VMD port	VMD domain
On-board	0x0110	IOU3	4.0	CPU0 3A	VMD4/CPU0
On-board	0x0120	IOU3	4.0	CPU0 3B	VMD4/CPU0
On-board	0x0130	IOU3	4.0	CPU0 3C	VMD4/CPU0
On-board	0x0140	IOU3	4.0	CPU0 3D	VMD4/CPU0
On-board	0x0150	IOU3	4.0	CPU1 3A	VMD4/CPU1
On-board	0x0160	IOU3	4.0	CPU1 3B	VMD4/CPU1
On-board	0x0170	IOU3	4.0	CPU1 3C	VMD4/CPU1
On-board	0x0180	IOU3	4.0	CPU1 3D	VMD4/CPU1
On-board M.2	0x101	IOU0	3.0	CPU0	VMD0/CPU0
On-board M.2	0x102	IOU0	3.0	CPU0	VMD0/CPU0
Riser 1	0x315	IOU2	4.0	CPU0 2B	VMD3/CPU0
Riser 1	0x316	IOU2	4.0	CPU0 2C	VMD3/CPU0
Riser 1	0x317	IOU2	4.0	CPU0 2D	VMD3/CPU0
Riser 1	0x318	IOU2	4.0	CPU0 2A	VMD3/CPU0
Riser 3	0x331	IOU0	4.0	CPU1 0A	VMD0/CPU1
Riser 3	0x332	IOU0	4.0	CPU1 0B	VMD0/CPU1
Riser 3	0x333	IOU0	4.0	CPU1 0C	VMD0/CPU1
Riser 3	0x334	IOU0	4.0	CPU1 0D	VMD0/CPU1

The drive slot number can be found by checking the NVMe* drive list, (refer to section 2.6 for details).

Note: The VMD ports must be disabled for the drives to show in this list, once the VMD ports are enabled, the drives will no longer show up in this list.

Note: Each time the VMD ports are enabled or disabled, the system must be rebooted for the changes to take effect.

The information on this table is useful when someone wants to know where a drive is installed and enable the corresponding NVMe port, without removing the system cover.

3.2 Enabling the Intel® VMD ports

By default, all Intel® VMD ports are disabled, and they must be enabled in the system BIOS Setup for Intel® VROC (VMD NVMe RAID) to work. Only the VMD ports with drives connected need to be enabled, therefore it's essential to know where the drives are connected, either by removing the server cover and see the cables, or by checking the drive slot numbers (refer to sections 2.6 and 3.1). The VMD ports can be enabled by accessing the following menu, choosing only the corresponding ones, and enabling them. Access the Volume Management Device menu by entering BIOS Setup and navigate to: Advanced → Integrated IO Configuration → Volume Management Device

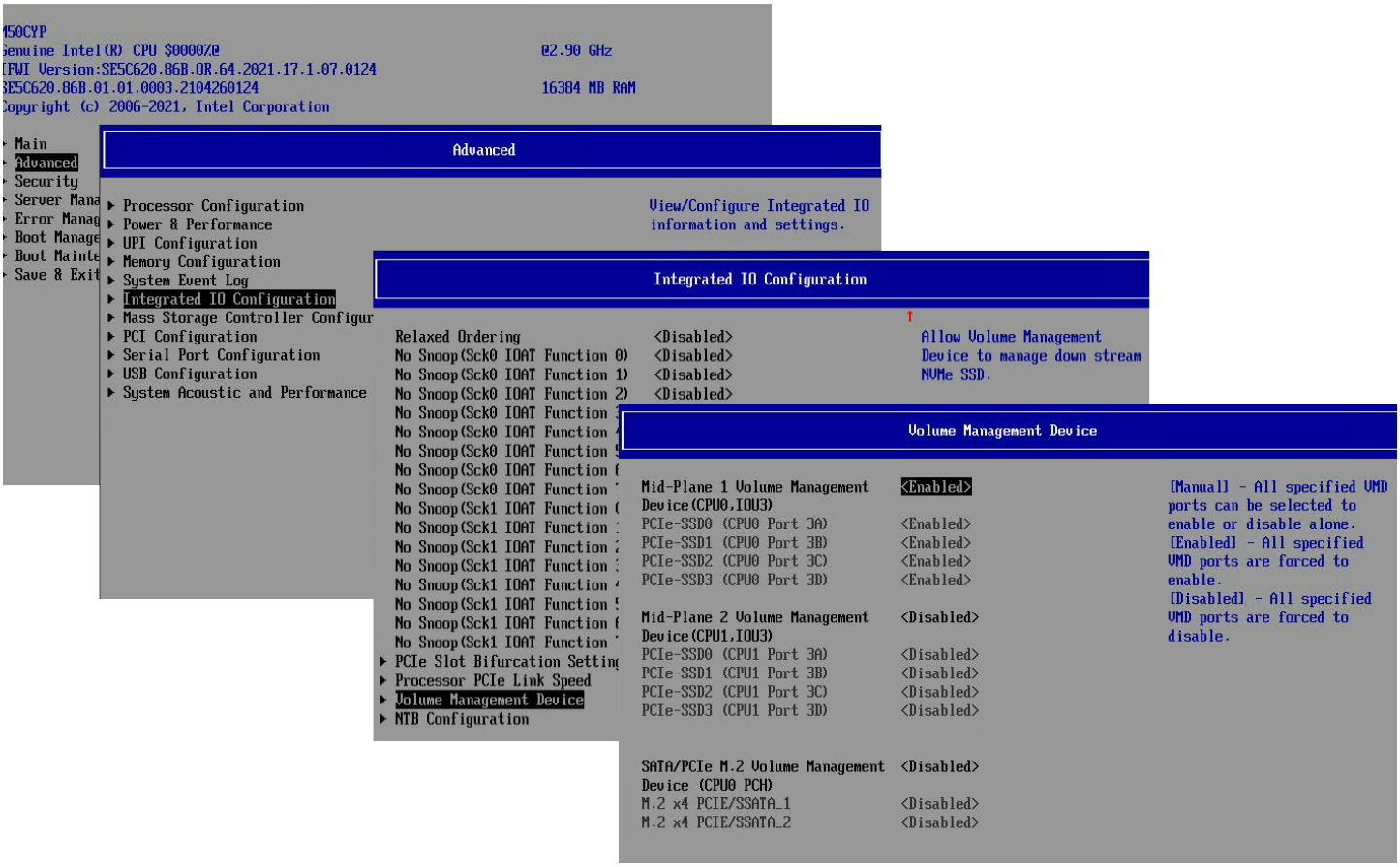

Figure 13. Accessing the Volume Management Device port enabling screen

The Volume Management Device screen will vary depending on the hardware configuration, the system BMC detects when a mid-plane switch or a re-timer is installed and the VMD screen will show the corresponding VMD ports accordingly.

VMD ports from the server board appear as **Direct HSBP Volume Management Device.**

VMD ports from a re-timer appear as **RiserX Volume Management Device** (where X is the riser number, either 1 or 3).

Shared VMD ports going through a Mid-Plane switch appear as **Mid-Plane Y Volume Management Device** (where Y is the switch number, either 1 or 2)

VMD ports from the M.2 slots appear as **SATA/PCIe M.2 Volume Management Device**

The below figures show the different VMD port options.

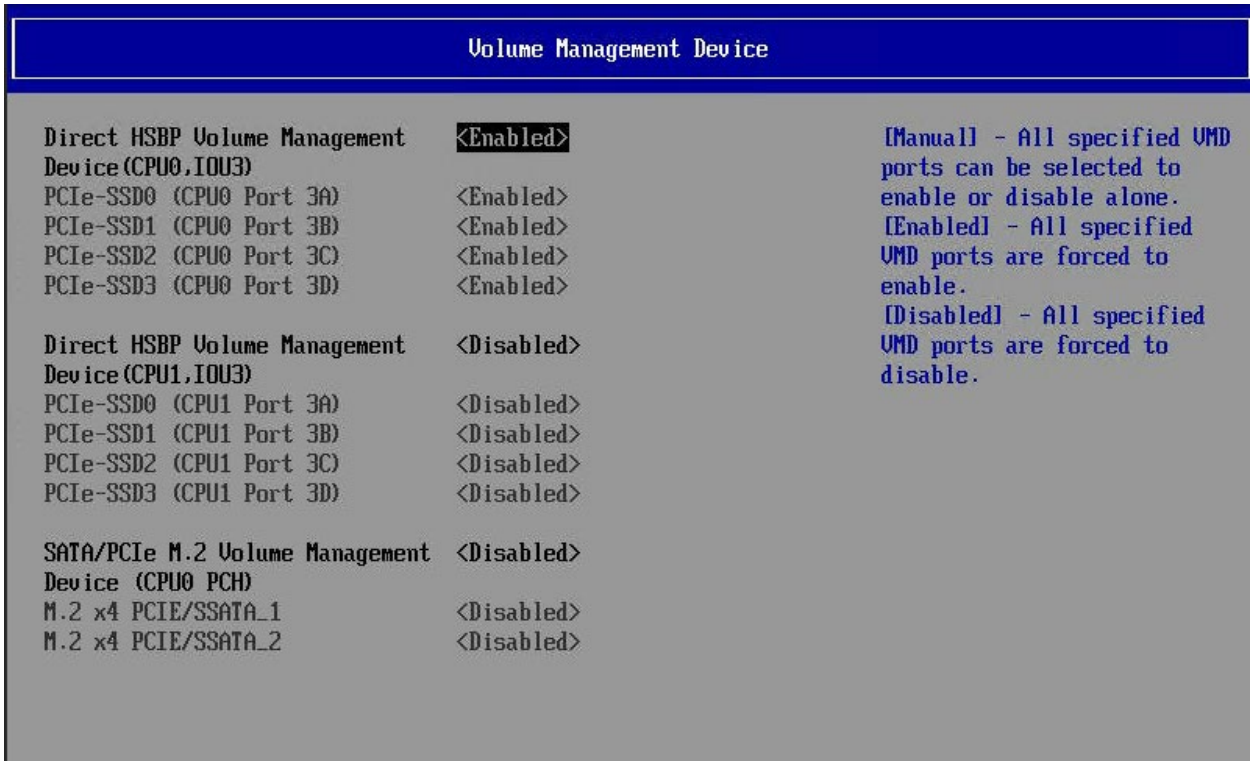

Figure 14. Direct HSBP Volume Management Device ports

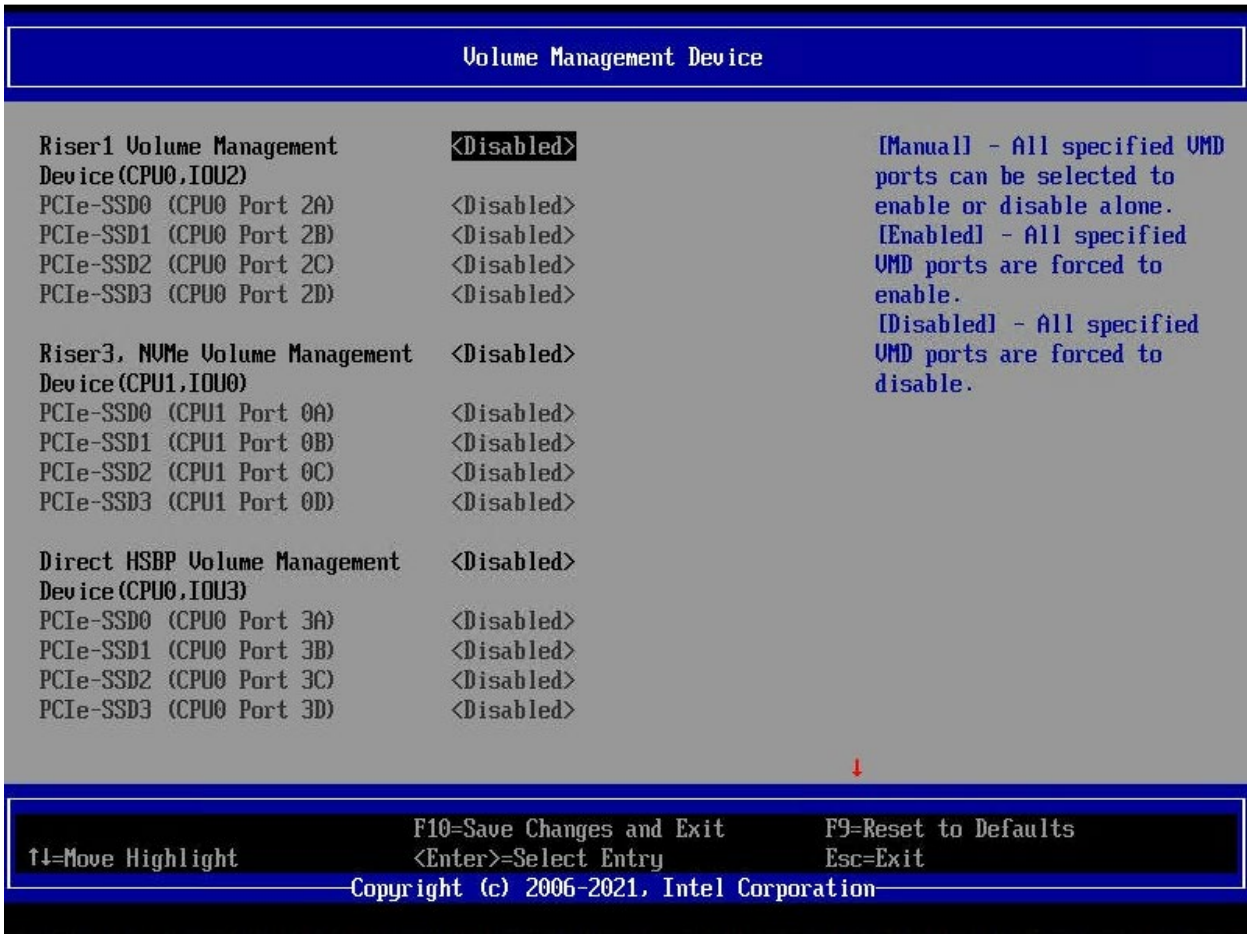

Figure 15. Riser Volume Management Device ports

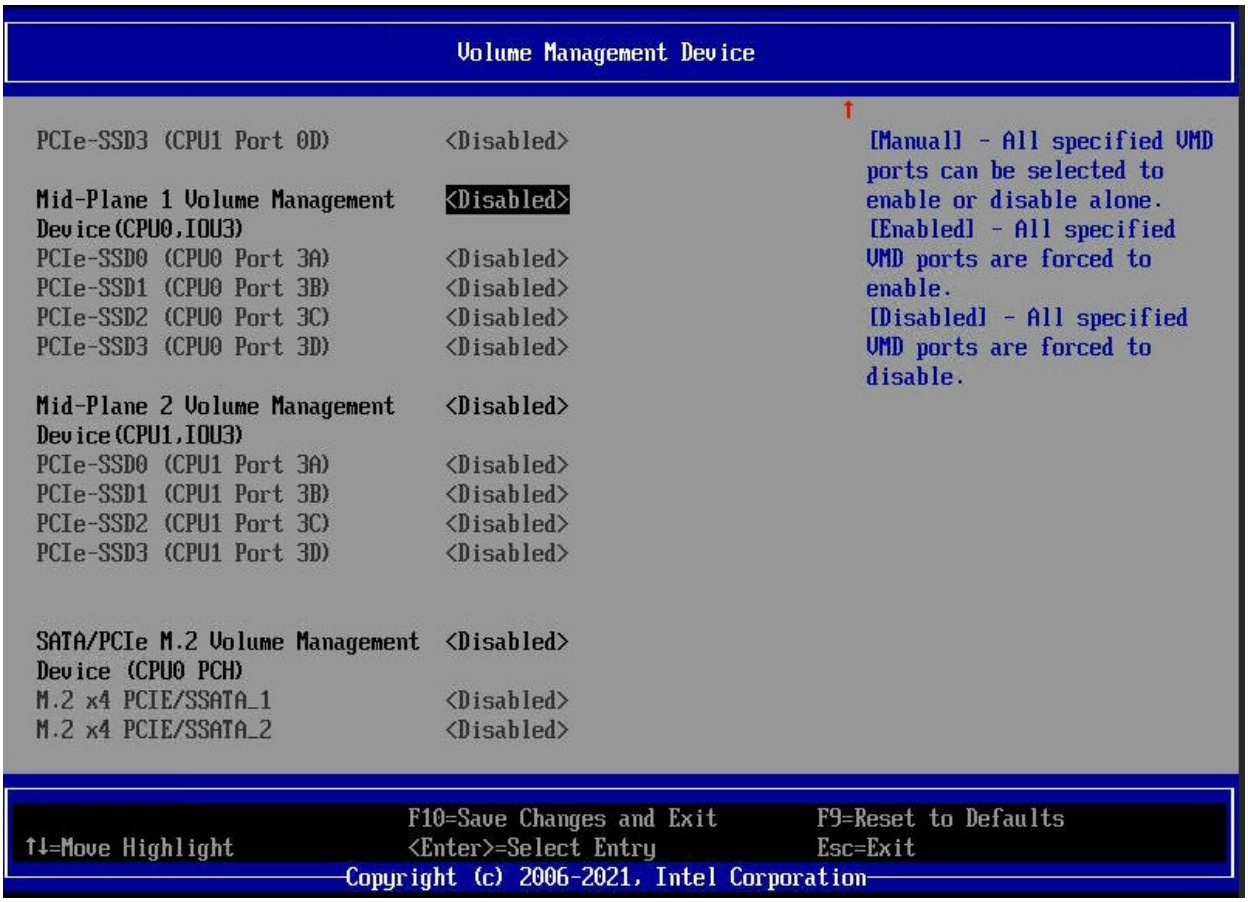

Figure 16.Mid-Plane switch Volume Management Device ports

Once the appropriate Intel® VMD ports are enabled, the system must be rebooted for the changes to take effect.

4. Creating Intel® VROC (VMD NVMe RAID) volumes

This section explains how to create RAID volumes using the Intel® VROC HII Configuration Utility. Intel® VROC RAID volumes can be used to store data and/or to install an operating system.

4.1 Accessing the Intel® VROC HII Configuration Utility

Intel® VROC HII is the utility used to create and manage RAID configurations using NVMe* drives in a pre-boot environment. The proper Intel® VMD ports must be enabled (and the system rebooted) to have the Intel® VROC HII visible (refer to section 3.2).

Access the HII configuration utility by entering BIOS Setup and selecting the following menu options in order:

1. Advanced
2. PCI Configuration
3. UEFI Option ROM Control
4. Intel® Virtual RAID on CPU

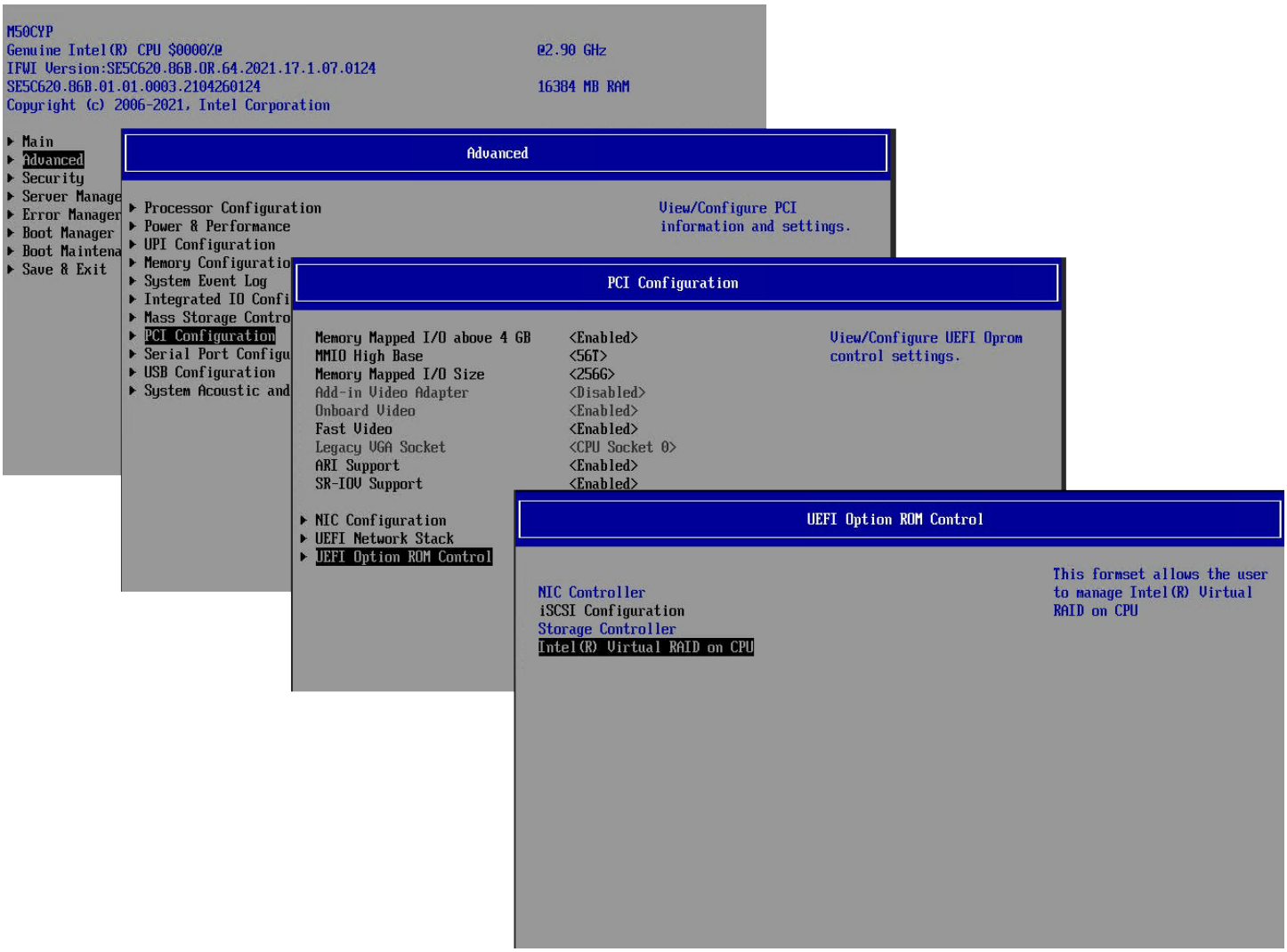

Figure 17. Steps to access the Intel® VROC HII configuration utility

4.2 Locate drives.

The ability to physically identify and replace a failed drive is critical in all RAID solutions, if for any reason, due to drive failure, the wrong drive is replaced, data loss can occur. The Intel® VROC HII Configuration Utility has an option to blink the drive's locate LED. It is a good practice to make sure that all the drives can be identified using the locate LED before continuing with the configuration, this way troubleshooting any failures is easier and safer. Follow the next instructions to locate each drive and make sure all of them can be physically identified.

1. Enter BIOS Setup, make sure the corresponding VMD ports are enabled.
2. Enter the Intel® VROC HII Configuration Utility.
3. Select "All VMD Controllers", the drive list should be visible.
4. Using the keyboard's down arrow, select the first drive in the list and press < Enter>. A menu will appear.
5. From the menu, select Locate LED and press <Enter>. Select "On" and press <Enter>. The drive's amber LED will start blinking.
6. Select "off" to stop the blinking.
7. Continue locating all the drives to make sure all work fine.

   See below screen showing the Locate LED option.

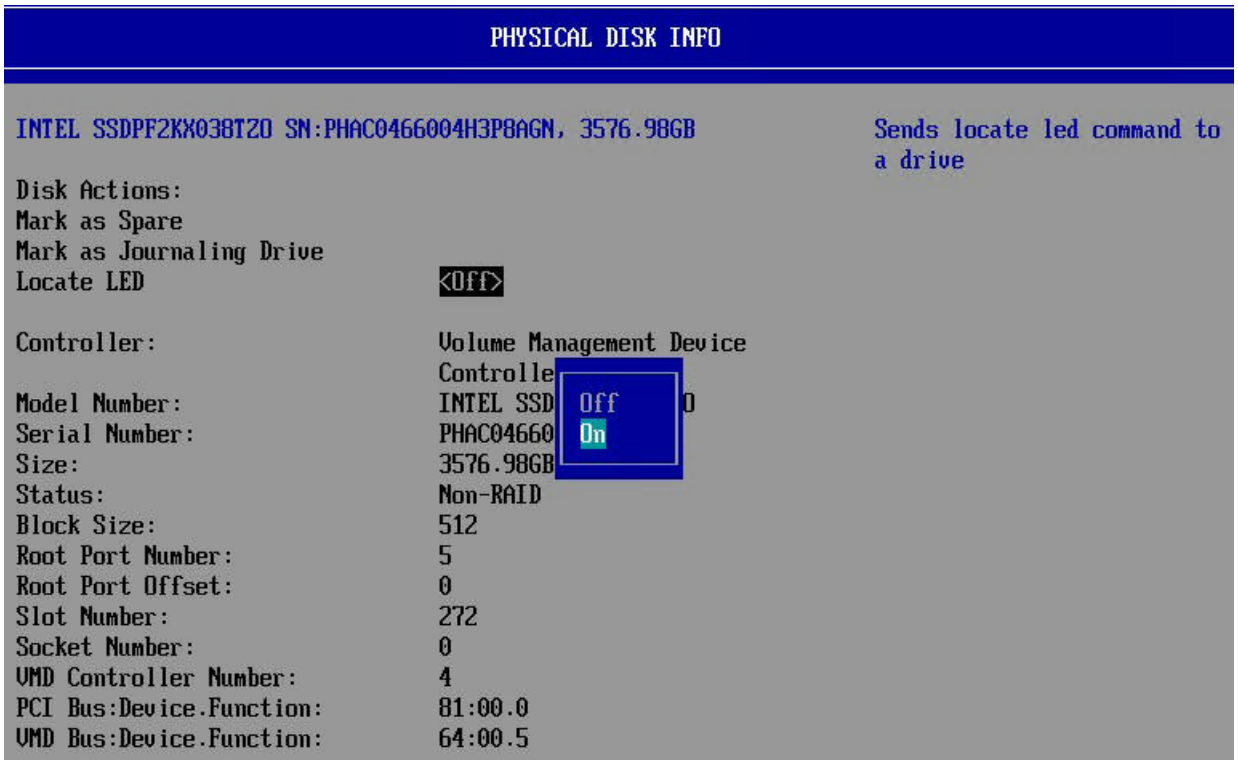

Figure 18. Locate LED option in HII

By locating the drives in sequence (top to down down), the drive numbering can be verified (left to right in the HSBP), the drive numbering must match, i.e. the first drive at the top of the screen must match the drive at the left of the HSBP and the last drive at the bottom of the screen must match the last drive at the right of the HSBP, similarly the drives in the middle, in sequence.

Note that the drive numbering is relative to the controller, and it doesn't necessarily match the drive position in the HSBP, i.e., a 24 bay HSBP can only be populated with 8 drives, and they can be in the middle of the chassis, or at the right, or at the left.

The following figure shows the amber LED that identifies the drive.

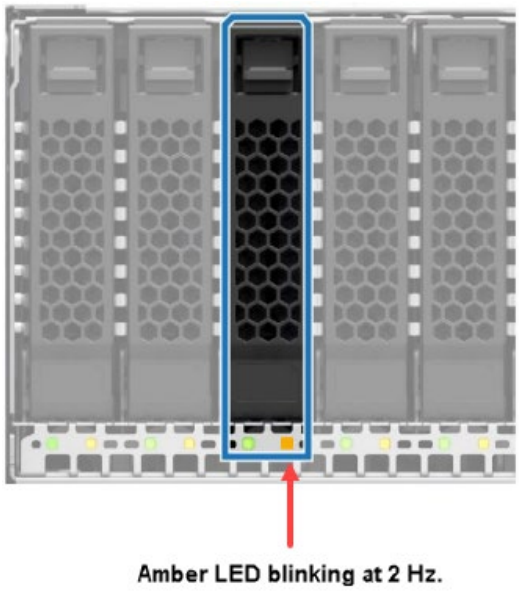

Figure 19. Locate LED

4.3 Creating RAID Volumes Using the Intel® VROC HII Configuration Utility

The following steps demonstrate the creation of RAID volumes within the Intel® VROC HII configuration utility:

1. Enter the HII VROC Configuration Utility.
2. The Intel® VROC HII main menu appears, showing the installed Upgrade Key and the configured Intel® VROC RAID volumes (if any).
3. Select **All Intel® VMD Controllers.** The Intel® VROC managed VMD menu will appear showing all Intel® VMD controllers with their corresponding NVME* drives.

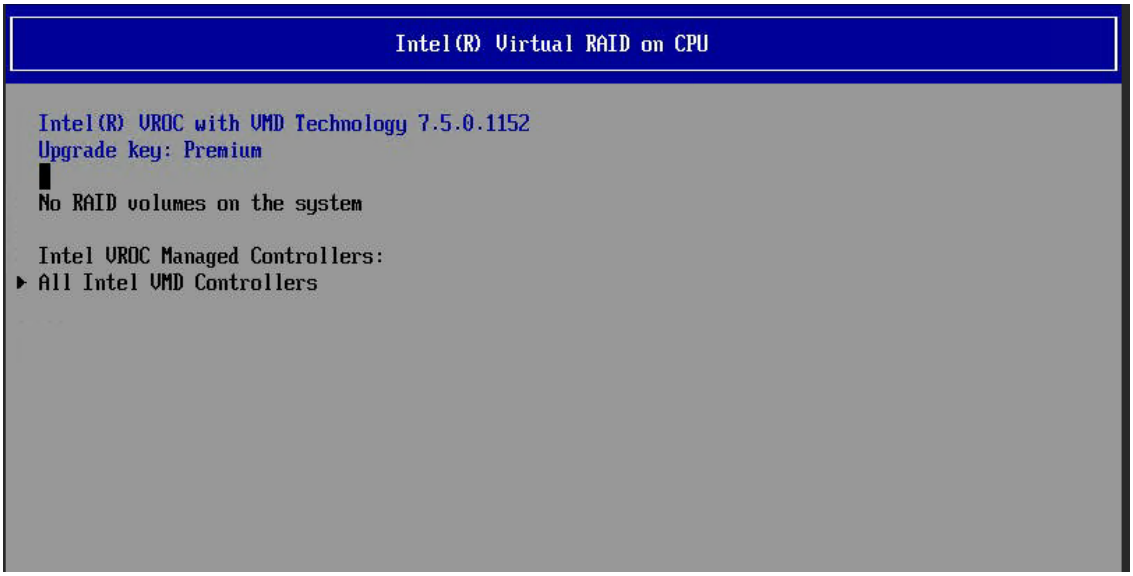

Figure 20. Intel® VROC Main menu

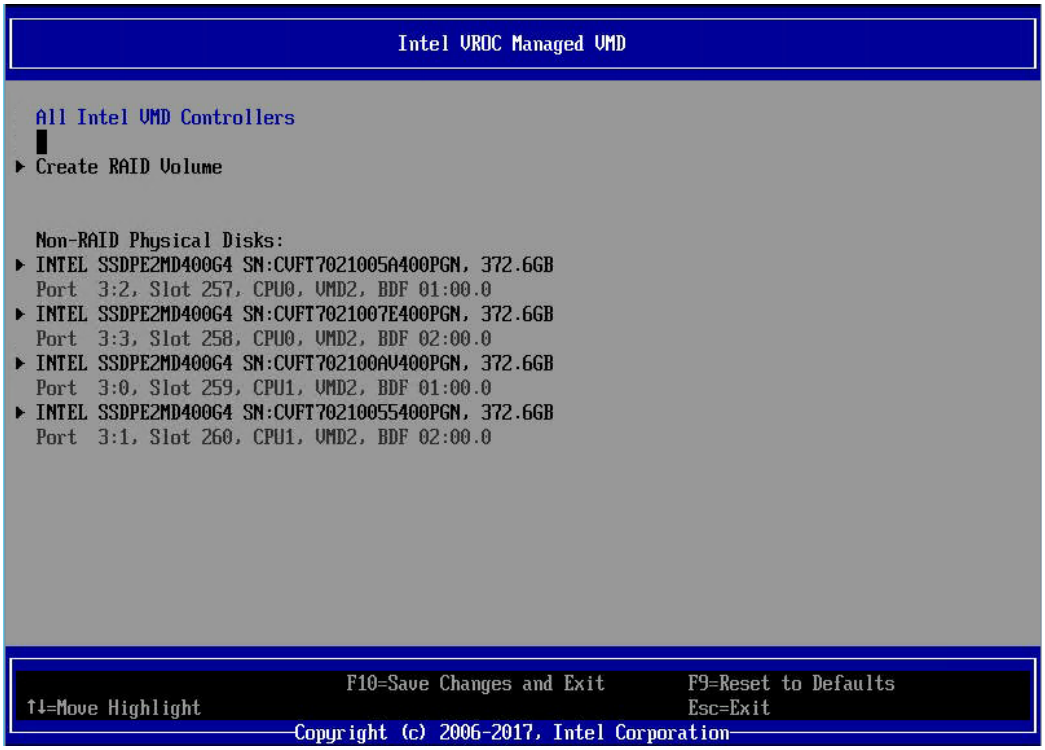

Figure 21. Intel® VROC Managed VMD menu

4. Select **Create RAID Volume.** The Create RAID Volume menu will appear.

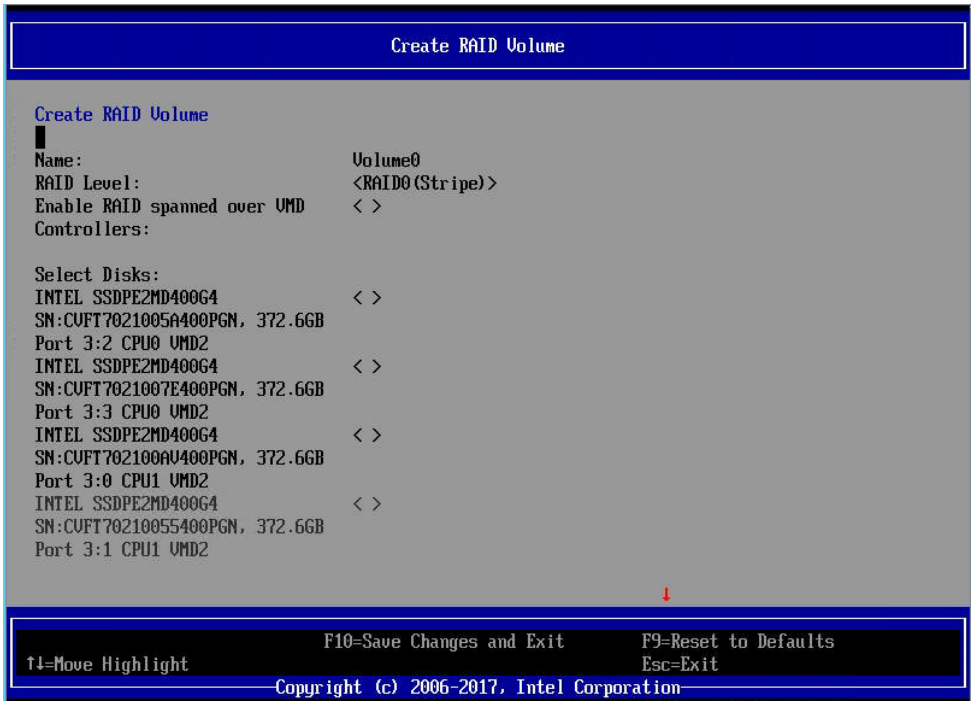

Figure 22. Create RAID Volume menu

5. Fill in the volume name (optional), then select the desired RAID level. Depending on the number of drives and upgrade key installed, the available options are:

    - RAID 0
    - RAID 1
    - RAID 10
    - RAID 5

Select whether to span drives across different VMD controllers, then select the drives that will be used for the chosen RAID level. The resulting capacity of the volume defaults to the maximum available for the selected drives but may be decreased by the user.

Note: Spanned RAID volumes cannot be made bootable.

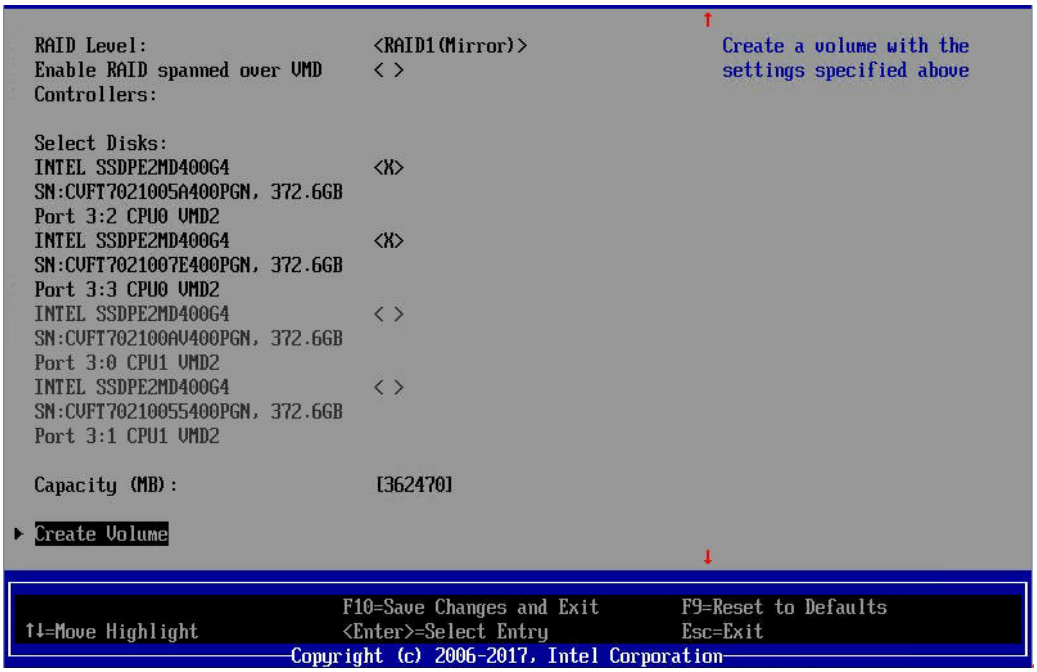

Figure 23. Completed Create RAID Volume menu

6. Once the required fields are populated, select **Create Volume**.
7. Once the RAID volume is created the Intel® VROC HII main menu displays the newly created volume.

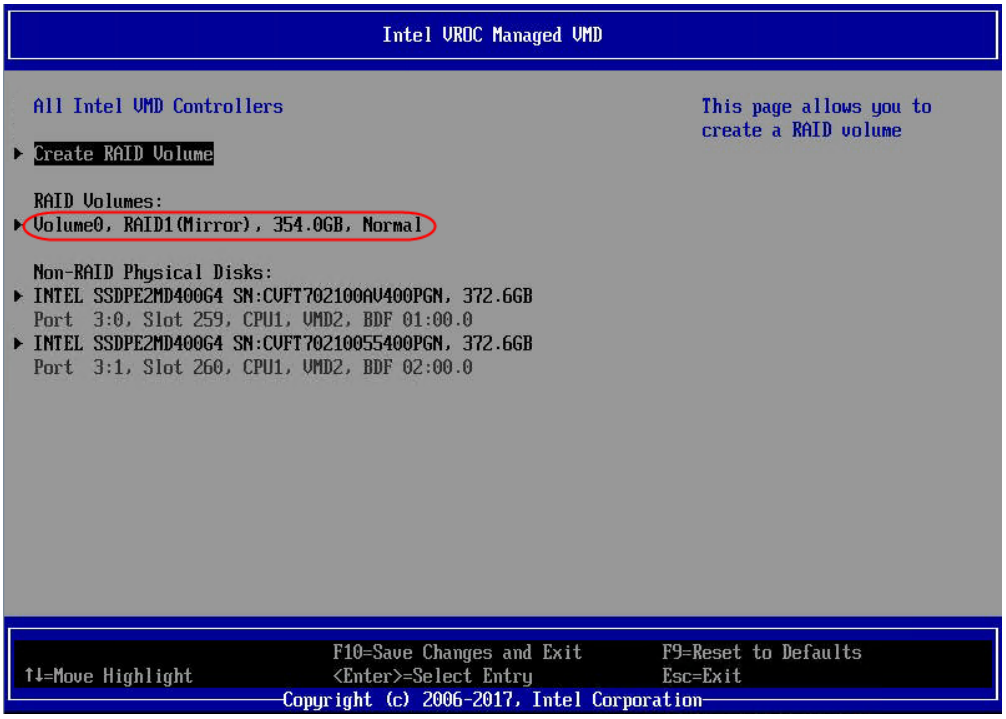

Figure 24. Intel® VROC Managed VMD menu

8. Exit the HII Configuration Utility by pressing **<F10>** and reboot. Then proceed to the Operating System installation.

Appendix A. Glossary

Term	Definition
NVMe*	Non-Volatile Memory Express*
Intel® VMD	Intel® Volume Management Devices
Intel® VROC	Intel® Virtual RAID on CPU
HII	Human Interface Infrastructure. It's the Configuration utility embedded in the system BIOS; it's used to manage VROC RAID configurations in a pre-boot environment.
PCH	Platform Controller Hub. An integrated circuit installed on the system server board that controls different support functions for the CPU, like clocking, Flexible Display Interface, Direct Media Interface, some I/O functions, etc.
SRIS	Separate Reference Clock with Independent Spread. Refers to a PCIe device using an independent clock signal.

Appendix B. Troubleshooting

Symptom	Suggested steps
NVMe drives not visible in VROC HII	1. VMD ports disabled. Make sure the corresponding VMD ports are enabled (refer to section 3.1) 2. NVMe drives not properly connected. Make sure the drives are visible (refer to section 2.6), if they still cannot be seen check cable connections and make sure the drives are compatible with the system.
Drive numbering incorrect	Check the cable order (refer to section 2.5)
Locate LED not working for some drives	Check the cable order (refer to section 2.5)
VROC GUI not launching	1. Make sure Microsoft .Net Framework Runtime version 4.8 is installed 2. Make Microsoft Visual C++ Redistributable version 2015-2019 is installed 3. Make sure the AHCI drivers from previous VROC versions (including RSTe) are uninstalled.
All VROC volumes disappear from the system	Make sure the corresponding VMD ports are enabled. By default, all VMD ports are disabled, if the system BIOS defaults are loaded, this behavior is expected. Enabling back the VMD ports will bring back all VROC volumes without any data loss.
Only RAID level 0 is available	Make sure the VROC RAID key is installed and fully inserted onto the server board, an AC cycle may be required after the installation.