C&T SOLUTION INC.

USER'S MANUAL

BCO-1000 Series

Basic Fanless Embedded System

Table of Contents

Prefaces

Revision

Revision	Description	Date
1.0	Manual Released	2018/01/15
1.1	Added WDT and GPIO Sample Code	2018/02/09
1.2	Model Name and Installation Instruction Update	2020/07/09

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Environmental Protection Announcement

Do not dispose this electronic device into the trash while discarding. Please recycle to minimize pollution and ensure environment protection.

Safety Precautions

Before installing and using the equipment, please read the following precautions:

- Put this equipment on a reliable surface during installation. Dropping it or letting it fall could cause damage.
- The power outlet shall be installed near the equipment and shall be easily accessible.
- Turn off the system power and disconnect the power cord from its source before making any installation. Be sure both the system and the external devices are turned OFF. Sudden surge
- of power could ruin sensitive components. Make sure the equipment is properly grounded.
- When the power is connected, never open the equipment. The equipment should be opened only by qualified service personnel.
- Make sure the voltage of the power source is correct before connecting the equipment to the power outlet.
- Disconnect this equipment from the power before cleaning. Use a damp cloth. Do not use liquid or spray detergents for cleaning.
- Avoid the dusty, humidity and temperature extremes.
- Do not place heavy objects on the equipment.
- If the equipment is not used for long time, disconnect it from the power to avoid being damaged by transient over-voltage.
- The storage temperature shall be above -30°C and below 70°C.
- The computer is provided with a battery-powered real-time clock circuit. There is a danger of explosion if incorrectly replaced. Replace only with the same or equivalent type recommended by the manufacturer.
- If one of the following situation arises, get the equipment checked be service personnel:
    - The power cord or plug is damaged.
    - Liquid has penetrated into the equipment.
    - The equipment has been exposed to moisture.
    - The equipment does not work well or it cannot work according the user's manual.
    - The equipment has been dropped and damaged.
    - The equipment has obvious signs of breakage.

Technical Support and Assistance

1. Visit the C&T Solution Inc. website at https://www.candtsolution.com where you can find the latest information about the product.
2. Contact your distributor, our technical support team or sales representative for technical support if you need additional assistance. Please have following information ready before you call:
   - Model name and serial number
   - Description of your peripheral attachments
   - Description of your software (operating system, version, application software, etc.)
   - A complete description of the problem
   - The exact wording of any error messages

Conventions Used in this Manual

WARNING This indication alerts operators to an operation that, if not strictly observed, may result in severe injury.

CAUTION This indication alerts operators to an operation that, if not strictly observed, may result in safety hazards to personnel or damage to equipment.

NOTE This indication provides additional information to complete a task easily.

Package Contents

Before installation, please ensure all the items listed in the following table are included in the package.

Item	Description	Q'ty
1	BCO-1000 Series Embedded System	1
2	Accessory Kit	1
3	DVI to VGA Adapter	1

Ordering Information

Model No.	Product Description
BCO-1000-J1900	Basic Fanless Embedded System with Intel® Celeron® J1900 Processor, 1x DVI-I, 2x COM
BCO-1010-J1900	Basic Fanless Embedded System with Intel® Celeron® J1900 Processor, 1x DVI-I, 2x COM, 1x 2.5" SATA HDD Bay
BCO-1010A-J1900	Basic Fanless Embedded System with Intel® Celeron® J1900 Processor, 1x DVI-I, 1x DP, 2x COM, 1x 2.5" SATA HDD Bay
BCO-1010B-J1900	Basic Fanless Embedded System with Intel® Celeron® J1900 Processor, 1x DVI-I, 4x COM, 1x 2.5" SATA HDD Bay
BCO-1010U-J1900	Basic Fanless Embedded System with Intel® Celeron® J1900 Processor, 2x COM, 2x LAN, 8x USB, 1x 2.5" SATA HDD Bay
BCO-1020C-J1900	Basic Fanless Embedded System with Intel® Celeron® J1900 Processor, 1x DVI-I, 1x DP, 4x COM, 1x 2.5" SATA HDD Bay
BCO-1020D-J1900	Basic Fanless Embedded System with Intel® Celeron® J1900 Processor, 1x DVI-I, 6x COM, 1x 2.5" SATA HDD Bay
BCO-1030-J1900	Basic Fanless Embedded System with Intel® Celeron® J1900 Processor, 1x DVI-I, 1x DP, 6x COM, 1x 2.5" SATA HDD Bay

Optional Accessories

Model No.	Product Description
1-E09A06002	Adapter AC/DC 12V 5A 60W with 3pin Terminal Block Plug 5.0mm Pitch
1-TPCD00005	Power Cord, 3-pin US Type, 180cm
1-TPCD00002	Power Cord, European Type, 180cm
1-TPCD00001	Power Cord, 3-pin UK Type, 180cm

Chapter 1

Product Introductions

1.1 Overview

BCO-1000 series powered by Intel® Celeron® Processor J1900 2.0GHz SoC, which delivers increased performance by up to 150% compared to previous Atom® platforms and low power consumption. The BCO-1000 series is compatible for applications that need a basic and simple but dependable solution. It is an ideal preference as an economical entry-level for diverse applications in computing functionality such as market application in industrial automation, industrial control, Kiosk & retail and digital signage.

This price-friendly fanless embedded system supports system memory up to 8 GB with one DDR3L-1066/1333 SO-DIMM socket and features an onboard DVI-I display interface to provide further VGA/DVI-D connection to deliver Ultra HD smooth visual display. The BCO-1000 series is equipped with one internal 2.5" SATA HDD bays and one mSATA (shared by 1x Mini PCI Express) to provide sufficient storage. It also comes with one full-size mini PCIe socket with USIM socket (PCIe + USB + SATA) that satisfy customized needs. Its rich I/O connectors (up to 6x COM, 2x LAN, 8x USB) provide versatile I/O expandability.

In addition to its efficient CPU computing performance, the BCO-1000 series can be configured through its two antenna for wireless communication. It adopts a wide range power input from 9V to 30V DC, increasing the reliability of the whole system dramatically. Furthermore, the BCO-1000 series is designed to operate dependably in critical conditions with its anti-vibration, anti-shock and wide operating ranging from -20˚C to 50˚C temperature range features. The built-in over voltage protection (OVP) makes the BCO-1000 series a safe and secure system for all industrial applications.

The BCO-1000 series is housed in a sturdy and rugged housing that makes it feel exceptionally solid. By complying with military grade endurance (MIL-STD-810G), the BCO-1000 series is designed to withstand significant shock, constant vibration, and sealed to survive the harshest environments or conditions. The neat and compact design facilitates easy integration, effortless expansion and trouble-free maintenance.

The BCO-1000 series is very competitive with its affordable price, but without compromising on performance. It is an optimal solution to fit in various type of interface and variety of applications that requires low cost high performance fanless computing. Aside from its rich I/O capabilities, the robust package of BCO-1000 series makes it an ideal choice for a cost-effective, high performance fanless embedded system.

BCO-1000

BCO-1010
BCO-1010A
BCO-1010B
BCO-1010U

BCO-1020C
BCO-1020D

BCO-1030

1.1.1 Key Features

- Intel® Celeron® processor J1900, up to 2.0GHz
- 1x 204-pin DDR3L SODIMM. max up to 8GB
- Dual independent display supported by 1x DVI-I (BCO-1000, BCO-1010, BCO-1010B, BCO-1010U, and BCO-1020D Only)
- Dual independent display supported by 1x DVI-I and 1x DisplayPort
- 2x Intel® GbE supporting Wake-on-LAN and PXE
- 1x mSATA (BCO-1000 Only)
- 1x 2.5" SATA HDD bay, 1x mSATA
- 2x full-size mini PCIe for communication or expansion modules, 1x SIM socket
- 2x RS-232/422/485, 1x USB 3.0, 3x USB 2.0
- 2x RS-232/422/485, 1x USB 3.0, 7x USB 2.0 (BCO-1010U Only)
- 4x RS-232/422/485, 1x USB 3.0, 3x USB 2.0 (BCO-1010B and BCO-1020C Only)
- 6x RS-232/422/485, 1x USB 3.0, 3x USB 2.0 (BCO-1020D and BCO-1030 Only)
- 4x DI + 4x DO with isolation (BCO-1010A, BCO-1020C, and BCO-1030 Only)
- 9 to 30VDC wide range power input supporting AT/ATX mode
- -20˚C to 50˚C extended operating temperature

1.2 Hardware Specification

Processor System
- Intel® Celeron® Processor J1900, Quad Core, 2MB Cache, 2.0 GHz with AMI 64Mbit SPI BIOS.

Memory
- 1x 204-Pin DDR3L 1066/1333MHz SODIMM. Max. up to 8 GB

Display
Dual Display
- 1x DVI-D and 1x VGA (w/ Optional Split Cable) (BCO-1000 / BCO-1010 / BCO-1010B / BCO-1010U / BCO-1020D Only)
- 1x DVI-D and 1x DisplayPort
- 1x DisplayPort and 1x VGA (w/ DVI to VGA Adapter)

Expansion
- 1x Full-size Mini PCIe Socket with USIM Socket (PCIe + USB + SATA)
- 1x Full-size Mini PCIe Socket (PCIe + USB)

Ethernet
- 1x Intel® I210-AT GbE LAN Port, Support Wake-on-LAN and PXE

Audio
- Realtek ALC888S Audio Codec
- 1x Mic-in and 1x Line-out

Watchdog Timer
- Software Programmable Supports 1~255 sec. System Reset

Storage
- 1x 2.5" SATA HDD Bay (Except BCO-1000)
- 1x mSATA (share by 1x Mini-PCIe Socket)
- 1x External SIM Card Socket

I/O Ports
- 1x USB 3.0 Port
- 1x USB 2.0 Port
- 2 x DB9 for COM1~2, Support RS232/422/485 with Auto Flow Control (BCO-1000 / BCO-1010 / BCO-1010A / BCO-1010U only)
- 4 x DB9 for COM1~4, Support RS232/422/485 with Auto Flow Control (BCO-1010B / BCO-1020C only)
- 6 x DB9 for COM1~6, Support RS232/422/485 with Auto Flow Control (BCO-1020D / BCO-1030 only)
- 1x Power Switch
- 1x Reset Hole
- 1x AT/ATX Switch

Digital Input & Output
(Except BCO-1000, BCO-1010, BCO-1010B, BCO-1010U, BCO-1020D)
- 4x Digital Input (Source Type)
  - Input Voltage (Dry Contact):
    Logic 0: Close to GND
    Logic 1: Open
  - Input Voltage:
    Logic 0: 3V max.
    Logic 1: 5V min. (DI to COM-)
- 4x Digital Output
  - Supply Voltage: 5~30VDC
  - Sink Current: 200 mA Max. Per Channel

Power
- Support AT, ATX Mode
- 1x 3-pin Terminal Block Connector with Power Input 9~30VDC
- 1x Optional AC/DC 12V/5A, 60W Power Adapter

Environment
- Operating Temperature: Ambient with Air Flow: -20°C to 50°C (with Industrial Grade Peripherals)
- Storage Temperature: -30°C to 70°C
- Relative humidity: 10%~95% (non-condensing)

Physical
- Dimension (WxDxH, mm):
  142 x 101 x 30 mm (BCO-1000 Only)
  142 x 101 x 41.5 mm (BCO-1010, BCO-1010A, BCO-1010B, and BCO-1010U Only)
  142 x 101 x 58 mm (BCO-1020C and BCO-1020D Only)
  142 x 101 x 75 mm (BCO-1030)
- Weight:
  BCO-1000：0.46 kg
  BCO-1010：0.58 ~ 0.62 kg
  BCO-1020：0.68 ~ 0.69 kg
  BCO-1030：0.72 kg
- Construction: Fanless Design
- Mounting: Wall Mounting

Operating System
- Windows® 10
- Windows® 7
- WES7

Certifications
- CE
- FCC Class A

1.3 System I/O

1.3.1 BCO-1000

Front Panel

ATX power on/off switch
Press to power-on or power-off the system

AT/ATX mode select switch
Used to select AT or ATX power mode

Power LED
Indicates the power status of the system

HDD LED
Indicates the status of the hard drive

Wachdog LED
Indicates the watchdog status of the system

USB 3.0 port
Used to connect USB 3.0/2.0/1.1 device

USB 2.0 port
Used to connect USB 2.0/1.1 device

SIM card
Used to insert a SIM card

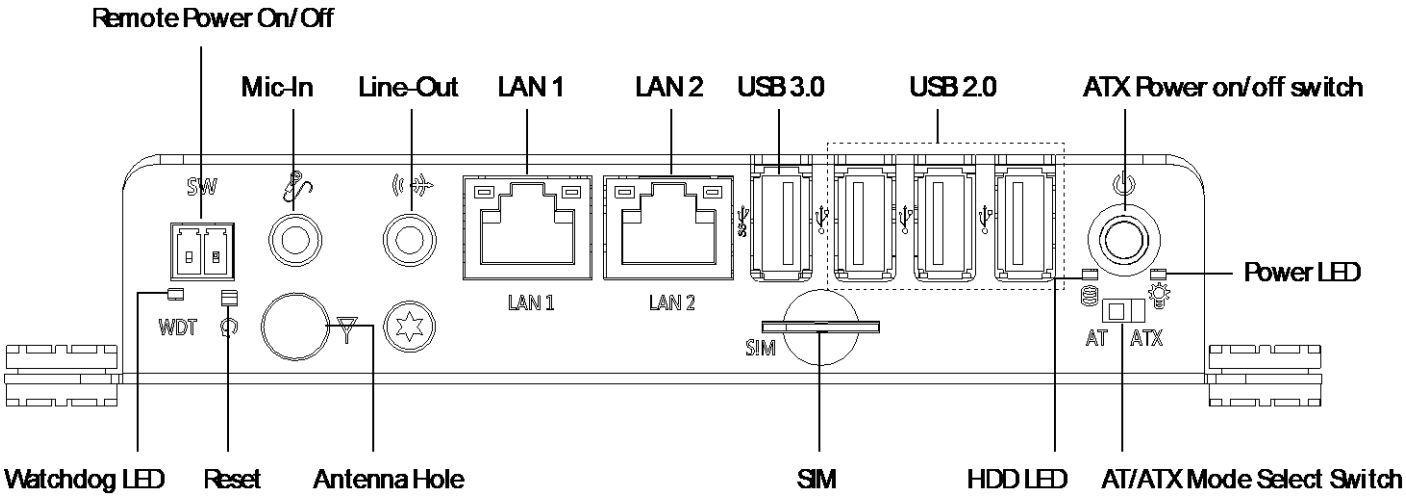
LAN port
Used to connect the system to a local area network

Line-out
Used to connect a speaker

Mic-in
Used to connect a microphone

Reset hole
Used to reset the system

Antenna hole
Used to connect an antenna for optional Mini-PCIe WiFi module



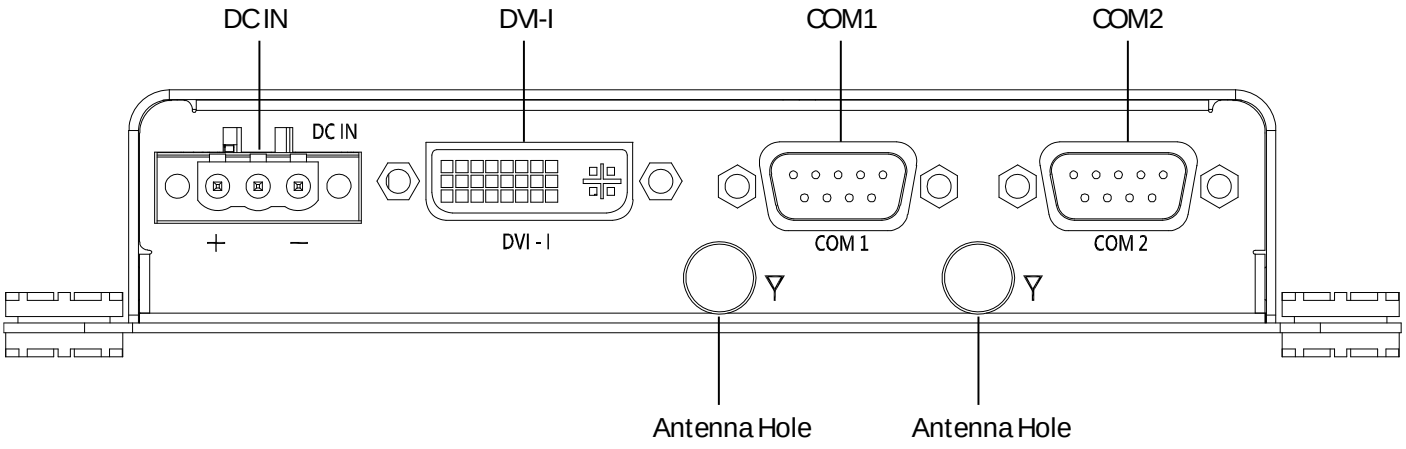
Rear Panel

DC IN
Used to plug a DC power input with terminal block

DVI-I port
Used to connect a DVI monitor or connect optional split cable for dual display mode

COM port
COM1 ~ COM2 support RS232/422/485 serial device

Antenna hole
Used to connect an antenna for optional Mini-PCIe WiFi module



1.3.2 BCO-1010 / BCO-1010A / BCO-1010B / BCO-1010U

Front Panel

ATX power on/off switch
Press to power-on or power-off the system

AT/ATX mode select switch
Used to select AT or ATX power mode

Power LED
Indicates the power status of the system

HDD LED
Indicates the status of the hard drive

Wachdog LED
Indicates the watchdog status of the system

USB 3.0 port
Used to connect USB 3.0/2.0/1.1 device

USB 2.0 port
Used to connect USB 2.0/1.1 device

SIM card
Used to insert a SIM card

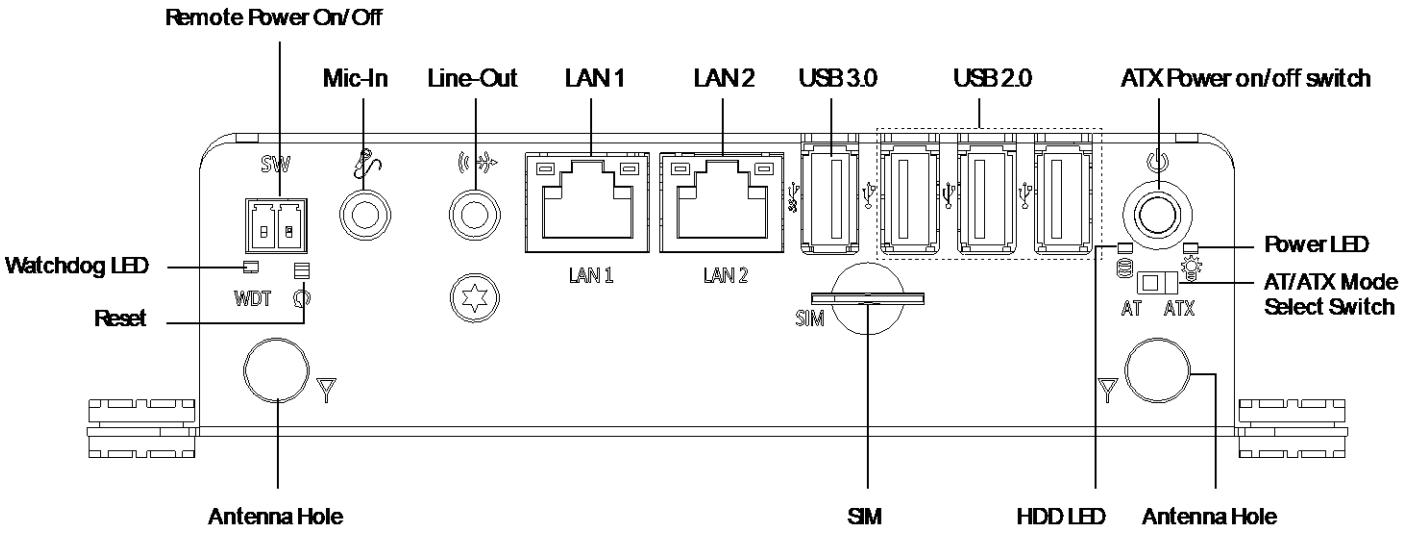
LAN port
Used to connect the system to a local area network

Line-out
Used to connect a speaker

Mic-in
Used to connect a microphone

Reset hole
Used to reset the system

Antenna hole
Used to connect an antenna for optional Mini-PCIe WiFi module



Rear Panel

DC IN
Used to plug a DC power input with terminal block

DVI-I port
Used to connect a DVI monitor or connect optional split cable for dual display mode

DisplayPort port
Used to connect a DisplayPort monitor (BCO-1010A Only)

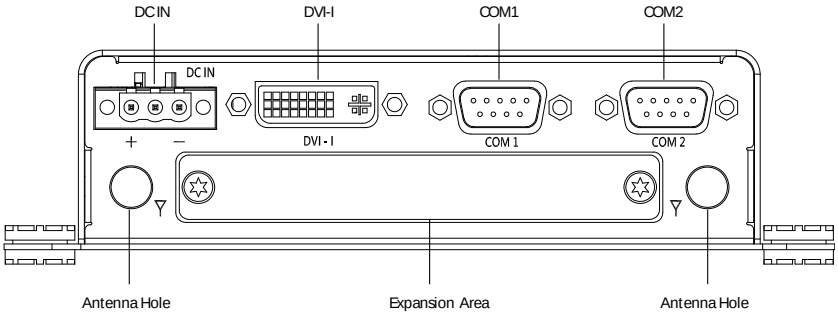
Digital I/O Terminal Block
The Digital I/O terminal block supports 4 digital input and 4 digital output (BCO-1010A Only)

COM port
COM1 ~ COM2 support RS232/422/485 serial device
COM1 ~ COM4 support RS232/422/485 serial device (BCO-1010B Only)

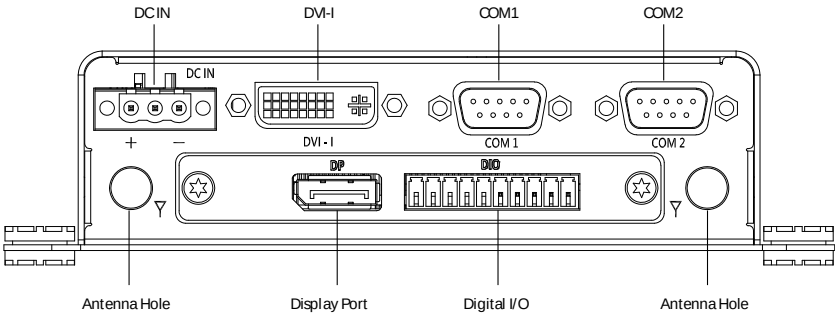
Antenna hole
Used to connect an antenna for optional Mini-PCIe WiFi module

Expandable I/O bracket
Used to customized I/O output (BCO-1010 Only)

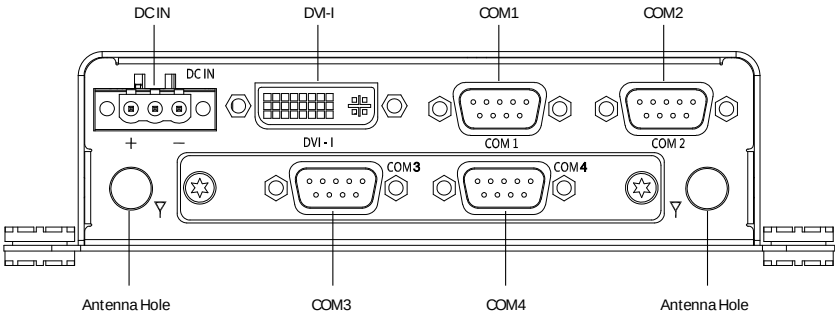
BCO-1010



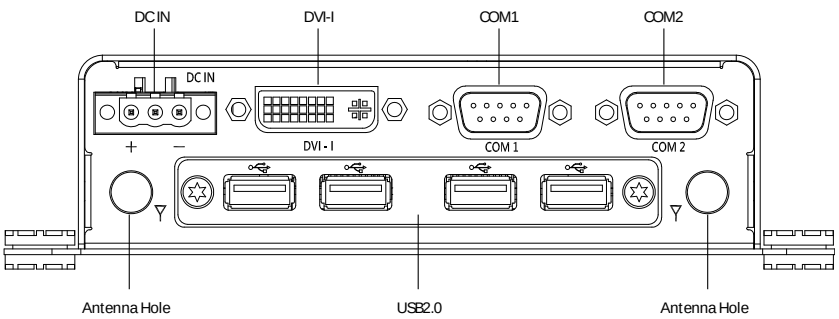
BCO-1010A



BCO-1010B



BCO-1010U



1.3.2 BCO-1020C / BCO-1020D

Front Panel

ATX power on/off switch
Press to power-on or power-off the system

AT/ATX mode select switch
Used to select AT or ATX power mode

Power LED
Indicates the power status of the system

HDD LED
Indicates the status of the hard drive

Wachdog LED
Indicates the watchdog status of the system

USB 3.0 port
Used to connect USB 3.0/2.0/1.1 device

USB 2.0 port
Used to connect USB 2.0/1.1 device

SIM card
Used to insert a SIM card

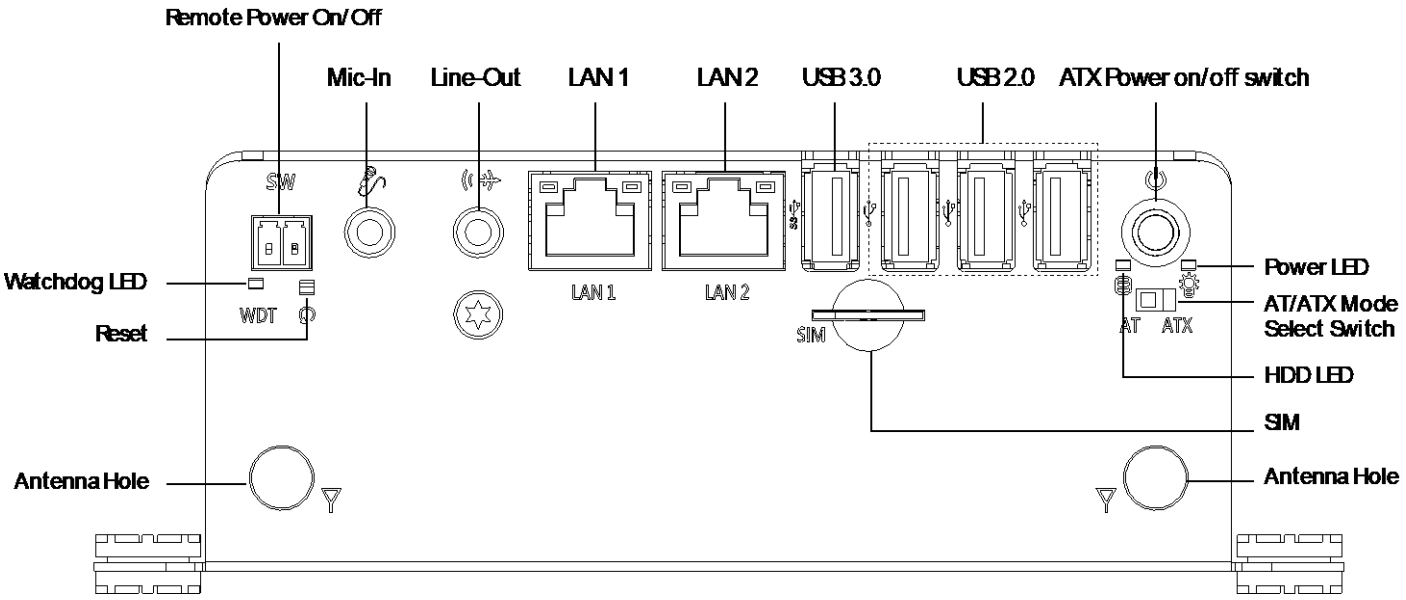
LAN port
Used to connect the system to a local area network

Line-out
Used to connect a speaker

Mic-in
Used to connect a microphone

Reset hole
Used to reset the system

Antenna hole
Used to connect an antenna for optional Mini-PCIe WiFi module



Rear Panel

DC IN
Used to plug a DC power input with terminal block

DVI-I port
Used to connect a DVI monitor or connect optional split cable for dual display mode

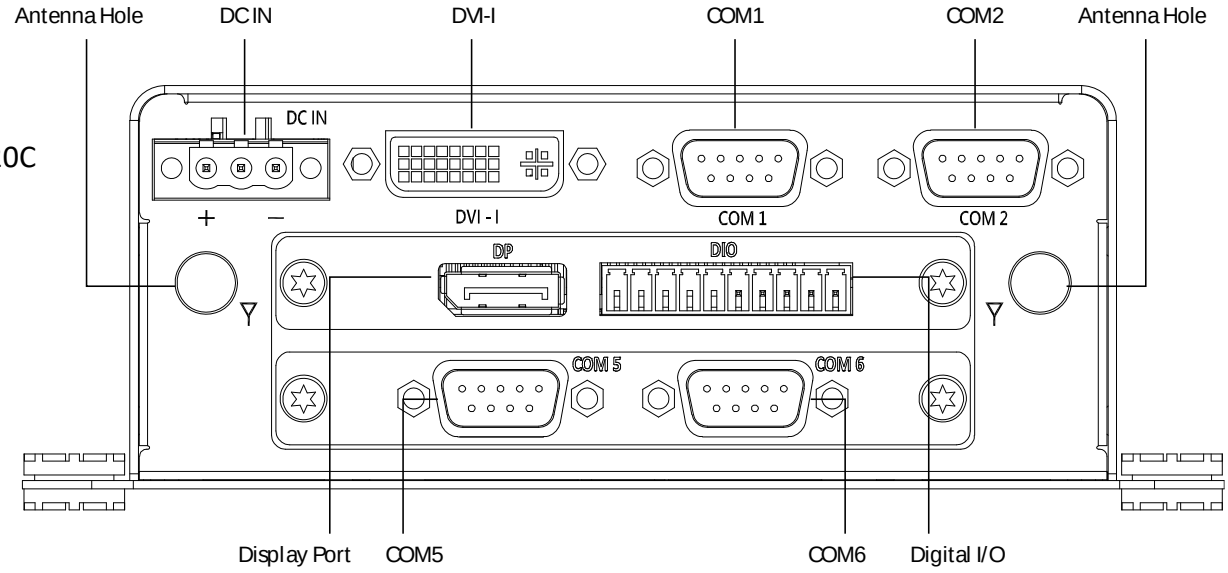
DisplayPort port
Used to connect a DisplayPort monitor

Digital I/O Terminal Block
The Digital I/O terminal block supports 4 digital input and 4 digital output

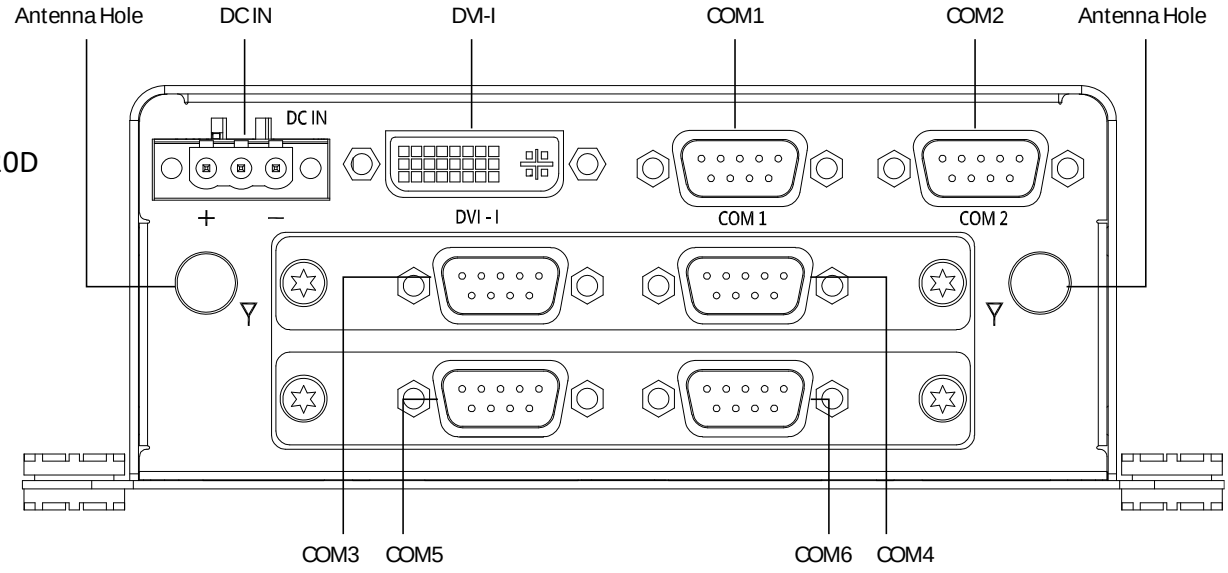
COM port
COM1 ~ COM4 support RS232/422/485 serial device
COM1 ~ COM6 support RS232/422/485 serial device (BCO-1020D Only)

Antenna hole
Used to connect an antenna for optional Mini-PCIe WiFi module

BCO-1020C



BCO-1020D



1.3.2 BCO-1030

Front Panel

ATX power on/off switch
Press to power-on or power-off the system

AT/ATX mode select switch
Used to select AT or ATX power mode

Power LED
Indicates the power status of the system

HDD LED
Indicates the status of the hard drive

Wachdog LED
Indicates the watchdog status of the system

USB 3.0 port
Used to connect USB 3.0/2.0/1.1 device

USB 2.0 port
Used to connect USB 2.0/1.1 device

SIM card
Used to insert a SIM card

LAN port
Used to connect the system to a local area network

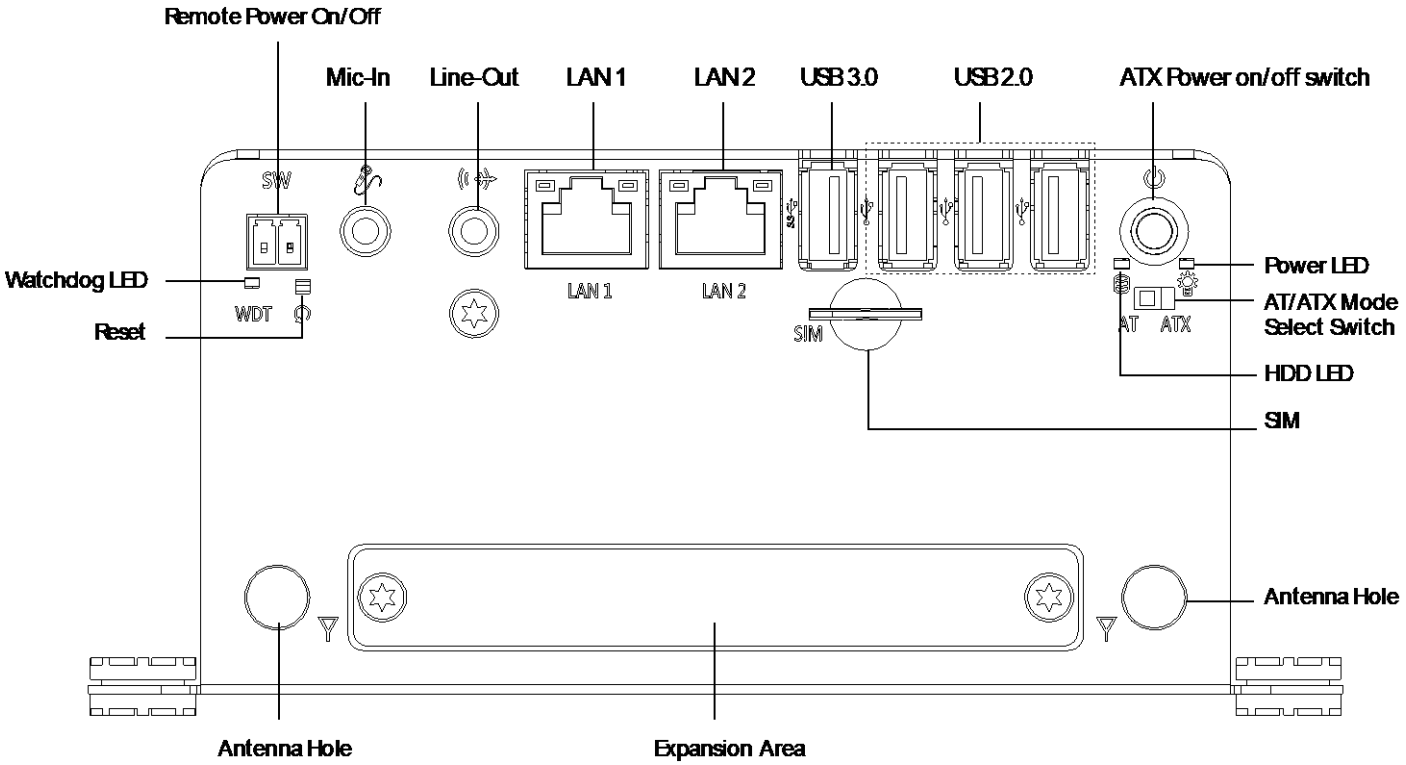
Line-out
Used to connect a speaker

Mic-in
Used to connect a microphone

Reset hole
Used to reset the system

Antenna hole
Used to connect an antenna for optional Mini-PCIe WiFi module

Expandable I/O bracket
Used to customized I/O output



Rear Panel

DC IN
Used to plug a DC power input with terminal block

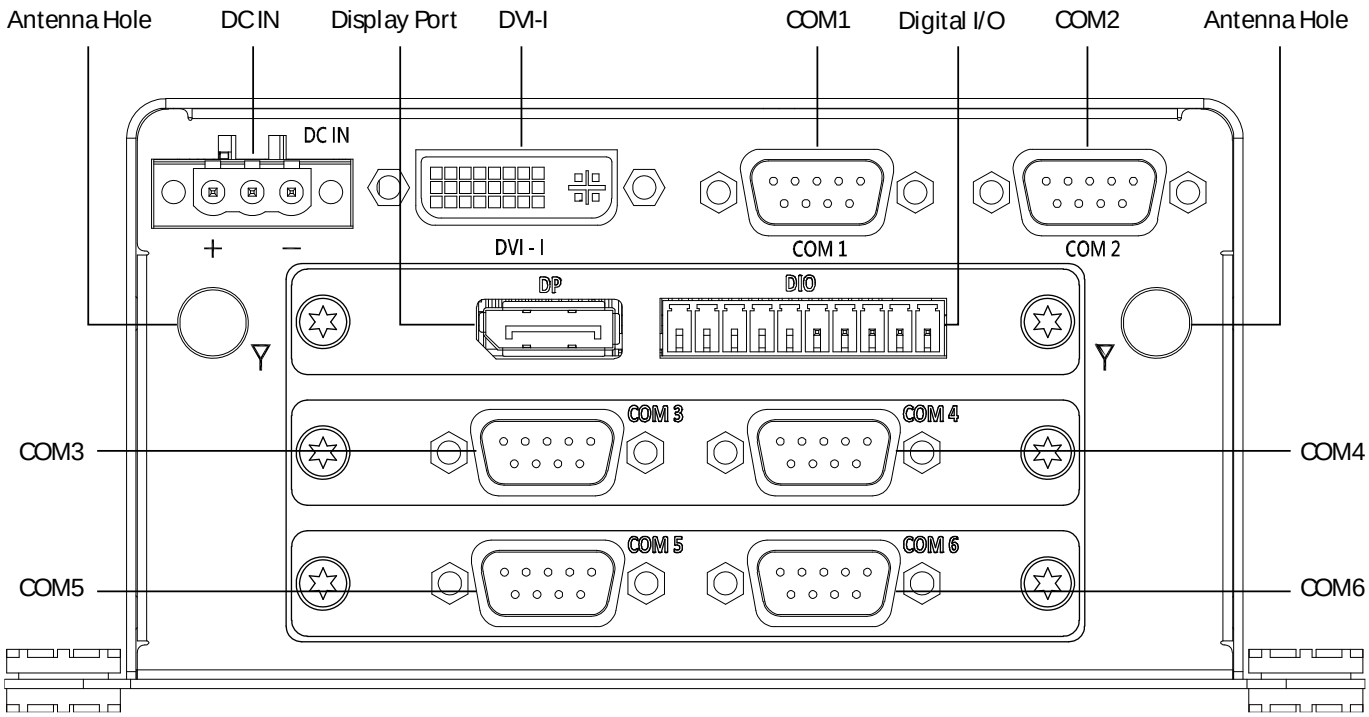
DVI-I port
Used to connect a DVI monitor or connect optional split cable for dual display mode

DisplayPort port
Used to connect a DisplayPort monitor

Digital I/O Terminal Block
The Digital I/O terminal block supports 4 digital input and 4 digital output

COM port
COM1 ~ COM6 support RS232/422/485 serial device

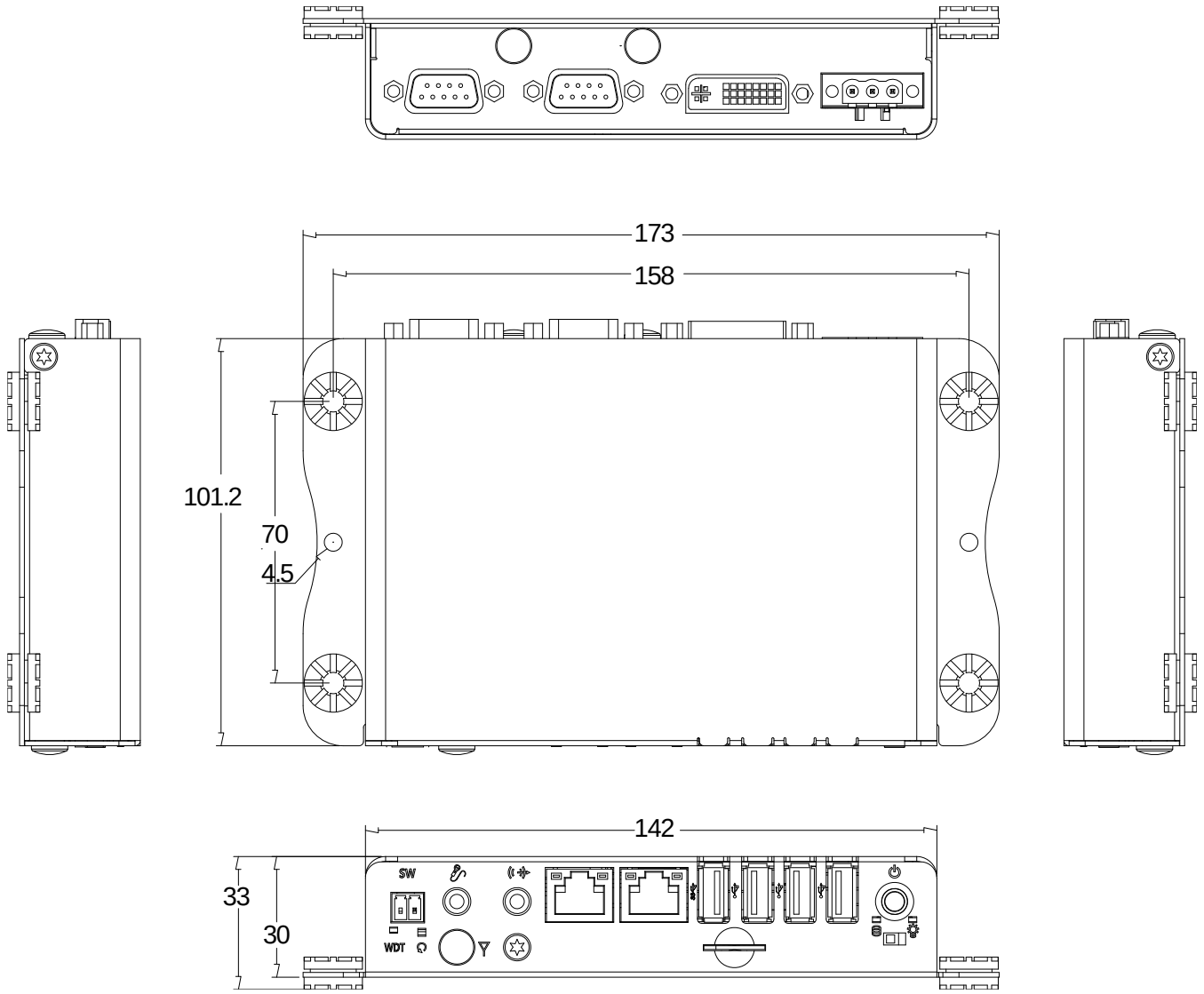
Antenna hole
Used to connect an antenna for optional Mini-PCIe WiFi module



1.4 Mechanical Dimensions

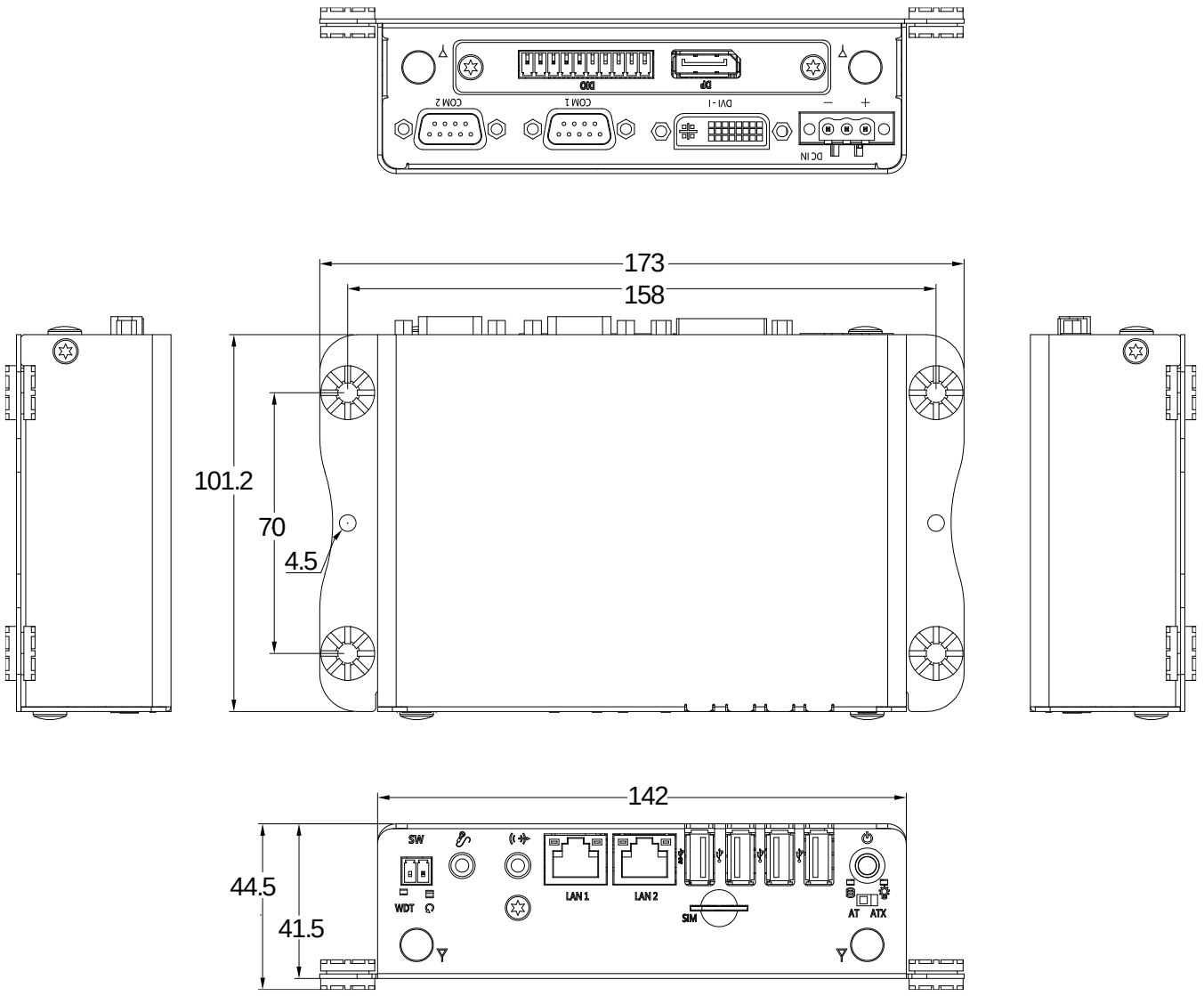
1.4.1 BCO-1000

Unit: mm



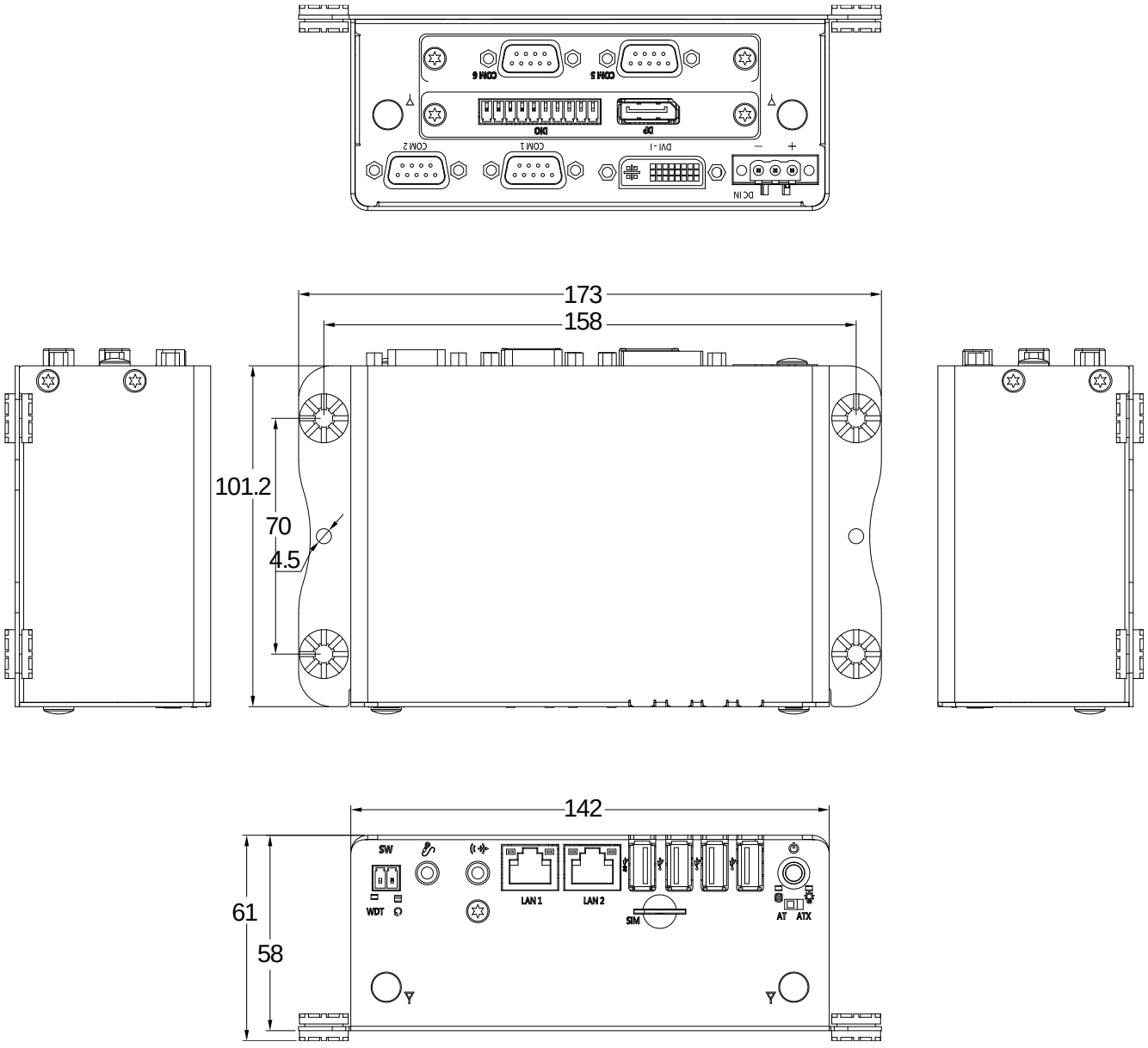
1.4.2 BCO-1010 / BCO-1010A / BCO-1010B / BCO-1010U

Unit: mm



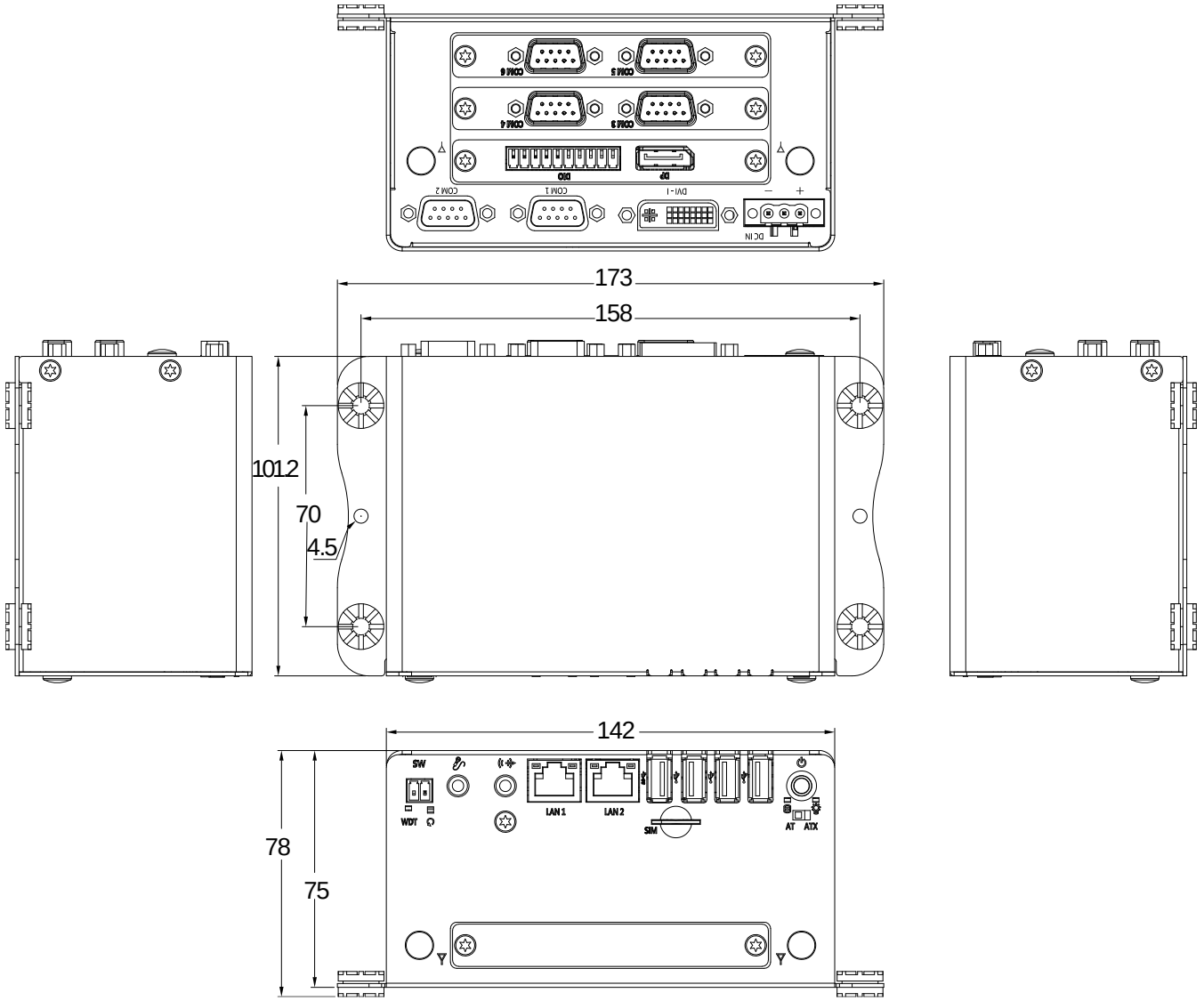
1.4.3 BCO-1020C / BCO-1020D

Unit: mm



1.4.4 BCO-1030

Unit: mm

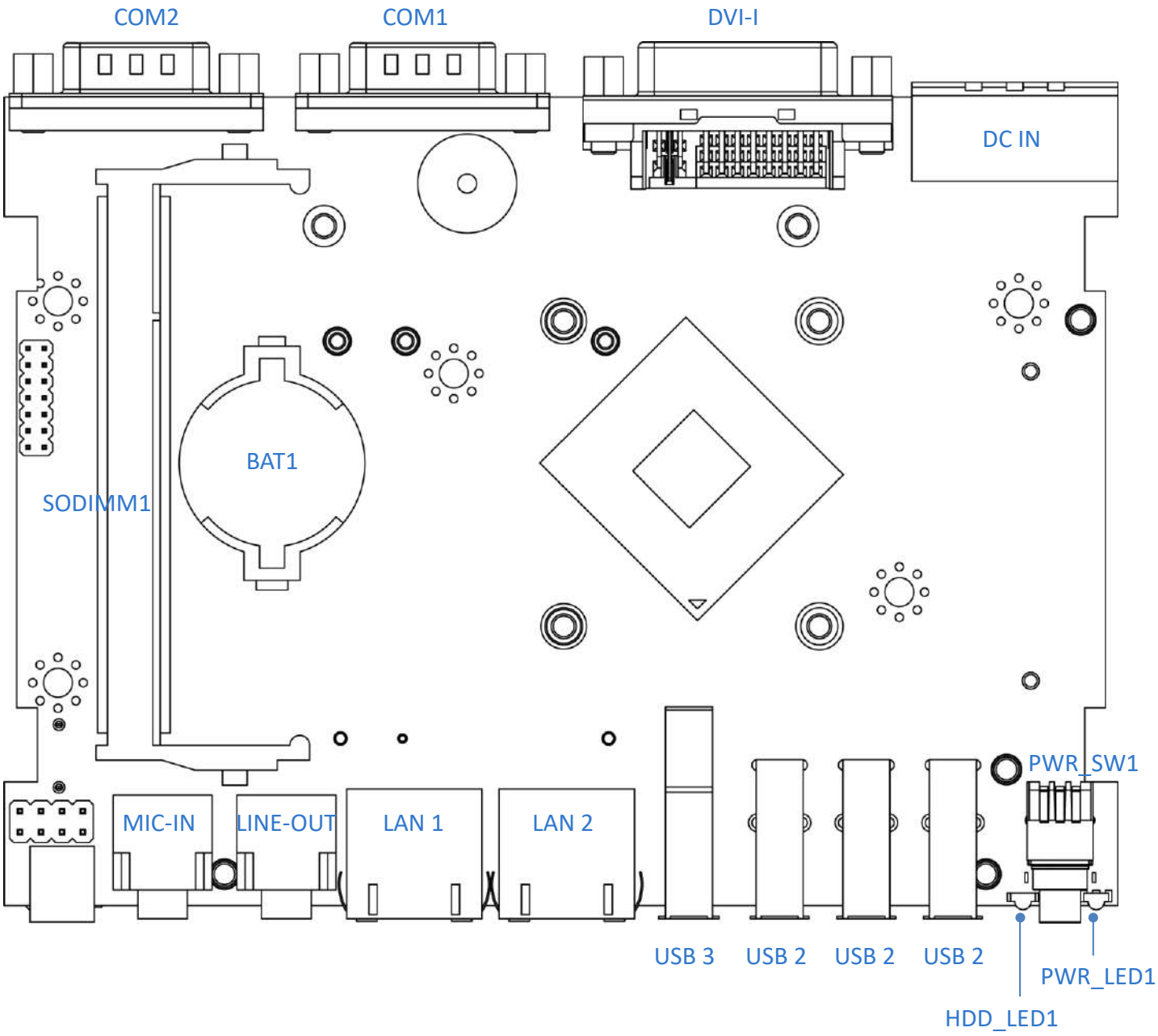


Chapter 2

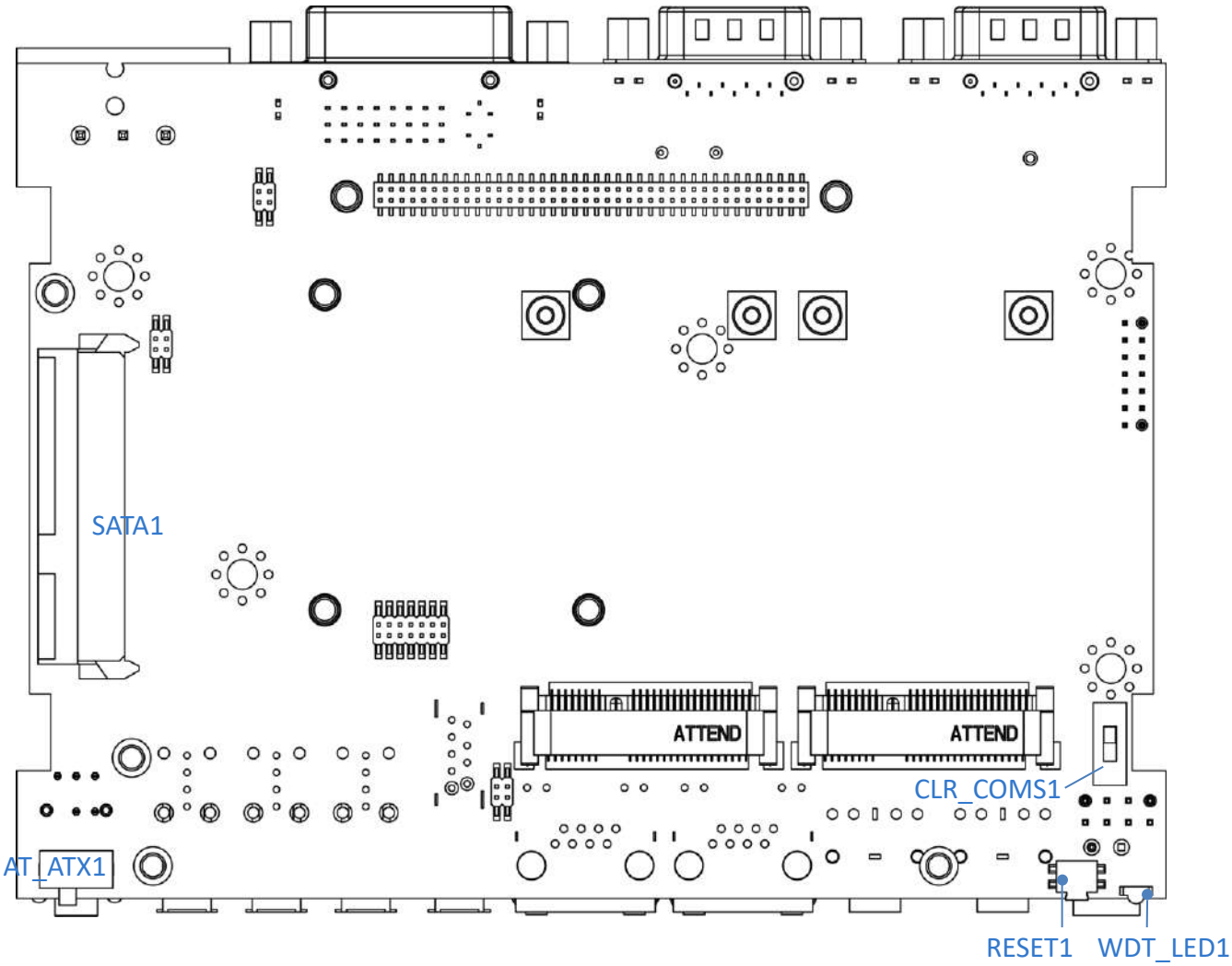
Switches and Connectors

2.1 Switch and Connector Locations

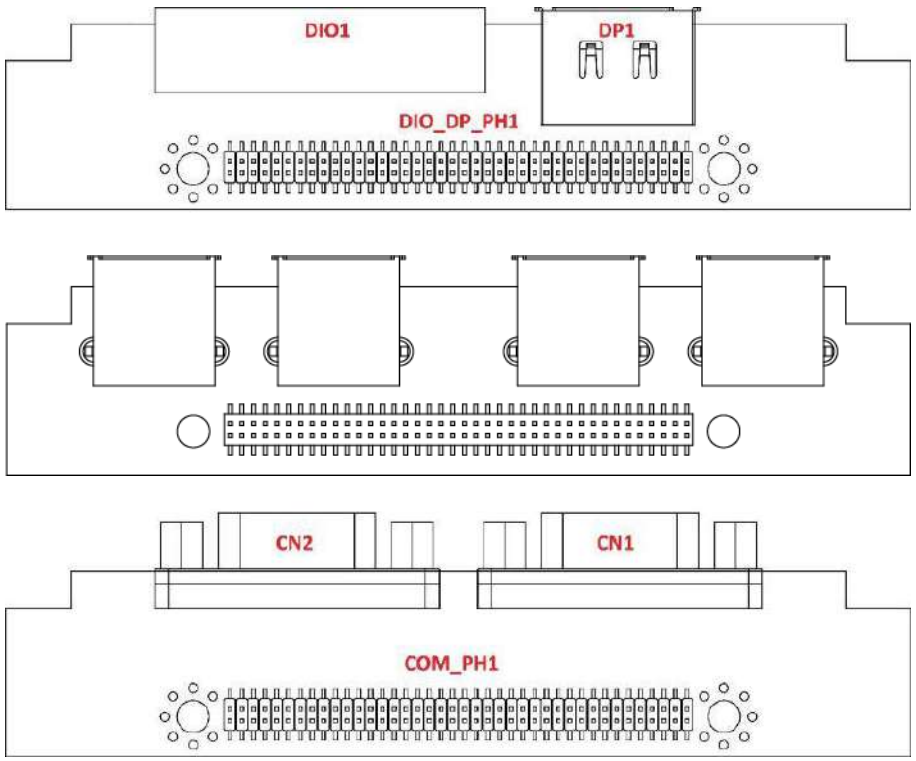
2.1.1 Top View



2.1.2 Bottom View



2.1.3 Daughter board view



2.2 Connector / Switch Definition

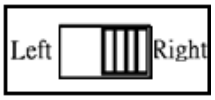
List of Connector / Switch

Connector Location	Definition
AT_ATX1	AT / ATX Power Mode Switch
CLR_CMOS1	Clear BIOS Switch
PWR_SW1	Power Switch
PWR_LED1	Power LED Status
HDD_LED1	HDD Access LED Status
WDT_LED1	Watchdog LED Status
USB2_1	USB 2.0 Port
USB3_1	USB 3.0 Port
LAN1	LAN Port
SIM1	SIM Card Socket
LINE_OUT1	Line-out Jack
MIC_IN1	Mic-in Jack
RESET1	Reset Switch
DC_IN1	3-pin DC 9~48V Power Input Connector
DVI_I1	DVI-I Connector
COM1_1, COM2_1, CN1, CN2	RS232 / RS422 / RS485 Connector
DP1	DisplayPort Connector
DIO1	4DI / 4DO Connector
MINIPCIE1	Mini PCI-Express Socket
CN3	Mini PCI-Express / mSATA Socket
SATA1	SATA with Power Connector

2.3 Switches Definitions

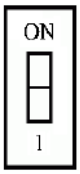
AT_ATX1: AT / ATX Power Mode Switch

Switch	Definition
1-2 (Right)	ATX Power Mode（Default）
2-3 (Left)	AT Power Mode



CLR_CMOS1: Clear BIOS Switch

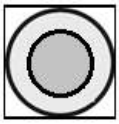
Switch	Definition
Off	Normal Status (Default)
ON	Clear BIOS



2.4 Connectors Definitions

PWR_SW1: Power Button

Pin	Definition	Pin	Definition
1	NC	4	GND
2	Power Button	5	NC
3	NC	6	GND



PWR_LED1: Power LED Status

Pin	Definition
1	POWER LED+
2	POWER LED-

HDD_LED1: HDD Access LED Status

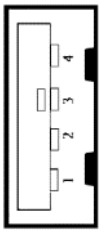
Pin	Definition
1	HDD LED+
2	HDD LED-

WDT_LED1: Watchdog LED Status

Pin	Definition
1	HDD LED+
2	HDD LED-

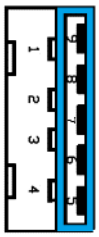
USB2_1: USB2.0 Connector, Type A

Pin	USB2_1 Definition
1	+5V
2	USB2_D2-
3	USB2_D2+
4	GND



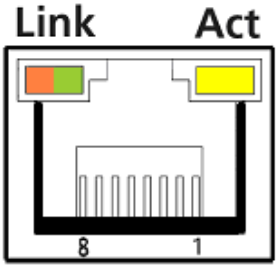
USB3_1: USB 3.0 Connector, Type A

Pin	Definition	Pin	Definition
1	+5V	6	USB3_RX+
2	USB2_DATA1-	7	GND
3	USB2_DATA1+	8	USB3_TX-
4	GND	9	USB3_TX+
5	USB3_RX-		



LAN1: RJ45 with LEDs Port

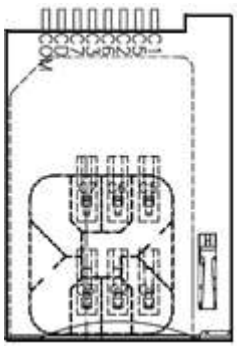
Pin	Definition	Pin	Definition
1	LAN1_MDI0P	5	LAN1_MDI2N
2	LAN1_MDI0N	6	LAN1_MDI1N
3	LAN1_MDI1P	7	LAN1_MDI3P
4	LAN1_MDI2P	8	LAN1_MDI3N



Link LED Status	Definition	Act LED Status	Definition
Steady Orange	1Gbps Network Link	Blinking Yellow	Data Activity
Steady Green	100Mbps Network Link	Off	No Activity
Off	10Mbps Network Link		

SIM1: SIM Card Socket

Pin	Definition	Pin	Definition
C1	UIM_PWR	C6	UIM_VPP
C2	UIM_RESET	C7	UIM_DATA
C3	UIM_CLK	CD	NC
C5	GND	COM	GND



LINE_OUT1 : Line-out Jack (Green)
Connector Type: 5-pin Phone Jack

Pin	Definition
1	GND
2	OUT_R
3	NC
4	GND
5	OUT_L

MIC_IN1: Microphone Jack (Pink)
Connector Type: 5-pin Phone Jack

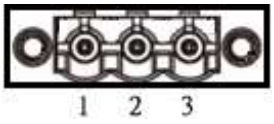
Pin	Definition
1	GND
2	MIC_R
3	NC
4	GND
5	MIC_L

RESET1 : Reset Button

Pin	Definition
1	RESET
2	GND

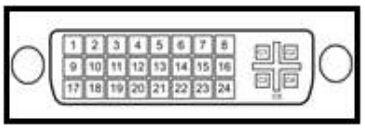
DC_IN1: DC Power Input Connector (+9~30V)
Connector Type: Terminal Block 1X3 3-pin, 5.0mm pitch

Pin	Definition
1	+9~30VIN
3	GND



DVI_I1: DVI-I Connector

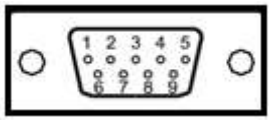
Pin	Definition	Pin	Definition
1	DVI_TX2-	16	DVI Hot Plug Detect
2	DVI_TX2+	17	DVI_TX0-
3	GND	18	DVI_TX0+
4	NC	19	GND
5	NC	20	NC
6	DDC_CLOCK	21	NC
7	DDC_DATA	22	GND
8	VGA VSYNC	23	DVI_TXCLK+
9	DVI_TX1-	24	DVI_TXCLK-
10	DVI_TX1+	C1	VGA_RED
11	GND	C2	VGA_GREEN
12	NC	C3	VGA_BLUE
13	NC	C4	VGA_HSYNC
14	+5V	C5	GND
15	GND		



COM1_1: RS232 / RS422 / RS485 Connector

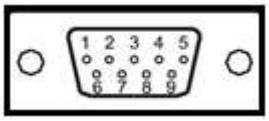
Connector Type: 9-pin D-Sub

Pin	RS232 Definition	RS422 / 485 Full Duplex Definition	RS485 Half Duplex Definition
1	DCD1	TX1-	DATA1-
2	RxD1	TX1+	DATA1+
3	TxD1	RX1+	
4	DTR1	RX1-	
5	GND		
6	DSR1		
7	RTS1		
8	CTS1		
9	RI1		



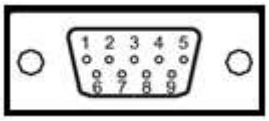
COM2_1: RS232 / RS422 / RS485 Connector
Connector Type: 9-pin D-Sub

Pin	RS232 Definition	RS422 / 485 Full Duplex Definition	RS485 Half Duplex Definition
1	DCD2	TX2-	DATA2-
2	RxD2	TX2+	DATA2+
3	TxD2	RX2+	
4	DTR2	RX2-	
5	GND		
6	DSR2		
7	RTS2		
8	CTS2		
9	RI2		



CN1: RS232 / RS422 / RS485 Connector
Connector Type: 9-pin D-Sub

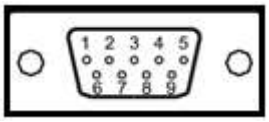
Pin	RS232 Definition	RS422 / 485 Full Duplex Definition	RS485 Half Duplex Definition
1	DCD3 (DCD5)	TX3- (TX5-)	DATA3- (DATA5-)
2	RxD3 (RxD5)	TX3+ (TX5+)	DATA3+ (DATA5+)
3	TxD3 (TxD5)	RX3+ (RX5+)	
4	DTR3 (DTR5)	RX3- (RX5-)	
5	GND		
6	DSR3 (DSR5)		
7	RTS3 (RTS5)		
8	CTS3 (CTS5)		
9	RI3 (RI5)		



CN2: RS232 / RS422 / RS485 Connector

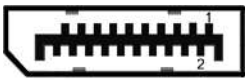
Connector Type: 9-pin D-Sub

Pin	RS232 Definition	RS422 / 485 Full Duplex Definition	RS485 Half Duplex Definition
1	DCD4 (DCD6)	TX4- (TX6-)	DATA4- (DATA6-)
2	RxD4 (RxD6)	TX4+ (TX6+)	DATA4+ (DATA6+)
3	TxD4 (TxD6)	RX4+ (RX6+)	
4	DTR4 (DTR6)	RX4- (RX6-)	
5	GND		
6	DSR4 (DSR6)		
7	RTS4 (RTS6)		
8	CTS4 (CTS6)		
9	RI4 (RI6)		



DP1: DisplayPort Connector

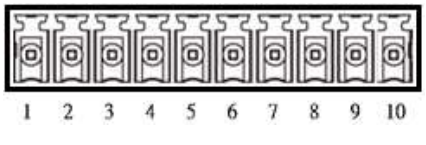
Pin	Definition	Pin	Definition
1	DP_LANE0_P	11	GND
2	GND	12	DP_LANE3_N
3	DP_LANE0_N	13	GND
4	DP_LANE1_P	14	GND
5	GND	15	DP_AUX_P
6	DP_LANE1_N	16	GND
7	DP_LANE2_P	17	DP_AUX_N
8	GND	18	DP_HPD
9	DP_LANE2_N	19	GND
10	DP_LANE3_P	20	DP_PWR



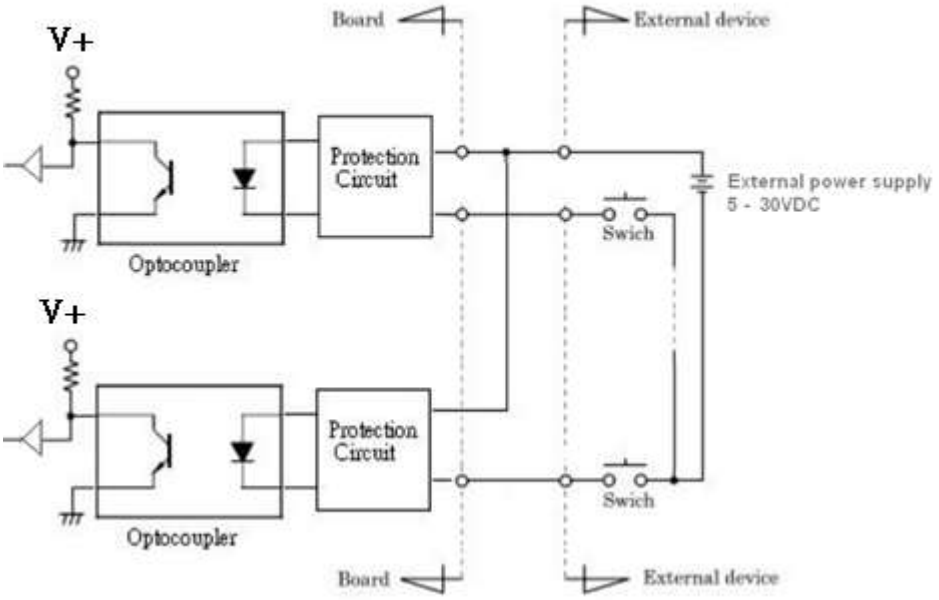
DIO1: Digital Input / Output Connector

Connector Type: Terminal Block 1X10 10-pin, 3.5mm pitch

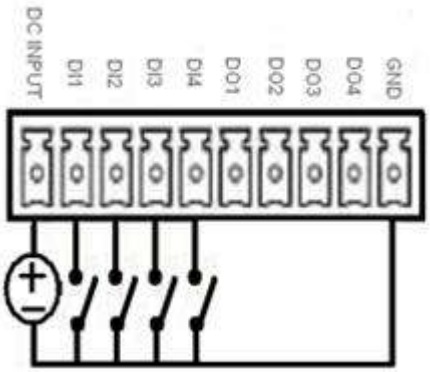
Pin	Definition	Pin	Definition
1	DC INPUT	6	DO1
2	DI1	7	DO2
3	DI2	8	DO3
4	DI3	9	DO4
5	DI4	10	GND



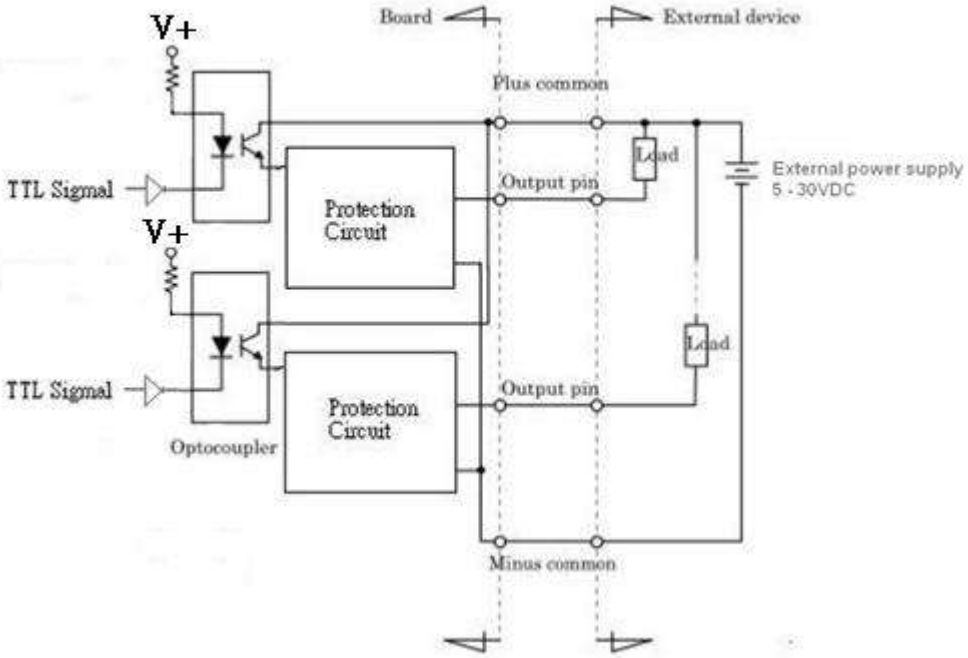
Reference Input Circuit



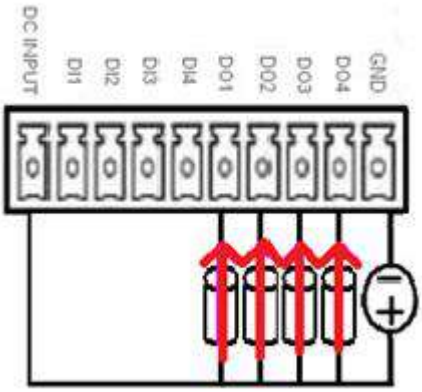
Digital Input Wiring



External Output Circuit

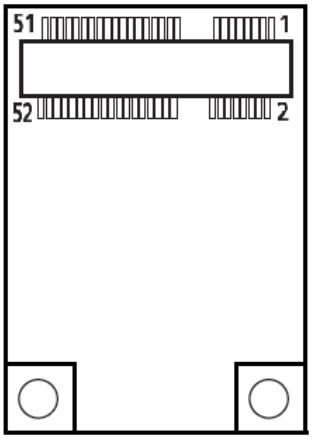


Digital Output Wiring



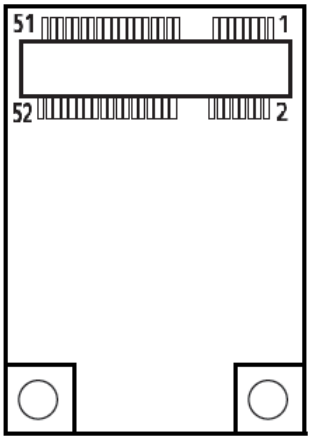
MINIPCIE1: Mini PCI-Express Socket

Pin	Definition	Pin	Definition	Pin	Definition
1	WAKE#	19	NC	37	GND
2	+3.3V	20	+3.3V	38	USB_DP1
3	NC	21	GND	39	+3.3V
4	GND	22	MINIPCIE RST#	40	GND
5	NC	23	MINIPCIE_RXN1	41	+3.3V
6	+1.5V	24	+3.3V	42	NC
7	CLKREQ1#	25	MINIPCIE_RXP1	43	GND
8	NC	26	GND	44	NC
9	GND	27	GND	45	NC
10	NC	28	+1.5V	46	NC
11	MINIPCIE_CLKN1	29	GND	47	NC
12	NC	30	SMB_CLK	48	+1.5V
13	MINIPCIE_CLKP1	31	MINIPCIE_TXN1	49	NC
14	NC	32	SMB_DATA	50	GND
15	GND	33	MINIPCIE_TXP1	51	NC
16	NC	34	GND	52	+3.3V
17	NC	35	GND		
18	GND	36	USB_DN1		



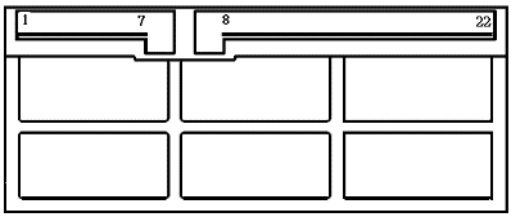
CN3: Mini PCI-Express / mSATA Socket

Pin	Definition	Pin	Definition	Pin	Definition
1	WAKE#	19	NC	37	GND
2	+3.3V	20	+3.3V	38	USB_DP2
3	NC	21	GND	39	+3.3V
4	GND	22	MINIPCIE RST#	40	GND
5	NC	23	MINIPCIE_RXN2 (SATA_RXP0)	41	+3.3V
6	+1.5V	24	+3.3V	42	NC
7	CLKREQ2#	25	MINIPCIE_RXP2 (SATA_RXN0)	43	GND
8	USIM_VCC	26	GND	44	NC
9	GND	27	GND	45	NC
10	USIM_DATA	28	+1.5V	46	NC
11	MINIPCIE_CLKN2	29	GND	47	NC
12	USIM_CLK	30	SMB_CLK	48	+1.5V
13	MINIPCIE_CLKP2	31	MINIPCIE_TXN2 (SATA_TXN0)	49	NC
14	USIM_RST	32	SMB_DATA	50	GND
15	GND	33	MINIPCIE_TXP2 (SATA_TXP0)	51	NC
16	USIM_VPP	34	GND	52	+3.3V
17	NC	35	GND		
18	GND	36	USB_DN1		



SATA1: SATA with Power Connector

Pin	Definition	Pin	Definition
1	GND	12	GND
2	SATA_TXP1	13	GND
3	SATA_TXN1	14	+5V
4	GND	15	+5V
5	SATA_RXN1	16	+5V
6	SATA_RXP1	17	GND
7	GND	18	GND
8	+3.3V	19	GND
9	+3.3V	20	+12V
10	+3.3V	21	+12V
11	GND	22	+12V



Chapter 3

System Setup

3.1 Set torque force to 3.5 kgf-cm to execute all the screwing and unscrewing.

WARNING

In order to prevent electric shock or system damage, before removing the chassis cover, must turn off power and disconnect the unit from power source.

3.2 Removing chassis bottom cover

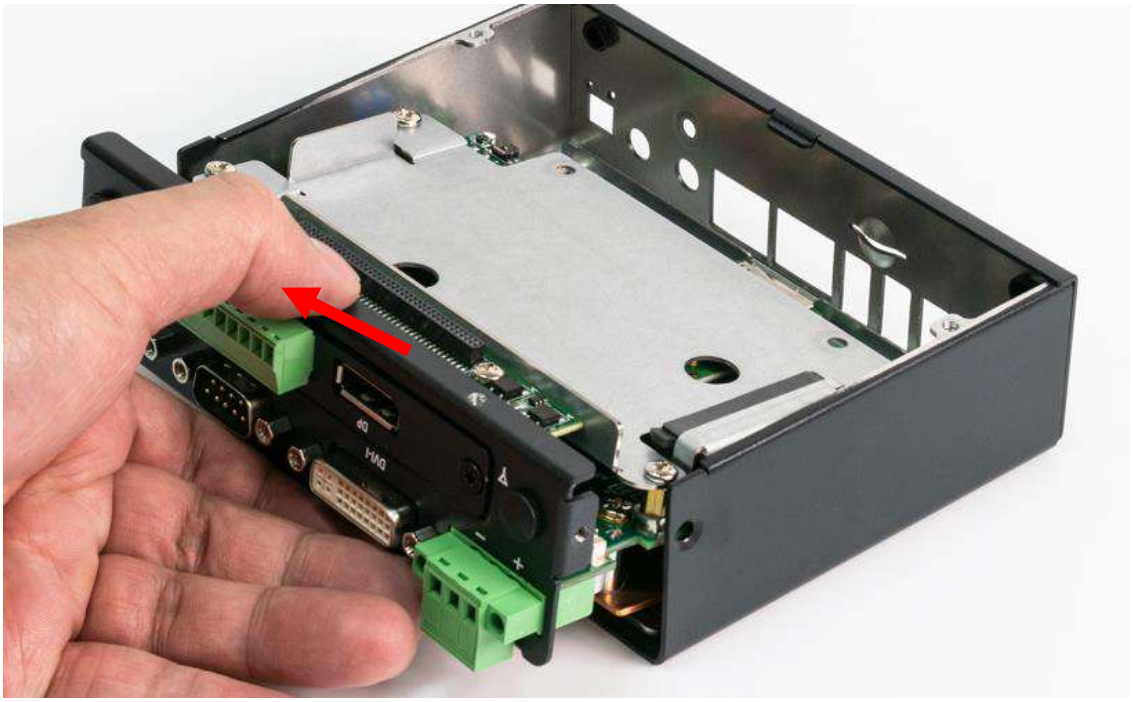
1. Turn the system upside down. Unscrew the 4 screws on the bottom cover.

2. Now you can remove the bottom cover.

3.3 Installing SODIMM

1. Unscrew three screws on the chassis: one screw on front panel, one screw on system left side, and one screw on system right side.

2. Hold the chassis top cover. Pull the system main body following the below direction so the top cover can be separated from it.



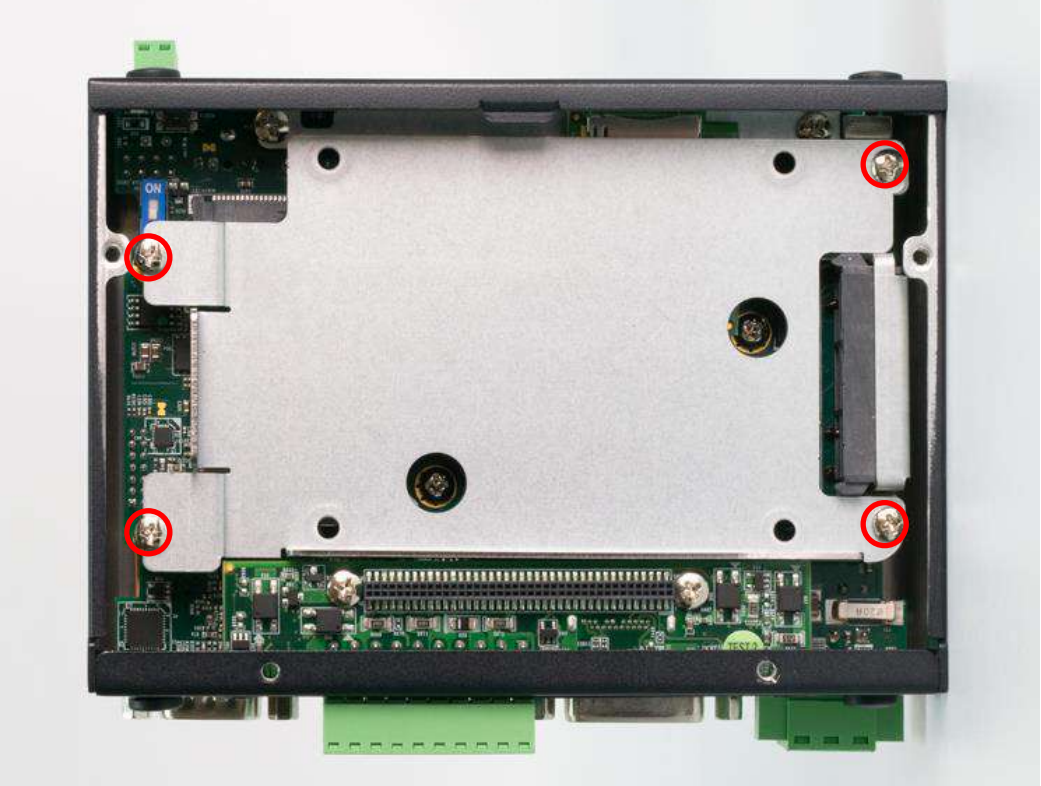
3. System main body and top cover separated.

4. Insert memory module from 45 degree direction.

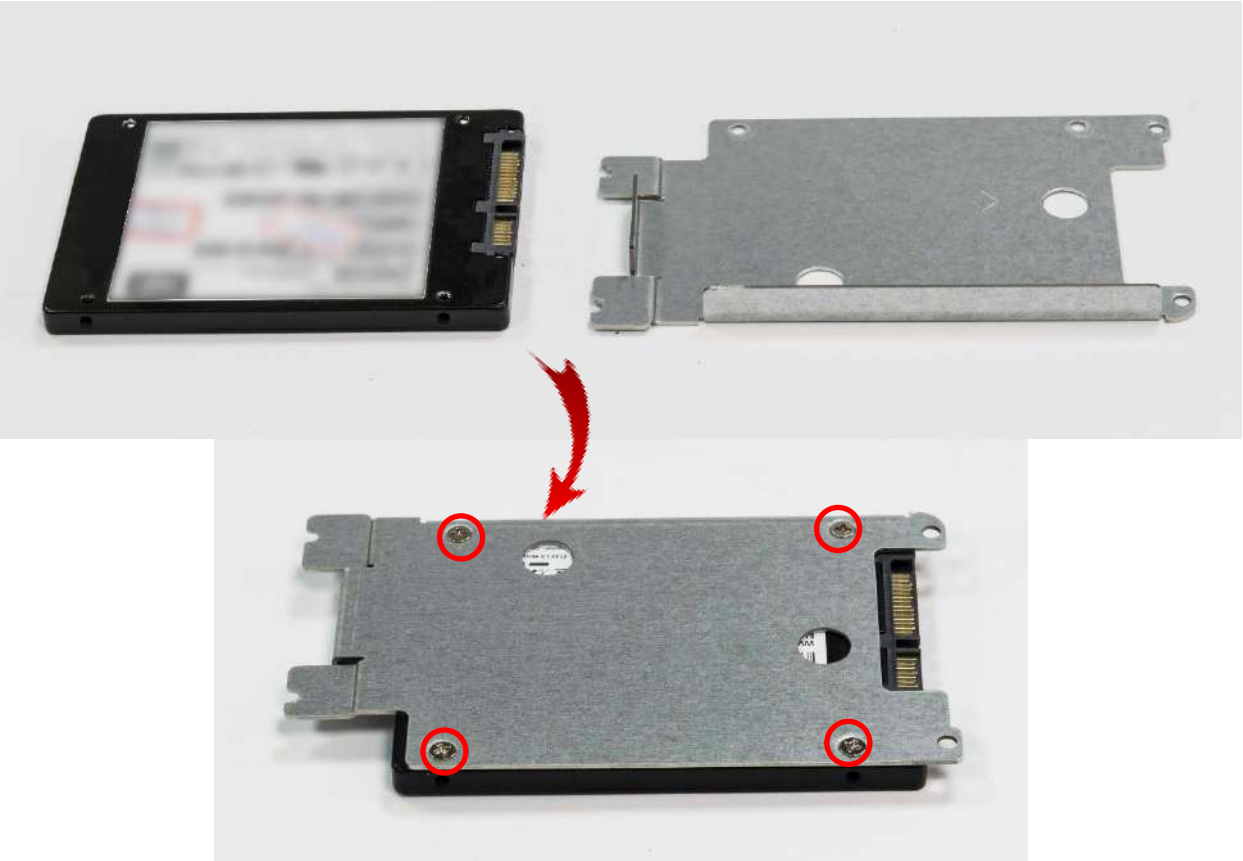
5. Press the memory module vertically downward until you hear the "click" sound. Make sure the memory module is firmly in place.

3.4 Installing SATA HDD/SSD

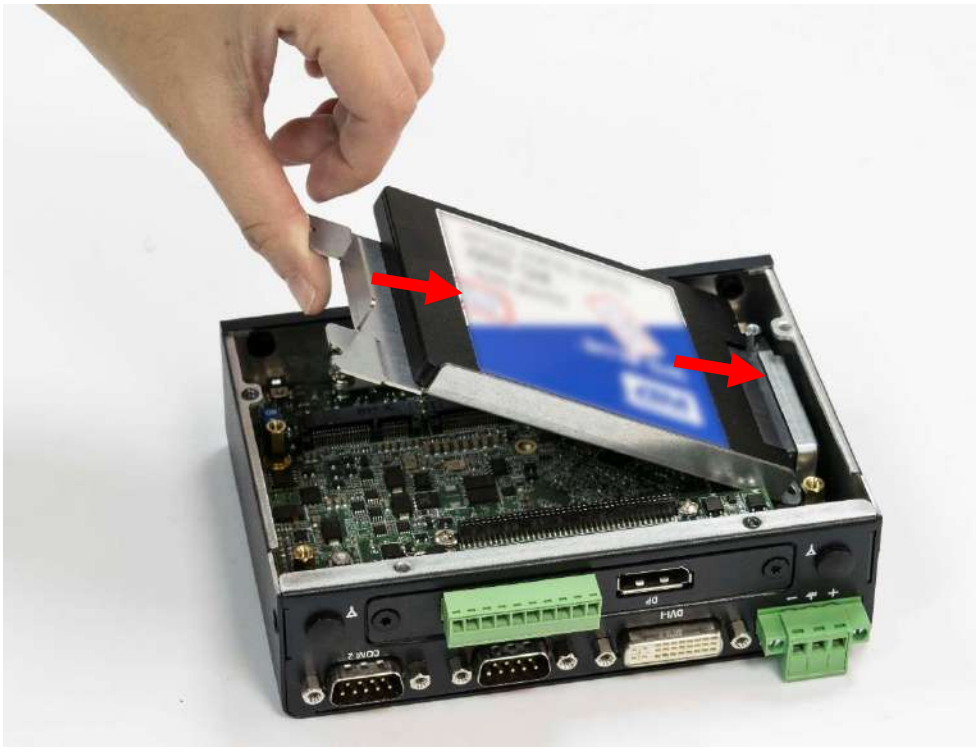
1. Remove HDD bracket by unscrewing the four screws.



2. Lock the 2.5" HDD with HDD bracket using four screws.



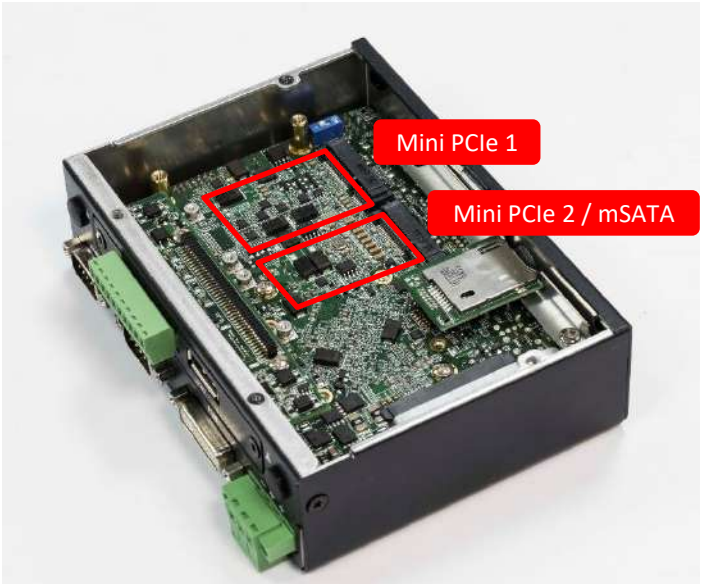
3. Insert the entire bracket following the below direction so the SATA connector is firmly plugged into the HDD.



4. Fasten the four screws to lock the HDD bracket in place.

3.5 Installing Mini PCIe card / mSATA

1. Place the system body upside down so you can see the 2x mini card socket. Mini PCIe 2 (CN3) can support mSATA.



2. Insert mini PCIe card or mSATA module from 45 degree direction.

3. Press the mini PCIe card or mSATA module down and lock it with two screws.

3.6 Installing antenna

1. Remove antenna hole cover on the system panel.

2. Have antenna jack penetrate through the hole.

3. Put on washer and fasten the nut with antenna jack.

4. Assemble the antenna and antenna jack together.

5. Attach the RF connector at the cable-end onto the communication module.

3.7 Assemble chassis bottom cover

1. Place the bottom cover according to the below direction.

2. Lock the bottom cover with the four screws.

3.8 Installing SIM card

1. SIM card socket is located on the front panel of the system.

2. Now you can insert SIM card into the socket.

3. To uninstall SIM card, simply press the installed SIM card and then the card will be pushed out.

Chapter 4

BIOS Setup

4.1 BIOS Introduction

The BIOS provides an interface to modify the configuration. When the battery is removed, all the parameters will be reset.

BIOS Setup

Power on the embedded system and by pressing <Del> immediately allows you to enter the setup screens. If the message disappears before you respond and you still wish to enter the Setup, restart the system by turning it OFF and ON or pressing the RESET button.
You may also restart the system by simultaneously pressing <Ctrl>, <Alt>, and <Delete> keys.

Control Keys	
<←> <→>	Select Screen
<↑> <↓>	Select Item
<Enter>	Select
<Page Up/+>	Increases the numeric value or makes changes
<Page Down/->	Decreases the numeric value or makes changes
<F1>	General Help
<F2>	Previous Value
<F3>	Load Optimized Defaults
<F4>	Save Configuration and Exit
<Tab>	Select Setup Fields
<Esc>	Exit BIOS Setup

Main Setup

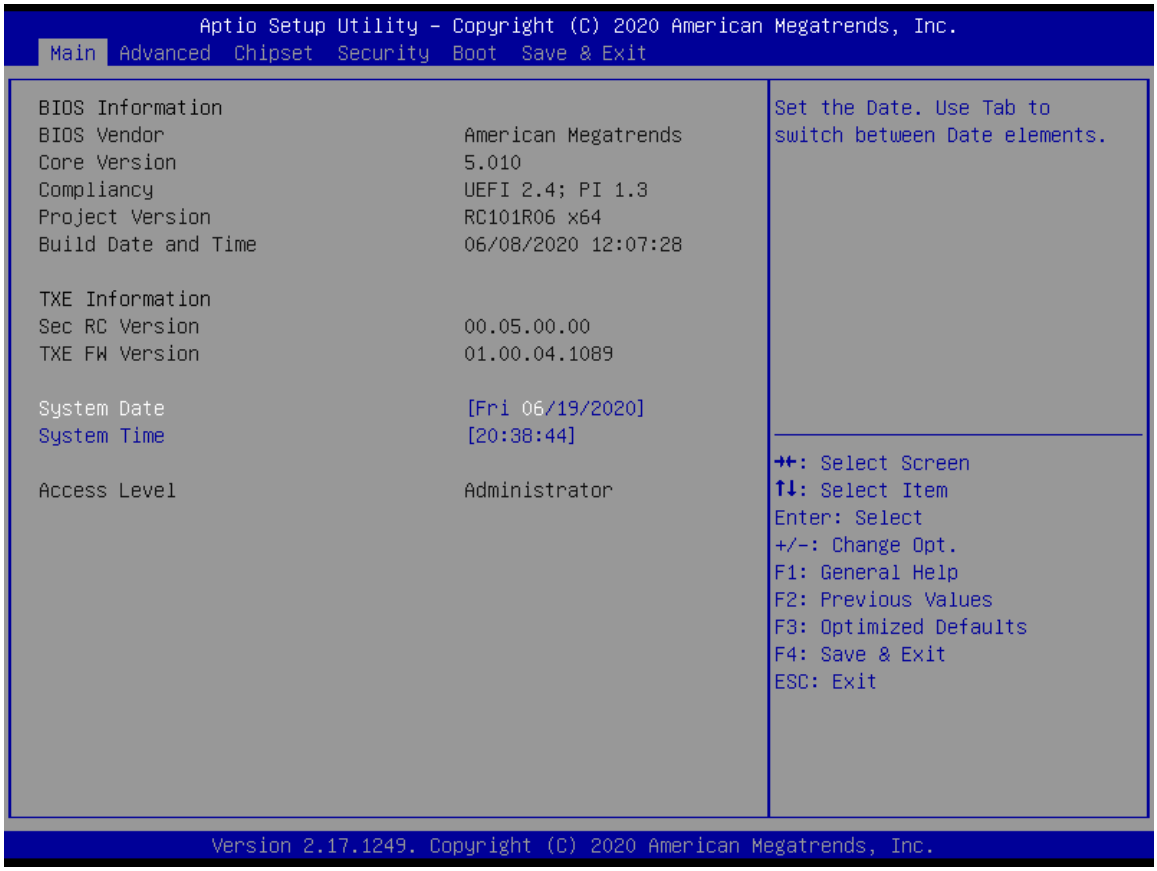
The main menu lists the setup functions you can make changes to. You can use the arrow keys (↑↓) to select the item. The on-line description of the highlighted setup function is displayed at the bottom of the screen.

General Help <F1>

The BIOS setup program provides a General Help screen. You can call up this screen from any menu by simply pressing <F1>. The Help screen lists the appropriate keys to use and the possible selections for the highlighted item. Press <Esc> to exit the Help screen.

4.2 Main Setup

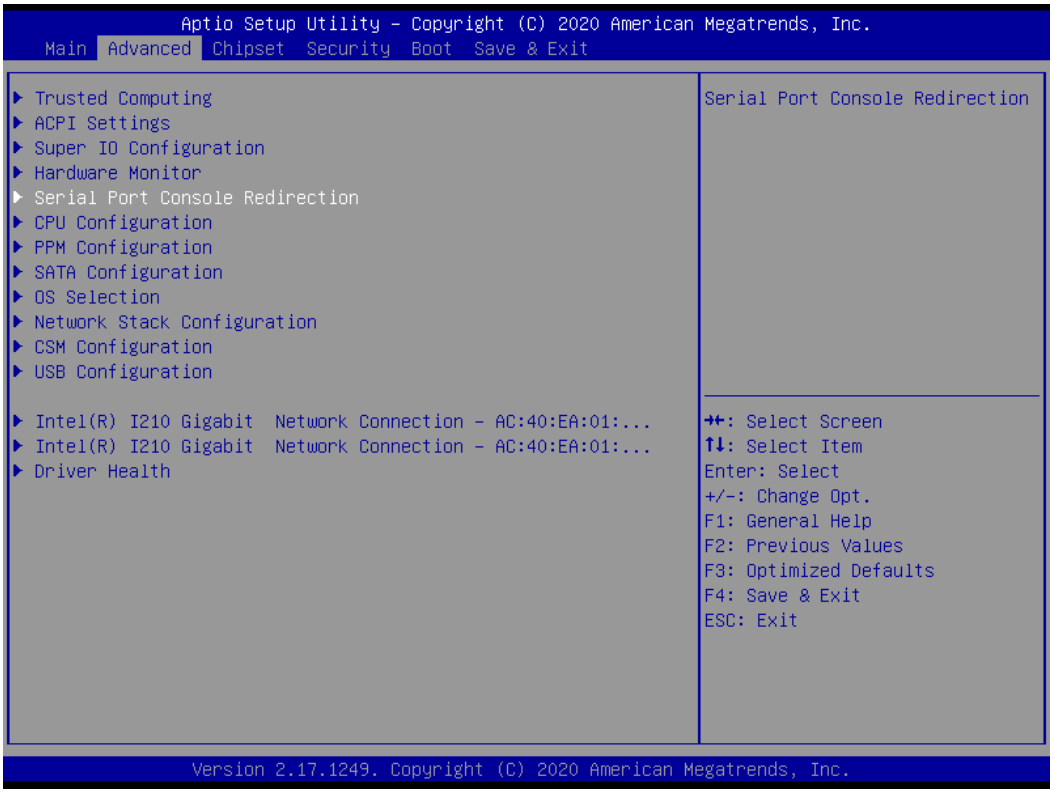
Press <Del> to enter BIOS CMOS Setup Utility. The Main setup screen is showed as following when the setup utility is entered. System Date/Time is set up in the Main Menu.



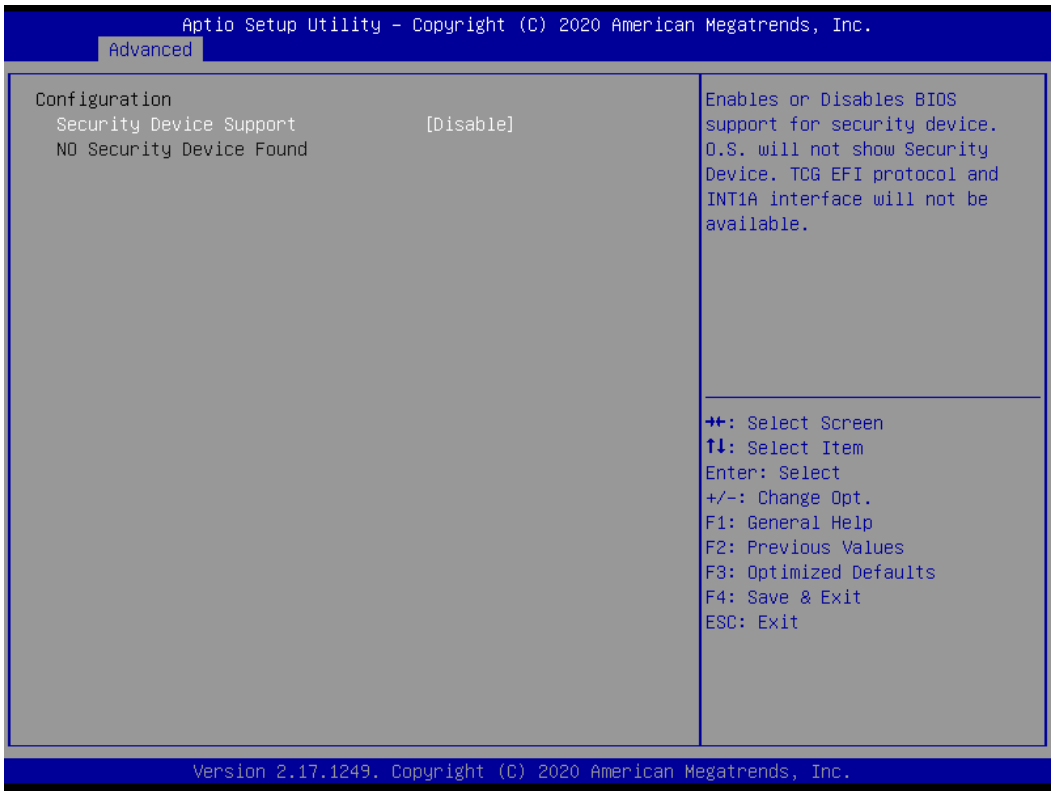
4.2.1 System Date

Set the system date. Please use <Tab> to switch between data elements.

4.3 Advanced Setup

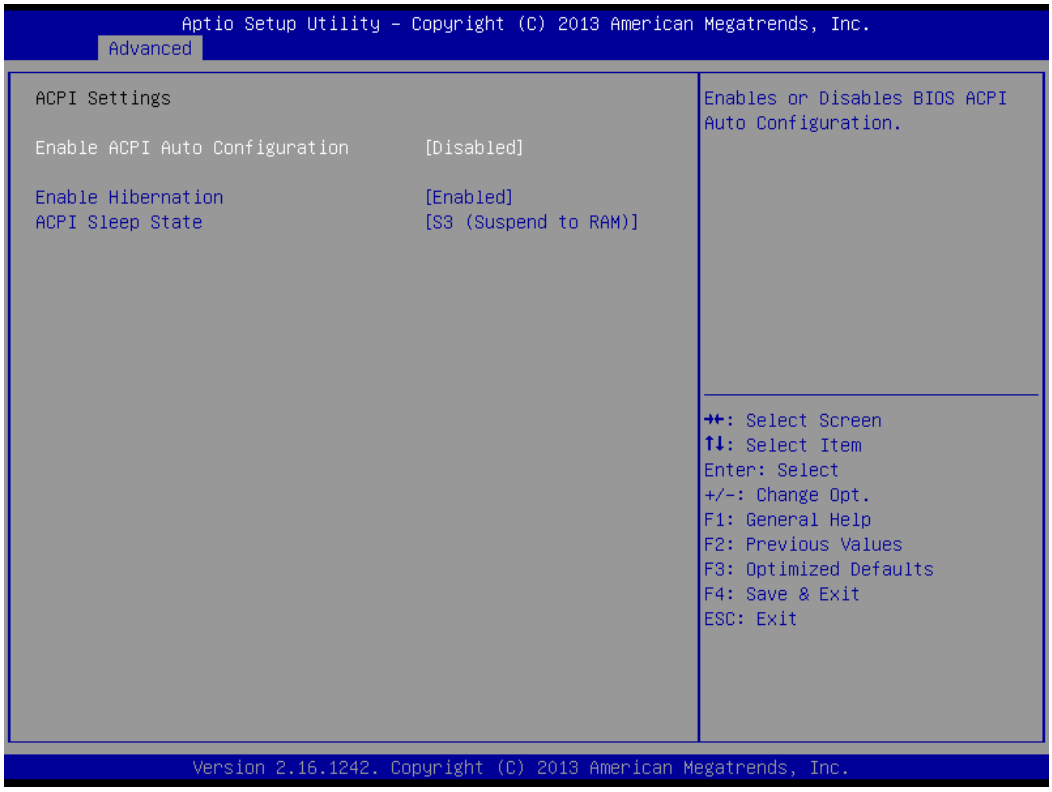


4.3.1 Trusted Computing



■ Security Device Support
Enable or disable TPM function

4.3.2 ACPI Settings



■ Enable ACPI Auto Configuration

This item allows you to enable or disable BIOS ACPI Auto Configuration.

■ Enable Hibernation

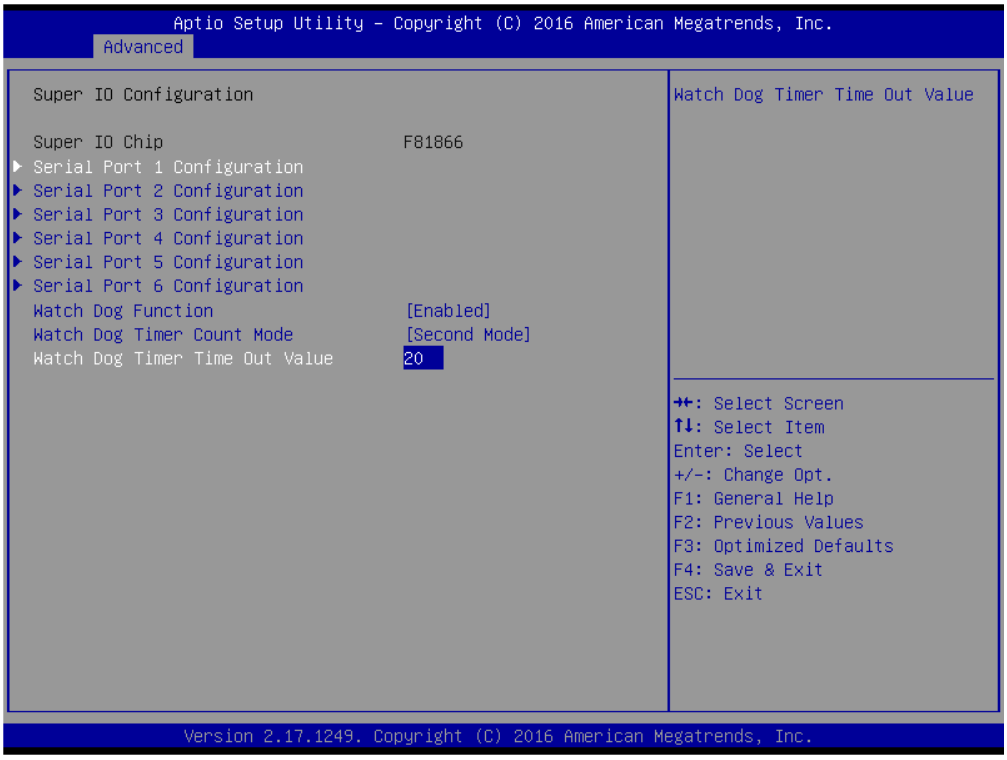
This item allows you to enable or disable system ability to hibernate.

■ ACPI Sleep State

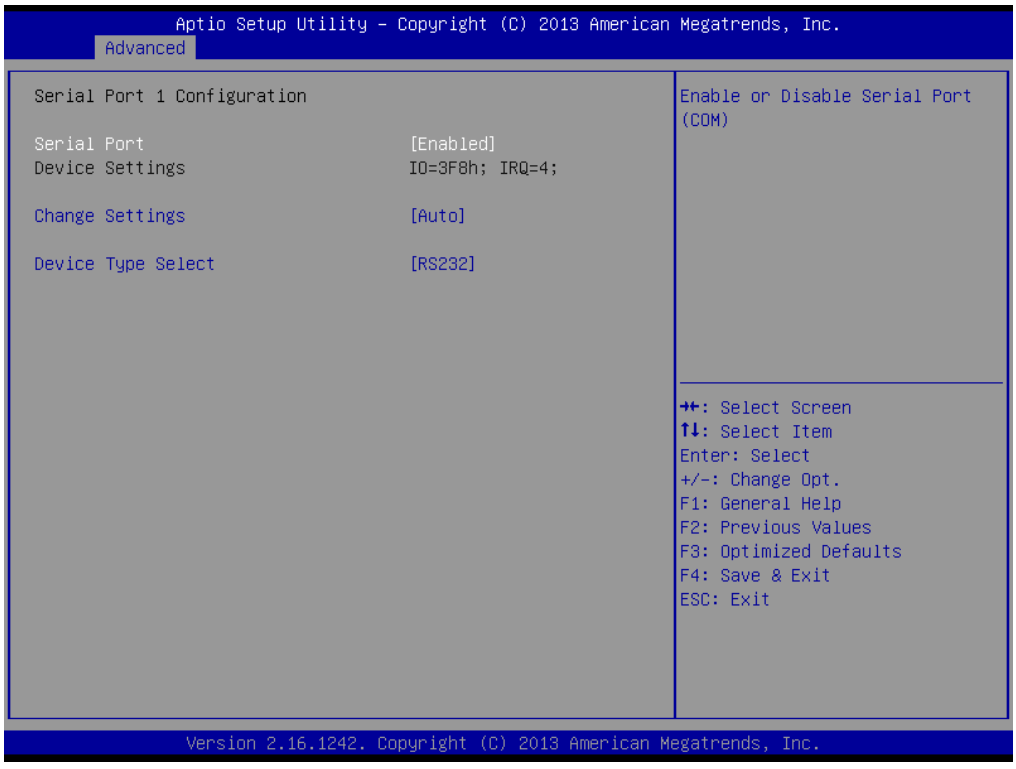
This item selects the highest ACPI sleep state the system will enter when the suspend button is pressed. Select <Suspend Disabled> or <S3 (Suspend to RAM)>.

4.3.3 Super IO Configuration

This setting allows you to select options for the Super IO Configuration, and change the value of the selected option.



■ Serial Port 1 Configuration



❑ Serial Port

This item allows you to enable or disable serial port.

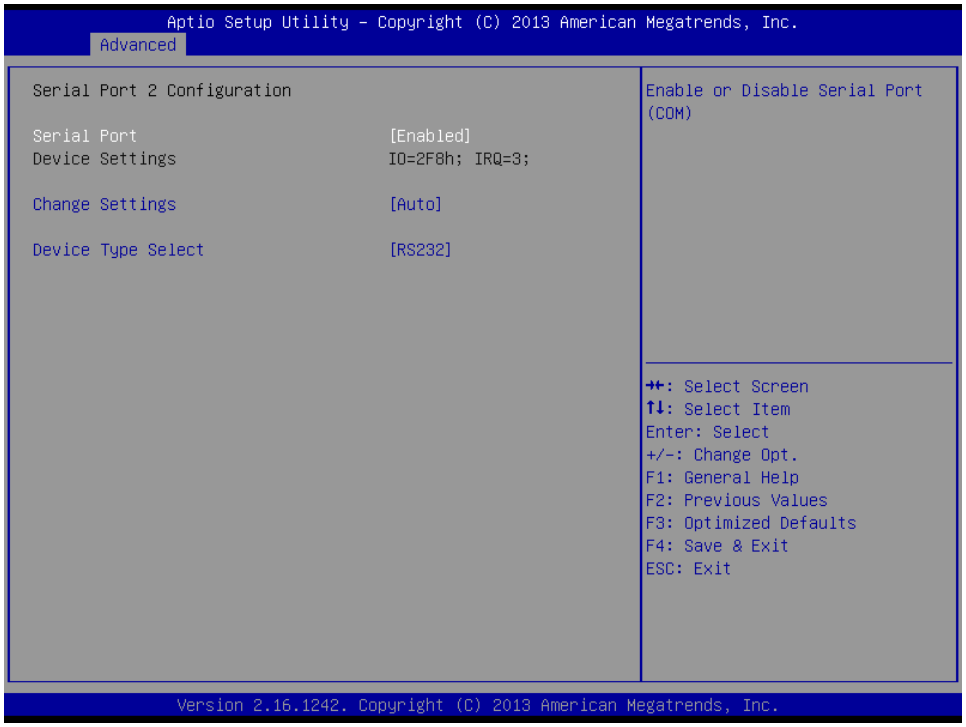
❑ Change Settings

This item allows you to change the address & IRQ settings of the specified serial port.

❑ Device Type Select

Change the Serial interface. Select <RS232> ,<RS422 Full Duplex> or <RS485 Half Duplex> interface.

■ Serial Port 2 Configuration



❑ Serial Port

This item allows you to enable or disable serial port.

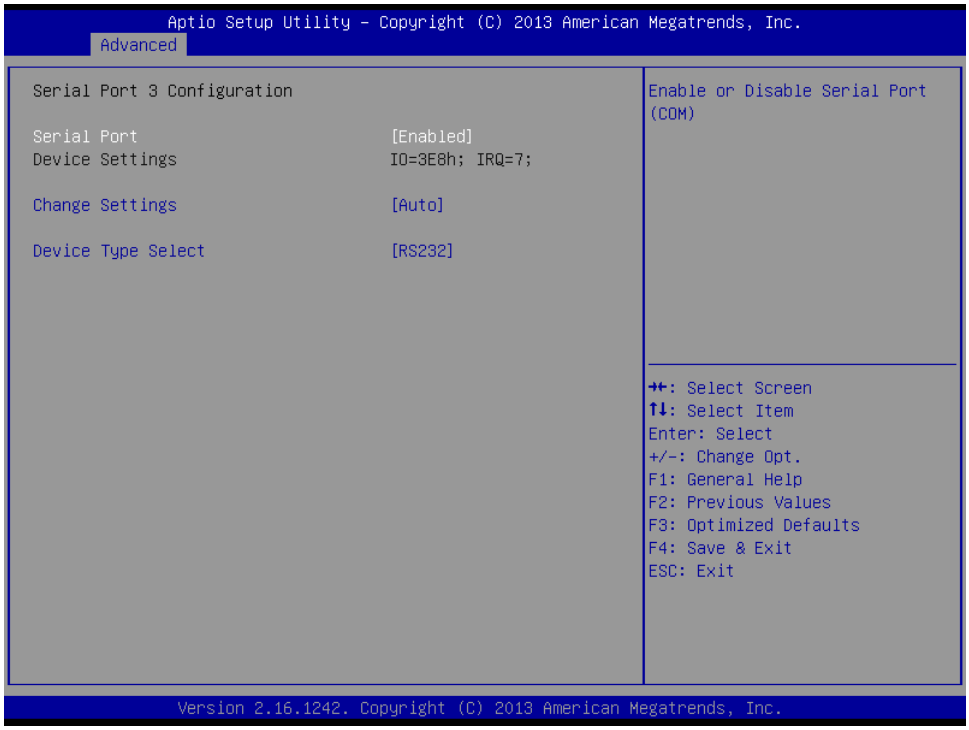
❑ Change Settings

This item allows you to change the address & IRQ settings of the specified serial port.

❑ Device Type Select

Change the Serial interface. Select <RS232> ,<RS422 Full Duplex> or <RS485 Half Duplex> interface.

■ Serial Port 3 Configuration



❑ Serial Port

This item allows you to enable or disable serial port.

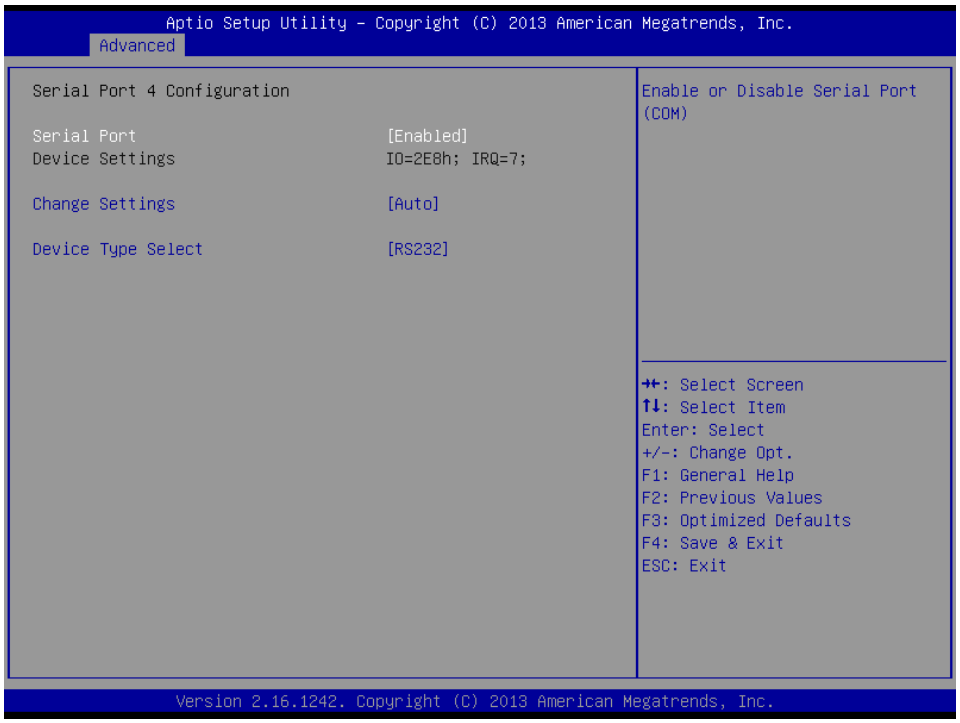
❑ Change Settings

This item allows you to change the address & IRQ settings of the specified serial port.

❑ Device Type Select

Change the Serial interface. Select <RS232> ,<RS422 Full Duplex> or <RS485 Half Duplex> interface.

■ Serial Port 4 Configuration



❑ Serial Port

This item allows you to enable or disable serial port.

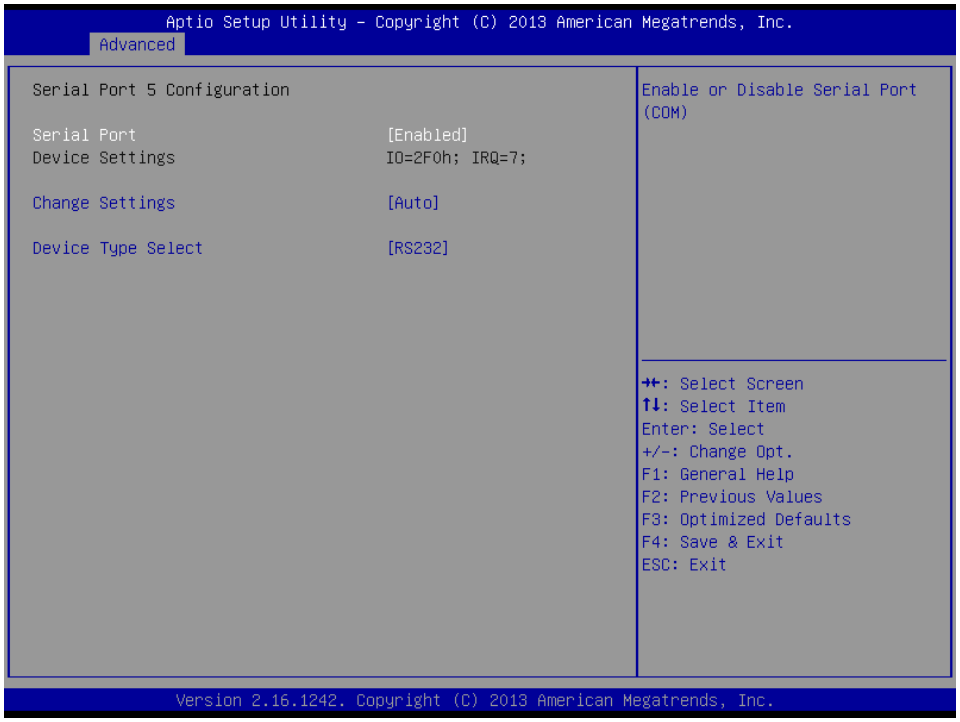
❑ Change Settings

This item allows you to change the address & IRQ settings of the specified serial port.

❑ Device Type Select

Change the Serial interface. Select <RS232> ,<RS422 Full Duplex> or <RS485 Half Duplex> interface.

■ Serial Port 5 Configuration



❑ Serial Port

This item allows you to enable or disable serial port.

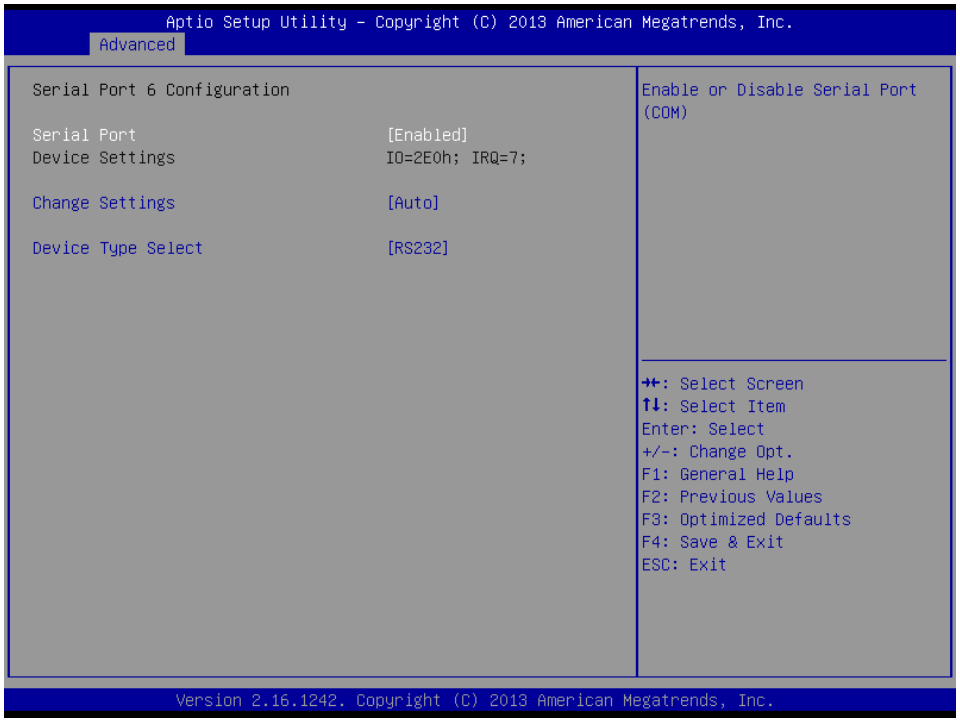
❑ Change Settings

This item allows you to change the address & IRQ settings of the specified serial port.

❑ Device Type Select

Change the Serial interface. Select <RS232> ,<RS422 Full Duplex> or <RS485 Half Duplex> interface.

■ Serial Port 6 Configuration



❑ **Serial Port**

This item allows you to enable or disable serial port.

❑ **Change Settings**

This item allows you to change the address & IRQ settings of the specified serial port.

❑ **Device Type Select**

Change the Serial interface. Select <RS232> ,<RS422 Full Duplex> or <RS485 Half Duplex> interface.

■ Watch Dog Function

This setting allows you to setup the system watch-dog timer, a hardware timer that generates a reset when the software that it monitors does not respond as expected each time the watch dog polls it.

❑ **Watch Dog Timer Count Mode**

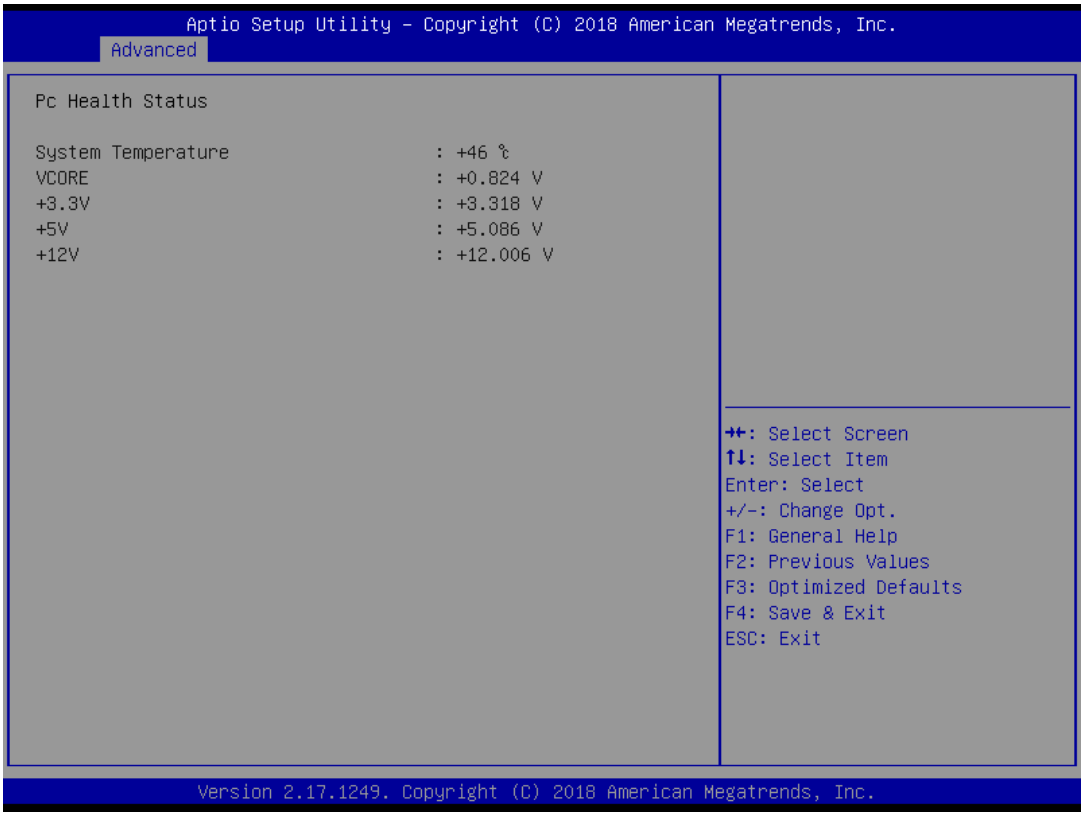
Change the Watch dog mode. Select <Second Mode> or <Minute Mode> mode.

❑ **Watch Dog Timer Time Out Value**

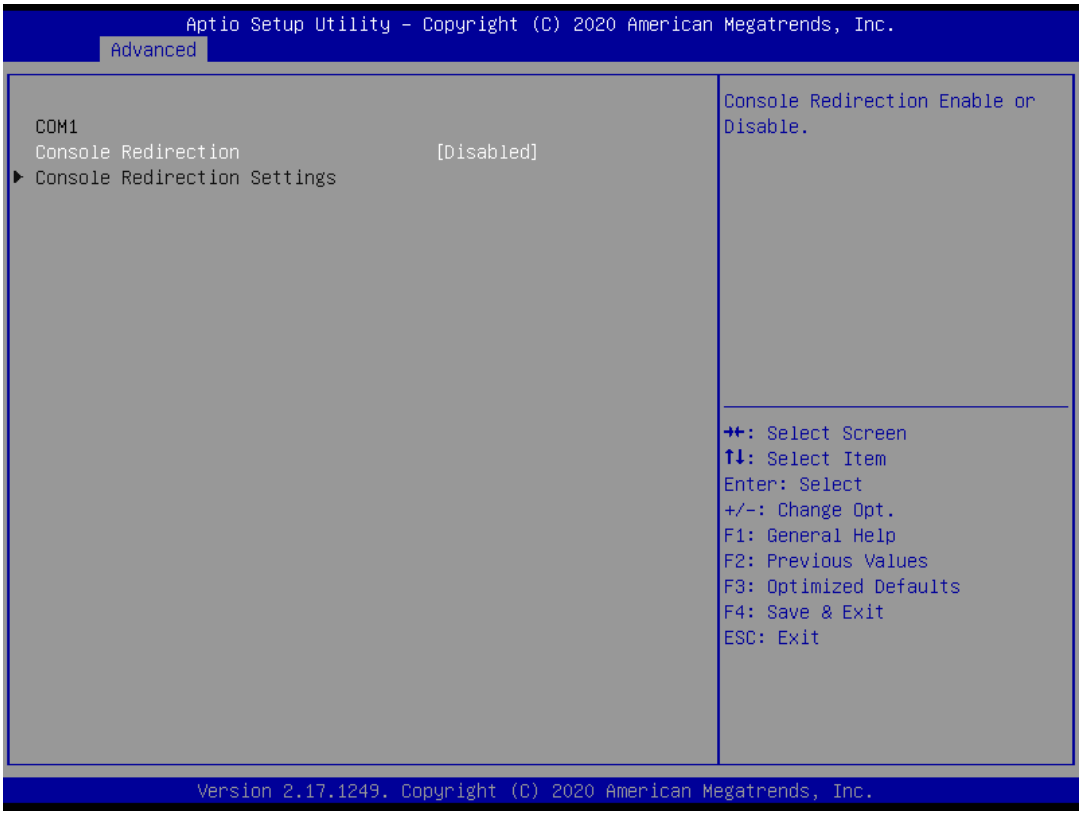
User can set a value in the range of 0 to 255.

4.3.4 Hardware Monitor

These items display the current status of all monitored hardware devices/ components such as voltages and temperatures.



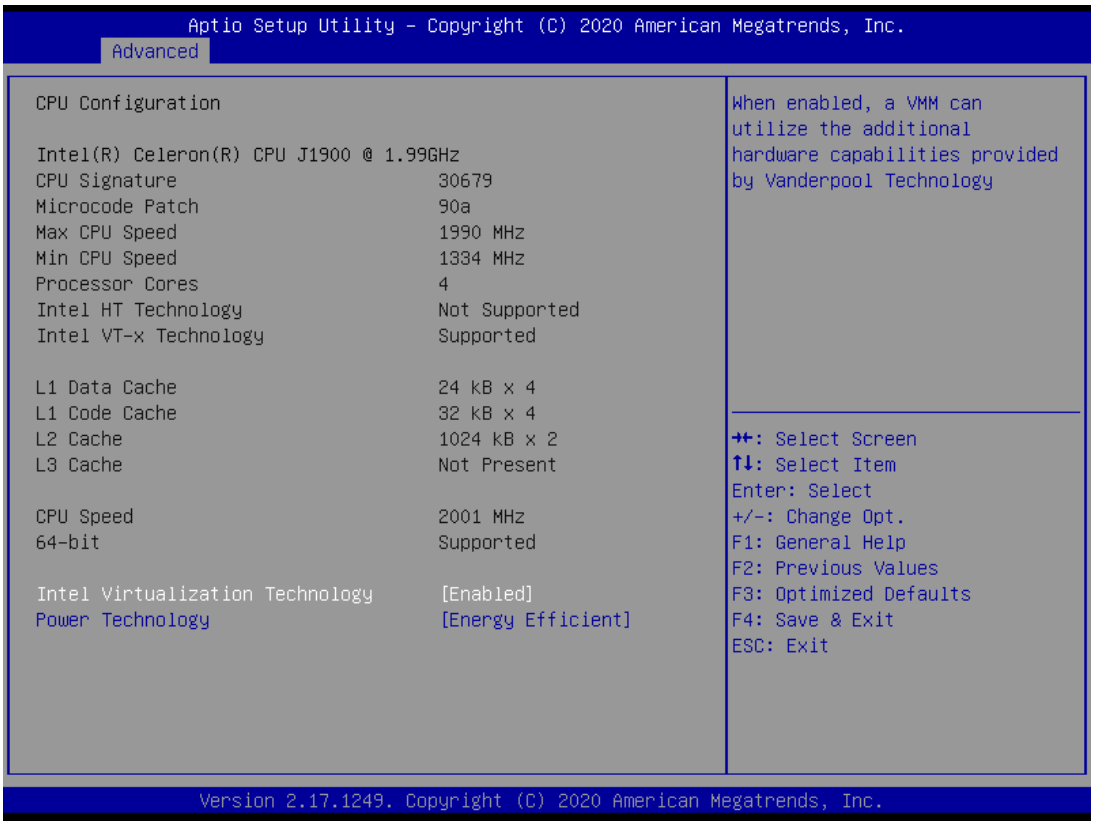
4.3.5 Serial Port Console Redirection



■ Console Redirection

These items allows you to enable or disable COM1 console redirection.

4.3.6 CPU Configuration



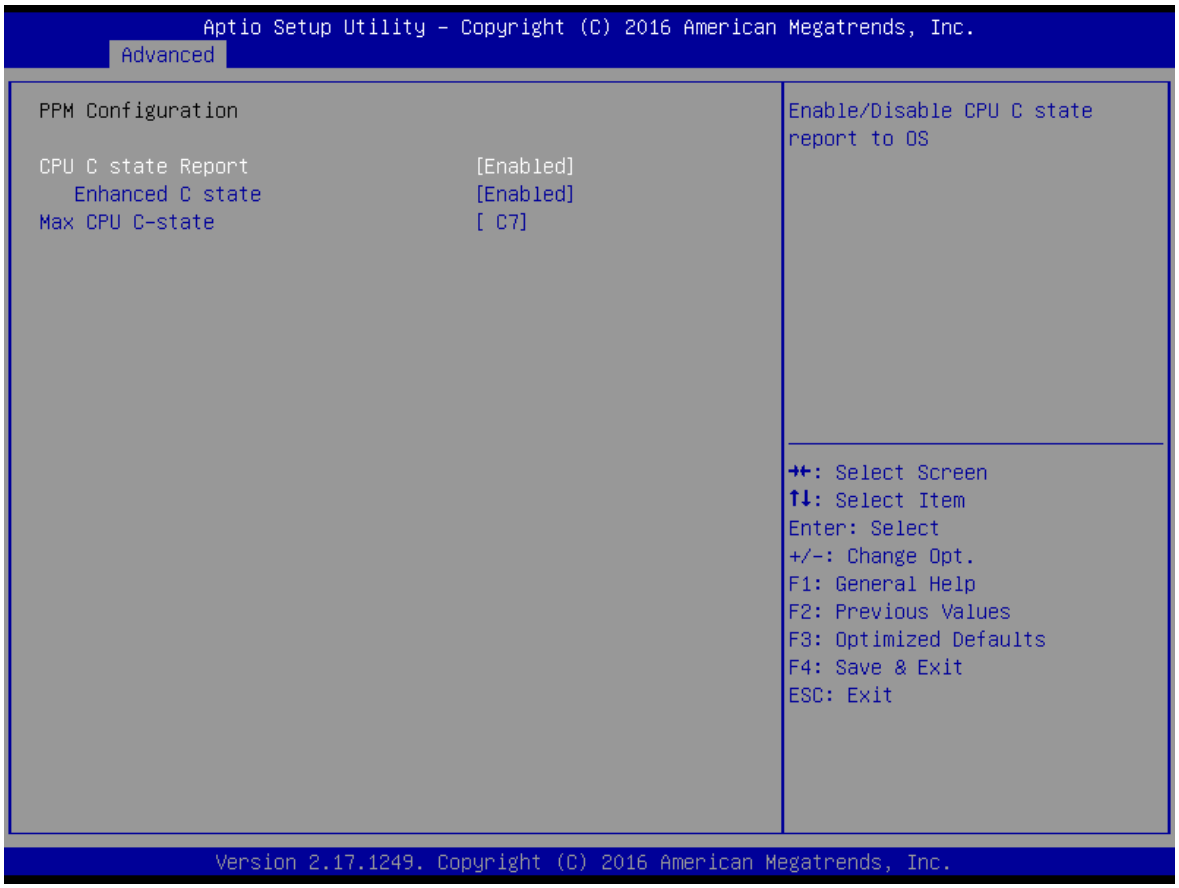
■ Intel Virtualization Technology

Virtualization enhanced by Intel Virtualization Technology will allow a platform to run multiple operating systems and applications in independent partitions. With virtualization, one computer system can function as multiple Virtual systems.

■ Power Technology

This item allows you to configure the power management features. Select <Disable>, <Energy Efficient> or <Custom>.

4.3.7 PPM Configuration



■ CPU C state Report

Enables or disables support for CPU's power-saving functions.

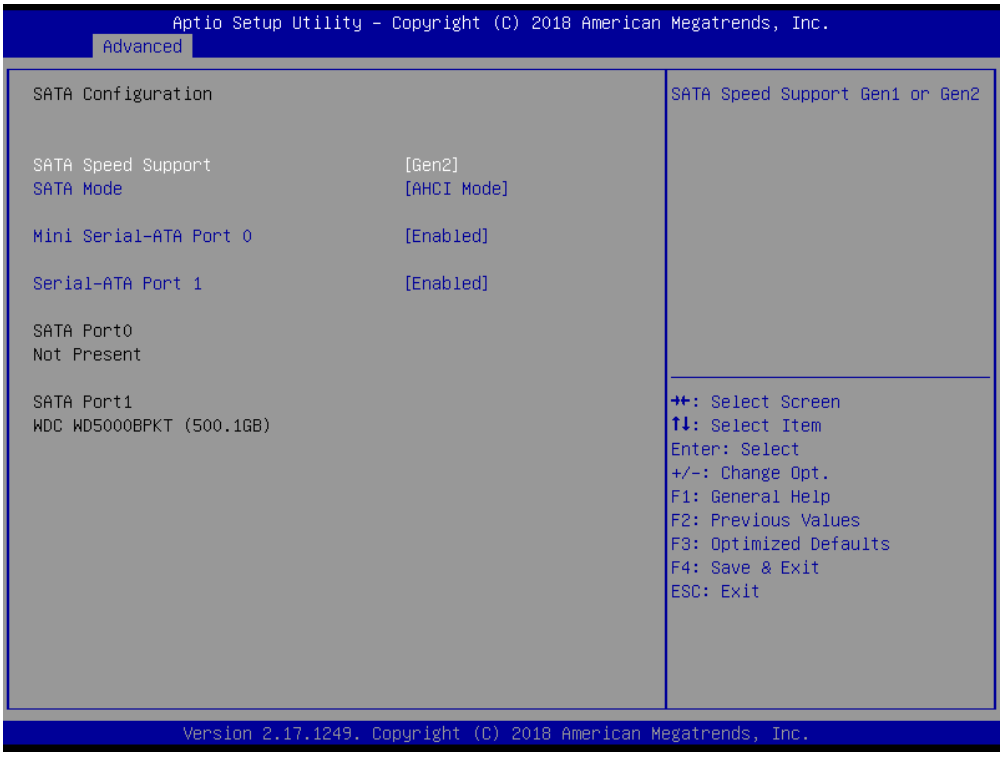
■ Enhanced C state

Enables or disables Intel CPU Enhanced Halt (C1E) function, a CPU power-saving function in system halt state. When enabled, the CPU core frequency and voltage will be reduced during system halt state to decrease power consumption. This item is configurable only when CPU C state Report is enabled.

■ Max CPU C-state

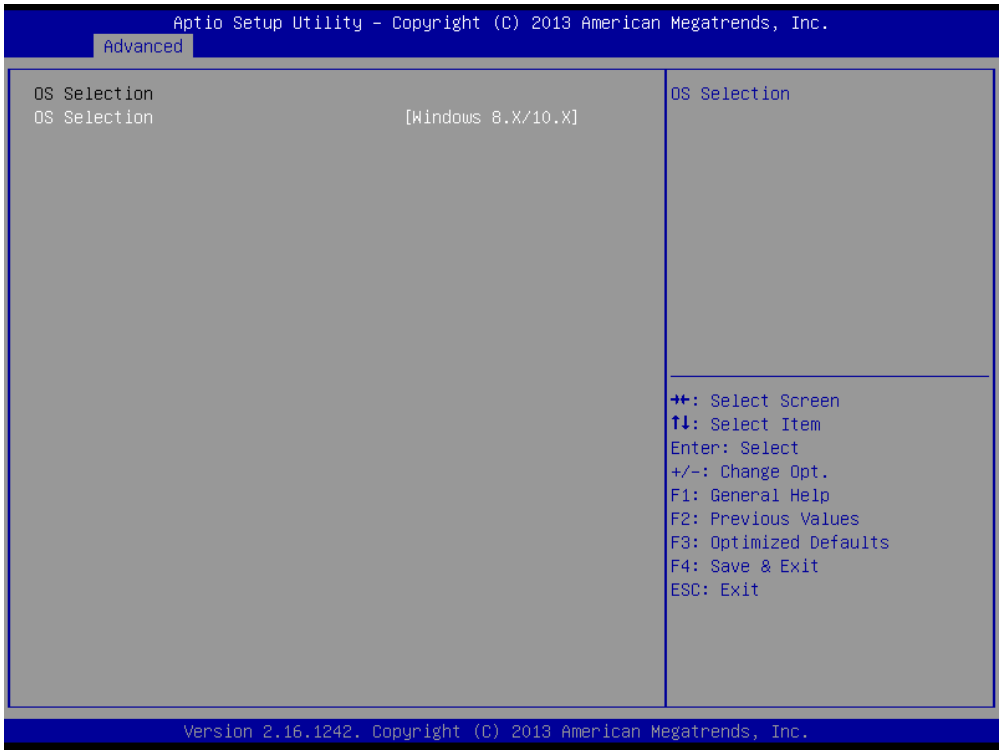
This item allows you to determine the maximum C state that the CPU will support.

4.3.8 SATA Configuration

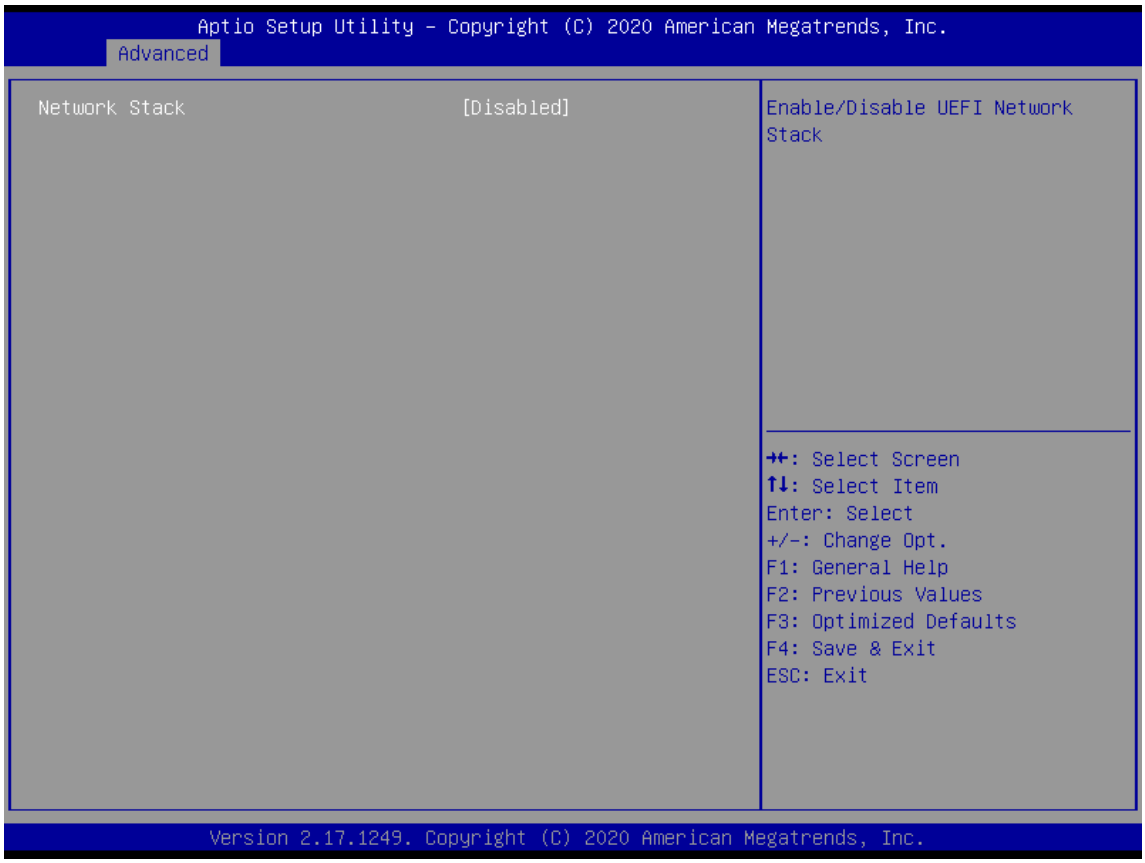


■ SATA Speed Support
Change the SATA Speed. Select <Gen1> or <Gen2> speed.
■ SATA Mode
This item allows you to select IDE or AHCI Mode.
■ Mini Serial – ATA Port 0
This item allows you to enable or disable Serial-ATA Port 0.
■ Serial – ATA Port 1
This item allows you to enable or disable Serial-ATA Port 1.

4.3.9 OS Selection

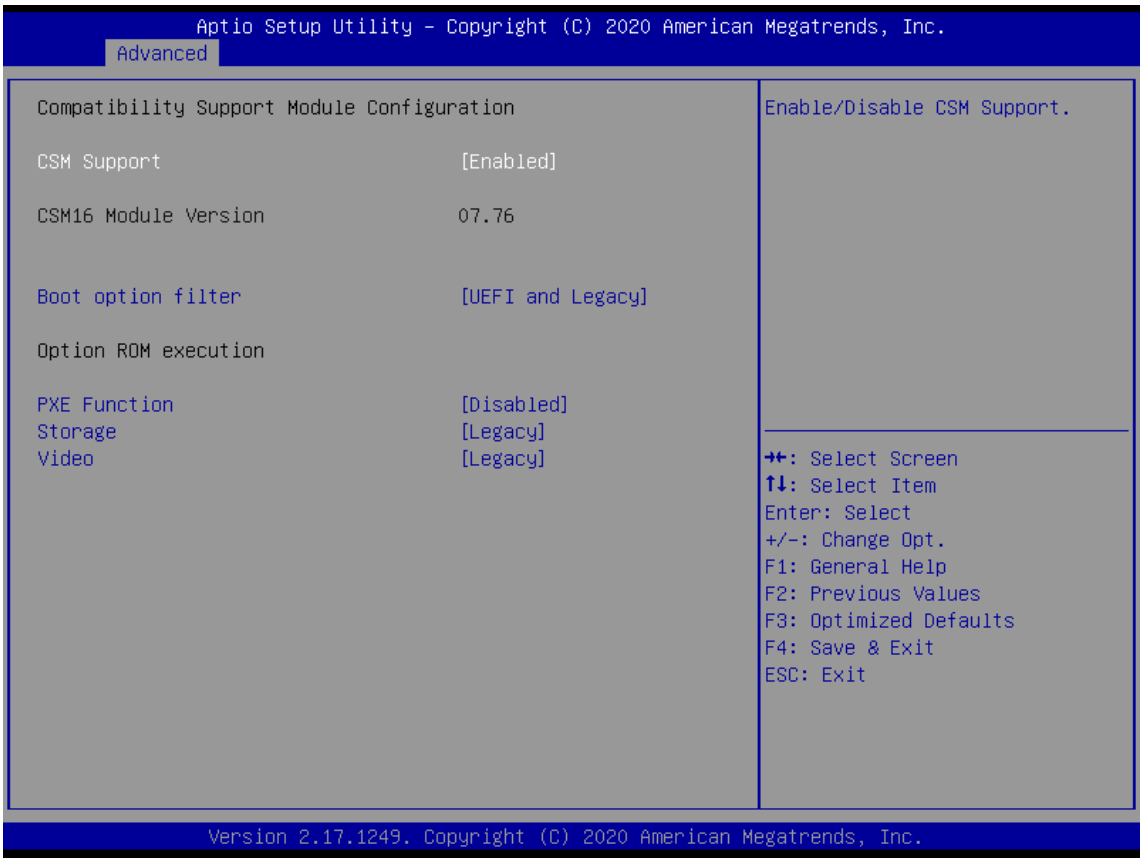


4.3.10 Network Stack Configuration



■ Network Stack
Enable/Disable UEFI Network Stack.

4.3.11 CSM Configuration



■ CSM Support
Enables or disables UEFI CSM (Compatibility Support Module) to support a legacy PC boot process.

■ Boot option filter
This item allows you to select which type of operating system to boot.
UEFI and Legacy: Allows booting from operating systems that support legacy option ROM or UEFI option ROM.
Legacy only: Allows booting from operating systems that only support legacy option ROM.
UEFI only: Allows booting from operating systems that only support UEFI option ROM.
This item is configurable only when CSM Support is set to Enabled.

■ PXE Function
This item allows you to enable or disable PXE function.

■ Storage
This setting allows you to select whether to enable the UEFI or legacy option ROM for the storage device controller.
Do not launch: Disables option ROM.
UEFI only: Enables UEFI option ROM only.
Legacy only: Enables legacy option ROM only.

■ Video
This item allows you to select whether to enable the UEFI or legacy option ROM for the storage device controller.
Do not launch: Disables option ROM.
UEFI only: Enables UEFI option ROM only.
Legacy only: Enables legacy option ROM only.

4.3.12 USB Configuration

■ Legacy USB Support
Allows USB keyboard/ mouse to be used in MS-DOS.

■ XHCI Hand-off
Determines whether to enable XHCI (USB3.0) Hand-off feature for an operating system without XHCI (USB3.0) Hand-off support.

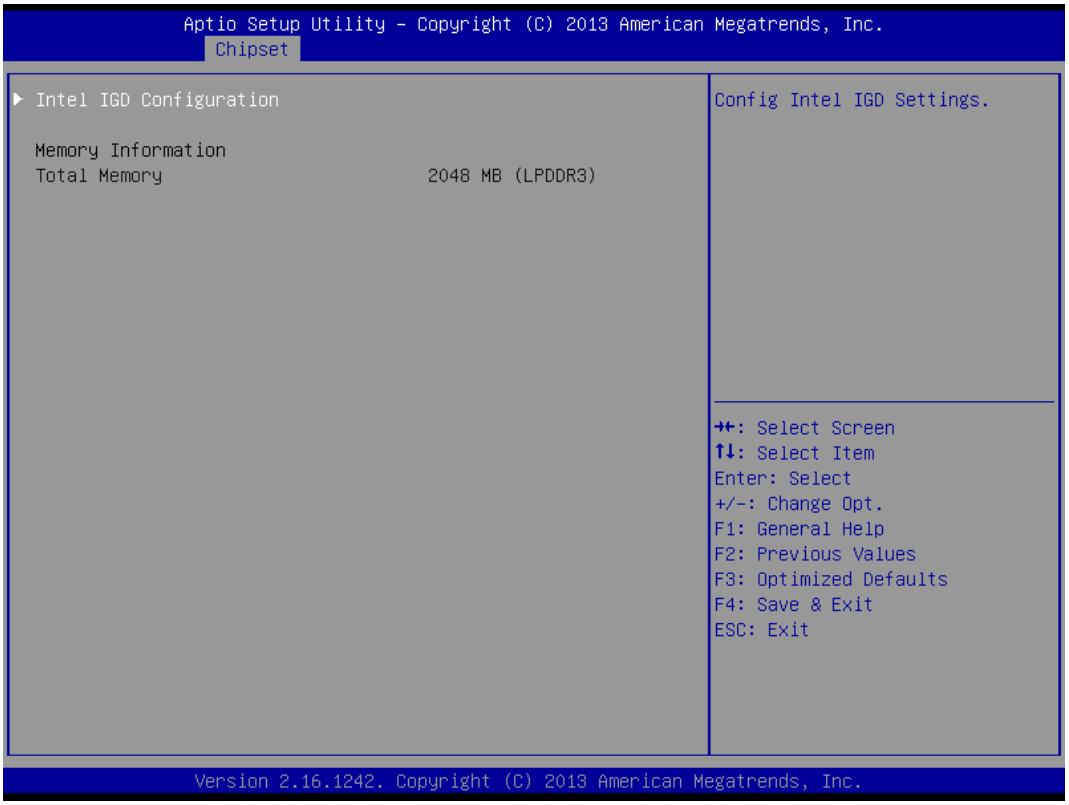
■ EHCI Hand-off
Determines whether to enable EHCI Hand-off feature for an operating system without EHCI Hand-off support.

■ USB Mass Storage Driver Support
Enables or disables support for USB storage devices.

4.4 Chipset

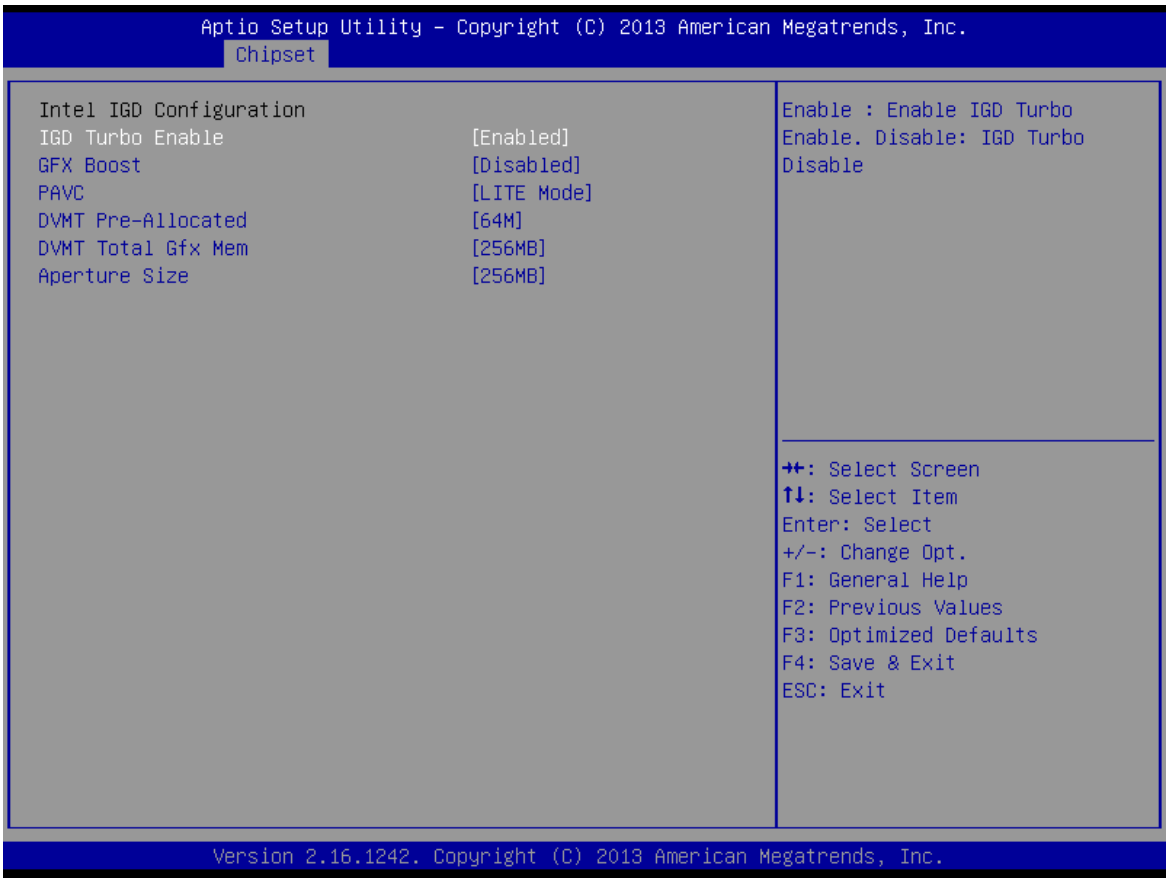
4.4.1 North Bridge

This section provides information on the installed memory size and memory/onboard graphics-related configuration options.



■ Intel IGD Configuration

This section provides onboard graphics-related configuration options.



❑ IGD Turbo Enable

This item allows you to enable or disable IGD Turbo.

❑ GFX Boost

This item allows you to enable or disable GFX Boost.

❑ PAVC

This item enables/disables Protected Audio Video Control. Select <Disabled>, <LITE Mode> or <SERPENT Mode>.

❑ DVMT Pre-Allocated

This item selects DVMT 5.0 Pre-Allocated (Fixed) Graphics Memory size used by the Internal Graphics Device. . Select <64M>, <96M>, <128M>, <160M>, <192M>, <224M>, <256M>, <288M>, <320M>, <352M>, <384M>, <416M>, <448M>, <480M> or <512M>.

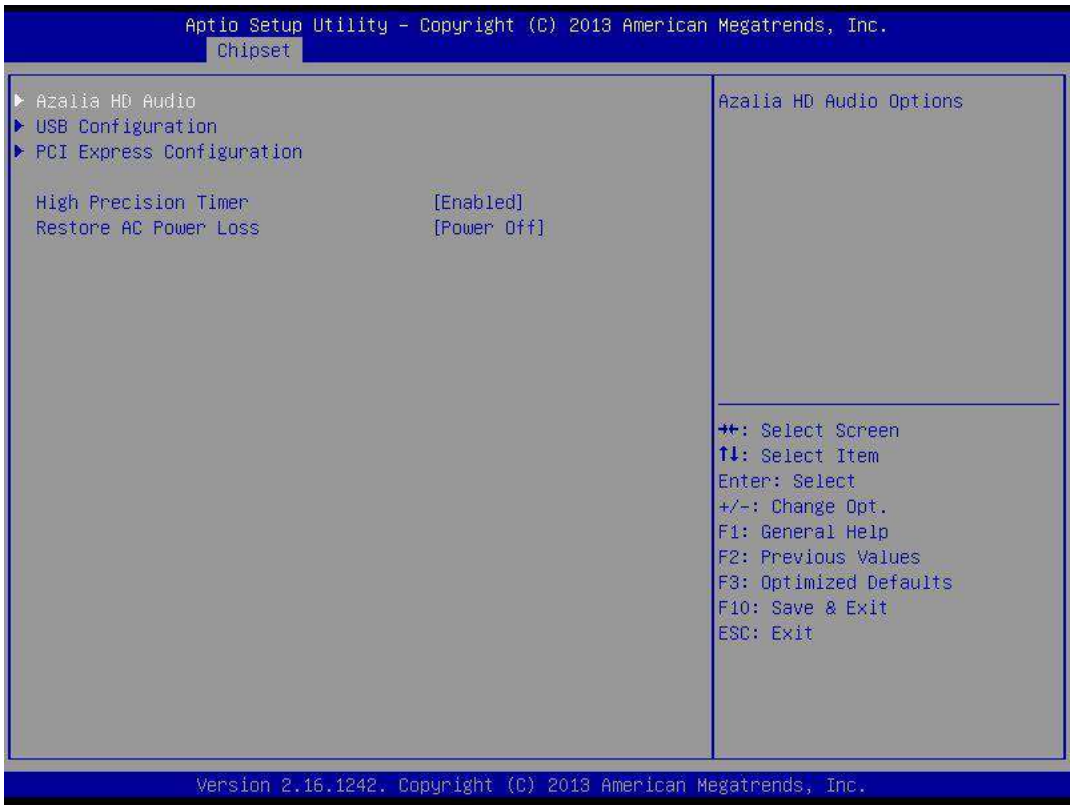
❑ DVMT Total Gfx Mem

This item selects DVMT5.0 Total Graphic Memory size used by the Internal Graphics Device. Select <128MB>, <256MB> or <Max>.

❑ Aperture Size

This item selects the Aperature Size. Select <128MB>, <256MB> or <512MB>.

4.4.2 South Bridge



■ Azalia HD Audio

Control detection of the Azaliadevice.

❑ Audio Controller

Enabled: Azalia will be unconditionally enabled.

Disabled: Azalia will be unconditionally disabled.

■ USB Configuration

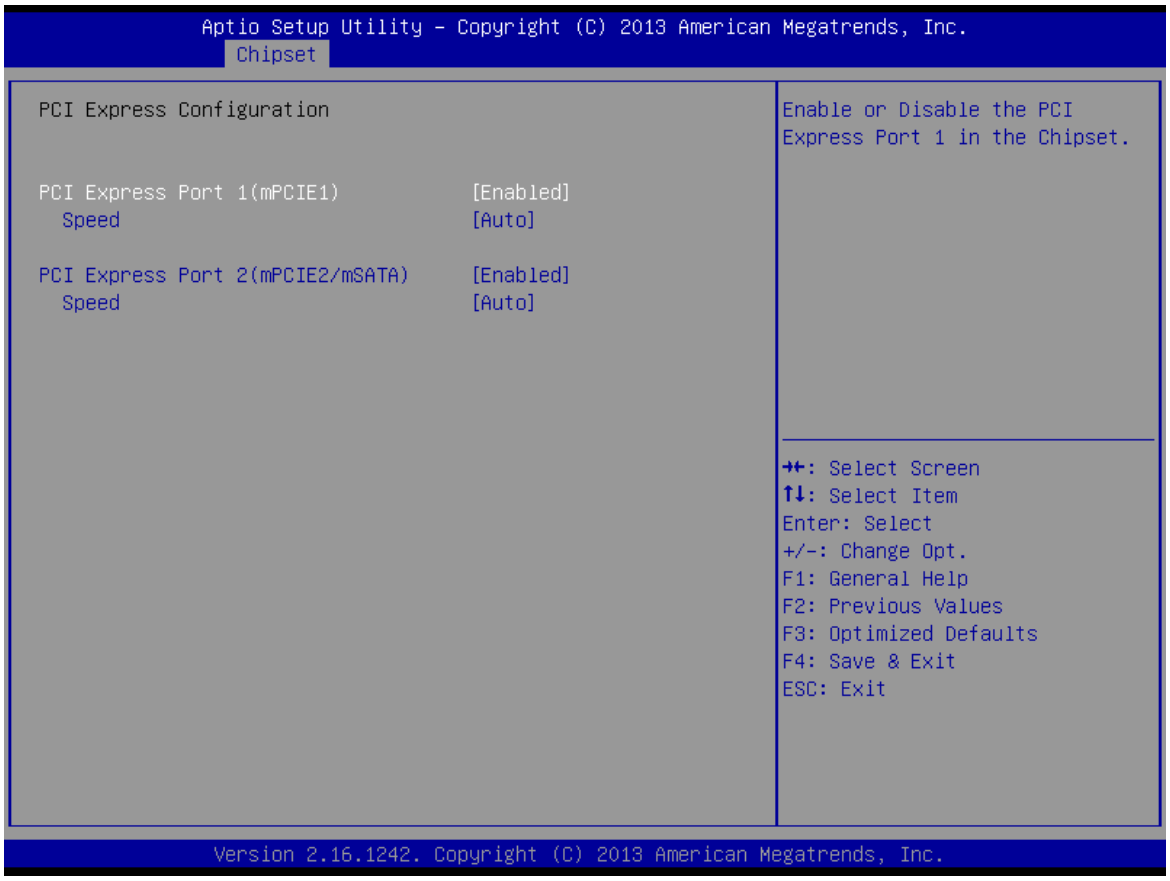
❑ XHCI Mode

This item allows you to enable or disable the USB XHCI controller.

❑ USB 2.0 (EHCI) Support

This item allows you to enable or disable the USB EHCI support.

■ PCI Express Configuration



❑ **PCI Express Port 1 (mPCIE1)**

This item allows you to enable or disable PCI Express Port 1 (mPCIE1) in the Chipset.

❑ **Speed**

❑ Change the PCIe Port Speed. Select <AUTO> ,<Gen 2> or <Gen 1>

❑ **PCI Express Port 2 (mPCIE2/mSATA)**

❑ This item allows you to enable or disable PCI Express Port 2 (mPCIE2/mSATA) in the Chipset.

❑ **Speed**

❑ Change the PCIe Port Speed. Select <AUTO> ,<Gen 2> or <Gen 1>

■ High Precision Timer

Enable or disable High Precision Event Timer (HPET) in the operating system.

■ Restore AC Power Loss

This item specifies whether your system will reboot after a power failure or interrupt occurs. Available settings are:

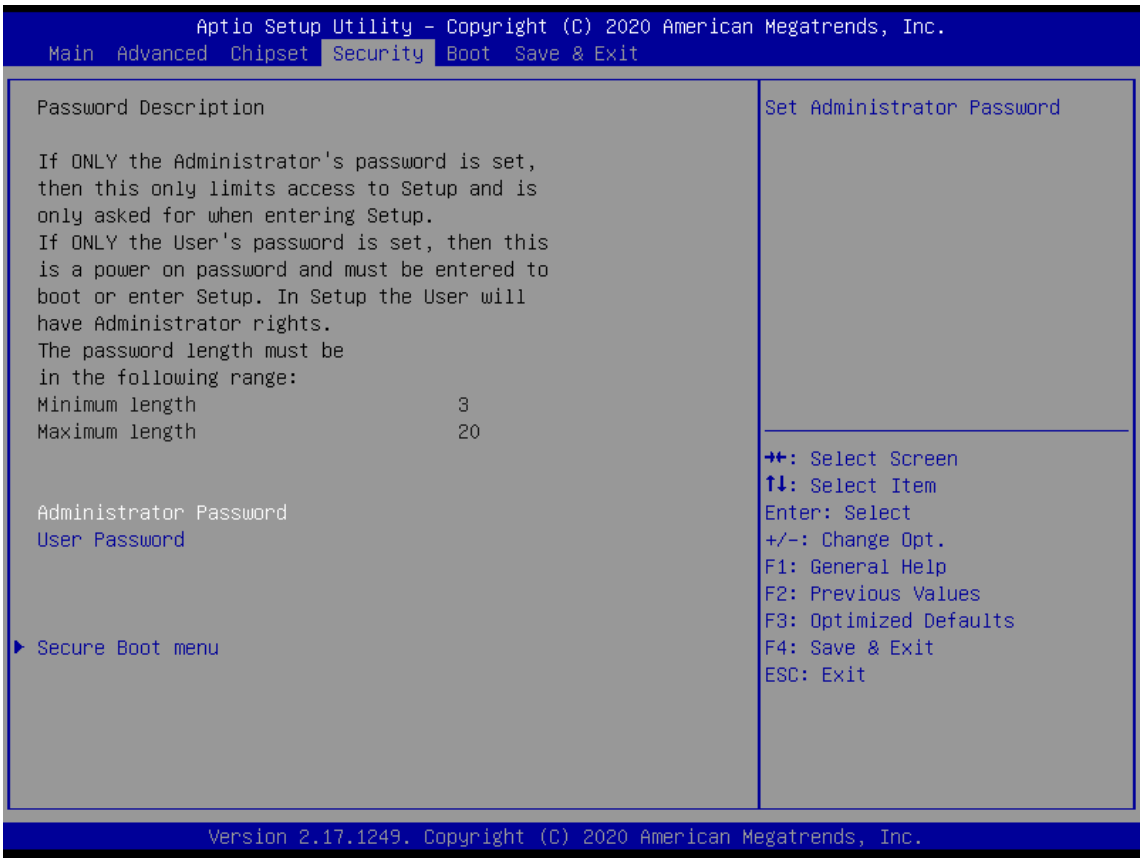
Power Off: Leave the computer in the power off state.

Power On: Leave the computer in the power on state.

Last State: Restore the system to the previous status before power failure or interrupt occurred.

4.5 Security

Security menu allow you to change administrator password and user password settings.



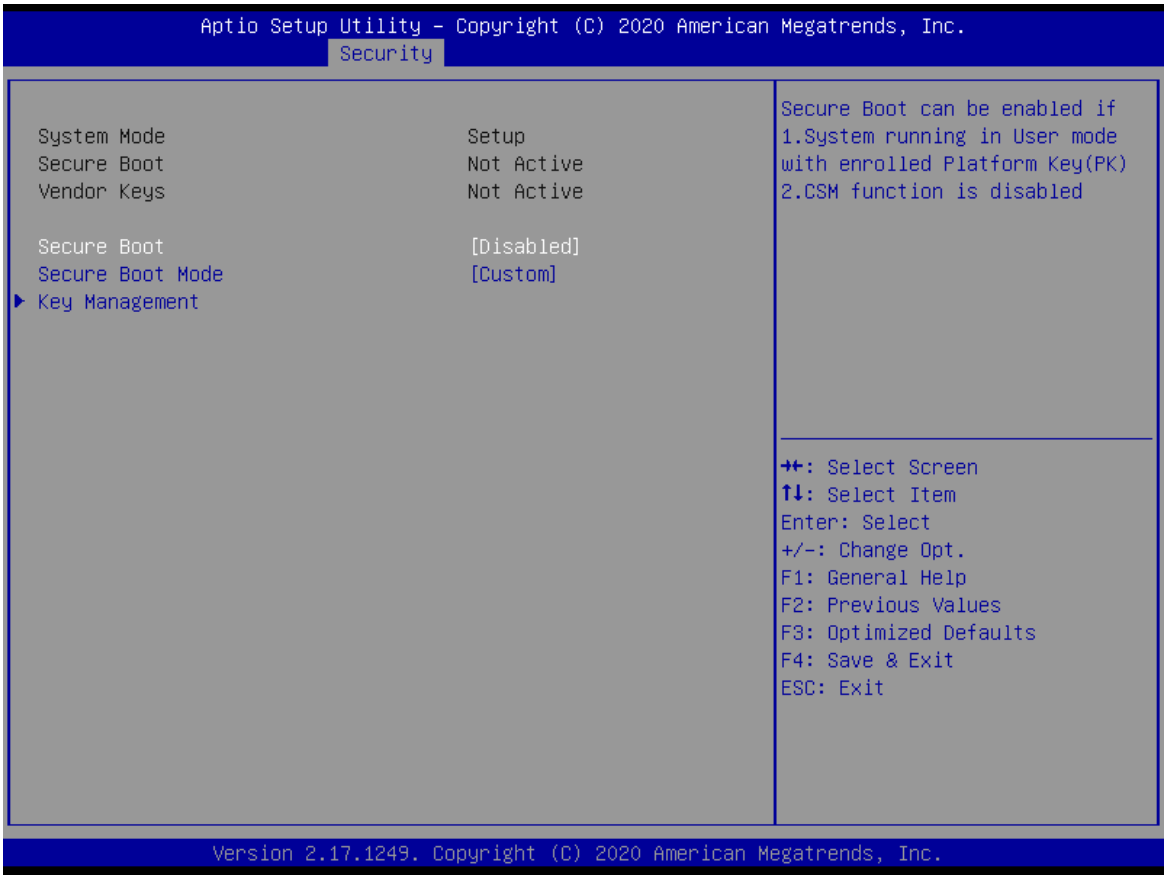
4.5.1 Administrator Password

This item allows you to set Administrator Password.

4.5.2 User Password

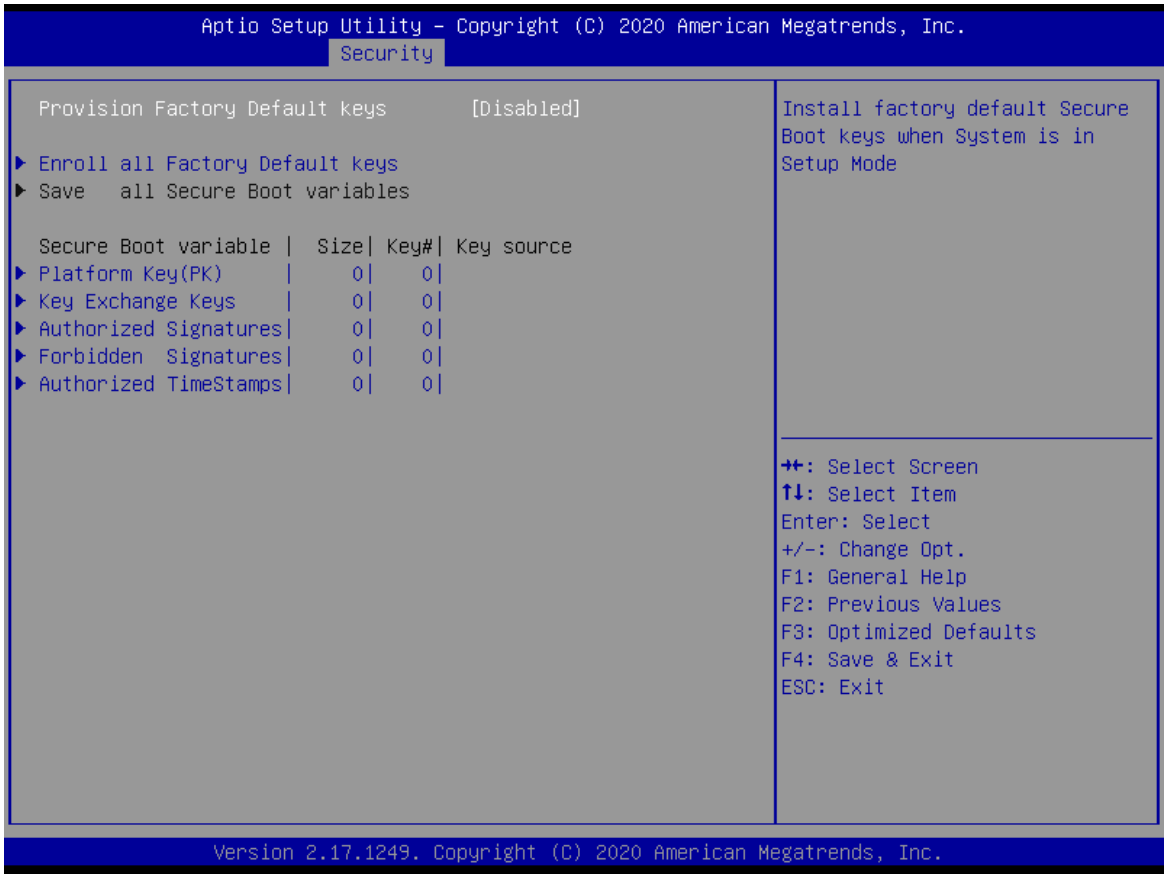
This item allows you to set User Password.

Security Boot



Item	Options	Description
Secure Boot	Disabled **[Default]** , Enabled	Secure Boot feature is Active if Secure Boot is Enabled,Platform Key(PK) is enrolled and the System is in User mode. The mode change requires platform reset
Secure Boot Mode	Standard, Custom**[Default]**	Secure Boot mode options:Standard or Custom. In Custom mode, Secure Boot Policy variables can be configured by a physically present user without full authentication

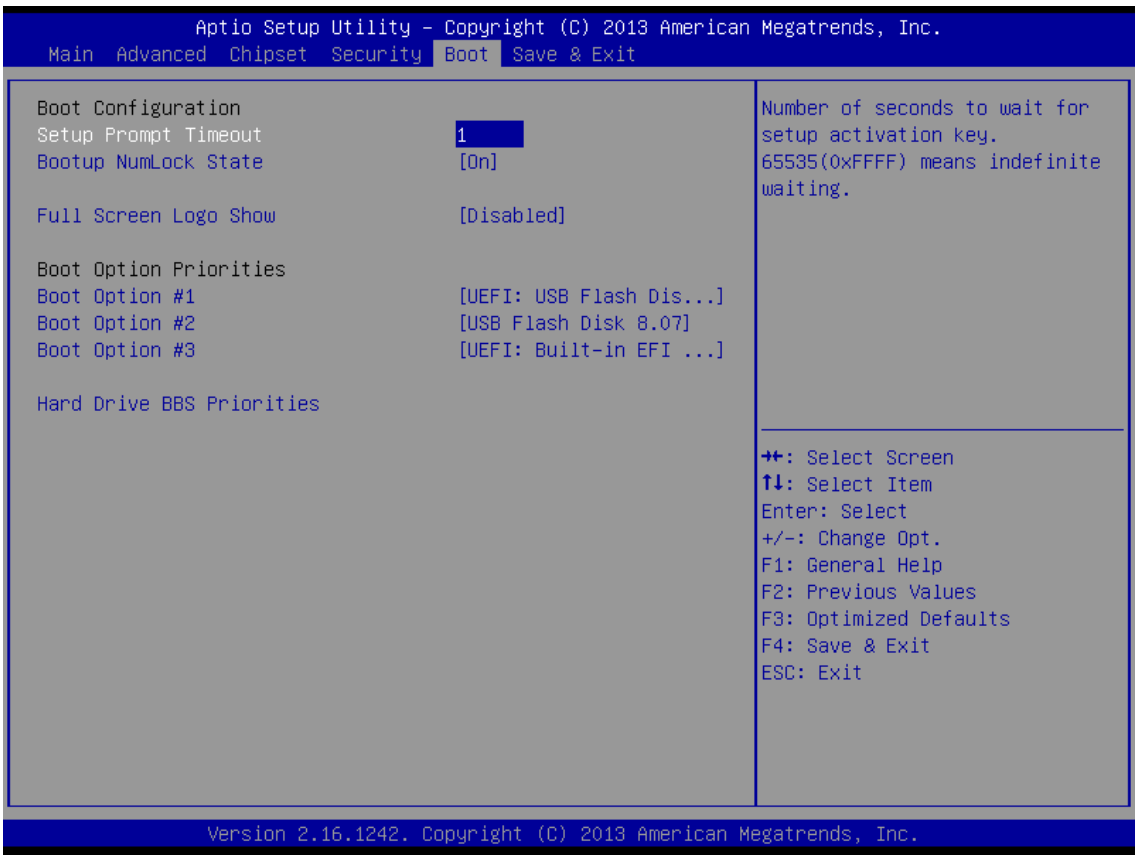
Key Management



Item	Options	Description
Provision Factory Default Key	Disabled **[Default] ,** Enabled	Install factory default Secure Boot keys after the platform reset and while the System is in Setup mode

4.6 Boot

This menu allows you to setup the system boot options.



4.6.1 Setup Prompt Timeout

This item sets number of seconds to wait for setup activation key.

4.6.2 Bootup NumLock State

This item selects the keyboard NumLock state. Select <On> or <Off>.

4.6.3 Full Screen Logo Show

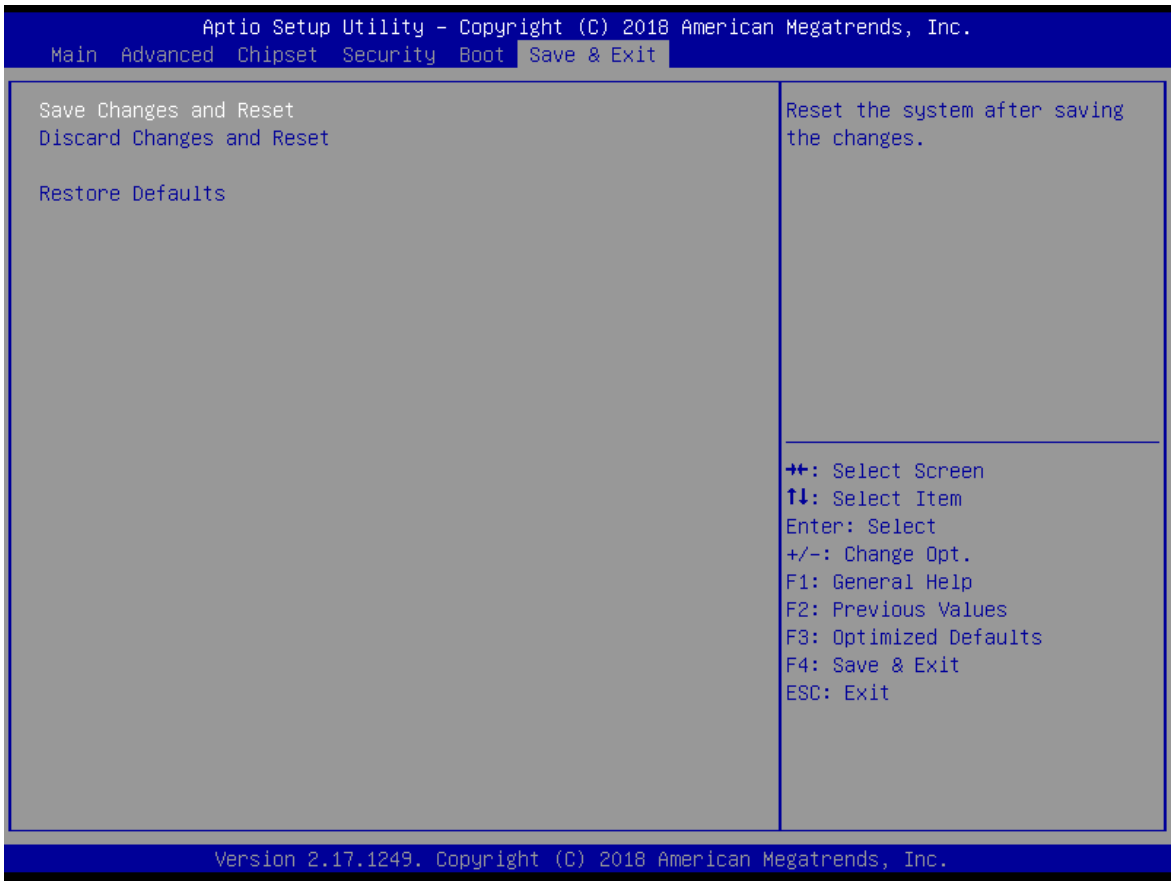
This item allows you to enable or disable Full Screen Logo Show function.

4.6.4 Boot Option Priorities

The items specify the boot device priority sequence from the available devices. The number of device items that appears on the screen depends on the number of devices installed in the system.

4.7 Save & Exit

This setting allows you to configure the boot settings.



4.7.1 Save Changes and Reset

This item allows you reset the system after saving the changes.

4.7.2 Discard Changes and Reset

Select this option to quit Setup without making any permanent changes to the system configuration.

4.7.3 Restore Defaults

This selection allows you to reload the BIOS when problem occurs during system booting sequence. These configurations are factory settings optimized for this system.

4.7.4 Save as User Defaults

When users have completed system configuration, select this option to save changes as user defaults without exit BIOS setup menu.

4.7.5 Restore User Defaults

Use this item to restore defaults to all the setup options.

WDT Sample Code

WDT Setting

// IO Address 0xA16 is time value
// IO Address 0xA15 is WDT enable and configuration
Example, Set 0xA16=-0x03, 0xA15=0x31, it will reset after 3 seconds

#define TimePort 0xA16
#define TimeEnablePort 0xA15

WriteByte (TimePort,0x03)
WriteByte (TimeEnablePort,0x31)

Watchdog Timer Configuration Register 1 – base address + 05h

Bit	Name	R/W	Reset	Default	Description
7	Reserved	R	-	0	Reserved
6	WDTMOUT_STS	R/W	5VSB	0	If watchdog timeout event occurred, this bit will be set to 1. Write a 1 to this bit will clear it to 0.
5	WD_EN	R/W	5VSB	0	If this bit is set to 1, this counting of watchdog time is enabled.
4	WD_PULSE	R/W	5VSB	0	Select output mode (0: level, 1: pulse) of RSTOUT# by setting this bit.
3	WD_UNIT	R/W	5VSB	0	Select time unit (0: 1 sec, 1: 60 sec) of watchdog timer by setting this bit.
2	WD_HACTIVE	R/W	5VSB	0	Select output polarity of RSTOUT# 1: high active, 0: low active) by setting this bit.
1-0	WD_PSWIDTH	R/W	5VSB	0	Select output pulse width of RSTOUT# 0: 1 ms 1: 25 ms 2: 125 ms 3: 5 sec

Watchdog Timer Configuration Register 2 – base address + 06h

Bit	Name	R/W	Reset	Default	Description
7-0	WD_TIME	R/W	5VSB	0	Time of watchdog timer

GPIO Sample Code

GPIO Setting

IO_DO4	I/O 0xA02h Bit3
IO_DO3	I/O 0xA02h Bit2
IO_DO2	I/O 0xA02h Bit1
IO_DO1	I/O 0xA02h Bit0
IO_DI4	I/O 0xA03h Bit7
IO_DI3	I/O 0xA03h Bit6
IO_DI2	I/O 0xA03h Bit5
IO_DI1	I/O 0xA03h Bit4

```
#define GPI_ADDR  0xA03
#define GPO_ADDR  0xA02h
```

1. // 0xA03h is Pin Status(default 0xF5)(at IO_DI1~ IO_DI4)
   ByteData = ReadByte (GPI_ADDR) //Read current Pin Status

2. //Offset 0xA02h default setting is 0xFF (output pin set to output high) (at IO_DO1~ IO_DO4)
   ByteData = 0x0F //set IO_DO1~ IO_DO4 to high
   WriteByte (GPO_ADDR, ByteData)

Appendix

WDT & GPIO

This appendix provides the sample codes of WDT (Watch Dog Timer) and GPIO (General Purpose Input/ Output).

WDT Sample Code

```
SIO_INDEX_Port      equ 04Eh
SIO_DATA_Port equ   04Fh
SIO_UnLock_Value    equ 087h
SIO_Lock_Value equ  0AAh
WatchDog_LDN        equ 007h
WDT_UNIT            equ 60h ;60h=second, 68h=minute, 40h=Disabled Watchdog timer
WDT_Timer           equ 30 ;ex. 30 seconds

Sample code:
;Enable config mode
    mov         dx, SIO_INDEX_Port
    mov         al, SIO_UnLock_Value
    out         dx, al
    jmp         short $+2       ;Io_delay
    jmp         short $+2       ;Io_delay
    out         dx, al
;Change to WDT
    mov         dx, SIO_INDEX_Port
    mov         al, 07h
    out         dx, al
    mov         dx, SIO_DATA_Port
    mov         al, WatchDog_LDN
    out         dx, al
;Acive WDT
    mov         dx, SIO_INDEX_Port
    mov         al, 30h
    out         dx, al
    mov         dx, SIO_DATA_Port
    in          al, dx
    or          al, 01h
    out         dx, al
;set timer
    mov         dx, SIO_INDEX_Port
    mov         al, 0F6h
    out         dx, al
    mov         dx, SIO_DATA_Port
    mov         al, WDT_Timer
    out         dx, al
;set UINT
    mov         dx, SIO_INDEX_Port
    mov         al, 0F5h
    out         dx, al
    mov         dx, SIO_DATA_Port
    mov         al, WDT_UNIT
    out         dx, al
;enable reset
    mov         dx, SIO_INDEX_Port
    mov         al, 0Fah
    out         dx, al
    mov         dx, SIO_DATA_Port
    in          al, dx
    or          al, 01h
    out         dx, al
;close config mode
    mov         dx, SIO_INDEX_Port
    mov         al, SIO_Lock_Value
    out         dx, al
```

GPIO Sample Code

- GPI 0 ~ GPI 3

	GPI 0	GPI 1	GPI 2	GPI 3
IO Address	0xA03h	0xA03h	0xA03h	0xA03h
Bit	4	5	6	7
Sample code	#1			

- GPO 0 ~ GPO 3

	GPO 0	GPO 1	GPO 2	GPO 3
IO Address	0xA02h	0xA02h	0xA02h	0xA02h
Bit	0	1	2	3
Sample code	#2			

```
GPI_REG     equ 0A03h
GPO_REG     equ 0A02h
GPO_0       equ 00000001b
```

Sample Code:

#1 : Get GPI 0 status

```
; Get GPI 0 Pin Status Register
    In      al, GPI_REG
    ;al bit4 = GPI 0 status
```

#2 : Set GPO 0 status to high

```
; Set GPO 0 Pin to High
    mov     dx, GPO_REG
    in      al, dx
    or      al, GPO_0
    out     dx, al
    ;al bit0 = GPO 0 status
```

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