User Manual

T0-RL50(RL50)



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MAXIMIZING YOUR COMPUTING PRODUCTIVITY

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Warning

1. Before using the product, carefully read the manual to ensure proper installation and operation.
2. If you are not ready to install any extension card, store it in an anti-static protective bag to prevent damage.
3. To discharge any static electricity, briefly touch a grounded metal object before removing the extension card from the protective bag.
4. Always wear anti-static gloves and handle the card by its edges to avoid damaging sensitive components.
5. Verify that the power supply voltage is correct before connecting the motherboard to the power supply.
6. To prevent electric shock or damage, always turn off the AC power or unplug the power cord before removing or reconfiguring the motherboard or any components.
7. Unplug the AC power cord from the outlet before relocating the motherboard or any components.
8. Ensure all power cords are unplugged before connecting or disconnecting any equipment to avoid electrical hazards.
9. Wait at least 30 seconds after powering off the system before powering it on again to prevent unnecessary wear.
10. If any issues arise during operation, consult a qualified professional for assistance.
11. This product may cause radio interference in certain environments; if necessary, users should take appropriate measures to mitigate such interference.

RL50(T0-RL50) User Manual

(English Version 1.0)

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NO.	Description	Issue Date:
V1.0	Initial Version (CN)	2024/10/13
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Chapter 1 Product Introduction

1.1 Brief Introduction

The T0-RL50 is a 4x4 small form factor PC featuring Intel® Alder Lake-P/H or Raptor Lake-P/H series processors. Combining innovative design with optimized performance, it delivers reliable, efficient computing for smart home setups, light gaming, office productivity, and a wide range of IoT applications.

1.2 Parameters

Processor: 12th/13th Generation Intel® Core™ Processors

CPU	Cores/Threads	Max Turbo Frequency (P-core/ E-core)	Cache	TDP
Intel® Core™ i5-1240P	12C/16T	4.4GHz/3.3GHz	12 MB	28W
Intel® Core™ i5-12450H	8C/12T	4.4GHz/3.3GHz	12 MB	45W
Intel® Core™ i7-13620H	10C/16T	4.9GHz/3.6GHz	24MB	45W

TDP:

- Intel® Core™ i5-1240P: Default 28 W TDP. Sustained power limit (PL1) and boost power limit (PL2) both set to 28 W.
- Intel® Core™ i5-12450H: Default 45 W TDP. PL1 and PL2 both set to 45 W.
- Intel® Core™ i7-13620H: Default 45 W TDP. PL1 and PL2 both set to 45 W.

Memory:

- Intel® Core™ i5-1240P/ i5-12450H: 2 × SO-DIMM DDR5-4800 MHz slots, dual-channel, up to 64 GB.
- Intel® Core™ i7-13620H: 2 × SO-DIMM DDR5-5200 MHz slots, dual-channel, up to 64 GB.

GPU: Integrated Intel® graphics with the following specifications

- Intel® Core™ i5-1240P: Intel® Iris® Xe Graphics eligible, max dynamic frequency 1.30 GHz.
- Intel® Core™ i5-12450H: Intel® UHD Graphics for 12th Gen processors, max dynamic frequency 1.20 GHz.
- Intel® Core™ i7-13620H: Intel® UHD Graphics for 13th Gen processors, max dynamic frequency 1.50 GHz.

Display Outputs:

- 1 × HDMI 2.0b (HDCP 2.3)
- 1 × DisplayPort 1.4
- 1 × Thunderbolt™ 4

Storage:

- 1 × M.2 Key M slot (labeled M.2_N1), supports 2280 NVMe SSD (PCIe 4.0).
- 1 × M.2 Key M slot (labeled M.2_N/S), supports 2280 NVMe SSD (PCIe 3.0) or SATA 3.0 SSD.

Expansion: 1xM.2 Key E slot (labeled M.2_E), supports 2230 Wi-Fi and Bluetooth modules (PCIE/USB2/CNVi).

USB Ports:

- **Front:**
  - 1 × USB Type-C (USB 3.2 Gen 2, up to 10 Gbps)
  - 2 × USB 3.2 Gen 2 Type-A (up to 10 Gbps)
- **Rear**:
  - 1 × Thunderbolt™ 4 (up to 40 Gbps)
  - 1 × USB 2.0 Type-A (up to 480 Mbps)

Ethernet: 1 × RJ45 port with Intel® i226 high-speed network controller. Speed: 2.5GbE(10/100/1000/2500Mbps).

Audio: Realtek ALC897 High-Definition Audio Codec, 1xCTIA Audio Jack, supports Line-out plus Mic-in.

Board Dimension: 120mm x 120mm
Enclosure Dimension: 135mm x 127mm x 52mm (LxWxH)
Cooling Method: Active Cooling
Operating Temp: 0°C to 50°C
Storage Temp: -20°C to 70°C
Power: 19V/20V DC-IN

Note!!! Power Supply Guidelines

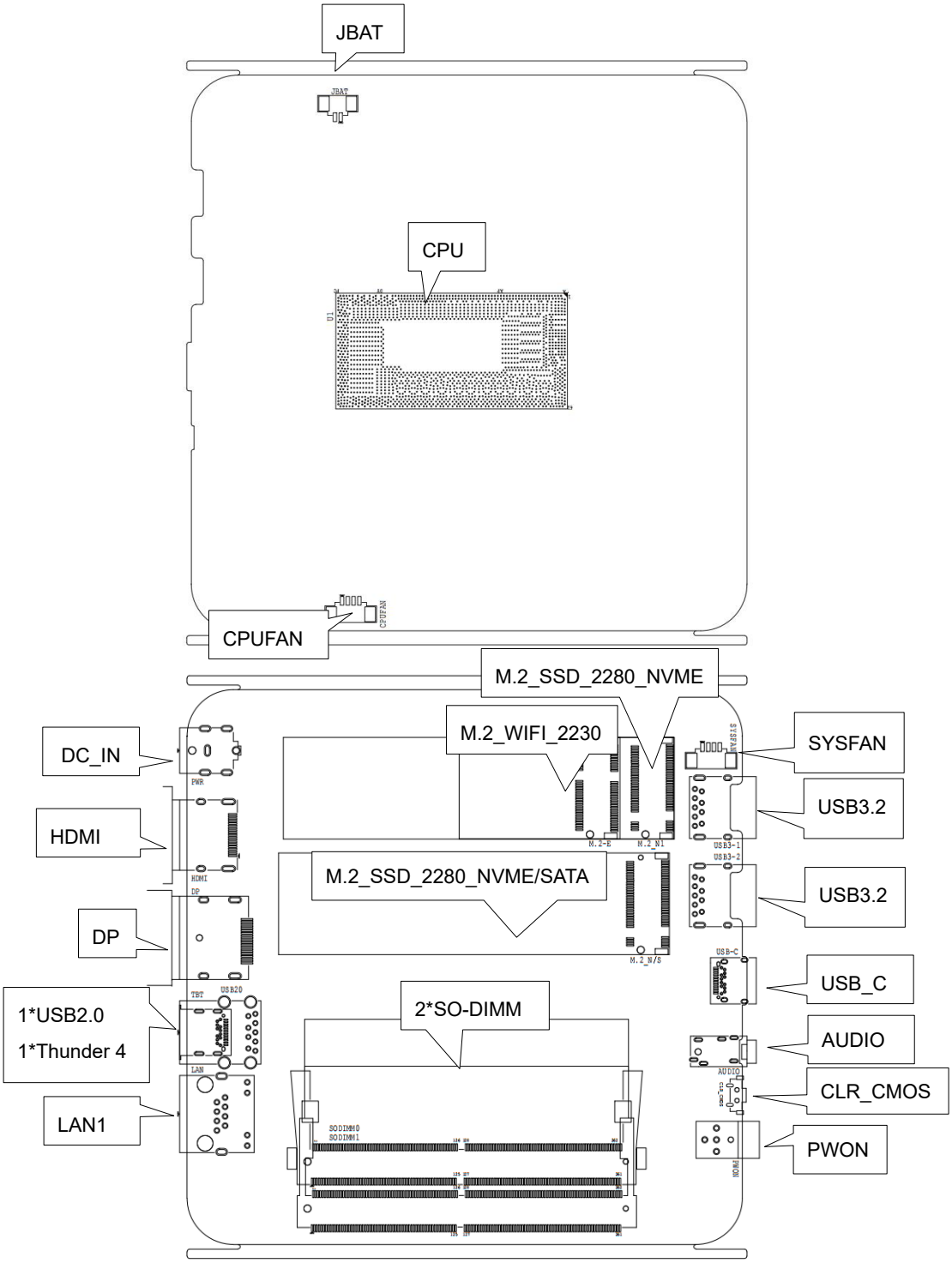
The DC power input and USB Type-C power input can be connected independently or simultaneously in any sequence. Both power sources must be rated at **90 W or higher**.

When both power inputs are active concurrently, **do not disconnect the DC power supply prior to the Type-C power supply** during shutdown or unplugging.

- Disconnecting the DC power input first will trigger the Type-C port's protective circuitry, disabling its power output.
- To re-enable power via the Type-C port, the Type-C power supply must be fully disconnected and reconnected to reset the protection mechanism.

1.3 Connector Diagram

RL50 Motherboard



1.4 I/O Interfaces

T0-RL50 Ultra-Compact Mini PC



Chapter 2 Hardware

2.1 Installations

Please refer to the following steps for installation:

1. Read the user manual carefully to make sure all the adjustments on the RL50 are correct.
2. Installing the Memory:
   - Press the ejector tab of the memory slot outwards with your fingertips.
   - Hold the memory module and align the key to the module with that on the memory slot.
   - Gently push the module into the slot until the ejector levers return completely to the closed position, holding the module in place when the module touches the bottom of the slot. To remove the module, press the ejector levers outwards to unseat the module.
3. Installing the expansion cards:
   - Locate the expansion slots and remove the screw, insert the cards into the slot at a 45-degree angle then attach the screw to the expansion cards, gently press down on it then install the screw back.
4. Connect all signal wires, cables, panel control wiring, and power supplies.
5. Start the computer and complete the setup of the BIOS program.

Attention!!!

The Motherboard's components are integrated circuits and can easily be damaged by Electrostatic Discharge or ESD; therefore, please follow the instructions:

- Hold the board's edge when handing, and do not touch onboard pins, components, or plug sockets.
- When touching integrated circuit components (such as CPU, RAM, etc.), please wear an anti-static wrist strap/glove to avoid electrostatic discharge damage to the board or other sensitive components.
- Before installing the integrated circuits/sensitive components, place the sensitive components in anti-static bags to keep them safe from ESD.
- Please make sure the power switch is OFF before plugging the power plug.

2.2 Jumper Setting

Please configure the jumpers according to your requirements before installing the hardware.

How to identify the first header of jumpers and pins: Observe the mark beside the jumper or pins and find the header marked by “1” or bold line or triangular symbol. Or observe the rear panel and the header with a square solder pad is the first header.

2.3 Memory Slots

The board provides two SO-DIMM DDR5 slots and supports dual-channel memory with a maximum capacity of up to 64 GB.

Note: When installing memory modules, carefully hold the module by its edges and align the notch (key) on the module with the key in the slot. Ensure that the selected memory module matches the board’s specifications to ensure optimal performance and compatibility.

2.4 Display Interfaces

The board provides multiple display interfaces, including one HDMI 2.0b port with HDCP 2.3 support,

one DisplayPort 1.4 output, and one Thunderbolt™ 4 port for high-speed video transmission.

2.5 Storage Interfaces

The board features 2xM.2 Key M slots for storage expansion. The first slot (labeled M.2_N1) supports 2280 NVMe SSDs with PCIe 4.0 interface, while the second slot (labeled M.2_N/S) supports 2280 NVMe SSDs via PCIe 3.0 or SATA 3.0 SSDs.

2.6 Expansion Slots

The board features 1x M.2 Key E slot (labeled M.2_E) for 2230 Wi-Fi and Bluetooth Modules (supports PCIe/USB2.0/CNVi).

2.7 USB Interfaces

The board provides multiple USB ports on both front and rear panels. On the front, there are two USB 3.2 Gen 2 Type-A ports (up to 10 Gbps) and one USB Type-C port supporting USB 3.2 Gen 2 speeds (up to 10 Gbps). The rear panel includes one USB 2.0 Type-A port (up to 480 Mbps) and one Thunderbolt™ 4 port, which supports data transfer up to 40 Gbps, display output, up to 15 W PD output, and up to 120 W PD input power.

2.8 LAN

The board features one RJ45 LAN interface powered by an Intel® i226 high-speed network controller, with a maximum data rate of 2.5 GbE. The LAN supports Wake-on-LAN (Magic Packet Wake-Up) and UEFI PXE network boot. To enable UEFI PXE boot, enter the BIOS setup and set IPv4 PXE Support to Enabled.

LED Status Indicators:

LI_LED Status (Green)	Function	ACT_LED Status (Orange)	Function
Always on	Network Connected	Flashing	Data transmission

2.9 Audio Interface

The system features the Realtek ALC897 HD Audio Codec, delivering high-fidelity audio through a 3.5mm CTIA-compliant combo jack (Line-out/Mic-in).

Two-in-one (CTIA) Audio Jack:



2.10 Board Power Supply (PWR)

The board supports power input via a 19V or 20V DC adapter, using a standard barrel connector with dimensions of 5.5mm outer diameter and 2.5mm inner diameter. The power adapter must deliver stable DC voltage within this range to ensure reliable system operation and protect against potential damage. Proper polarity and connector specifications must be observed to maintain safe and optimal performance.

2.11 Power Button (PWON)

The board is equipped with a dedicated power switch button featuring an integrated blue LED indicator. The LED illuminates when the system is powered on.

2.12 CPU Fan Socket/System Fan Socket (CPUFAN/SYSFAN)

The board provides a 5V CPU fan socket (labeled CPUFAN) and an optional 5V system fan socket (labeled SYSFAN). Both sockets share the same pin configuration as detailed below:

CPU Fan Socket (Screen Printing: CPUFAN)

Pin	Signal
1	GND
2	VCC
3	TAC
4	CTL

SYSTEM Fan Socket (Screen Printing: SYSFAN)

Pin	Signal
1	GND
2	VCC
3	TAC
4	CTL

2.16 CMOS Clearance/Retention (CLR_CMOS)

CMOS is powered by onboard button batteries. Clearing CMOS will permanently remove the previous system settings and restore the board system to original settings (factory settings).

Step 1: Turn off the PC and disconnect the power.

Step 2: Press CLR_CMOS for 15 seconds then disconnect.

Step 3: Restart the device, press the <DEL> button to enter the BIOS, load the optimal default value, save, and exit the settings.

COMS (Screen Printing: CLR_CMOS)

Setting	Function
Close	Clear COMS

⚠ **Attention!!!** Do not clear the CMOS while the computer is powered on, as this may damage the motherboard.

Chapter 3 BIOS Setup

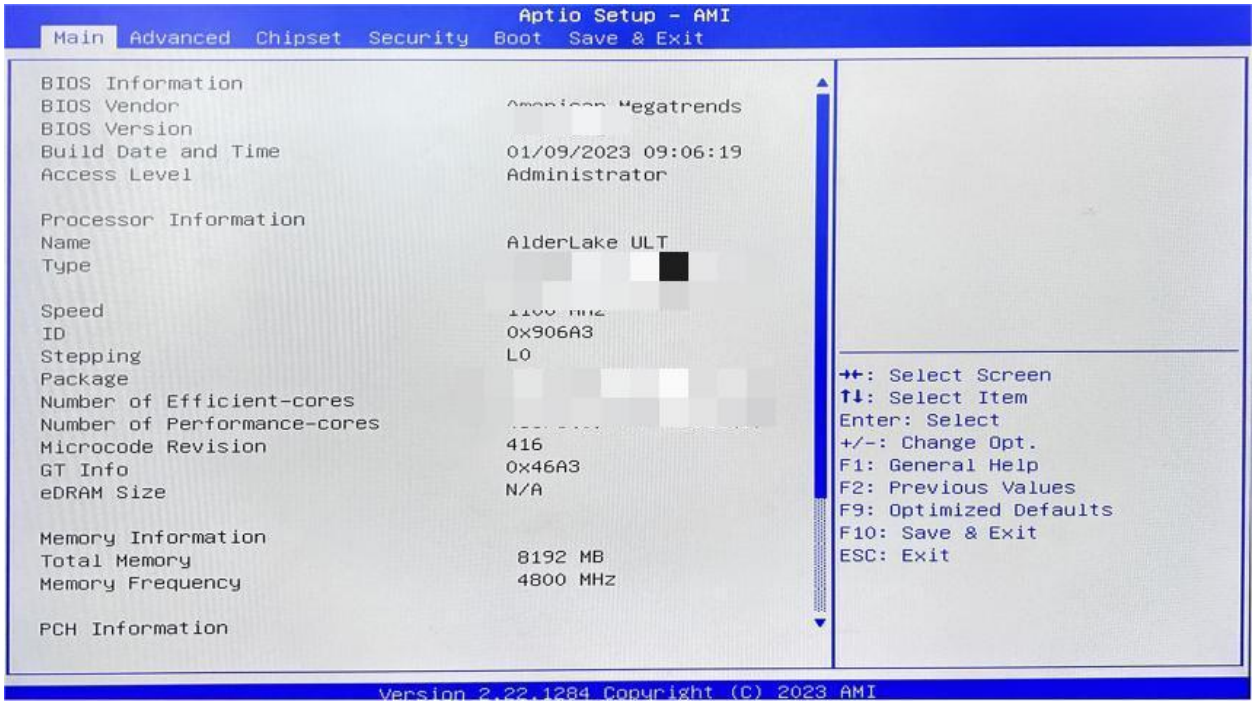
3.1 Entering the BIOS

1. Turn on the computer and press <Delete> entering the BIOS
2. BIOS Hotkey Functions:

Key	Function	Description
→←	Select Screen	Navigate between menu screens.
↑↓	Select Item	Move between menu items or options.
Enter	Select	Open a submenu or confirm a selection.
+/-	Change Option	Adjust values or change settings.
F1	General Help	Display help information for the selected item.
F2	Previous Values	Load the previously saved settings.
F9	Optimized Defaults	Restore factory default settings.
F10	Save & Exit	Save changes and exit BIOS.
ESC	Exit	Exit BIOS or return to the previous menu.

3.2 Main Setup (BIOS info, Date, Time)

When you enter the BIOS Setup utility, the first things you will encounter is the Main Setup screen. Below is shown on the Main BIOS Setup screen. You can always return to the Main setup by selecting the Main tab.



BIOS Vendor: American Megatrends

BIOS Version: Displays the current BIOS version.

Build Date & Time: Shows the BIOS build date and time.

Processor Information: Displays CPU details.

Total Memory: Indicates the total installed system memory.

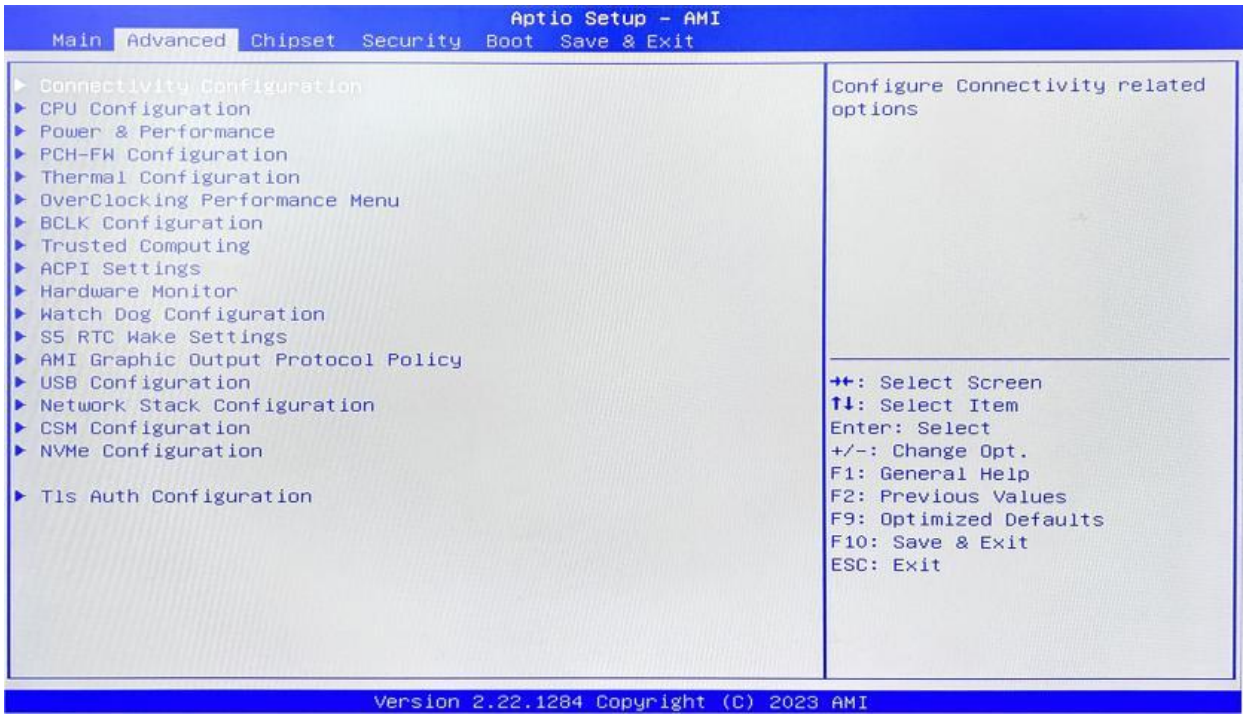
Memory Frequency: Displays the operating memory frequency.

ME FW Version: Shows the Management Engine (ME) firmware version.

System Date: Sets the system date in **MM/DD/YYYY** format.

System Time: Sets the system time in **HH:MM:SS** format.

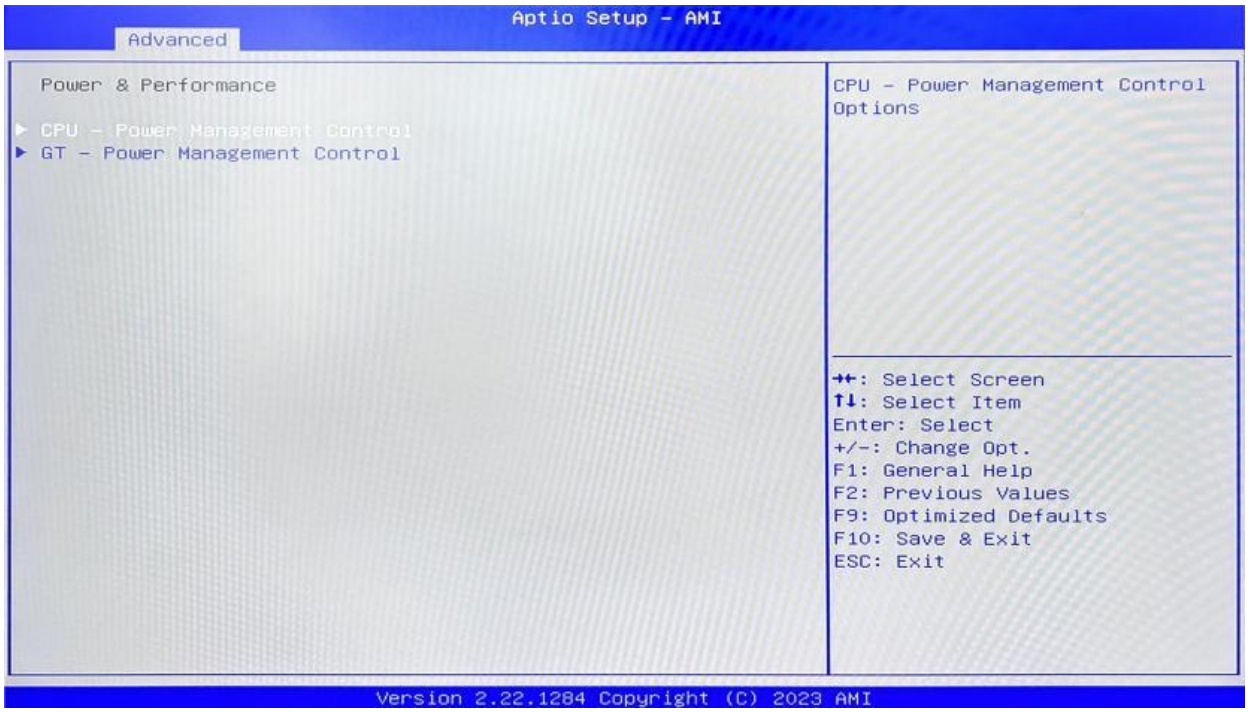
3.3 Advanced Settings



Select any of the items in the left frame of the screen. The advanced sections allow you to configure, improve and set up system features according to the preference of the CPU Configuration. All Advanced BIOS Setup options are described as follows.

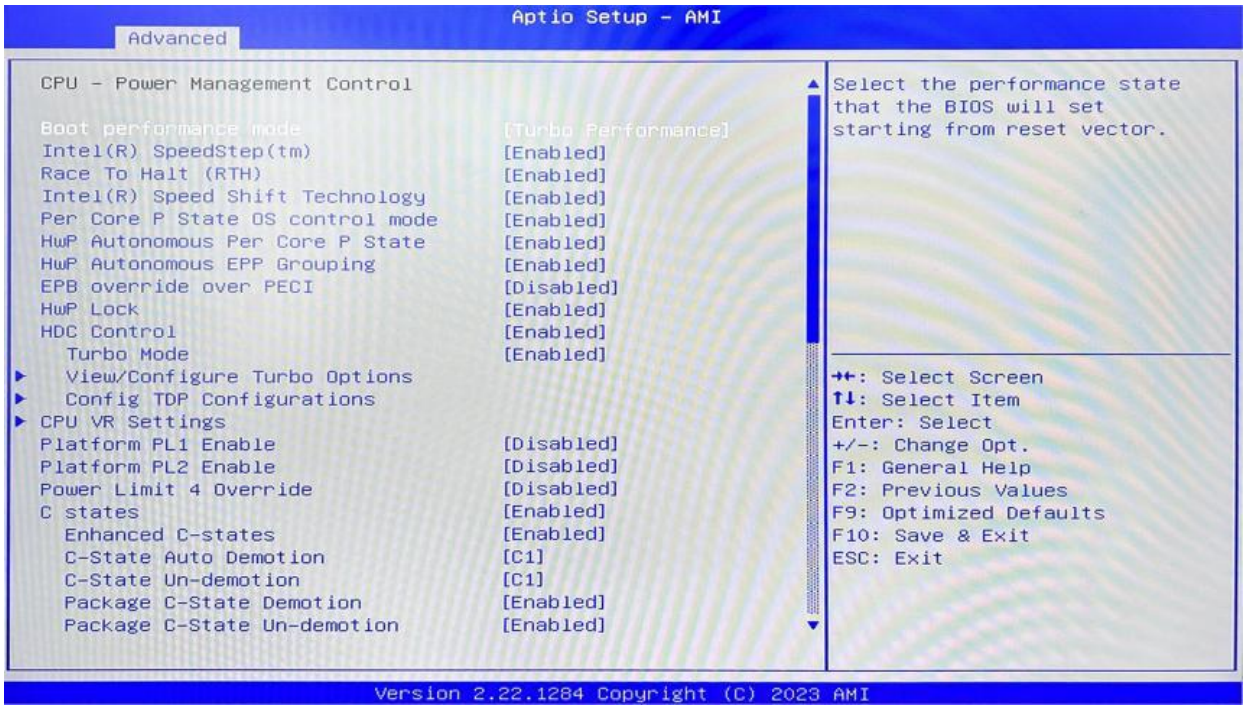
1. Connectivity Configuration: Connection Configuration
2. CPU Configuration: CPU Parameter Information and Common Settings Selection
3. Power & Configuration: Power & Configuration
4. System Agent (SA) Configuration: System Agent (SA) Configuration
5. PCIE Configuration: PCIE Configuration
6. PCH-IO Configuration: PCH-IO Configuration
7. PCH-FW Configuration: PCH Firmware Configuration
8. Thermal Configuration: Thermal Configuration
9. Trusted Computing: Trusted Computing
10. Super IO Configuration: Super IO Configuration
11. Hardware Monitor: Hardware Monitor
12. Watchdog Configuration: Watchdog Configuration
13. HDMI HPD Lock Configuration: HDMI HPD Lock Configuration
14. Timer Switch On/Off Setting: Timer Switch Setting
15. S5 RTC Wake Settings: S5 RTC Wake Settings
16. AMI Graphic Output Protocol Policy: AMI Graphic Output Protocol Policy
17. USB Configuration: USB Configuration
18. Network Stack Configuration: Network Stack Configuration
19. NVMe Configuration: NVMe Configuration
20. TLS Auth Configuration: TLS Auth Configuration

3.3.1 Power & Performance



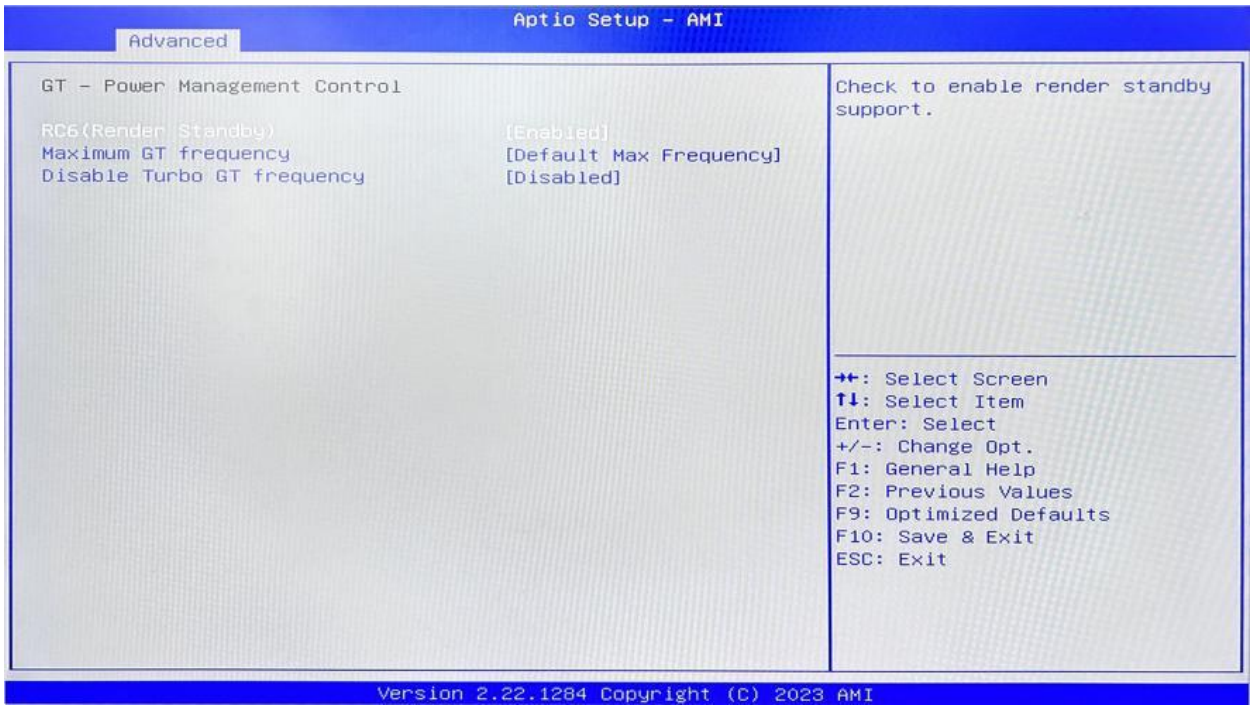
1. CPU-Power Management Control
2. GT-Power Management Control

3.3.2 CPU-Power Management Control



1. **Intel® Speedstep®(TM):**
   Enhanced Intel SpeedStep® Technology enables the operating system to control multiple frequencies and voltage points for optimal performance and power efficiency.
2. **Intel® Speed Shift Technology:**
   An energy-efficient frequency control method by the hardware rather than relying on OS control. Processor decision is based on the different system constraints for example Workload demand, and thermal limits while taking into consideration the minimum and maximum levels and activity window of performance requested by the operating system. Default enabled.
3. **Turbo Mode**
   The Turbo mode refers to Nehalem's "Integrated Power Gate" power management technology, which allows running off some cores and adding power to the others so that they run at a higher frequency. The capacity of the entire CPU remains unchanged, and the efficiency of the CPU is optimized. Default enabled.
4. **C states**
   Idle States (C-states) are used to save power when the processor is idle. C0 is the operational state, meaning that the CPU is doing useful work 100% load. C1 is the first idle state, C2 the second, and so on, where more power-saving actions are taken for numerically higher C-states. C1 to C3 cuts off the clock inside the CPU, and C4 to C6 reduces the CPU voltage. Default enabled.
5. **Enhanced C states**
   C1 to C3 cuts the clock inside the CPU. C4 and C6 mode reduces CPU voltage. Features two way "Enhanced" mode, enable by default.

3.3.3 GT-Power Management Control



RC6(Render Standby)：

(Standby)Enable/disable integrated graphics standby, default Enabled.

MC6(Media Standby)：

(Standby)Enable/disable Media standby, default Enabled.

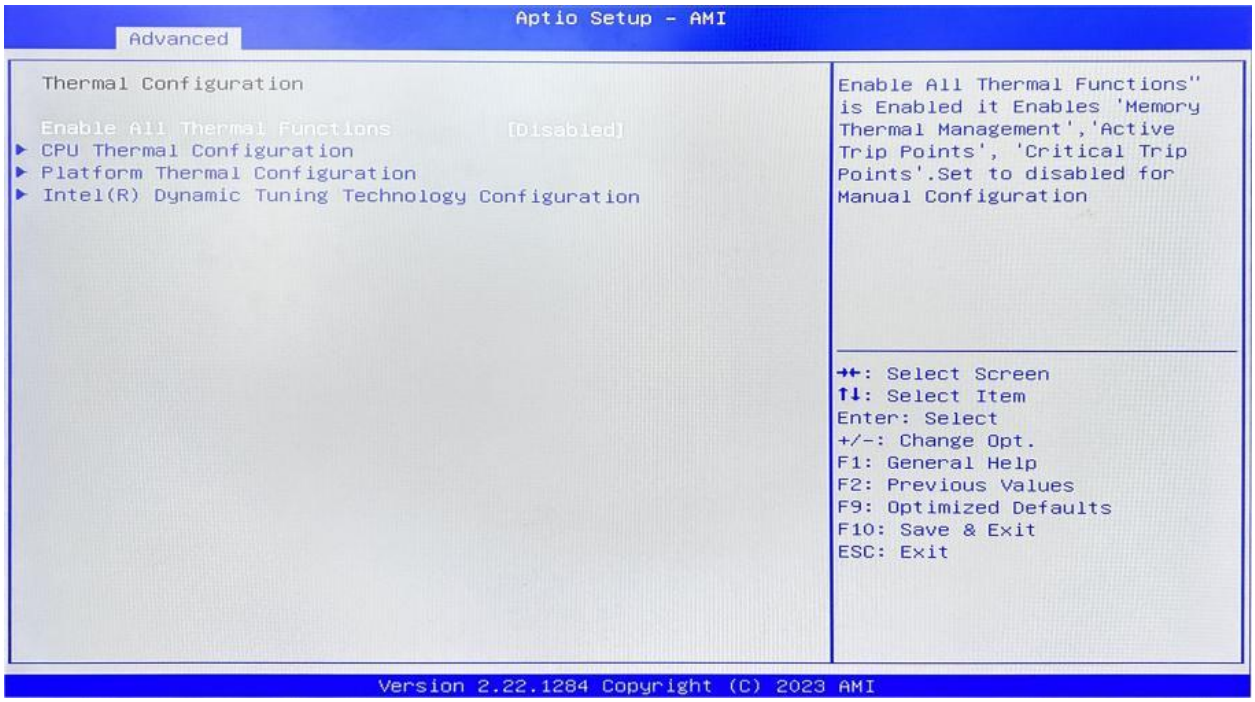
Maximum GT frequency：

Maximum GT Frequency, Default max frequency.

Disable Turbo GT frequency：

Disable Turbo GT Frequency mode, Default disabled.

3.3.4 Thermal Configuration



Enable All Thermal Functions

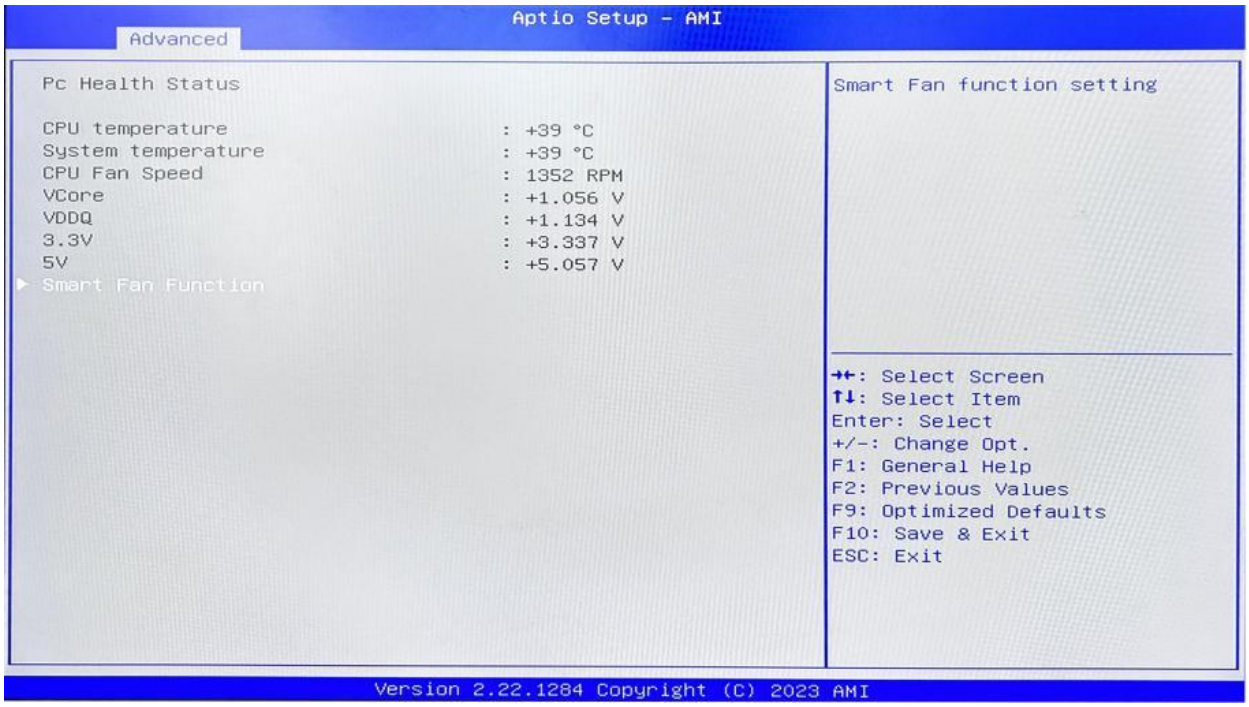
CPU Thermal Configuration:

Unlocks the temperature setting, the “Tcc Activation Offset” is the temperature adjustment option, the highest temperature is 100°C. Change the temperature by minus the number of degrees you wish to change. For example, minus 0(100-0) to set the temperature at 100°C, minus 20(100-20) to set the temperature at 80°C. (Please note the maximum supported temperature for the processor can be found on ark.intel.com.)

Platform Thermal Configuration

Intel(R) Dynamic Tuning Technology Configuration

3.3.5 Hardware Monitor



PC Health Status

The PC health status displays CPU temperature, system temperature, fan speed, and other relevant voltage values. The above parameters have a certain range, and the system cannot run beyond these ranges.

1. System Temperature
2. CPU Temperature
3. CPU Fan Speed
4. System Fan Speed
5. V3.3_S: 3.3V
6. V5.0S: 5V
7. Smart Fan Function:
    i. Automatic Mode
    ii. Full on Mode
    iii. Manual Mode

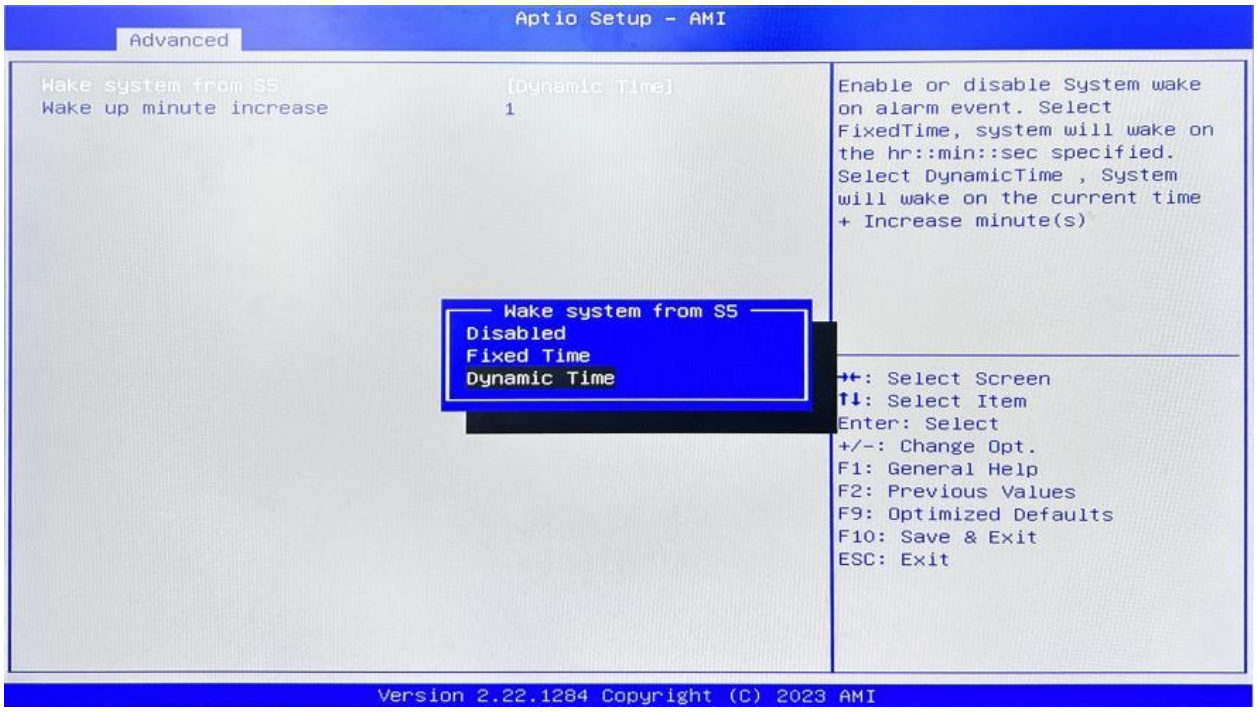
3.3.6 Watch Dog Configuration



Watch Dog Configuration

WDT Timeout Mode select: Minute or Second

3.3.7 S5 RTC Wake Setting

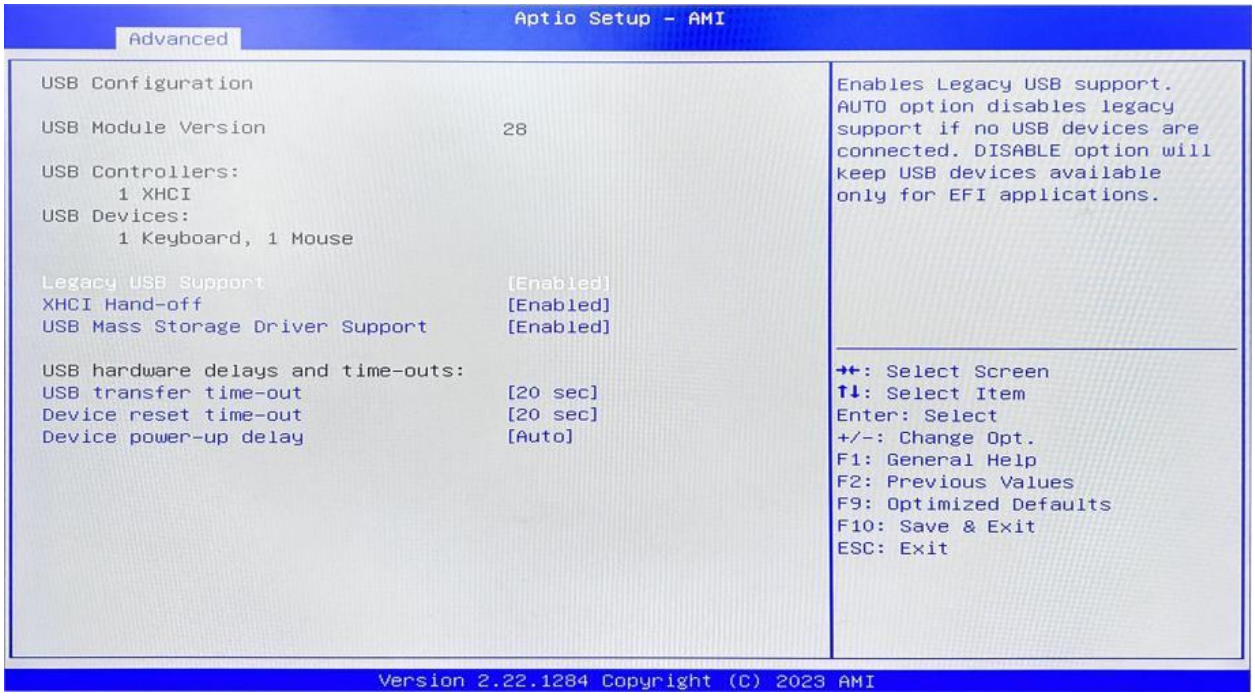


Wake system From S5: timing boot settings, disabled by default.

Fixed Time: Select Fixed Time and the system will wake on the Hr: Min: Sec specified.

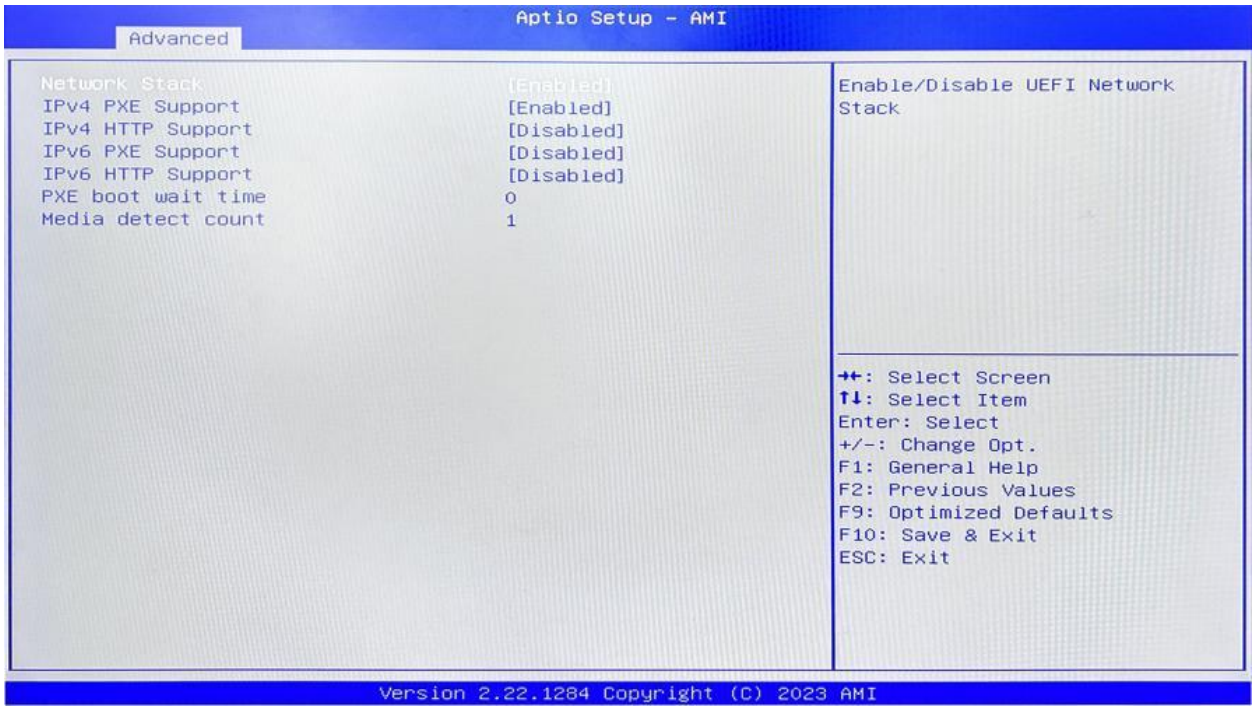
Dynamic Time: Select Dynamic Time and the system will wake on a dynamic time.

3.3.8 USB Configuration



1. **Legacy USB Support**
   a) Enable Legacy USB support. Disables legacy support if no USB devices are connected. Select enable will keep USB devices available under UEFI's support.
2. **XHCI Hand-off**
   a) A workaround for OS without XHCI hand-off support. The XHCI ownership change should be claimed by the USB XCHI driver.
3. **USB Mass Storage Driver Support**
   a) Enable(default) or disable USB Mass Storage Driver Support.
4. **USB transfer time-out**
   a) Time-out value for control, bulk, and interrupt transfers, default time:20 second.
5. **Device reset time-out**
   a) USB mass storage device starts unit command time-out, default time:20 second.
6. **Device Power-up Delay**
   a) Maximum time the device will take before it properly reports itself to the host controller.

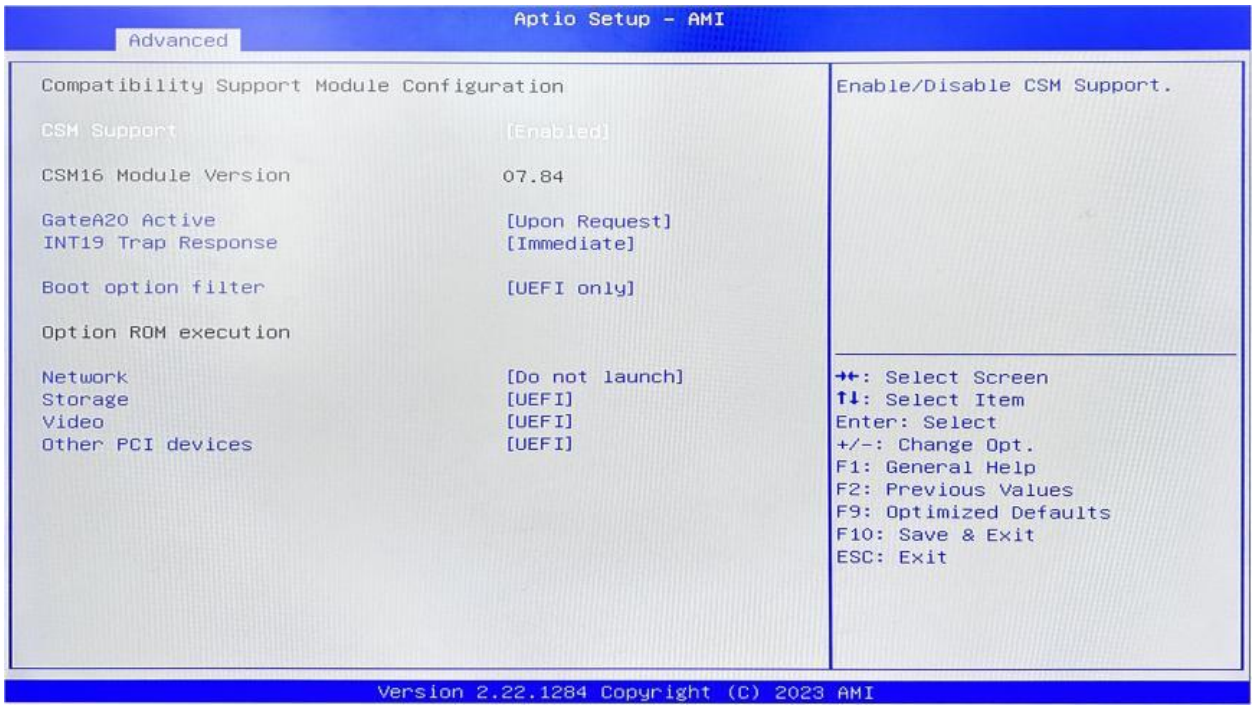
3.3.9 Network Stack Configuration



Network Stack

PXE Network boot setting, disabled by default.

3.3.10 CSM Configuration



Boot Option Filter: Configure boot options for the system.

Option ROM Execution:

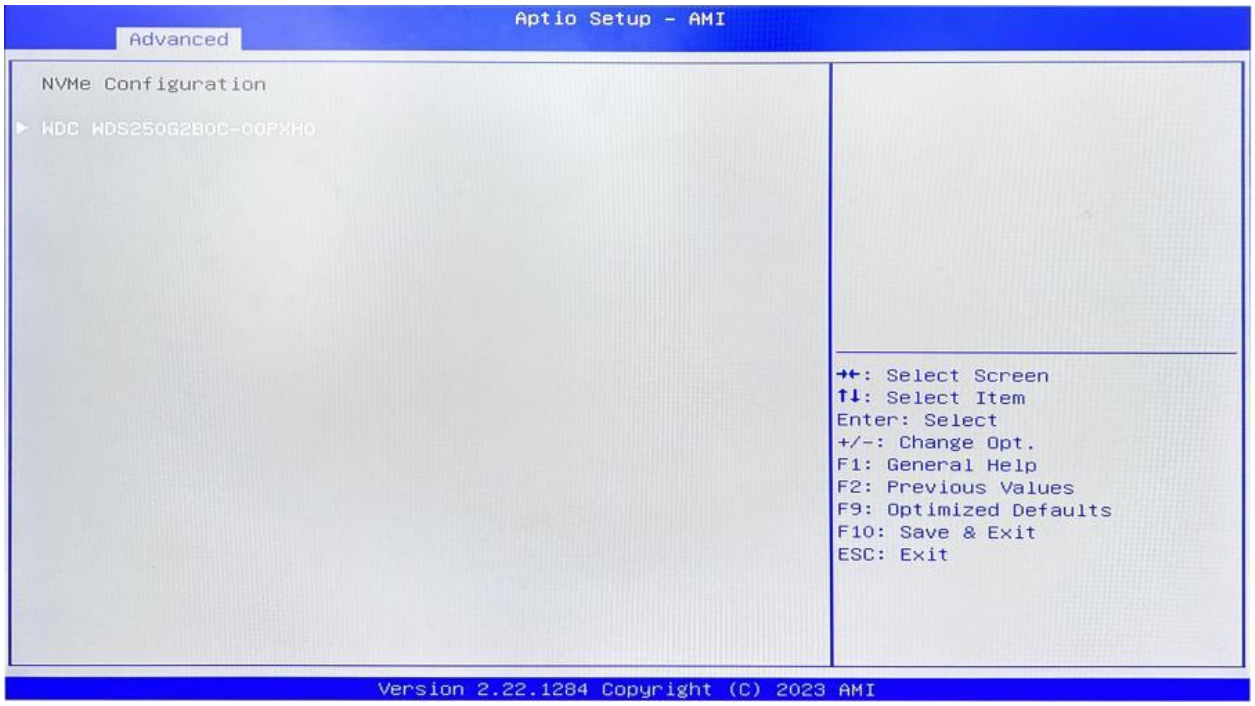
Network: Network Option ROM execution.

Storage: Storage Option ROM execution.

Video: Video Option ROM execution.

Other PCI Devices: Option ROM execution for other PCI devices.

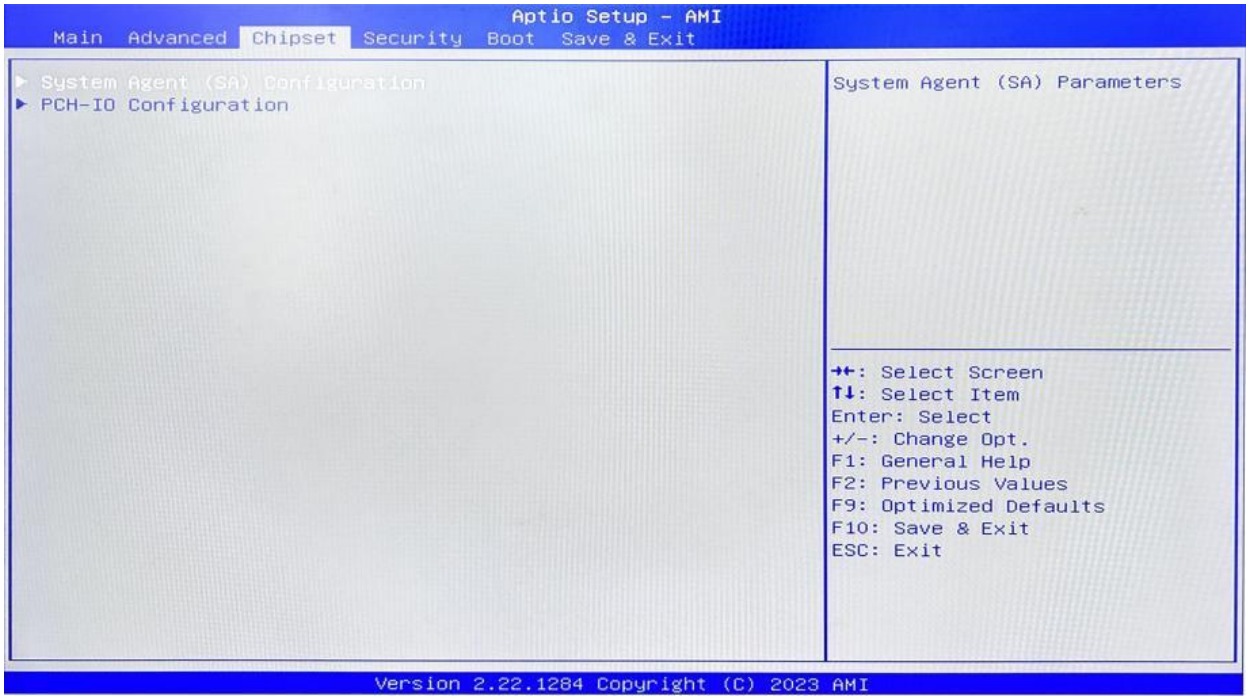
3.3.11 NVME Configuration



The capacity and model of the SSD will be displayed under the option after the NVMe protocol SSD has been installed.

3.4 Chipset

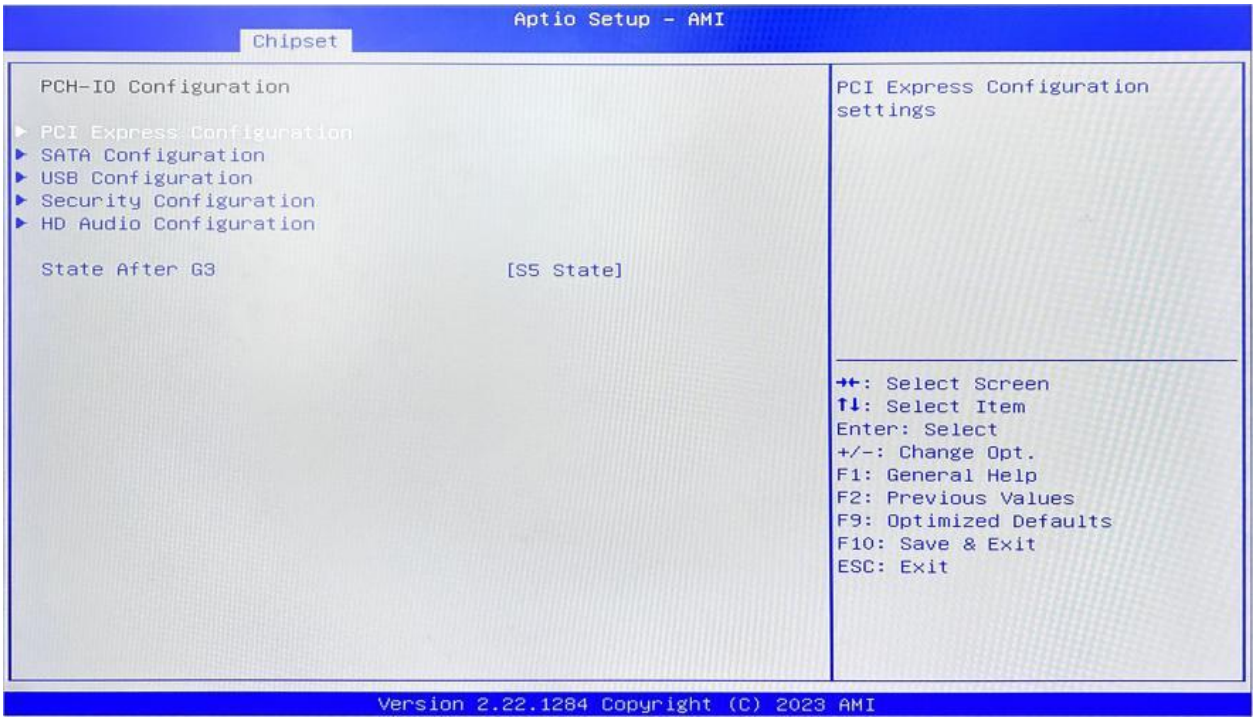
Select the chipset tab from the setup screen to enter the chipset BIOS Setup screen.



System Agent (SA) Configuration: Northbridge configuration options, including video memory, display devices, and other options.

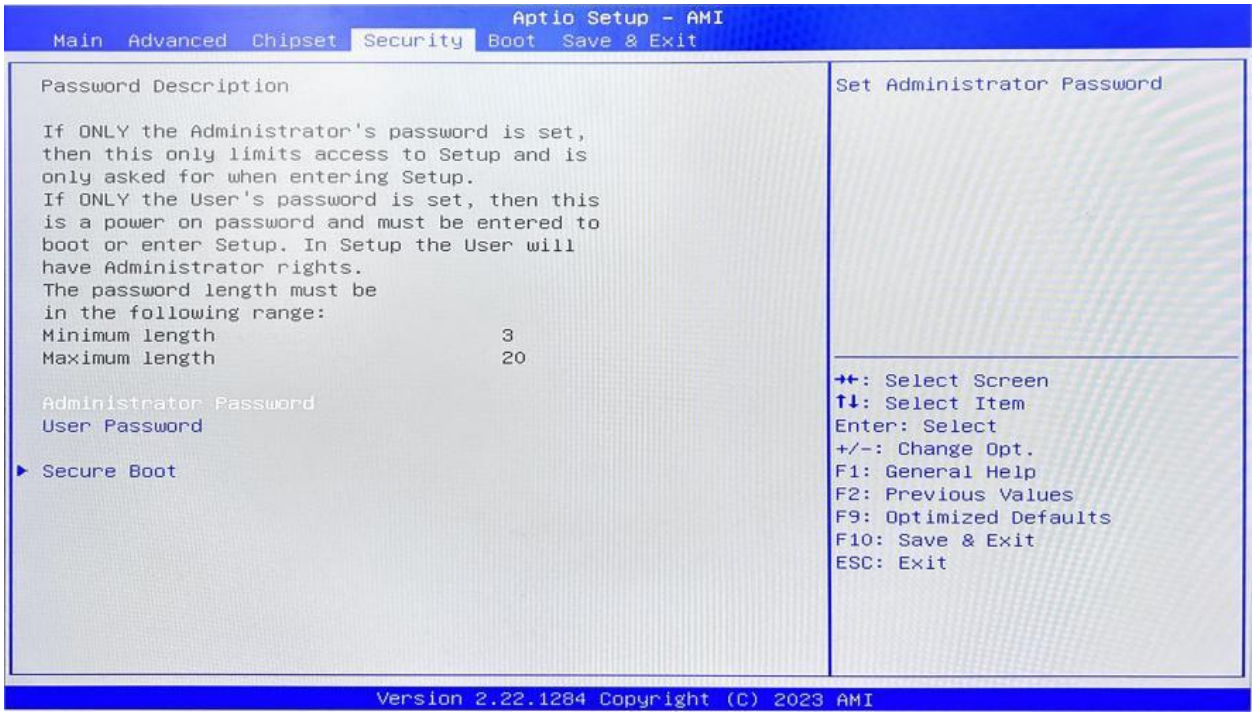
PCH-IO Configuration: Southbridge configuration options, including hard disk, audio codec and other options.

3.4.1 PCH-IO Configuration



1. **PCI Express Configuration**
2. **SATA Configuration**
3. **USB Configuration**
4. **Security Configuration**
5. **HD Audio Configuration**
6. **State After G3:**
   i. S0 State: Power-on self-start (system powers on automatically).
   ii. S5 State: Power-off state (system powers on but does not boot).

3.5 Security

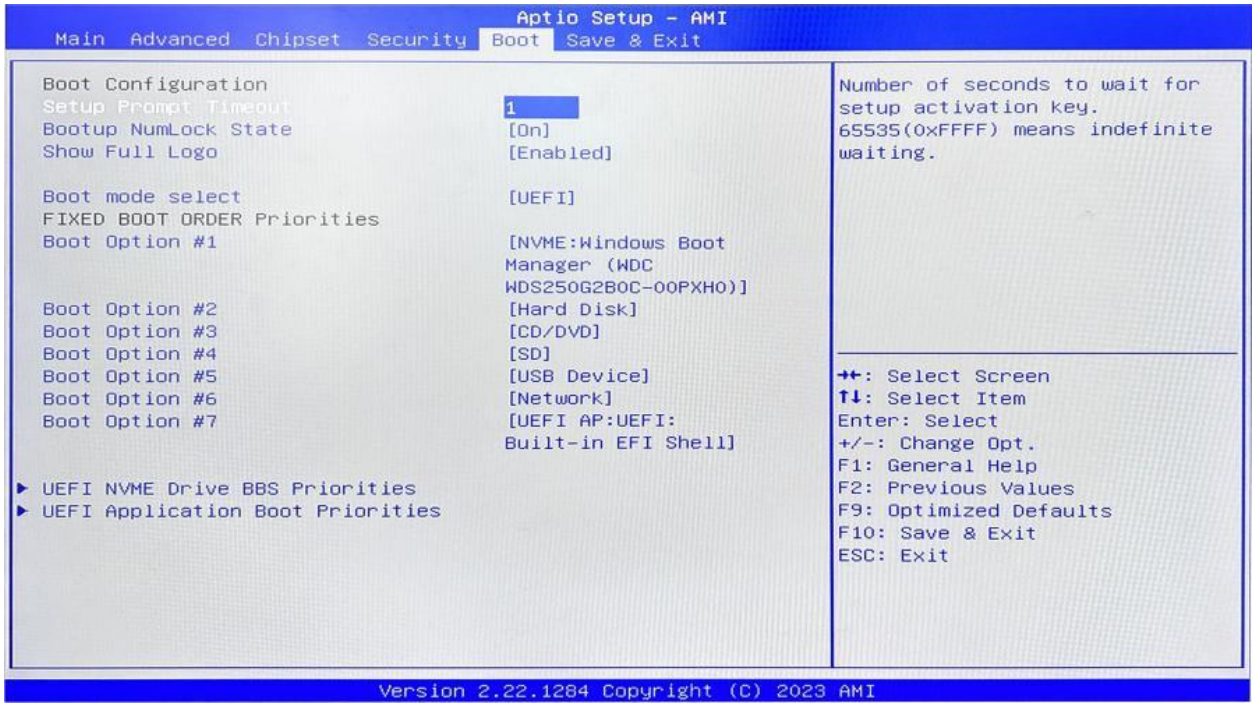


Administrator Password: Set the Administrator Password.

User Password: Set User Password.

Secure Boot: Secure boot

3.6 Boot



Setup Prompt Timeout:

Number of seconds that the firmware will wait before initiating the original default boot selection. A value of 0 indicates that the default boot selection is to be initiated immediately on boot. A value of 65535(0xFFFF) indicates that firmware will wait for user input before booting. This means the default boot selection is not automatically started by the firmware.

Bootup NumLock State:

Select the keyboard NumLock State

Show Full Logo:

Enabled/Disabled Displays customized boot logo.

Boot Option #1~#7:

Set the system boot order from Number 1 to Number 7.

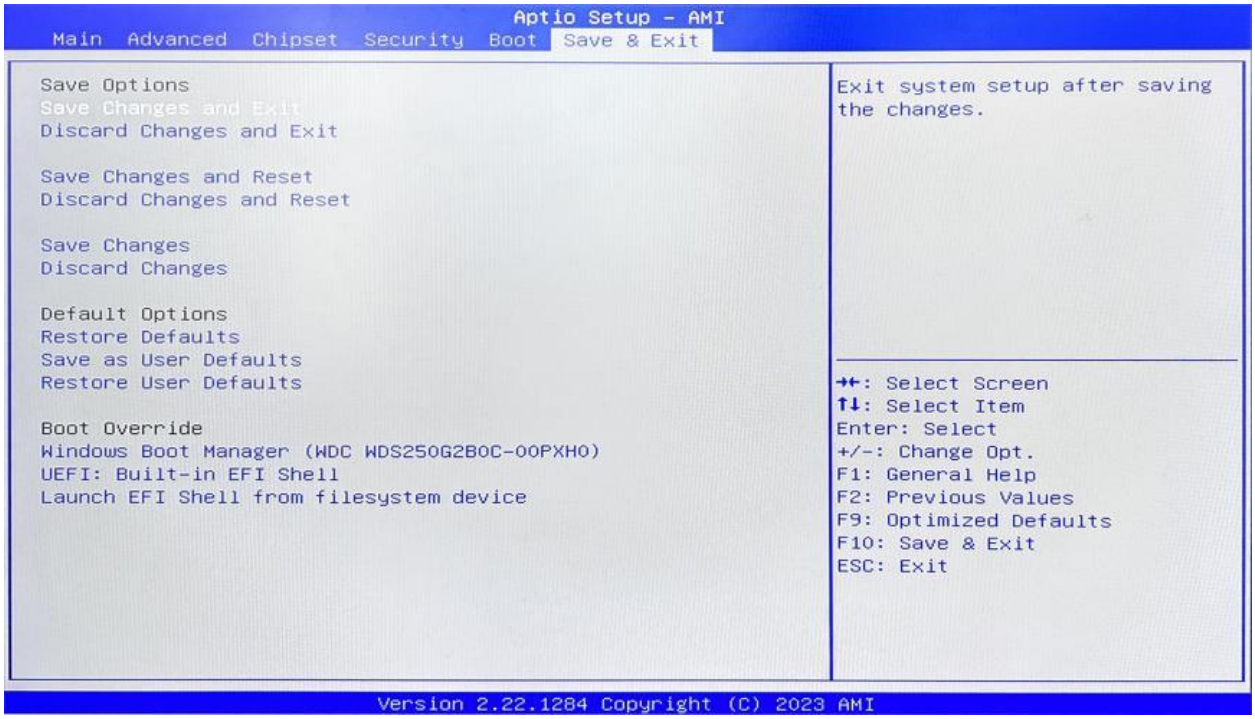
UEFI USB Drive BBS Priorities:

UEFI USB Drive BBS priorities setting.

UEFI Application boot Priorities:

UEFI application boot priority.

3.7 Save & Exit



1. **Save Changes and Exit:** Exit the system setup after saving the changes and continue to start the computer.
2. **Discard Changes and Exit:** Exit the system setup without saving any changes and continue to start the computer.
3. **Save Changes and Reset:** Reset the system after saving the changes.
4. **Discard changes and Reset:** Reset the system without saving any changes.
5. **Save Changes:** Save changes done so far to any of the options.
6. **Discard Changes:** Discard changes done so far to any of the options.
7. **Restore Defaults:** Restore/load default values for all the options.
8. **Save as User Defaults:** Save the changes done so far as the user defaults.
9. **Restore User Defaults:** Restore the user defaults to all the options.
10. **Boot Override:** Boot device selection can override your boot priority. Select the specified boot device such as SATA, USB Flash Disk, EFI Shell, PXE, etc., and boot directly. Or press F11 boot by selecting the specified boot device.