Kontron COMe-bHL6 i7-4700EQ

Basic Form Factor Computer-On-Module

» Kontron User's Guide «

COMe-bHL6

Document Revision 2.1

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1 User Information

1.1 Revision History

Version	Brief Description of Change	Date of Issue
110	Initial version	
2.0	Removed ADA-LVDS-DVI 18-bit and 24-bit accessories Updates SM bus 8-bit address information for the hardware monitor Included a Revision History table	2017-Aug-10
2.1	Updates SPI Flash manufacturer information	2019-April-12

1.2 About This Document

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Kontron is ISO certified.

1.6 Warranty

For this Kontron product warranty for defects in material and workmanship exists as long as the warranty period, beginning with the date of shipment, lasts. During the warranty period, Kontron will decide on its discretion if defective products are to be repaired or replaced.

Within the warranty period, the repair of products is free of charge as long as warranty conditions are observed.

Warranty does not apply for defects arising/resulting from improper or inadequate maintenance or handling by the buyer, unauthorized modification or misuse, as well as the operation outside of the product´s environmental specifications and improper installation and maintenance.

Kontron will not be responsible for any defects or damages to other products not supplied by Kontron that are caused by a faulty Kontron product.

1.7 Technical Support

Technicians and engineers from Kontron and/or its subsidiaries are available for technical support. We are committed to make our product easy to use and will help you use our products in your systems.

Please consult our Website at http://www.kontron.com/support for the latest product documentation, utilities, drivers and support contacts. Consult our customer section http://emdcustomersection.kontron.com for the latest BIOS downloads, Product Change Notifications, Board Support Packages, DemoImages, 3D drawings and additional tools and software. In any case you can always contact your board supplier for technical support.

2 Introduction

2.1 Product Description

The brand new application-ready COMe-bHL6 offers increased performance density and up to twice the graphics performance compared to its predecessors. Up to three independent, daisy-chained displays with up to 4K resolution are supported to create stunning user experiences. Further to this, DirectX® 11.1 and OpenGL 4.0 support paves the way for compelling visuals when videos, graphics and interactive content are being displayed. By integrating the new Intel® AVX2 and OpenCL 1.2, Kontron’s new Computer-on-Modules additionally not only provide an increase in floating-point performance they also possess improved parallel processing capacities. Typical application areas can be found in markets such as digital signage, professional gaming and entertainment, medical imaging and surveillance and security as well as industrial plant and machine line control on shop floor- and control room-level.

Engineers can immediately commence with evaluating these new benchmark Computer-on-Modules on all Kontron COM Express® pin-out type 6-compliant starter kits.

The Kontron COM Express® pin-out type 6 COMe-bHL6 module is available in several different variants ranging from the cost-optimized low-power processor versions up to quad-core Intel® Core™ i7 processors with up to 4x 2.4 GHz. The modules are designed with the Intel® Mobile QM87 chipset, host up to 16 GB DDR3L RAM and support 7 PCI Express x1 lanes and 1 PEG x16 interface which is also compatible to standard PCI Express devices. Less complex peripherals can be connected via SPI and LPC. Additional dedicated features include 3x SATA 6Gb/s ports, 1 SATA 3Gb/s port, as well as Gigabit Ethernet, 4 USB 3.0 ports, 4 USB 2.0 and 2 serial ports. The Kontron COMe-bHL6 features comprehensive display support with 3x dual mode DisplayPort++ which can also output, HDMI, DVI and DisplayPort 1.2. Industrial applications benefit from the watchdog and real-time clock. The module supports an 8.5-20V wide-range power supply. The support of smart batteries via MARS and the standardized embedded application programming interface EAPI round off the feature set and provide engineers with a comprehensive service package that eases system development as well as system programming.

For customers wanting to instantly leverage the new graphics and computing power in their existing designs based on individual carrier boards, Kontron also offers standardized migration support services to accelerate the design-in phase and thus achieve fastest field deployment.

The Kontron COM Express® basic Computer-on-Module COMe-bHL6 supports the full Windows OS portfolio along with Linux and VxWorks.

2.2 Naming clarification

COM Express® defines a Computer-On-Module, or COM, with all components necessary for a bootable host computer, packaged as a super component.

» COMe-bXX# modules are Kontron's COM Express® modules in basic form factor (125mm x 95mm)

» COMe-cXX# modules are Kontron's COM Express® modules in compact form factor (95mm x 95mm)

» COMe-mXX# modules are Kontron's COM Express® modules in mini form factor (55mm x 84mm)

The product names for Kontron COM Express® Computer-on-Modules consist of a short form of the industry standard (**COMe-**), the form factor (**b**=basic, **c**=compact, **m**=mini), the capital letters for the CPU and Chipset Codenames (**XX**) and the pin-out type (**#**) followed by the CPU Name.

2.3 Understanding COM Express® Functionality

All Kontron COM Express® basic and compact modules contain two 220pin connectors; each of it has two rows called Row A & B on primary connector and Row C & D on secondary connector. COM Express® Computer-on-modules feature the following maximum amount of interfaces according to the PICMG module Pin-out type:

Feature	Pin-Out Type 1	Pin-Out Type 10	Pin-Out Type 2	Pin-Out Type 6
HD Audio	1x	1x	1x	1x
Gbit Ethernet	1x	1x	1x	1x
Serial ATA	4x	4x	4x	4x
Parallel ATA	-	-	1x	-
PCI	-	-	1x	-
PCI Express x1	6x	6x	6x	8x
PCI Express x16 (PEG)	-	-	1x	1x
USB Client	1x	1x	-	-
USB 2.0	8x	8x	8x	8x
USB 3.0	-	2x	-	4x
VGA	1x	-	1x	1x
LVDS	Dual Channel	Single Channel	Dual Channel	Dual Channel
DP++ (SDVO/DP/HDMI/DVI)	1x optional	1x	3x shared with PEG	3x
LPC	1x	1x	1x	1x
External SMB	1x	1x	1x	1x
External I2C	1x	1x	1x	1x
GPIO	8x	8x	8x	8x
SDIO shared w/GPIO	1x optional	1x optional	-	1x optional
UART (2-wire COM)	-	2x	-	2x
FAN PWM out	-	1x	-	1x

2.4 COM Express® Documentation

This product manual serves as one of three principal references for a COM Express® design. It documents the specifications and features of COMe-bHL6. Additional references are available at your Kontron Support or at PICMG®:

» The COM Express® Specification defines the COM Express® module form factor, pin-out, and signals. This document is available at the PICMG® website by filling out the order form.

» The COM Express® Design Guide by PICMG® serves as a general guide for baseboard design, with a focus on maximum flexibility to accommodate a wide range of COM Express® modules.

Some of the information contained within this product manual applies only to certain product revisions (CE: xxx). If certain information applies to specific product revisions (CE: xxx) it will be stated. Please check the product revision of your module to see if this information is applicable.

2.5 COM Express® Benefits

COM Express® modules are very compact, highly integrated computers. All Kontron COM Express® modules feature a standardized form factor and a standardized connector layout which carry a specified set of signals. Each COM is based on the COM Express® specification. This standardization allows designers to create a single-system baseboard that can accept present and future COM Express® modules.

The baseboard designer can optimize exactly how each of these functions implements physically. Designers can place connectors precisely where needed for the application on a baseboard designed to optimally fit a system’s packaging.

A single baseboard design can use a range of COM Express® modules with different sizes and pin-outs. This flexibility can differentiate products at various price/performance points, or when designing future proof systems that have a built-in upgrade path. The modularity of a COM Express® solution also ensures against obsolescence when computer technology evolves. A properly designed COM Express® baseboard can work with several successive generations of COM Express® modules.

A COM Express® baseboard design has many advantages of a customized computer-board design and, additionally, delivers better obsolescence protection, heavily reduced engineering effort, and faster time to market.

3 Product Specification

3.1 Module definition

The COM Express® basic sized Computer-on-Module COMe-bHL6 (BHL6 / BBL6) follows pin-out Type 6 and is compatible to PICMG specification COM.0 Rev 2.1. The COMe-bHL6 based on latest Shark Bay Mobile platform is available in different variants to cover the demand of different performance, price and power:

Commercial grade modules (0°C to 60°C operating)

Product Number	Product Name	Processor	TDP	PCH	USB 3.0	SATA 6G	SATA 3G
38025-0000-18-7	COMe-bHL6 i7-4860EQ	Intel® Core™ i7-4860EQ	47W	QM87	4	3	1
38025-0000-16-7	COMe-bHL6 i7-4850EQ	Intel® Core™ i7-4850EQ	47W	QM87	4	3	1
38025-0000-24-7	COMe-bHL6 i7-4700EQ	Intel® Core™ i7-4700EQ	47W/37W	QM87	4	3	1
38025-0000-29-5	COMe-bHL6 i5-4410E	Intel® Core™ i5-4410E	37W	QM87	4	3	1
38025-0000-27-5	COMe-bHL6 i5-4400E	Intel® Core™ i5-4400E	37W	QM87	4	3	1
38025-0000-18-5	COMe-bHL6 i5-4422E	Intel® Core™ i5-4422E	25W	QM87	4	3	1
38025-0000-16-5	COMe-bHL6 i5-4402E	Intel® Core™ i5-4402E	25W	QM87	4	3	1
38025-0000-26-3	COMe-bHL6 i3-4110E	Intel® Core™ i3-4110E	37W	HM86	2	2	2
38025-0000-24-3	COMe-bHL6 i3-4100E	Intel® Core™ i3-4100E	37W	HM86	2	2	2
38025-0000-18-3	COMe-bHL6 i3-4112E	Intel® Core™ i3-4112E	25W	HM86	2	2	2
38025-0000-16-3	COMe-bHL6 i3-4102E	Intel® Core™ i3-4102E	25W	HM86	2	2	2
38025-0000-22-1	COMe-bHL6 2000E	Intel® Celeron 2000E	37W	HM86	2	2	2
38025-0000-15-1	COMe-bHL6 2002E	Intel® Celeron 2002E	25W	HM86	2	2	2

Extended temperature grade modules (E1, -25°C to 75°C operating) and

Industrial temperature grade modules (XT, -40°C to 85°C operating)

The COMe-bHL6 is available for extended and industrial temperature range. General capability was tested for following options:

» CPU: all

» Memory: E2 DDR3L memory only 97015-xxxx-16-3

» VCC: 12V only, no support for Wide-Range Input

The RXT product line includes modules with following featureset:

» industrial grade temperature range (-40 to +85°C) by screening

» ECC Memory support (97016-xxxx-16-3)

» Kontron Rapid Shutdown support

Product Number	Product Name	Processor	TDP	PCH	USB 3.0	SATA 6G	SATA 3G
38026-0000-18-7	COMe-bHL6RXT i7-4860EQ	Intel® Core™ i7-4860EQ	47W	QM87	4	3	1
38026-0000-24-7	COMe-bHL6RXT i7-4700EQ	Intel® Core™ i7-4700EQ	47W/37W	QM87	4	3	1
38026-0000-29-5	COMe-bHL6RXT i5-4410E	Intel® Core™ i5-4410E	37W	QM87	4	3	1
38026-0000-27-5	COMe-bHL6RXT i5-4400E	Intel® Core™ i5-4400E	37W	QM87	4	3	1
38026-0000-18-5	COMe-bHL6RXT i5-4422E	Intel® Core™ i5-4422E	25W	QM87	4	3	1

Please contact your local sales for further information and MOQ for RXT modules

3.2 Functional Specification

Processor

The 22nm Intel® 4th Gen Core™ i7/i5/i3/Celeron® embedded (Haswell-H (Halo) / Crystal Well) CPU family with 37.5x32mm package size (BGA1364 socket) supports:

» Intel® Turbo Boost Technology 2.01

» Intel® 64

» Intel® Virtualization Technology (VT-x)

» Intel® Virtualization Technology for Directed I/O (VT-d)

» Intel® Hyper-Threading Technology

» Enhanced Intel SpeedStep® Technology

» Idle States (C-States)

» Intel® Smart Cache

» Thermal Monitoring Technologies

» Intel® Fast Memory Access

» Intel® Flex Memory Access

» Integrated Intel® HD Graphics with Dynamic Frequency

Optional available (with customized BIOS, Evaluation Copy on request):

» Intel® vPRO™ Technology including:

» Intel® Active Management Technology (AMT)

» Intel® Trusted Execution Technology (TXT)

» Advanced Encryption Standard Instructions (AES-NI)

The integrated Intel® HD Graphics 5200/4600 supports:

» GraphicsTechnology GT3 with 40 Execution Units (HD5200)

» GraphicsTechnology GT2 with 20 Execution Units (HD4600)

» Intel® Quick Sync Video

» Intel® InTru™ 3D Technology

» Intel® Wireless Display

» Intel® Flexible Display Interface (Intel® FDI)

» Intel® Clear Video HD Technology

» Intel® Graphics Render C-State RC6

» Intel® Smart 2D Display Technology (S2DDT)

» 3 simultaneous displays (Win7/8 and Linux)

» Hybrid Multi Monitor with 2 internal and 2 external displays

» Video Decode for AVC/H.264/VC-1/MPEG-2

» Video Encode for AVC/H.264/MPEG-2

» Blu-ray Playback (incl. PAVP)

The integrated Intel® HD Graphics supports:

» GraphicsTechnology GT1 with 10 Execution Units

» Dual Display

» Video Decode for AVC/H.264/VC-1/MPEG-2

» Video Encode for AVC/H.264/MPEG-2

» Blu-ray Playback (incl. PAVP)

CPU Features

Intel®	Core™	Core™	Core™	Core™	Core™	Core™	Core™	Celeron@	Celeron@
-	i7-4860EQ	i7-4850EQ	i7-4700EQ	i5-4400E	i5-4402E	i3-4100E	i3-4102E	2000E	2002E
# of Cores	4	4	4	2	2	2	2	2	2
# of Threads	8	8	8	4	4	4	4	2	2
TDP Core frequency (HFM)	**1800MHz**	**1600MHz**	**2400MHz**	**2700MHz**	**1600MHz**	**2400MHz**	**1600MHz**	**2200MHz**	**1500MHz**
Max Turbo Frequency 1 core	3200MHz	3200MHz	3400MHz	3300MHz	2700MHz	-	-	-	-
Max Turbo all cores	2600MHz	2600MHz	2800MHz	3200MHz	2600MHz	-	-	-	-
LFM/LPM Frequency	800MHz	800MHz	800MHz	800MHz	800MHz	800MHz	800MHz	800MHz	800MHz
Bus/Core Ratio	8 - 20	8 - 16	8 - 24	8 - 27	8 - 16	8 - 24	8 - 16	8 - 22	8 - 15
TjMax	100°C	100°C	100°C	100°C	100°C	100°C	100°C	100°C	100°C
Thermal Design Power (TDP/PL1)	47W	47W	47W	37W	25W	37W	25W	37W	25W
cTDP-Down	-	-	37W	-	-	-	-	-	-
cTDP-Down Core frequency	-	-	**1700MHz**	-	-	-	-	-	-
Power Limit 2 (PL2 max)	58.75W	58.75W	58.75/46.25 W	46.25W	31.25W	46.25W	31.25W	46.25W	31.25W
C-States	C0-C7	C0-C7	C0-C7	C0-C7	C0-C7	C0-C7	C0-C7	C0-C7	C0-C7
eDRAM	128MB 1.6GHz	128MB 1.6GHz	-	-	-	-	-	-	-
Smart Cache	6MB	6MB	6MB	3MB	3MB	3MB	3MB	2MB	2MB
Min Memory Type	DDR3L-1066	DDR3L-1066	DDR3L-1066	DDR3L-1066	DDR3L-1066	DDR3L-1066	DDR3L-1066	DDR3L-1066	DDR3L-1066
Max Memory Type	DDR3L-1600	DDR3L-1600	DDR3L-1600	DDR3L-1600	DDR3L-1600	DDR3L-1600	DDR3L-1600	DDR3L-1600	DDR3L-1600
Max Memory Size	2x8GB	2x8GB	2x8GB	2x8GB	2x8GB	2x8GB	2x8GB	2x8GB	2x8GB
# of Memory Channels	2	2	2	2	2	2	2	2	2
Graphics Model	Iris Pro 5200	Iris Pro 5200	HD4600	HD4600	HD4600	HD4600	HD4600	HD	HD
GFX LFM Frequency	200MHz	200MHz	200MHz	200MHz	200MHz	200MHz	200MHz	200MHz	200MHz
GFX Base Frequency	650MHz	750MHz	400MHz	400MHz	400MHz	400MHz	400MHz	400MHz	400MHz
GFX Turbo Frequency	1000MHz	1000MHz	1000MHz	1000MHz	900MHz	900MHz	900MHz	900MHz	900MHz
GFX Technology	GT3e 40EU	GT3e 40EU	GT2 20EU	GT2 20EU	GT2 20EU	GT2 20EU	GT2 20EU	GT1 10EU	GT1 10EU
GFX Func/Phys Cores	3/3	3/3	2/2	2/2	2/2	2/2	2/2	1/2	1/2
Quick Sync Video	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-
InTru™ 3D	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-
Wireless Display	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-
Clear Video HD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-
vPRO™ (optional)	Yes	Yes	Yes	Yes	Yes	-	-	-	-
TXT (optional)	Yes	Yes	Yes	Yes	Yes	-	-	-	-
AES-NI (optional)	Yes	Yes	Yes	Yes	Yes	-	-	-	-
VT-x	Yes	Yes	Yes	Yes	Yes	-	-	-	-
VT-d	Yes	Yes	Yes	Yes	Yes	-	-	-	-
PCI Express Graphics x16	Gen 3.0	Gen 3.0	Gen 3.0	Gen 3.0	Gen 3.0	Gen 3.0	Gen 3.0	Gen 2.0	Gen 2.0

Intel®	Core™	Core™	Core™	Core™
-	i5-4410E	i5-4422E	i3-4110E	i3-4112E
# of Cores	2	2	2	2
# of Threads	4	4	4	4
TDP Core frequency (HFM)	**2900MHz**	**1800MHz**	**2600MHz**	**1800MHz**
Max Turbo Frequency 1 core	Note 1	2900MHz	-	-
Max Turbo all cores	Note 1	2800MHz	-	-
LFM/LPM Frequency	800MHz	800MHz	800MHz	800MHz
Bus/Core Ratio	8 - 29	8 - 16	8 - 24	8 - 16
TjMax	100°C	100°C	100°C	100°C
Thermal Design Power (TDP/PL1)	37W	25W	37W	25W
cTDP-Down	-	-	-	-
cTDP-Down Core frequency	-	-	-	-
Power Limit 2 (PL2 max)	46.25W	31.25W	46.25W	31.25W
C-States	C0-C7	C0-C7	C0-C7	C0-C7
eDRAM	-	-	-	-
Smart Cache	3MB	3MB	3MB	3MB
Min Memory Type	DDR3L-1066	DDR3L-1066	DDR3L-1066	DDR3L-1066
Max Memory Type	DDR3L-1600	DDR3L-1600	DDR3L-1600	DDR3L-1600
Max Memory Size	2x8GB	2x8GB	2x8GB	2x8GB
# of Memory Channels	2	2	2	2
Graphics Model	HD4600	HD4600	HD4600	HD4600
GFX LFM Frequency	200MHz	200MHz	200MHz	200MHz
GFX Base Frequency	400MHz	400MHz	400MHz	400MHz
GFX Turbo Frequency	1000MHz	900MHz	900MHz	900MHz
GFX Technology	GT2 20EU	GT2 20EU	GT2 20EU	GT2 20EU
GFX Func/Phys Cores	2/2	2/2	2/2	2/2
Quick Sync Video	Yes	Yes	Yes	Yes
InTru™ 3D	Yes	Yes	Yes	Yes
Wireless Display	Yes	Yes	Yes	Yes
Clear Video HD	Yes	Yes	Yes	Yes
vPRO™ (optional)	Yes	Yes	-	-
TXT (optional)	Yes	Yes	-	-
AES-NI (optional)	Yes	Yes	Yes	Yes
VT-x	Yes	Yes	Yes	Yes
VT-d	Yes	Yes	-	-
PCI Express Graphics x16	Gen 3.0	Gen 3.0	Gen 3.0	Gen 3.0

Memory

Sockets	2x DDR3 SO-DIMM
Memory Type	DDR3L-1600 (ECC on RXT Ver.)
Maximum Size	2x8GB
Technology	Dual Channel

Chipset

The 32nm Intel® 8-Series Platform Controller Hub Lynx Point supports:

» PCI Express Revision 2.0

» PCI Express Configurations x1, x2, x4

» Intel® Virtualization Technology for Directed I/O (VT-d)

» Intel® Trusted Execution Technology (TXT)

» Intel® vPro Technology (optional)

» Intel® Active Management Technology 9.0 (optional)

» Intel® Anti-Theft Technology

» Intel® Rapid Storage Technology

» Intel® Smart Response Technology

PCH comparison

Feature	QM87	HM86
TDP	2.7W	2.7W
USB 3.0 (USB 2.0 compatible)	YES (4x on COMe)	YES (2x on COMe)
USB 2.0	YES (4x on COMe)	YES (6x on COMe)
SATA 6Gb/s (Gen3)	YES (3x on COMe)	YES (2x on COMe)
SATA 3Gb/s (Gen2)	YES (1x on COMe)	YES (2x on COMe)
Wireless Display	YES	YES
3 Displays simultaneously	YES	YES
Rapid Storage	AHCI, RAID 0/1/5/10	AHCI only
VT-d	YES	NO
vPRO	YES with custom BIOS	NO
AMT	YES with custom BIOS	NO
TXT	YES with custom BIOS	NO

The Intel® vPro Technology including Trusted Execution Technology (TXT), Active Management Technology (AMT) and Encryption AES-NI is not supported by default on COMe-bHL6. Please contact your local sales or support for custom BIOS variants supporting vPro.

HighSpeed I/O Port Configuration

-	QM87 I/O	HM86 I/O	COMe-bHL6 with QM87	COMe-bHL6 with HM86
Port1	USB3 #1	USB3 #1	USB #0 = USB3.0	USB #0 = USB3.0
Port2	USB3 #2	USB3 #2	USB #1 = USB3.0	USB #1 = USB3.0
Port3	USB3 #5	-	USB #2 = USB3.0	-
Port4	USB3 #6	-	USB #3 = USB3.0	-
-	USB2	USB2	USB #4-7 = USB 2.0	USB #2-7 = USB 2.0
Port5	USB3 #3 or PCIe #1	USB3 #3 or PCIe #1	PCIe #0	PCIe #0
Port6	USB3 #4 or PCIe #2	USB3 #4 or PCIe #2	PCIe #1	PCIe #1
Port7	PCIe #3	PCIe #3	PCIe #2	PCIe #2
Port8	PCIe #4	PCIe #4	PCIe #3	PCIe #3
Port9	PCIe #5	PCIe #5	PCIe #4	PCIe #4
Port10	PCIe #6	PCIe #6	PCIe #5	PCIe #5
Port11	PCIe #7	PCIe #7	PCIe #6	PCIe #6
Port12	PCIe #8	PCIe #8	LAN/PCIe #7	LAN/PCIe #7
Port13	SATA3 #4 or PCIe #1	SATA3 #4	SATA #0 = SATA 6Gb/s	SATA #0 = SATA 6Gb/s
Port14	SATA3 #5 or PCIe #2	SATA3 #5	SATA #1 = SATA 6Gb/s	SATA #1 = SATA 6Gb/s
Port15	SATA3 #0	SATA2 #0	SATA #2 = SATA 6Gb/s	SATA #2 = SATA 3Gb/s
Port16	SATA3 #1	-	-	-
Port17	SATA2 #2	SATA2 #2	SATA #3 = SATA 3Gb/s	SATA #3 = SATA 3Gb/s
Port18	SATA2 #3	-	-	-

Graphics Core

The integrated Intel® HD/HD4600/HD5200 (Gen7.5) supports:

Graphics Core Render Clock	GT1/GT2/GT3; Base clock: 400/200 MHz; GT Turbo: up to 1000 MHz
Execution Units / Pixel Pipelines	GT3: 40EU / GT2: 20EU / GT1: 10EU
Max Graphics Memory	1720MB
GFX Memory Bandwidth (GB/s)	25.6
GFX Memory Technology	DVMT
API (DirectX/OpenGL)	11.1 / 4.0 + OCL 1.2
Shader Model	5.0
Hardware accelerated Video	MPEG2, VC-1, AVC, Blu-ray (+3D)
Independent/Simultaneous Displays	3
Display Port	DP 1.2 / eDP 1.3
HDCP support	HDCP 1.4a

Monitor output

CRT max Resolution	1920x1200
TV out:	-

LVDS

LVDS Bits/Pixel	1x18/24, 2x18/24 with DP2LVDS
LVDS Bits/Pixel with dithering	-
LVDS max Resolution:	1920x1200
PWM Backlight Control:	YES
Supported Panel Data:	JILI2/JILI3/EDID/DID

Display Interfaces

Discrete Graphics	1x PEG 3.0/2.0
Digital Display Interface DDI1	DP++
Digital Display Interface DDI2	DP++
Digital Display Interface DDI3	DP++
Maximum Resolution on DDI	HDMI: 4096x2304, DP: 3840x2160

PEG Configuration

The x16 PCI Express Graphics Port (PEG) is compatible to standard PCI Express devices like Ethernet or RAID controllers. The COMe-bHL6 supports following PEG Port configuration when used as PCI Express Interface:

» 1×16

» 1×8

» 1×4

» 1×2

» 1×1

The internal PCI Express controller can be re-configured to support up to 3 PCIe ports on PEG16 interface. The PEG lane splitting is configurable in setup:

» 1×16 (lanes #0-15)

» 2×8 (lanes #0-7 + #8-15)

» 1×8 + 2×4 (lanes #0-7 + #8-11 + #12-15)

With splitted ports, Port2 (#8-15 or #8-11) and Port3 (#12-15) cannot have more lanes active as Port1 (#0-7) has

Storage

onboard SSD	-
SD Card support	-
IDE Interface	-
Serial-ATA	up to 3x SATA 6Gb/s, 1x SATA 3Gb/s
SATA AHCI	NCQ, HotPlug, Staggered Spinup, eSATA, PortMultiplier
SATA RAID	0, 1, 5, 10 (QM87 only)

If SATA AHCI or RAID is disabled in setup, the SATA Interface only supports 3Gb/s transfer rate and Staggered Spin-Up. To configure a RAID Setup connect at least two hard drives and enable RAID support in BIOS Advanced/HDD Settings. After reboot, setup your RAID configuration in the new setup item “Addon Devices”

Connectivity

USB 2.0	8x USB 2.0
USB 3.0	up to 4x USB 3.0
USB Client	-
PCI	-
PCI External Masters	-
PCI Express	7x PCIe x1 Gen 2.0
Max PCI Express	8x PCIe without LAN
PCI Express x2/x4 configuration	YES (Softstrap option)
Ethernet	10/100/1000 Mbit
Ethernet controller	Intel® i218-LM (Clarkville)

PCI Express Configuration

By default, the COMe-bHL6 supports x1 PCIexpress lane configuration only (Configuration 0). Following x2/x4 configurations are available via Management Engine Softstrap Options with a customized Flash Descriptor.

PCIe	Port #0	Port #1	Port #2	Port #3	Port #4	Port #5	Port #6	Port #7*
Configuration 0	x1	x1	x1	x1	x1	x1	x1	x1
Configuration 1	x2		x1	x1	x1	x1	x1	x1
Configuration 2	x2		x2		x1	x1	x1	x1
Configuration 3	x2		x2		x2		x1	x1
Configuration 4	x2		x2		x2		x2	
Configuration 5	x4				x1	x1	x1	x1
Configuration 6	x4				x2		x1	x1
Configuration 7	x4				x2		x2	
Configuration 8	x4				x4			

- *PCIe Port #7 is available without Ethernet Controller only
- Configuration 0 is the default setting
- Configuration 3 & Configuration 5 are available in UEFI download package on EMD Customer Section

Ethernet

The Intel® i218-LM (Clarkville) ethernet supports:

» Jumbo Frames - 9K

» MACsec IEEE 802.1 AE

» Time Sync Protocol Indicator

» WOL (Wake On LAN)

» PXE (Preboot eXecution Environment)

» IEEE1588

Misc Interfaces and Features

Supported BIOS Size/Type	16MB SPI
Audio	HD Audio + DisplayPort dual stream
Onboard Hardware Monitor	Nuvoton NCT7802Y
Trusted Platform Module	Atmel AT97SC3204-U2A1A-10
Miscellaneous	2x UART / PWM FAN / eDP optional

Kontron Features

External I2C Bus	Fast I2C, MultiMaster capable
Smart Battery (M.A.R.S.) support	YES
Embedded API	KEAPI3
Custom BIOS Settings / Flash Backup	YES
Watchdog support	Dual Staged

Additional features

» All solid capacitors (POSCAP). No tantalum capacitors used.

» Optimized RTC Battery monitoring to secure highest longevity

» Real fast I2C with transfer rates up to 40kB/s.

» Discharge logic on all onboard voltages for highest reliability

Power Features

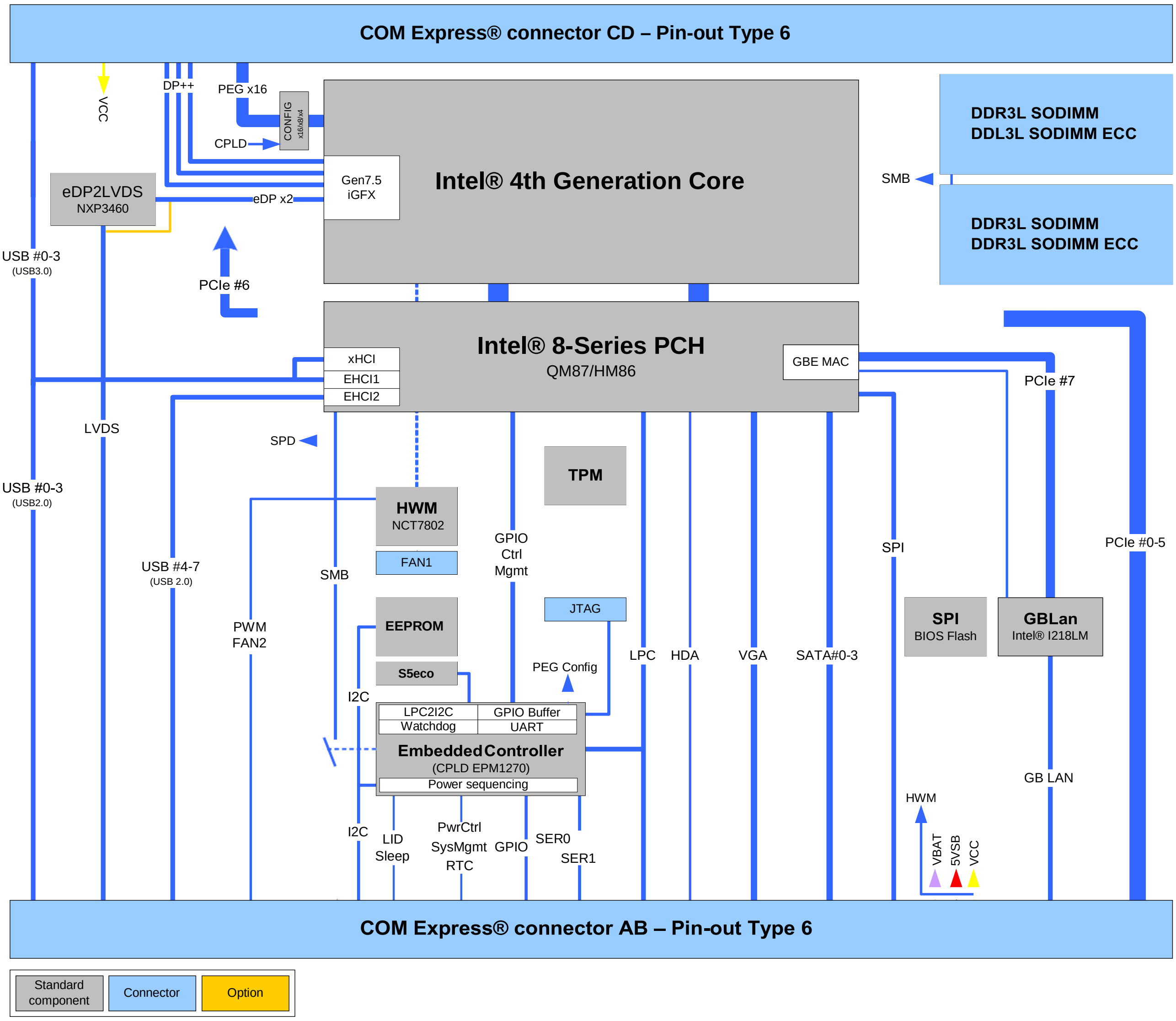
Singly Supply Support	YES
Supply Voltage	8.5V - 20V
ACPI	ACPI 4.0
S-States	S0, S3, S4, S5
S5 Eco Mode	YES
Misc Power Management	cTDP @ i7-4700EQ

Power Consumption and Performance

Full Load Power Consumption	17 - 48W
Kontron Performance Index	32645 - 100815
Kontron Performance/Watt	1723 - 3105

Detailed Power Consumption measurements and benchmarks for CPU, Graphics and Memory are available in Application Note KEMAP054 at EMD Customer Section.

3.3 Block Diagram



3.4 Accessories

Product specific accessories

Product Number	Heatspreader and Cooling Solutions	Comment
38025-0000-99-2	HSP COMe-bHL6 heatpipe thread	For all CPUs and temperature grades
38025-0000-99-3	HSP COMe-bHL6 heatpipe through	For all CPUs and temperature grades
38025-0000-99-0C05	HSK COMe-bHL6 active (w/o HSP)	For all CPUs and commercial temperature grade usage
38025-0000-99-0C06	HSK COMe-bHL6 passive (w/o HSP)	For all CPUs and commercial temperature grade usage

General accessories

Part Number	COMe pin-out Type 6 compatible accessories	Project Code	Comment
38114-0000-00-0	COM Express® Reference Carrier Type 6	ADAS	mITX Carrier with 8mm COMe connector
38106-0000-00-0	COM Express® Eval Carrier Type 6	Topanga Canyon	ATX Carrier with 5mm COMe connector
96007-0000-00-3	ADA-PCIe-DP	APDP	PCIe x16 to DP Adapter for Evaluation Carrier
96007-0000-00-7	ADA-Type6-DP3	DV06	(sandwich) Adapter Card for 3x DisplayPort
96006-0000-00-2	COMe POST T6	NFCB	POST Code / Debug Card
38019-0000-00-0	ADA-COMe-Height-dual	EERC	Height Adapter
38106-0000-00-S	COMe Eval Starterkit T6	Topanga Canyon	Starterkit with COMe Evaluation Carrier T6
38114-0000-00-S	COMe Ref. Starterkit T6	ADAS	Starterkit with COMe Reference Carrier T6

Part Number	Mounting	Comment
38017-0000-00-5	COMe Mount KIT 5mm 1set	Mounting Kit for 1 module including screws for 5mm connectors
38017-0100-00-5	COMe Mount KIT 5mm 100sets	Mounting Kit for 100 modules including screws for 5mm connectors
38017-0000-00-0	COMe Mount KIT 8mm 1set	Mounting Kit for 1 module including screws for 8mm connectors
38017-0100-00-0	COMe Mount Kit 8mm 100sets	Mounting Kit for 100 modules including screws for 8mm connectors

Part Number	Cooling Solutions	Comment
36099-0000-99-0	COMe Active Uni Cooler	for CPUs up to 20W TDP, to be mounted on HSP
36099-0000-99-1	COMe Passive Uni Cooler	for CPUs up to 10W TDP, to be mounted on HSP

Part Number	Display Adapter	Comment
96006-0000-00-8	ADA-DP-LVDS	DP to LVDS adapter
96082-0000-00-0	KAB-ADAPT-DP-DVI	DP to DVI adapter cable
96083-0000-00-0	KAB-ADAPT-DP-VGA	DP to VGA adapter cable
96084-0000-00-0	KAB-ADAPT-DP-HDMI	DP to HDMI adapter cable

Part Number	Cables	Comment
96079-0000-00-0	KAB-HSP 200mm	Cable adapter to connect FAN to module (COMe basic/compact)
96079-0000-00-2	KAB-HSP 40mm	Cable adapter to connect FAN to module (COMe basic/compact)

Part Number	Miscellaneous	Comment
18029-0000-00-0	MARS Smart Battery Kit	Starterkit Kontron Mobile Application platform for Rechargeable Systems

For COMe-bHL6 standard (38025-xxxx-xx-x)

Part Number	DDR3L SODIMM, commercial temperature grade
97015-1024-16-1	DDR3L-1600 SODIMM 1GB
97015-2048-16-1	DDR3L-1600 SODIMM 2GB
97015-4096-16-1	DDR3L-1600 SODIMM 4GB
97015-8192-16-1	DDR3L-1600 SODIMM 8GB
Part Number	**DDR3L SODIMM, industrial temperature grade**
97015-1024-16-3	DDR3L-1600 SODIMM 1GB E2
97015-2048-16-3	DDR3L-1600 SODIMM 2GB E2
97015-4096-16-3	DDR3L-1600 SODIMM 4GB E2
97015-8192-16-3	DDR3L-1600 SODIMM 8GB E2

For COMe-bHL6RXT (38026-xxxx-xx-x)

Part Number	DDR3L ECC SODIMM, industrial temperature grade
97016-1024-16-3	DDR3L-1600 SODIMM 1GB ECC E2
97016-2048-16-3	DDR3L-1600 SODIMM 2GB ECC E2
97016-4096-16-3	DDR3L-1600 SODIMM 4GB ECC E2
97016-8192-16-3	DDR3L-1600 SODIMM 8GB ECC E2

3.5 Electrical Specification

3.5.1 Supply Voltage

Following supply voltage is specified at the COM Express® connector:

VCC:	8.5V - 20V
Standby:	5V DC +/- 5%
RTC:	2.5V - 3.47V

- 5V Standby voltage is not mandatory for operation.
- Extended Temperature (E1) variants are validated for 12V supply only

3.5.2 Power Supply Rise Time

» The input voltages shall rise from ≤10% of nominal to within the regulation ranges within 0.1ms to 20ms.

» There must be a smooth and continuous ramp of each DC input voltage from 10% to 90% of its final set-point following the ATX specification

3.5.3 Supply Voltage Ripple

» Maximum 100 mV peak to peak 0 – 20 MHz

3.5.4 Power Consumption

The maximum Power Consumption of the different COMe-bHL6 variants is 17 - 48W (100% CPU load on all cores; 90°C CPU temperature). Further information with detailed measurements are available in Application Note KEMAP054 available on EMD Customer Section. Information there is available after registration.

3.5.5 ATX Mode

By connecting an ATX power supply with VCC and 5VSB, PWR_OK is set to low level and VCC is off. Press the Power Button to enable the ATX PSU setting PWR_OK to high level and powering on VCC. The ATX PSU is controlled by the PS_ON# signal which is generated by SUS_S3# via inversion. VCC can be 8.5V - 20V in ATX Mode. On Computer-on-Modules supporting a wide range input down to 4.75V the input voltage shall always be higher than 5V Standby (VCC > 5VSB).

State	PWRBTN#	PWR_OK	V5_StdBy	PS_ON#	VCC
G3	x	x	0V	x	0V
S5	high	low	5V	high	0V
S5 → S0	PWRBTN Event	low → high	5V	high → low	0 V→ VCC
S0	high	high	5V	low	VCC

3.5.6 Single Supply Mode

In single supply mode (or automatic power on after power loss) without 5V Standby the module will start automatically when VCC power is connected and Power Good input is open or at high level (internal PU to 3.3V). PS_ON# is not used in this mode and VCC can be 8.5V - 20V.

To power on the module from S5 state press the power button or reconnect VCC. Suspend/Standby States are not supported in Single Supply Mode.

State	PWRBTN#	PWR_OK	V5_StdBy	VCC
G3	x	x	x	0
G3 → S0	high	open / high	x	connecting VCC
S5	high	open / high	x	VCC
S5 → S0	PWRBTN Event	open / high	x	reconnecting VCC

Signals marked with “x” are not important for the specific power state. There is no difference if connected or open.

All ground pins have to be tied to the ground plane of the carrier board.

3.6 Power Control

Power Supply

The COMe-bHL6 supports a power input from 8.5V - 20V. The supply voltage is applied through the VCC pins (VCC) of the module connector.

Power Button (PWRBTN#)

The power button (Pin B12) is available through the module connector described in the pinout list. To start the module via Power Button the PWRBTN# signal must be at least 50ms (50ms ≤ t < 4s, typical 400ms) at low level (Power Button Event).

Pressing the power button for at least 4seconds will turn off power to the module (Power Button Override).

Power Good (PWR_OK)

The COMe-bHL6 provides an external input for a power-good signal (Pin B24). The implementation of this subsystem complies with the COM Express® Specification. PWR_OK is internally pulled up to 3.3V and must be high level to power on the module.

Reset Button (SYS_RESET#)

The reset button (Pin B49) is available through the module connector described in the pinout list. The module will stay in reset as long as SYS_RESET# is grounded. If available, the BIOS setting for “Reset Behavior” must be set to “Power Cycle”.

> Modules with Intel® Chipset and active Management Engine do not allow to hold the module in Reset out of S0 for a long time. At about 10s holding the reset button the ME will reboot the module automatically

SM-Bus Alert (SMB_ALERT#)

With an external battery manager present and SMB_ALERT# (Pin B15) connected the module always powers on even if BIOS switch “After Power Fail” is set to “Stay Off”.

3.7 Environmental Specification

3.7.1 Temperature Specification

Kontron defines following temperature grades for Computer-on-Modules in general. Please see chapter 'Product Specification' for available temperature grades for the COMe-bHL6

Temperature Specification	Operating	Non-operating	Validated Input Voltage
Commercial grade	0°C to +60°C	-30°C to +85°C	VCC: 8.5V - 20V
Extended Temperature (E1)	-25°C to +75°C	-30°C to +85°C	VCC: 12V
Industrial grade by **Screening** (XT)	-40°C to +85°C	-40°C to +85°C	VCC: 12V
Industrial grade by **Design** (E2)	-40°C to +85°C	-40°C to +85°C	VCC: 8.5V - 20V

Operating with Kontron heatspreader plate assembly

The operating temperature defines two requirements:

» the maximum ambient temperature with ambient being the air surrounding the module.

» the maximum measurable temperature on any spot on the heatspreader's surface

Test specification:

Temperature Grade	Validation requirements
Commercial grade	at 60°C HSP temperature the CPU @ 100% load needs to run at nominal frequency
Extended Temperature (E1)	at 75°C HSP temperature the CPU @ 75% load is allowed to start speedstepping for thermal protection
Industrial grade by **Screening** (XT)	at 85°C HSP temperature the CPU @ 50% load is allowed to start throttling for thermal protection
Industrial grade by **Design** (E2)	at 85°C HSP temperature the CPU @ 50% load is allowed to start throttling for thermal protection

Operating without Kontron heatspreader plate assembly

The operating temperature is the maximum measurable temperature on any spot on the module's surface.

3.7.2 Humidity

» 93% relative Humidity at 40°C, non-condensing (according to IEC 60068-2-78)

3.8 Standards and Certifications

RoHS II

The **COMe-bHL6** is compliant to the directive 2011/65/EU on the Restriction of the use of certain Hazardous Substances (RoHS II) in electrical and electronic equipment

Component Recognition UL 60950-1

The **COM Express® basic** form factor Computer-on-Modules are Recognized by Underwriters Laboratories Inc. Representative samples of this component have been evaluated by UL and meet applicable UL requirements.

UL Listings:

» NWGQ2.E304278

» NWGQ8.E304278

WEEE Directive

WEEE Directive 2002/96/EC is not applicable for Computer-on-Modules.

Conformal Coating

Conformal Coating is available for Kontron Computer-on-Modules and for validated SO-DIMM memory modules. Please contact your local sales or support for further details.

Shock & Vibration

The **COM Express® basic** form factor Computer-on-Modules successfully passed shock and vibration tests according to

» IEC/EN 60068-2-6 (Non operating Vibration, sinusoidal, 10Hz-4000Hz, +/-0.15mm, 2g)

» IEC/EN 60068-2-27 (Non operating Shock Test, half-sinusoidal, 11ms, 15g)

EMC

Validated in Kontron reference housing for EMC the **COMe-bHL6** follows the requirements for electromagnetic compatibility standards

» EN55022

3.9 MTBF

The following MTBF (Mean Time Before Failure) values were calculated using a combination of manufacturer's test data, if the data was available, and the Telcordia (Bellcore) issue 2 calculation for the remaining parts.

The calculation method used is "Telcordia Issue 2 Method 1 Case 3" in a ground benign, controlled environment (GB,GC). This particular method takes into account varying temperature and stress data and the system is assumed to have not been burned in.

Other environmental stresses (extreme altitude, vibration, salt water exposure, etc) lower MTBF values.

System MTBF (hours): 215836 @ 40°C (w/PCB)

> Fans usually shipped with Kontron products have 50,000-hour typical operating life. The above estimates assume no fan, but a passive heat sinking arrangement Estimated RTC battery life (as opposed to battery failures) is not accounted for in the above figures and need to be considered separately. Battery life depends on both temperature and operating conditions. When the Kontron unit has external power; the only battery drain is from leakage paths.

3.10 Mechanical Specification

Dimension

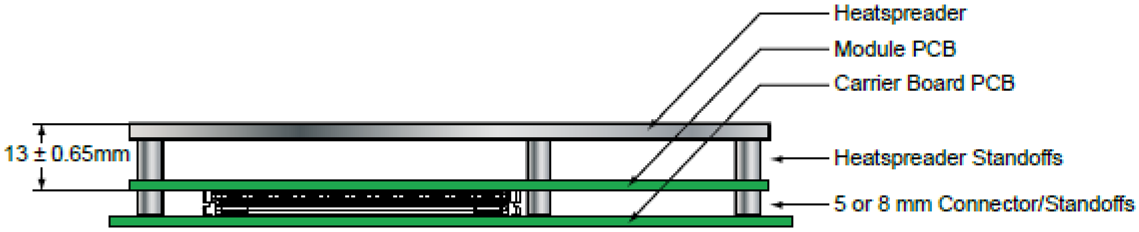
» 95.0 mm x 125.0 mm

» Height approx. 12mm (0.4”)

CAD drawings are available at EMD CustomerSection

Height

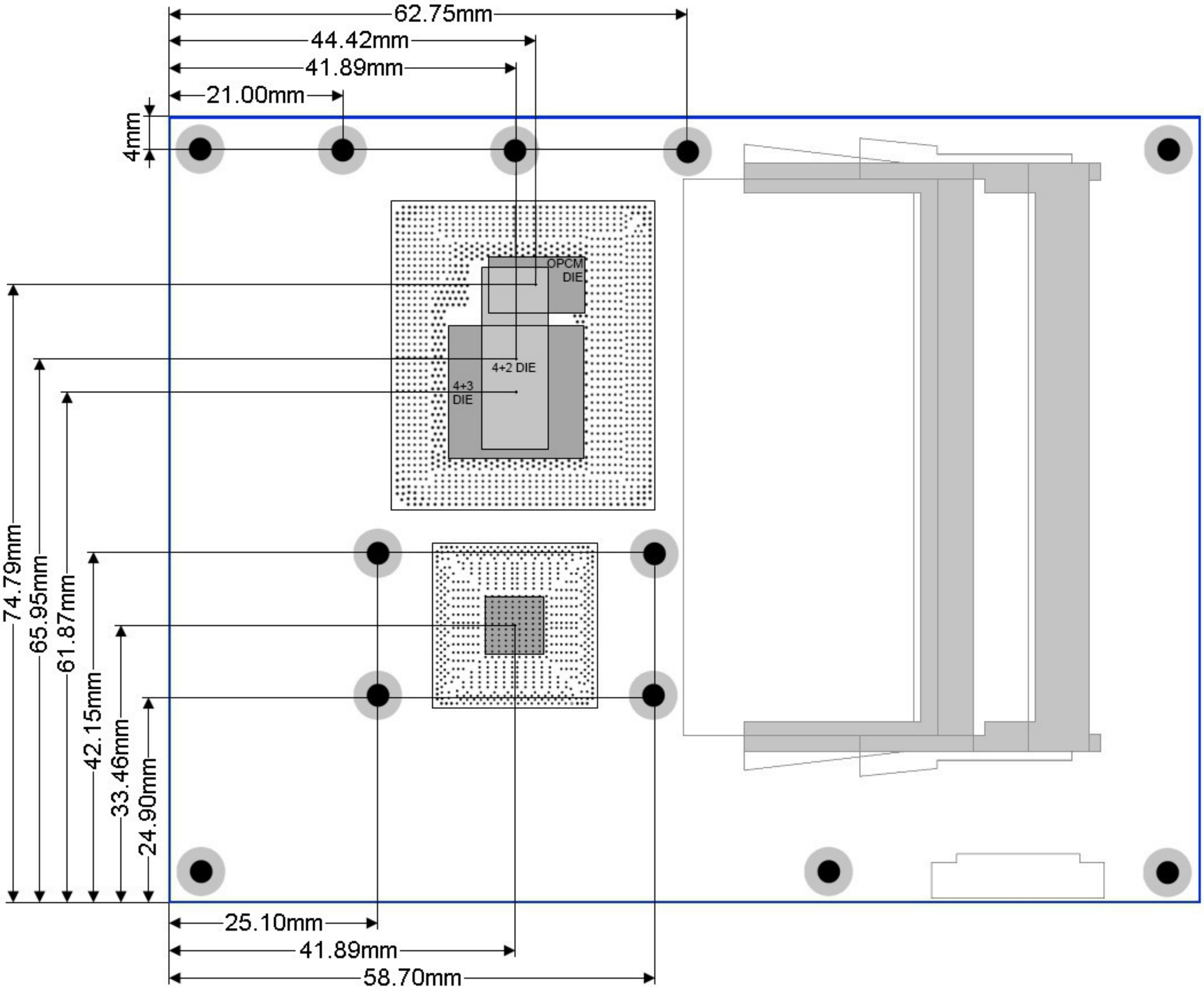
The COM Express® specification defines a module height of 13mm from module PCB bottom to heatspreader top:



Cooling solutions provided from Kontron for basic sized Computer-on-Modules are 27mm in height from module bottom to Heatsink top.

Universal Cooling solutions to be mounted on the HSP (36099-0000-00-x) are 14.3mm in height for an overall height of 27.3mm from module bottom to Heatsink top.

3.11 Module Dimensions



4+2 DIE: CPU with GT1 or GT2 graphics

4+3 DIE: CPU with GT3 graphics

OPCM DIE: eDRAM for GT3 graphics

3.12 Thermal Management, Heatspreader and Cooling Solutions

A heatspreader plate assembly is available from Kontron for the COMe-bHL6. The heatspreader plate on top of this assembly is NOT a heat sink. It works as a COM Express®-standard thermal interface to use with a heat sink or external cooling devices.

External cooling must be provided to maintain the heatspreader plate at proper operating temperatures. Under worst-case conditions, the cooling mechanism must maintain an ambient air and heatspreader plate temperature on any spot of the heatspreader's surface according the module specifications:

» 60°C for commercial grade modules

» 75°C for extended temperature grade modules (E1)

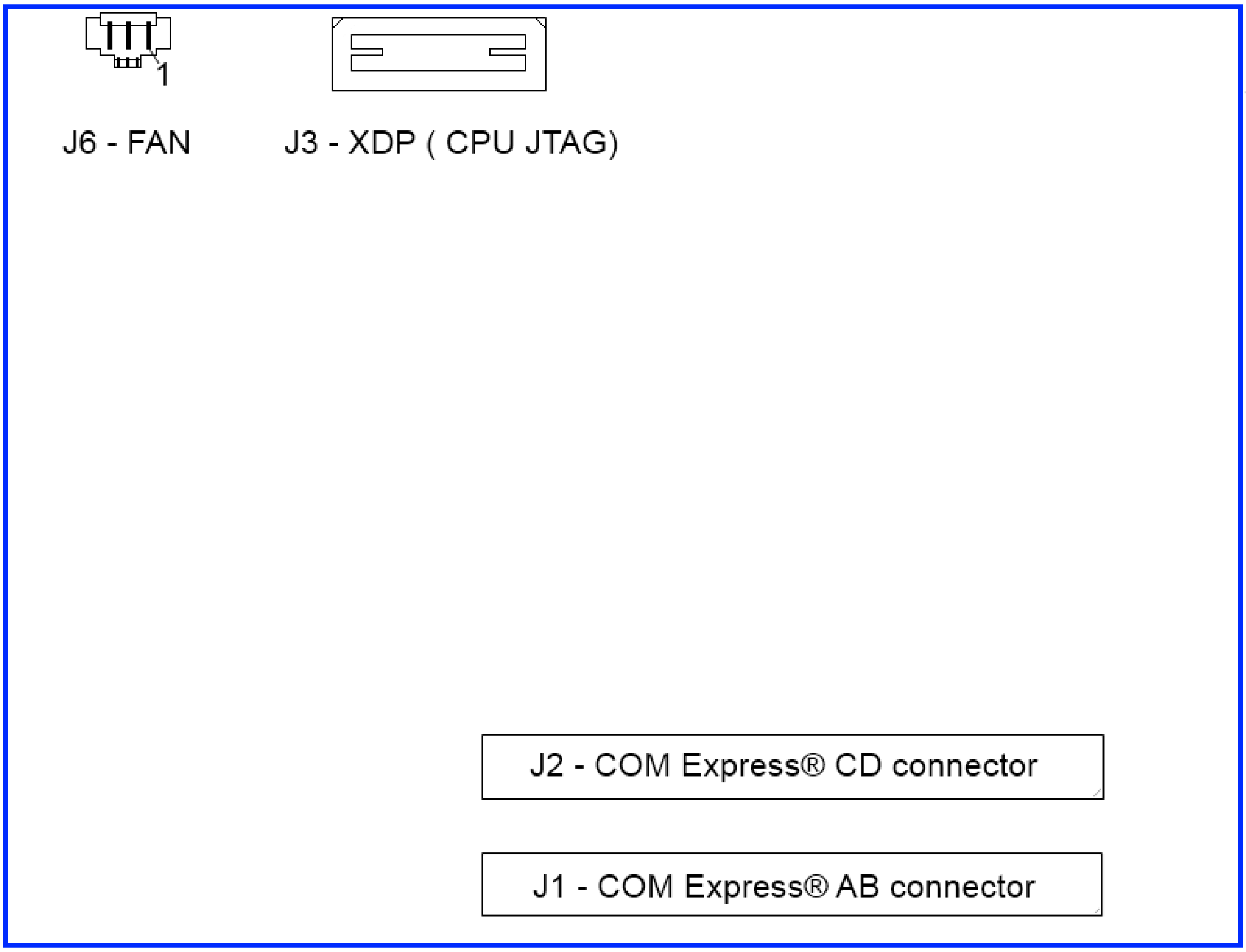
» 85°C for industrial temperature grade modules (E2/XT)

The aluminum slugs and thermal pads or the heat-pipe on the underside of the heatspreader assembly implement thermal interfaces between the heatspreader plate and the major heat-generating components on the COMe-bHL6. About 80 percent of the power dissipated within the module is conducted to the heatspreader plate and can be removed by the cooling solution.

You can use many thermal-management solutions with the heatspreader plates, including active and passive approaches. The optimum cooling solution varies, depending on the COM Express® application and environmental conditions. Active or passive cooling solutions provided from Kontron for the COMe-bHL6 are usually designed to cover the power and thermal dissipation for a commercial grade temperature range used in a housing with proper air flow.

Documentation and CAD drawings of COMe-bHL6 heatspreader and cooling solutions are provided at http://emdcustomersection.kontron.com.

3.13 Onboard Connectors


1
J6 - FAN
J3 - XDP (CPU JTAG)
J2 - COM Express® CD connector
J1 - COM Express® AB connector

3.13.1 FAN Connector J6 - PCB bottom

Specification

» Part number (Molex) J8: 53261-0371

» Mates with: 51021-0300

» Crimp terminals: 50079-8100

Pin assignment

» Pin1: Tacho, Pin2: VCC, Pin3: GND

Electrical characteristic

Module Input Voltage	8.5 - 13V	13 - 20V
FAN Output Voltage	8.5 - 13V	13V
Max. FAN Output Current	350mA	150mA

To connect a standard FAN with 3pin connector to the module please use adaptor cable KAB-HSP 200mm (96079-0000-00-0) or KAB-HSP 40mm (96079-0000-00-2)

3.13.2 CPU JTAG connector J3 - PCB bottom

The XDP connector is for internal use only. Do not use under any circumstances

3.13.3 CPLD Debug connector J7 - PCB top

The CPLD Debug and programming connector is for internal use only. Do not use under any circumstances

4 Features and Interfaces

4.1 S5 Eco Mode

Kontron’s new high-efficient power-off state S5 Eco enables lowest power-consumption in soft-off state – less than 1 mA compared to the regular S5 state this means a reduction by at least factor 200!

In the “normal” S5 mode the board is supplied by 5V_Stb and needs usually up to 300mA just to stay off. This mode allows to be switched on by power button, RTC event and WakeOnLan, even when it is not necessary. The new S5 Eco mode reduces the current enormous.

The S5 Eco Mode can be enabled in BIOS Setup, when the BIOS supports this feature.

Following prerequisites and consequences occur when S5 Eco Mode is enabled

» The power button must be pressed at least for 200ms to switch on.

» Wake via Power button only.

» “Power On After Power Fail”/“State after G3”: only “stay off” is possible

4.2 Rapid Shutdown

Overview

For "R" or the "RXT" version of the COMe-bHL6, Kontron has implemented a rapid shutdown function. It works as follows:

1) An active-high shutdown signal is asserted by the COM Express Eval Type 2 carrier board via pin C67 of the COM Express connector. The characteristics of the shutdown signal are as follows:

» Amplitude 5.0V +/- 5%

» Source impedance < = 50 ohms

» Rise time ⇐ 1uS

» Duration >= 20uS

The assertion of this signal causes all power regulators to be disabled and the internal power supply rails to be discharged by crowbar circuits. The shutdown circuitry provides internal energy storage that maintains crowbar activation for at least 2mS following the de-assertion of the shutdown signal. The circuit also incorporates a weak input pulldown resistor so that the RXT module will operate normally in systems where the rapid shutdown functionality is not used and pin C67 of the COM Express is left unconnected.

2) Simultaneously with the leading edge of shutdown, the 12V (main) input power to the RXT module is removed and these input power pins are externally clamped to ground though a crowbar circuit located on the COM Express carrier board. This external clamping circuit must maintain a maximum resistance of approximately 1 ohm and be activated for a minimum of 2mS.

3) Simultaneously with the leading edge of shutdown, the 5V (standby) input power to the RXT module is removed, if present. External clamping on these pins is not necessary.

Crowbar implementation details

As a tool for designing the internal crowbars, Kontron developed tallied the total capacitance present on each of the internal power rails, and calculates the required discharge resistance in order to achieve the desired voltage decay time constant. The principal design criteria are that each supply rail must decay to 37% of initial value (equivalent to 1RC) within 250uS, and to below 1.5V within 2mS. Analysis shows that the power rails fall into four general classes. Each class of power rails has a corresponding discharge strategy.

1) Power Input Rails: The main 12V power input rail incorporates about 300uF of distributed capacitance. This rail must be discharged by an external crowbar located on the carrier board, which must provide a shunt resistance of approximately 1 ohm. The peak power dissipation in this crowbar resistance will be relatively high (on the order of 150W when the crowbar is activated), but will diminish very rapidly as the input capacitors discharge.

2) Low Voltage, High Power Rails: Each of these 5 "major" internal supply rails has an output voltage in the 1.0 V to 1.5V range, and each rail has between 1500uF and 3300uF of output capacitance. The required discharge resistances for these rails are in the range of 0.1 to 0.2 ohm, and peak discharge currents are in the range of 8 to 16A.

The discharge circuit for each rail is implemented with a "pulse withstanding" thick-film SMT resistor in series with a low-RDSon MOSFET. The resistor peak powers are in the 8W to 20W range; depending on PCB layout considerations either a single resistor or multiple smaller resistors may be used to achieve sufficient pulse handling capability.

Because of the relatively high currents in the discharge paths, these crowbar circuits require wide copper traces and careful component placement adjacent to the output components of the corresponding power supplies.

3) Low Voltage, Low Power Rails: These rails have voltages of 1.8V or less and capacitances under 1000uF, with peak discharge currents <3A. The discharge circuits for these rails are also implemented with resistor(s) and a low-RDSon

MOSFET. In some cases, the peak pulse power dissipation in the resistor(s) is low enough that specialty "pulse withstanding" resistors are not required.

4) Medium Voltage Rails: These 3.3V and 5V rails typically have relatively small output capacitances and peak discharge currents <1A. The discharge circuits for these rails are typically implemented with conventional resistor(s) and a low-RDSon MOSFET.

Shutdown input circuit details

The shutdown input pin to the RXT module is coupled through a series Schottky diode and a small series resistor to the gates of all crowbar MOSFETs, connected in parallel. All crowbar MOSFETs are N-channel "logic level" parts that have are specified for operation at Vgs = 4.5V. Three additional components are connected in parallel between the MOSFET gates and ground:

» A capacitor that provides energy storage to keep the MOSFETs conducting for several mS after the shutdown signal is de-asserted.

» A high-value resistor that provides a discharge path for the capacitor as well as a pulldown resistance (to insure that the shutdown circuits remain inactive if the shutdown pin is left floating).

» A 6.2V zener diode that protects the MOSFET gates from damage due to input ESD or input overdrive.

In order to insure that the crowbars do not "fight" active switching regulators while the input capacitors are being discharged, the shutdown circuit rapidly crowbars the 5V rail, with a time constant <10uS. The 5V rail powers most of the remaining switching regulators, and as its voltage falls below about 4V those regulators enter under-voltage lockout mode and cease to operate. Additionally, by using the UVLO mechanism in the design of the RXT module, Kontron minimizes the risk of inadvertently affecting the standard power sequencing logic for such RXT modules. Two of the switching regulators do not require the 5V supply for operation, and in those two cases it will be necessary to clamp the enable inputs to ground when shutdown begins.

4.3 LPC

The Low Pin Count (LPC) Interface signals are connected to the LPC Bus bridge located in the CPU or chipset. The LPC low speed interface can be used for peripheral circuits such as an external Super I/O Controller, which typically combines legacy-device support into a single IC. The implementation of this subsystem complies with the COM Express® Specification. Implementation information is provided in the COM Express® Design Guide maintained by PICMG. Please refer to the official PICMG documentation for additional information.

The LPC bus does not support DMA (Direct Memory Access) and a clock buffer is required when more than one device is used on LPC. This leads to limitations for ISA bus and SIO (standard I/O´s like Floppy or LPT interfaces) implementations.

All Kontron COM Express® Computer-on-Modules imply BIOS support for following external baseboard LPC Super I/O controller features for the **Winbond/Nuvoton 5V 83627HF/G and 3.3V 83627DHG-P**:

83627HF/G	Phoenix BIOS	AMI CORE8	AMI / Phoenix EFI
PS/2	YES	YES	YES
COM1/COM2	YES	YES	YES
LPT	YES	YES	YES
HWM	YES	YES	NO
Floppy	NO	NO	NO
GPIO	NO	NO	NO
83627DHG-P	**Phoenix BIOS**	**AMI CORE8**	**AMI / Phoenix EFI**
PS/2	YES	YES	YES
COM1/COM2	YES	YES	YES
LPT	YES	YES	YES
HWM	NO	NO	NO
Floppy	NO	NO	NO
GPIO	NO	NO	NO

Features marked as not supported do not exclude OS support (e.g. HWM can be accessed via SMB). For any other LPC Super I/O additional BIOS implementations are necessary. Please contact your local sales or support for further details.

4.4 Serial Peripheral Interface (SPI)

The Serial Peripheral Interface Bus or SPI bus is a synchronous serial data link standard named by Motorola that operates in full duplex mode. Devices communicate in master/slave mode where the master device initiates the data frame. Multiple slave devices are allowed with individual slave select (chip select) lines. Sometimes SPI is called a “four wire” serial bus, contrasting with three, two, and one wire serial buses.

The SPI interface can only be used with a SPI flash device to boot from external BIOS on the baseboard.

4.5 SPI boot

The COMe-bHL6 supports boot from an external SPI Flash. It can be configured by pin A34 (BIOS_DIS#0) and pin B88 (BIOS_DIS1#) in following configuration:

BIOS_DIS0#	BIOS_DIS1#	Function
open	open	Boot on-module BIOS
GND	open	Boot baseboard LPC FWH
open	GND	Baseboard SPI = Boot Device 1, on-module SPI = Boot Device 2
GND	GND	Baseboard SPI = Boot Device 2, on-module SPI = Boot Device 1

By default only SPI Boot Device 1 is used in configuration 3 & 4. Both SPI Boot Devices are used by splitting the BIOS with modified descriptor table in customized versions only

Recommended SPI boot flash types for 8-SOIC package

Size	Vendor	Vendor ID	Part Number	Device ID
128 Mbit	Macronix	0xC2	MX25L12835FM2I-10G	Device ID0 0x20 / Device ID1 0x18
128 Mbit	Micron Technology	0x20	N25Q128A13ESE40F	Device ID0 0xBA / Device ID1 0x18
128 Mbit	Micron Technology	0x20	N25Q128A13ESE40E	Device ID0 0xBA / Device ID1 0x18
128 Mbit	Winbond	0xEF	W25Q128FVSIG	Device ID0 0x40 / Device ID1 0x18
128 Mbit	Winbond	0xEF	W25Q128JVSIQTR	Device ID0 0x40 / Device ID1 0x18
128 Mbit	Winbond	0xEF	W25Q128JVSIQ	Device ID0 0x40 / Device ID1 0x18

Using an external SPI flash

To program an external SPI flash follow these steps:

» Connect a SPI flash with correct size (similar to BIOS ROM file size) to the module SPI interface

» Open pin A34 and B88 to boot from the module BIOS

» Boot the module to DOS/EFI-Shell with access to the BIOS image and Firmware Update Utility provided on EMD Customer Section

» Connect pin B88 (BIOS_DIS1#) to ground to enable the external SPI flash

» Execute Flash.bat/Flash.efi to program the complete BIOS image to the external SPI flash

» reboot

Your module will now boot from the external SPI flash when BIOS_DIS1# is grounded.

External SPI flash on Modules with Intel® ME

If booting from the external (baseboard mounted) SPI flash then exchanging the COM Express® module for another one of the same type will cause the Intel® Management Engine to fail during next start. This is by design of the ME because it bounds itself to the very module it has been flashed to. In the case of an external SPI flash this is the module present at flash time.

To avoid this issue please make sure to conduct a complete flash of the external SPI flash device after changing the COMexpress module for another one. If disconnecting and reconnecting the same module again this step is not necessary.

4.6 M.A.R.S.

The Smart Battery implementation for Kontron Computer-on-Modules called **M**obile **A**pplication for **R**echargeable **S**ystems is a BIOS extension for external Smart Battery Manager or Charger. It includes support for SMBus charger/selector (e.g. Linear Technology LTC1760 Dual Smart Battery System Manager) and provides ACPI compatibility to report battery information to the Operating System.

Reserved SM-Bus addresses for Smart Battery Solutions on the carrier:

8-bit Address	7-bit Address	Device
12h	0x09	SMART_CHARGER
14h	0x0A	SMART_SELECTOR
16h	0x0B	SMART_BATTERY

4.7 UART

The COMe-bHL6 supports up to two Serial RX/TX only Ports defined in COM Express® specification on Pins A98/A99 for UART0 and Pins A101/A102 for UART1. The implementation of the UART is compatible to 16450 and is supported by default from most operating systems. Resources are subordinated to other UARTS e.g. from external LPC Super I/O.

UART features:

» 450 to 115.2k Baud (except 56000)

» 5, 6, 7 or 8bit characters

» 1 or 2 Stop bit generation

» Even, odd or no-parity generation/detection

» Complete status reporting capabilities

» Line break generation and detection

» Full prioritized interrupt system control

» No FIFO

» One additional shift register for transmit and one for receive

» No Flow Control

» No FCR register due to unavailability of FIFO

» MCR and MSR registers only implemented in loopback mode for compatibility with existing drivers and APIs

» Initialized per default to COM3 3F8h/IRQ4 and COM4 2F8/IRQ3 without external SIO

» Initialized per default to COM3 3E8h/IRQ5 and COM4 2E8/IRQ10 with external SIO present

The UART clock is generated by the 33MHz LPC clock which results in an accuracy of 0.5% on all UART timings

- Due to the protection circuitry required according COM Express® specification the transfer speed can only be guaranteed for 9600 Baud. Please contact your local sales or support for customized versions without protection circuitry

- Legacy console redirection via onboard serial ports may be restricted in terms of serial input stream. Since they're only emulating a 16450 device (w/o FIFO) an input stream generated by a program may lose characters. Inputs from a keyboard via terminal program will be safe.

4.8 Fast I2C

The COMe-bHL6 supports a CPLD implemented LPC to I2C bridge using the WISHBONE I2C Master Core provided from opencores.org. The I2C Interface supports transfer rates up to 40kB/s and can be configured in Setup

Specification for external I2C:

- » Speed up to 400kHz
- » Compatible to Philips I2C bus standard
- » Multi-Master capable
- » Clock stretching support and wait state generation
- » Interrupt or bit-polling driven byte-by-byte data-transfers
- » Arbitration lost interrupt with automatic transfer cancellation
- » Start/Stop signal generation/detection
- » Bus busy detection
- » 7bit and 10bit addressing

4.9 Dual Staged Watchdog Timer

Basics

A watchdog timer (or computer operating properly (COP) timer) is a computer hardware or software timer that triggers a system reset or other corrective action if the main program, due to some fault condition, such as a hang, neglects to regularly service the watchdog (writing a “service pulse” to it, also referred to as “kicking the dog”, “petting the dog”, “feeding the watchdog” or “triggering the watchdog”). The intention is to bring the system back from the nonresponsive state into normal operation.

The COMe-bHL6 offers a watchdog which works with two stages that can be programmed independently and used one by one.

Time-out events

Reset	A reset will restart the module and starts POST and operating system new.
NMI	A non-maskable interrupt (NMI) is a computer processor interrupt that cannot be ignored by standard interrupt masking techniques in the system. It is typically used to signal attention for non-recoverable hardware errors.
SCI	A system control interrupt (SCI) is a OS-visible interrupt to be handled by the OS using AML code
Delay	Might be necessary when an operating system must be started and the time for the first trigger pulse must extended. (Only available in the first stage)
WDT Signal only	This setting triggers the WDT Pin on baseboard connector (COM Express® Pin B27) only
Cascade:	Does nothing, but enables the 2nd stage after the entered time-out.

WDT Signal

B27 on COM Express® Connector offers a signal that can be asserted when a watchdog timer has not been triggered within time. It can be configured to any of the 2 stages. Deassertion of the signal is automatically done after reset. If deassertion during runtime is necessary please ask your Kontron technical support for further help.

4.10 Intel® Fast Flash Standby™ / Rapid Start Technology™

The target of Intel® Fast Flash Standby™ (iFFS) (also known as Intel® Rapid Start Technology™ iRST) is to get a wake-up time from S4 compareable to S3. Normally S4 is caused by OS which stores it's information to the hard disk and does then a normal shutdown. S4 resume takes quite long as the system does a normal BIOS POST and OS restores it's information from the hard disk.

IFFS does it in a different way. The Operating System initiates an S3 and stores it's information in memory. After that BIOS copies this OS information from DRAM to SSD and does a sleep state similar to S4 with nearly zero power. If system is resumed by power button, BIOS restores memory content from SSD to the DRAM and does an S3 resume which is much faster.

Requirements

» SATA Solid State Disk in AHCI mode

» Free disk space on the SSD with at least the DRAM size

» Operating System with disk partition tool to allocate the hibernation partition (e.g. Windows 7/8)

» BIOS supporting iFFS feature

How to setup once the operating system is installed

» Prepare a free disk space on your onboard or external SSD with at least the size of DRAM

» Open *cmd.exe* in Administrator Mode and type *diskpart.exe* to open the Windows disk partition tool

» DISKPART> list disk

» DISKPART> select disk X (X is disk number where you want to create the store partition. Refer to results from “list disk” for exact disk number)

» DISKPART> create partition primary

» DISKPART> detail disk

» DISKPART> select Volume X (X is Volume of your store partition. Refer to results from “detail disk” for exact volume number)

» DISKPART> set id=84 override (ID 84 marks the partition as hibernate partition)

» DISKPART> exit

» Now there should be a Hibernate Partition visible in your disk management

» Reboot and enable iFFS in BIOS

Usage

» Activate Lid / move system to Sleep/Standby (→S3)

» After configured period of time in Setup the system powers on automatically and information in DRAM moves to non-volatile memory (Default is *'immediately'*)

» System switches off again to iFFS (→comparable to S4, Power Supply can now be disconnected)

» When System is powered on, information moved back to DRAM (No display output during copy process)

» System resumes same as Sleep/Standby S3

Note

» Depending on the platform iFFS enabled may disable the hibernate function in Windows automatically

Benefits

» System transitions from S3 to S4 automatically

» Up to 6x battery life compared to Standby

» Resume time reduced up to 75%

Measured resume times from Power-on to Win7 Log-on Screen on COMe-mCT10:

» 2.5” SATA II HDD 5400rpm: Hibernate: 22s, iFFs on onboard NANDrive: 17s

» 2.5” SATA III SSD: Hibernate: 18s, iFFS on SSD: 10s

4.11 Speedstep Technology

The Intel® processors offer the Intel® Enhanced SpeedStep™ technology that automatically switches between maximum performance mode and battery-optimized mode, depending on the needs of the application being run. It enables you to adapt high performance computing on your applications. When powered by a battery or running in idle mode, the processor drops to lower frequencies (by changing the CPU ratios) and voltage, conserving battery life while maintaining a high level of performance. The frequency is set back automatically to the high frequency, allowing you to customize performance.

In order to use the Intel® Enhanced SpeedStep™ technology the operating system must support SpeedStep™ technology.

By deactivating the SpeedStep feature in the BIOS, manual control/modification of CPU performance is possible. Setup the CPU Performance State in the BIOS Setup or use 3rd party software to control CPU Performance States.

4.12 C-States

New generation platforms include power saving features like SuperLFM, EIST (P-States) or C-States in O/S idle mode.

Activated C-States are able to dramatically decrease power consumption in idle mode by reducing the Core Voltage or switching of parts of the CPU Core, the Core Clocks or the CPU Cache.

Following C-States are defined:

C-State	Description	Function
C0	Operating	CPU fully turned on
C1	Halt State	Stops CPU main internal clocks via software
C1E	Enhanced Halt	Similar to C1, additionally reduces CPU voltage
C2	Stop Grant	Stops CPU internal and external clocks via hardware
C2E	Extended Stop Grant	Similar to C2, additionally reduces CPU voltage
C3	Deep Sleep	Stops all CPU internal and external clocks
C3E	Extended Stop Grant	Similar to C3, additionally reduces CPU voltage
C4	Deeper Sleep	Reduces CPU voltage
C4E	Enhanced Deeper Sleep	Reduces CPU voltage even more and turns off the memory cache
C6	Deep Power Down	Reduces the CPU internal voltage to any value, including 0V
C7	Deep Power Down	Similar to C6, additionally LLC (LastLevelCache) is switched off

C-States are usually enabled by default for low power consumption, but active C-States my influence performance sensitive applications or real-time systems.

» Active C6-State may influence data transfer on external Serial Ports

» Active C7-State may cause lower CPU and Graphics performance

It's recommended to disable C-States / Enhanced C-States in BIOS Setup if any problems occur.

4.13 Hyper Threading

Hyper Threading (officially termed Hyper Threading Technology or HTT) is an Intel®-proprietary technology used to improve parallelization of computations performed on PC´s. Hyper-Threading works by duplicating certain sections of the processor—those that store the architectural state but not duplicating the main execution resources. This allows a Hyper-Threading equipped processor to pretend to be two “logical” processors to the host operating system, allowing the operating system to schedule two threads or processes simultaneously. Hyper Threading Technology support always relies on the Operating System.

4.14 Dynamic FSB Frequency Switching

Dynamic FSB frequency switching effectively reduces the internal bus clock frequency by half to further decrease the minimum processor operating frequency from the Enhanced Intel SpeedStep Technology performance states and achieve the Super Low Frequency Mode (Super LFM). This feature is supported at FSB frequencies of 1066 MHz, 800 MHz and 667 MHz and does not entail a change in the external bus signal (BCLK) frequency. Instead, both the processor and GMCH internally lower their BCLK reference frequency to 50% of the externally visible frequency. Both the processor and GMCH maintain a virtual BCLK signal (VBCLK) that is aligned to the external BCLK but at half the frequency.

After a downward shift, it would appear externally as if the bus is running with a 133-MHz base clock in all aspects, except that the actual external BCLK remains at 266 MHz. See Figure 3 for details. The transition into Super LFM, a “down-shift,” is done following a handshake between the processor and GMCH. A similar handshake is used to indicate an “up-shift,” a change back to normal operating mode. Please ensure this feature is enabled and supported in the BIOS.

4.15 VID-x

The processor implements the VID-x feature for improved control of core voltage levels when the processor enters a reduced power consumption state. VID-x applies only when the processor is in the Intel Dynamic Acceleration Technology performance state and one or more cores are in low-power state (i.e., CC3/CC4/CC6). VID-x provides the ability for the processor to request core voltage level reductions greater than one VID tick. The amount of VID tick reduction is fixed and only occurs while the processor is in Intel Dynamic Acceleration Technology mode. This improved voltage regulator efficiency during periods of reduced power consumption allows for leakage current reduction which results in platform power savings and extended battery life.

When in Intel Dynamic Acceleration Technology mode, it is possible for both cores to be active under certain internal conditions. In such a scenario the processor may draw an Instantaneous current (ICC_CORE_INST) for a short duration of tINST; however, the average ICC current will be lesser than or equal to ICCDES current specification.

4.16 Intel® Turbo Boost Technology and AVX

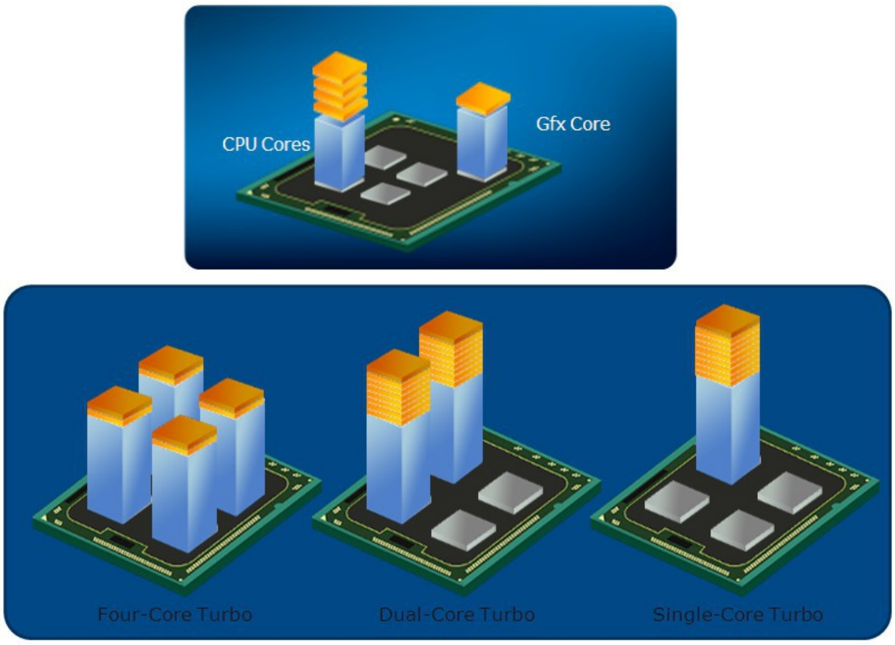
For applications that are particularly power-hungry, the new processors provide enhanced Intel® Turbo Boosttechnology. This automatically shifts processor cores and processor graphics resources to accelerate performance, tailoring a workload to give users an immediate performance boost for their applications whenever needed. Another innovation is the enhancement to the 256-bit instruction set, known as Intel® Advanced Vector Extensions (AVX). AVX delivers improved performance, rich functionality and the ability to manage, rearrange and sort data in a better way. The new instruction set accelerates floating-point intensive applications such as “number crunchers” or digital processing of images, videos and audio data.

Intel® Turbo Boost Technology 2.0

Intel has optimized Intel® Turbo Boost Technology to provide even more performance when needed on the latest-generation Intel® microarchitecture. Intel® Turbo Boost Technology 2.0 automatically allows processor cores to run faster than the base operating frequency if it's operating below power, current, and temperature specification limits. Intel Turbo Boost Technology 2.0 is activated when the Operating System (OS) requests the highest processor performance state (P0).

The maximum frequency of Intel Turbo Boost Technology 2.0 is dependent on the number of active cores. The amount of time the processor spends in the Intel Turbo Boost Technology 2.0 state depends on the workload and operating environment. Any of the following can set the upper limit of Intel Turbo Boost Technology 2.0 on a given workload:

- » Number of active cores
- » Estimated current consumption
- » Estimated power consumption
- » Processor temperature



When the processor is operating below these limits and the user's workload demands additional performance, the processor frequency will dynamically increase until the upper limit of frequency is reached. Intel Turbo Boost Technology 2.0 has multiple algorithms operating in parallel to manage current, power, and temperature to maximize performance and energy efficiency. Note: Intel Turbo Boost Technology 2.0 allows the processor to operate at a power level that is higher than its rated upper power limit (TDP) for short durations to maximize performance.

4.17 Display Configuration

Maximum supported Resolutions in Single Display Configuration

Port	Max Resolution
DP	3840×2160@60Hz, 24bpp 4096×2160@24Hz, 24bpp
HDMI	4096×2160@24Hz, 24bpp 2560×1600@60Hz, 24bpp 1920×1080@60Hz, 36bpp
DVI	1920×1200@60Hz, 24bpp
VGA	1920×1200@60Hz, 24bpp
WiDi	1920×1080@30Hz, 24bpp 1280×720@60Hz, 24bpp
eDP (x2)	1920×1200@60Hz
LVDS	1920×1200@60Hz

Maximum supported Pixel Clock

Port	Max Pixel Clock
DP	533 MHz
HDMI	300 MHz
DVI	165 MHz
VGA	180 MHz

DDI supported resolutions in 3 Display Configurations

Display1	Display2	Display3	Max.Res Display 1	Max.Res Display 2	Max.Res Display 3
HDMI/DP	HDMI/DP	DP	4096×2160@24Hz 3840×2160@60Hz	4096×2160@24Hz 3840×2160@60Hz	3840×2160@60Hz
HDMI/DP	HDMI/DP	eDP/LVDS	4096×2160@24Hz 3840×2160@60Hz	4096×2160@24Hz 3840×2160@60Hz	1920×1200@60Hz
DP	DVI/WiDi	DVI	3840×2160@60Hz	1920×1200@60Hz 1920×1080@30Hz	1920×1200@60Hz
eDP/LDVS	DVI/WiDi	DVI	1920×1200@60Hz	1920×1200@60Hz 1920×1080@30Hz	1920×1200@60Hz
VGA/WiDi	DP/HDMI	DP/HDMI	1920×1200@60Hz 1920×1080@30Hz	3840×2160@60Hz 4096×2160@24Hz	3840×2160@60Hz 4096×2160@24Hz
VGA/WiDi	eDP/LVDS	DP/HDMI	1920×1200@60Hz 1920×1080@30Hz	1920×1200@60Hz	3840×2160@60Hz 4096×2160@24Hz
DP	DP	DVI	3840×2160@60Hz	3840×2160@60Hz	1920×1200@60Hz
eDP/LVDS	DP	DVI	1920×1200@60Hz	3840×2160@60Hz	1920×1200@60Hz
VGA	DVI	DVI/WiDi	1920×1200@60Hz	1920×1200@60Hz	1920×1200@60Hz 1920×1080@30Hz
VGA	DP/HDMI	DVI/WiDi	1920×1200@60Hz	3840×2160@60Hz 4096×2160@24Hz	1920×1200@60Hz 1920×1080@30Hz
VGA	eDP/LVDS	DVI/WiDi	1920×1200@60Hz	1920×1200@60Hz	1920×1200@60Hz 1920×1080@30Hz
DVI	DVI	WiDi	1920×1200@60Hz	1920×1200@60Hz	1920×1080@30Hz

Link Data Rate

The maximum supported Display Ports resolutions are dependent on the Link Data Rate and the used Lane Count:

Link Data Rate	1 Lane	2 Lanes	4 Lanes
RBR	1024×600	1400×1050	2240×1400
HBR	1280×960	1920×1200	2880×1800
HBR2	1920×1200	2880×1800	3840×2160

3 independent Display Support

The COMe-bHL6 supports up to 3 independent displays in Windows 7/8 and Linux by using the following rules:

» Max of 2 HDMIs

» Max of 2 DVIs

» Max of 1 HDMI and 1DVI

» Any 3 DisplayPort

» One VGA

Digital Display Interface Features

The integrated Intel® HD/HD4600/HD5200 (Gen7.5) graphics supports:

» High-bandwidth Digital Content Protection (HDCP) on HDMI and DisplayPort with up to 2 HDCP streams simultaneously

» One active Protected Audio and Video Path (PAVP) session on HDMI or DisplayPort

» Dual Stream DP/HDMI Audio

» DP/HDMI/DVI Hot-plug (low-active)

Supported Audio Formats on HDMI and DisplayPort

Audio Formats	HDMI	DisplayPort
AC-3 Dolby Digital	YES	YES
Dolby Digital Plus	YES	YES
DTS-HD	YES	YES
LPCM, 192kHz/24bit, 8 channel	YES	YES
Dolby True HD, DTS HD Master Audio	YES	YES

DDI Design Consideration

» For sufficient signal quality baseboard designs with long signal lanes or impedance leaps may require an Equalizer or Re-driver for the digital display interfaces

» DDI hot-plug detection is high active

» DisplayPort can be used directly or with external adapters for HDMI, DVI or VGA

» HDMI or DVI usage on a baseboard requires a level shifter

Find more details for DDI usage as DisplayPort, HDMI or DVI with schematic examples available on http://emdcustomersection.kontron.com

DVI-I Design Topology

DVI-I is supported on PCH Digital Display Port B (COM DDI1) only. The implementation involves routing VGA and DVI-D signals to DVI-I connector:

» VGA port RGB signals should be routed to Analog RGB pins on the DVI-I connector

» DVI Data and Clock signals on PCH Digital Display Port B should be routed to TMDS Data 0, 1 and 2 pins and TMDS Clock pin of DVI-I connector respectively

» DVI HPD signals should be routed to the HPD pin of the DVI-I connector

» DVI DDC Clock and Data signals on PCH Digital Display Port B should be routed to the DDC Clock and Data pins of the DVI-I connector.

4.18 Hybrid Graphics / Multi-monitor

The COMe-bHL6 supports Hybrid Multi-monitor function which is one form of Intel's Hybrid Graphics where integrated graphics (in Chipset or CPU) is available to operate simultaneously with external PEG; PCIe or PCI graphics. This feature enables concurrent function of Intel's integrated Graphics Processing Unit (GPU/iGFX) along with a discrete GPU solution, allowing for operability of greater than two independently-driven displays. The O/S will handle control of the multiple GPU display adapters appropriately. For example, WindowsXP supports The Microsoft Windows XP Display Driver Model (XPDM) which allows loading and support of multiple graphics drivers. Windows 7 continues that legacy XPDM support but also adds WDDM v1.1 which, like XPDM, allows for simultaneous multiple graphics drivers (Windows Vista WDDM v1.0 did not allow this capability). Operating system applications will be adapter-unaware through use of the O/S GUI APIs and will utilize the adapter associated with the primary display, regardless of which display the image is located on.

Some applications may be adapter-aware, e.g., full-screen applications and system applications like the compositor. A number of software tools designed to assist multi-monitor use are available from third parties. One example is the UltraMon* utility for multi-monitor systems, which helps with the position of applications, assists desktop wallpapers and screen savers in multi-monitor configurations.

Hybrid Multi-monitor mode is recommended to be accomplished using a discrete third-party PCI Express graphics card either into the PEG slot of the platform or into an available PCI Express slot routed off of the I/O subsection of the chipset.

Requirements

» Baseboard supporting PEG (alternatively PCIe or PCI)

» Module BIOS which allows switching between iGFX and discrete GPU (iGFX must be set to primary boot display)

» O/S supporting heterogeneous display adapters (Linux / WindowsXP / Windows 7)

Setup a Multi-monitor system

» Start without the discrete GPU seated in the system

» Select IGD as Primary Boot Display in BIOS Setup

» Boot into O/S and install drivers requested for the integrated GPU

» Shut down the system and insert the discrete GPU

» Boot into O/S and install drivers requested for the discrete GPU (if necessary in Safe mode)

» Set the Windows Display properties as referenced below (example: WindowsXP)

In most cases the graphical user interfaces (e.g. ATI Catalyst Control Center) for both GPUs may not run properly. It's recommended to use O/S implemented Display Properties like in screenshot above

Detailed documentation is available in Intel Paper 323214

4.19 Intel® Wireless Display

Intel® Wireless Display, most commonly known as WiDi, is a wireless display standard developed by Intel, based on the existing Wi-Fi standard. It allows a portable device or computer to send up to 1080p HD video and 5.1 surround sound to a compatible display wirelessly.

The COMe-bHL6 supports WiDi in combination with following requirements:

CPU:

» 2nd Generation Intel® Core(TM) i7/i5/i3

» 3rd Generation Intel® Core(TM) i7/i5/i3

» 4th Generation Intel® Core(TM) i7/i5/i3

» Intel® Celeron N28xx / N29xx Series

One of the following Wireless Devices:

» Intel® Centrino® Wireless-N 1000, 1030, 2200, or 2230

» Intel® Centrino® Wireless-N 2200 for Desktop

» Intel® Centrino® Advanced-N 6200, 6205, 6230, or 6235

» Intel® Centrino® Advanced-N 6205 for Desktop

» Intel® Centrino® Wireless-N + WiMAX 6150

» Intel® Centrino® Advanced-N + WiMAX 6250

» Intel® Centrino® Ultimate-N 6300

» Intel® Dual Band Wireless-N 7260

» Intel® Dual Band Wireless-AC 7260

» Intel® Dual Band Wireless-AC 7260 for Desktop

» Intel® Dual Band Wireless-AC 3160

» Intel® Wireless-N 7260

» Broadcom BCM43228*

» Broadcom BCM43241*

» Broadcom BCM4352*

Operating System:

» Windows 7 64-bit, Home Premium, Ultimate or Professional

» Windows 7 32-bit, Home Premium, Ultimate, Professional or Basic

» Windows 8 32-bit and 64-bit editions

» Windows 8.1 32-bit and 64-bit editions

Software:

» Intel® Wireless Display pre-installed and enabled

An Intel® WiDi compatible streaming target such as:

» WiDi Adapter (e.g. Belkin ScreenCast, D-Link DHD-131, NETGEAR Push2TV ...)

- » HDTV's with built in WiDi Support (e.g. LG Smart TV ...)
- » Any other WiDi compatible CE Devices (e.g. Netgear Media Player NTV200S ...)

More information about Intel® Wireless Display Technology are available on www.intel.com

4.20 Intel® vPro™ technology

Kontron and Intel® are addressing the security and manageability challenges facing embedded systems today with the implementation of Intel® vPro™ technology to enable: » System integrity » Secure isolation » Remote systems management

First, system integrity is the ability to identify whether the system hardware or system software has been modified without authorization. When a system's integrity is known, the system can be thought of as a trusted system. Second, secure isolation is the ability to use platform hardware to separate processes, resources, and data on the system such that they cannot interact with each other in unintended ways. By providing hardware-assisted isolation, there is limitless security, privacy, and cost savings that can be realized through consolidation and workload isolation. Finally, remote systems management is the ability to troubleshoot, perform power management or system verification through secure channels. Significant cost savings and efficiencies can be realized through remote management allowing for increased system up time and the ability to manage or diagnose a system, even when powered down.

Intel® vPro™ technology itself is special functionality designed into both, the processor and the chipset. The three technologies that comprise Intel® vPro™ technology are: Intel Virtualization Technology (Intel® VT), Intel Trusted Execution Technology (Intel® TXT) and Intel Active Management Technology (Intel® AMT).

Intel® VT provides hardware-based assists making secure isolation more efficient and decreases the virtualization footprint, lowering the effective attack surface of a solution. This hardware-based technology can help to protect applications and information by running multiple operating systems (OSs) in isolation on the same physical system. A virtual guest OS can be created in an entirely separate space on the physical system to run specialized or critical applications. Virtual environments leverage Intel® VT for memory, CPU, and Directed I/O virtualization. Intel® TXT provides the ability to use hardware-based mechanisms to verify system integrity during the boot process. It also provides system memory scrubbing that protects against soft reset attacks. Virtualized environments take advantage of Intel® TXT launch environment verification to establish a dynamic root of trust providing added security to hypervisor or virtual machine monitor (VMM).

Mechanisms employed by Intel® AMT include domain authentication, session keys, persistent data storage in the Intel® AMT hardware, and access control lists. Only firmware images that are digitally signed by Intel are permitted to load and execute. This set of hardware-based features is targeted for businesses and allows remote access to the system, whether wired or wireless, for management and security tasks. Because of the special hardware capabilities provided by Intel® AMT, out of band access is available even when the OS is not functional or system power is off.

Intel® TXT and Intel® AMT are disabled by default. Please contact your local sales or support for BIOS versions with full vPro™ support

4.21 ACPI Suspend Modes and Resume Events

The COMe-bHL6 supports the S-states S0, S3, S4, S5. S5eco Support: YES

The following events resume the system from S3:

» USB Keyboard (1)

» USB Mouse (1)

» Power Button

» WakeOnLan (2)

The following events resume the system from S4:

» Power Button

» WakeOnLan (2)

The following events resume the system from S5:

» Power Button

» WakeOnLan (2)

The following events resume the system from S5Eco:

» Power Button

(1) OS must support wake up via USB devices and baseboard must power the USB Port with StBy-Voltage
(2) Depending on the Used Ethernet MAC/Phy WakeOnLan must be enabled in BIOS setup and driver options

5 System Resources

5.1 Interrupt Request (IRQ) Lines

IRQ #	Used For	Available	Comment
0	Timer0	No	-
1	Keyboard	No	-
2	Cascade	No	-
3	COM2	No	onboard UART2
4	COM1	No	onboard UART1
5	SIO LPT	Note(4)	external SIO LPT
6	COM3	Note(4)	external SIO COM1
7	COM4	Note(4)	external SIO COM2
8	RTC	No	-
9	ACPI	No	-
10	-	Yes	-
11	-	Yes	-
12	PS/2 Mouse	Note(4)	external SIO
13	FPU	No	-
14	-	Yes	-
15	-	Yes	-
16	LNK A	No	P.E.G + I.G.D + SA Audio + XHCI + Intel ME + USB EHCI2 + PCIe RP 0 + PCIe RP 4; Note(3)
17	LNK B	No	PCIe RP 1 + PCIe RP 5; Note(3)
18	LNK C	No	PCIe RP 2 + PCIe RP 6 + SMBus; Note(3)
19	LNK D	No	PCIe RP 3 + SATA; Note(3)
20	LNK E	No	Onboard LAN;Note(3)
21	LNK F	No	Note(3)
22	LNK G	No	PCH HDA;Note(3)
23	LNK H	No	USB EHCI#1

(1) If the "Used For" device is disabled in setup, the corresponding interrupt is available for other device.

(2) Not available if ACPI is used

(3) ACPI OS decides on particular IRQ usage

(4) Depends on system configuration (onboard COM Port support and external SIO presence)

5.2 Memory Area

The first 640 kB of DRAM are used as main memory. Using DOS, you can address 1 MB of memory directly. Memory area above 1 MB (high memory, extended memory) is accessed under DOS via special drivers such as HIMEM.SYS and EMM386.EXE, which are part of the operating system. Please refer to the operating system documentation or special textbooks for information about HIMEM.SYS and EMM386.EXE. Other operating systems (Linux or Windows versions) allow you to address the full memory area directly.

Upper Memory	Used for	Available	Comment
A0000h – BFFFFh	VGA Memory	No	Mainly used by graphic controller
C0000h – CFFFFh	VGA BIOS	No	Used by onboard VGA ROM
D0000h – DFFFFh	-	Yes	Free for shadow RAM in standard configurations.
E0000h – FFFFFh	System BIOS	No	Fixed
20000000h-201FFFFFh	IGFX	No	Fixed
40000000h-401FFFFFh	IGFX	No	Fixed
E0000000h–FEAFFFFFh	PCIe Config Space	No	Fixed
FEC00000 - FECFFFFF	Local APIC/IOAPIC(s)	No	Fixed
FED00000h-FED003FFh	HPET	No	Fixed
FED10000h-FED17FFFh	MCH	No	Fixed
FED18000h-FED18FFFh	DMI	No	Fixed
FED19000h-FED19FFFh	EPBA	No	Fixed
FED1C000h-FED1FFFFh	RCBA	No	Fixed
FED20000h FED3FFFFh	TXT	No	Fixed
FED40000h FED44FFFh	TPM	No	Fixed
FED45000h FED8FFFFh	TPM	No	Fixed
FED90000h-FED93FFFh	VT-d	No	Fixed
FEE00000h-FEEFFFFFh	MSI area	No	Fixed
FF000000h-FFFFFFFFh	BIOS Flash	No	Fixed

5.3 I/O Address Map

The I/O-port addresses of the are functionally identical to a standard PC/AT. All addresses not mentioned in this table should be available. We recommend that you do not use I/O addresses below 0100h with additional hardware for compatibility reasons, even if available.

I/O Address	Used for	Available	Comment
0000 - 001F	System Resources	No	Fixed
0020 - 003F	Interrupt Controller 1	No	Fixed
002E - 002F	Ext. SIO	No	Fixed
0040 - 005F	Timer, Counter	No	Fixed
004E - 004F	TPM	No	Fixed
0060 - 006F	Keyboard controller	No	Fixed
0070 - 007F	RTC and CMOS Registers	No	Fixed
0080	BIOS Postcode	No	Fixed
0081 - 009F	DMA Controller	No	Fixed
00A0 - 00BF	Interrupt Controller	No	Fixed
00C0 - 00DF	DMA Controller	No	Fixed
00F0 - 00FF	Math Coprocessor	No	Fixed
03B0 - 03DF	VGA	No	Fixed
0400 - 047F	Chipset	No	Fixed
04D0 - 04D1	Chipset	No	Fixed
0800 - 087F	Chipset	No	Fixed
0A00 - 0A0F	LPC	Yes	Routed to LPC
0A80 - 0A8F	CPLD	No	Fixed
0A90 - 0AFF	LPC	Yes	Routed to LPC
0CF8 - 0CFF	Chipset	No	Fixed

5.4 Peripheral Component Interconnect (PCI) Devices

All devices follow the Peripheral Component Interconnect 2.3 (PCI 2.3) respectively the PCI Express Base 1.0a specification. The BIOS and OS control memory and I/O resources. Please see the PCI 2.3 specification for details.

PCI Device	B:D:F	PCI IRQ	Interface	Comment
Host Bridge	0:0:0	None	internal	Chipset
P.E.G. Root Port	0:1:0	LNK A	internal	Chipset
Video Controller	0:2:0	LNK A	internal	Chipset
SA Audio	0:3:0	LNK A	internal	Chipset
XHCI	0:20:0	LNK A	internal	Chipset
ME	0:22:0	LNK A	internal	Chipset
GbE	0:25:0	LNK E	internal	Chipset
EHCI2	0:26:0	LNK A	internal	Chipset
PCH HDA	0:27:0	LNK G	PCIe	Chipset
PCIe Port 0	0:28:0	LNK A	internal	Chipset
PCIe Port 0 Slot	-	A/B/C/D	PCIe	Port 0
PCIe Port 1	0:28:1	LNK A	internal	Chipset
PCIe Port 1 Slot	-	B/C/D/A	PCIe	Port 1
PCIe Port 2	0:28:2	LNK A	internal	Chipset
PCIe Port 2 Slot	-	C/D/A/B	PCIe	Port 2
PCIe Port 3	0:28:3	LNK A	internal	Chipset
PCIe Port 3 Slot	-	D/A/B/A	PCIe	Port 3
PCIe Port 4	0:28:4	LNK A	internal	Chipset
PCIe Port 4 Slot	-	A/B/C/D	PCIe	Port 4
PCIe Port 5	0:28:5	LNK A	internal	Chipset
PCIe Port 5 Slot	-	B/C/D/A	PCIe	Port 5
PCIe Port 6	0:28:6	LNK A	internal	Chipset
PCIe Port 6 Slot	-	C/D/A/B	PCIe	Port 6
EHCI1	0:29:0	LNK H	internal	Chipset
LPC Bridge	0:31:0	-	internal	Chipset
SATA	0:31:2	LNK D	internal	Chipset
SMBus	0:31:3	LNK C	internal	Chipset

5.5 Internal I2C Bus

I2C Address	Used For	Available	Comment
58h	S5 Eco	No	S5 Eco Resistor
A0h	JILI-EEPROM	No	external LVDS EEPROM for JILI Data
C0h	LVDS bridge	No	DP to LVDS Bridge

5.6 External I2C Bus

I2C Address	Used For	Available	Comment
A0h	JIDA-EEPROM	No	Module EEPROM
AEh	FRU-EEPROM	No	Recommended for Baseboard EEPROM

5.7 System Management (SM) Bus

The 8-bit SMBus addresses uses the LSB (Bit 0) for the direction. Bit0 = 0 defines the write address, Bit0 = 1 defines the read address for the device. The 8-bit addresses listed below shows the write address for all devices. 7-bit SMBus addresses shows the device address without Bit0.

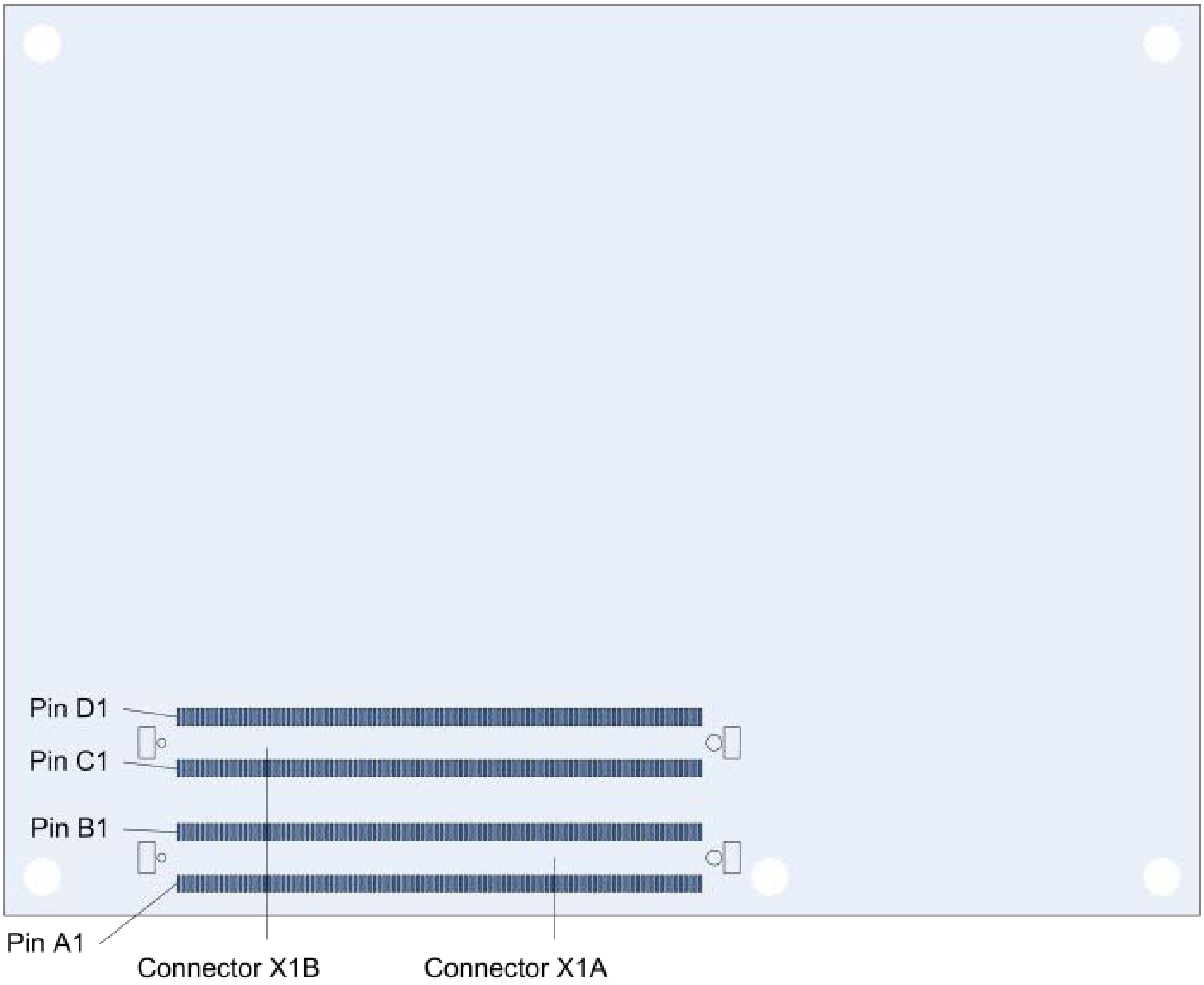
8-bit Address	7-bit Address	Device	Comment	SMBus
12h	0x09	SMART_CHARGER	Not to be used with any SM bus device except a charger	SMB
14h	0x0A	SMART_SELECTOR	Not to be used with any SM bus device except a selector or manager	SMB
16h	0x0B	SMART_BATTERY	Not to be used with any SM bus device except a battery	SMB
30h	0x18	DDR3 Thermal Sensor Chan. A	Do not use under any circumstances	SMB
34h	0x1A	DDR3 Thermal Sensor Chan. B	Do not use under any circumstances	SMB
58h	0x2C	Hardware Monitor	Do not use under any circumstances	SMB
A0h	0x50	DDR3 channel A SPD	Do not use under any circumstances	SMB
A4h	0x52	DDR3 channel B SPD	Do not use under any circumstances	SMB
C8h	0x64	Ethernet I218-LM	Do not use under any circumstances	SML0

A JIDA Bus No. like in former Modules cannot be provided because the EAPI driver implementation enumerates the I2C busses dynamically. Please follow the initialization process like it is provided in the EAPI specification.

6 Connectors

The pin-outs for Interface Connectors X1A and X1B are documented for convenient reference. Please see the COM Express® Specification and COM Express® Design Guide for detailed, design-level information.

6.1 Connector Location



7 Pinout List

7.1 General Signal Description

Type	Description
I/O-3,3	Bi-directional 3,3 V IO-Signal
I/O-5T	Bi-dir. 3,3V I/O (5V Tolerance)
I/O-5	Bi-directional 5V I/O-Signal
I-3,3	3,3V Input
I/OD	Bi-directional Input/Output Open Drain
I-5T	3,3V Input (5V Tolerance)
OA	Output Analog
OD	Output Open Drain
O-1,8	1,8V Output
O-3,3	3,3V Output
O-5	5V Output
DP-I/O	Differential Pair Input/Output
DP-I	Differential Pair Input
DP-O	Differential Pair Output
PU	Pull-Up Resistor
PD	Pull-Down Resistor
PWR	Power Connection

To protect external power lines of peripheral devices, make sure that: the wires have the right diameter to withstand the maximum available current the enclosure of the peripheral device fulfills the fire-protection requirements of IEC/EN60950

7.2 Connector X1A Row A

Pin	Signal	Description	Type	Termination	Comment
A1	GND	Power Ground	PWR GND	-	-
A2	GBE0_MDI3-	Ethernet Media Dependent Interface 3 -	DP-I/O	-	-
A3	GBE0_MDI3+	Ethernet Media Dependent Interface 3 +	DP-I/O	-	-
A4	GBE0_LINK100#	Ethernet 100 Mbit Link Indicator	OD	-	-
A5	GBE0_LINK1000#	Ethernet 1000 Mbit Link Indicator	OD	-	-
A6	GBE0_MDI2-	Ethernet Media Dependent Interface 2 -	DP-I/O	-	-
A7	GBE0_MDI2+	Ethernet Media Dependent Interface 2 +	DP-I/O	-	-
A8	GBE0_LINK#	Ethernet Link Indicator	OD	-	-
A9	GBE0_MDI1-	Ethernet Media Dependent Interface 1 -	DP-I/O	-	-
A10	GBE0_MDI1+	Ethernet Media Dependent Interface 1 +	DP-I/O	-	-
A11	GND	Power Ground	PWR GND	-	-
A12	GBE0_MDI0-	Ethernet Media Dependent Interface 0 -	DP-I/O	-	-
A13	GBE0_MDI0+	Ethernet Media Dependent Interface 0 +	DP-I/O	-	-
A14	GBE0_CTREF	Center Tab Reference Voltage	O	-	1µF capacitor to GND
A15	SUS_S3#	Suspend To RAM (or deeper) Indicator	O-3.3	PD 10k	-
A16	SATA0_TX+	SATA 0 Transmit Pair +	DP-O	-	-
A17	SATA0_TX-	SATA 0 Transmit Pair -	DP-O	-	-
A18	SUS_S4#	Suspend To Disk (or deeper) Indicator	O-3.3	-	-
A19	SATA0_RX+	SATA 0 Receive Pair +	DP-I	-	-
A20	SATA0_RX-	SATA 0 Receive Pair -	DP-I	-	-
A21	GND	Power Ground	PWR GND	-	-
A22	SATA2_TX+	SATA 2 Transmit Pair +	DP-O	-	-
A23	SATA2_TX-	SATA 2 Transmit Pair -	DP-O	-	-
A24	SUS_S5#	Soft Off Indicator	O-3.3	-	-
A25	SATA2_RX+	SATA 2 Receive Pair +	DP-I	-	-
A26	SATA2_RX-	SATA 2 Receive Pair -	DP-I	-	-
A27	BATLOW#	Battery Low	I-3.3	PU 10k 3.3V (S5)	assertion will prevent wake from S3-S5 state
A28	(S)ATA_ACT#	Serial ATA LED	OD-3.3	PU 10k 3.3V (S0)	can pull down 3mA
A29	AC/HDA_SYnc	HD Audio Sync	O-3.3	PD 15k in PCH	resistor value can range from 9kOhm to 50kOhm
A30	AC/HDA_RST#	HD Audio Reset	O-3.3	-	-
A31	GND	Power Ground	PWR GND	-	-
A32	AC/HDA_BITCLK	HD Audio Bit Clock Output	O-3.3	-	-
A33	AC/HDA_SDOUT	HD Audio Serial Data Out	O-3.3	PD 15k in PCH	resistor value can range from 9kOhm to 50kOhm
A34	BIOS_DIS0#	BIOS Selection Strap 0	I-3.3	PU 10k 3.3V (SPI)	PU might be powered during suspend
A35	THRMTRIP#	Thermal Trip	O-3.3	PU 10k 3.3V (S0)	do not use for overtemperatur detection (because this signal is a S0 signal, it's not possible to see if module shuts down regular or caused by CPU overtemperatur)
A36	USB6-	USB 2.0 Data Pair Port 6 –	DP-I/O	PD 15k in PCH	resistor value can range from 14kOhm to 25kOhm
A37	USB6+	USB 2.0 Data Pair Port 6 +	DP-I/O	PD 15k in PCH	resistor value can range from 14kOhm to 25kOhm
A38	USB_6_7_OC#	USB Overcurrent Indicator Port 6/7	I-3.3	PU 10k 3.3V (S5)	-
A39	USB4-	USB 2.0 Data Pair Port 4 -	DP-I/O	PD 15k in PCH	resistor value can range from 14kOhm to 25kOhm
A40	USB4+	USB 2.0 Data Pair Port 4 +	DP-I/O	PD 15k in PCH	resistor value can range from 14kOhm to 25kOhm
A41	GND	Power Ground	PWR GND	-	-
A42	USB2-	USB 2.0 Data Pair Port 2 –	DP-I/O	PD 15k in PCH	resistor value can range from 14kOhm to 25kOhm
A43	USB2+	USB 2.0 Data Pair Port 2 +	DP-I/O	PD 15k in PCH	resistor value can range from 14kOhm to 25kOhm
A44	USB_2_3_OC#	USB Overcurrent Indicator Port 2/3	I-3.3	PU 10k 3.3V (S5)	-
A45	USB0-	USB 2.0 Data Pair Port 0 –	DP-I/O	PD 15k in PCH	resistor value can range from 14kOhm to 25kOhm
A46	USB0+	USB 2.0 Data Pair Port 0 +	DP-I/O	PD 15k in PCH	resistor value can range from 14kOhm to 25kOhm
A47	VCC_RTC	Real-Time Clock Circuit Power Input	PWR 3V	-	-
A48	EXCD0_PERST#	Express Card Reset Port 0	O-3.3	-	-
A49	EXCD0_CPPE#	Express Card Capable Card Request Port 0	I-3.3	PU 10k 3.3V (S0)	-
A50	LPC_SERIRQ	Serial Interrupt Request	I/OD-3.3	PU 8k25 3.3V (S0)	-
A51	GND	Power Ground	PWR GND	-	-
A52	PCIE_TX5+	PCI Express Lane 5 Transmit +	DP-O	-	-
A53	PCIE_TX5-	PCI Express Lane 5 Transmit -	DP-O	-	-
A54	GPI0	General Purpose Input 0	I-3.3	PU 10k 3.3V (S0)	-
A55	PCIE_TX4+	PCI Express Lane 4 Transmit +	DP-O	-	-
A56	PCIE_TX4-	PCI Express Lane 4 Transmit -	DP-O	-	-
A57	GND	Power Ground	PWR GND	-	-
A58	PCIE_TX3+	PCI Express Lane 3 Transmit +	DP-O	-	-
A59	PCIE_TX3-	PCI Express Lane 3 Transmit -	DP-O	-	-
A60	GND	Power Ground	PWR GND	-	-
A61	PCIE_TX2+	PCI Express Lane 2 Transmit +	DP-O	-	-
A62	PCIE_TX2-	PCI Express Lane 2 Transmit -	DP-O	-	-

A63	GPI1	General Purpose Input 1	I-3.3	PU 10k 3.3V (S0)	-
A64	PCIE_TX1+	PCI Express Lane 1 Transmit +	DP-O	-	-
A65	PCIE_TX1-	PCI Express Lane 1 Transmit -	DP-O	-	-
A66	GND	Power Ground	PWR GND	-	-
A67	GPI2	General Purpose Input 2	I-3.3	PU 10k 3.3V (S0)	-
A68	PCIE_TX0+	PCI Express Lane 0 Transmit +	DP-O	-	-
A69	PCIE_TX0-	PCI Express Lane 0 Transmit -	DP-O	-	-
A70	GND	Power Ground	PWR GND	-	-
A71	LVDS_A0+	LVDS Channel A Data0 +	DP-O	-	-
A72	LVDS_A0-	LVDS Channel A Data0 -	DP-O	-	-
A73	LVDS_A1+	LVDS Channel A Data1 +	DP-O	-	configuration as eDP_TX1+ in customised article version possible
A74	LVDS_A1-	LVDS Channel A Data1 -	DP-O	-	configuration as eDP_TX1- in customised article version possible
A75	LVDS_A2+	LVDS Channel A Data2 +	DP-O	-	configuration as eDP_TX0+ in customised article version possible
A76	LVDS_A2-	LVDS Channel A Data2 -	DP-O	-	configuration as eDP_TX0- in customised article version possible
A77	LVDS_VDD_EN	LVDS Panel Power Control	O-3.3	PD 100k	configuration as eDP_VDD_EN in customised article version possible
A78	LVDS_A3+	LVDS Channel A Data3 +	DP-O	-	-
A79	LVDS_A3-	LVDS Channel A Data3 -	DP-O	-	-
A80	GND	Power Ground	PWR GND	-	-
A81	LVDS_A_CK+	LVDS Channel A Clock +	DP-O	-	-
A82	LVDS_A_CK-	LVDS Channel A Clock -	DP-O	-	-
A83	LVDS_I2C_CK	LVDS Data Channel Clock	I/O-3.3	PU 2k21 3.3V (S0)	configuration as eDP_AUX+ in customised article version possible
A84	LVDS_I2C_DAT	LVDS Data Channel Data	I/O-3.3	PU 2k21 3.3V (S0)	configuration as eDP_AUX- in customised article version possible
A85	GPI3	General Purpose Input 3	I-3.3	PU 10k 3.3V (S0)	-
A86	RSVD	Reserved for future use	nc	-	-
A87	RSVD	Reserved for future use	nc	-	configuration as eDP_HPD in customised article version possible
A88	PCIE_CLK_REF+	Reference PCI Express Clock +	DP-O	-	-
A89	PCIE_CLK_REF-	Reference PCI Express Clock -	DP-O	-	-
A90	GND	Power Ground	PWR GND	-	-
A91	SPI_POWER	3.3V Power Output Pin for external SPI flash	O-3.3	-	might be powered during suspend
A92	SPI_MISO	SPI Master IN Slave OUT	I-3.3	PU 20k in PCH (SPI)	resistor value can range from 15kOhm to 40kOhm and might be powered during suspend
A93	GPO0	General Purpose Output 0	O-3.3	PD 10k	-
A94	SPI_CLK	SPI Clock	O-3.3	-	-
A95	SPI_MOSI	SPI Master Out Slave In	O-3.3	PD 20k in PCH	resistor value can range from 15kOhm to 40kOhm
A96	TPM_PP	TPM Physical Presence	I-3.3	PD 100k	-
A97	TYPE10#	No Connect for type 6 modules	nc	-	-
A98	SER0_TX	Serial Port 0 TXD	O-3.3	-	20V protection circuit implemented on module, PD on carrier board needed for proper operation
A99	SER0_RX	Serial Port 0 RXD	I-5T	PU 47k 3.3V (S0)	20V protection circuit implemented on module
A100	GND	Power Ground	PWR GND	-	-
A101	SER1_TX	Serial Port 1 TXD	O-3.3	-	20V protection circuit implemented on module, PD on carrier board needed for proper operation
A102	SER1_RX	Serial Port 1 RXD	I-5T	PU 47k 3.3V (S0)	20V protection circuit implemented on module
A103	LID#	LID Switch Input	I-3.3	PU 47k 3.3V (S5)	20V protection circuit implemented on module
A104	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
A105	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
A106	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
A107	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
A108	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
A109	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
A110	GND	Power Ground	PWR GND	-	-

7.3 Connector X1A Row B

Pin	Signal	Description	Type	Termination	Comment
B1	GND	Power Ground	PWR GND	-	-
B2	GBE0_ACT	Ethernet Activity LED	OD	-	-
B3	LPC_FRAME#	LPC Frame Indicator	O-3.3	-	-
B4	LPC_AD0	LPC Multiplexed Command, Address & Data 0	I/O-3.3	PU 20k in PCH (S0)	resistor value can range from 15kOhm to 40kOhm
B5	LPC_AD1	LPC Multiplexed Command, Address & Data 1	I/O-3.3	PU 20k in PCH (S0)	resistor value can range from 15kOhm to 40kOhm
B6	LPC_AD2	LPC Multiplexed Command, Address & Data 2	I/O-3.3	PU 20k in PCH (S0)	resistor value can range from 15kOhm to 40kOhm
B7	LPC_AD3	LPC Multiplexed Command, Address & Data 3	I/O-3.3	PU 20k in PCH (S0)	resistor value can range from 15kOhm to 40kOhm
B8	LPC_DRQ0#	LPC Serial DMA/Master Request 0	I-3.3	PU 20k in PCH (S0)	resistor value can range from 15kOhm to 40kOhm
B9	LPC_DRQ1#	LPC Serial DMA/Master Request 1	I-3.3	PU 20k in PCH (S0)	resistor value can range from 15kOhm to 40kOhm
B10	LPC_CLK	33MHz LPC clock	O-3.3	-	-
B11	GND	Power Ground	PWR GND	-	-
B12	PWRBTN#	Power Button	I-3.3	PU 10k 3.3V (S5eco)	-
B13	SMB_CK	SMBUS Clock	O-3.3	PU 3k3 3.3V (S5)	-
B14	SMB_DAT	SMBUS Data	I/O-3.3	PU 3k3 3.3V (S5)	-
B15	SMB_ALERT#	SMBUS Alert	I/O-3.3	PU 10k0 3.3V (S5)	-
B16	SATA1_TX+	SATA 1 Transmit Pair +	DP-O	-	-
B17	SATA1_TX-	SATA 1 Transmit Pair -	DP-O	-	-
B18	SUS_STAT#	Suspend Status	O-3.3	-	-
B19	SATA1_RX+	SATA 1 Receive Pair +	DP-I	-	-
B20	SATA1_RX-	SATA 1 Receive Pair -	DP-I	-	-
B21	GND	Power Ground	PWR GND	-	-
B22	SATA3_TX+	SATA 3 Transmit Pair +	DP-O	-	-
B23	SATA3_TX-	SATA 3 Transmit Pair -	DP-O	-	-
B24	PWR_OK	Power OK	I-5T	PU 511k 3.3V	pullup voltage depends on ATX or single supply mode / 5V tolerant
B25	SATA3_RX+	SATA 3 Receive Pair +	DP-I	-	-
B26	SATA3_RX-	SATA 3 Receive Pair -	DP-I	-	-
B27	WDT	Watch Dog Time-Out event	O-3.3	-	-
B28	AC/HDA_SDIN2	HD Audio Serial Data In 2	I-3.3	PD 15k in PCH	resistor value can range from 9kOhm to 50kOhm
B29	AC/HDA_SDIN1	HD Audio Serial Data In 1	I-3.3	PD 15k in PCH	resistor value can range from 9kOhm to 50kOhm
B30	AC/HDA_SDIN0	HD Audio Serial Data In 0	I-3.3	PD 15k in PCH	resistor value can range from 9kOhm to 50kOhm
B31	GND	Power Ground	PWR GND	-	-
B32	SPKR	Speaker	O-3.3	PD 20k in PCH (S0)	resistor value can range from 15kOhm to 40kOhm, PCH strap function
B33	I2C_CK	I2C Clock	O-3.3	PU 2k21 3.3V (S5)	-
B34	I2C_DAT	I2C Data	I/O-3.3	PU 2k21 3.3V (S5)	-
B35	THRM#	Over Temperature Input	I-3.3	PU 10k 3.3V (S0)	no function implemented
B36	USB7-	USB 2.0 Data Pair Port 7 –	DP-I/O	PD 15K in PCH	resistor value can range from 14kOhm to 25kOhm
B37	USB7+	USB 2.0 Data Pair Port 7 +	DP-I/O	PD 15K in PCH	resistor value can range from 14kOhm to 25kOhm
B38	USB_4_5_OC#	USB Overcurrent Indicator Port 4/5	I-3.3	PU 10k 3.3V (S5)	-
B39	USB5-	USB 2.0 Data Pair Port 5 –	DP-I/O	PD 15K in PCH	resistor value can range from 14kOhm to 25kOhm
B40	USB5+	USB 2.0 Data Pair Port 5 +	DP-I/O	PD 15K in PCH	resistor value can range from 14kOhm to 25kOhm
B41	GND	Power Ground	PWR GND	-	-
B42	USB3-	USB 2.0 Data Pair Port 3 –	DP-I/O	PD 15K in PCH	resistor value can range from 14kOhm to 25kOhm
B43	USB3+	USB 2.0 Data Pair Port 3 +	DP-I/O	PD 15K in PCH	resistor value can range from 14kOhm to 25kOhm
B44	USB_0_1_OC#	USB Overcurrent Indicator Port 0/1	I-3.3	PU 10k 3.3V (S5)	-
B45	USB1-	USB 2.0 Data Pair Port 1 –	DP-I/O	PD 15K in PCH	resistor value can range from 14kOhm to 25kOhm
B46	USB1+	USB 2.0 Data Pair Port 1 +	DP-I/O	PD 15K in PCH	resistor value can range from 14kOhm to 25kOhm
B47	EXCD1_PERST#	Express Card Reset Port 1	O-3.3	-	-
B48	EXCD1_CPPE#	Express Card Capable Card Request Port 1	I-3.3	PU 10k 3.3V (S0)	-
B49	SYS_RESET#	Reset Button Input	I-3.3	PU 10k 3.3V (S5)	-
B50	CB_RESET#	Carrier Board Reset	O-3.3		-
B51	GND	Power Ground	PWR GND	-	-
B52	PCIE_RX5+	PCI Express Lane 5 Receive +	DP-I	-	-
B53	PCIE_RX5-	PCI Express Lane 5 Receive -	DP-I	-	-
B54	GPO1	General Purpose Output 1	O-3.3	PD 10k	-
B55	PCIE_RX4+	PCI Express Lane 4 Receive +	DP-I	-	-
B56	PCIE_RX4-	PCI Express Lane 4 Receive -	DP-I	-	-
B57	GPO2	General Purpose Output 2	O-3.3	PD 10k	-
B58	PCIE_RX3+	PCI Express Lane 3 Receive +	DP-I	-	-
B59	PCIE_RX3-	PCI Express Lane 3 Receive -	DP-I	-	-
B60	GND	Power Ground	PWR GND	-	-
B61	PCIE_RX2+	PCI Express Lane 2 Receive +	DP-I	-	-
B62	PCIE_RX2-	PCI Express Lane 2 Receive -	DP-I	-	-

B63	GPO3	General Purpose Output 3	O-3.3	PD 10k	-
B64	PCIE_RX1+	PCI Express Lane 1 Receive +	DP-I	-	-
B65	PCIE_RX1-	PCI Express Lane 1 Receive -	DP-I	-	-
B66	WAKE0#	PCI Express Wake Event	I-3.3	PU 10k 3.3V (S5)	-
B67	WAKE1#	General Purpose Wake Event	I-3.3	PU 10k 3.3V (S5)	-
B68	PCIE_RX0+	PCI Express Lane 0 Receive +	DP-I	-	-
B69	PCIE_RX0-	PCI Express Lane 0 Receive -	DP-I	-	-
B70	GND	Power Ground	PWR GND	-	-
B71	LVDS_B0+	LVDS Channel B Data0 +	DP-O	-	-
B72	LVDS_B0-	LVDS Channel B Data0 -	DP-O	-	-
B73	LVDS_B1+	LVDS Channel B Data1 +	DP-O	-	-
B74	LVDS_B1-	LVDS Channel B Data1 -	DP-O	-	-
B75	LVDS_B2+	LVDS Channel B Data2 +	DP-O	-	-
B76	LVDS_B2-	LVDS Channel B Data2 -	DP-O	-	-
B77	LVDS_B3+	LVDS Channel B Data3 +	DP-O	-	-
B78	LVDS_B3-	LVDS Channel B Data3 -	DP-O	-	-
B79	LVDS_BKLT_EN	Panel Backlight On	O-3.3	PD 100k	configuration as eDP_BKLT_EN in customised article version possible
B80	GND	Power Ground	PWR GND	-	-
B81	LVDS_B_CK+	LVDS Channel B Clock +	DP-O	-	-
B82	LVDS_B_CK-	LVDS Channel B Clock -	DP-O	-	-
B83	LVDS_BKLT_CTRL	Backlight Brightness Control	O-3.3	-	-
B84	VCC_5V_SBY	5V Standby	PWR 5V (S5)	-	optional (not neccessary in single supply mode)
B85	VCC_5V_SBY	5V Standby	PWR 5V (S5)	-	optional (not neccessary in single supply mode)
B86	VCC_5V_SBY	5V Standby	PWR 5V (S5)	-	optional (not neccessary in single supply mode)
B87	VCC_5V_SBY	5V Standby	PWR 5V (S5)	-	optional (not neccessary in single supply mode)
B88	BIOS_DIS1#	BIOS Selection Strap 1	I-3.3	PU 10k 3.3V (SPI)	PU might be powered during suspend
B89	VGA_RED	Red Analog Video Output	OA	PD 150R	-
B90	GND	Power Ground	PWR GND	-	-
B91	VGA_GRN	Green Analog Video Output	OA	PD 150R	-
B92	VGA_BLU	Blue Analog Video Output	OA	PD 150R	-
B93	VGA_HSYnc	VGA Horizontal Synchronisation	O-3.3	-	-
B94	VGA_VSYnc	VGA Vertical Synchronization	O-3.3	-	-
B95	VGA_I2C_CK	VGA Data Channel Clock	I/O-3.3	PU 1k1 3.3V (S0)	-
B96	VGA_I2C_DAT	VGA Data Channel Data	I/O-3.3	PU 1k1 3.3V (S0)	-
B97	SPI_CS#	SPI Chip Select	O-3.3	-	-
B98	RSVD	Reserved for future use	nc	-	-
B99	RSVD	Reserved for future use	nc	-	-
B100	GND	Power Ground	PWR GND	-	-
B101	FAN_PWMOUT	Fan PWM Output	O-3.3	-	20V protection circuit implemented on module, PD on carrier board needed for proper operation
B102	FAN_TACHIN	Fan Tach Input	I-3.3	PU 47k 3.3V (S0)	20V protection circuit implemented on module
B103	SLEEP#	Sleep Button Input	I-3.3	PU 47k 3.3V (S5)	20V protection circuit implemented on module
B104	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
B105	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
B106	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
B107	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
B108	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
B109	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
B110	GND	Power Ground	PWR GND	-	-

7.4 Connector X1B Row C

Pin	Signal	Description	Type	Termination	Comment
C1	GND	Power Ground	PWR GND	-	-
C2	GND	Power Ground	PWR GND	-	-
C3	USB_SSRX0-	USB Super Speed Receive Port 0 -	DP-I	-	-
C4	USB_SSRX0+	USB Super Speed Receive Port 0 +	DP-I	-	-
C5	GND	Power Ground	PWR GND	-	-
C6	USB_SSRX1-	USB Super Speed Receive Port 1 -	DP-I	-	-
C7	USB_SSRX1+	USB Super Speed Receive Port 1 +	DP-I	-	-
C8	GND	Power Ground	PWR GND	-	-
C9	USB_SSRX2-	USB Super Speed Receive Port 2 -	DP-I	-	-
C10	USB_SSRX2+	USB Super Speed Receive Port 2 +	DP-I	-	-
C11	GND	Power Ground	PWR GND	-	-
C12	USB_SSRX3-	USB Super Speed Receive Port 3 -	DP-I	-	-
C13	USB_SSRX3+	USB Super Speed Receive Port 3 +	DP-I	-	-
C14	GND	Power Ground	PWR GND	-	-
C15	DDI1_PAIR6+	DDI1 Pair 6 +	DP-I	-	-
C16	DDI1_PAIR6-	DDI1 Pair 6 +	DP-I	-	-
C17	RSVD	Reserved for future use	nc	-	-
C18	RSVD	Reserved for future use	nc	-	-
C19	PCIE_RX6+	PCI Express Lane 6 Receive +	DP-I	-	-
C20	PCIE_RX6-	PCI Express Lane 6 Receive -	DP-I	-	-
C21	GND	Power Ground	PWR GND	-	-
C22	PCIE_RX7+	No Connect (opt. PCI Express Lane 7 Receive +)	nc (opt. DP-I)	-	configuration as PCIE_RX7+ in customised article version without LAN controller possible
C23	PCIE_RX7-	No Connect (opt. PCI Express Lane 7 Receive -)	nc (opt. DP-I)	-	configuration as PCIE_RX7- in customised article version without LAN controller possible
C24	DDI1_HPD	DDI1 Hotplug Detect	I-3.3	PD 100k	-
C25	DDI1_PAIR4+	DDI1 Pair 4 +	DP-I	-	-
C26	DDI1_PAIR4-	DDI1 Pair 4 -	DP-I	-	-
C27	RSVD	Reserved for future use	nc	-	-
C28	RSVD	Reserved for future use	nc	-	-
C29	DDI1_PAIR5+	DDI1 Pair 5 +	DP-I	-	-
C30	DDI1_PAIR5-	DDI1 Pair 5 -	DP-I	-	-
C31	GND	Power Ground	PWR GND	-	-
C32	DDI2_CTRLCLK_AUX+	Multiplexed DDI2 Data Channel Clock & AUX +	I/O-3.3	PD 100k	2k21 PU (S0) when DDI2_DDC_AUX_SEL is high
C33	DDI2_CTRLDATA_AUX-	Multiplexed DDI2 Data Channel Data & AUX -	I/O-3.3	PU 100k (S0)	2k21 PU (S0) when DDI2_DDC_AUX_SEL is high
C34	DDI2_DDC_AUX_SEL	DDI2 DDC/AUX Select	I-3.3	PD 1M	-
C35	RSVD	Reserved for future use	nc	-	-
C36	DDI3_CTRLCLK_AUX+	Multiplexed DDI3 Data Channel Clock & AUX +	I/O-3.3	PD 100k	2k21 PU (S0) when DDI3_DDC_AUX_SEL is high
C37	DDI3_CTRLDATA_AUX-	Multiplexed DDI3 Data Channel Data & AUX -	I/O-3.3	PU 100k (S0)	2k21 PU (S0) when DDI3_DDC_AUX_SEL is high
C38	DDI3_DDC_AUX_SEL	DDI3 DDC/AUX Select	I-3.3	PD 1M	-
C39	DDI3_PAIR0+	DDI3 Pair 0 +	DP-O	-	-
C40	DDI3_PAIR0-	DDI3 Pair 0 -	DP-O	-	-
C41	GND	Power Ground	PWR GND	-	-
C42	DDI3_PAIR1+	DDI3 Pair 1 +	DP-O	-	-
C43	DDI3_PAIR1-	DDI3 Pair 1 -	DP-O	-	-
C44	DDI3_HPD	DDI3 Hotplug Detect	I-3.3	PD 100k	-
C45	RSVD	Reserved for future use	nc	-	-
C46	DDI3_PAIR2+	DDI3 Pair 2 +	DP-O	-	-
C47	DDI3_PAIR2-	DDI3 Pair 2 -	DP-O	-	-
C48	RSVD	Reserved for future use	nc	-	-
C49	DDI3_PAIR3+	DDI3 Pair 3 +	DP-O	-	-
C50	DDI3_PAIR3-	DDI3 Pair 3 -	DP-O	-	-
C51	GND	Power Ground	PWR GND	-	-
C52	PEG_RX0+	PCI Express Graphics Lane 0 Receive +	DP-I	-	-
C53	PEG_RX0-	PCI Express Graphics Lane 0 Receive -	DP-I	-	-
C54	TYPE0#	No Connect for type 6 module	nc	-	-
C55	PEG_RX1+	PCI Express Graphics Lane 1 Receive +	DP-I	-	-
C56	PEG_RX1-	PCI Express Graphics Lane 1 Receive -	DP-I	-	-
C57	TYPE1#	No Connect for type 6 module	nc	-	-
C58	PEG_RX2+	PCI Express Graphics Lane 2 Receive +	DP-I	-	-
C59	PEG_RX2-	PCI Express Graphics Lane 2 Receive -	DP-I	-	-
C60	GND	Power Ground	PWR GND	-	-
C61	PEG_RX3+	PCI Express Graphics Lane 3 Receive +	DP-I	-	-
C62	PEG_RX3-	PCI Express Graphics Lane 3 Receive -	DP-I	-	-

C63	RSVD	Reserved for future use	nc	-	-
C64	RSVD	Reserved for future use	nc	-	-
C65	PEG_RX4+	PCI Express Graphics Lane 4 Receive +	DP-I	-	-
C66	PEG_RX4-	PCI Express Graphics Lane 4 Receive -	DP-I	-	-
C67	RSVD	Reserved for future use	nc	-	-
C68	PEG_RX5+	PCI Express Graphics Lane 5 Receive +	DP-I	-	-
C69	PEG_RX5-	PCI Express Graphics Lane 5 Receive -	DP-I	-	-
C70	GND	Power Ground	PWR GND	-	-
C71	PEG_RX6+	PCI Express Graphics Lane 6 Receive +	DP-I	-	-
C72	PEG_RX6-	PCI Express Graphics Lane 6 Receive -	DP-I	-	-
C73	GND	Power Ground	PWR GND	-	-
C74	PEG_RX7+	PCI Express Graphics Lane 7 Receive +	DP-I	-	-
C75	PEG_RX7-	PCI Express Graphics Lane 7 Receive -	DP-I	-	-
C76	GND	Power Ground	PWR GND	-	-
C77	RSVD	Reserved for future use	nc	-	-
C78	PEG_RX8+	PCI Express Graphics Lane 8 Receive +	DP-I	-	-
C79	PEG_RX8-	PCI Express Graphics Lane 8 Receive -	DP-I	-	-
C80	GND	Power Ground	PWR GND	-	-
C81	PEG_RX9+	PCI Express Graphics Lane 9 Receive +	DP-I	-	-
C82	PEG_RX9-	PCI Express Graphics Lane 9 Receive -	DP-I	-	-
C83	RSVD	Reserved for future use	nc	-	-
C84	GND	Power Ground	PWR GND	-	-
C85	PEG_RX10+	PCI Express Graphics Lane 10 Receive +	DP-I	-	-
C86	PEG_RX10-	PCI Express Graphics Lane 10 Receive -	DP-I	-	-
C87	GND	Power Ground	PWR GND	-	-
C88	PEG_RX11+	PCI Express Graphics Lane 11 Receive +	DP-I	-	-
C89	PEG_RX11-	PCI Express Graphics Lane 11 Receive –	DP-I	-	-
C90	GND	Power Ground	PWR GND	-	-
C91	PEG_RX12+	PCI Express Graphics Lane 12 Receive +	DP-I	-	-
C92	PEG_RX12-	PCI Express Graphics Lane 12 Receive -	DP-I	-	-
C93	GND	Power Ground	PWR GND	-	-
C94	PEG_RX13+	PCI Express Graphics Lane 13 Receive +	DP-I	-	-
C95	PEG_RX13-	PCI Express Graphics Lane 13 Receive -	DP-I	-	-
C96	GND	Power Ground	PWR GND	-	-
C97	RSVD	Reserved for future use	nc	-	-
C98	PEG_RX14+	PCI Express Graphics Lane 14 Receive +	DP-I	-	-
C99	PEG_RX14-	PCI Express Graphics Lane 14 Receive -	DP-I	-	-
C100	GND	Power Ground	PWR GND	-	-
C101	PEG_RX15+	PCI Express Graphics Lane 15 Receive +	DP-I	-	-
C102	PEG_RX15-	PCI Express Graphics Lane 15 Receive -	DP-I	-	-
C103	GND	Power Ground	PWR GND	-	-
C104	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
C105	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
C106	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
C107	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
C108	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
C109	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
C110	GND	Power Ground	PWR GND	-	-

7.5 Connector X1B Row D

Pin	Signal	Description	Type	Termination	Comment
D1	GND	Power Ground	PWR GND	-	-
D2	GND	Power Ground	PWR GND	-	-
D3	USB_SSTX0-	USB Super Speed Transmit Port 0 -	DP-O	-	-
D4	USB_SSTX0+	USB Super Speed Transmit Port 0 +	DP-O	-	-
D5	GND	Power Ground	PWR GND	-	-
D6	USB_SSTX1-	USB Super Speed Transmit Port 1 -	DP-O	-	-
D7	USB_SSTX1+	USB Super Speed Transmit Port 1 +	DP-O	-	-
D8	GND	Power Ground	PWR GND	-	-
D9	USB_SSTX2-	USB Super Speed Transmit Port 2 -	DP-O	-	-
D10	USB_SSTX2+	USB Super Speed Transmit Port 2 +	DP-O	-	-
D11	GND	Power Ground	PWR GND	-	-
D12	USB_SSTX3-	USB Super Speed Transmit Port 3 -	DP-O	-	-
D13	USB_SSTX3+	USB Super Speed Transmit Port 3 +	DP-O	-	-
D14	GND	Power Ground	PWR GND	-	-
D15	DDI1_CTRLCLK_AUX+	Multiplexed DDI1 Data Channel Clock & AUX +	I/O-3.3	PD 100k	2k21 PU (S0) when DDI1_DDC_AUX_SEL is high
D16	DDI1_CTRLDATA_AUX-	Multiplexed DDI1 Data Channel Data & AUX -	I/O-3.3	PU 100k (S0)	2k21 PU (S0) when DDI1_DDC_AUX_SEL is high
D17	RSVD	Reserved for future use	nc	-	-
D18	RSVD	Reserved for future use	nc	-	-
D19	PCIE_TX6+	PCI Express Lane 6 Transmit +	DP-O	-	-
D20	PCIE_TX6-	PCI Express Lane 6 Transmit -	DP-O	-	-
D21	GND	Power Ground	PWR GND	-	-
D22	PCIE_TX7+	No Connect (opt. PCI Express Lane 7 Transmit +)	nc (opt. DP-O)	-	configuration as PCIE_RX7+ in customised article version without LAN controller possible
D23	PCIE_TX7-	No Connect (opt. PCI Express Lane 7 Transmit -)	nc (opt. DP-O)	-	configuration as PCIE_RX7- in customised article version without LAN controller possible
D24	RSVD	Reserved for future use	nc	-	-
D25	RSVD	Reserved for future use	nc	-	-
D26	DDI1_PAIR0+	DDI1 Pair 0 +	DP-O	-	-
D27	DDI1_PAIR0-	DDI1 Pair 0 -	DP-O	-	-
D28	RSVD	Reserved for future use	nc	-	-
D29	DDI1_PAIR1+	DDI1 Pair 1 +	DP-O	-	-
D30	DDI1_PAIR1-	DDI1 Pair 1 -	DP-O	-	-
D31	GND	Power Ground	PWR GND	-	-
D32	DDI1_PAIR2+	DDI1 Pair 2 +	DP-O	-	-
D33	DDI1_PAIR2-	DDI1 Pair 2 -	DP-O	-	-
D34	DDI1_DDC_AUX_SEL	DDI1 DDC/AUX Select	I-3.3	PD 1M	-
D35	RSVD	Reserved for future use	nc	-	-
D36	DDI1_PAIR3+	DDI1 Pair 3 +	DP-O	-	-
D37	DDI1_PAIR3-	DDI1 Pair 3 -	DP-O	-	-
D38	RSVD	Reserved for future use	PWR GND	-	pin might change to Not Connect (nc) in later product revision
D39	DDI2_PAIR0+	DDI2 Pair 0 +	DP-O	-	-
D40	DDI2_PAIR0-	DDI2 Pair 0 -	DP-O	-	-
D41	GND	Power Ground	PWR GND	-	-
D42	DDI2_PAIR1+	DDI2 Pair 1 +	DP-O	-	-
D43	DDI2_PAIR1-	DDI2 Pair 1 -	DP-O	-	-
D44	DDI2_HPD	DDI2 Hotplug Detect	I-3.3	PD 100k	-
D45	RSVD	Reserved for future use	nc	-	-
D46	DDI2_PAIR2+	DDI2 Pair 2 +	DP-O	-	-
D47	DDI2_PAIR2-	DDI2 Pair 2 -	DP-O	-	-
D48	RSVD	Reserved for future use	nc	-	-
D49	DDI2_PAIR3+	DDI2 Pair 3 +	DP-O	-	-
D50	DDI2_PAIR3-	DDI2 Pair 3 -	DP-O	-	-
D51	GND	Power Ground	PWR GND	-	-
D52	PEG_TX0+	PCI Express Graphics Lane 0 Transmit +	DP-O	-	-
D53	PEG_TX0-	PCI Express Graphics Lane 0 Transmit -	DP-O	-	-
D54	PEG_Lane_RV#	PCI Express Graphics Lane Reversal	I-3.3	PU 10k 3.3V (S0)	-
D55	PEG_TX1+	PCI Express Graphics Lane 1 Transmit +	DP-O	-	-
D56	PEG_TX1-	PCI Express Graphics Lane 1 Transmit -	DP-O	-	-
D57	TYPE2#	GND for type 6 module	O-PWR	-	-
D58	PEG_TX2+	PCI Express Graphics Lane 2 Transmit +	DP-O	-	-
D59	PEG_TX2-	PCI Express Graphics Lane 2 Transmit -	DP-O	-	-
D60	GND	Power Ground	PWR GND	-	-
D61	PEG_TX3+	PCI Express Graphics Lane 3 Transmit +	DP-O	-	-
D62	PEG_TX3-	PCI Express Graphics Lane 3 Transmit -	DP-O	-	-

D63	RSVD	Reserved for future use	nc	-	-
D64	RSVD	Reserved for future use	nc	-	-
D65	PEG_TX4+	PCI Express Graphics Lane 4 Transmit +	DP-O	-	-
D66	PEG_TX4-	PCI Express Graphics Lane 4 Transmit -	DP-O	-	-
D67	GND	Power Ground	PWR GND	-	-
D68	PEG_TX5+	PCI Express Graphics Lane 5 Transmit +	DP-O	-	-
D69	PEG_TX5-	PCI Express Graphics Lane 5 Transmit -	DP-O	-	-
D70	GND	Power Ground	PWR GND	-	-
D71	PEG_TX6+	PCI Express Graphics Lane 6 Transmit +	DP-O	-	-
D72	PEG_TX6-	PCI Express Graphics Lane 6 Transmit -	DP-O	-	-
D73	GND	Power Ground	PWR GND	-	-
D74	PEG_TX7+	PCI Express Graphics Lane 7 Transmit +	DP-O	-	-
D75	PEG_TX7-	PCI Express Graphics Lane 7 Transmit -	DP-O	-	-
D76	GND	Power Ground	PWR GND	-	-
D77	RSVD	Reserved for future use	nc	-	-
D78	PEG_TX8+	PCI Express Graphics Lane 8 Transmit +	DP-O	-	-
D79	PEG_TX8-	PCI Express Graphics Lane 8 Transmit -	DP-O	-	-
D80	GND	Power Ground	PWR GND	-	-
D81	PEG_TX9+	PCI Express Graphics Lane 9 Transmit +	DP-O	-	-
D82	PEG_TX9-	PCI Express Graphics Lane 9 Transmit -	DP-O	-	-
D83	RSVD	Reserved for future use	nc	-	-
D84	GND	Power Ground	PWR GND	-	-
D85	PEG_TX10+	PCI Express Graphics Lane 10 Transmit +	DP-O	-	-
D86	PEG_TX10-	PCI Express Graphics Lane 10 Transmit -	DP-O	-	-
D87	GND	Power Ground	PWR GND	-	-
D88	PEG_TX11+	PCI Express Graphics Lane 11 Transmit +	DP-O	-	-
D89	PEG_TX11-	PCI Express Graphics Lane 11 Transmit -	DP-O	-	-
D90	GND	Power Ground	PWR GND	-	-
D91	PEG_TX12+	PCI Express Graphics Lane 12 Transmit +	DP-O	-	-
D92	PEG_TX12-	PCI Express Graphics Lane 12 Transmit -	DP-O	-	-
D93	GND	Power Ground	PWR GND	-	-
D94	PEG_TX13+	PCI Express Graphics Lane 13 Transmit +	DP-O	-	-
D95	PEG_TX13-	PCI Express Graphics Lane 13 Transmit -	DP-O	-	-
D96	GND	Power Ground	PWR GND	-	-
D97	RSVD	Reserved for future use	nc	-	-
D98	PEG_TX14+	PCI Express Graphics Lane 14 Transmit +	DP-O	-	-
D99	PEG_TX14-	PCI Express Graphics Lane 14 Transmit -	DP-O	-	-
D100	GND	Power Ground	PWR GND	-	-
D101	PEG_TX15+	PCI Express Graphics Lane 15 Transmit +	DP-O	-	-
D102	PEG_TX15-	PCI Express Graphics Lane 15 Transmit -	DP-O	-	-
D103	GND	Power Ground	PWR GND	-	-
D104	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
D105	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
D106	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
D107	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
D108	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
D109	VCC_12V	Main Input Voltage (8.5-20V)	PWR 8.5-20V	-	-
D110	GND	Power Ground	PWR GND	-	-

The termination resistors in these tables are already mounted on the module. Refer to the design guide for information about additional termination resistors.

8 BIOS Operation

The BIOS (Basic Input and Output System) or UEFI (Unified Extensible Firmware Interface) records hardware parameters of the system in the CMOS on the Computer-on-Module. It's major functions include exectution of the POST(Power-On-Self-Test) during system start-up, saving system parameters and loading the operating system. The BIOS includes a BIOS Setup programm that allows to modify system configuration settings. The module is equipped with Phoenix SecureCore, which is located in an onboard SPI serial flash memory.

8.1 Determining the BIOS Version

To determine the BIOS version currently used on the Computer-on-Modules please check System Information Page inside Setup

8.2 BIOS Update

Kontron provides continous BIOS updates for Computer-on-Modules. The updates are provided for download on http://emdcustomersection.kontron.com with detailed change descriptions within the according Product Change Notification (PCN). Please register for EMD Customer Section to get access to BIOS downloads and PCN service.

Modules with BIOS Region/Setup only inside the flash can be updated with AFU utilities (usually 1-3MB BIOS binary file size) directly. Modules with Intel® Management Engine, Ethernet, Flash Descriptor and other options additionally to the BIOS Region (usually 4-16MB BIOS binary file size) requires a different update process with Intel Flash Utility FPT and a wrapper to backup and restore configurations and the MAC address. Therefore it is strongly recommended to use the batch file inside the BIOS download package available on EMD Customer Section.

» Boot the module to DOS/EFI Shell with access to the BIOS image and Firmware Update Utility provided on EMD Customer Section

» Execute Flash.bat in DOS or Flash.nsh in EFI Shell

Any modification of the update process may damage your module!

8.3 POST Codes

Important POST codes during boot-up

8B	Booted to DOS
68	Booted to Setup / EFI Shell
00	Booted to Windows

8.4 Setup Guide

The Setup Utility changes system behavior by modifying the Firmware configuration. The setup program uses a number of menus to make changes and turn features on or off.

Functional keystrokes in POST:

[F2]	Enter Setup
[F5]	Boot Menu
[ESC] + [2]	Enter Setup via Remote Keyboard in Console Redirection Mode

Functional keystrokes in Setup:

[F1]	Help
[F9]	Load default settings
[F10]	Save and Exit

Menu Bar

The menu bar at the top of the window lists different menus. Use the left/right arrow keys to make a selection.

Legend Bar

Use the keys listed in the legend bar on the bottom to make your selections or exit the current menu. The table below describes the legend keys and their alternates.

Key	Function
← or → Arrow key	Select a menu.
↑ or ↓ Arrow key	Select fields in current menu.
<Home> or <End>	Move cursor to top or bottom of current window.
<PgUp> or <PgDn>	Move cursor to next or previous page.
+/- or F5/F6	Change Option
<Enter>	Execute command or select submenu.

Selecting an Item

Use the ↑ or ↓ key to move the cursor to the field you want. Then use the + and – keys to select a value for that field. The Save Value commands in the Exit menu save the values displayed in all the menus.

Displaying Submenus

Use the ← or → key to move the cursor to the submenu you want. Then press <Enter>. A pointer (►) marks all submenus.

Item Specific Help Window

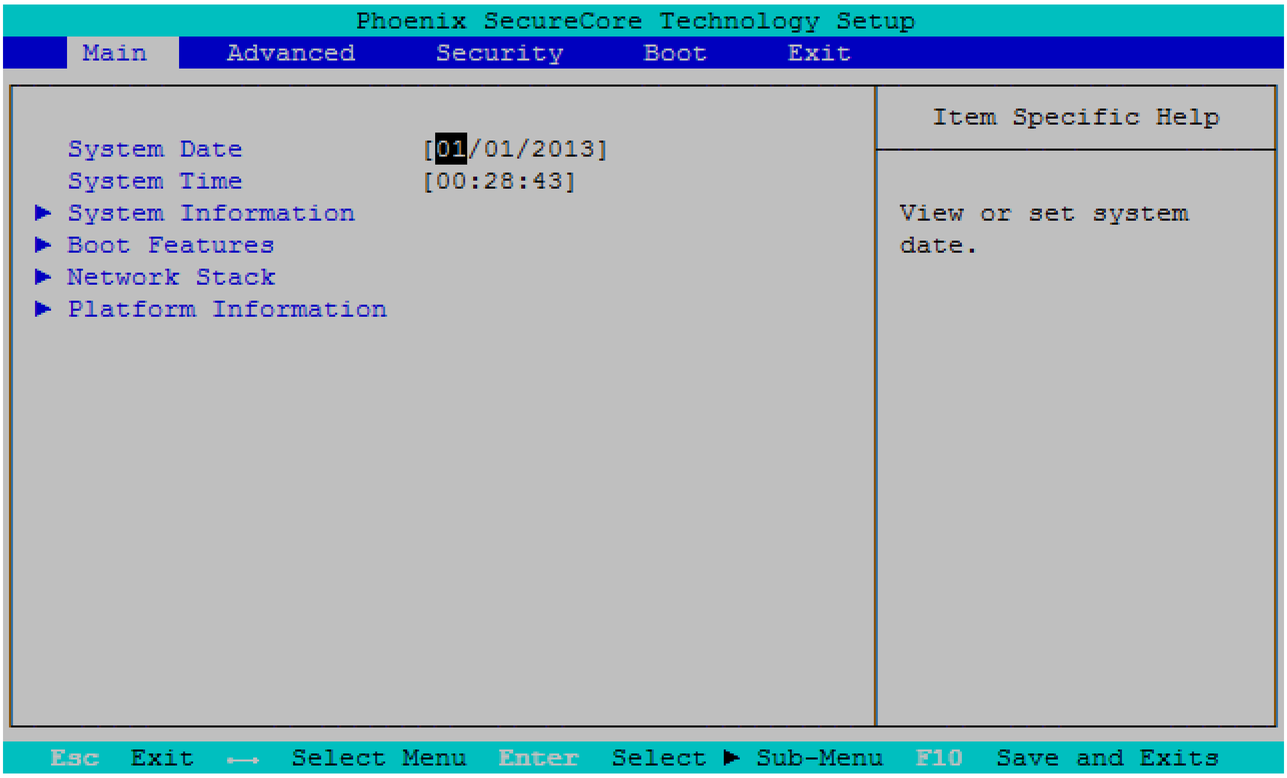
The Help window on the right side of each menu displays the Help text for the selected item. It updates as you move the cursor to each field.

General Help Window

Pressing <F1> on a menu brings up the General Help window that describes the legend keys and their alternates. Press <Esc> to exit the General Help window.

8.5 BIOS Setup

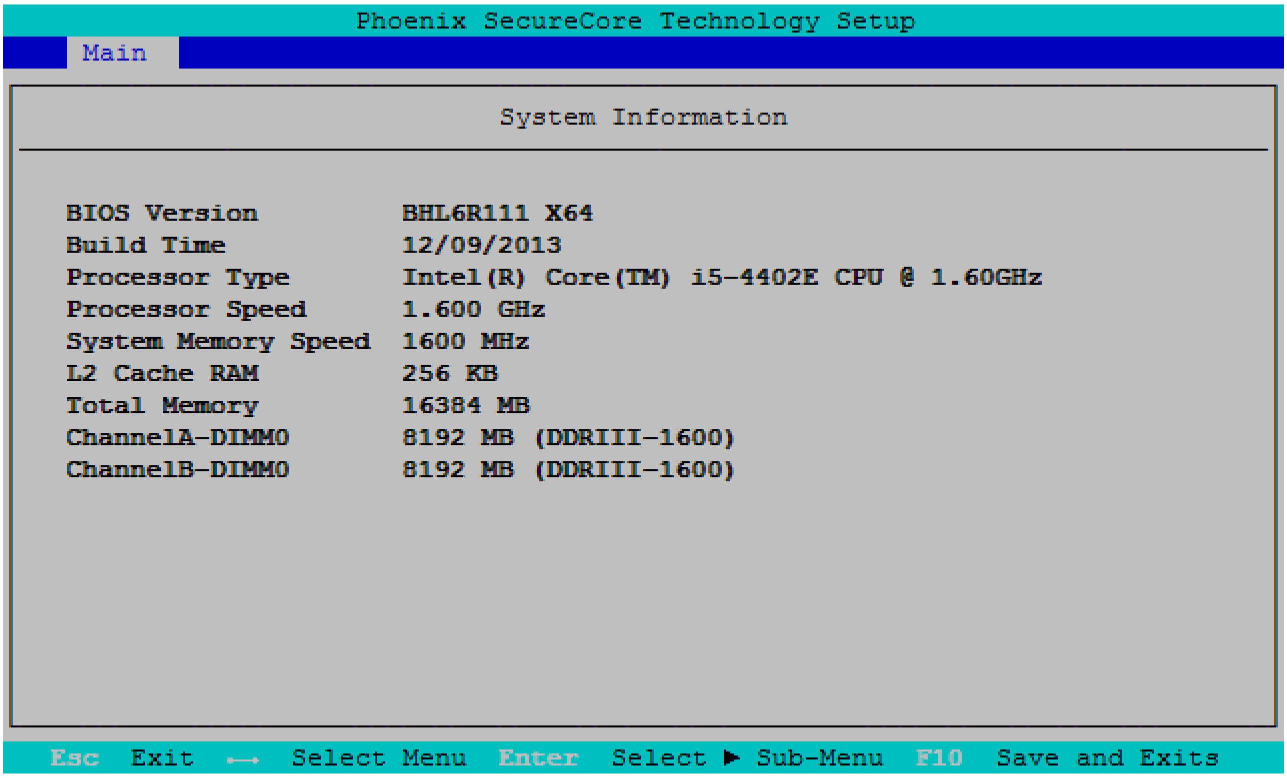
8.5.1 Main



```
                    Phoenix SecureCore Technology Setup
   Main      Advanced      Security      Boot      Exit

    System Date              [01/01/2013]            Item Specific Help
    System Time              [00:28:43]
  ▶ System Information                              View or set system
  ▶ Boot Features                                   date.
  ▶ Network Stack
  ▶ Platform Information

 Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

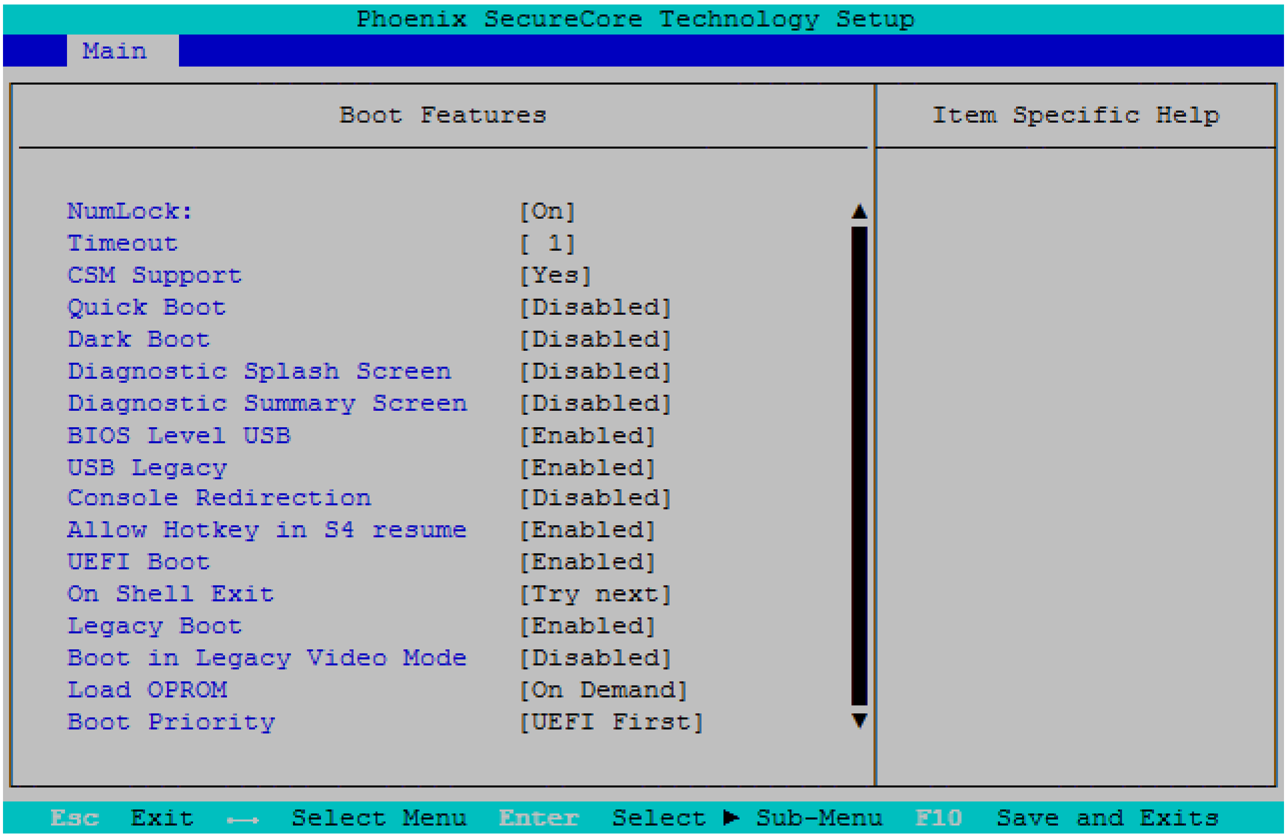
Feature	Options	Description
System Date	[mm/dd/yyyy]	Set the Date. Use 'Tab' to switch between Date elements
System Time	[hh:mm:ss]	Set the Time. Use 'Tab' to switch between Time elements

System Information



```
                     Phoenix SecureCore Technology Setup
    Main

                             System Information

   BIOS Version         BHL6R111 X64
   Build Time           12/09/2013
   Processor Type       Intel(R) Core(TM) i5-4402E CPU @ 1.60GHz
   Processor Speed      1.600 GHz
   System Memory Speed  1600 MHz
   L2 Cache RAM         256 KB
   Total Memory         16384 MB
   ChannelA-DIMM0       8192 MB (DDRIII-1600)
   ChannelB-DIMM0       8192 MB (DDRIII-1600)

   Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Boot Features

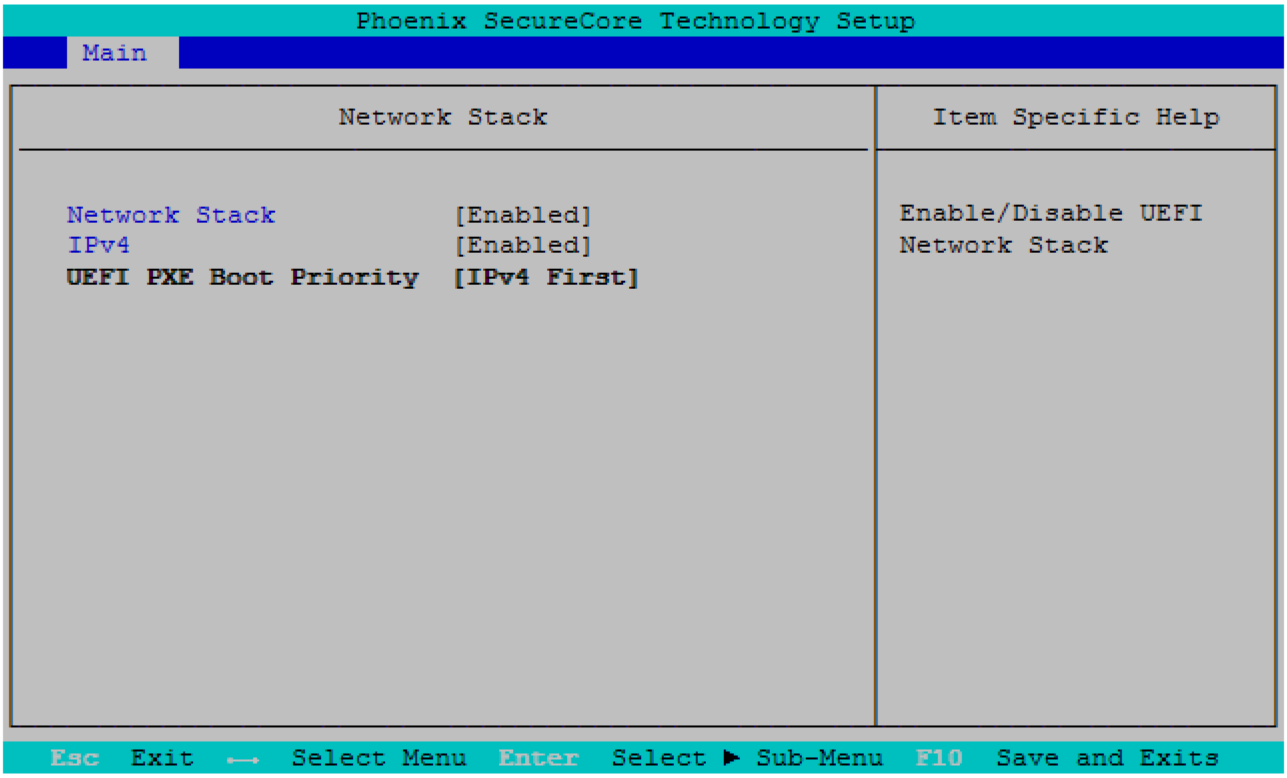


```
Phoenix SecureCore Technology Setup
Main

Boot Features                                    Item Specific Help

NumLock:                      [On]
Timeout                       [ 1]
CSM Support                   [Yes]
Quick Boot                    [Disabled]
Dark Boot                     [Disabled]
Diagnostic Splash Screen      [Disabled]
Diagnostic Summary Screen     [Disabled]
BIOS Level USB                [Enabled]
USB Legacy                    [Enabled]
Console Redirection           [Disabled]
Allow Hotkey in S4 resume     [Enabled]
UEFI Boot                     [Enabled]
On Shell Exit                 [Try next]
Legacy Boot                   [Enabled]
Boot in Legacy Video Mode     [Disabled]
Load OPROM                    [On Demand]
Boot Priority                 [UEFI First]

Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
NumLock	**On** Off	Selects Power-on state for NumLock
Timeout	**1**	Number of seconds that P.O.S.T will wait for the user input before booting
CSM Support	**Yes** No	Enables or Disables the UEFI CSM (Compatibility Support Module)to support legacy PC boot process. Both legacy and UEFI boots are feasible
Quick Boot	**Disabled** Enabled	Enable or Disable Quick Boot
Dark Boot	**Disabled** Enabled	Enable or Disable Dark Boot
Diagnostic Splash Screen	**Disabled** Enabled	Enable or Disable the Diagnostic Splash Screen
Diagnostic Summary Screen	**Disabled** Enabled	Display the Diagnostic Summary Screen during boot
BIOS Level USB	**Enabled** Disabled	Enable/Disable all BIOS support for USB in order to reduce boot time. Note that this will prevent using a USB keyboard in setup or a USB biometric scanner such as a fingerprint reader to control access to setup, but does not prevent the operating system from supporting such hardware
USB Legacy	**Enabled** Disabled	Enable/Disable USB BIOS SMM support for mouse, keyboard, mass storage, etc, in legacy operating systems such as DOS
Console Redirection	**Disabled** Enabled	Enable/Disable Universal Console Redirection
- Console Port	All **Onboard COM1** Onboard COM2 SIO COM1 SIO COM2	Select Port for console redirection. Note: the respective port has to be enabled in setup!
- Terminal Type	**ANSI** VT100 VT100+ UTF8	Set terminal type of UCR
- Baudrate	**9600** 19200 38400 57600 115200	Set terminal type of UCR
- Flow Control	**None**	Set flow control method for UCR. None = No flow

	RTS/CTS XON/XOFF	control, RTS/CTS = Hardware flow control, XON/XOFF = Software flow control
- Continue C.R. after POST	**Enabled** Disabled	Enables Console Redirection after OS has loaded
Allow Hotkey in S4 resume	**Enabled** Disabled	Enable hotkey detection when system resuming from Hybernate state
UEFI Boot	**Enabled** Disabled	Enable the UEFI boot
On Shell Exit	**Try next** Launch Setup\Launch Boot Menu	Select behavior after exit from shell
Legacy Boot	**Enabled**\Disabled	Enable the Legacy boot
Boot in Legacy Video Mode	**Disabled** Enabled	Enable to force the display adapter to switch the video mode to Text Mode 3 at the end of BIOS POST for non-UEFI boot mode (Legacy Boot). Some legacy software, such as DUET, requires that the BIOS explicitly enter text video mode prior to boot
Load OPROM	**On Demand** All	Load all OPROMs or on demand according to the boot device
Boot Priority	**UEFI First** Legacy First	Select priority of boot option between UEFI and Legacy

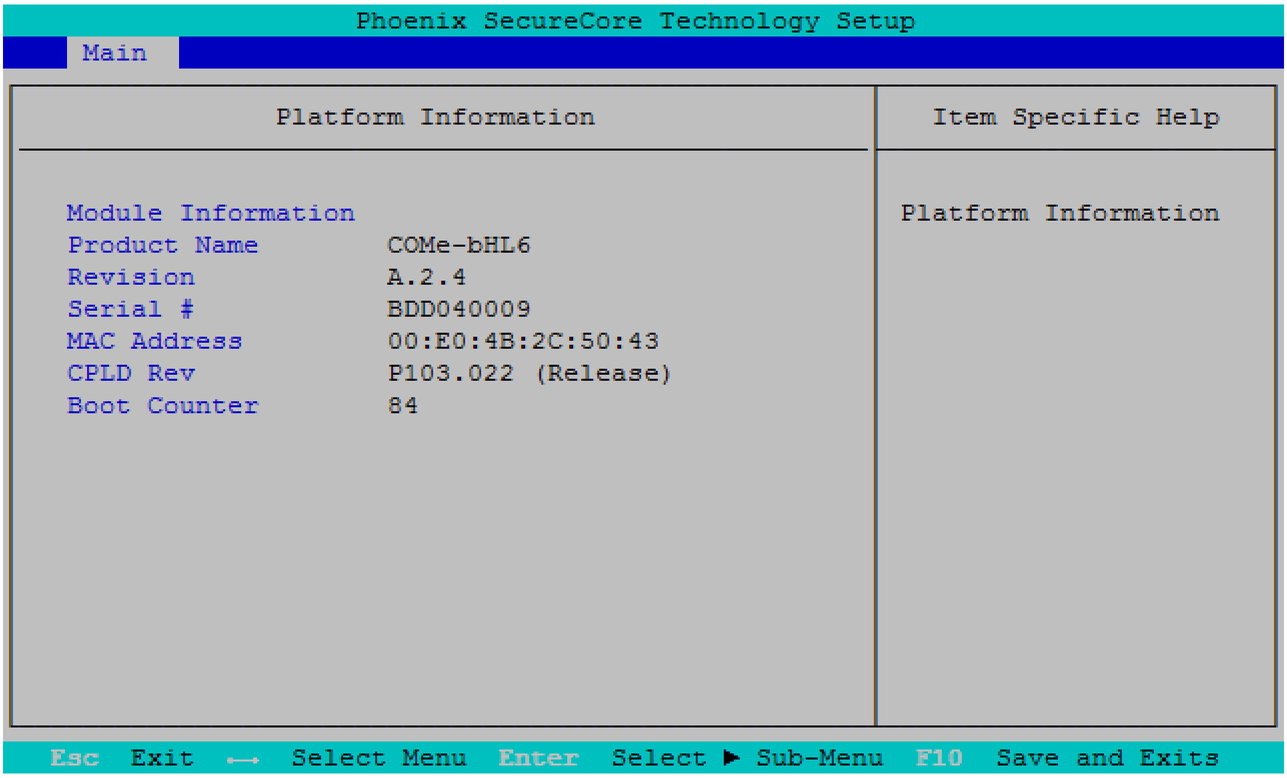
Network Stack



```
                 Phoenix SecureCore Technology Setup
  Main

              Network Stack                      Item Specific Help

   Network Stack            [Enabled]          Enable/Disable UEFI
   IPv4                     [Enabled]          Network Stack
   UEFI PXE Boot Priority   [IPv4 First]

 Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

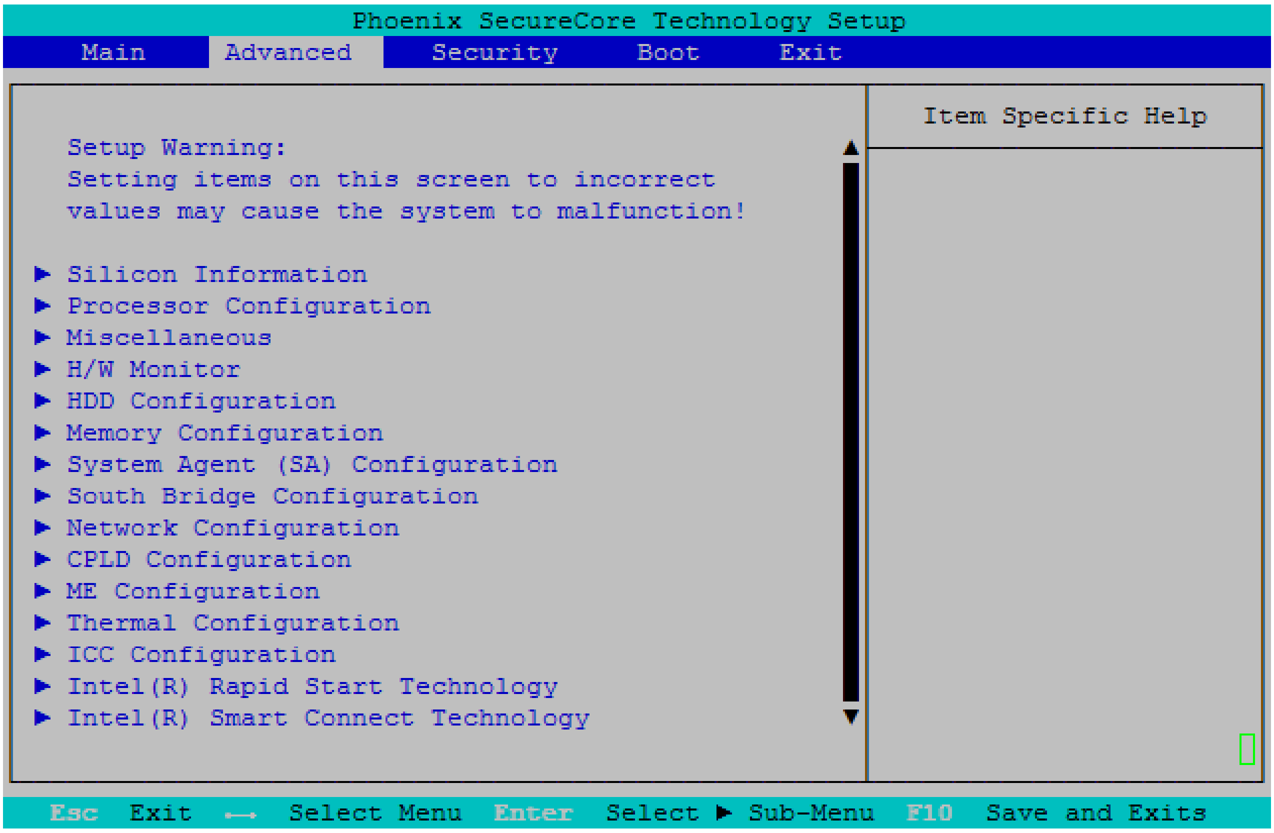
Feature	Options	Description
Network Stack	**Enabled** Disabled	Enable / Disable UEFI Network Stack
IPv4	**Enabled** Disabled	Enable / Disable IPv4
UEFI PXE Boot Priority	**IPv4 first**	Select PXE Boot Priority (IPv4 only)

Platform Information



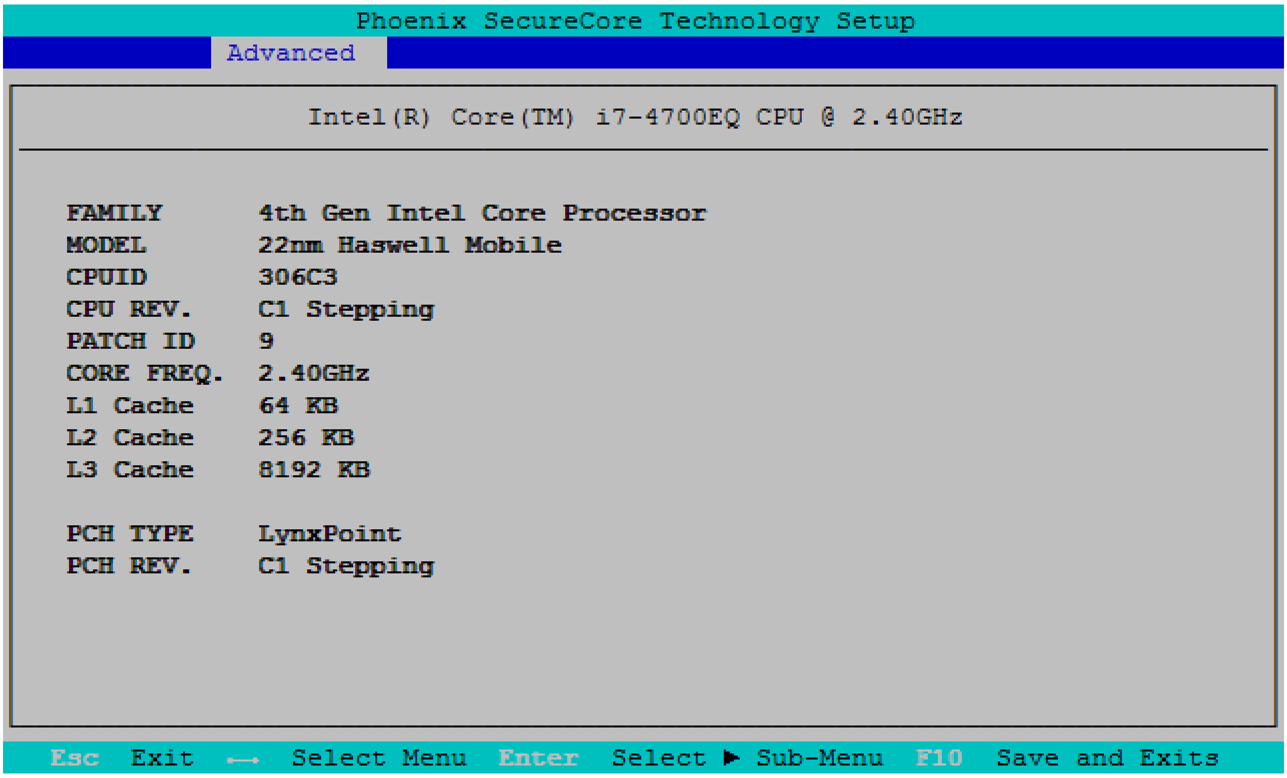
```
                  Phoenix SecureCore Technology Setup
    Main

                 Platform Information                      Item Specific Help

   Module Information                                   Platform Information
   Product Name           COMe-bHL6
   Revision               A.2.4
   Serial #               BDD040009
   MAC Address            00:E0:4B:2C:50:43
   CPLD Rev               P103.022 (Release)
   Boot Counter           84

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

8.5.2 Advanced



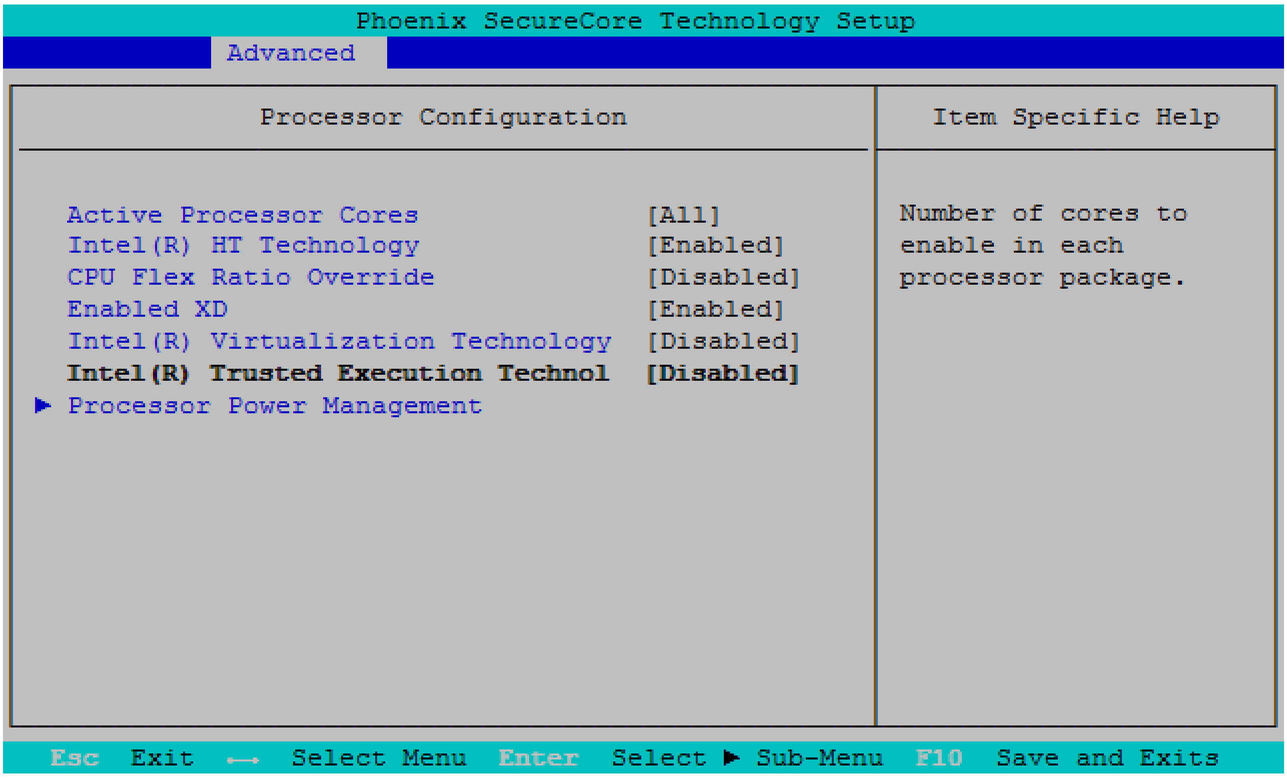
```
                 Phoenix SecureCore Technology Setup
   Main     Advanced     Security     Boot     Exit

                                                      Item Specific Help
   Setup Warning:
   Setting items on this screen to incorrect
   values may cause the system to malfunction!

 ▶ Silicon Information
 ▶ Processor Configuration
 ▶ Miscellaneous
 ▶ H/W Monitor
 ▶ HDD Configuration
 ▶ Memory Configuration
 ▶ System Agent (SA) Configuration
 ▶ South Bridge Configuration
 ▶ Network Configuration
 ▶ CPLD Configuration
 ▶ ME Configuration
 ▶ Thermal Configuration
 ▶ ICC Configuration
 ▶ Intel(R) Rapid Start Technology
 ▶ Intel(R) Smart Connect Technology

 Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Silicon Information



```
                Phoenix SecureCore Technology Setup
      Advanced

             Intel(R) Core(TM) i7-4700EQ CPU @ 2.40GHz

   FAMILY      4th Gen Intel Core Processor
   MODEL       22nm Haswell Mobile
   CPUID       306C3
   CPU REV.    C1 Stepping
   PATCH ID    9
   CORE FREQ.  2.40GHz
   L1 Cache    64 KB
   L2 Cache    256 KB
   L3 Cache    8192 KB

   PCH TYPE    LynxPoint
   PCH REV.    C1 Stepping

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

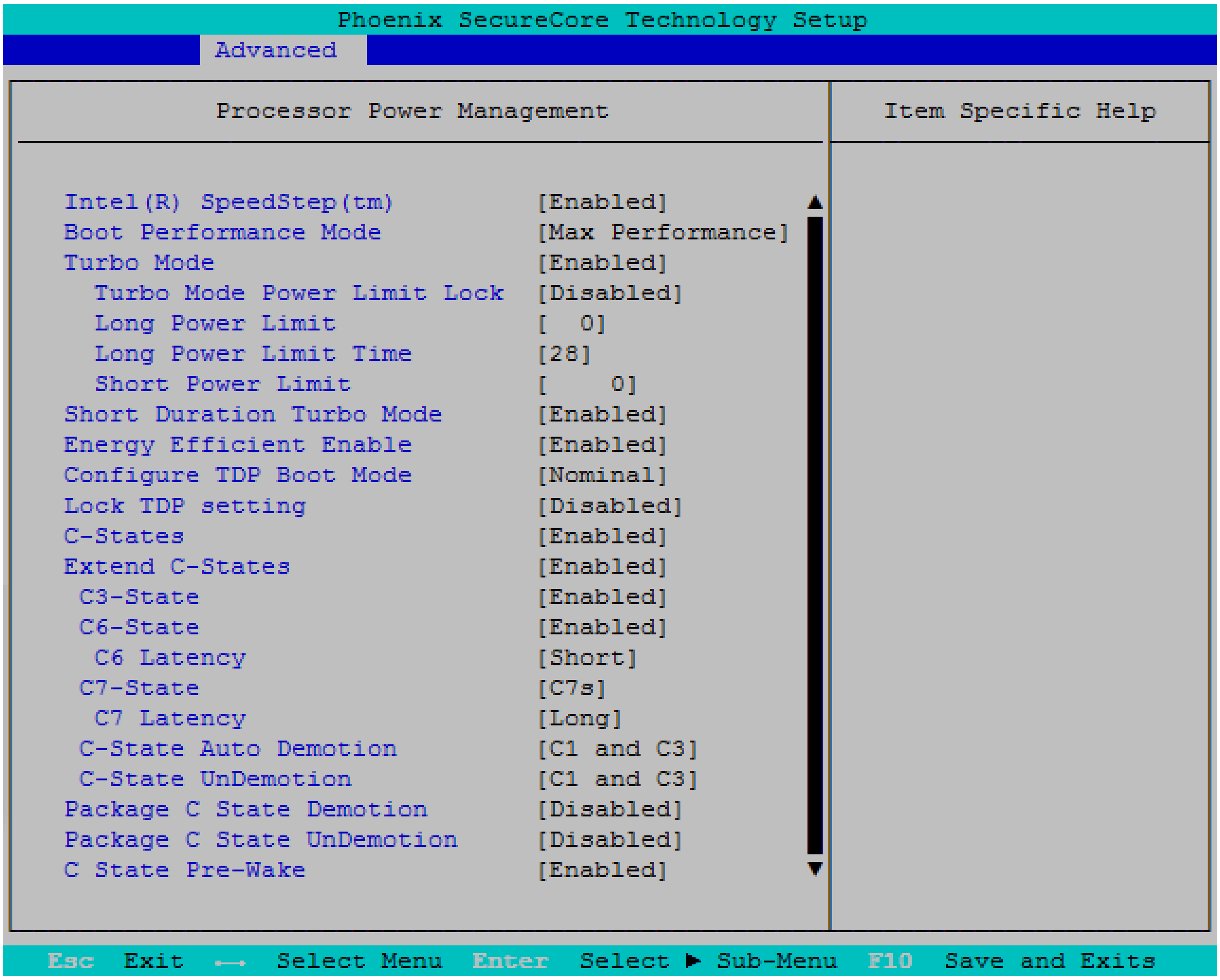
Processor Configuration



```
                 Phoenix SecureCore Technology Setup
          Advanced

  Processor Configuration                                Item Specific Help

    Active Processor Cores                 [All]         Number of cores to
    Intel(R) HT Technology                 [Enabled]     enable in each
    CPU Flex Ratio Override                [Disabled]    processor package.
    Enabled XD                             [Enabled]
    Intel(R) Virtualization Technology     [Disabled]
    Intel(R) Trusted Execution Technol     [Disabled]
  ▶ Processor Power Management

  Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Active Processor Cores	**All** 1 2 3	Number of cores to enable in each processor package
Intel® HT Technology	**Enabled** Disabled	When Disabled only one thread per enabled core is enabled
CPU Flex Ratio Override	**Disabled** Enabled	Enable/Disable CPU Flex Ratio Programming. If Disabled, CPU frequency is set to maximum Ratio automatically
- CPU Flex Ratio Settings	**24**	This value must be between Max Efficiency Ratio (LFM / Low Frequency Mode) and Maximum non-turbo ratio set by Hardware (High Frequency Mode). See CPU Featureset in chapter Specifications for possible Bus/Core Ratio Settings. The active nominal CPU frequency is Ratio*100MHz
Enabled XD	**Enabled** Disabled	Enables/Disables 'Execute Disable functionality', also known as Data Execution Prevention DEP
Intel® Virtualization Technology	**Disabled** Enabled	When enabled, a VMM can utilize the additional hardware capabilities
Intel® Trusted Execution Technology	**Disabled** Enabled	Enable/Disable Intel TXT (enabled only in customized BIOS versions)

Processor Power Management

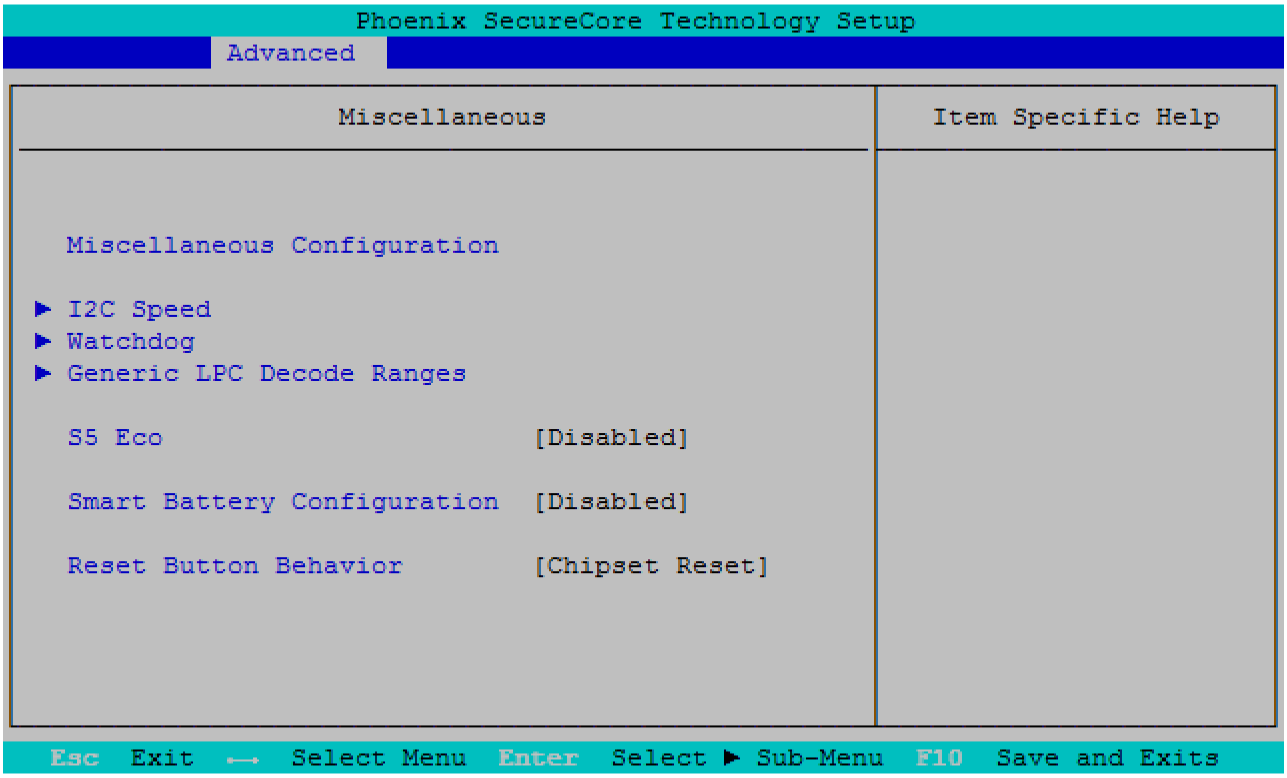


```
                     Phoenix SecureCore Technology Setup
             Advanced
   Processor Power Management                            Item Specific Help

   Intel(R) SpeedStep(tm)             [Enabled]
   Boot Performance Mode              [Max Performance]
   Turbo Mode                         [Enabled]
     Turbo Mode Power Limit Lock      [Disabled]
     Long Power Limit                 [   0]
     Long Power Limit Time            [28]
     Short Power Limit                [     0]
   Short Duration Turbo Mode          [Enabled]
   Energy Efficient Enable            [Enabled]
   Configure TDP Boot Mode            [Nominal]
   Lock TDP setting                   [Disabled]
   C-States                           [Enabled]
   Extend C-States                    [Enabled]
    C3-State                          [Enabled]
    C6-State                          [Enabled]
     C6 Latency                       [Short]
    C7-State                          [C7s]
     C7 Latency                       [Long]
    C-State Auto Demotion             [C1 and C3]
    C-State UnDemotion                [C1 and C3]
   Package C State Demotion           [Disabled]
   Package C State UnDemotion         [Disabled]
   C State Pre-Wake                   [Enabled]

   Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Intel® SpeedStep(TM)	**Enabled** Disabled	Enable/Disable processor performance states (P-States)
Boot Performance Mode	**Max Performance** Max Battery Auto	Select the performance state that the BIOS sets before OS hand-off
Turbo Mode	**Enabled** Disabled	Enable processor Turbo Mode
- Turbo Mode Power Limit Lock	**Disabled** Enabled	Enable/Disable Locking of turbo settings. When enabled, Turbo_Power_Limit MSR will be locked and a reset will be required to unlock the register
- Long Power Limit	**0**	Turbo Mode Long Duration Power Limit (also known as Power Limit PL1) in Watts. The value may vary from 0 to Fused Value. If the value is 0, the fused value will be programmed. A value greater than fused TDP value will not be programmed
- Long Power Limit Time	**28**	Long Duration Time Windows (also known as PL1 Time) value in seconds. The value may vary from 0 to 56. Indicates the time window over which TDP value should be maintained. If the value is 0, the fused value will be programmed
- Short Power Limit	**0**	Turbo Mode Short Duration Power Limit (also known as Power Limit PL2) in Watts. The value may vary from 0 to Fused Value. If the value is 0, the fused value will be programmed. A value greater than fused TDP value will not be programmed
- Short Duration Turbo Mode	**Enabled** Disabled	Enable/Disable Short Duration Turbo Mode for processor
- Energy Efficient Enable	**Enabled** Disabled	Enable/Disable Energy Efficient for processor
Configure TDP Boot Mode	**Nominal** Down Up Disabled	Configure TDP Mode (cTDP). Disabled option will skip all cTDP boot configurations

Lock TDP Settings	**Disabled** Enabled	Lock TDP in MSR_CONFIG_TDP_CONTROL
C-States	**Enabled** Disabled	Enable processor idle power saving states
- Extend C-States	**Enabled** Disabled	Enable C-State transitions to occur in combination with P-States
- C3 State	**Enabled** Disabled	Enable processor idle power saving C3 state
- C6 State	**Enabled** Disabled	Enable processor idle power saving C6 state
- C6 Latency	**Short** Long	Configure Short/Long latency
- C7 State	Disabled C7 **C7s**	Enable processor idle power saving C7 state
- C7 Latency	**Short** Long	Configure Short/Long latency
- C-State Auto Demotion	Disabled C1 C3 **C1 and C3**	Configure C-State Auto Demotion
- C-State Auto UnDemotion	Disabled C1 C3 **C1 and C3**	Configure C-State Auto UnDemotion
- Package C-State Demotion	**Disabled** Enabled	Enable/Disable Package C-State Demotion
- Package C-State UnDemotion	**Disabled** Enabled	Enable/Disable Package C-State UnDemotion
- C-State Pre-Wake	**Enabled** Disabled	Enable/Disable C-State Pre-Wake

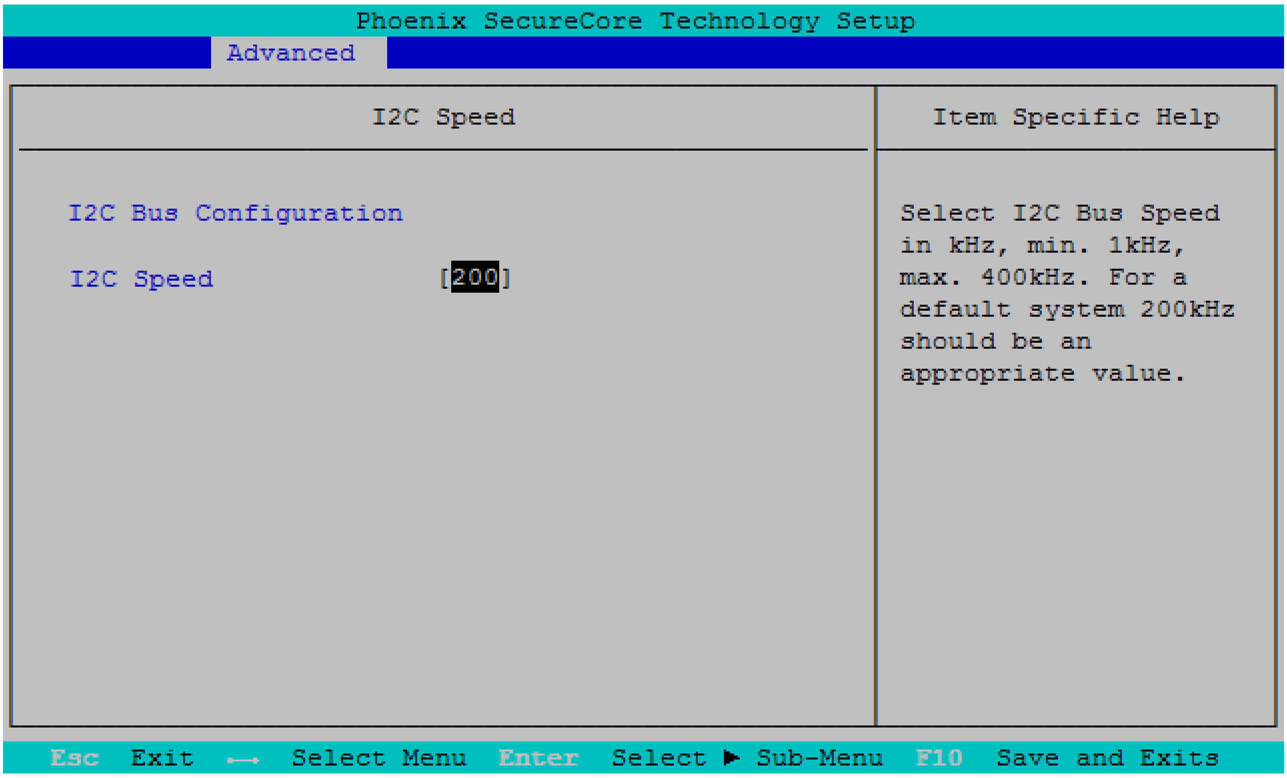
Miscellaneous



```
                 Phoenix SecureCore Technology Setup
              Advanced

                     Miscellaneous                      Item Specific Help


     Miscellaneous Configuration

   ▶ I2C Speed
   ▶ Watchdog
   ▶ Generic LPC Decode Ranges

     S5 Eco                       [Disabled]

     Smart Battery Configuration  [Disabled]

     Reset Button Behavior        [Chipset Reset]


   Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
S5 Eco	**Disabled** Enabled	Enable/Disable Kontron S5 Eco mode. Reduces supply current in Soft Off (S5) to less than 1mA. If enabled, power button is the only wake-up source in S5! See chapter S5 Eco for further details
Smart Battery Configuration	**Disabled** Auto Charger Manager	Enable/Disable Smart Battery System Support (e.g. Kontron M.A.R.S.)
Reset Button Behavior	**Chipset Reset** Power Cycle	Select the system behavior on reset button event

I2C Speed



Phoenix SecureCore Technology Setup

Advanced

I2C Speed

Item Specific Help

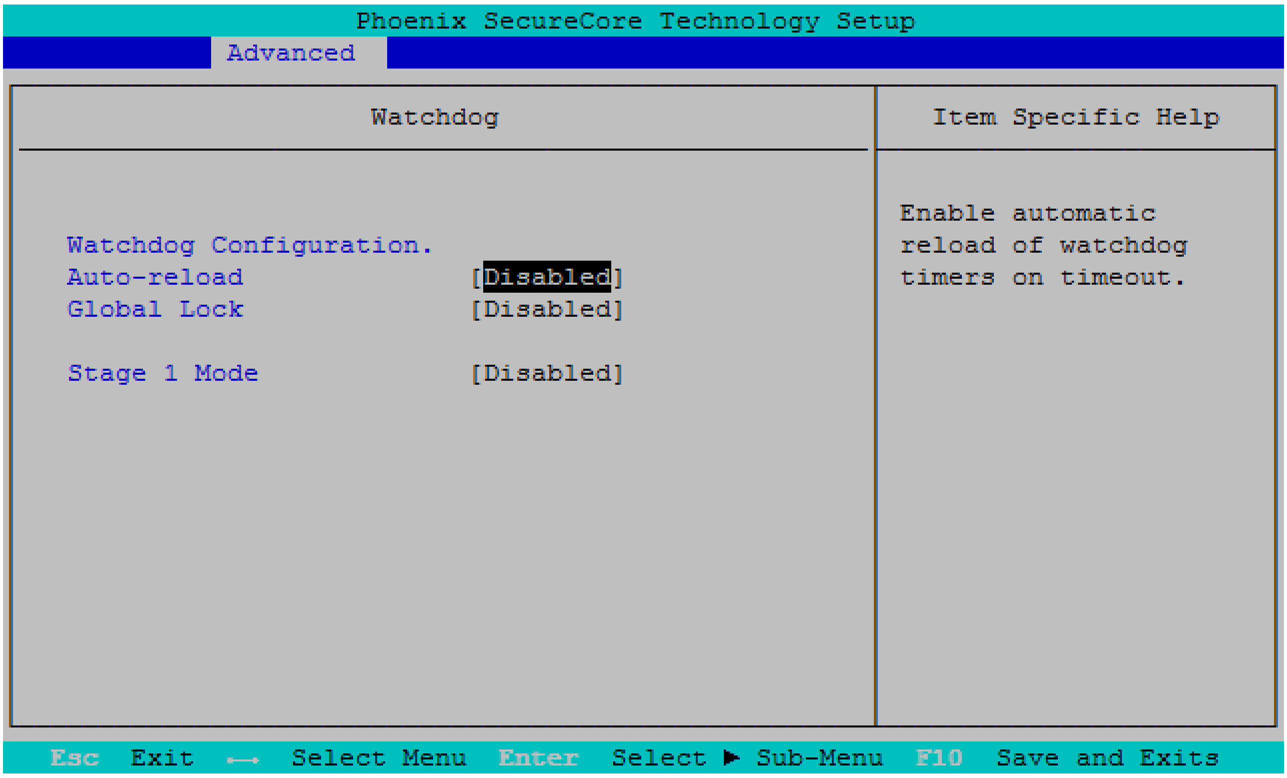
I2C Bus Configuration

I2C Speed [200]

Select I2C Bus Speed in kHz, min. 1kHz, max. 400kHz. For a default system 200kHz should be an appropriate value.

Feature	Options	Description
I2C Speed	200	Select I2C Bus Speed in kHz from 1kHz to 400kHz

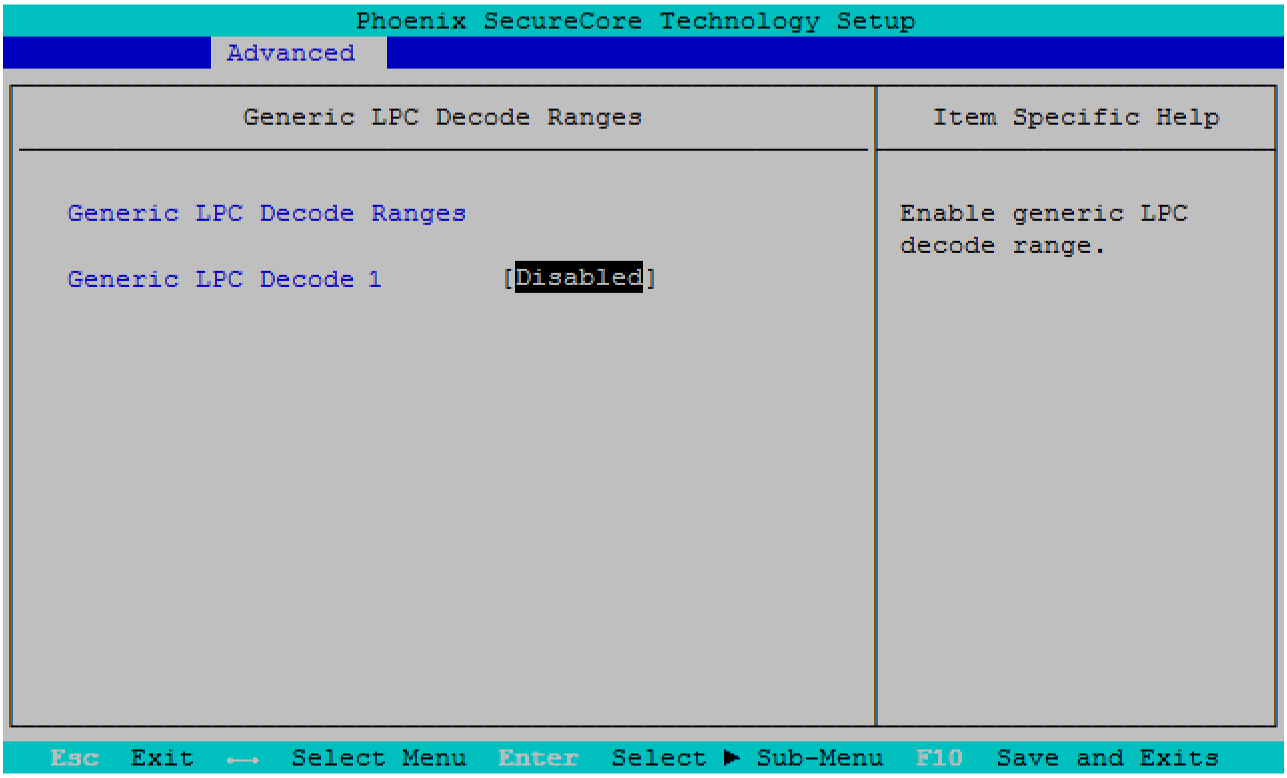
Watchdog



```
                 Phoenix SecureCore Technology Setup
           Advanced

                  Watchdog                          Item Specific Help

                                                  Enable automatic
   Watchdog Configuration.                        reload of watchdog
   Auto-reload                 [Disabled]         timers on timeout.
   Global Lock                 [Disabled]

   Stage 1 Mode                [Disabled]

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Auto-reload	**Disabled** Enabled	Enable automatic reload of watchdog timers on timeout
Global Lock	**Disabled** Enabled	If set to enabled, all Watchdog registers (except WD_KICK) become read only until the board is reset
Stage 1 Mode	**Disabled** Reset NMI SCI	Select Action for first Watchdog stage
- Assert WDT Signal	**Enabled** Disabled	Enable/Disable assertion of WDT signal to baseboard on stage timeout
- Stage 1 Timeout	1s 5s 10s **30s** 1m 3m 10m 30m	Select Timeout value for first watchdog stage
Stage 2 Mode	**Disabled** Reset NMI SCI	Select Action for first Watchdog stage
- Assert WDT Signal	**Disabled** Enabled	Enable/Disable assertion of WDT signal to baseboard on stage timeout
- Stage 2 Timeout	1s 5s 10s **30s** 1m 3m 10m 30m	Select Timeout value for second watchdog stage

Generic LPC Decode Ranges



Phoenix SecureCore Technology Setup

Generic LPC Decode Ranges

Item Specific Help

Generic LPC Decode Ranges

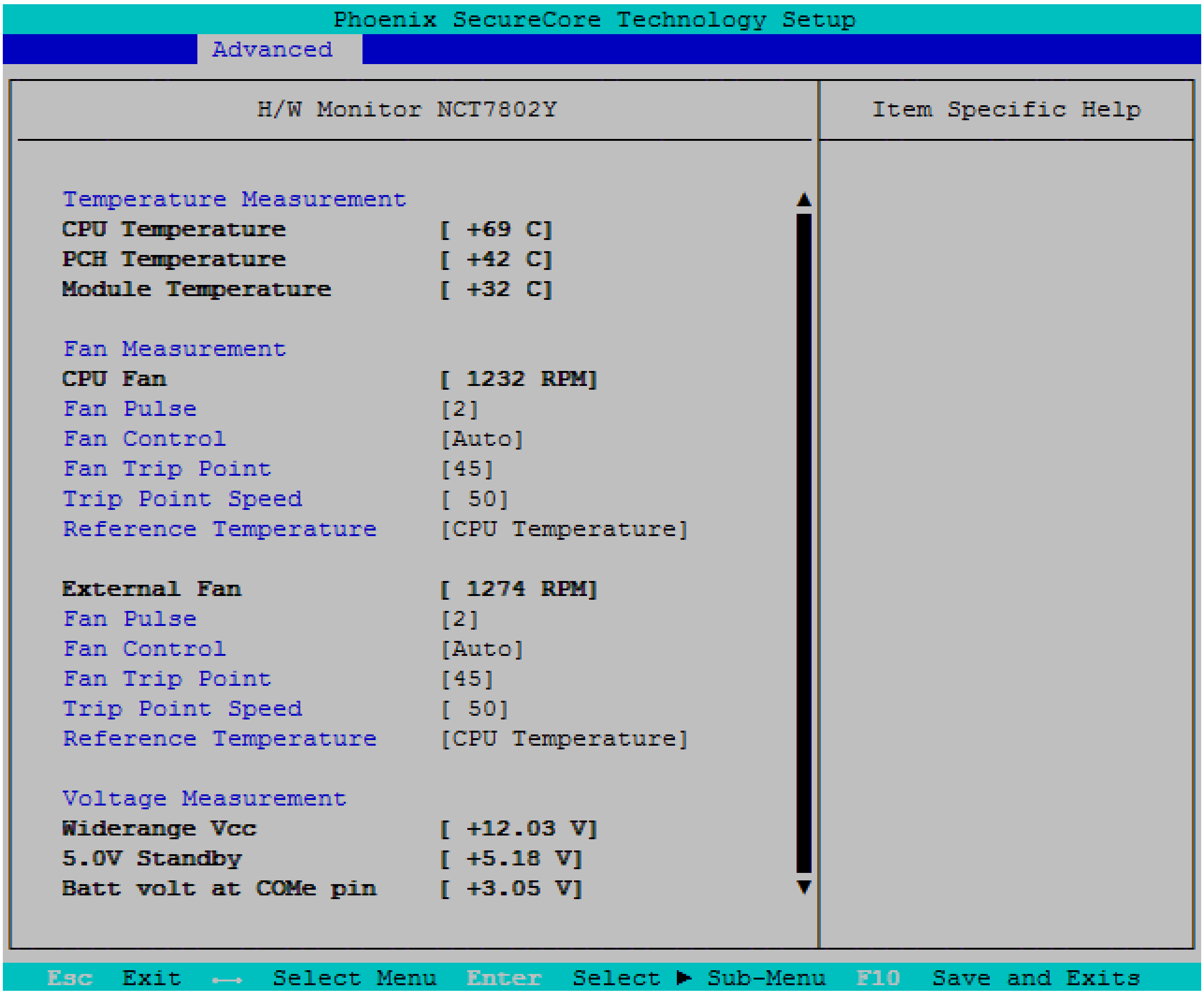
Generic LPC Decode 1 [Disabled]

Enable generic LPC decode range.

Esc Exit ←→ Select Menu Enter Select ► Sub-Menu F10 Save and Exits

Feature	Options	Description
Generic LPC Decode 1	**Disabled** Enabled	Enable generic LPC decode range
- Base Address	**0100h**	Base address of the generic decode range. Valid between 0100h - FFF0h. Must be 8-byte aligned
- Length	**0008h**	Length of the generic decode range. Valid between 0800h - 0100h. Must be multiple of 8.
Generic LPC Decode 2	**Disabled** Enabled	Enable generic LPC decode range
- Base Address	**0100h**	Base address of the generic decode range. Valid between 0100h - FFF0h. Must be 8-byte aligned
- Length	**0008h**	Length of the generic decode range. Valid between 0800h - 0100h. Must be multiple of 8.
Generic LPC Decode 3	**Disabled** Enabled	Enable generic LPC decode range
- Base Address	**0100h**	Base address of the generic decode range. Valid between 0100h - FFF0h. Must be 8-byte aligned
- Length	**0008h**	Length of the generic decode range. Valid between 0800h - 0100h. Must be multiple of 8.

H/W Monitor

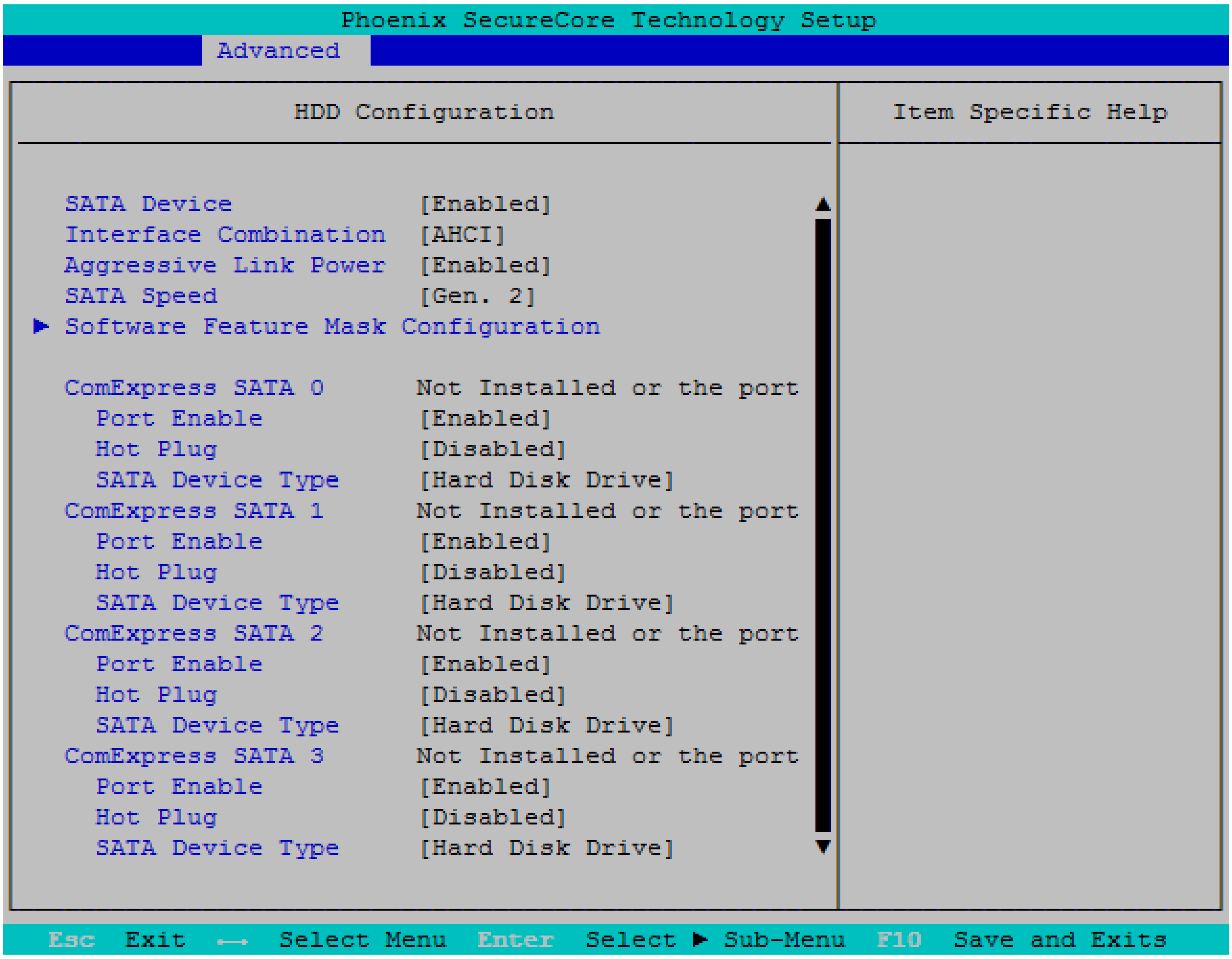


```
                    Phoenix SecureCore Technology Setup
            Advanced

            H/W Monitor NCT7802Y                          Item Specific Help

   Temperature Measurement
   CPU Temperature                  [ +69 C]
   PCH Temperature                  [ +42 C]
   Module Temperature               [ +32 C]

   Fan Measurement
   CPU Fan                          [ 1232 RPM]
   Fan Pulse                        [2]
   Fan Control                      [Auto]
   Fan Trip Point                   [45]
   Trip Point Speed                 [ 50]
   Reference Temperature            [CPU Temperature]

   External Fan                     [ 1274 RPM]
   Fan Pulse                        [2]
   Fan Control                      [Auto]
   Fan Trip Point                   [45]
   Trip Point Speed                 [ 50]
   Reference Temperature            [CPU Temperature]

   Voltage Measurement
   Widerange Vcc                    [ +12.03 V]
   5.0V Standby                     [ +5.18 V]
   Batt volt at COMe pin            [ +3.05 V]

   Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Value/Options	Description
CPU Temperature	xx°C	Shows the measured temperature of the CPU Diode with onboard HWM
PCH Temperature	xx°C	Shows the internal Platform Controller Hub temperature
Module Temperature	xx°C	Shows the internal hardware-monitor temperature
CPU FAN	xxxx rpm	Shows the fan speed of onboard FAN connector
Fan Pulse	**2**	Number of pulses the CPU fan produces during one revolution. Range 1-4
FAN Control	Disabled Manual **Auto**	Set fan control mode. 'Disable' will totally stop the fan
Fan Trip Point	**45**	Temperature where fan accelerates. Range 20 - 80°C
Fan Speed	**70**	Manual fan speed in %. Minimum value is 30 (in Manual mode only)
Trip Point Speed	**50**	Fan speed at trip point in %. Minimum value is 30. Fan always runs at 100% at Tjmax - 10°C
Reference Temperature	**CPU Temperature** PCH Temperature Module Temperature	Determines the temperature source which is used for automatic fan control
External FAN	xxxx rpm	Shows the fan speed of external COMe FAN
Fan Pulse	**2**	Select the number of pulses the external fan produces during one revolution. Range 1-4
FAN Control	Disabled Manual **Auto**	Set fan control mode. 'Disable' will totally stop the fan
Fan Trip Point	**45**	Temperature where fan accelerates. Range 20 - 80°C
Fan Speed	**70**	Manual fan speed in %. Minimum value is 30 (in Manual mode only)
Trip Point Speed	**50**	Fan speed at trip point in %. Minimum value is 30. Fan always runs at 100% at Tjmax - 10°C

Reference Temperature	PCH Temperature Module Temperature **CPU Temperature**	Determines the temperature source which is used for automatic fan control
Widerange Vcc	x.xx V	Shows the Module Main Input Voltage
5.0V Standby	x.xx V	Shows the 5V Standby Voltage input
Batt volt at COMe pin	x.xx V	Shows the RTC Battery Voltage input measured at COMe connector

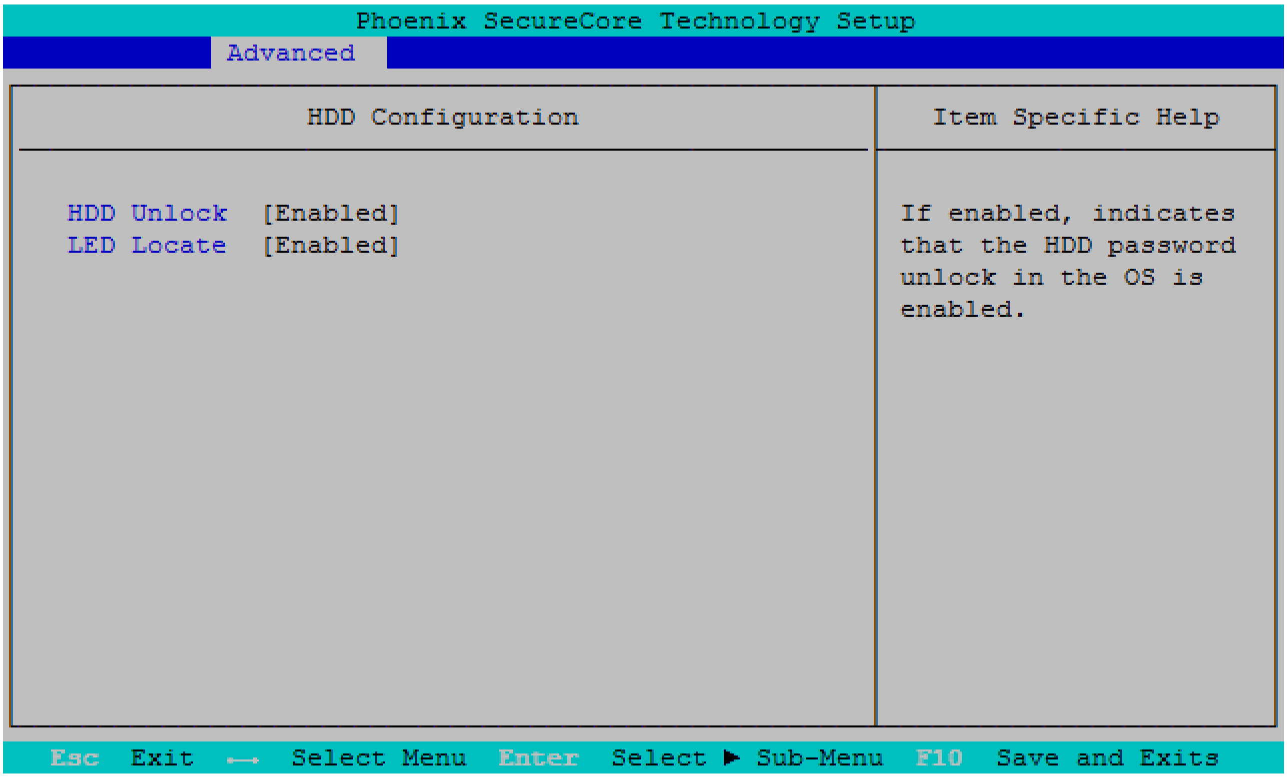
HDD Configuration



```
                    Phoenix SecureCore Technology Setup
        Advanced

            HDD Configuration                        Item Specific Help

   SATA Device                [Enabled]
   Interface Combination      [AHCI]
   Aggressive Link Power      [Enabled]
   SATA Speed                 [Gen. 2]
 ► Software Feature Mask Configuration

   ComExpress SATA 0         Not Installed or the port
     Port Enable              [Enabled]
     Hot Plug                 [Disabled]
     SATA Device Type         [Hard Disk Drive]
   ComExpress SATA 1         Not Installed or the port
     Port Enable              [Enabled]
     Hot Plug                 [Disabled]
     SATA Device Type         [Hard Disk Drive]
   ComExpress SATA 2         Not Installed or the port
     Port Enable              [Enabled]
     Hot Plug                 [Disabled]
     SATA Device Type         [Hard Disk Drive]
   ComExpress SATA 3         Not Installed or the port
     Port Enable              [Enabled]
     Hot Plug                 [Disabled]
     SATA Device Type         [Hard Disk Drive]

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
SATA Device	**Enabled** Disabled	Enable/Disable SATA Device
Interface Combination	IDE **AHCI** RAID	Select the SATA controllers operation mode
Aggressive Link Power	Disabled **Enabled**	If enabled, turns on Aggressive Link Power Management on all HDD ports
SATA Speed	Gen1 **Gen2** Gen3	Select the supported SATA speed mode
Port Enable	**Enabled** Disabled	Enable or Disable SATA Port
Hot Plug	**Disabled** Enabled	Designates this port as Hot Pluggable. Requires hardware support
SATA Device Type	**Hard Disk Drive** Solid State Drive	Identify the SATA port is connected to Solid State Drive or Hard Disk Drive

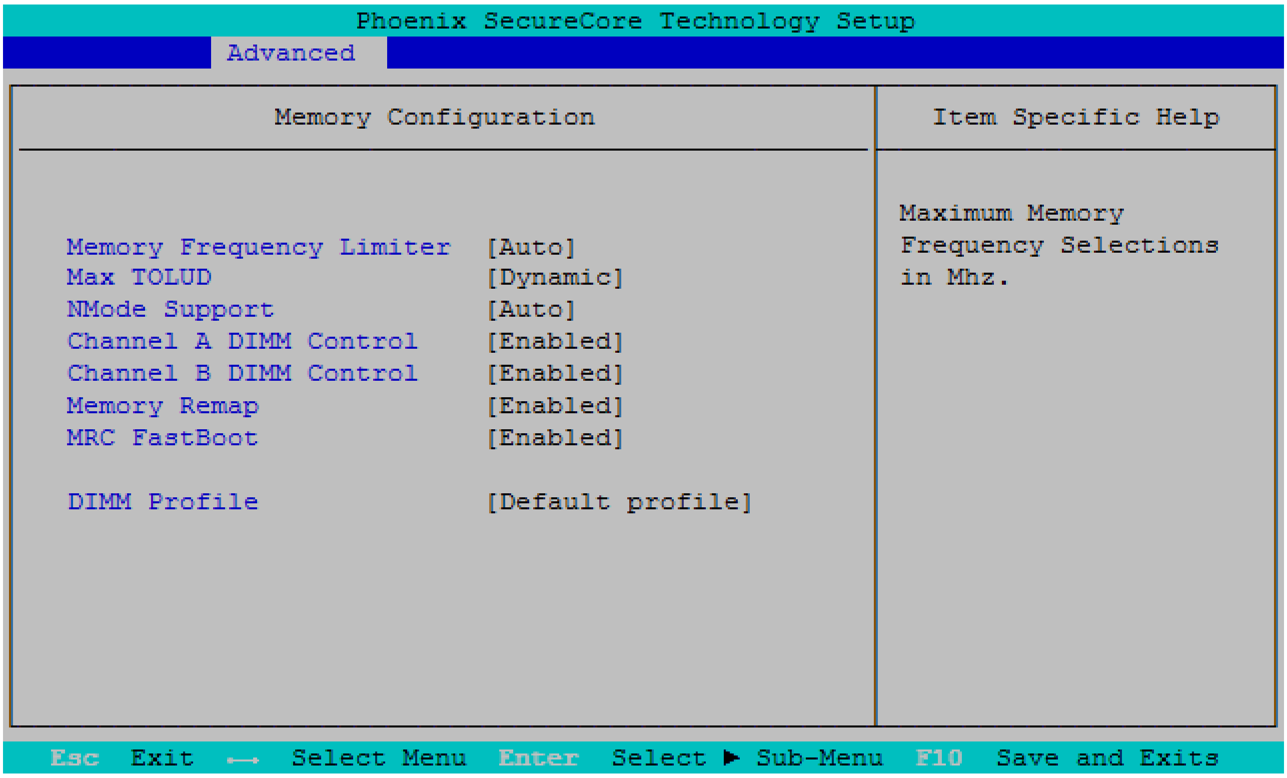
Software Feature Mask Configuration



```
                    Phoenix SecureCore Technology Setup
            Advanced
                     HDD Configuration                     Item Specific Help

   HDD Unlock   [Enabled]                                If enabled, indicates
   LED Locate   [Enabled]                                that the HDD password
                                                         unlock in the OS is
                                                         enabled.

  Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
HDD Unlock	**Enabled** Disabled	If enabled, indicates that the HDD password unlock in the OS is enabled
LED Locate	**Enabled** Disabled	If enabled, indicates that the LED/SGPIO hardware is attached and ping to locate feature is enabled on the OS

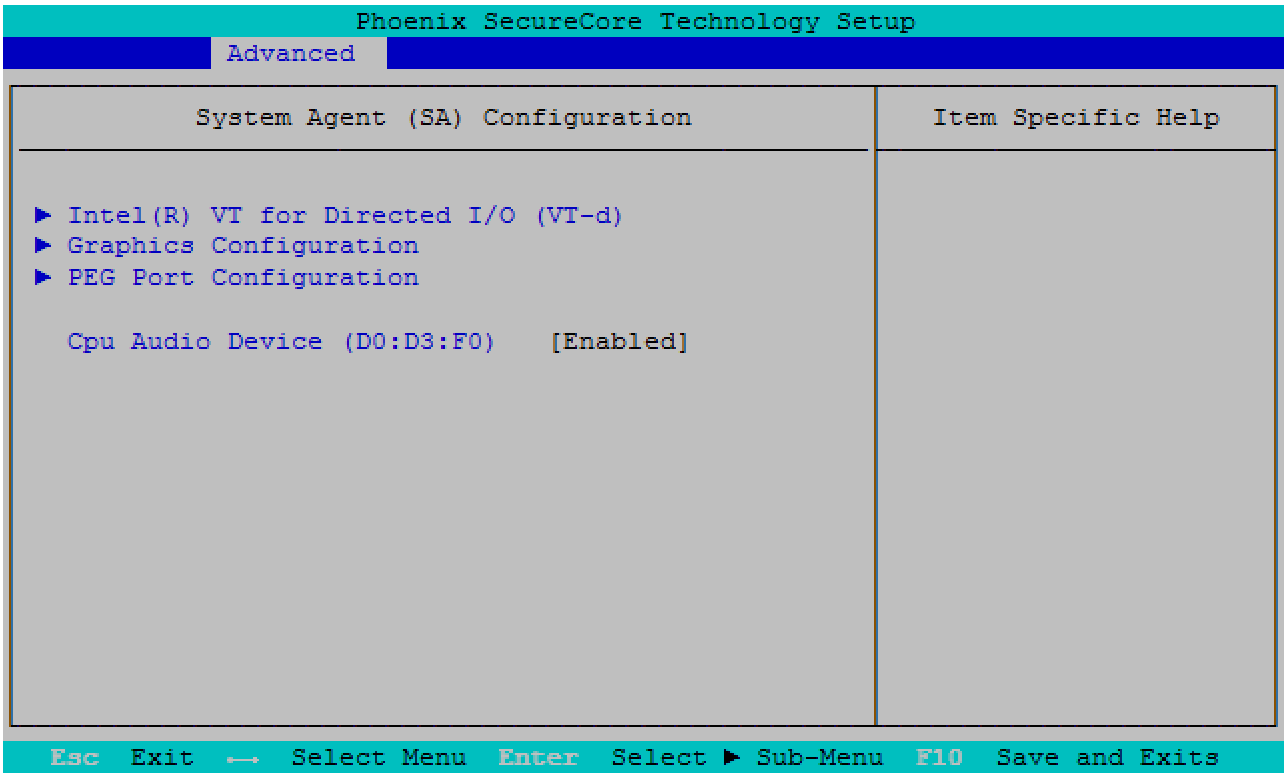
Memory Configuration



```
                 Phoenix SecureCore Technology Setup
          Advanced

          Memory Configuration                    Item Specific Help

                                                  Maximum Memory
  Memory Frequency Limiter      [Auto]            Frequency Selections
  Max TOLUD                     [Dynamic]         in Mhz.
  NMode Support                 [Auto]
  Channel A DIMM Control        [Enabled]
  Channel B DIMM Control        [Enabled]
  Memory Remap                  [Enabled]
  MRC FastBoot                  [Enabled]

  DIMM Profile                  [Default profile]

 Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Memory Frequency Limiter	**Auto** 2067 1333 1600 1867 2133 2400 2667	Select the memory frequency in MHz
Max TOLUD	**Dynamic** 1 GB ... 3.25GB	Maximum Value of TOLUD. Dynamic assignment would adjust TOLUD automatically based on largest MMIO length of installed graphic controller. Manual TOLUD setting from 1GB to 3.25GB in 0.25GB steps
NMode Support	**Auto** 1N Mode 2N Mode	Select the memory supported Command Rate (N-Mode)
Channel A DIMM Control	**Enabled** Disabled	Enables or disables DIMMs on channel A
Channel B DIMM Control	**Enabled** Disabled	Enables or disables DIMMs on channel B
Memory Remap	**Enabled** Disabled	Enable/Disable Memory Remap above 4GB
MRC FastBoot	**Enabled** Disabled	Enable/Disable MRC FastBoot. Generally, this option only takes effect when doing cold boots/resets
DIMM Profile	**Default DIMM profile** XMP profile 1 XMP Profile 2	Select Intel Extreme Memory Profile XMP if supported by DIMM SPD

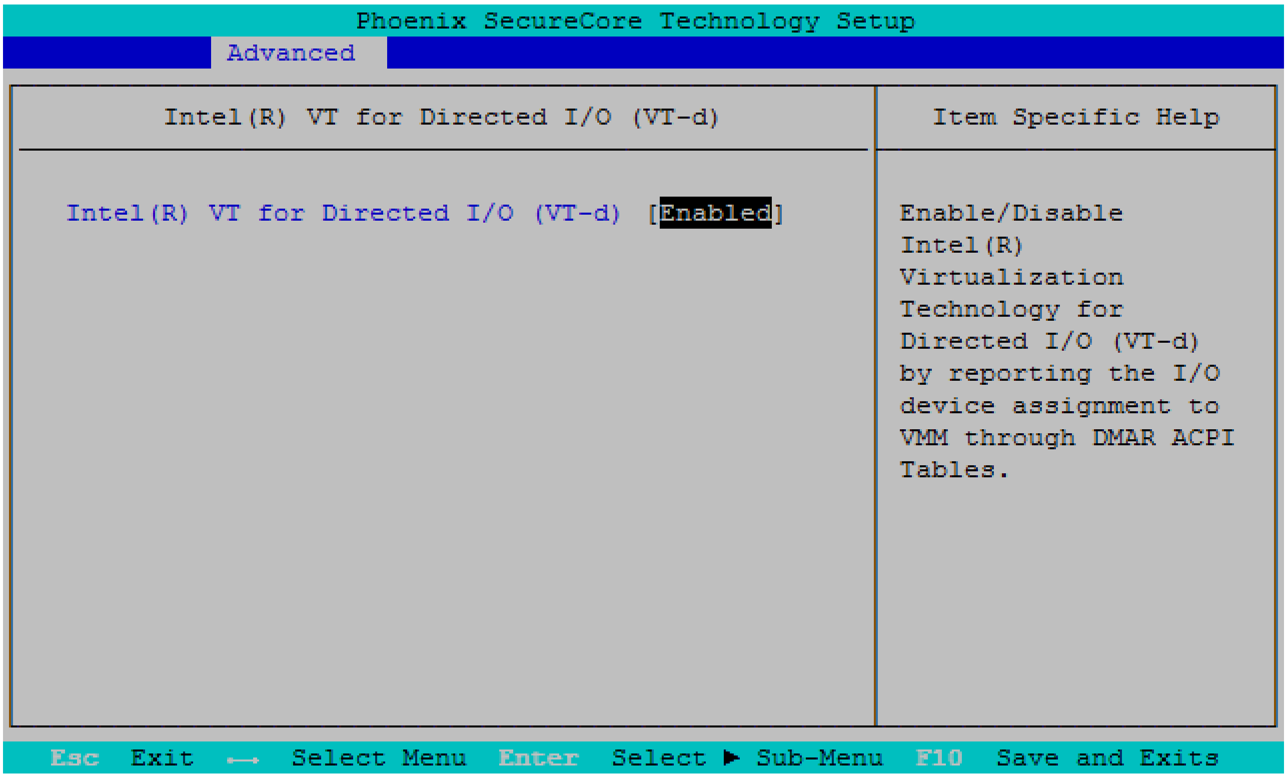
System Agent (SA) Configuration



```
                 Phoenix SecureCore Technology Setup
         Advanced

         System Agent (SA) Configuration              Item Specific Help

 ▶ Intel(R) VT for Directed I/O (VT-d)
 ▶ Graphics Configuration
 ▶ PEG Port Configuration

   Cpu Audio Device (D0:D3:F0)    [Enabled]

  Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
CPU Audio Device (D0:D3:F0)	**Enabled** Disabled	Enable/Disable CPU Audio Device

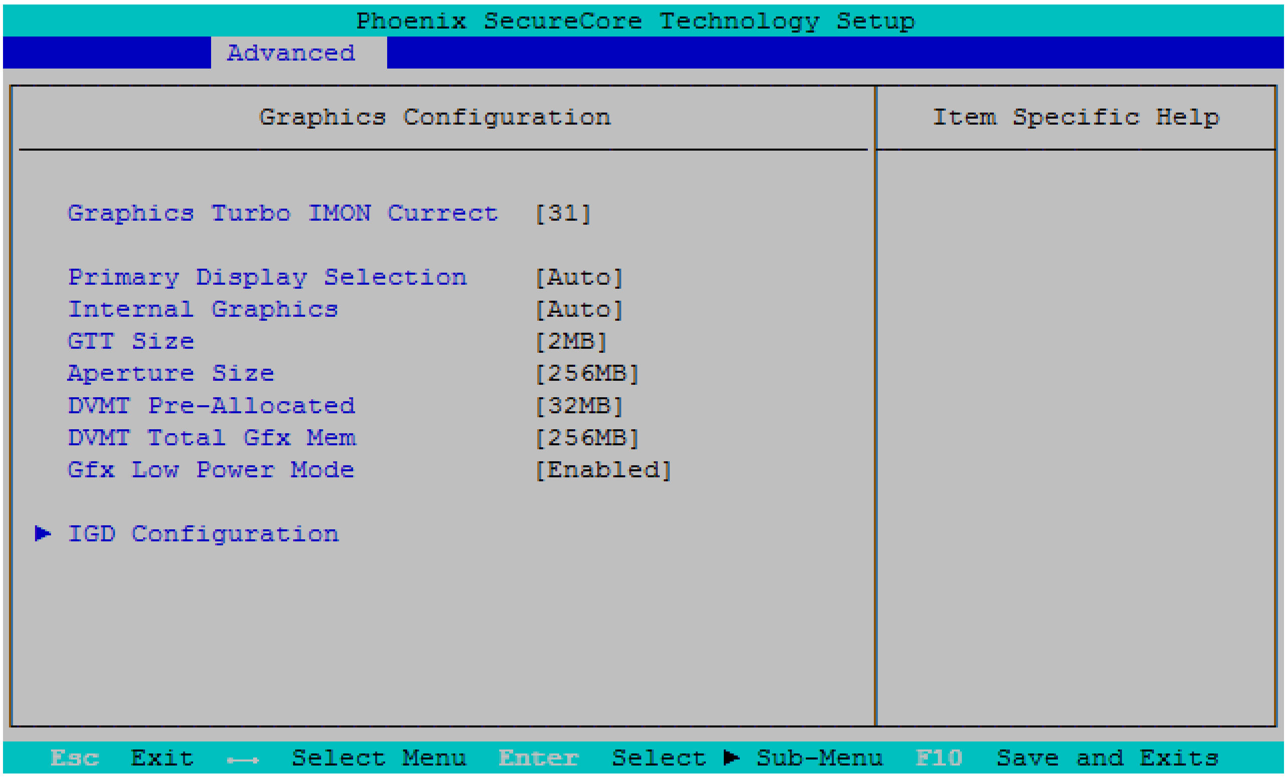
Intel® VT for Directed I/O (VT-d)



```
                 Phoenix SecureCore Technology Setup
          Advanced

      Intel(R) VT for Directed I/O (VT-d)          Item Specific Help

  Intel(R) VT for Directed I/O (VT-d)  [Enabled]  Enable/Disable
                                                   Intel(R)
                                                   Virtualization
                                                   Technology for
                                                   Directed I/O (VT-d)
                                                   by reporting the I/O
                                                   device assignment to
                                                   VMM through DMAR ACPI
                                                   Tables.

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Intel® VT for Directed I/O (VT-d)	**Enabled** Disabled	Enable/Disable Intel Virtualization Technology for Directed I/O (VT-d) by reporting the I/O device assignment to VMM through DMAR ACPI Tables

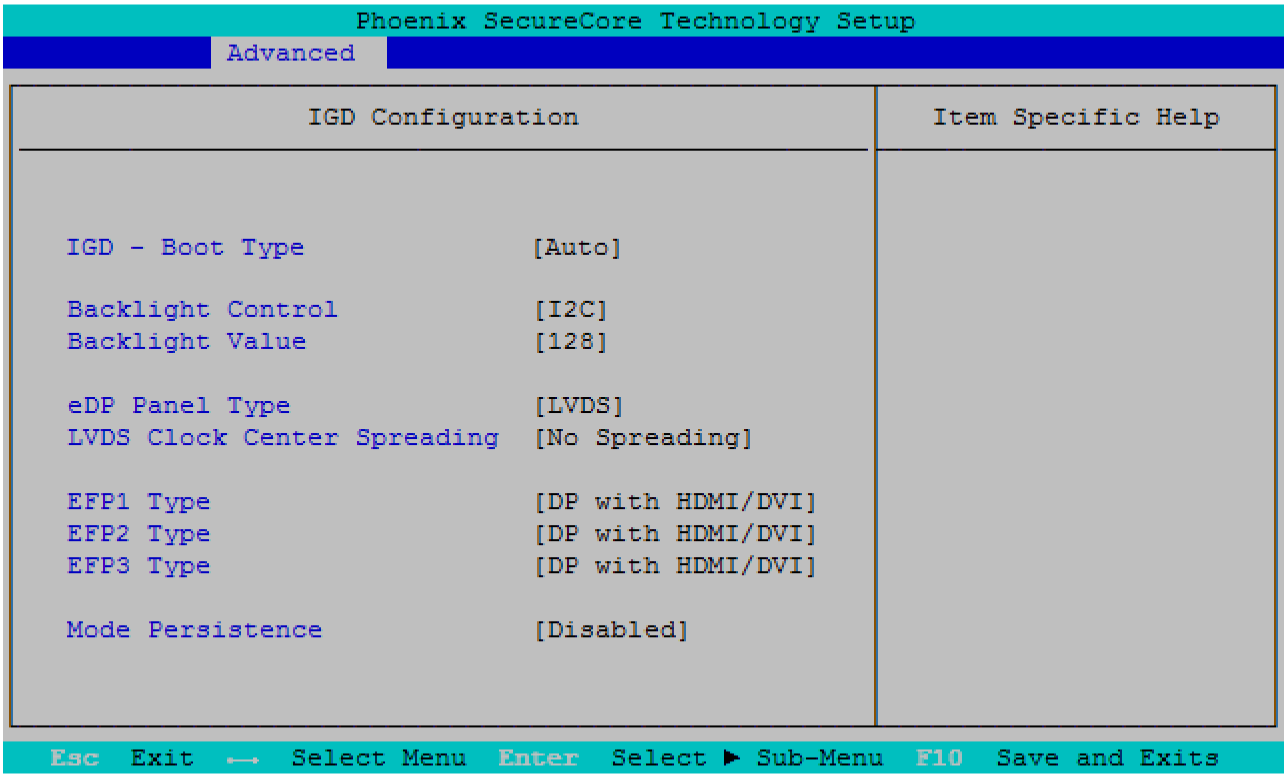
Graphics Configuration



```
                 Phoenix SecureCore Technology Setup
            Advanced

          Graphics Configuration                 Item Specific Help

   Graphics Turbo IMON Currect   [31]

   Primary Display Selection     [Auto]
   Internal Graphics             [Auto]
   GTT Size                      [2MB]
   Aperture Size                 [256MB]
   DVMT Pre-Allocated            [32MB]
   DVMT Total Gfx Mem            [256MB]
   Gfx Low Power Mode            [Enabled]

 ▶ IGD Configuration

 Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Graphics Turbo IMON Current	**31**	Graphics turbo IMON current value supported (14-31)
Primary Display Selection	IGD PEG PCI **Auto**	Select the primary display device
Internal Graphics	Disabled Enabled **Auto**	Enable/Disable the Internal Graphics Device. This has no effect if external graphics are present
GTT Size	1MB **2MB**	Select the GTT Memory Size of IGD
Aperture Size	128MB **256MB** 512MB	Select the Graphics Aperture Size
DVMT Pre-Allocated	**32MB** 64MB 128MB	Select Pre-Allocated Graphics Memory size used by the Internal Graphics device
DVMT Total Gfx Mem	128MB **256MB** Max	Select the maximum DVMT5.0 Graphics Memory Size
GFX Low Power Mode	**Enabled** Disabled	Enable/Disable Gfx Low Power Mode

IGD Configuration

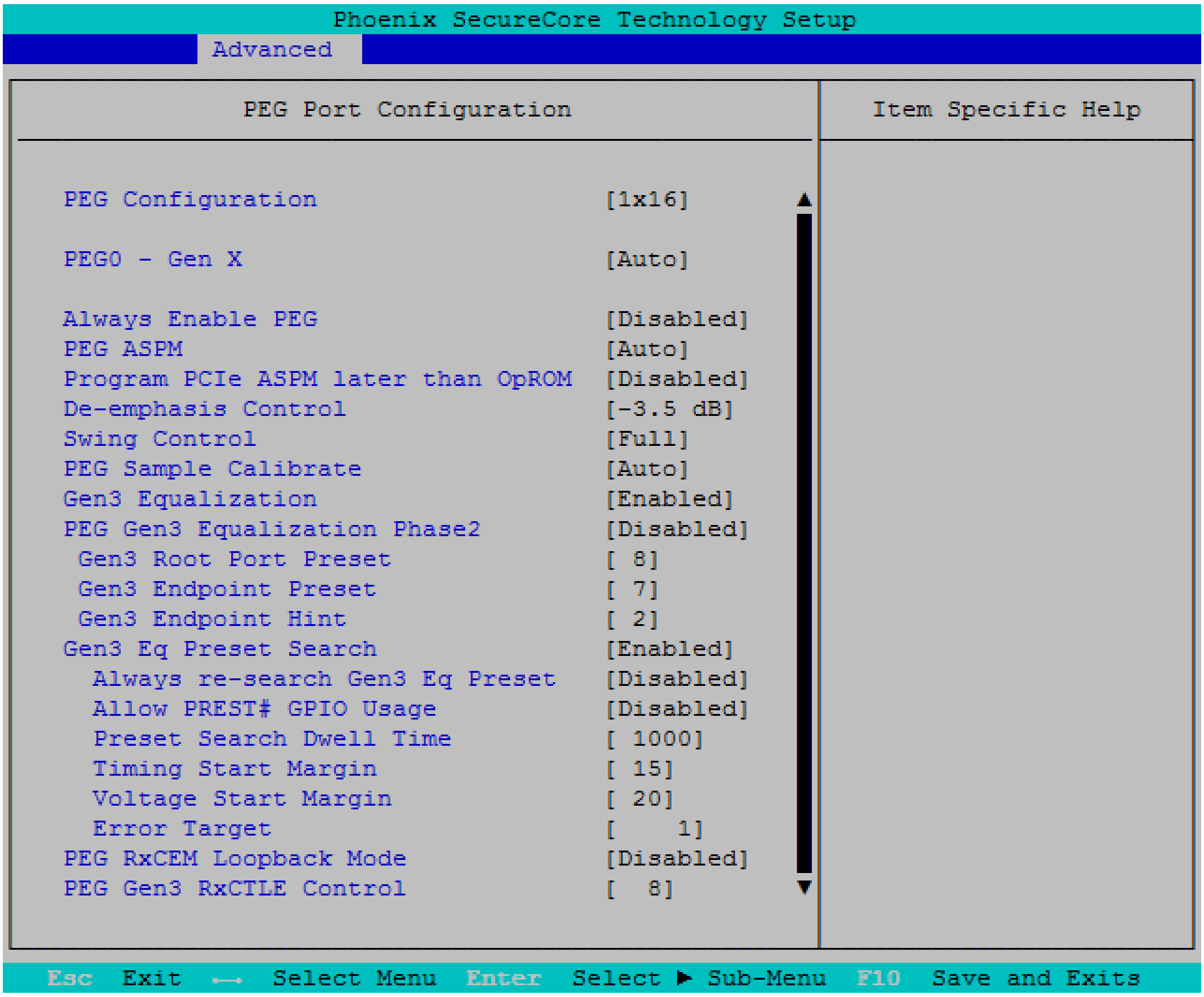


```
                 Phoenix SecureCore Technology Setup
           Advanced

              IGD Configuration                      Item Specific Help


   IGD - Boot Type                [Auto]

   Backlight Control              [I2C]
   Backlight Value                [128]

   eDP Panel Type                 [LVDS]
   LVDS Clock Center Spreading    [No Spreading]

   EFP1 Type                      [DP with HDMI/DVI]
   EFP2 Type                      [DP with HDMI/DVI]
   EFP3 Type                      [DP with HDMI/DVI]

   Mode Persistence               [Disabled]

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
IGD - Boot Type	**Auto** CRT EFP LFP EFP3 EFP2	Select the Integrated Graphics Video Device which will be activated during POST
IGD - Secondary Boot Type	**Disabled** CRT EFP LFP EFP3 EFP2	Select the second Video Device which will be activated during POST
LFP Type	**AUTO** VGA 640×480 1×18 WVGA 800×480 1×18 SVGA 800×600 1×18 XGA 1024×768 1×18 XGA 1024×768 1×24 WXGA 1280×768 1×24 WXGA 1280×800 1×18 WXGA 1366×768 1×24 WXGA+ 1440×900 2×18 WXGA+ 1440×900 2×24 SXGA 1280×1024 2×18 SXGA 1280×1024 2×24 WSXGA+ 1680×1050 2×18 WSXGA+ 1680×1050 2×24 UXGA 1600×1200 2×18 UXGA 1600×1200 2×24 WUXGA 1920×1200 2×18 WUXGA 1920×1200 2×24 Custom	Select LFP used by Internal Graphics Device by selecting the appropriate panel setup item
Backlight Control	None/External PWM PWM Inverted **I2C**	Backlight Control Setting
Backlight Value	**128**	Set LCD backlight brightness (0-255)
eDP Panel Type	**LVDS** eDP	Select Panel Type connected to eDP Port (eDP only available with customized hardware)
LVDS Clock Center Spreading	**No Spreading** 0.5% 1.0% 1.5% 2.0% 2.5%	Select LVDS clock frequency center spreading depth
EFP1 Type	DisplayPort Only	Integrated HDMI/DisplayPort Configuration with

EFP2 Type EFP3 Type	**DP with HDMI/DVI** DP with DVI HDMI/DVI	External Connectors
Mode Persistence	**Disabled** Enabled	Enables/Disables Mode Persistence

PEG Port Configuration

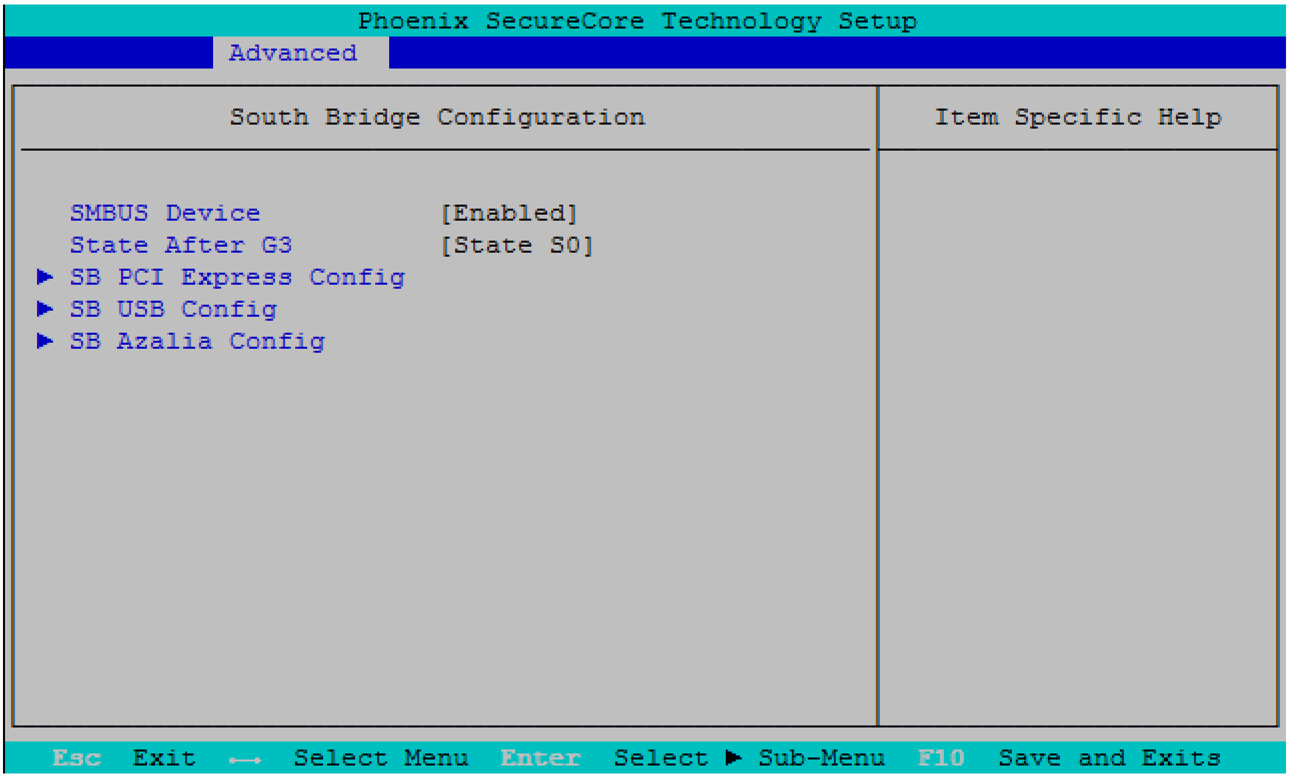


```
                    Phoenix SecureCore Technology Setup
             Advanced

                 PEG Port Configuration                    Item Specific Help

   PEG Configuration                       [1x16]
 
   PEG0 - Gen X                            [Auto]

   Always Enable PEG                       [Disabled]
   PEG ASPM                                [Auto]
   Program PCIe ASPM later than OpROM      [Disabled]
   De-emphasis Control                     [-3.5 dB]
   Swing Control                           [Full]
   PEG Sample Calibrate                    [Auto]
   Gen3 Equalization                       [Enabled]
   PEG Gen3 Equalization Phase2            [Disabled]
    Gen3 Root Port Preset                  [ 8]
    Gen3 Endpoint Preset                   [ 7]
    Gen3 Endpoint Hint                     [ 2]
   Gen3 Eq Preset Search                   [Enabled]
     Always re-search Gen3 Eq Preset       [Disabled]
     Allow PREST# GPIO Usage               [Disabled]
     Preset Search Dwell Time              [ 1000]
     Timing Start Margin                   [ 15]
     Voltage Start Margin                  [ 20]
     Error Target                          [    1]
   PEG RxCEM Loopback Mode                 [Disabled]
   PEG Gen3 RxCTLE Control                 [  8]

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
PEG Configuration	**1×16** 2×8 1×8 + 1×4	Set PEG Configuration to 1×16, 2×8 or 1×8 + 2×4
PEG0 - Gen X	**Auto** Gen1 Gen2 Gen3	Configure PEG0 B0:D1:F0 Speed
Always Enable PEG	**Disabled** Enabled	Enabled: PEG is always on. Disabled: PEG is only enabled with connected PCIe device
PEG ASPM	Disabled L0s L1 L0s and L1 **Auto**	Control ASPM support for the PEG Device
Program PCIe ASPM later than OpROM	**Disabled** Enabled	Select whether the PCIe ASPM will be programmed before (disabled) or after (enabled) OpROM
De-emphasis Control	-6 dB **-3.5 dB**	Configure the De-emphasis control on PEG
Swing Control	Reduced Half **Full**	Perform PEG Swing Control
PEG Sample Calibrate	Disabled Enabled **Auto**	Enable/Disable PEG Sample Calibrate
Gen3 Equalization	Disabled **Enabled**	Perform PEG Gen3 Equalization steps
PEG Gen3 Equalization Phase2	**Disabled** Enabled	Enable/Disable PEG Gen3 Equalization Phase2
Gen3 Root Port Preset	**8**	Root port preset value for Gen3 Equalization
Gen3 Endpoint Preset	**7**	Endpoint preset value for Gen3 Equalization

Gen3 Endpoint Hint	**2**	Endpoint Hint value for Gen3 Equalization
Gen3 Eq Preset Search	Disabled **Enabled**	Perform PEG Gen3 SW Preset Search algorithm
Always re-search Gen3 Eq Preset	**Disabled** Enabled	Always re-search PEG Gen3 Preset, even it has been done once
Allow PREST# GPIO Usage	**Disabled** Enabled	Enable/Disable GPIO-based resets to PEG endpoint(S) during margin search, if needed
Preset Search Dwell Time	**1000**	PEG Gen3 Preset Search dwell time in (ms)
Timing Start Margin	**15**	The starting value (4 … 255) for the backward margin search
Voltage Start Margin	**20**	The starting value (4 … 255) for the backward margin search
Error Target	**1**	The margin search errortarget value (1 … 65535)
PEG RxCEM Loopback Mode	**Disabled** Enabled	Enable/Disable PEG RxCEM Loopback Mode
PEG Gen3 RxCTLE Control	**8**	PEG Gen3 RxCTLE setting for Bundle0 (Lane0, Lane1)

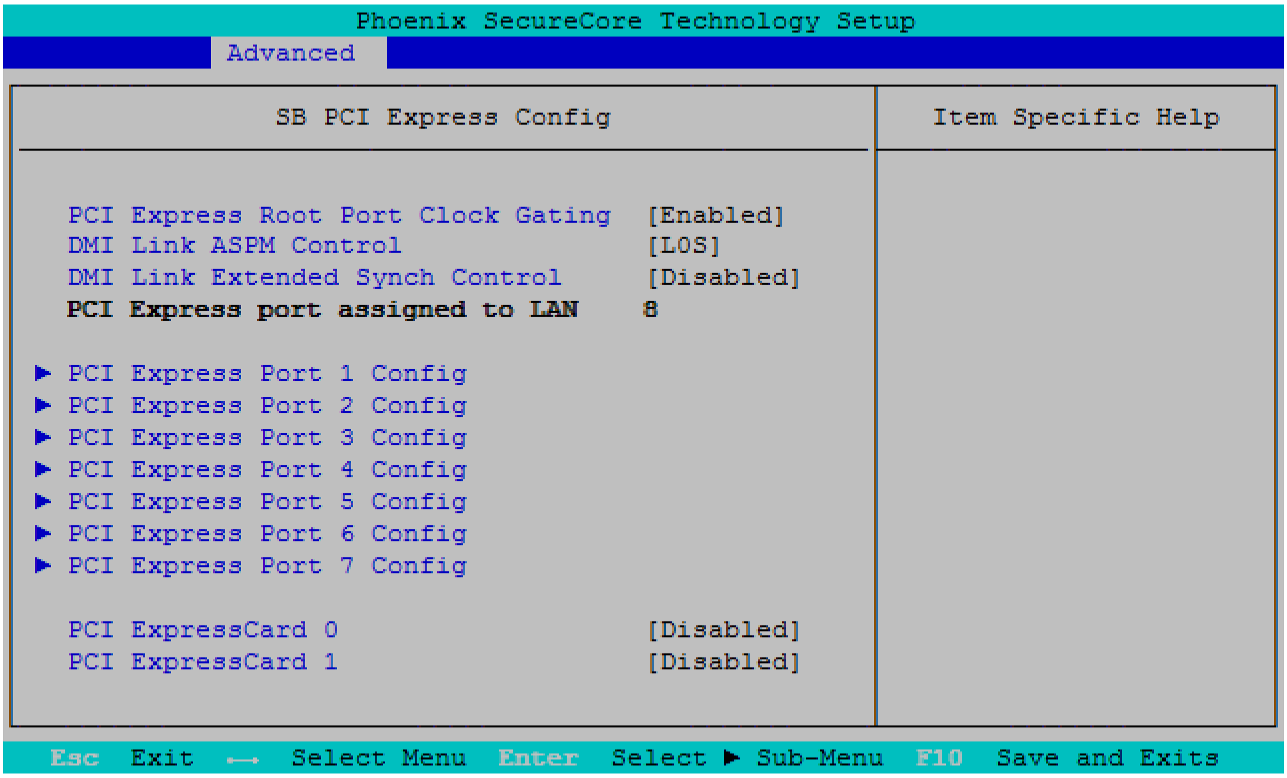
South Bridge Configuration



```
                Phoenix SecureCore Technology Setup
          Advanced

          South Bridge Configuration                 Item Specific Help

     SMBUS Device               [Enabled]
     State After G3             [State S0]
   ▶ SB PCI Express Config
   ▶ SB USB Config
   ▶ SB Azalia Config

 Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
SMBUS Device	Disabled **Enabled**	Enable/Disable SMBUS Device
State After G3	State S5 **State S0** Last State	Specify what state to switch to when power is re-applied after a power failure (G3 state). S5 = Stay Off, S0 = switch on

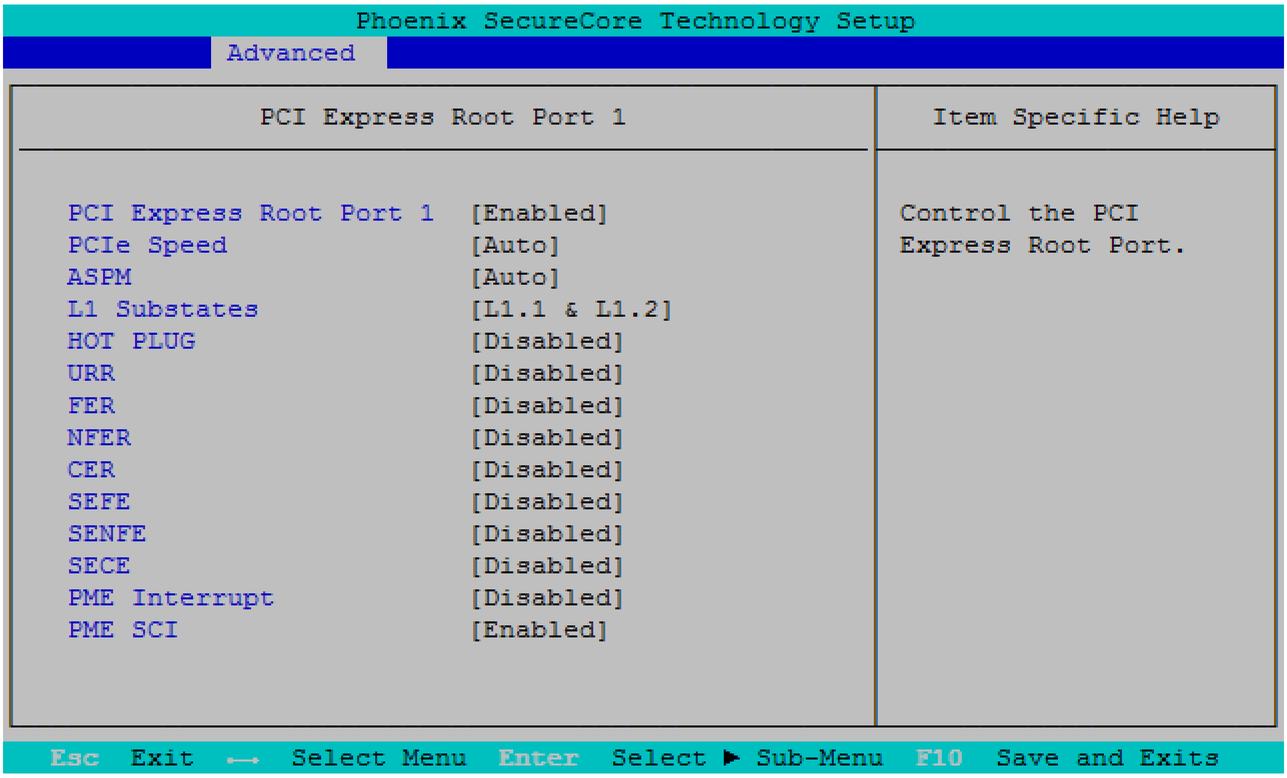
SB PCI Express Config



```
                    Phoenix SecureCore Technology Setup
            Advanced

              SB PCI Express Config                     Item Specific Help

   PCI Express Root Port Clock Gating     [Enabled]
   DMI Link ASPM Control                  [L0S]
   DMI Link Extended Synch Control        [Disabled]
   PCI Express port assigned to LAN      8

 ▶ PCI Express Port 1 Config
 ▶ PCI Express Port 2 Config
 ▶ PCI Express Port 3 Config
 ▶ PCI Express Port 4 Config
 ▶ PCI Express Port 5 Config
 ▶ PCI Express Port 6 Config
 ▶ PCI Express Port 7 Config

   PCI ExpressCard 0                      [Disabled]
   PCI ExpressCard 1                      [Disabled]

  Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
PCIe Root Port Clock Gating	Disabled **Enabled**	Enable or Disable PCI Express Clock Gating for each root port
DMI Link ASPM Control	Disabled **Enabled**	Controls Active State Power Management on both NB side and SB side of the DMI Link
DMI Link Ext Synch	**Disabled** Enabled	Controls Extended Synch on SB side of the DMI Link
PCIe-USB Glitch W/A	Disabled **Enabled**	PCIe-USB Glitch W/A for bad USB device(s) connected behind PCIe/PEG Port
PCI ExpressCard 0 PCI ExpressCard 1	Port 0 Port 1 Port 2 Port 3 Port 4 Port 5 Port 6 Port 7 **Disabled**	Controls PCIe Port for ExpressCard support

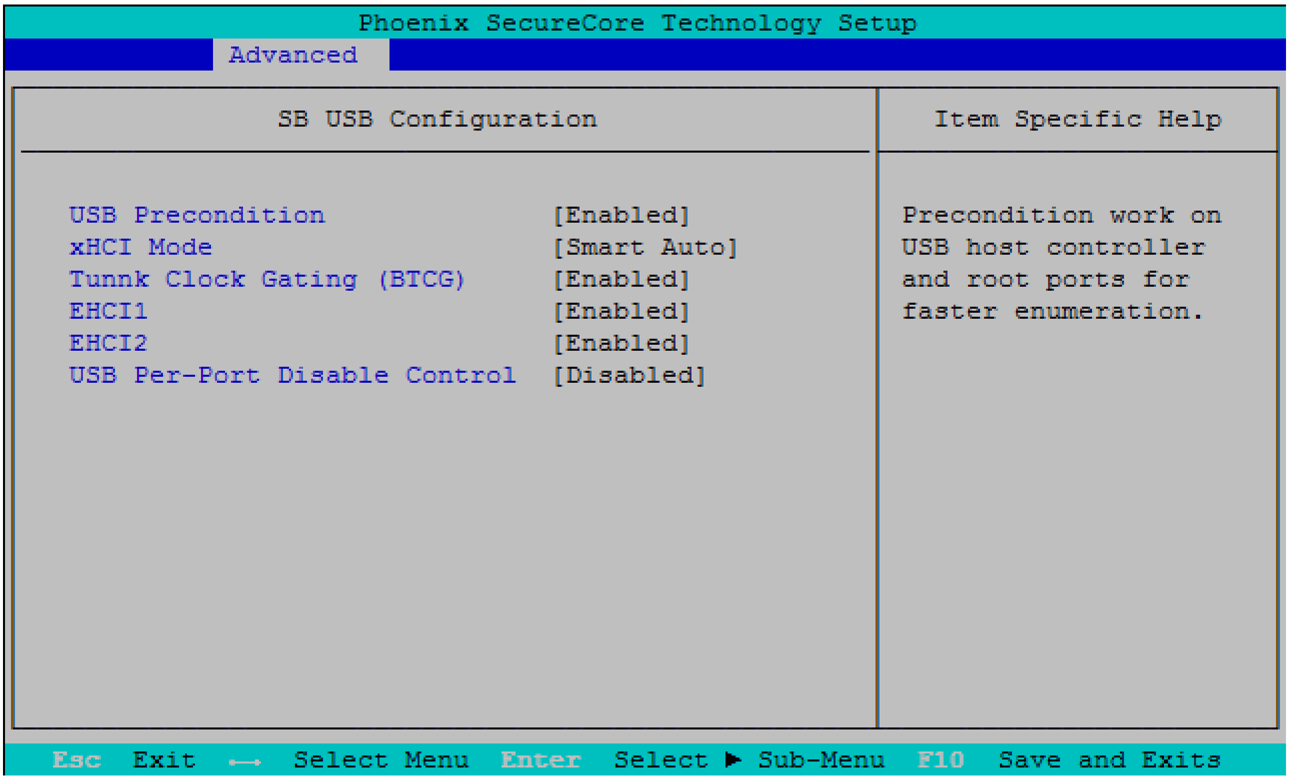
PCI Express Root Port 0/1/2/3/4/5/6



```
                    Phoenix SecureCore Technology Setup
         Advanced

            PCI Express Root Port 1              Item Specific Help

   PCI Express Root Port 1    [Enabled]          Control the PCI
   PCIe Speed                 [Auto]             Express Root Port.
   ASPM                       [Auto]
   L1 Substates               [L1.1 & L1.2]
   HOT PLUG                   [Disabled]
   URR                        [Disabled]
   FER                        [Disabled]
   NFER                       [Disabled]
   CER                        [Disabled]
   SEFE                       [Disabled]
   SENFE                      [Disabled]
   SECE                       [Disabled]
   PME Interrupt              [Disabled]
   PME SCI                    [Enabled]

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
PCI Express Root Port #	Disabled **Enabled**	Control the PCI Express Root Port
PCIe Speed	**Auto** Gen1 Gen2	Select PCIe Speed to Gen1 or Gen2
ASPM	Disabled L0s L1 L0s and L1 **Auto**	Control PCIe Active State Power Management settings
L1 Substates	Disabled L1.1 L1.2 L1.1 & L1.2	PCI Express L1 Substates setting
HOT PLUG	**Disabled** Enabled	PCI Express Hot Plug Enabled/Disabled
URR	**Disabled** Enabled	PCI Express Unsupported Request Reporting
FER	**Disabled** Enabled	PCI Express Device Fatal Error Reporting
NFER	**Disabled** Enabled	PCI Express Device Non-Fatal Error Reporting
CER	**Disabled** Enabled	PCI Express Device Correctable Error Reporting
SEFE	**Disabled** Enabled	PCI Express System Error on Fatal Error
SENFE	**Disabled** Enabled	PCI Express System Error on Non-Fatal Error
SECE	**Disabled** Enabled	PCI Express System Error on Correctable Error
PME Interrupt	**Disabled** Enabled	Root PCI Express PME Interrupt
PME SCI	Disabled **Enabled**	PCI Express PME SCI

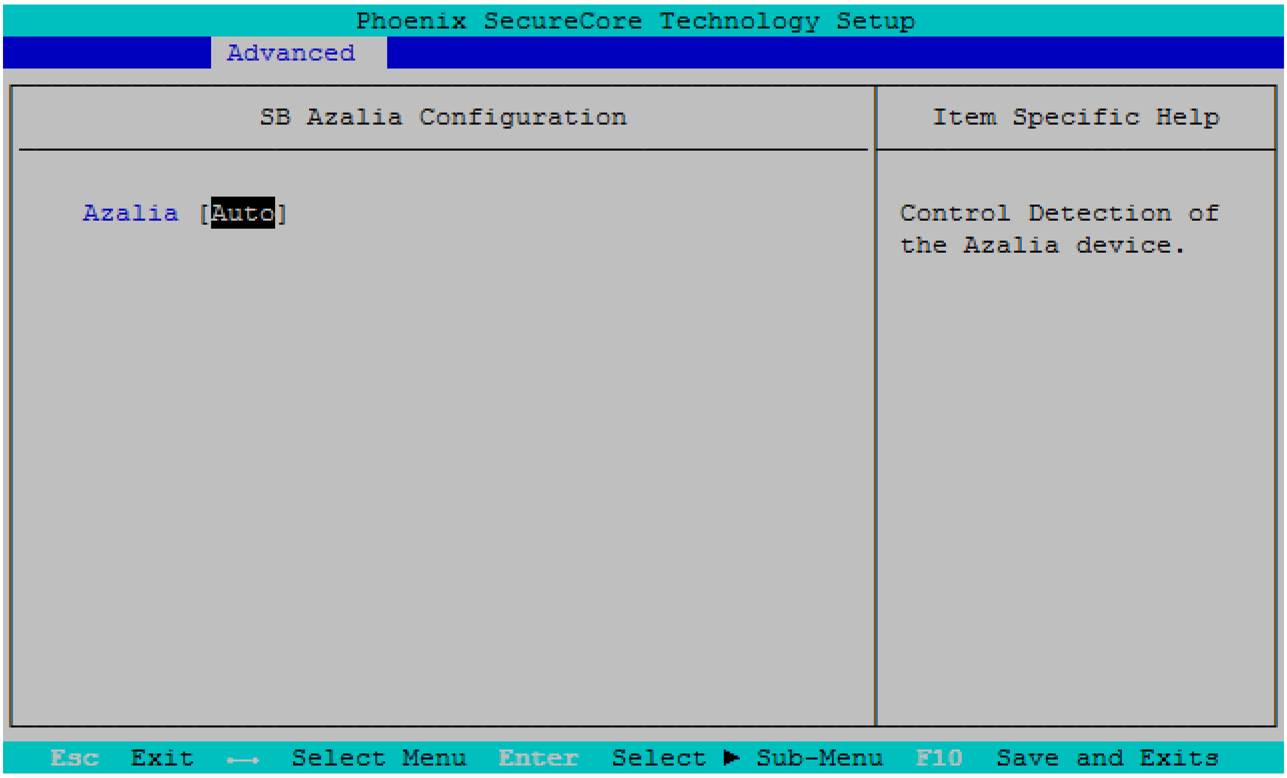
SB USB Config



```
                  Phoenix SecureCore Technology Setup
            Advanced

              SB USB Configuration                     Item Specific Help

    USB Precondition                  [Enabled]       Precondition work on
    xHCI Mode                         [Smart Auto]    USB host controller
    Tunnk Clock Gating (BTCG)         [Enabled]       and root ports for
    EHCI1                             [Enabled]       faster enumeration.
    EHCI2                             [Enabled]
    USB Per-Port Disable Control      [Disabled]

  Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
USB Precondition	Disabled **Enabled**	Precondition work on USB host controller and root ports for faster enumeration
xHCI Mode	Disabled Enabled Auto **Smart Auto**	Mode of operation of xHCI controller
Trunk Clock Gating (BTCG)	Disabled **Enabled**	Enable/Disable BTCG
EHCI1	Disabled **Enabled**	Control the USB EHCI (USB2.0) functions for COMe Ports #0-3
EHCI2	Disabled **Enabled**	Control the USB EHCI (USB2.0) functions for COMe Ports #4-7
USB Per-Port Disable Control	**Disabled** Enabled	Controls each of the USB ports (0~13)
- USB Port #0 Enable/Disable - USB Port #1 Enable/Disable - USB Port #2 Enable/Disable - USB Port #3 Enable/Disable - USB Port #4 Enable/Disable - USB Port #5 Enable/Disable - USB Port #6 Enable/Disable - USB Port #7 Enable/Disable	Disabled **Enabled**	Enable/Disable USB port

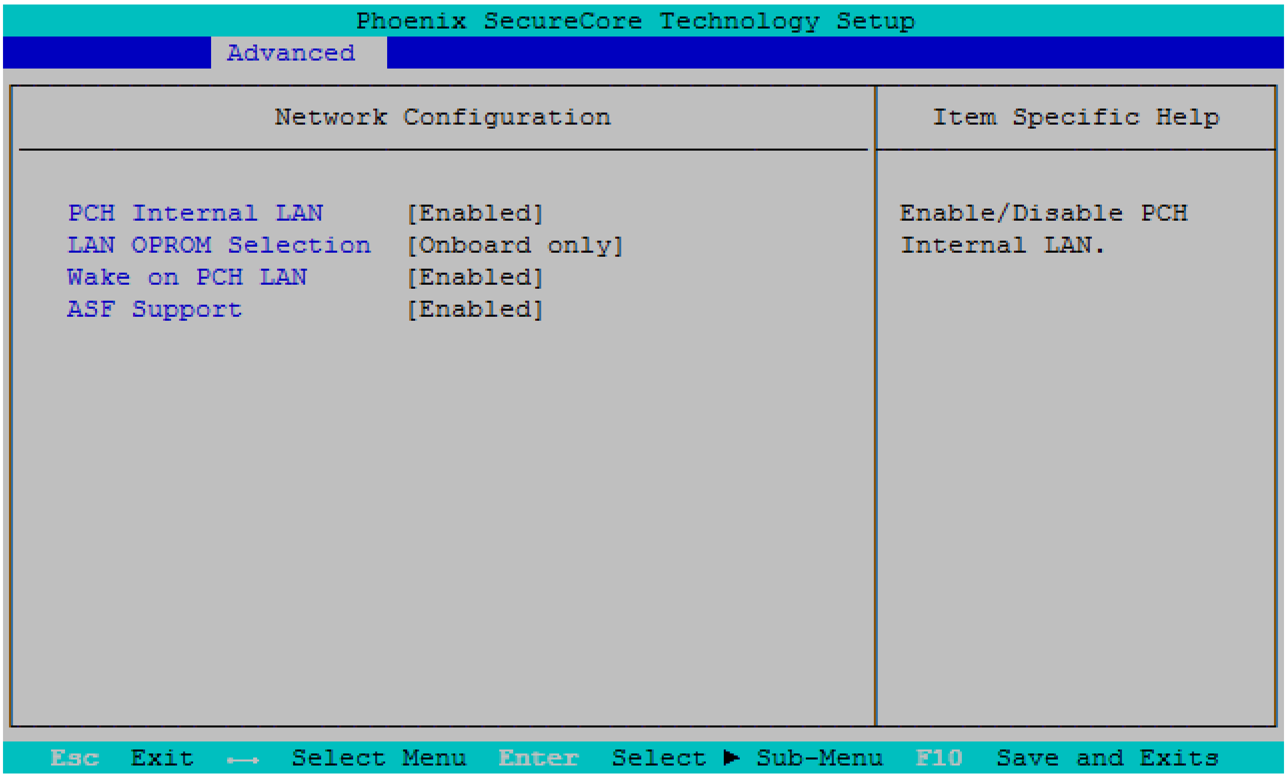
SB Azalia Config



```
                    Phoenix SecureCore Technology Setup
              Advanced

              SB Azalia Configuration              Item Specific Help

    Azalia [Auto]                                  Control Detection of
                                                   the Azalia device.

  Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Azalia	Disabled **Enabled**	Control Detection of the Azalia HD Audio Device

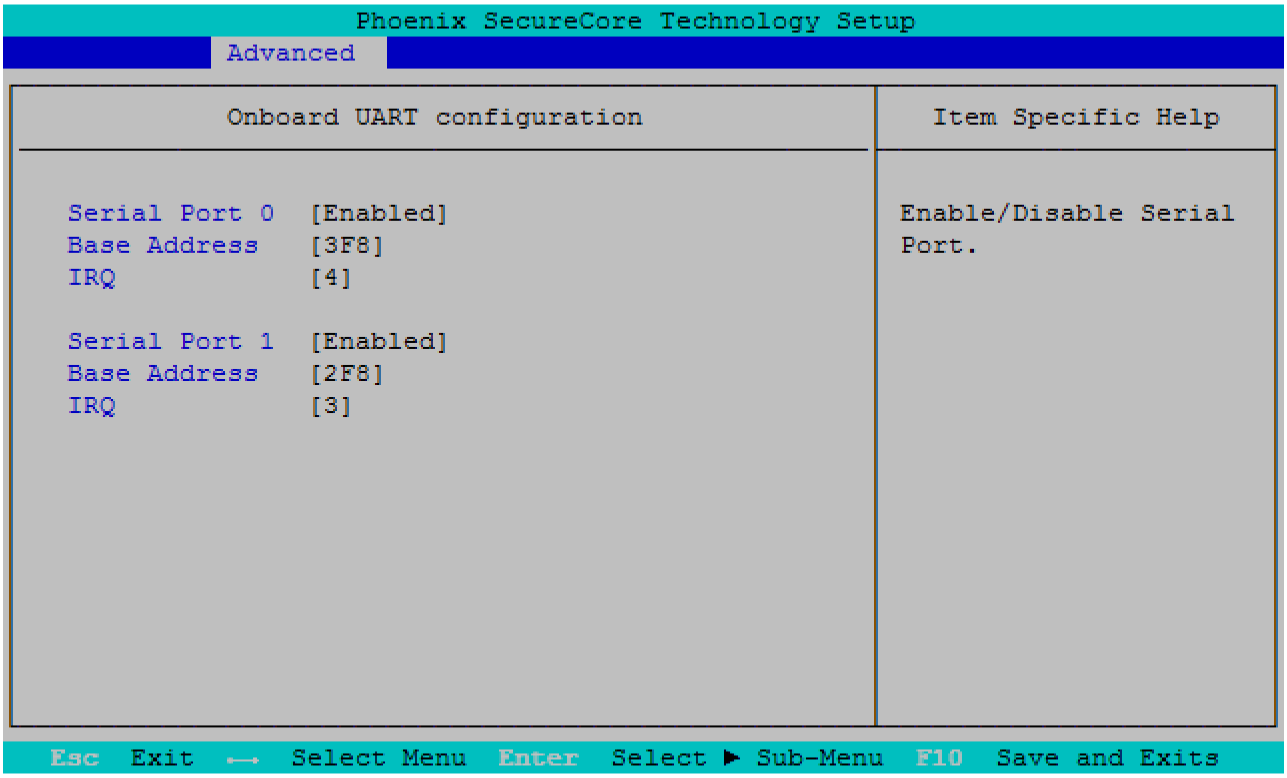
Network Configuration



```
                 Phoenix SecureCore Technology Setup
          Advanced

            Network Configuration                  Item Specific Help

   PCH Internal LAN       [Enabled]               Enable/Disable PCH
   LAN OPROM Selection    [Onboard only]          Internal LAN.
   Wake on PCH LAN        [Enabled]
   ASF Support            [Enabled]

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
PCH Internal LAN	Disabled **Enabled**	Enable/Disable PCH internal LAN
LAN OPROM Selection	Disabled **Onboard only** Addon only Both	This is used to select LAN OPROM for quick boot minimal configuration
Wake on PCH LAN	Disabled **Enabled**	Enable PCH internal Wake on LAN capability
ASF Support	Disabled **Enabled**	Enable/Disable Alert Specifications Format

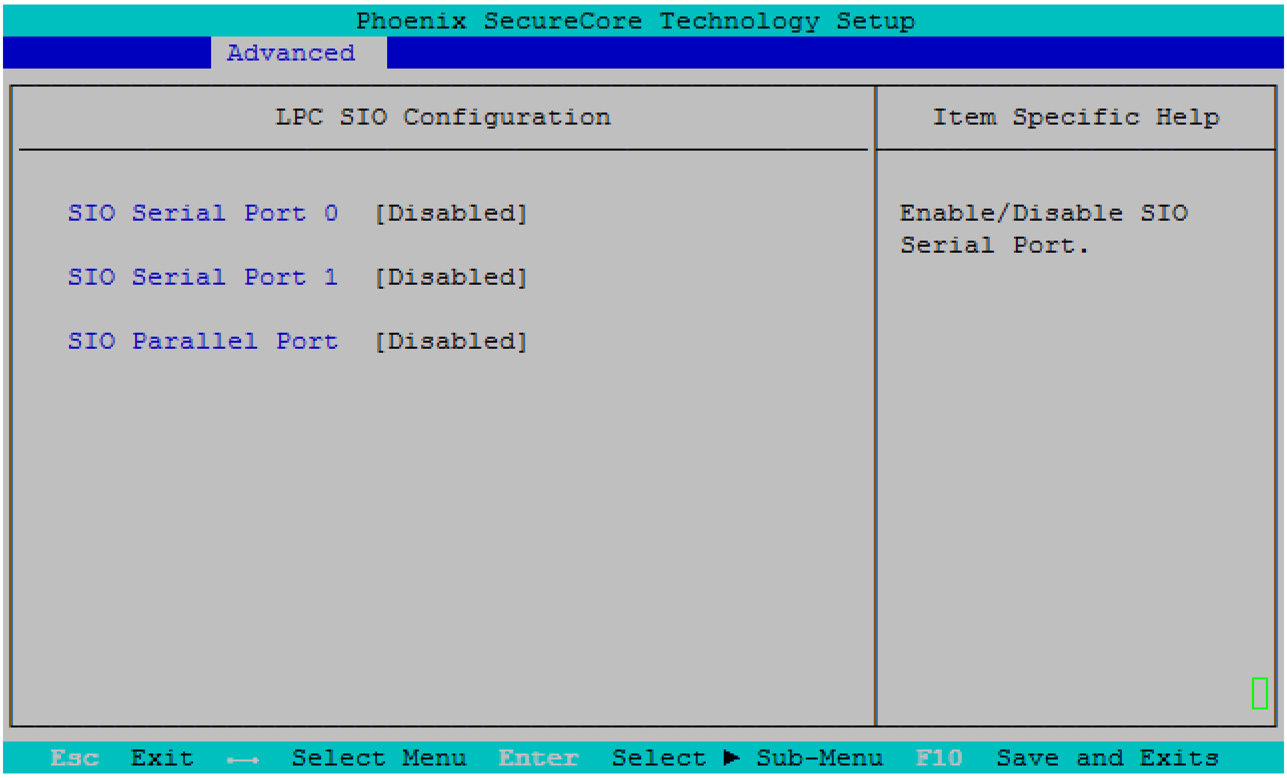
CPLD Configuration



```
                    Phoenix SecureCore Technology Setup
            Advanced

          Onboard UART configuration                  Item Specific Help

    Serial Port 0   [Enabled]                       Enable/Disable Serial
    Base Address    [3F8]                           Port.
    IRQ             [4]

    Serial Port 1   [Enabled]
    Base Address    [2F8]
    IRQ             [3]

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Serial Port 0	Disabled **Enabled**	Enable or Disable Serial Port (COM) 0
Base Address	**3F8** 2F8 3E8 2E8	Configure Serial Port Base Address
IRQ	3 **4** 5 6 7 12	Configure Serial Port IRQ
Serial Port 1	Disabled **Enabled**	Enable or Disable Serial Port (COM) 1
Base Address	3F8 **2F8** 3E8 2E8	Configure Serial Port Base Address
IRQ	**3** 4 5 6 7 12	Configure Serial Port IRQ
GPIO IRQ	**Disabled** 14 15	Configure IRQ for GPIO pins
I2C IRQ	**Disabled** 14 15	Configure IRQ for I2C controller

LPC SIO Configuration



Phoenix SecureCore Technology Setup

Advanced

LPC SIO Configuration

SIO Serial Port 0 [Disabled]

SIO Serial Port 1 [Disabled]

SIO Parallel Port [Disabled]

Item Specific Help

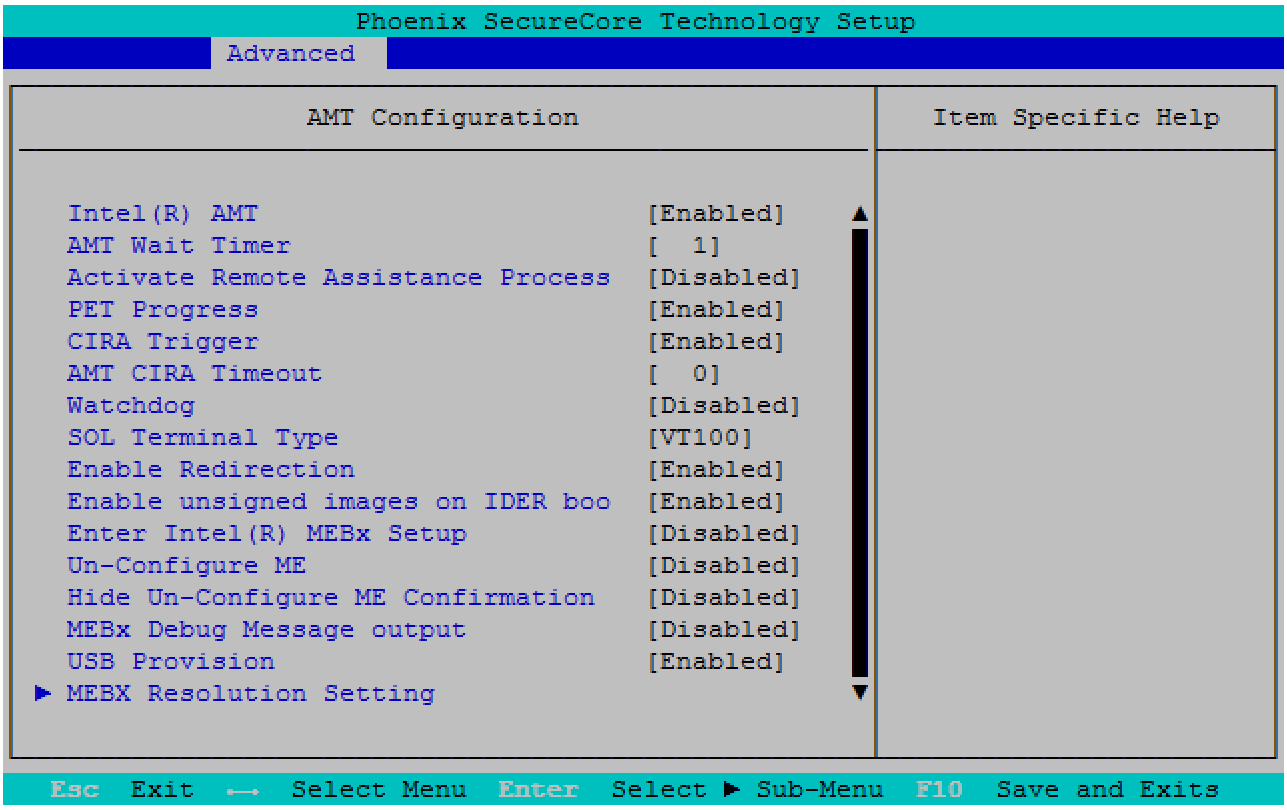
Enable/Disable SIO Serial Port.

Esc Exit ←→ Select Menu Enter Select ► Sub-Menu F10 Save and Exits

This setup option is only available with LPC SuperI/O Nuvoton 83627 present on the carrier board. By default the COMe-bHL6 supports the legacy interfaces of a 5V 83627HF(J) or 3.3V 83627DHG-P on external LPC. The SIO hardware monitor is not supported in setup.

Serial Port 0	**Disabled** Enabled	Enable or Disable SIO Serial Port
- Base Address	3F8 2F8 **3E8** 2E8	Configure Serial Port Base Address
- IRQ	3 4 5 **6** 7 12	Configure Serial Port IRQ
Serial Port 1	**Disabled** Enabled	Enable or Disable SIO Serial Port
- Base Address	3F8 2F8 3E8 **2E8**	Configure Serial Port Base Address
- IRQ	3 4 5 6 **7** 12	Configure Serial Port IRQ
SIO Parallel Port	**Disabled** Enabled	Enable or Disable SIO Parallel Port
- Device Mode	**Standard Parallel Port** EPP ECP & EPP 1.9 ECP & EPP 1.7	Configure Parallel Port Mode
- Base Address	**378** 278 3BC	Configure Parallel Port Base Address

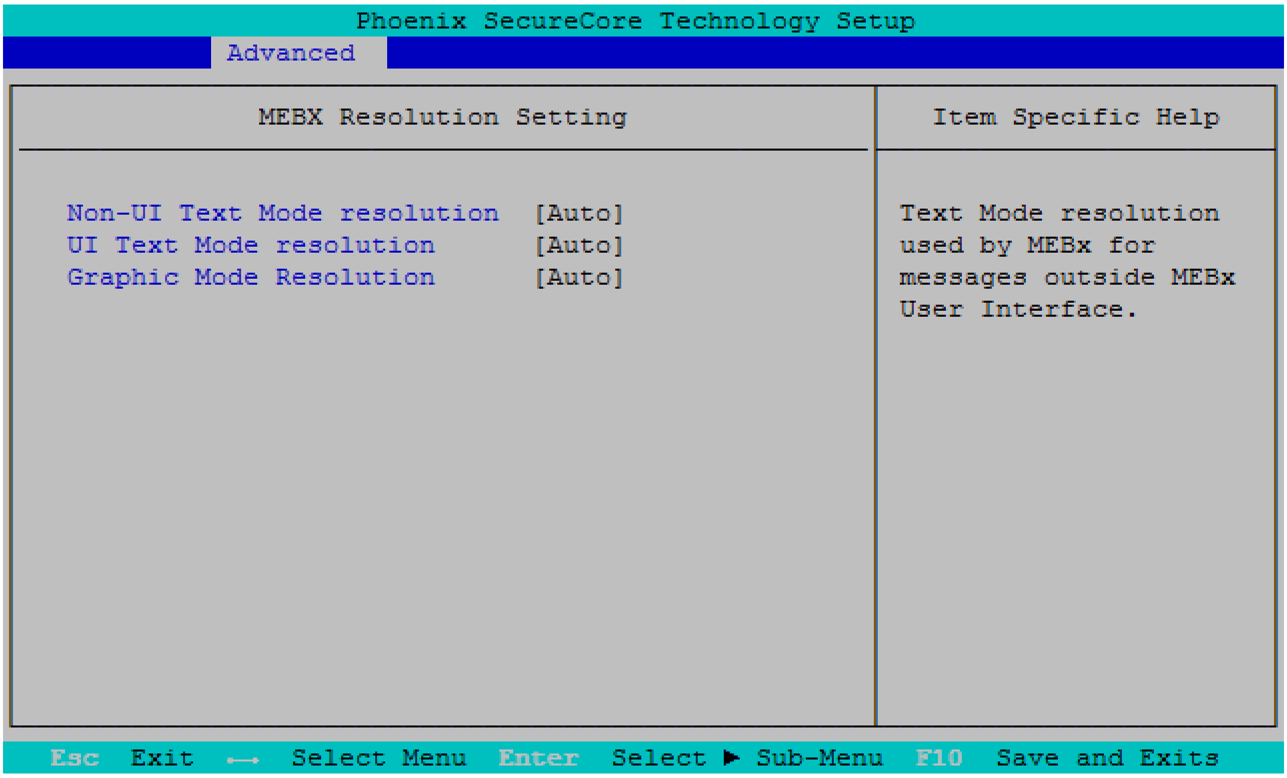
AMT Configuration (vPRO Version only)



```
                    Phoenix SecureCore Technology Setup
           Advanced

              AMT Configuration                       Item Specific Help

   Intel(R) AMT                               [Enabled]
   AMT Wait Timer                             [   1]
   Activate Remote Assistance Process         [Disabled]
   PET Progress                               [Enabled]
   CIRA Trigger                               [Enabled]
   AMT CIRA Timeout                           [   0]
   Watchdog                                   [Disabled]
   SOL Terminal Type                          [VT100]
   Enable Redirection                         [Enabled]
   Enable unsigned images on IDER boo         [Enabled]
   Enter Intel(R) MEBx Setup                  [Disabled]
   Un-Configure ME                            [Disabled]
   Hide Un-Configure ME Confirmation          [Disabled]
   MEBx Debug Message output                  [Disabled]
   USB Provision                              [Enabled]
 ► MEBX Resolution Setting

   Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Intel® AMT	Disabled **Enabled**	Enable/Disable Intel® Active Management Technology BIOS Extension. Note: iAMT H/W is always enabled. This option just controls the BIOS extension execution.
AMT Wait Timer	**1**	Set timer to wait before sending ASF_GET_BOOT_OPTIONS
Active Remote Assistance Process	**Disabled** Enabled	Trigger CIRA boot
PET Progress	Disabled **Enabled**	Users can Enable/Disable PET Events progress to receive PET events or not
CIRA Trigger	Disabled **Enabled**	Enable/Disable Trigger for Remote Assistance Process using HotKey
AMT CIRA Timeout	**0**	OEM defined timeout for the MPS connection to establish
Watchdog	**Disabled** Enabled	Enable/Disable Watchdog Timer
- OS Timer	**1**	Set OS Watchdog timer
- BIOS Timer	**1**	Set BIOS Watchdog timer
SOL Terminal Type	ANSI **VT100** VT100+ UTF8	Set Terminal Type for Serial Over LAN Sessions
Enable Redirection	Disabled **Enabled**	Enable/Disable Redirection
Enable unsigned images on IDER boot	Disabled **Enabled**	Enable the BIOS to boot from an unsigned image even when secure boot is enabled
Enter Intel® MEBx Setup	**Disabled** Enabled	Enter Intel® MEBx Setup on the next boot
Un-Configure ME	**Disabled** Enabled	Un-Configure ME without a password
Hide Un-Configure ME Confirmation	**Disabled** Enabled	Hide Un-Configure ME without password Confirmation Prompt
MEBx Debug Message output	**Disabled** Enabled	Enable/Disable MEBx debug message output
USB Provision	Disabled **Enabled**	Enable/Disable USB Provision function

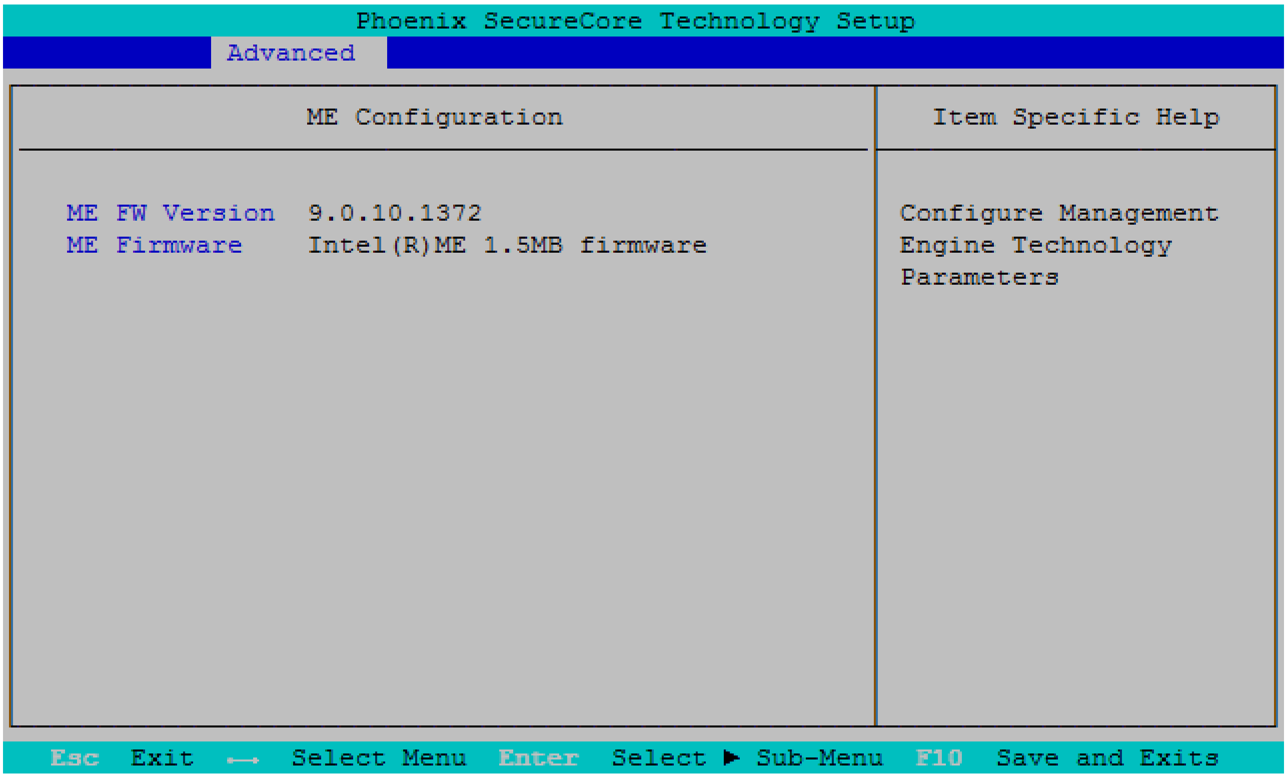
MEBx Resolution Setting (vPRO Version only)



```
                 Phoenix SecureCore Technology Setup
          Advanced

            MEBX Resolution Setting                     Item Specific Help

   Non-UI Text Mode resolution   [Auto]              Text Mode resolution
   UI Text Mode resolution       [Auto]              used by MEBx for
   Graphic Mode Resolution       [Auto]              messages outside MEBx
                                                     User Interface.

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

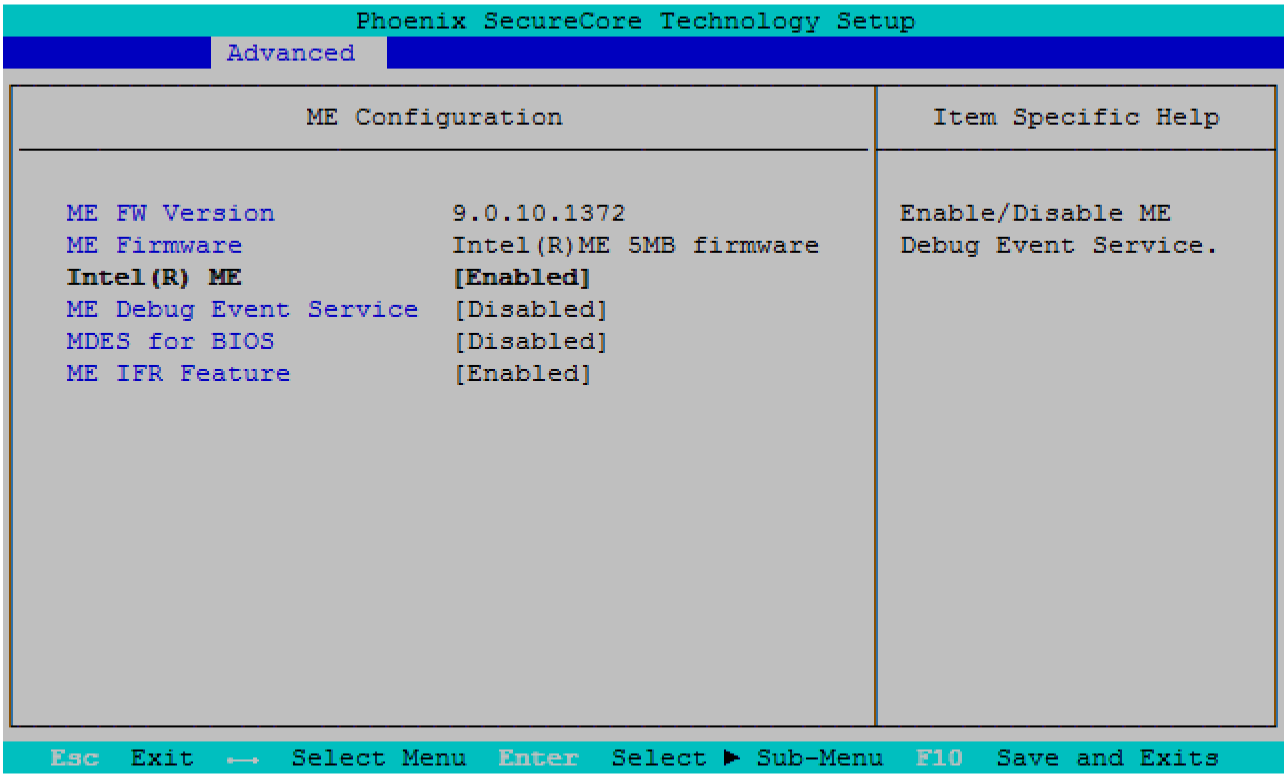
Feature	Options	Description
Non-UI Text Mode resolution	**Auto** 80×25 100×31	Text Mode resolution used by MEBx for messages outside MEBx User Interface
UI Text Mode resolution	**Auto** 80×25 100×31	Text Mode resolution used by MEBx to display the User Interface forms
Graphic Mode resolution	**Auto** 640×480 800×600 1024×768	Graphic Mode resolution used by MEBx to display boxes like consent sprite

ME Configuration (default)



```
                    Phoenix SecureCore Technology Setup
            Advanced

                 ME Configuration                      Item Specific Help

   ME FW Version    9.0.10.1372                      Configure Management
   ME Firmware      Intel(R)ME 1.5MB firmware        Engine Technology
                                                     Parameters

 Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

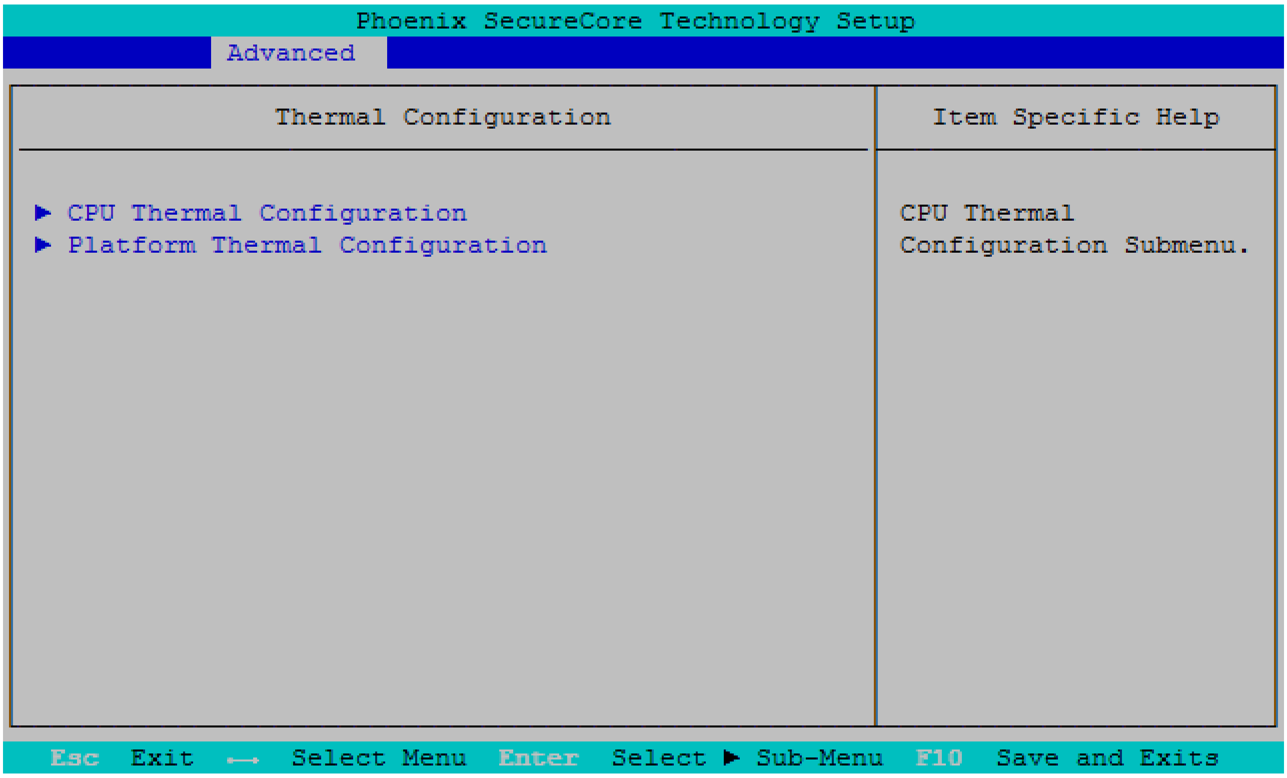
ME Configuration (vPRO Version only)



```
                 Phoenix SecureCore Technology Setup
             Advanced

                 ME Configuration                    Item Specific Help

   ME FW Version               9.0.10.1372           Enable/Disable ME
   ME Firmware                 Intel(R)ME 5MB firmware  Debug Event Service.
   Intel(R) ME                 [Enabled]
   ME Debug Event Service      [Disabled]
   MDES for BIOS               [Disabled]
   ME IFR Feature              [Enabled]

   Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

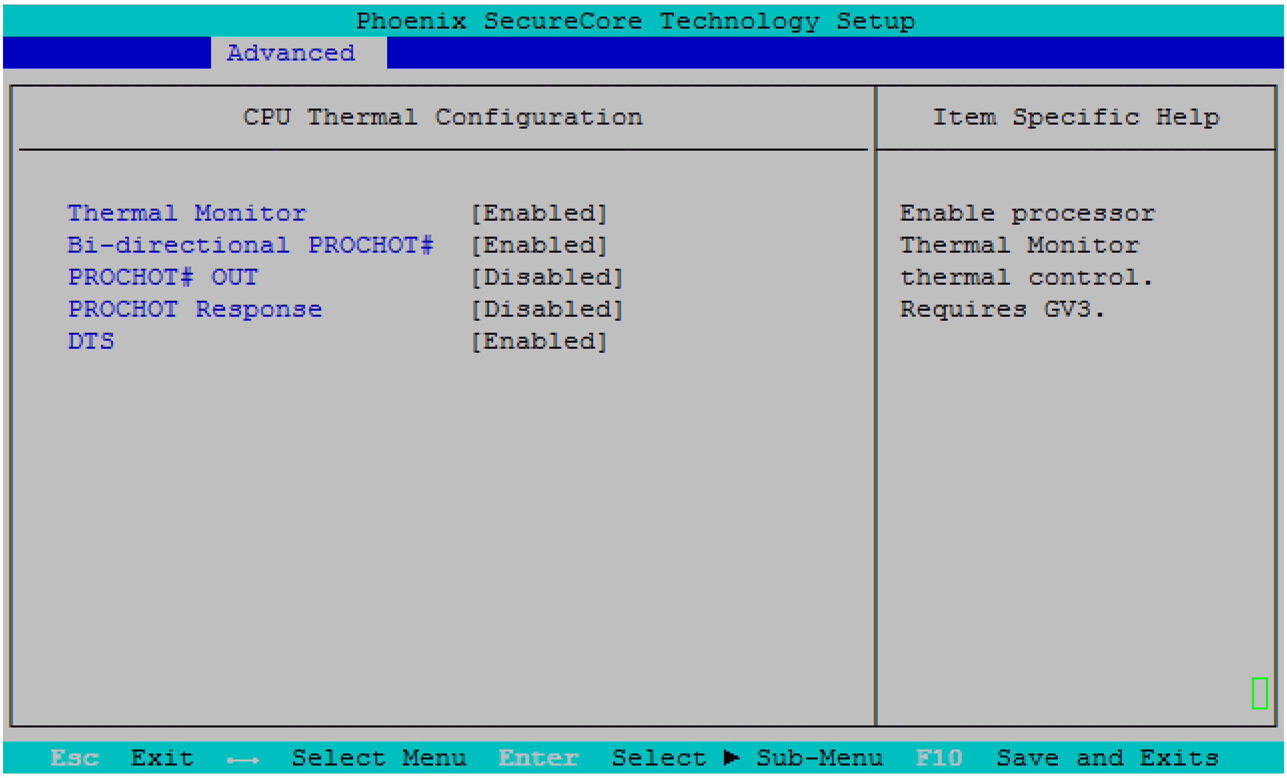
Feature	Options	Description
ME Debug Event Service	**Disabled** Enabled	Enable or Disable ME Debug Event Service
MDES for BIOS	**Disabled** Enabled	Enable or Disable ME Debug Event Service for BIOS events
ME IFR Feature	Disabled **Enabled**	Enable or Disable Intel® ME Independent Firmware Recovery

Thermal Configuration



```
                    Phoenix SecureCore Technology Setup
            Advanced

              Thermal Configuration                  Item Specific Help

 ▶ CPU Thermal Configuration                       CPU Thermal
 ▶ Platform Thermal Configuration                  Configuration Submenu.

 Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

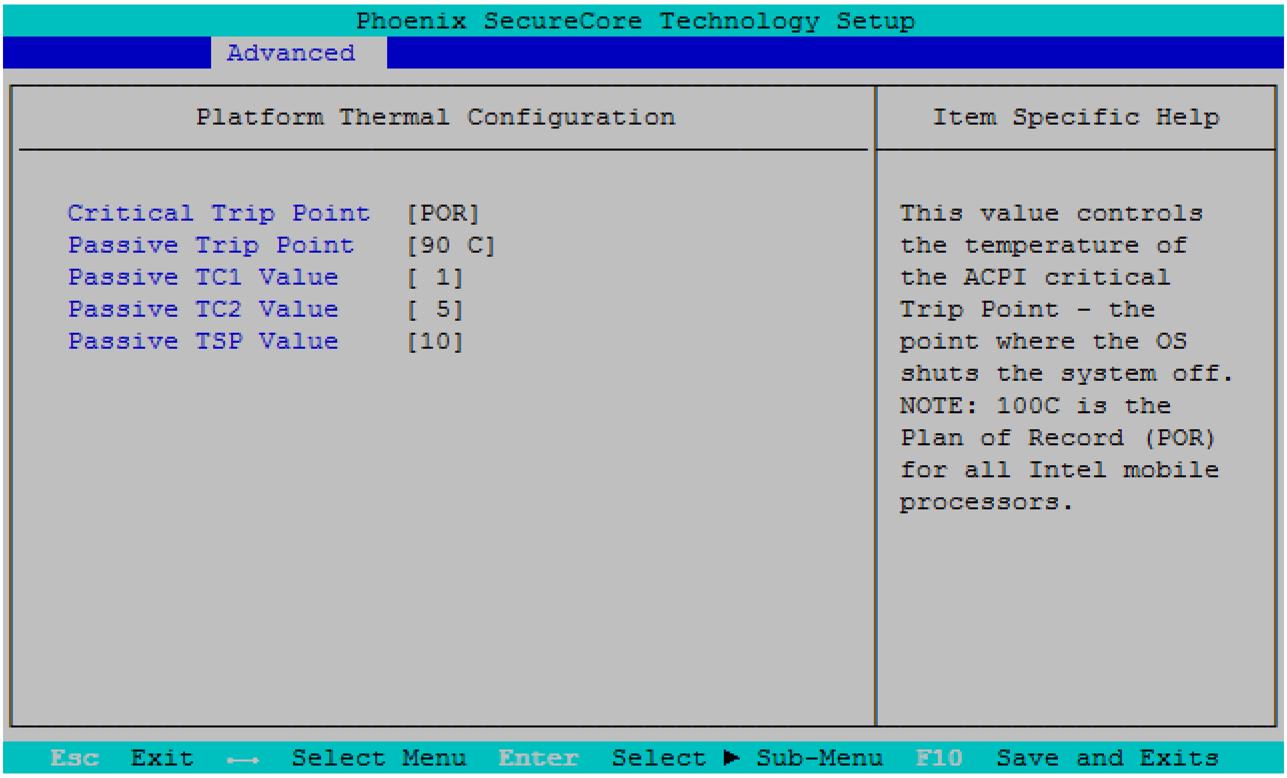
CPU Thermal Configuration



```
                  Phoenix SecureCore Technology Setup
             Advanced

           CPU Thermal Configuration                    Item Specific Help

   Thermal Monitor             [Enabled]            Enable processor
   Bi-directional PROCHOT#     [Enabled]            Thermal Monitor
   PROCHOT# OUT                [Disabled]           thermal control.
   PROCHOT Response            [Disabled]           Requires GV3.
   DTS                         [Enabled]

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Thermal Monitor	Disabled **Enabled**	Enable processor Thermal Monitor thermal control. Requires GV3
Bi-directional PROCHOT#	Disabled **Enabled**	When a processor thermal sensor trips (either core), the PROCHOT# is driven. If bi-direction is enabled, external agents can drive PROCHOT# to throttle the processor
PROCHOT# OUT	**Disabled** Enabled	If Bi-directional PROCHOT# is enabled, PROCHOT# OUT can be disabled selectively
PROCHOT# Response	**Disabled** Enabled	Enable/Disable PROCHOT Response
DTS	Disabled **Enabled**	Enable CPU Digital Thermal Sensor function. DTS has to be enabled for ACPI Critical Shutdown and Passive Cooling

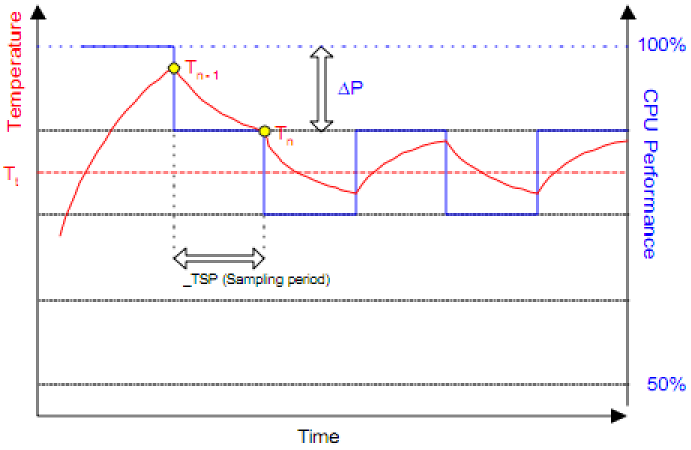
Platform Thermal Configuration



```
                Phoenix SecureCore Technology Setup
          Advanced

           Platform Thermal Configuration            Item Specific Help

   Critical Trip Point   [POR]                       This value controls
   Passive Trip Point    [90 C]                      the temperature of
   Passive TC1 Value     [ 1]                        the ACPI critical
   Passive TC2 Value     [ 5]                        Trip Point - the
   Passive TSP Value     [10]                        point where the OS
                                                     shuts the system off.
                                                     NOTE: 100C is the
                                                     Plan of Record (POR)
                                                     for all Intel mobile
                                                     processors.

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Critical Trip Point	**POR** 15°C ... 95°C	This value controls the temperature of the ACPI Critical Trip Point - the point where the OS shuts the system off. Note: 100°C is the Plan Of Record (POR) for all Intel mobile processors
Passive Trip Point	15°C ... **90°C** 95°C	This value controls the temperature of the ACPI Passive Trip Point - the point where the OS begins throttling the processor
- Passive TC1 Value	**1**	This value sets the TC1 value for the ACPI Passive Cooling Formula. Range 1 - 16
- Passive TC2 Value	**5**	This value sets the TC2 value for the ACPI Passive Cooling Formula. Range 1 - 16
- Passive TSP Value	**10**	This item sets the TSP value for the ACPI Passive Cooling Formula. It represents in tenth of a second how often the OS will read the temperature when passive cooling is enabled. Range 2 - 32

Passive Cooling



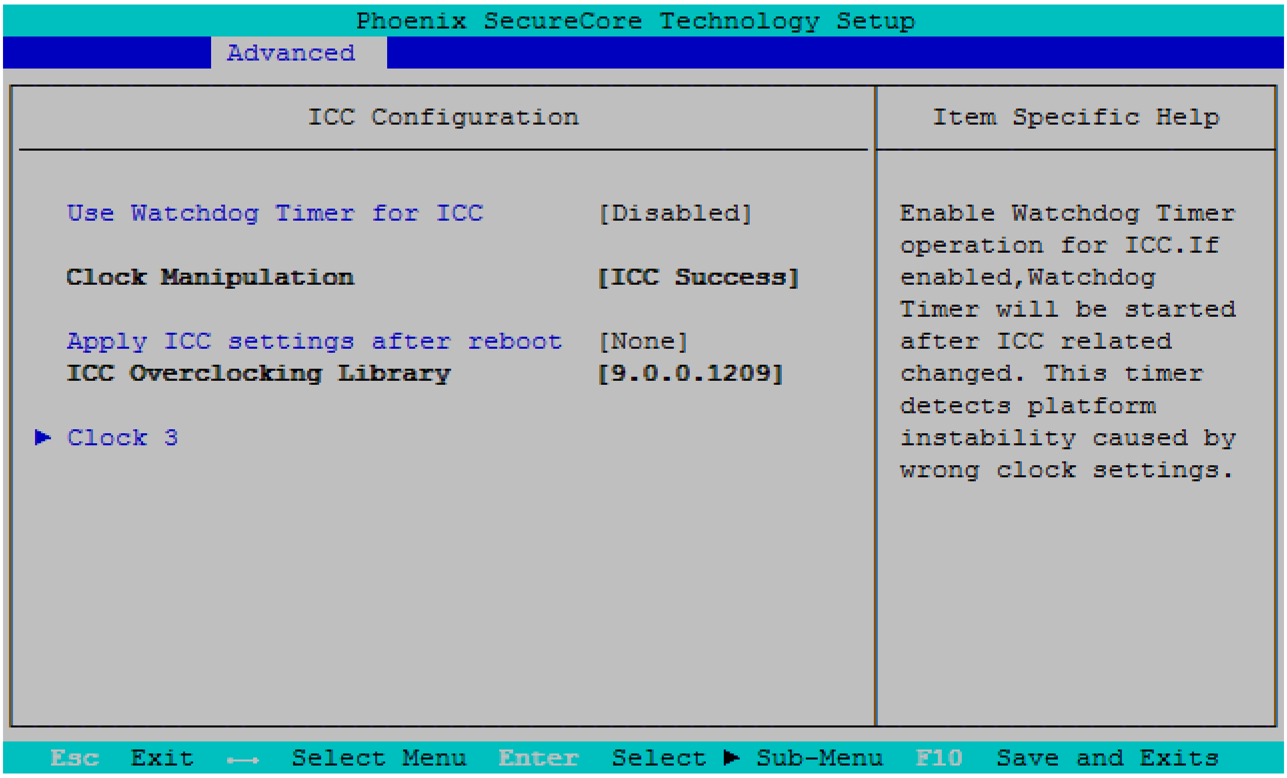
The ACPI OS assesses the optimum CPU performance change necessary to lower the temperature using the following equation

ΔP[%] = TC1 (Tn-Tn-1) + TC2 (Tn-Tt)

ΔP is the performance delta, Tt is the target temperature = passive cooling trip point. The two coefficients TC1 and TC2 and the sampling period TSP are hardware dependent constants the end user must supply. It's up to the end user to set the cooling preference of the system by setting the appropriate trip points in the BIOS setup.

See chapter 12 of the ACPI specification (www.acpi.info) for more details

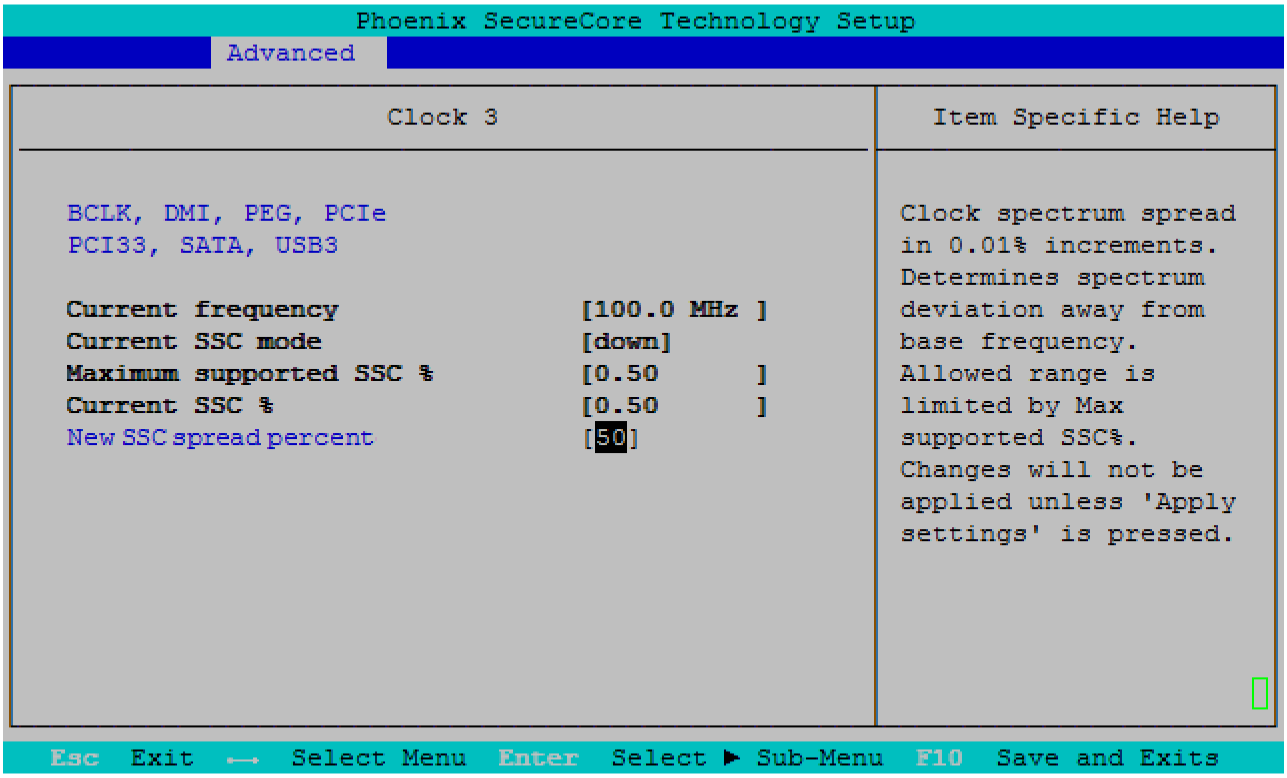
ICC Configuration



```
                    Phoenix SecureCore Technology Setup
             Advanced
 ICC Configuration                                  Item Specific Help

   Use Watchdog Timer for ICC        [Disabled]      Enable Watchdog Timer
                                                     operation for ICC.If
   Clock Manipulation                [ICC Success]   enabled,Watchdog
                                                     Timer will be started
   Apply ICC settings after reboot   [None]          after ICC related
   ICC Overclocking Library          [9.0.0.1209]    changed. This timer
                                                     detects platform
 ▶ Clock 3                                           instability caused by
                                                     wrong clock settings.

  Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Use Watchdog Timer for ICC	**Disabled** Enabled	Enable Watchdog Timer operation for ICC. If enabled, Watchdog Timer will be started after ICC related changed. This timer detects platform instability caused by wrong clock settings
Apply ICC settings after reboot	Permanently after reboot **None**	None: Change will not apply Permanently: Changes will be applied permanently, starting after the next reboot. Use it to provide changes that are verified and safe.

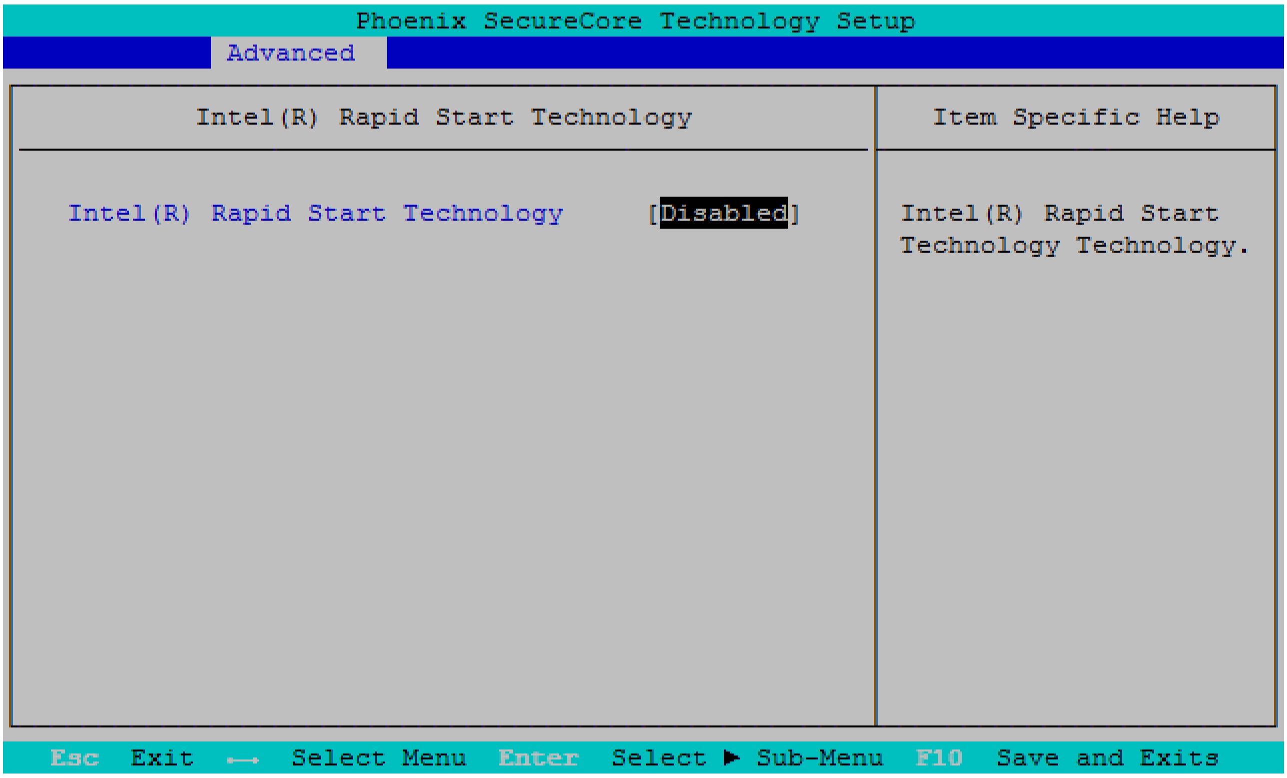
Clock 3



```
                    Phoenix SecureCore Technology Setup
             Advanced
 Clock 3                                            Item Specific Help

   BCLK, DMI, PEG, PCIe                             Clock spectrum spread
   PCI33, SATA, USB3                                in 0.01% increments.
                                                    Determines spectrum
   Current frequency               [100.0 MHz ]     deviation away from
   Current SSC mode                [down]           base frequency.
   Maximum supported SSC %         [0.50      ]     Allowed range is
   Current SSC %                   [0.50      ]     limited by Max
   New SSC spread percent          [50]             supported SSC%.
                                                    Changes will not be
                                                    applied unless 'Apply
                                                    settings' is pressed.

  Esc  Exit  ←→  Select Menu  Enter  Select ▶ Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
New SSC spread percent	**50**	Clock spectrum spread in **0.01%** increments. Determines spectrum deviation away from base frequency. Allowed range is limited by Max supported SSC%.

Intel® Rapid Start Technology



Phoenix SecureCore Technology Setup

Advanced

Intel(R) Rapid Start Technology

Item Specific Help

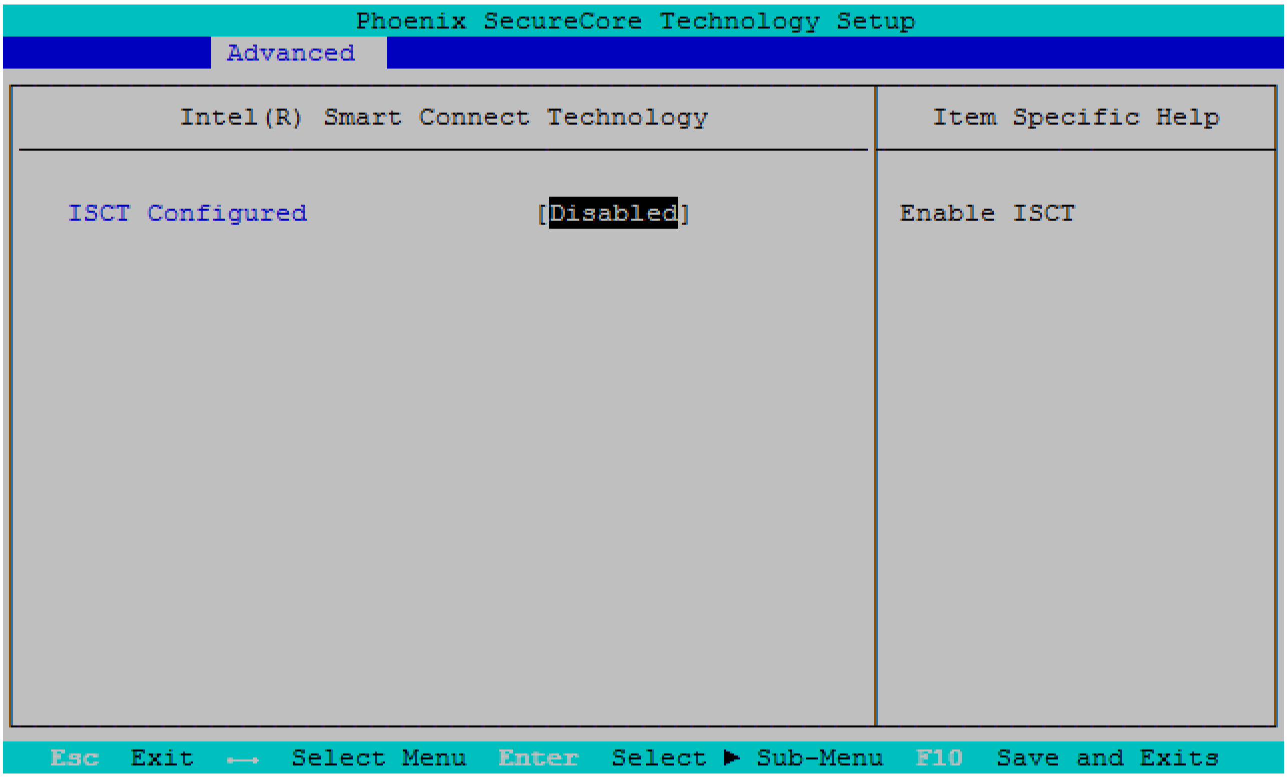
Intel(R) Rapid Start Technology [Disabled]

Intel(R) Rapid Start Technology Technology.

Esc Exit ←→ Select Menu Enter Select ► Sub-Menu F10 Save and Exits

Feature	Options	Description
Intel® Rapid Start Technology Support	**Disabled** Enabled	Enable/Disable Intel® Rapid Start Technology
- Entry on S3 RTC wake	Disabled **Enabled**	Intel® Rapid Start Technology invocation upon S3 RTC wake
- Entry after	Immediately 1 minute 2 minutes 5 minutes **10 minutes** 15 minutes 30 minutes 1 hour 2 hours	RTC wake timer at S3 entry
- Display Save Restore	Disabled **Enabled**	Display Save Restore configuration
- Intel® Rapid Start Technology Partition	-	Indicates a valid partition for Rapid Start Support

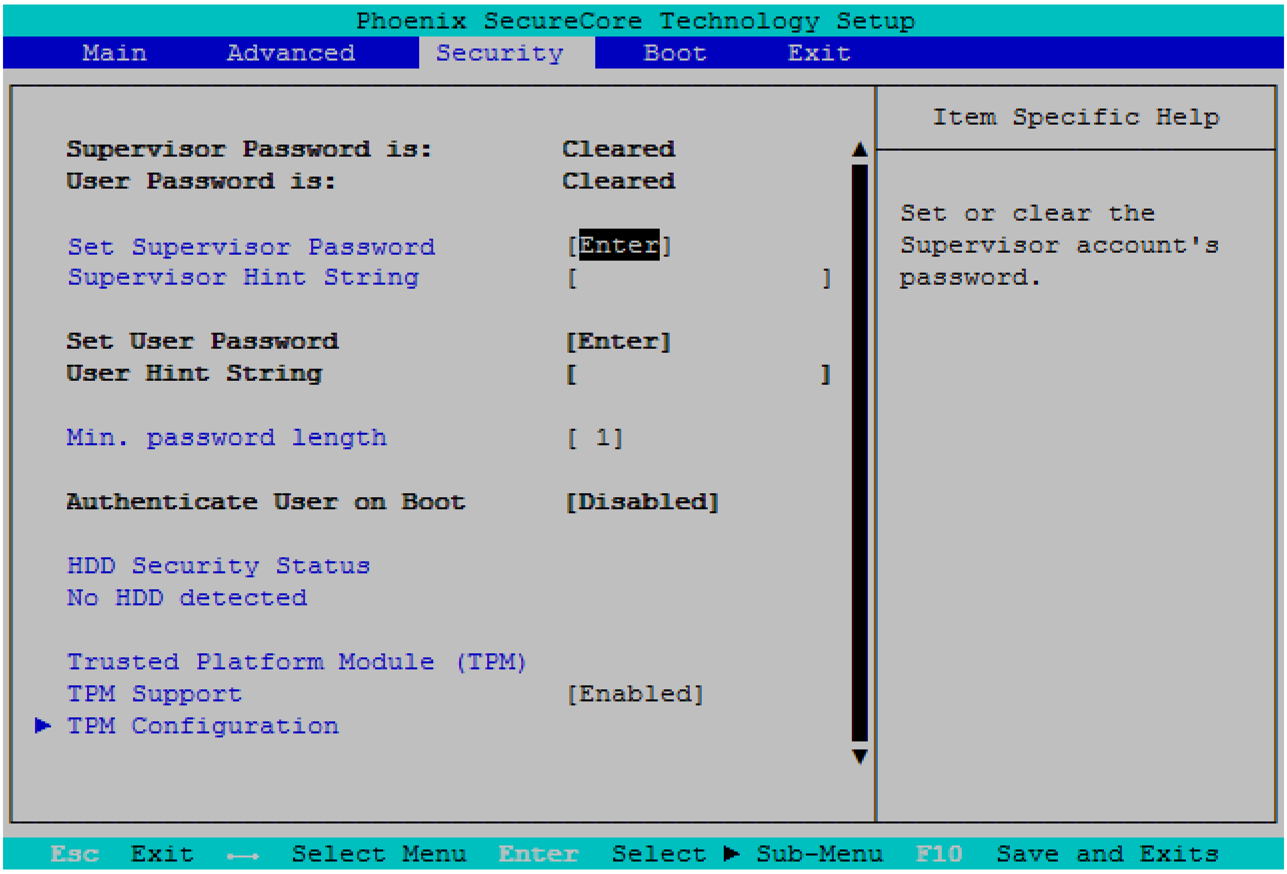
Intel® Smart Connect Technology



```
                    Phoenix SecureCore Technology Setup
            Advanced

         Intel(R) Smart Connect Technology          Item Specific Help

   ISCT Configured                 [Disabled]       Enable ISCT

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
ISCT Configured	**Disabled** Enabled	Enable Intel® Smart Connect Technology
ISCT Notification Control	Disabled **Enabled**	Enable ISCT Notification Control
ISCT WLAN Power Control	Disabled **Enabled**	Enable ISCT WLAN Power Control
ISCT WWAN Power Control	Disabled **Enabled**	Enable ISCT WWAN Power Control
ISCT SASD Format Control	**Actual Time** Sleep Duration	Select ISCT wake time format for ACPI SASD method. Actual Time: -YYMMDDHHMMSS Sleep Duration: - Duration in seconds

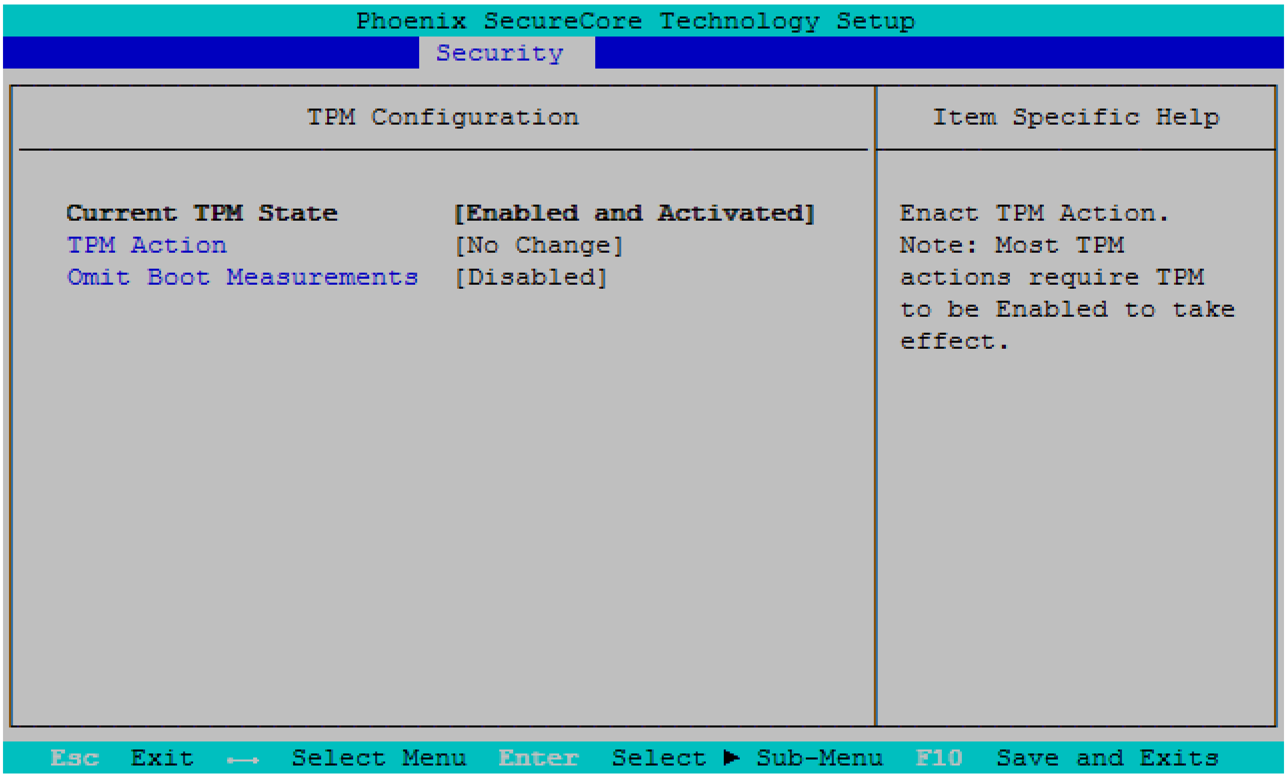
8.5.3 Security



```
                    Phoenix SecureCore Technology Setup
    Main      Advanced      Security      Boot      Exit

                                                         Item Specific Help
   Supervisor Password is:        Cleared
   User Password is:              Cleared
                                                        Set or clear the
   Set Supervisor Password        [Enter]               Supervisor account's
   Supervisor Hint String         [               ]     password.

   Set User Password              [Enter]
   User Hint String               [               ]

   Min. password length           [ 1]

   Authenticate User on Boot      [Disabled]

   HDD Security Status
   No HDD detected

   Trusted Platform Module (TPM)
   TPM Support                    [Enabled]
 ► TPM Configuration

   Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Feature	Options	Description
Set Supervisor Password	**Enter**	Set or clear the Supervisor account's password
Supervisor Hint String	**-**	Press Enter to type Supervisor Hint String
Min. password length	**1**	Set the minimum number of characters for password (1-20)
TPM Support	Disabled **Enabled**	This is used to decide whether TPM support should be enabled or disabled

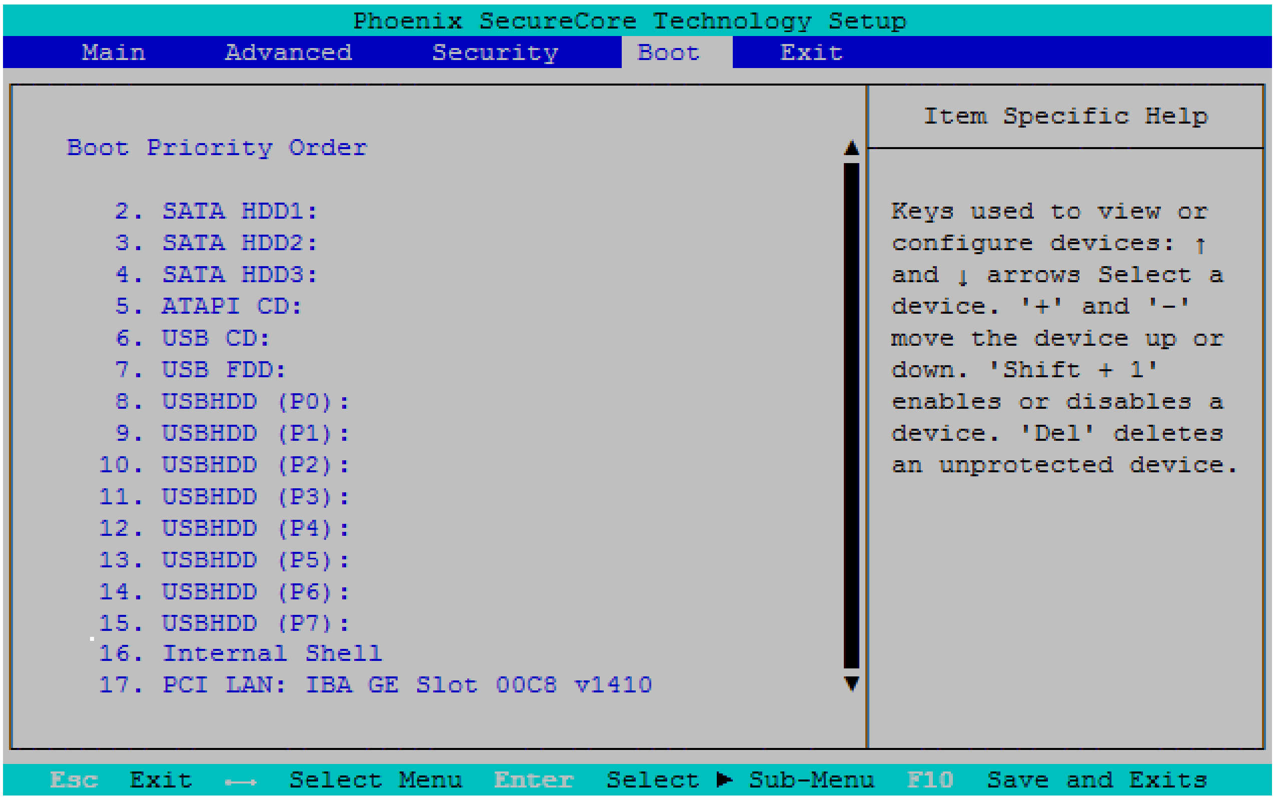
Security



```
                  Phoenix SecureCore Technology Setup
                              Security

                TPM Configuration                    Item Specific Help

  Current TPM State          [Enabled and Activated]  Enact TPM Action.
  TPM Action                 [No Change]              Note: Most TPM
  Omit Boot Measurements     [Disabled]               actions require TPM
                                                      to be Enabled to take
                                                      effect.

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

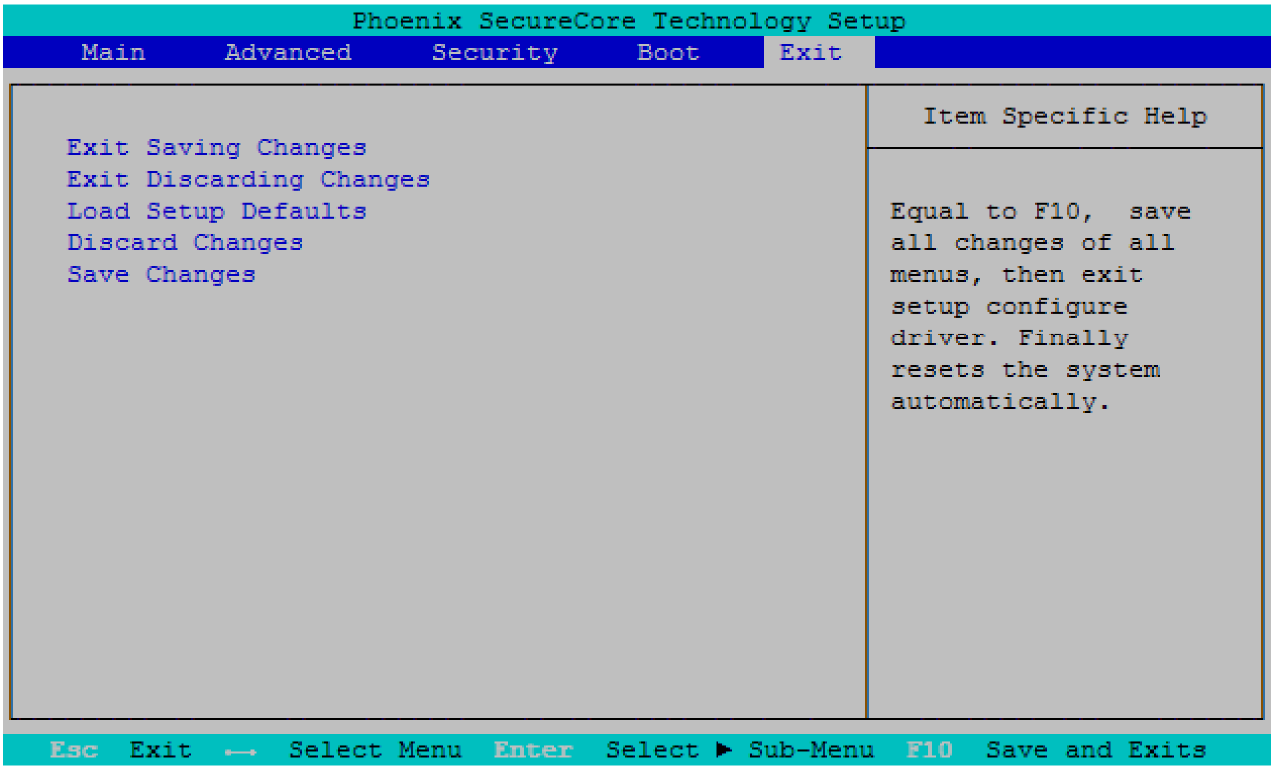
Feature	Options	Description
TPM Action	**No Change** Enable Disable Activate Deactivate Clear Enable and Activate Disable and Deactivate Set Owner Install, with state=True Set Owner Install, with state=False Enable, Activate, and Set Owner Install with state=True Disable, Deactivate, and Set Owner Install with state=False Clear, Enable, and Activate Require PP for provisioning Do not require PP for provisioning Require PP for clear Do not require PP for clear Enable, Activate, and clear Enable, Activate, Clear, Enable, and Activate	Enact TPM Action
Omit Boot Measurements	Disabled **Enabled**	Enabling this option causes the system to omit recording boot device attempts in PCR[4]

8.5.4 Boot



```
                    Phoenix SecureCore Technology Setup
    Main      Advanced      Security      Boot      Exit

                                                    Item Specific Help
   Boot Priority Order
                                                Keys used to view or
      2. SATA HDD1:                             configure devices: ↑
      3. SATA HDD2:                             and ↓ arrows Select a
      4. SATA HDD3:                             device. '+' and '-'
      5. ATAPI CD:                              move the device up or
      6. USB CD:                                down. 'Shift + 1'
      7. USB FDD:                               enables or disables a
      8. USBHDD (P0):                           device. 'Del' deletes
      9. USBHDD (P1):                           an unprotected device.
     10. USBHDD (P2):
     11. USBHDD (P3):
     12. USBHDD (P4):
     13. USBHDD (P5):
     14. USBHDD (P6):
     15. USBHDD (P7):
     16. Internal Shell
     17. PCI LAN: IBA GE Slot 00C8 v1410

  Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

8.5.5 Exit



```
Phoenix SecureCore Technology Setup
Main      Advanced      Security      Boot      Exit

   Exit Saving Changes                          Item Specific Help
   Exit Discarding Changes
   Load Setup Defaults                          Equal to F10,  save
   Discard Changes                              all changes of all
   Save Changes                                 menus, then exit
                                                setup configure
                                                driver. Finally
                                                resets the system
                                                automatically.

Esc  Exit  ←→  Select Menu  Enter  Select ► Sub-Menu  F10  Save and Exits
```

Corporate Offices

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