# MS-98H7

## *COM Express Type-6 Basic Module*

# Copyright Notice



# Trademarks



# Revision History

| Revision | Date |
|---|---|
| V1.0 | 2018/ 11 |

# Technical Support

If a problem arises with your system and no solution can be obtained from the user's manual, please contact your place of purchase or local distributor. Alternatively, please visit the MSI website for technical guide, BIOS updates, driver updates and other information, or contact our technical staff via http://www.msi.com/support/

# Safety Instructions

- Always read the safety instructions carefully.
- Keep this User's Manual for future reference.
- Keep this equipment away from humidity.
- Lay this equipment on a reliable flat surface before setting it up.
- The openings on the enclosure are for air convection hence protects the equipment from overheating. DO NOT COVER THE OPENINGS.
- Make sure the voltage of the power source and adjust properly 110/220V before connecting the equipment to the power inlet.
- Place the power cord such a way that people can not step on it. Do not place anything over the power cord.
- Always Unplug the Power Cord before inserting any add-on card or module.
- All cautions and warnings on the equipment should be noted.
- Never pour any liquid into the opening that could damage or cause electrical shock.
- If any of the following situations arises, get the equipment checked by 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 you can not get it work according to User's Manual.
  - The equipment has dropped and damaged.
  - The equipment has obvious sign of breakage.
- DO NOT LEAVE THIS EQUIPMENT IN AN ENVIRONMENT UNCONDITIONED, STORAGE TEMPERATURE ABOVE 60°C (140°F), IT MAY DAMAGE THE EQUIPMENT.

# Chemical Substances Information

In compliance with chemical substances regulations, such as the EU REACH Regulation (Regulation EC No. 1907/2006 of the European Parliament and the Council), MSI provides the information of chemical substances in products at:

http://www.msi.com/html/popup/csr/evmtprtt_pcm.html

# Battery Information

European Union:

Batteries, battery packs, and accumulators should not be disposed of as unsorted household waste. Please use the public collection system to return, recycle, or treat them in compliance with the local regulations.

廢電池請回收

Taiwan:

For better environmental protection, waste batteries should be collected separately for recycling or special disposal.

California, USA:

The button cell battery may contain perchlorate material and requires special handling when recycled or disposed of in California.

For further information please visit:

http://www.dtsc.ca.gov/hazardouswaste/perchlorate/

Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended by the manufacturer.

# CE Conformity

Hereby, Micro-Star International CO., LTD declares that this device is in compliance with the essential safety requirements and other relevant provisions set out in the European Directive.

# FCC-B Radio Frequency Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1) this device may not cause harmful interference, and

2) this device must accept any interference received, including interference that may cause undesired operation.

# WEEE Statement

Under the European Union (“EU”) Directive on Waste Electrical and Electronic Equipment, Directive 2002/96/EC, which takes effect on August 13, 2005, products of “electrical and electronic equipment” cannot be discarded as municipal waste anymore and manufacturers of covered electronic equipment will be obligated to take back such products at the end of their useful life.

# CONTENTS

# 1 Overview

Thank you for choosing the MS-98H7, an excellent COM (computer-on-module) Express Type-6 Basic Module. Integrating core CPU and memory functionality, it is the entry-level model for applications looking to transition from other small form factor solutions to COM Express® and offers full PCI Express, USB, SATA, graphics and network support.

# Specifications

## Processor

- Intel® Coffee Lake Embedded Mobile Xeon® E/ Core™ i7/ i5/ i3 Processor
  - Intel® Xeon® E-2176M Processor
  - Intel® Core™ i7-8850H Processor
  - Intel® Core™ i5-8400H Processor
  - Intel® Core™ i3-8100H Processor

## Chipsets

- Mobile Intel® PCH-H CM246 Series for Intel® Xeon® Processor
- Mobile Intel® PCH-H QM370 Series

## Memory

- 2 * DDR4 SO-DIMM slots
- Supports DDR4 2400/2666 MHz frequency
- Supports ECC Memory (CM246 SKU only)
- Supports non-ECC Memory
- Up to 32 GB

## LAN

- Intel® I219LM GbE-PHY LAN (iAMT 12.x supported)

## Graphics

- Graphics integrated in Intel® processor
- 1 * LVDS 18/24-Bit Dual Channel
  - LVDS resolution up to 1920x1200 @ 60 Hz
- 3 * DDI ports support HDMI1.4 or DP1.2 multiplexed (BIOS modification needed)
  - HDMI1.4 up to 4096x2160 @ 24 Hz
  - DP up to 4096x2304 @ 60Hz
  - DVI up to 1920x1200 @ 60Hz
- 1 * VGA port
  - Resolution up to 1920 x 1080
- 2 Independent Displays supported
  - DDI1+DDI2, DDI1+DDI3, DDI2+DDI3
  - DDI1+LVDS, DDI1+VGA,
  - DDI2+LVDS, DDI2+VGA,
  - DDI3+LVDS, DDI3+VGA
- 3 Independent Displays supported
  - DDI1+DDI2+DDI3
  - DDI1+DDI2+LVDS or VGA
  - DDI1+LVDS+VGA
  - DDI2+LVDS+VGA
  - DDI3+LVDS+VGA

Note: 1. DDI3 default is HDMI (DP by option)

2. VGA is not useable when DDI3 option to DP from HDMI.

## EC

- ITE IT8528 controller chip

## Storage

- Controller integrated in Intel® processor
- Supports 4 Serial ATA interfaces
  - 4 * SATA 6Gb/s ports
  - AHCI & RAID0/1/5/10

## USB

- Controller integrated in Intel® processor
- 4 * USB 3.1 (to carrier board)
- 8 * USB 2.0 (to carrier board)

## PCI Express Interface

- PEG
  - 1 * PCIe x16 (supports 1 x16 or 2 x8 or 1 x8 or 2 x4)
- PCIe (supports up to 5 devices and 8 lanes)
  - 5 * PCIe x1 or
  - 4 * PCIe x1 + 1 * PCIe x4 or
  - 3 * PCIe x1 + 2 * PCIe x2

## TPM

- Infineon SLB9665TT 2.0 (optional)

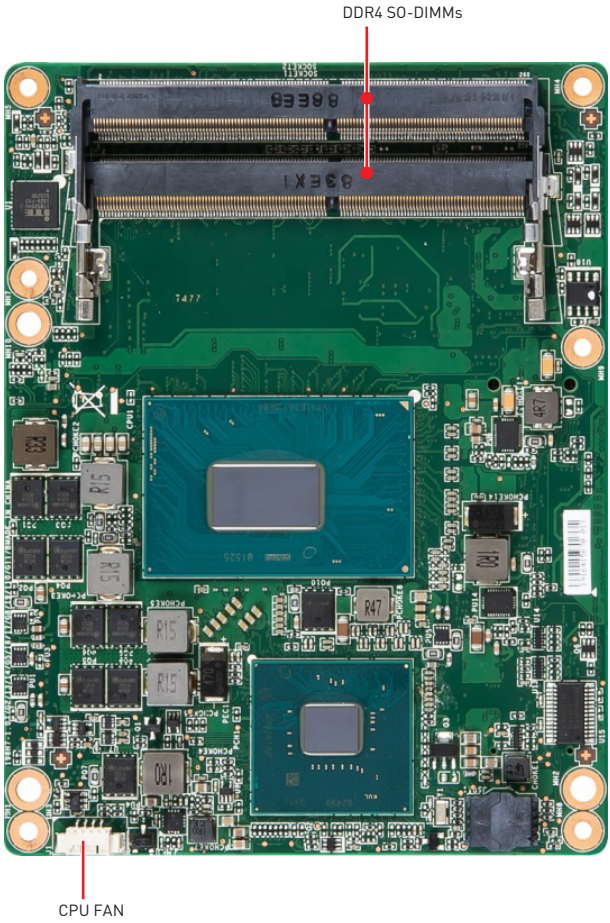
## Form Factor

- COM Express Type-6 Basic: 125mm x 95mm

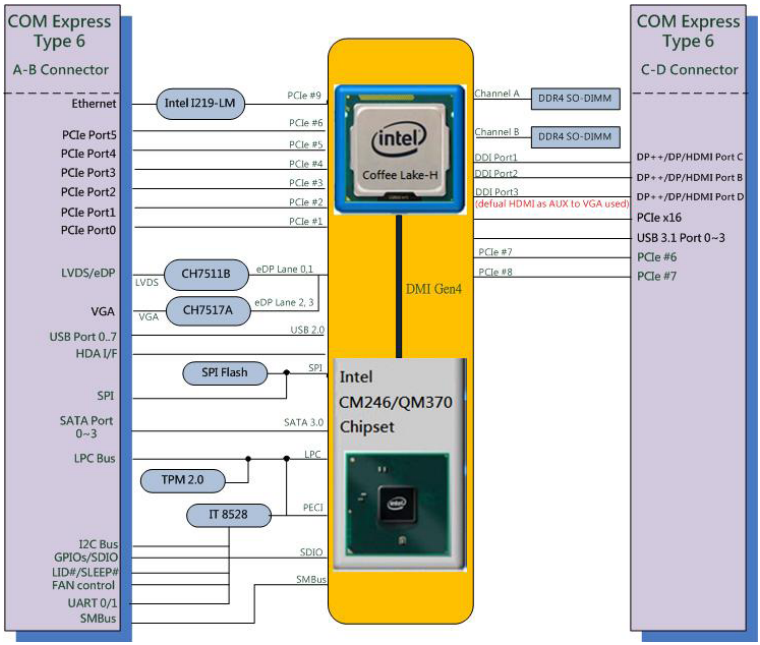
## Environment

- Operating Temperature: -10 ~ 60°C
- Storage Temperature: -20 ~ 80°C
- Humidity: 10% ~ 90% RH, non-condensing

# Layout



# Block Diagram



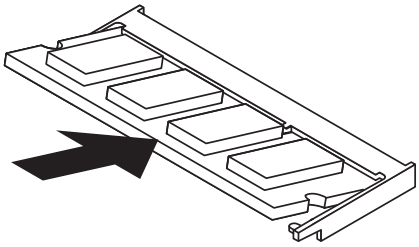
# 2 Hardware Setup

This chapter provides you with the information about hardware setup procedures. While doing the installation, be careful in holding the components and follow the installation procedures. For some components, if you install in the wrong orientation, the components will not work properly.
Use a grounded wrist strap before handling computer components. Static electricity may damage the components.

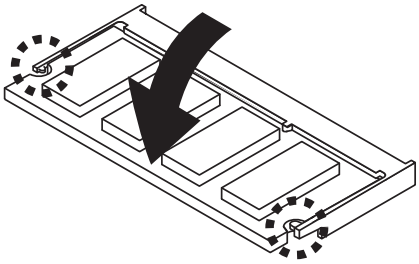
# Memory

The SO-DIMM slot is intended for memory modules.

1. Locate the SO-DIMM slot. Align the notch on the DIMM with the key on the slot and insert the DIMM into the slot.



2. Push the DIMM gently downwards until the slot levers click and lock the DIMM in place.



3. To uninstall the DIMM, flip the slot levers outwards and the DIMM will be released instantly.

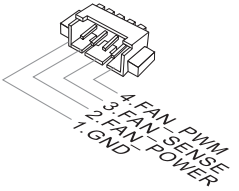
**Important**

*You can barely see the golden finger if the DIMM is properly inserted in the DIMM slot.*

# Connector

## Fan Power Connector: CPUFAN1

The fan power connectors support system cooling fan with +12V. When connecting the wire to the connectors, always note that the red wire is the positive and should be connected to the +12V; the black wire is Ground and should be connected to GND. If the motherboard has a System Hardware Monitor chipset onboard, you must use a specially designed fan with speed sensor to take advantage of the CPU fan control.

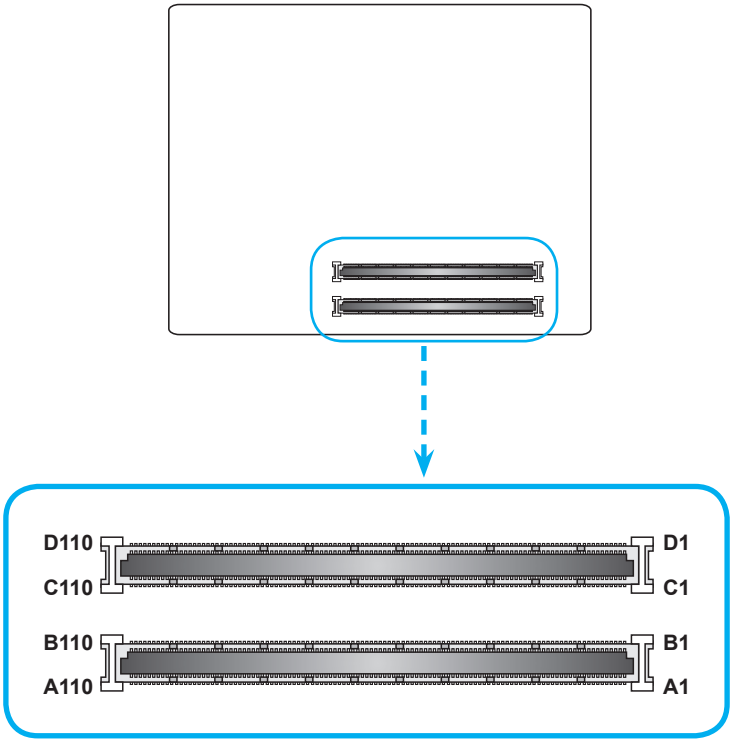



**Important**

*Please refer to the recommended CPU fans at processor's official website or consult the vendors for proper CPU cooling fan.*

## COM Express Connectors

The COM Express connectors are used to interface the COM Express module board to a carrier board. Connect the COM Express connectors located on the solder side of the module board (as indicated below) to the COM Express connectors on the carrier board.



| Row A | | Row B | | Row C | | Row D | |
|---|---|---|---|---|---|---|---|
| A1 | GND (FIXED) | B1 | GND (FIXED) | C1 | GND (FIXED) | D1 | GND (FIXED) |
| A2 | GBE0_MDI3- | B2 | GBE0_ACT# | C2 | GND | D2 | GND |
| A3 | GBE0_MDI3+ | B3 | LPC_FRAME# | C3 | USB_SSRX0- | D3 | USB_SSTX0- |
| A4 | GBE0_LINK100# | B4 | LPC_AD0 | C4 | USB_SSRX0+ | D4 | USB_SSTX0+ |
| A5 | GBE0_LINK1000# | B5 | LPC_AD1 | C5 | GND | D5 | GND |
| A6 | GBE0_MDI2- | B6 | LPC_AD2 | C6 | USB_SSRX1- | D6 | USB_SSTX1- |
| A7 | GBE0_MDI2+ | B7 | LPC_AD3 | C7 | USB_SSRX1+ | D7 | USB_SSTX1+ |
| A8 | GBE0_LINK# | B8 | | C8 | GND | D8 | GND |
| A9 | GBE0_MDI1- | B9 | | C9 | USB_SSRX2- | D9 | USB_SSTX2- |
| A10 | GBE0_MDI1+ | B10 | LPC_CLK | C10 | USB_SSRX2+ | D10 | USB_SSTX2+ |
| A11 | GND (FIXED) | B11 | GND (FIXED) | C11 | GND (FIXED) | D11 | GND (FIXED) |
| A12 | GBE0_MDI0- | B12 | PWRBTN# | C12 | USB_SSRX3- | D12 | USB_SSTX3- |
| A13 | GBE0_MDI0+ | B13 | SMB_CK | C13 | USB_SSRX3+ | D13 | USB_SSTX3+ |
| A14 | GBE0_CTREF | B14 | SMB_DAT | C14 | GND | D14 | GND |
| A15 | SUS_S3# | B15 | SMB_ALERT# | C15 | | D15 | DDI1_CTRLCLK_AUX+ |
| A16 | SATA0_TX+ | B16 | SATA1_TX+ | C16 | | D16 | DDI1_CTRLDATA_AUX- |
| A17 | SATA0_TX- | B17 | SATA1_TX- | C17 | RSVD* | D17 | RSVD* |
| A18 | SUS_S4# | B18 | SUS_STAT# | C18 | RSVD* | D18 | RSVD* |
| A19 | SATA0_RX+ | B19 | SATA1_RX+ | C19 | PCIE_RX6+ | D19 | PCIE_TX6+ |
| A20 | SATA0_RX- | B20 | SATA1_RX- | C20 | PCIE_RX6- | D20 | PCIE_TX6- |
| A21 | GND (FIXED) | B21 | GND (FIXED) | C21 | GND (FIXED) | D21 | GND (FIXED) |
| A22 | SATA2_TX+ | B22 | SATA3_TX+ | C22 | PCIE_RX7+ | D22 | PCIE_TX7+ |
| A23 | SATA2_TX- | B23 | SATA3_TX- | C23 | PCIE_RX7- | D23 | PCIE_TX7- |
| A24 | SUS_S5# | B24 | PWR_OK | C24 | DDI1_HPD | D24 | RSVD* |
| A25 | SATA2_RX+ | B25 | SATA3_RX+ | C25 | | D25 | RSVD* |
| A26 | SATA2_RX- | B26 | SATA3_RX- | C26 | | D26 | DDI1_PAIR0+ |
| A27 | BATLOW# | B27 | WDT | C27 | RSVD* | D27 | DDI1_PAIR0- |
| A28 | (S)ATA_ACT# | B28 | AC/HDA_SDIN2 | C28 | RSVD* | D28 | RSVD* |
| A29 | AC/HDA_SYNC | B29 | AC/HDA_SDIN1 | C29 | | D29 | DDI1_PAIR1+ |
| A30 | AC/HDA_RST# | B30 | AC/HDA_SDIN0 | C30 | | D30 | DDI1_PAIR1- |
| A31 | GND (FIXED) | B31 | GND (FIXED) | C31 | GND (FIXED) | D31 | GND (FIXED) |
| A32 | AC/HDA_BITCLK | B32 | SPKR | C32 | DDI2_CTRLCLK_AUX+ | D32 | DDI1_PAIR2+ |
| A33 | AC/HDA_SDOUT | B33 | I2C_CK | C33 | DDI2_CTRLDATA_AUX- | D33 | DDI1_PAIR2- |
| A34 | BIOS_DIS0# | B34 | I2C_DAT | C34 | DDI2_DDC_AUX_SEL | D34 | DDI1_DDC_AUX_SEL |
| A35 | THRMTRIP# | B35 | THRM# | C35 | RSVD* | D35 | RSVD* |
| A36 | USB6- | B36 | USB7- | C36 | DDI3_CTRLCLK_AUX+ | D36 | DDI1_PAIR3+ |
| A37 | USB6+ | B37 | USB7+ | C37 | DDI3_CTRLDATA_AUX- | D37 | DDI1_PAIR3- |
| A38 | USB_6_7_OC# | B38 | USB_4_5_OC# | C38 | DDI3_DDC_AUX_SEL | D38 | RSVD* |
| A39 | USB4- | B39 | USB5- | C39 | DDI3_PAIR0+ | D39 | DDI2_PAIR0+ |
| A40 | USB4+ | B40 | USB5+ | C40 | DDI3_PAIR0- | D40 | DDI2_PAIR0- |
| A41 | GND (FIXED) | B41 | GND (FIXED) | C41 | GND (FIXED) | D41 | GND (FIXED) |
| A42 | USB2- | B42 | USB3- | C42 | DDI3_PAIR1+ | D42 | DDI2_PAIR1+ |
| A43 | USB2+ | B43 | USB3+ | C43 | DDI3_PAIR1- | D43 | DDI2_PAIR1- |
| A44 | USB_2_3_OC# | B44 | USB_0_1_OC# | C44 | DDI3_HPD | D44 | DDI2_HPD |
| A45 | USB0- | B45 | USB1- | C45 | RSVD* | D45 | RSVD* |
| A46 | USB0+ | B46 | USB1+ | C46 | DDI3_PAIR2+ | D46 | DDI2_PAIR2+ |
| A47 | VCC_RTC | B47 | EXCD1_PERST# | C47 | DDI3_PAIR2- | D47 | DDI2_PAIR2- |
| A48 | EXCD0_PERST# | B48 | EXCD1_CPPE# | C48 | RSVD* | D48 | RSVD* |
| A49 | EXCD0_CPPE# | B49 | SYS_RESET# | C49 | DDI3_PAIR3+ | D49 | DDI2_PAIR3+ |
| A50 | LPC_SERIRQ | B50 | CB_RESET# | C50 | DDI3_PAIR3- | D50 | DDI2_PAIR3- |
| A51 | GND (FIXED) | B51 | GND (FIXED) | C51 | GND (FIXED) | D51 | GND (FIXED) |
| A52 | PCIE_TX5+ | B52 | PCIE_RX5+ | C52 | PEG_RX0+ | D52 | PEG_TX0+ |
| A53 | PCIE_TX5- | B53 | PCIE_RX5- | C53 | PEG_RX0- | D53 | PEG_TX0- |
| A54 | GPI0 | B54 | GPO1 | C54 | TYPE0# | D54 | |
| A55 | PCIE_TX4+ | B55 | PCIE_RX4+ | C55 | PEG_RX1+ | D55 | PEG_TX1+ |
| A56 | PCIE_TX4- | B56 | PCIE_RX4- | C56 | PEG_RX1- | D56 | PEG_TX1- |
| A57 | GND | B57 | GPO2 | C57 | TYPE1# | D57 | TYPE2# |
| A58 | PCIE_TX3+ | B58 | PCIE_RX3+ | C58 | PEG_RX2+ | D58 | PEG_TX2+ |
| A59 | PCIE_TX3- | B59 | PCIE_RX3- | C59 | PEG_RX2- | D59 | PEG_TX2- |
| A60 | GND (FIXED) | B60 | GND (FIXED) | C60 | GND (FIXED) | D60 | GND (FIXED) |
| A61 | PCIE_TX2+ | B61 | PCIE_RX2+ | C61 | PEG_RX3+ | D61 | PEG_TX3+ |
| A62 | PCIE_TX2- | B62 | PCIE_RX2- | C62 | PEG_RX3- | D62 | PEG_TX3- |
| A63 | GPI1 | B63 | GPO3 | C63 | RSVD* | D63 | RSVD* |
| A64 | PCIE_TX1+ | B64 | PCIE_RX1+ | C64 | RSVD* | D64 | RSVD* |
| A65 | PCIE_TX1- | B65 | PCIE_RX1- | C65 | PEG_RX4+ | D65 | PEG_TX4+ |
| A66 | GND | B66 | WAKE0# | C66 | PEG_RX4- | D66 | PEG_TX4- |
| A67 | GPI2 | B67 | WAKE1# | C67 | RSVD* | D67 | GND |
| A68 | PCIE_TX0+ | B68 | PCIE_RX0+ | C68 | PEG_RX5+ | D68 | PEG_TX5+ |
| A69 | PCIE_TX0- | B69 | PCIE_RX0- | C69 | PEG_RX5- | D69 | PEG_TX5- |
| A70 | GND (FIXED) | B70 | GND (FIXED) | C70 | GND (FIXED) | D70 | GND (FIXED) |
| A71 | eDP_D0+ / LVDS_A0+ | B71 | LVDS_B0+ | C71 | PEG_RX6+ | D71 | PEG_TX6+ |
| A72 | eDP_D0- / LVDS_A0- | B72 | LVDS_B0- | C72 | PEG_RX6- | D72 | PEG_TX6- |
| A73 | eDP_D1+ / LVDS_A1+ | B73 | LVDS_B1+ | C73 | GND | D73 | GND |
| A74 | eDP_D1- / LVDS_A1- | B74 | LVDS_B1- | C74 | PEG_RX7+ | D74 | PEG_TX7+ |
| A75 | eDP_D2+ / LVDS_A2+ | B75 | LVDS_B2+ | C75 | PEG_RX7- | D75 | PEG_TX7- |
| A76 | eDP_D2- / LVDS_A2- | B76 | LVDS_B2- | C76 | GND | D76 | GND |
| A77 | eDP_LVDS_VDD_EN | B77 | LVDS_B3+ | C77 | RSVD* | D77 | RSVD* |
| A78 | LVDS_A3+ | B78 | LVDS_B3- | C78 | PEG_RX8+ | D78 | PEG_TX8+ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A79 | LVDS_A3- | B79 | eDP_LVDS_BKLT_EN | C79 | PEG_RX8- | D79 | PEG_TX8- |
| A80 | GND (FIXED) | B80 | GND (FIXED) | C80 | GND (FIXED) | D80 | GND (FIXED) |
| A81 | eDP_D3+ / LVDS_A_CK+ | B81 | LVDS_B_CK+ | C81 | PEG_RX9+ | D81 | PEG_TX9+ |
| A82 | eDP_D3- / LVDS_A_CK- | B82 | LVDS_B_CK- | C82 | PEG_RX9- | D82 | PEG_TX9- |
| A83 | eDP_AUX+ / LVDS_I2C_CK | B83 | eDP_LVDS_BKLT_CTRL | C83 | RSVD* | D83 | RSVD* |
| A84 | eDP_AUX- / LVDS_I2C_DAT | B84 | VCC_5V_SBY | C84 | GND | D84 | GND |
| A85 | GPI3 | B85 | VCC_5V_SBY | C85 | PEG_RX10+ | D85 | PEG_TX10+ |
| **A86** | **SLP_SUS# / RSVD*** | B86 | VCC_5V_SBY | C86 | PEG_RX10- | D86 | PEG_TX10- |
| **A87** | **eDP_HPD / RSVD*** | B87 | VCC_5V_SBY | C87 | GND | D87 | GND |
| A88 | **PCIE_CLK_REF+** | B88 | BIOS_DIS1# | C88 | PEG_RX11+ | D88 | PEG_TX11+ |
| A89 | **PCIE_CLK_REF-** | B89 | VGA_RED | C89 | PEG_RX11- | D89 | PEG_TX11- |
| A90 | GND (FIXED) | B90 | GND (FIXED) | C90 | GND (FIXED) | D90 | GND (FIXED) |
| A91 | **SPI_POWER** | B91 | VGA_GRN | C91 | PEG_RX12+ | D91 | PEG_TX12+ |
| A92 | **SPI_MISO** | B92 | VGA_BLU | C92 | PEG_RX12- | D92 | PEG_TX12- |
| A93 | GPO0 | B93 | VGA_HSYNC | C93 | GND | D93 | GND |
| A94 | **SPI_CLK** | B94 | VGA_VSYNC | C94 | PEG_RX13+ | D94 | PEG_TX13+ |
| A95 | **SPI_MOSI** | B95 | VGA_I2C_CK | C95 | PEG_RX13- | D95 | PEG_TX13- |
| **A96** | **TPM_PP** | B96 | VGA_I2C_DAT | C96 | GND | D96 | GND |
| A97 | **TYPE10#** | B97 | **SPI_CS#** | C97 | RSVD* | D97 | **RSVD*** |
| **A98** | **SER0_TX** | B98 | **RSVD*** | C98 | PEG_RX14+ | D98 | PEG_TX14+ |
| **A99** | **SER0_RX** | B99 | **RSVD*** | C99 | PEG_RX14- | D99 | PEG_TX14- |
| A100 | GND (FIXED) | B100 | GND (FIXED) | C100 | GND (FIXED) | D100 | GND (FIXED) |
| **A101** | **SER1_TX** | **B101** | **FAN_PWMOUT** | C101 | PEG_RX15+ | D101 | PEG_TX15+ |
| **A102** | **SER1_RX** | **B102** | **FAN_TACHIN** | C102 | PEG_RX15- | D102 | PEG_TX15- |
| **A103** | **LID#** | **B103** | **SLEEP#** | C103 | GND | D103 | GND |
| A104 | VCC_12V | B104 | VCC_12V | C104 | VCC_12V | D104 | VCC_12V |
| A105 | VCC_12V | B105 | VCC_12V | C105 | VCC_12V | D105 | VCC_12V |
| A106 | VCC_12V | B106 | VCC_12V | C106 | VCC_12V | D106 | VCC_12V |
| A107 | VCC_12V | B107 | VCC_12V | C107 | VCC_12V | D107 | VCC_12V |
| A108 | VCC_12V | B108 | VCC_12V | C108 | VCC_12V | D108 | VCC_12V |
| A109 | VCC_12V | B109 | VCC_12V | C109 | VCC_12V | D109 | VCC_12V |
| A110 | GND (FIXED) | B110 | GND (FIXED) | C110 | GND (FIXED) | D110 | GND (FIXED) |

** RSVD pins are reserved for future use and **should** be no connect. Do not tie the RSVD pins together.*

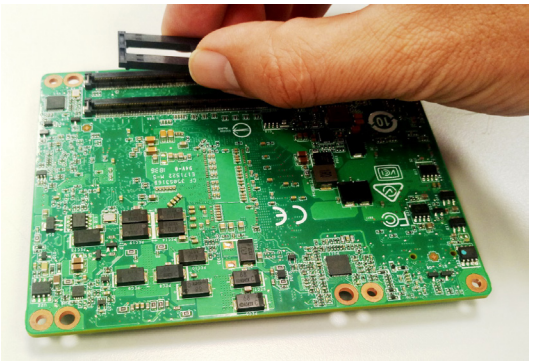
# Hardware Installation

## ➤ Installing Module Board onto Carrier Board

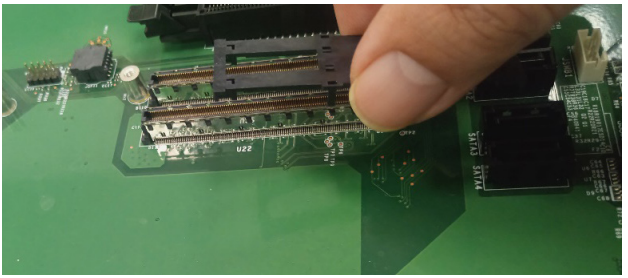
***Important***

*The illustrations are provided to guide users on how to install the module board onto the carrier board of their choice and should be held for reference only.*

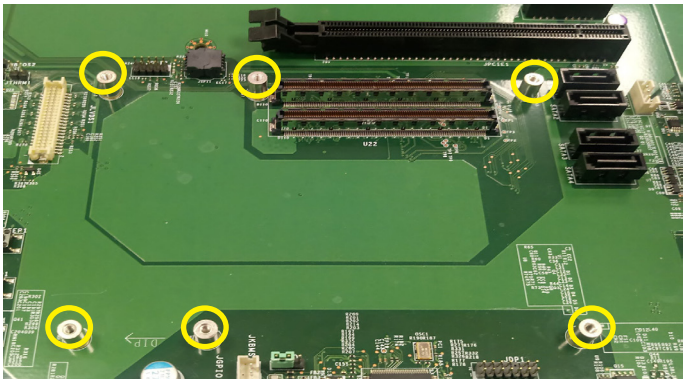
1. Remove the protection cover of COM Express connectors on the module board (if there is one).



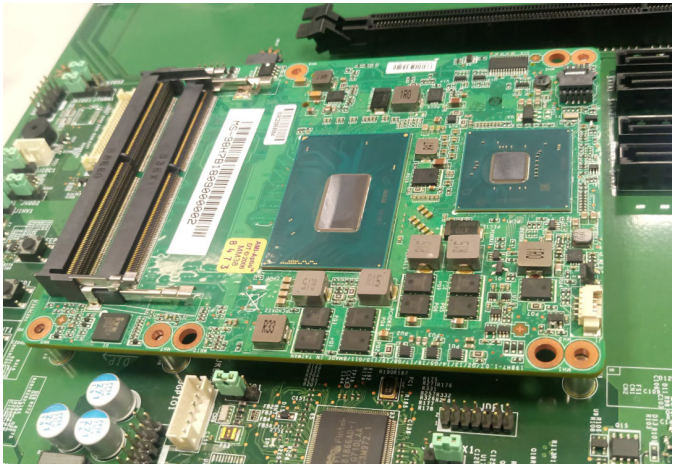
2. Remove the protection cover of COM Express slot on the carrier board (if there is one).



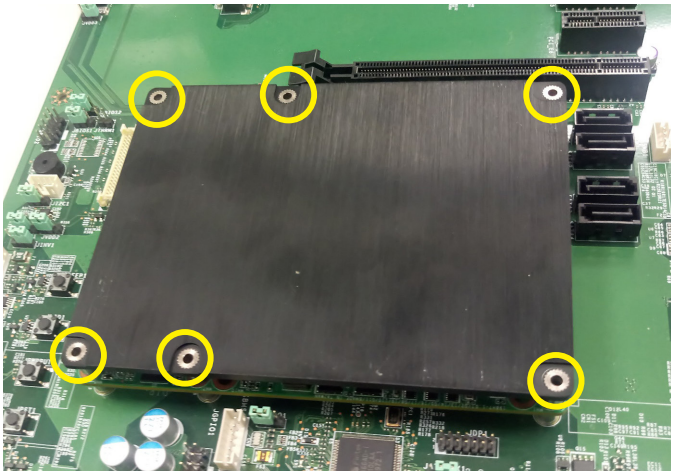
3. Locate the threaded standoffs on the carrier board.



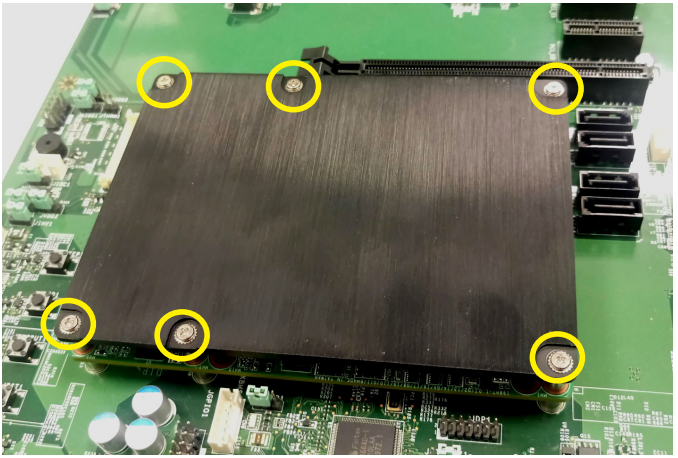
4. Install the module board to the carrier board via the COM Express connectors. Press the module board down firmly.



5. Flip the heat spreader over and remove the protective film from its thermal paste. Mount the heat spreader onto the module board with mounting holes aligned.



6. Use the provided mounting screws to secure the heat spreader to the module board and the carrier board.



# 3 BIOS Setup

This chapter provides information on the BIOS Setup program and allows users to configure the system for optimal use.

Users may need to run the Setup program when:

- An error message appears on the screen at system startup and requests users to run SETUP.
- Users want to change the default settings for customized features.

***Important***

- *Please note that BIOS update assumes technician-level experience.*
- *As the system BIOS is under continuous update for better system performance, the illustrations in this chapter should be held for reference only.*

# Entering Setup

Power on the computer and the system will start POST (Power On Self Test) process. When the message below appears on the screen, press <DEL> key to enter Setup.

Press <DEL> to enter SETUP

If the message disappears before you respond and you still wish to enter 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.

**Important**

*The items under each BIOS category described in this chapter are under continuous update for better system performance. Therefore, the description may be slightly different from the latest BIOS and should be held for reference only.*

## Control Keys

| | |
|---|---|
| ← → | Select Screen |
| ↑ ↓ | Select Item |
| Enter | Select |
| + - | Change Option |
| F1 | General Help |
| F7 | Previous Values |
| F9 | Optimized Defaults |
| F10 | Save & Reset |
| Esc | Exit |

## Getting Help

After entering the Setup menu, the first menu you will see is the Main Menu.

## Main Menu

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.

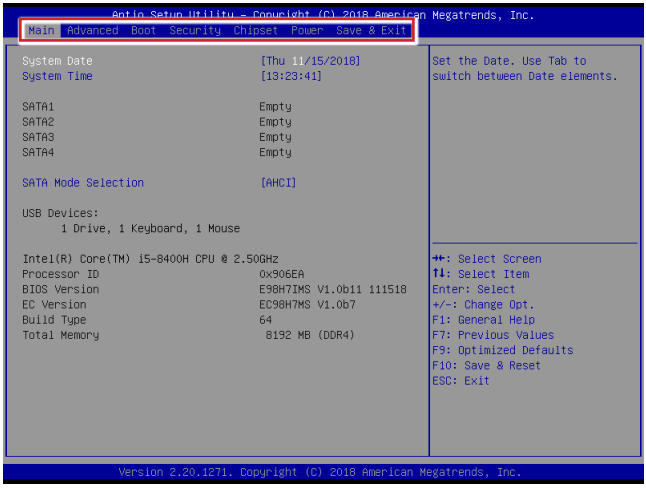
## Sub-Menu

If you find a right pointer symbol appears to the left of certain fields that means a sub-menu can be launched from this field. A sub-menu contains additional options for a field parameter. You can use arrow keys ( ↑↓ ) to highlight the field and press <Enter> to call up the sub-menu. Then you can use the control keys to enter values and move from field to field within a sub-menu. If you want to return to the main menu, just press the <Esc >.

## 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.

# The Menu Bar




▸ **Main**

Use this menu for basic system configurations, such as time, date, etc.

▸ **Advanced**

Use this menu to set up the items of special enhanced features.

▸ **Boot**

Use this menu to specify the priority of boot devices.

▸ **Security**

Use this menu to set supervisor and user passwords.

▸ **Chipset**

This menu controls the advanced features of the onboard chipsets.

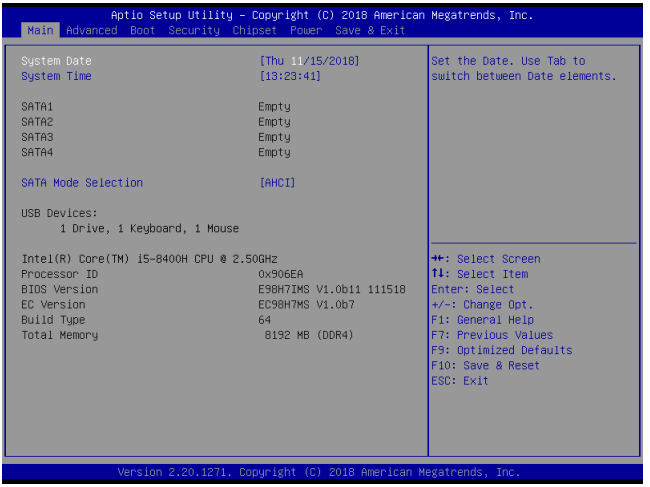
▸ **Power**

Use this menu to specify your settings for power management.

▸ **Save & Exit**

This menu allows you to load the BIOS default values or factory default settings into the BIOS and exit the BIOS setup utility with or without changes.

# Main




### ▸System Date

This setting allows you to set the system date. The date format is <Day>, <Month> <Date> <Year>.

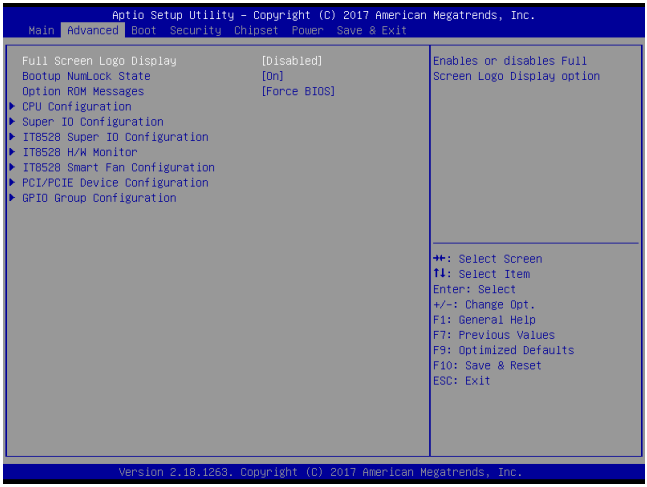
### ▸System Time

This setting allows you to set the system time. The time format is <Hour> <Minute> <Second>.

### ▸SATA Mode Selection

This setting specifies the SATA controller mode.

# Advanced




**▸Full Screen Logo Display**

This BIOS feature determines if the BIOS should hide the normal POST messages with the motherboard or system manufacturer's full-screen logo.

When it is enabled, the BIOS will display the full-screen logo during the boot-up sequence, hiding normal POST messages.

When it is disabled, the BIOS will display the normal POST messages, instead of the full-screen logo.

Please note that enabling this BIOS feature often adds 2-3 seconds of delay to the booting sequence. This delay ensures that the logo is displayed for a sufficient amount of time. Therefore, it is recommended that you disable this BIOS feature for a faster boot-up time.

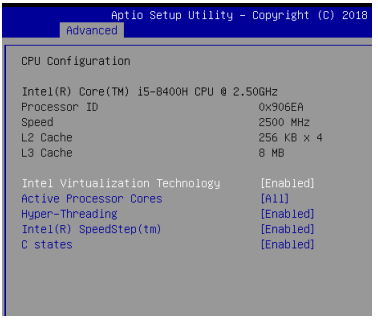
**▸Bootup NumLock State**

This setting is to set the Num Lock status when the system is powered on. Setting to [On] will turn on the Num Lock key when the system is powered on. Setting to [Off] will allow users to use the arrow keys on the numeric keypad.

**▸Option ROM Messages**

This item is used to determine the display mode when an optional ROM is initialized during POST. When set to [Force BIOS], the display mode used by AMI BIOS is used. Select [Keep Current] if you want to use the display mode of optional ROM.

### ▸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.

#### ▸Active Processor Cores

This setting specifies the number of active processor cores.

#### ▸Hyper-Threading

The processor uses Hyper-Threading technology to increase transaction rates and reduces end-user response times. The technology treats the two cores inside the processor as two logical processors that can execute instructions simultaneously. In this way, the system performance is highly improved. If you disable the function, the processor will use only one core to execute the instructions. Please disable this item if your operating system doesn’t support HT Function, or unreliability and instability may occur.

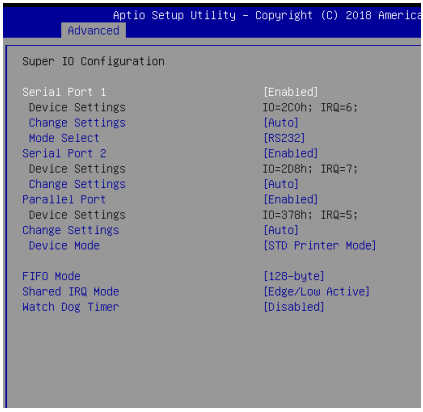
#### ▸Intel(R) SpeedStep(TM)

EIST (Enhanced Intel SpeedStep Technology) allows the system to dynamically adjust processor voltage and core frequency, which can result in decreased average power consumption and decreased average heat production. When disabled, the processor will return the actual maximum CPUID input value of the processor when queried.

#### ▸C States

C-state performance indicates the ability to run the processor in lower power states when the PC is idle. This setting enables/disables the C-State Configuration for power saving purposes.

▸**Super IO Configuration** *(the Carrier Board)*




▸**Serial Port 1, Serial Port 2**

This setting enables/disables the specified serial port.

▸**Change Settings**

This setting is used to change the address & IRQ settings of the specified serial port.

▸**Mode Select**

Select an operation mode for the serial port 1/ 2.

▸**Parallel Port**

This setting enables/disables the parallel port.

▸**Change Settings**

This setting is used to change the address & IRQ settings of the parallel port.

▸**Device Mode**

Select an operation mode for the parallel port.

▸**FIFO Mode**

This setting controls the FIFO data transfer mode.

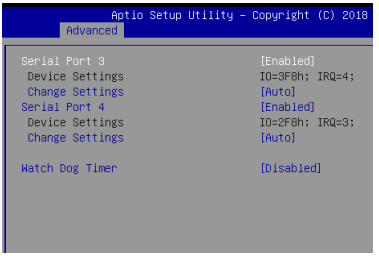
▸**Shared IRQ Mode**

This setting provides the system with the ability to share interrupts among its serial ports.

▸ **Watch Dog Timer**

You can enable 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.

### ▸IT8528 Super IO Configuration




#### ▸Serial Port 3, Serial Port 4

This setting enables/disables the specified serial port.

##### ▸Change Settings

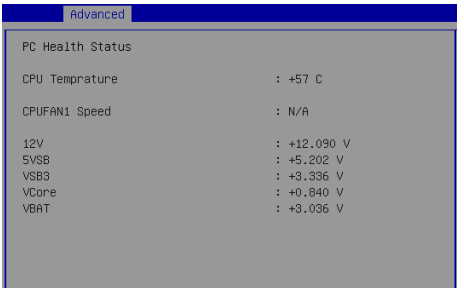
This setting is used to change the address & IRQ settings of the specified serial port.

#### ▸Watch Dog Timer

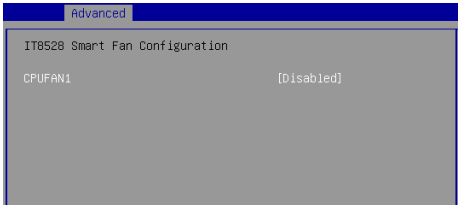
You can enable the system watch-dog timer, a hardware timer that generates a reset when the software that it monitors does not respond as expected each time the watch dog polls it.

### ▸IT8528 H/W Monitor *(the Compact Module)*

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



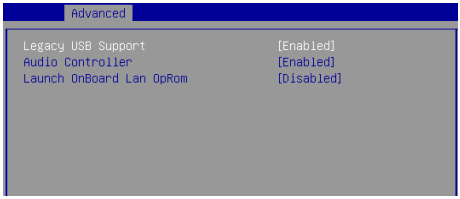
▸**IT8528 Smart Fan Configuration** *(the Compact Module)*




▸**CPUFAN1**

These settings enable/disable the Smart Fan function. Smart Fan is an excellent feature which will adjust the CPU/system fan speed automatically depending on the current CPU/system temperature, avoiding the overheating to damage your system.

▸**PCI/PCIE Device Configuration**




▸**Legacy USB Support**

Set to [Enabled] if you need to use any USB 1.1/2.0 device in the operating system that does not support or have any USB 1.1/2.0 driver installed, such as DOS and SCO Unix.

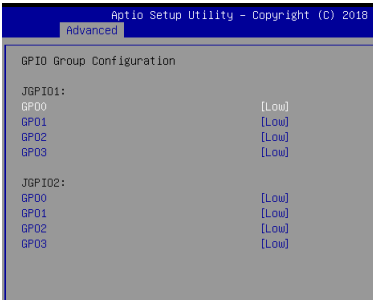
▸**Audio Controller**

This setting enables/disables the onboard audio controller.

▸**Launch Onboard LAN OpROM**

This setting enables/disables the initialization of the specified LAN Boot ROM during bootup. Selecting [Disabled] will speed up the boot process.

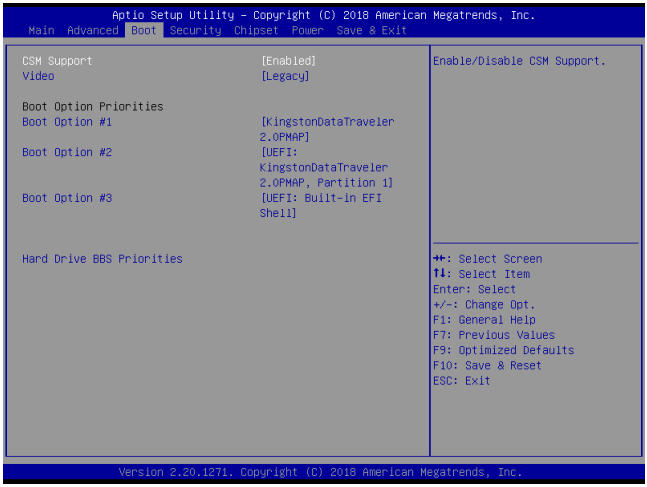
▸**GPIO Group Configuration** *(the Carrier Board)*




▸**JGPIO1/ 2: GPO0 ~ GPO3**

These settings control the operation mode of the specified GPIO.

# Boot




**▸CSM Support**

This setting enables/disables the support for Compatibility Support Module, a part of the Intel Platform Innovation Framework for EFI providing the capability to support legacy BIOS interfaces.

**▸ Video**

Select the type of primary video for your system.

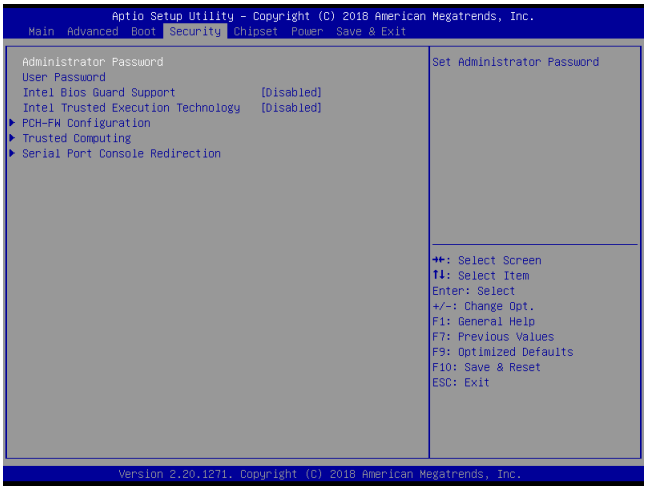
**▸Boot Option Priorities**

This setting allows users to set the sequence of boot devices where BIOS attempts to load the disk operating system.

**▸Hard Drive BBS Priorities**

This setting allows users to set the priority of the specified devices. First press <Enter> to enter the sub-menu. Then you may use the arrow keys ( ↑↓ ) to select the desired device, then press <+>, <-> or <PageUp>, <PageDown> key to move it up/down in the priority list.

# Security




**▸Administrator Password**

Administrator Password controls access to the BIOS Setup utility.

**▸User Password**

User Password controls access to the system at boot and to the BIOS Setup utility.

**▸Intel BIOS Guard Support**

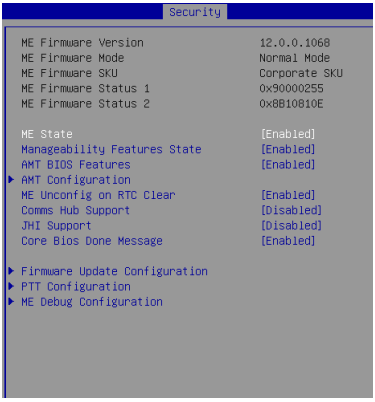
Intel BIOS Guard Support ensures that updates to system BIOS flash are secure.

**▸Intel Trusted Execution Technology**

Intel Trusted Execution Technology provides highly scalable platform security in physical and virtual infrastructures.

### ▸PCH-FW Configuration

This menu provides settings for PCH-FW Configuration.



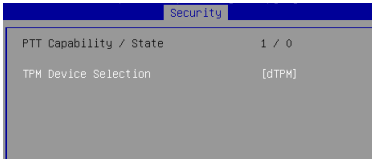

### ▸Firmware Update Configuration


#### ▸ME FW Image Re-Flash

This setting enables/disables the ME FW image reflash.

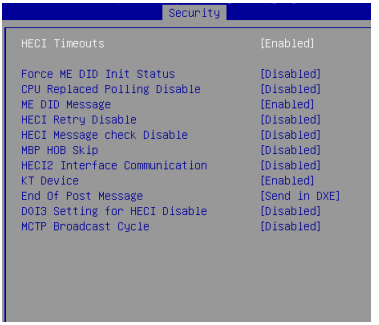
### ▸PTT Configuration

Intel Platform Trust Technology (PTT) is a platform functionality for credential storage and key management used by Microsoft Windows.



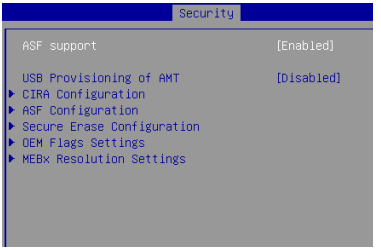
### ▸ME Debug Configuration

This menu provides settings for ME Debug Configuration.

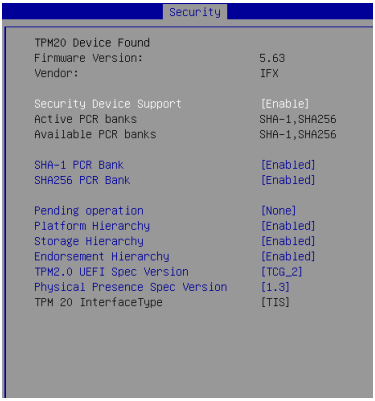



### ▸AMT Configuration

Intel Active Management Technology (AMT) is hardware-based technology for remotely managing and securing PCs out-of-band.



### ▸Trusted Computing




**▸Security Device Support**

This setting enables/disables BIOS support for security device. When set to [Disable], the OS will not show security device. TCG EFI protocol and INT1A interface will not be available.

**▸SHA-1 PCR Bank, SHA256 PCR Bank**

These settings enable/disable the SHA-1 PCR Bank and SHA256 PCR Bank.

**▸Pending Operation**

This setting shows pending operation.

**▸Platform Hierarchy, Storage Hierarchy, Endorsement Hierarchy**

These settings enable/disable the Platform Hierarchy, Storage Hierarchy and Endorsement Hierarchy.

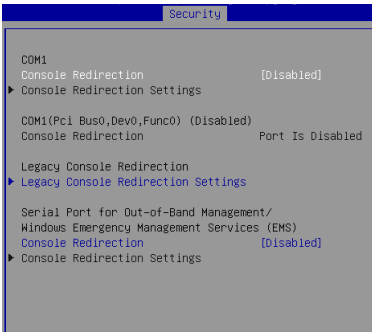
**▸TPM2.0 UEFI Spec Version, Physical Presence Spec Version**

This settings show the TPM2.0 UEFI Spec Version and Physical Presence Spec Version.

**▸TPM2.0 Interface Type**

This setting shows the TPM2.0 Interface Type.

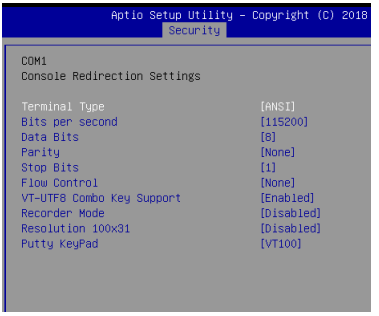
### ▸Serial Port Console Redirection




#### ▸Console Redirection

Console Redirection operates in host systems that do not have a monitor and keyboard attached. This setting enables/disables the operation of console redirection. When set to [Enabled], BIOS redirects and sends all contents that should be displayed on the screen to the serial COM port for display on the terminal screen. Besides, all data received from the serial port is interpreted as keystrokes from a local keyboard.

#### ▸Console Redirection Settings (COM1)




#### ▸Terminal Type

To operate the system's console redirection, you need a terminal supporting ANSI terminal protocol and a RS-232 null modem cable connected between the host system and terminal(s). This setting specifies the type of terminal device for console redirection.

#### ▸ Bits per second, Data Bits, Parity, Stop Bits

This setting specifies the transfer rate (bits per second, data bits, parity, stop bits) of Console Redirection.

▸**Flow Control**

Flow control is the process of managing the rate of data transmission between two nodes. It's the process of adjusting the flow of data from one device to another to ensure that the receiving device can handle all of the incoming data. This is particularly important where the sending device is capable of sending data much faster than the receiving device can receive it.

▸**VT-UTF8 Combo Key Support**

This setting enables/disables the VT-UTF8 combination key support for ANSI/VT100 terminals.

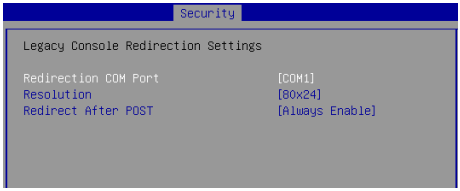
▸**Recorder Mode, Resolution 100x31**

These settings enable/disable the recorder mode and the resolution 100x31.

▸**Putty Keypad**

PuTTY is a terminal emulator for Windows. This setting controls the numeric keypad for use in PuTTY.

▸**Legacy Console Redirection Settings**




▸**Redirection COM Port**

This setting selects a COM port to display redirection of Legacy OS and Legacy OPROM Messages

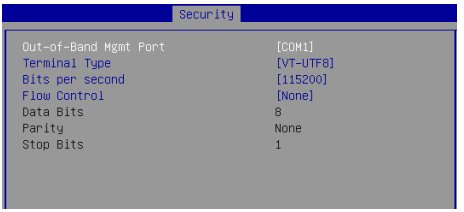
▸**Resolution**

In Legacy OS, this setting selects the Number of Rows and Columns supported redirection.

▸**Redirect After POST**

When Boot loader is selected, Legacy Console Redirection is disabled before booting to legacy OS. When Always Enable is selected, Legacy Console Redirection is enabled for legacy OS.

### ▸Console Redirection Settings (Serial port for Out-of-Band Management/ Windows Emergency Management Services)




**▸Out-of-Band Mgmt Port**

Microsoft Windows Emergency Management Services (EMS) allows for remote management of a Windows Server OS through a serial port.

**▸Terminal Type**

VT-UTF8 is the preferred terminal type for out-of-band management. The next best choice is VT100+ and then VT100.

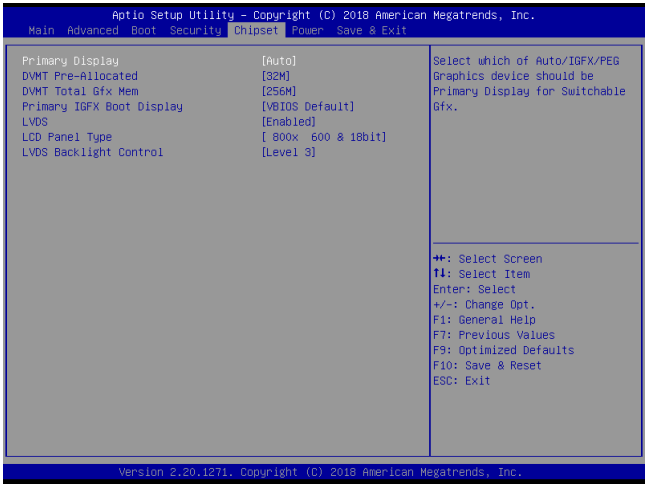
**▸ Bits per second**

This setting selects serial port transmission speed. The speed must be matched on the other side. Long or noisy lines may require lower speeds.

**▸Flow Control**

Flow control can prevent data loss from buffer overflow. When sending data, if the receiving buffers are full, a ‘stop’ signal can be sent to stop the data flow. Once the buffers are empty, a ‘start’ signal can be sent to re-start the flow. Hardware flow control uses two wires to send start/stop signals.

# Chipset




**▸Primary Display**

This setting selects the primary display.

**▸DVMT Pre-Allocated**

This setting defines the DVMT pre-allocated memory. Pre-allocated memory is the small amount of system memory made available at boot time by the system BIOS for video. Pre-allocated memory is also known as locked memory. This is because it is "locked" for video use only and as such, is invisible and unable to be used by the operating system.

**▸DVMT Total Gfx Mem**

This setting specifies the memory size for DVMT.

**▸Primary IGFX Boot Display**

Use the field to select the type of device you want to use as the display(s) of the system.

**▸LVDS**

This setting enables/disables the LVDS interface.

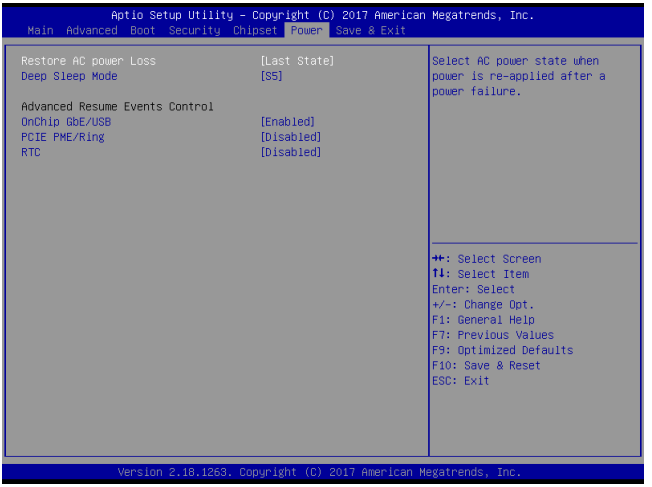
**▸LCD Panel Type**

This setting specifies the LCD panel type.

**▸LVDS Backlight Control**

This setting controls the intensity of the LVDS backlight.

# Power




**▸Restore AC Power Loss**

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

| | |
|---|---|
| [Power Off] | Leaves the computer in the power off state. |
| [Power On] | Leaves the computer in the power on state. |
| [Last State] | Restores the system to the previous status before power failure or interrupt occurred. |

**▸Deep Sleep Mode**

The setting enables/disables the Deep S5 power saving mode. S5 is almost the same as G3 Mechanical Off, except that the PSU still supplies power, at a minimum, to the power button to allow return to S0. A full reboot is required. No previous content is retained. Other components may remain powered so the computer can “wake” on input from the keyboard, clock, modem, LAN, or USB device.

**** Advanced Resume Events Control ****

**▸OnChip GbE/USB**

This field specifies whether the system will be awakened from power saving modes when the activity of USB devices or input signal of onchip LAN is detected.

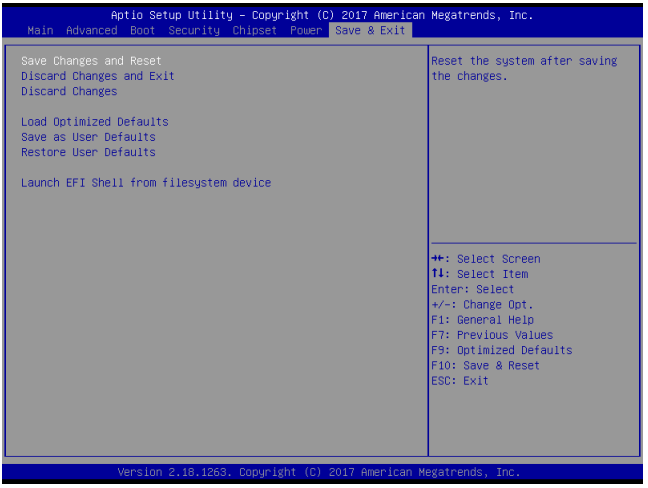
▸**PCIE PME/Ring**

This field specifies whether the system will be awakened from power saving modes when input signals on the serial Ring Indicator (RI) line or input signals of onboard PCIE PME are detected.

▸**RTC**

When [Enabled], your can set the date and time at which the RTC (real-time clock) alarm awakens the system from suspend mode.

# Save & Exit




**▸Save Changes and Reset**

Save changes to CMOS and reset the system.

**▸Discard Changes and Exit**

Abandon all changes and exit the Setup Utility.

**▸Discard Changes**

Abandon all changes.

**▸Load Optimized Defaults**

Use this menu to load the default values set by the motherboard manufacturer specifically for optimal performance of the motherboard.

**▸Save as User Defaults**

Save changes as the user's default profile.

**▸Restore User Defaults**

Restore the user's default profile.

**▸Launch EFI Shell from filesystem device**

This setting helps to launch the EFI Shell application from one of the available file system devices.

# *Appendix*
# GPIO WDT BKL Programming

This appendix provides WDT (Watch Dog Timer), GPIO (General Purpose Input/ Output) and LVDS Backlight programming guide.

# CONTENT

# Abstract

In this document, code examples based on C programming language are provided for customer interest. **Inportb**, **Outportb**, **Inportl** and **Outportl** are basic functions used for access IO ports and defined as following.

**Inportb:** Read a single 8-bit I/O port.

**Outportb:** Write a single byte to an 8-bit port.

**Inportl:** Reads a single 32-bit I/O port.

**Outportl:** Write a single long to a 32-bit port.

# General Purposed IO

## 1. General Purposed IO – GPIO/DIO

The associated access method (**EC_ReadByte**, **EC_WriteByte**) are provided in part 5. The GPIO port configuration offset in EC and addresses are listed in the following table:

| Name | OFFSET | IO address | Name | OFFSET | IO address |
|---|---|---|---|---|---|
| **N_GPI0** | 0x97 | Bit 0 | **N_GPO0** | 0x97 | Bit 4 |
| **N_GPI1** | 0x97 | Bit 1 | **N_GPO1** | 0x97 | Bit 5 |
| **N_GPI2** | 0x97 | Bit 2 | **N_GPO2** | 0x97 | Bit 6 |
| **N_GPI3** | 0x97 | Bit 3 | **N_GPO3** | 0x97 | Bit 7 |

### 1.1 Set output value of GPO

1. Read the value from the OFFSET in EC RAM of GPO.
2. Set the value of GPO address.
3. Write the value back to the OFFSET in EC RAM of GPO.

**Example:** Set **N_GPO0** output “high”

```
val = EC_ReadByte (0x97);          // Read value from N_GPO0.
val = val | (1<<4);                // Set N_GPO0 address (bit 4) to 1 (output “high”).
EC_WriteByte (0x97, val);          // Write back to N_GPO0.
```

**Example:** Set **N_GPO1** output “low”

```
val = EC_ReadByte (0x97);          // Read value from N_GPO1.
val = val & (~(1<<5));             // Set N_GPO1 address (bit 5) to 0 (output “low”).
EC_WriteByte (0x97, val);          // Write back to N_GPO1.
```

### 1.2 Read input value from GPI

1. Read the value from the OFFSET in EC of GPI.
2. Get the value of GPI address.

**Example:** Get **N_GPI2** input value.

```
val = EC_ReadByte (0x97);          // Read value from N_GPI2.
val = val & (1<<2);                // Check N_GPI2 address (bit 2).
if (val)    printf (“Input of  N_GPI2  is High”);
else        printf (“Input of  N_GPI2  is Low”);
```

# Watchdog Timer

## 2. Watchdog Timer – WDT

The watchdog timer unit is in second. It starts immediately after setting time. The counter value will increase per second. When the counter value equals the setting time, WDT will reset the system. Associated access method (**EC_ReadByte** and **EC_WriteByte**) are provided in part 5.

### 2.1 Set WDT Time and Enable WDT

```
EC_WriteByte (0x98, Time);      // Enable WDT immediately after setting WDT time, value 1 to 255.
EC_WriteByte (0x99, 0);         // Set counter to 0. WDT start all over
```

### 2.2 Disable WDT

```
EC_WriteByte (0x99, 0);         // Set counter to 0
EC_WriteByte (0x98, 0);         // Disable WDT after setting WDT time to 0
```

# LVDS Backlight Brightness Control

## 3. LVDS Backlight Brightness Control

The LVDS controller support 17 level of backlight brightness value from 0 (30%) to 16 (100%) and it is accessible through SMBus. The associated access method (**SMBus_ReadByte**, **SMBus_WriteByte**) are provided in part 4.

### 3.1 Set the Level of LVDS Backlight

1. Write **0xED** into address **0x7F** on SMBus device **0x42**.
2. Write desired backlight level from 0x0 (30%) to 0x10 (100%) into address **0x6E** on SMBus device **0x42**.

**Example:** Set LVDS backlight level to 0x10 (100%)

```
SMBus_WriteByte (0x42, 0x7F, 0xED);
SMBus_WriteByte (0x42, 0x6E, 0x10);     // Set brightness to 100%
```

### 3.2 Read the Level of LVDS Backlight

1. Write **0xED** into address **0x7F** on SMBus device **0x42**.
2. Read current backlight level from address **0x6E** on SMBus device **0x42**.

**Example:** Get LVDS backlight level

```
SMBus_WriteByte (0x42, 0x7F, 0xED);
BKL_Value = SMBus_ReadByte (0x42, 0x6E);
```

# SMBus Access

## 4. SMBus Access

The base address of SMBus must be known before access. The relevant bus and device information are as following.

```
#define IO_SC               0xCF8
#define IO_DA               0xCFC
#define PCIBASEADDRESS      0x80000000
#define PCI_BUS_NUM         0
#define PCI_DEV_NUM         31
#define PCI_FUN_NUM         4
```

### 4.1 Get SMBus Base Address

```
int SMBUS_BASE;
int DATA_ADDR = PCIBASEADDRESS + (PCI_BUS_NUM<<16) +
                                 (PCI_DEV_NUM<<11) +
                                 (PCI_FUN_NUM<<8);
Outportl (DATA_ADDR + 0x20, IO_SC);
SMBUS_BASE = Inportl (IO_DA) & 0xfffffff0;
```

### 4.2 SMBus_ReadByte (char DEVID, char OFFSET)

Read the value of **OFFSET** from SMBus device **DEVID**.

```
Outportb (LOWORD (SMBUS_BASE), 0xFE);
Outportb (LOWORD (SMBUS_BASE) + 0x04, DEVID + 1);   // out Base + 04, (DEVID + 1)
Outportb (LOWORD (SMBUS_BASE) + 0x03, OFFSET);      // out Base + 03, OFFSET
Outportb (LOWORD (SMBUS_BASE) + 0x02, 0x48);        // out Base + 02, 48H
mdelay (20);                                        // delay 20ms to let data ready
while ((Inportl (SMBUS_BASE) & 0x01) != 0);         // wait SMBus ready
SMB_DATA = Inportb (LOWORD (SMBUS_BASE) + 0x05);    // input Base + 05
```

### 4.3 SMBus_WriteByte (char DEVID, char OFFSET, char DATA)

Write **DATA** to **OFFSET** on SMBus device **DEVID**.

```
Outportb (LOWORD (SMBUS_BASE), 0xFE);
Outportb (LOWORD (SMBUS_BASE) + 0x04, DEVID);       // out Base + 04, (DEVID)
Outportb (LOWORD (SMBUS_BASE) + 0x03, OFFSET);      // out Base + 03, OFFSET
Outportb (LOWORD (SMBUS_BASE) + 0x05, DATA);        // out Base + 05, DATA
Outportb (LOWORD (SMBUS_BASE) + 0x02, 0x48);        // out Base + 02, 48H
mdelay (20);                                        // wait 20ms
```

# Embedded Controller

## 5. Embedded Controller – EC Access

The relevant control information are as following.

```
#EC_CMD_PORT      0x66          // EC command port
#EC_DATA_PORT     0x62          // EC data port
#EC_DELAY         100
#EC_STAT_OBF      0x1           // bit 0: OBF
#EC_STAT_IBF      0x2           // bit 1: IBF
```

### 5.1 WaitPortStatus (char BITS, bool ONOFF)

```
int time=0, tick= EC_DELAY;
bool state;
for (time = 0; time < EC_DELAY*100; time += tick)   // *100 is the loop count to avoid infinite wait
{
    udelay (EC_DELAY);                              // Delay 100us to let data ready
    char data= Inportb (EC_CMD_PORT);
    state = ((data & BITS) !=0 );                   // Check EC status of desired bits
    if (state == ONOFF) {
        break;
    }
}
```

### 5.2 EC_ReadByte (char OFFSET)

Read the value from **OFFSET** of EC RAM.

```
WaitPortStatus (EC_STAT_IBF, false);        // Wait IBF = 0
Outportb (EC_CMD_PORT, 0x80);               // 0x80: EC read command
WaitPortStatus (EC_STAT_IBF, false);        // Wait IBF = 0
Outportb (EC_DATA_PORT, OFFSET);            // Write OFFSET to EC_DATA_PORT
WaitPortStatus (EC_STAT_OBF, true);         // Wait OBF = 1
EC_DATA = Inportb (EC_DATA_PORT);           // Get value from EC_DATA_PORT
```

### 5.3 EC_WriteByte (char OFFSET, char DATA)

Write **DATA** to **OFFSET** of EC RAM.

```
WaitPortStatus (EC_STAT_IBF, false);        // Wait IBF = 0
Outportb (EC_CMD_PORT, 0x81);               // 0x81: EC write command
WaitPortStatus (EC_STAT_IBF, false);        // Wait IBF = 0
Outportb (EC_DATA_PORT, OFFSET);            // Write OFFSET to EC_DATA_PORT
WaitPortStatus (EC_STAT_IBF, false);        // Wait IBF = 0
Outportb (EC_DATA_PORT, DATA);              // Write DATA to EC_DATA_PORT
WaitPortStatus (EC_STAT_IBF, false);        // Wait IBF = 0
```