

Intel® Desktop Board

DH87RL

Technical Product Specification

October 2013

Part Number: G85647-003

The Intel Desktop Board DH87RL may contain design defects or errors known as errata that may cause the product to deviate from published specifications. Current characterized errata are documented in the Intel Desktop Board DH87RL Specification Update.

Revision History

| Revision | Revision History | Date |
|----------|--|--------------|
| -001 | First release of the Intel® Desktop Board DH87RL Technical Product Specification | May 2013 |
| -002 | Specification Clarification | July 2013 |
| -003 | Specification Clarification | October 2013 |

This product specification applies to only the standard Intel® Desktop Board with BIOS identifier RLH8710H.86A.

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Board Identification Information

Basic Desktop Board DH87RL Identification Information

| AA Revision | BIOS Revision | Notes |
|-------------|-------------------|-------|
| G74240-400 | RLH8710H.86A.0314 | 1,2 |

Notes:

1. The AA number is found on a small label on the component side of the board.
2. The H87 chipset used on this AA revision consists of the following component:

| Device | Stepping | S-Spec Numbers |
|---------------------------|----------|----------------|
| Intel H87 Express Chipset | C1 | SR139 |

Specification Changes or Clarifications

The table below indicates the Specification Changes or Specification Clarifications that apply to the Intel® Desktop Board DH87RL.

Specification Changes or Clarifications

| Date | Type of Change | Description of Changes or Clarifications |
|--------------|--------------------|---|
| July 2013 | Spec Clarification | <ul style="list-style-type: none">Deleted references to ENERGY STARDeleted the Note in Section 3.9.3 Power Button Menu regarding Fast Boot |
| October 2013 | Spec Clarification | Updated Section 1.3.1.2 to correct the maximum supported resolution for DVI-I |

Errata

Current characterized errata, if any, are documented in a separate Specification Update. See <http://www.intel.com/content/www/us/en/motherboards/desktop-motherboards/motherboards.html?wapkw=desktop+boards> for the latest documentation.

Intel Desktop Board DH87RL Technical Product Specification

Preface

This Technical Product Specification (TPS) specifies the board layout, components, connectors, power and environmental requirements, and the BIOS for Intel® Desktop Board DH87RL.

Intended Audience

The TPS is intended to provide detailed, technical information about Intel Desktop Board DH87RL and its components to the vendors, system integrators, and other engineers and technicians who need this level of information. It is specifically *not* intended for general audiences.

What This Document Contains

| Chapter | Description |
|---------|---|
| 1 | A description of the hardware used on Intel Desktop Board DH87RL |
| 2 | A map of the resources of the Intel Desktop Board |
| 3 | The features supported by the BIOS Setup program |
| 4 | A description of the BIOS error messages, beep codes, and Power-On-Self-Test (POST) codes |
| 5 | Regulatory compliance and battery disposal information |

Typographical Conventions

This section contains information about the conventions used in this specification. Not all of these symbols and abbreviations appear in all specifications of this type.

Notes, Cautions, and Warnings



NOTE

Notes call attention to important information.



CAUTION

Cautions are included to help you avoid damaging hardware or losing data.

Other Common Notation

| | |
|-------|--|
| # | Used after a signal name to identify an active-low signal (such as USBP0#) |
| GB | Gigabyte (1,073,741,824 bytes) |
| GB/s | Gigabytes per second |
| Gb/s | Gigabits per second |
| KB | Kilobyte (1024 bytes) |
| Kb | Kilobit (1024 bits) |
| kb/s | 1000 bits per second |
| MB | Megabyte (1,048,576 bytes) |
| MB/s | Megabytes per second |
| Mb | Megabit (1,048,576 bits) |
| Mb/s | Megabits per second |
| TDP | Thermal Design Power |
| xxh | An address or data value ending with a lowercase h indicates a hexadecimal value. |
| x.x V | Volts. Voltages are DC unless otherwise specified. |
| * | This symbol is used to indicate third-party brands and names that are the property of their respective owners. |

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1 Product Description

1.1 Overview

1.1.1 Feature Summary

Table 1 summarizes the major features of the board.

Table 1. Feature Summary

| | |
|--------------------|---|
| Form Factor | MicroATX (9.60 inches by 9.60 inches [243.84 millimeters by 243.84 millimeters]) |
| Processor | <ul style="list-style-type: none">• 4th generation Intel® Core™ processor with up to 95 W TDP in an LGA1150 socket<ul style="list-style-type: none">— One PCI Express* x16 graphics interface— Integrated memory controller with dual channel DDR3 memory support— Integrated graphics processing— External graphics interface controller |
| Graphics | <ul style="list-style-type: none">• Integrated graphics support for processors with Intel HD Graphics:<ul style="list-style-type: none">— High Definition Multimedia Interface* (HDMI*) v1.4a— DVI-I v1.0— DisplayPort* v1.2• Support for a PCI Express* 3.0 x16 add-in graphics card |
| Memory | <ul style="list-style-type: none">• Four 240-pin DDR3 SDRAM Dual Inline Memory Module (DIMM) sockets• Support for DDR3 1333 MHz to DDR3 1600 MHz DIMMs• Support for 1 Gb, 2 Gb, and 4 Gb memory technology• Support for up to 32 GB of system memory with four DIMMs using 4 Gb memory technology• Support for non-ECC memory• Support for 1.5 V (standard voltage) and 1.35 V (low voltage) JEDEC memory• Support for XMP memory |
| Chipset | Intel® H87 Express Chipset consisting of the Intel® H87 Express Platform Controller Hub (PCH) |

continued

Table 1. Feature Summary (continued)

| | |
|--|---|
| Peripheral Interfaces | <ul style="list-style-type: none"> • USB 3.0 ports: <ul style="list-style-type: none"> — Four USB 3.0 ports are implemented with stacked back panel connectors — Two front panel USB 3.0 ports are implemented through one internal connector • USB 2.0 ports: <ul style="list-style-type: none"> — Two ports are implemented with stacked back panel connectors — Four front panel ports are implemented through two dual-port internal connectors — One single-port internal header for front panel cabling — One port is reserved for the PCI Express Full-/Half-Mini Card slot • Five Serial ATA (SATA) 6.0 Gb/s ports |
| Audio | 10-channel (8 + 2) Intel High Definition Audio via the Realtek® ALC892 audio codec |
| LAN Support | Gigabit (10/100/1000 Mb/s) LAN subsystem using the Intel® I217V Gigabit Ethernet Controller |
| Expansion Capabilities | <ul style="list-style-type: none"> • One PCI Express x16 3.0/2.x/1.x add-in card connector • Three PCI Express x1 2.x/1.x add-in card connectors • One PCI Express Full-/Half-Mini Card slot with support for mSATA |
| Intel® Visual BIOS | <ul style="list-style-type: none"> • Intel® BIOS resident in SPI Flash device • Support for Advanced Configuration and Power Interface (ACPI), Plug and Play, and SMBIOS |
| Instantly Available PC Technology | <ul style="list-style-type: none"> • Support for PCI Express* Revision 3.0 • Suspend to RAM support • Wake on PCI Express, LAN, front panel, Consumer Infrared (CIR), and USB ports |
| Super I/O Control | Nuvoton NCT6883D-T I/O controller for CIR and hardware management support |
| Hardware Monitor Subsystem | <ul style="list-style-type: none"> • Hardware monitoring through the Nuvoton I/O controller • Voltage sense to detect out of range power supply voltages • Thermal sense to detect out of range thermal values • Three fan headers • Three fan sense inputs used to monitor fan activity • Fan speed control |

1.1.2 Board Layout

Figure 1 shows the location of the major components on Intel Desktop Board DH87RL.

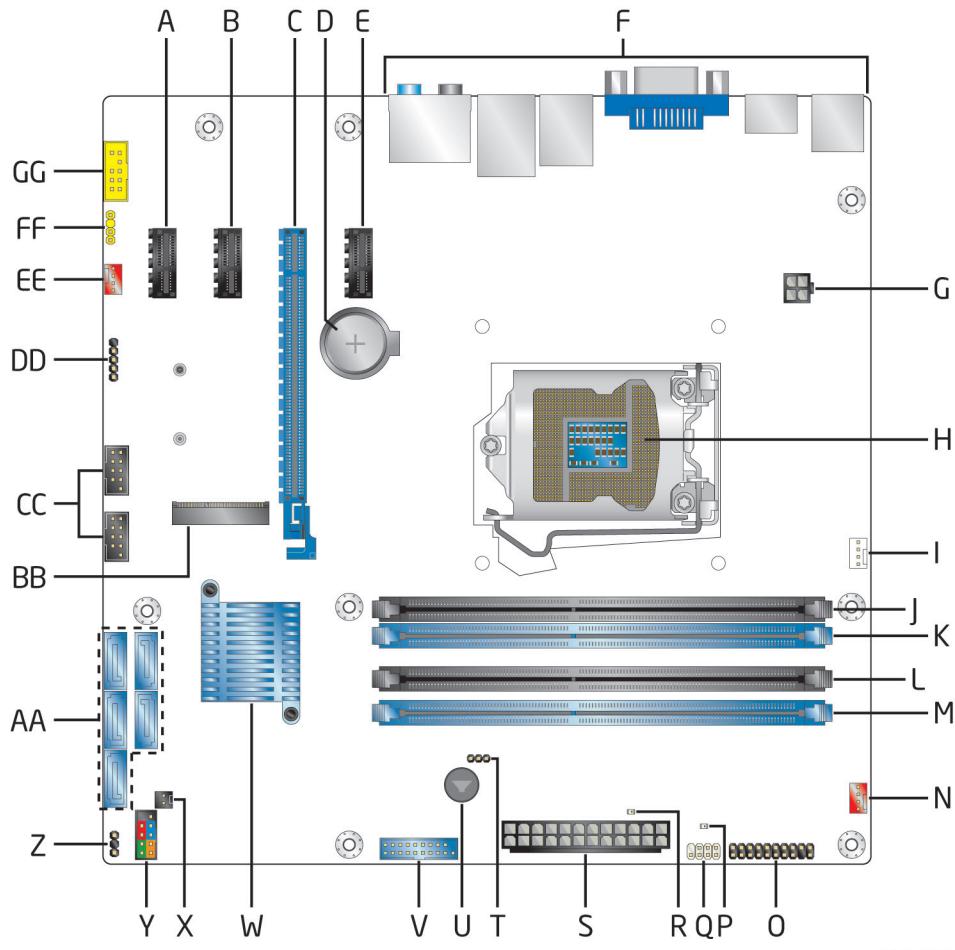


Figure 1. Major Board Components

Table 2 lists the components identified in Figure 1.

Table 2. Components Shown in Figure 1

| Item/callout from Figure 1 | Description |
|-----------------------------------|--|
| A | PCI Express x1 add-in card connector |
| B | PCI Express x1 add-in card connector |
| C | PCI Express x16 add-in card connector |
| D | Battery |
| E | PCI Express x1 add-in card connector |
| F | Back panel connectors |
| G | Processor core power connector (2 x 2) |
| H | LGA1150 processor socket |
| I | Processor fan header |
| J | DIMM 3 (Channel A DIMM 0) |
| K | DIMM 1 (Channel A DIMM 1) |
| L | DIMM 4 (Channel B DIMM 0) |
| M | DIMM 2 (Channel B DIMM 1) |
| N | Front fan header |
| O | Trusted Platform Module header |
| P | Power supervisor LED |
| Q | Consumer IR receiver (input) header |
| R | Enhanced standby power LED |
| S | Main power connector (2 x 12) |
| T | BIOS security jumper |
| U | Piezoelectric speaker |
| V | Front panel USB 3.0 connector |
| W | Intel H87 Express Chipset |
| X | Chassis intrusion header |
| Y | Front panel connector |
| Z | Alternate front panel power/sleep LED header |
| AA | SATA 6.0 Gb/s connectors |
| BB | PCI Express Full-/Half-Mini Card slot |
| CC | Front panel dual-port USB 2.0 connectors |
| DD | Front panel single-port USB 2.0 header |
| EE | Rear chassis fan header |
| FF | S/PDIF out header |
| GG | Front panel audio connector |

1.1.3 Block Diagram

Figure 2 is a block diagram of the major functional areas of the board.

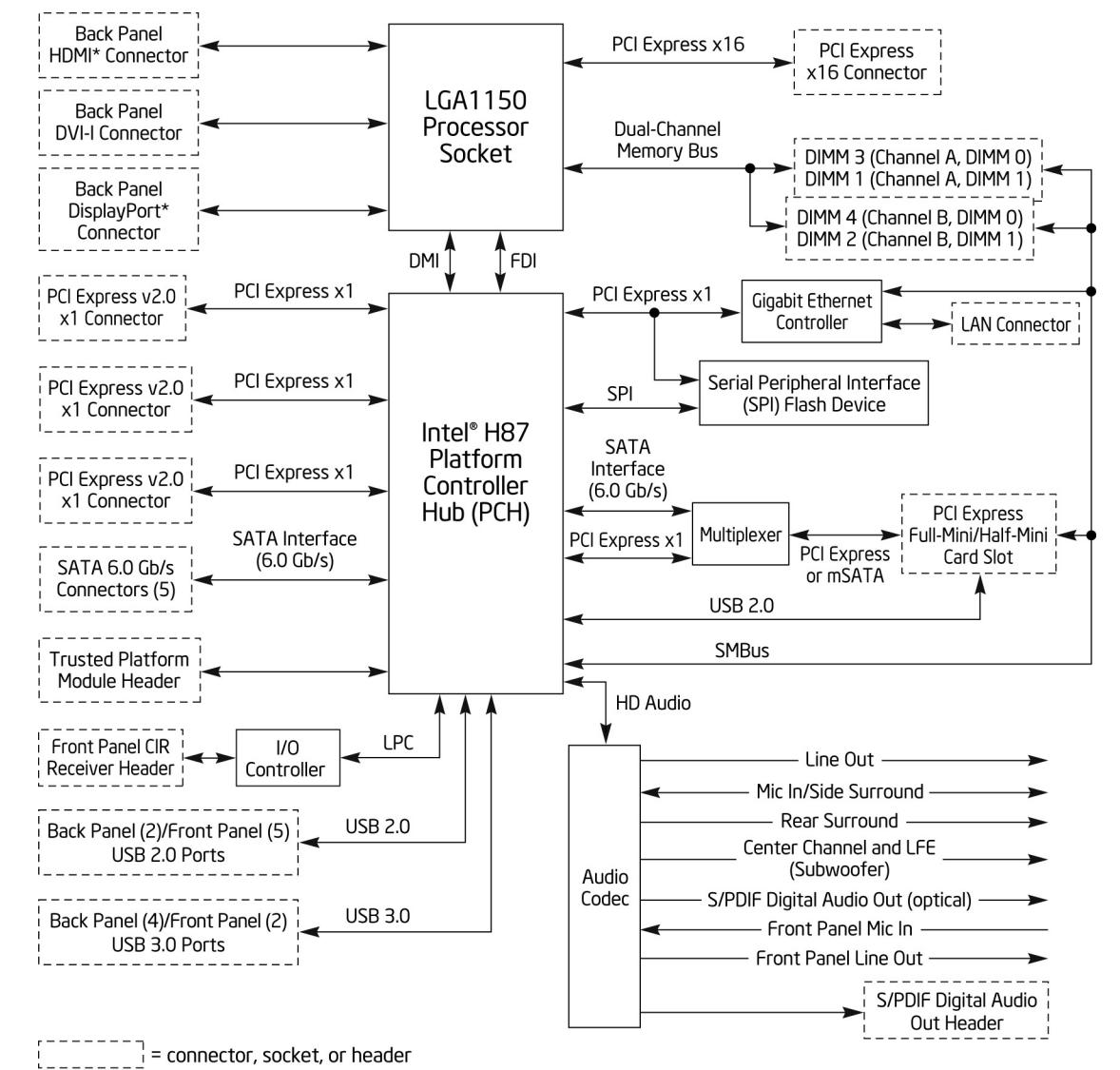


Figure 2. Block Diagram

OM23933

1.2 Online Support

To find information about...

Intel Desktop Board DH87RL

Desktop Board Support

Available configurations for Intel Desktop Board DH87RL

Supported processors

Chipset information

BIOS and driver updates

Tested memory

Integration information

Visit this World Wide Web site:

<http://www.intel.com/products/motherboard/index.htm>

http://www.intel.com/p/en_US/support?iid=hdr+support

<http://ark.intel.com>

<http://processormatch.intel.com>

<https://www-ssl.intel.com/content/www/us/en/chipsets/performance-chipsets/chipsets.html>

<http://downloadcenter.intel.com>

<http://www.intel.com/support/motherboards/desktop/sb/CS-025414.htm>

<http://www.intel.com/support/go/buildit>

1.3 Processor

The board supports 4th generation Intel Core processors. Other processors may be supported in the future. This board supports processors with a maximum wattage of 95 W Thermal Design Power (TDP). The processors listed above are only supported when falling within the wattage requirements of Intel Desktop Board DH87RL. See the Intel web site listed below for the most up-to-date list of supported processors.

For information about...

Supported processors

Refer to:

<http://processormatch.intel.com>



CAUTION

Use only the processors listed on the web site above. Use of unsupported processors can damage the board, the processor, and the power supply.



NOTE

This board has specific requirements for providing power to the processor. Refer to Section 2.5.1 on page 56 for information on power supply requirements for this board.

1.3.1 Processor Graphics Subsystem

The board supports graphics through either the processor Intel HD Graphics or a PCI Express x16 add-in graphics card.

The board supports integrated graphics for processors with Intel HD Graphics.

1.3.1.1 Intel® High Definition (Intel® HD) Graphics

The Intel HD graphics controller features the following:

- 3D Features
 - DirectX* 11.1 support
 - OpenGL* 4.0 support
- Video
 - Next Generation Intel® Clear Video Technology HD support is a collection of video playback and enhancement features that improve the end user's viewing experience
 - Encode/transcode HD content
 - Playback of high definition content including Blu-ray* disc
 - Superior image quality with sharper, more colorful images
 - Playback of Blu-ray disc S3D content using HDMI (1.4a spec compliant with 3D)
 - DirectX* Video Acceleration (DXVA) support for accelerating video processing
 - Full AVC/VC1/MPEG2 HW Decode
 - Intel® HD Graphics with Advanced Hardware Video Transcoding (Intel® Quick Sync Video)

Note: Intel Quick Sync Video is enabled by an appropriate software application.

1.3.1.2 Digital Visual Interface (DVI-I)

The DVI-I port supports both digital and analog DVI displays. The maximum supported resolution is 1920 x 1200 @ 60Hz. The DVI port is compliant with the DVI 1.0 specification. DVI analog output can also be converted to VGA using a DVI-VGA converter.

Depending on the type of add-in card installed in the PCI Express x16 connector, the DVI port will behave as described in Table 3.

Table 3. DVI Port Status Conditions

| PCI Express x16 Connector Status | DVI Digital (DVI-D) Port Status | DVI Analog (DVI-A) Port Status <small>(Note 1)</small> |
|---------------------------------------|------------------------------------|---|
| No add-in card installed | Enabled | Enabled |
| PCI Express x16 add-in card installed | Enabled <small>(Note 2)</small> | Enabled <small>(Note 2)</small> |

Notes:

1. DVI analog output can also be converted to VGA with a DVI-VGA converter.
2. May require BIOS setup menu changes.

1.3.1.3 High Definition Multimedia Interface* (HDMI*)

The High-Definition Multimedia Interface (HDMI) is provided for transmitting uncompressed digital audio and video signals to television sets, projectors and other video displays. It can carry high quality multi-channel audio data and all standard and high-definition consumer electronics video formats. The HDMI display interface connecting the processor and display devices utilizes transition minimized differential signaling (TMDS) to carry audiovisual information through the same HDMI cable. The processor HDMI interface is designed according to the High-Definition Multimedia Interface Specification with 3D, 4K, Deep Color, and x.v.Color.

The maximum supported resolution is 4096 x 2304 @ 24Hz or 2560 x 1600 @ 60Hz. The HDMI interface supports the HDMI 1.4a specification.

Depending on the type of add-in card installed in the PCI Express x16 connector, the HDMI port will behave as described in Table 4.

Table 4. HDMI Port Status Conditions

| PCI Express x16 Connector Status | HDMI Port Status |
|---------------------------------------|-------------------------------|
| No add-in card installed | Enabled |
| PCI Express x16 add-in card installed | Enabled <small>(Note)</small> |

Note: May require BIOS setup menu changes.

1.3.1.4 DisplayPort*

DisplayPort is a digital communication interface that utilizes differential signaling to achieve a high bandwidth bus interface designed to support connections between PCs and monitors, projectors, and TV displays. DisplayPort is suitable for display connections between consumer electronics devices such as high definition optical disc players, set top boxes, and TV displays. DisplayPort output can also be converted to HDMI using a DisplayPort-HDMI converter. The DisplayPort interface supports the 1.2 specification, including Multi-Stream Transport (MST) for monitor daisy-chaining.

DisplayPort's maximum supported display resolution is 3840 x 2160 @ 60 Hz.

Table 5. DisplayPort Status Conditions

| PCI Express x16 Connector Status | DisplayPort Status |
|---------------------------------------|-------------------------------|
| No add-in card installed | Enabled |
| PCI Express x16 add-in card installed | Enabled <small>(Note)</small> |

Note: May require BIOS setup menu changes.

For information about

DisplayPort technology

Refer to

<http://www.displayport.org>

1.3.1.5 High-bandwidth Digital Content Protection (HDCP)

HDCP is the technology for protecting high definition content against unauthorized copy or interception between a source (computer, digital set top boxes, etc.) and the sink (panels, monitor, and TVs). The PCH supports HDCP 1.4 for content protection over wired displays (HDMI, DVI, and DisplayPort).

1.3.1.6 Integrated Audio Provided by the HDMI and DisplayPort Interfaces

The HDMI and DisplayPort interfaces from the PCH support audio. The processor supports two High Definition audio streams on two digital ports simultaneously.

Table 6 shows the specific audio technologies supported by the PCH.

Table 6. Audio Formats Supported by the HDMI and DisplayPort Interfaces

| Audio Formats | HDMI | DisplayPort |
|---|------|-------------|
| AC-3 - Dolby* Digital | Yes | Yes |
| Dolby Digital Plus | Yes | Yes |
| DTS-HD* | Yes | Yes |
| LPCM, 192 kHz/24 bit, 8 Channel | Yes | Yes |
| Dolby TrueHD, DTS-HD Master Audio* (Lossless Blu-ray Disc Audio Format) | Yes | Yes |

1.3.1.7 Multiple Display Configurations

The following multiple display configuration modes are supported (with appropriate driver software):

- Single Display is a mode with one display port activated to display the output to one display device.
- Intel® Display Clone is a mode with up to three display ports activated to drive the display content of same color depth setting but potentially different refresh rate and resolution settings to all the active display devices connected.
- Extended Desktop is a mode with up to three display ports activated to drive the content with potentially different color depth, refresh rate, and resolution settings on each of the active display devices connected.

1.3.1.8 PCI Express Graphics

4th generation Intel Core processors support PCI Express 3.0, 2.x, and 1.x:

- PCI Express 3.0 with a raw bit rate of 8.0 GT/s results in an effective bandwidth of 1 GB/s each direction per lane. The maximum theoretical bandwidth of the x16 interface is 16 GB/s in each direction, simultaneously, for a total bandwidth of 32 GB/s.
- PCI Express 2.x with a raw bit rate of 5.0 GT/s results in an effective bandwidth of 500 MB/s each direction per lane. The maximum theoretical bandwidth of the x16 interface is 8 GB/s in each direction, simultaneously, for a total bandwidth of 16 GB/s.
- PCI Express 1.x with a raw bit rate of 2.5 GT/s results in an effective bandwidth of 250 MB/s each direction per lane. The maximum theoretical bandwidth of the x16 interface is 4 GB/s in each direction, simultaneously, for a total bandwidth of 8 GB/s.

| For information about | Refer to |
|------------------------|---|
| PCI Express technology | http://www.pcisig.com |

1.4 Intel® H87 Express Chipset

Intel H87 Express Chipset with Direct Media Interface (DMI) interconnect provides interfaces to the processor and USB, SATA, LPC, LAN, and PCI Express. The Intel H87 Express Chipset is a centralized controller for the board's I/O paths.

| For information about | Refer to |
|-------------------------------|---|
| The Intel H87 chipset | http://www.intel.com/products/desktop/chipsets/index.htm |
| Resources used by the chipset | Chapter 2 |

1.4.1 Direct Media Interface (DMI)

Direct Media Interface (DMI) is the chip-to-chip connection between the processor and the PCH. This high-speed interface integrates advanced priority-based servicing allowing for concurrent traffic and true isochronous transfer capabilities.

1.5 System Memory

The board has four DIMM sockets and supports the following memory features:

- 1.5 V DDR3 SDRAM DIMMs with gold plated contacts, with the option to raise the voltage to support higher performance DDR3 SDRAM DIMMs.
- 1.35 V Low Voltage DDR3 DIMMs (JEDEC specification)
- Two independent memory channels with interleaved mode support
- Unbuffered, single-sided or double-sided DIMMs with the following restriction:
Double-sided DIMMs with x16 organization are not supported.
- 32 GB maximum total system memory (with 4 Gb memory technology). Refer to Section 2.1.1 on page 39 for information on the total amount of addressable memory.
- Minimum recommended total system memory: 1 GB
- Non-ECC DIMMs
- Serial Presence Detect
- DDR3 1333 MHz to DDR3 1600 MHz SDRAM DIMMs
- XMP version 1.3 performance profile support for memory speeds up to 1600 MHz



NOTE

To be fully compliant with all applicable DDR SDRAM memory specifications, the board should be populated with DIMMs that support the Serial Presence Detect (SPD) data structure. This allows the BIOS to read the SPD data and program the chipset to accurately configure memory settings for optimum performance. If non-SPD memory is installed, the BIOS will attempt to correctly configure the memory settings, but performance and reliability may be impacted or the DIMMs may not function under the determined frequency.

Table 7 lists the supported DIMM configurations.

Table 7. Supported Memory Configurations

| DIMM Capacity | Configuration (Note) | SDRAM Density | SDRAM Organization Front-side/Back-side | Number of SDRAM Devices |
|---------------|----------------------|---------------|---|-------------------------|
| 1024 MB | SS | 1 Gbit | 128 M x8/empty | 8 |
| 2048 MB | DS | 1 Gbit | 128 M x8/128 M x8 | 16 |
| 4096 MB | DS | 2 Gbit | 256 M x8/256 M x8 | 16 |
| 4096 MB | SS | 4 Gbit | 512 M x8/empty | 8 |
| 8192 MB | DS | 4 Gbit | 512 M x8/512 M x8 | 16 |

Note: "DS" refers to double-sided memory modules (containing two rows of SDRAM) and "SS" refers to single-sided memory modules (containing one row of SDRAM).

For information about...

Refer to:

Tested Memory

<http://support.intel.com/support/motherboards/desktop/sb/CS-025414.htm>

1.5.1 Memory Configurations

4th generation Intel Core processors support the following types of memory organization:

- **Dual channel (Interleaved) mode.** This mode offers the highest throughput for real world applications. Dual channel mode is enabled when the installed memory capacities of both DIMM channels are equal. Technology and device width can vary from one channel to the other but the installed memory capacity for each channel must be equal. If different speed DIMMs are used between channels, the slowest memory timing will be used.
- **Single channel (Asymmetric) mode.** This mode is equivalent to single channel bandwidth operation for real world applications. This mode is used when only a single DIMM is installed or the memory capacities are unequal. Technology and device width can vary from one channel to the other. If different speed DIMMs are used between channels, the slowest memory timing will be used.
- **Flex mode.** This mode provides the most flexible performance characteristics. The bottommost DRAM memory (the memory that is lowest within the system memory map) is mapped to dual channel operation; the topmost DRAM memory (the memory that is nearest to the 8 GB address space limit), if any, is mapped to single channel operation. Flex mode results in multiple zones of dual and single channel operation across the whole of DRAM memory. To use flex mode, it is necessary to populate both channels.

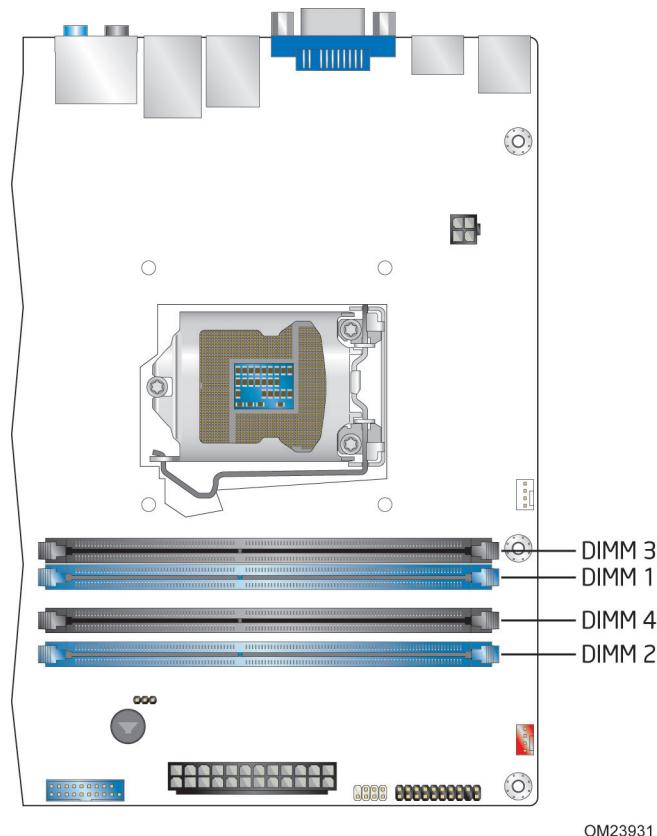
For information about...

Memory Configuration Examples

Refer to:

<http://www.intel.com/support/motherboards/desktop/sb/cs-011965.htm>

Figure 3 illustrates the memory channel and DIMM configuration.



OM23931

Figure 3. Memory Channel and DIMM Configuration



NOTE

For best memory performance always install memory in the blue DIMM sockets if installing only two DIMMs on your board.

1.5.2 USB

The PCH contains up to two Enhanced Host Controller Interface (EHCI) host controllers that support USB high-speed signaling. High-speed USB 2.0 allows data transfers up to 480 Mb/s. All ports are high-speed, full-speed, and low-speed capable.

The PCH also contains an integrated eXtensible Host Controller Interface (xHCI) host controller which supports USB 3.0 ports. This controller allows data transfers up to 5 Gb/s. The controller supports SuperSpeed (SS), high-speed (HS), full-speed (FS), and low-speed (LS) traffic on the bus.

The Intel H87 Express Chipset provides the USB controller for the USB 2.0/3.0 ports. The port arrangement is as follows:

- USB 3.0 ports:
 - Four USB 3.0 ports are implemented with stacked back panel connectors
 - Two front panel USB 3.0 ports are implemented through one internal connector
- USB 2.0 ports:
 - Two ports are implemented with stacked back panel connectors
 - Four front panel ports are implemented through two dual-port internal connectors
 - One single-port internal header for front panel cabling
 - One port is reserved for the PCI Express Full-/Half-Mini Card slot



NOTE

Computer systems that have an unshielded cable attached to a USB port may not meet FCC Class B requirements, even if no device is attached to the cable. Use a shielded cable that meets the requirements for full-speed devices.

| For information about | Refer to |
|--|-------------------|
| The location of the USB connectors on the back panel | Figure 8, page 41 |
| The location of the front panel USB headers | Figure 9, page 42 |

1.5.3 SATA Interfaces

The board provides five SATA connectors, through the PCH, which support one device each.

The PCH provides independent SATA ports with a theoretical maximum transfer rate of 6.0 Gb/s. A point-to-point interface is used for host to device connections.

The PCH supports the Serial ATA Specification, Revision 3.0. The PCH also supports several optional sections of the Serial ATA II: Extensions to Serial ATA 1.0 Specification, Revision 1.0 (AHCI support is required for some elements).

For more information, see: <http://www.serialata.org/>.

| For information about | Refer to |
|-------------------------------------|-------------------|
| The location of the SATA connectors | Figure 9, page 42 |

1.5.3.1 Intel® Rapid Storage Technology / SATA RAID

The PCH supports Intel® Rapid Storage Technology, providing both AHCI and integrated RAID functionality. The RAID capability provides high-performance RAID 0, 1, 5, and 10 functionality on all SATA ports. Other RAID features include hot spare support, SMART alerting, and RAID 0 auto replace. Software components include an Option ROM for pre-boot configuration and boot functionality, a Microsoft* Windows* compatible driver, and a user interface for configuration and management of the RAID capability of the PCH.

1.5.3.2 Intel® Smart Response Technology

Intel® Smart Response Technology is a disk caching solution that can provide improved computer system performance with improved power savings. It allows configuration of a computer system with the advantage of having HDDs for maximum storage capacity with system performance at or near SSD performance levels.

For more information on Intel Smart Response Technology, go to
<http://www.intel.com/support/chipsets/sb/CS-032826.htm>



NOTE

In order to use supported RAID and Intel Smart Response Technology features, you must first enable RAID in the BIOS.

1.6 Real-Time Clock Subsystem

A coin-cell battery (CR2032) powers the real-time clock and CMOS memory. When the computer is not plugged into a wall socket, the battery has an estimated life of three years. When the computer is plugged in, the standby current from the power supply extends the life of the battery. The clock is accurate to \pm 13 minutes/year at 25 °C with 3.3 V_{STBY} applied via the power supply 5 V_{STBY} rail.



NOTE

If the battery and AC power fail, date and time values will be reset and the user will be notified during the Power-On-Self-Test (POST).

When the voltage drops below a certain level, the BIOS Setup program settings stored in CMOS RAM (for example, the date and time) might not be accurate. Replace the battery with an equivalent one. Figure 1 on page 13 shows the location of the battery.

1.7 Super I/O Controller

The I/O controller provides the following features:

- Consumer Infrared (CIR) header
- Serial IRQ interface compatible with serialized IRQ support for PCI systems
- Intelligent power management, including a programmable wake-up event interface

The BIOS Setup program provides configuration options for the I/O controller.

| For information about | Refer to |
|------------------------------|--------------------------|
| CIR header | Heading 2.2.2.7, page 52 |

1.8 Audio Subsystem

The board supports Intel HD Audio via the Realtek ALC892 audio codec. The audio subsystem supports the following features:

- Advanced jack sense for the back panel audio jacks that enables the audio codec to recognize the device that is connected to an audio port.
- Digital-to-Analog Converters (DAC) with 95 dB SNR (A-weighting) and Analog-to-Digital Converters (ADC) with 90 dB SNR (A-weighting).
- Ten DAC channels support 16/20/24-bit PCM format for 7.1 channel sound playback, plus two channels of concurrent independent stereo sound output (multiple streaming) through the front panel output.
- Two stereo ADCs support 16/20-bit PCM format, multiple stereo recording
- Microphone Acoustic Echo Cancellation (AEC), Noise Suppression (NS), and Beam Forming (BF) technology for voice applications.
- Windows 7 Ultimate and Windows 8 Pro certification.

Table 8 lists the supported functions of the front panel and back panel audio jacks.

Table 8. Audio Jack Support

| Audio Jack | Micro-phone | Head-phones | Front Speaker | Line-In | Rear Surround | Center/Sub | Side Surround |
|-------------|-------------|-------------|---------------|------------|---------------|------------|---------------|
| FP Green | | Default | Ctrl panel | Ctrl panel | | | |
| FP Pink | Default | Ctrl panel | | Ctrl panel | | | |
| Rear Blue | | | Ctrl panel | Default | Ctrl panel | Ctrl panel | Ctrl panel |
| Rear Green | | Ctrl panel | Default | Ctrl panel | | | |
| Rear Pink | Default | | Ctrl panel | Ctrl panel | Ctrl panel | Ctrl panel | Ctrl panel |
| Rear Black | | | | Ctrl panel | Default | | |
| Rear Orange | | | | Ctrl panel | | Default | |

1.8.1 Audio Subsystem Software

The latest audio software and drivers are available from Intel's World Wide Web site.

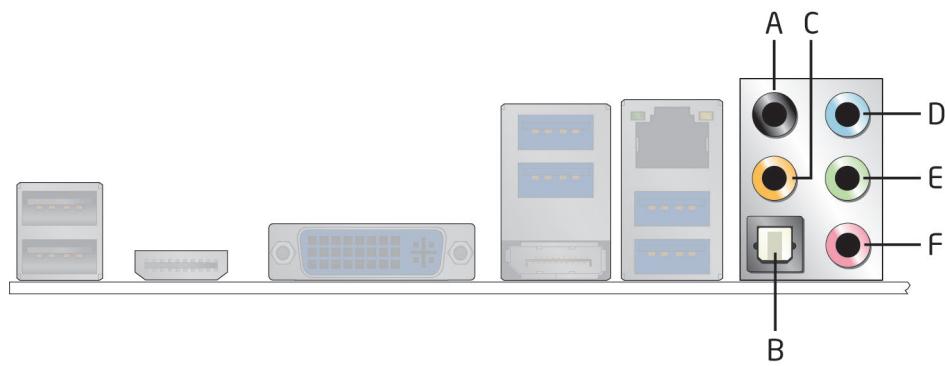
| For information about | Refer to |
|--------------------------------------|---|
| Obtaining audio software and drivers | Section 1.2, page 16 |
| Realtek 892 | http://www.realtek.com.tw/products/productsView.aspx?Langid=1&PFid=28&Level=5&Conn=4&ProdID=284 |

1.8.2 Audio Subsystem Components

The audio subsystem includes the following components:

- Intel H87 Express Chipset
- Realtek ALC892 audio codec
- Front panel audio header that supports Intel HD audio and AC '97 audio (a 2 x 5-pin header that provides mic in and line out signals for front panel audio connectors) (yellow)
- S/PDIF digital audio out header (1 x 4-pin header) (yellow)
- S/PDIF digital audio out connector on the back panel
- 5-port analog audio input/output stack on the back panel

The back panel audio connectors are configurable through the audio device drivers. The available configurable back panel audio connectors are shown in Figure 4.



| Item | Description |
|------|------------------------------------|
| A | Rear surround |
| B | S/PDIF out (optical) |
| C | Center channel and LFE (subwoofer) |
| D | Line-in |
| E | Front speaker |
| F | Mic-in |

Figure 4. Back Panel Audio Connectors



NOTE

The back panel audio line out connector is designed to power headphones or amplified speakers only. Poor audio quality occurs if passive (non-amplified) speakers are connected to this output.

For information about

Refer to

The locations of the front panel audio header and S/PDIF audio header

Figure 9, page 42

The signal names of the front panel audio header and S/PDIF audio header

Section 2.2.2.1, page 44

The back panel audio connectors

Section 2.2.1, page 41

1.9 LAN Subsystem

The LAN subsystem consists of the following:

- Intel I217V Gigabit Ethernet Controller (10/100/1000 Mb/s)
- Intel H87 Express Chipset
- RJ-45 LAN connector with integrated status LEDs

Additional features of the LAN subsystem include:

- CSMA/CD protocol engine
- LAN connect interface between the PCH and the LAN controller
- ACPI technology support
- LAN wake capabilities
- LAN subsystem software

| For information about | Refer to |
|--------------------------|---|
| LAN software and drivers | http://downloadcenter.intel.com |

1.9.1 Intel® I217V Gigabit Ethernet Controller

The Intel I217V Gigabit Ethernet Controller supports the following features:

Network Features:

- Compliant with the 1 Gb/s Ethernet 802.3, 802.3u, 802.3z, 802.3ab specifications
- Multi-speed operation: 10/100/1000 Mb/s
- Full-duplex operation at 10/100/1000 Mb/s; Half-duplex operation at 10/100 Mb/s
- Flow control support compliant with the 802.3X specification as well as the specific operation of asymmetrical flow control defined by 802.3z
- VLAN support compliant with the 802.3q specification
- MAC address filters: perfect match unicast filters, multicast hash filtering, broadcast filter, and promiscuous mode

Performance Features:

- Configurable receive and transmit data FIFO, programmable in 1 KB increments
- TCP segmentation capability compatible with Windows NT 5.x off-loading features
- Fragmented UDP checksum offload for packet reassembly
- IPv4 and IPv6 checksum offload support (receive, transmit, and TCP segmentation offload)
- Split header support to eliminate payload copy from user space to host space
- Receive Side Scaling (RSS) with two hardware receive queues
- Supports 9018 bytes of jumbo packets
- Packet buffer size
- LinkSec offload compliant with 802.3ae specification
- TimeSync offload compliant with 802.1as specification

Power Management Features:

- Magic Packet* wake-up enable with unique MAC address
- ACPI register set and power down functionality supporting D0 and D3 states
- Full wake up support (APM, ACPI)
- MAC power down at Sx, DMoff with and without WoL
- Auto connect battery saver at S0 no link and Sx no link
- Energy Efficient Ethernet (EEE) support
- Latency Tolerance Reporting (LTR)
- Optimized Buffer Flash/Fill (OBFF) support
- ARP and ND proxy support through LAN Connected Device proxy
- Wake on LAN (WoL) from Deep Sx
- Provides lower power usage to meet ENERGY STAR 5.2 and ErP specifications

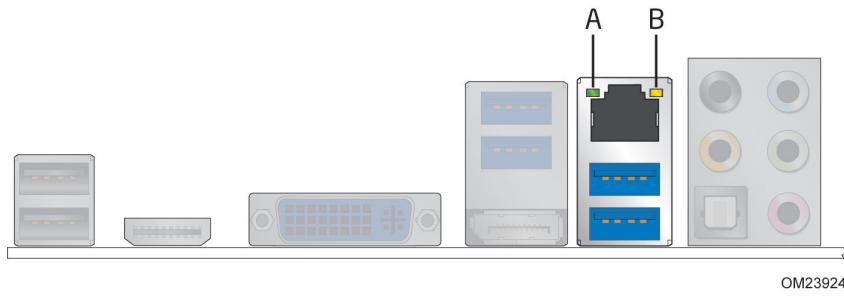
1.9.2 LAN Subsystem Software

LAN software and drivers are available from Intel's World Wide Web site.

| For information about | Refer to |
|------------------------------------|---|
| Obtaining LAN software and drivers | http://downloadcenter.intel.com |

1.9.3 RJ-45 LAN Connector with Integrated LEDs

Two LEDs are built into the RJ-45 LAN connector (shown in Figure 5).



| Item | Description |
|-------------|------------------------------|
| A | Link LED (Green) |
| B | Data Rate LED (Green/Yellow) |

Figure 5. LAN Connector LED Locations

Table 9 describes the LED states when the board is powered up and the LAN subsystem is operating.

Table 9. LAN Connector LED States

| LED | LED Color | LED State | Condition |
|------------|------------------|------------------|----------------------------------|
| Link | Green | Off | LAN link is not established. |
| | | On | LAN link is established. |
| | | Blinking | LAN activity is occurring. |
| Data Rate | Green/Yellow | Off | 10 Mb/s data rate is selected. |
| | | Green | 100 Mb/s data rate is selected. |
| | | Yellow | 1000 Mb/s data rate is selected. |

1.10 Hardware Management Subsystem

The hardware management features enable the board to be compatible with the Wired for Management (WfM) specification. The board has several hardware management features, including the following:

- Thermal and voltage monitoring
- Chassis intrusion detection

1.10.1 Hardware Monitoring

The hardware monitoring and fan control subsystem is based on the Nuvoton NCT6883D-T device, which supports the following:

- Processor and system ambient temperature monitoring
- Chassis fan speed monitoring
- Power monitoring of +12 V, +5 V, +3.3 V, V_{SM} , $+V_{CCP}$, and PCH V_{CC}
- SMBus interface

1.10.2 Fan Monitoring

Fan monitoring can be implemented using Intel® Desktop Utilities or third-party software.

| For information about | Refer to |
|----------------------------------|---------------------------|
| The functions of the fan headers | Section 1.11.2.2, page 36 |

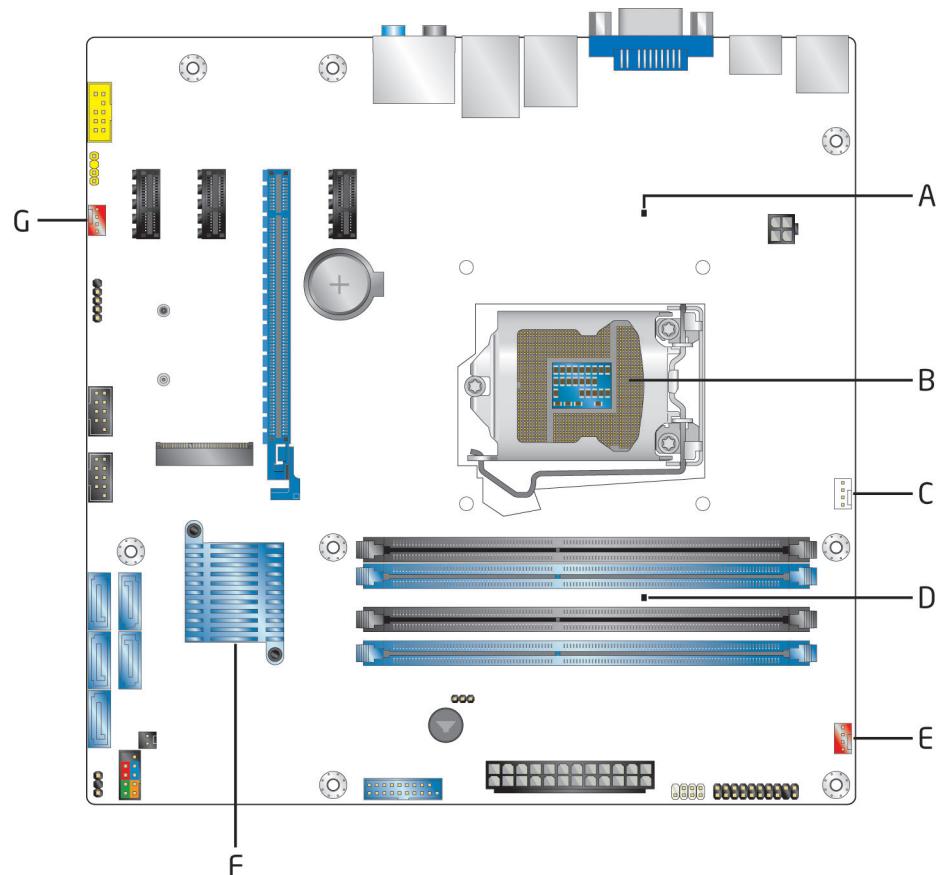
1.10.3 Chassis Intrusion and Detection

The board supports a chassis security feature that detects if the chassis cover is removed. The security feature uses a mechanical switch on the chassis that attaches to the chassis intrusion header. When the chassis cover is removed, the mechanical switch is in the closed position.

| For information about | Refer to |
|--|-------------------|
| The location of the chassis intrusion header | Figure 9, page 42 |

1.10.4 Thermal Monitoring

Figure 6 shows the locations of the thermal sensors and fan headers.



OM23932

| Item | Description |
|------|---|
| A | Voltage regulator thermal sensor |
| B | Thermal diode, located on the processor die |
| C | Processor fan header |
| D | DIMM thermal sensor |
| E | Front chassis fan header |
| F | Thermal diode, located on the Intel H87 PCH |
| G | Rear chassis fan header |

Figure 6. Thermal Sensors and Fan Headers

1.11 Power Management

Power management is implemented at several levels, including:

- Software support through Advanced Configuration and Power Interface (ACPI)
- Hardware support

1.11.1 Software Support (ACPI)

ACPI gives the operating system direct control over the power management and Plug and Play functions of a computer. The use of ACPI with this board requires an operating system that provides full ACPI support. ACPI features include:

- Plug and Play (including bus and device enumeration)
- Power management control of individual devices, add-in boards (some add-in boards may require an ACPI-aware driver), video displays, and hard disk drives
- Methods for achieving less than 15-watt system operation in the power-on/standby sleeping state
- A Soft-off feature that enables the operating system to power-off the computer
- Support for multiple wake-up events (see Table 12 on page 34)
- Support for a front panel power and sleep mode switch

Table 10 lists the system states based on how long the power switch is pressed, depending on how ACPI is configured with an ACPI-aware operating system.

Table 10. Effects of Pressing the Power Switch

| If the system is in this state... | ...and the power switch is pressed for | ...the system enters this state |
|-------------------------------------|--|--|
| Off (ACPI G2/G5 – Soft off) | Less than four seconds | Power-on (ACPI G0 – working state) |
| On (ACPI G0 – working state) | Less than four seconds | Soft-off/Standby (ACPI G1 – sleeping state) |
| On (ACPI G0 – working state) | More than six seconds | Fail safe power-off (ACPI G2/G5 – Soft off) |
| Sleep (ACPI G1 – sleeping state) | Less than four seconds | Wake-up (ACPI G0 – working state) |
| Sleep (ACPI G1 – sleeping state) | More than six seconds | Power-off (ACPI G2/G5 – Soft off) |

1.11.1.1 System States and Power States

Under ACPI, the operating system directs all system and device power state transitions. The operating system puts devices in and out of low-power states based on user preferences and knowledge of how devices are being used by applications. Devices that are not being used can be turned off. The operating system uses information from applications and user settings to put the system as a whole into a low-power state.

Table 11 lists the power states supported by the board along with the associated system power targets. See the ACPI specification for a complete description of the various system and power states.

Table 11. Power States and Targeted System Power

| Global States | Sleeping States | Processor States | Device States | Targeted System Power <small>(Note 1)</small> |
|--|--|-------------------------|--|--|
| G0 – working state | S0 – working | C0 – working | D0 – working state. | Full power > 30 W |
| G1 – sleeping state | S3 – Suspend to RAM. Context saved to RAM. | No power | D3 – no power except for wake-up logic. | Power < 5 W <small>(Note 2)</small> |
| G1 – sleeping state | S4 – Suspend to disk. Context saved to disk. | No power | D3 – no power except for wake-up logic. | Power < 5 W <small>(Note 2)</small> |
| G2/S5 | S5 – Soft off. Context not saved. Cold boot is required. | No power | D3 – no power except for wake-up logic. | Power < 5 W <small>(Note 2)</small> |
| G3 – mechanical off AC power is disconnected from the computer. | No power to the system. | No power | D3 – no power for wake-up logic, except when provided by battery or external source. | No power to the system. Service can be performed safely. |

Notes:

1. Total system power is dependent on the system configuration, including add-in boards and peripherals powered by the system chassis' power supply.
2. Dependent on the standby power consumption of wake-up devices used in the system.

1.11.1.2 Wake-up Devices and Events

Table 12 lists the devices or specific events that can wake the computer from specific states.

Table 12. Wake-up Devices and Events

| These devices/events can wake up the computer... | ...from this state |
|---|---|
| Power switch | S3, S4, S5 <small>(Note 1)</small> |
| RTC alarm | S3, S4, S5 <small>(Note 1)</small> |
| LAN | S3, S4, S5 <small>(Notes 1and 3)</small> |
| USB | S3 |
| WAKE# | S3, S4, S5 <small>(Note 1)</small> |
| Consumer IR | S3, S4, S5 <small>(Notes 2 and 4)</small> |

Notes:

1. S4 implies operating system support only.
2. Wake from S4 and S5 is recommended by Microsoft
3. Wake on LAN is only supported from sleep (S3) or hibernate (S4) in Windows 8.
4. When Deep S4/S5 is enabled only Wake from RTC and Front Panel is supported.



NOTE

The use of these wake-up events from an ACPI state requires an operating system that provides full ACPI support. In addition, software, drivers, and peripherals must fully support ACPI wake events.

1.11.2 Hardware Support



CAUTION

Ensure that the power supply provides adequate +5 V standby current if LAN wake capabilities and Instantly Available PC technology features are used. Failure to do so can damage the power supply. The total amount of standby current required depends on the wake devices supported and manufacturing options.

The board provides several power management hardware features, including:

- Power connector
- Fan headers
- LAN wake capabilities
- Instantly Available PC technology
- Wake from USB
- PCI Express WAKE# signal support
- Wake from Consumer IR
- Wake from S5
- Power Supervisor
- +5 V Standby Power Indicator LED

LAN wake capabilities and Instantly Available PC technology require power from the +5 V standby line.



NOTE

The use of Wake from USB from an ACPI state requires an operating system that provides full ACPI support.

1.11.2.1 Power Connector

ATX12V-compliant power supplies can turn off the system power through system control. When an ACPI-enabled system receives the correct command, the power supply removes all non-standby voltages.

When resuming from an AC power failure, the computer returns to the power state it was in before power was interrupted (on or off). The computer's response can be set using the Last Power State feature in the BIOS Setup program's Boot menu.

| For information about | Refer to |
|--|-------------------|
| The location of the main power connector | Figure 9, page 42 |
| The signal names of the main power connector | Table 27, page 48 |

1.11.2.2 Fan Headers

The function/operation of the fan headers is as follows:

- The fans are on when the board is in the S0 state
- The fans are off when the board is off or in the S3, S4, or S5 state
- Each fan header is wired to a fan tachometer input of the SIO
- All fan headers support closed-loop fan control that can adjust the fan speed or switch the fan on or off as needed
- All fan headers have a +12 V DC connection
- The fan headers are controlled by Pulse Width Modulation

| For information about | Refer to |
|--|-------------------|
| The location of the fan headers | Figure 9, page 42 |
| The location of the fan headers and sensors for thermal monitoring | Figure 6, page 32 |

1.11.2.3 LAN Wake Capabilities



CAUTION

For LAN wake capabilities, the +5 V standby line for the power supply must be capable of providing adequate +5 V standby current. Failure to provide adequate standby current when implementing LAN wake capabilities can damage the power supply.

LAN wake capabilities enable remote wake-up of the computer through a network. The LAN subsystem PCI bus network adapter monitors network traffic at the Media Independent Interface. Upon detecting a Magic Packet* frame, the LAN subsystem asserts a wake-up signal that powers up the computer. Table 12 on page 34 lists the devices and events that can wake the computer from the S3 state. Depending on the LAN implementation, the board supports LAN wake capabilities with ACPI in the following ways:

- The PCI Express WAKE# signal
- By Ping
- Magic Packet
- The onboard LAN subsystem

1.11.2.4 Instantly Available PC Technology



CAUTION

For Instantly Available PC technology, the +5 V standby line for the power supply must be capable of providing adequate +5 V standby current. Failure to provide adequate standby current when implementing Instantly Available PC technology can damage the power supply.

Instantly Available PC technology enables the board to enter the ACPI S3 (Suspend-to-RAM) sleep-state. While in the S3 sleep-state, the computer will appear to be off (the power supply is off, and the front panel LED is amber if dual colored, or off if single colored.) When signaled by a wake-up device or event, the system quickly returns to

its last known wake state. Table 12 on page 34 lists the devices and events that can wake the computer from the S3 state.

The board supports the *PCI Bus Power Management Interface Specification*. Add-in boards that also support this specification can participate in power management and can be used to wake the computer.

The use of Instantly Available PC technology requires operating system support and PCI Express add-in cards and drivers.

1.11.2.5 Wake from USB

USB bus activity wakes the computer from an ACPI S3 state.



NOTE

Wake from USB requires the use of a USB peripheral that supports Wake from USB.

1.11.2.6 WAKE# Signal Wake-up Support

When the WAKE# signal on the PCI Express bus is asserted, the computer wakes from an ACPI S3, S4, or S5 state.

1.11.2.7 Wake from Consumer IR

CIR activity wakes the computer from an ACPI S3, S4, or S5 state.

1.11.2.8 Wake from S5

When the RTC Date and Time is set in the BIOS, the computer will automatically wake from an ACPI S5 state.

1.11.2.9 Power Supervisor

The Power Supervisor actively monitors the input voltages from the power supply and protects the board and any attached peripherals from electrical overstress and possible physical damage. The Power Supervisor will activate if it detects the power supply voltage rails have deviated outside the current ATX power supply specification and safe operating levels.

If the Power Supervisor detects an out of spec voltage, the following will happen:

1. The board will be powered down immediately to protect circuits from electrical overstress and possible physical damage.
2. A red warning LED (see Figure 1) on the board will activate as a visual cue.
3. During the next power on, a message will be displayed on the screen to notify the user that the power supply voltage rails have deviated outside the current ATX power supply specification and safe operating levels.
4. A message will be added to the BIOS Event Log for each event that takes place until the BIOS Event Log is cleared.

1.11.2.10 Enhanced Standby Power LED

The enhanced standby power LED is lit when the board has +5 V standby voltage applied to it. It also blinks as soon as the BIOS has started executing code, once the power button has been pressed and before video has been initialized. Figure 7 shows the location of the LED.



CAUTION

If AC power has been switched off and the standby power indicator is still lit, disconnect the power cord before installing or removing any devices connected to the board. Failure to do so could damage the board and any attached devices.

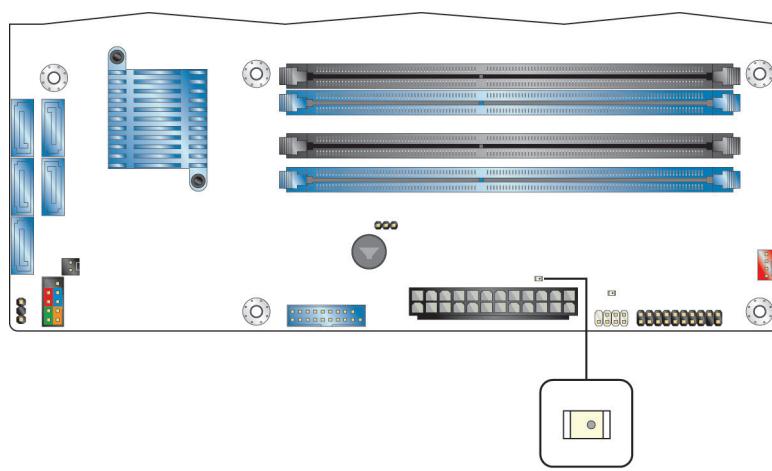


Figure 7. Location of the Enhanced Standby Power LED

2 Technical Reference

2.1 Memory Resources

2.1.1 Addressable Memory

The board utilizes 32 GB of addressable system memory. Typically the address space that is allocated for add-in cards, PCI Express configuration space, BIOS (SPI Flash device), and chipset overhead resides above the top of DRAM (total system memory). On a system that has 32 GB of system memory installed, it is not possible to use all of the installed memory due to system address space being allocated for other system critical functions. These functions include the following:

- BIOS/SPI Flash device (96 Mb)
- Local APIC (19 MB)
- Direct Media Interface (40 MB)
- PCI Express configuration space (256 MB)
- PCH base address registers PCI Express ports (up to 256 MB)
- Memory-mapped I/O that is dynamically allocated for PCI Express add-in cards (256 MB)

The board provides the capability to reclaim the physical memory overlapped by the memory mapped I/O logical address space. The board remaps physical memory from the top of usable DRAM boundary to the 4 GB boundary to an equivalent sized logical address range located just above the 4 GB boundary. All installed system memory can be used when there is no overlap of system addresses.

2.2 Connectors and Headers



CAUTION

Only the following connectors and headers have overcurrent protection: back panel and front panel USB.

The other internal connectors and headers are not overcurrent protected and should connect only to devices inside the computer's chassis, such as fans and internal peripherals. Do not use these connectors or headers to power devices external to the computer's chassis. A fault in the load presented by the external devices could cause damage to the computer, the power cable, and the external devices themselves.

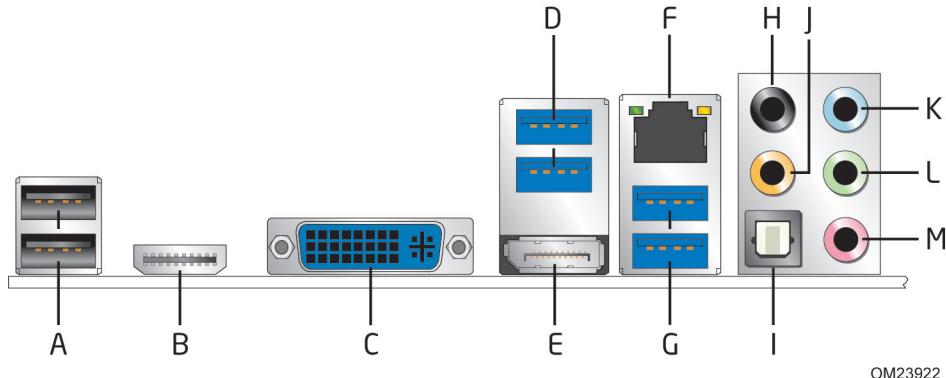
Furthermore, improper connection of USB header single wire connectors may eventually overload the overcurrent protection and cause damage to the board.

This section describes the board's connectors. The connectors can be divided into these groups:

- Back panel I/O connectors
- Component-side connectors and headers (see page 42)

2.2.1 Back Panel Connectors

Figure 8 shows the location of the back panel connectors for the board.



| Item | Description |
|------|------------------------------------|
| A | USB 2.0 connectors |
| B | HDMI connector |
| C | DVI-I connector |
| D | USB 3.0 connectors |
| E | DisplayPort connector |
| F | LAN port |
| G | USB 3.0 connectors |
| H | Rear surround |
| I | S/PDIF out (optical) |
| J | Center channel and LFE (subwoofer) |
| K | Line-in |
| L | Front speaker |
| M | Mic-in |

Figure 8. Back Panel Connectors



NOTE

The back panel audio line out connector is designed to power headphones or amplified speakers only. Poor audio quality occurs if passive (non-amplified) speakers are connected to this output.

2.2.2 Component-side Connectors and Headers

Figure 9 shows the locations of the component-side connectors and headers.

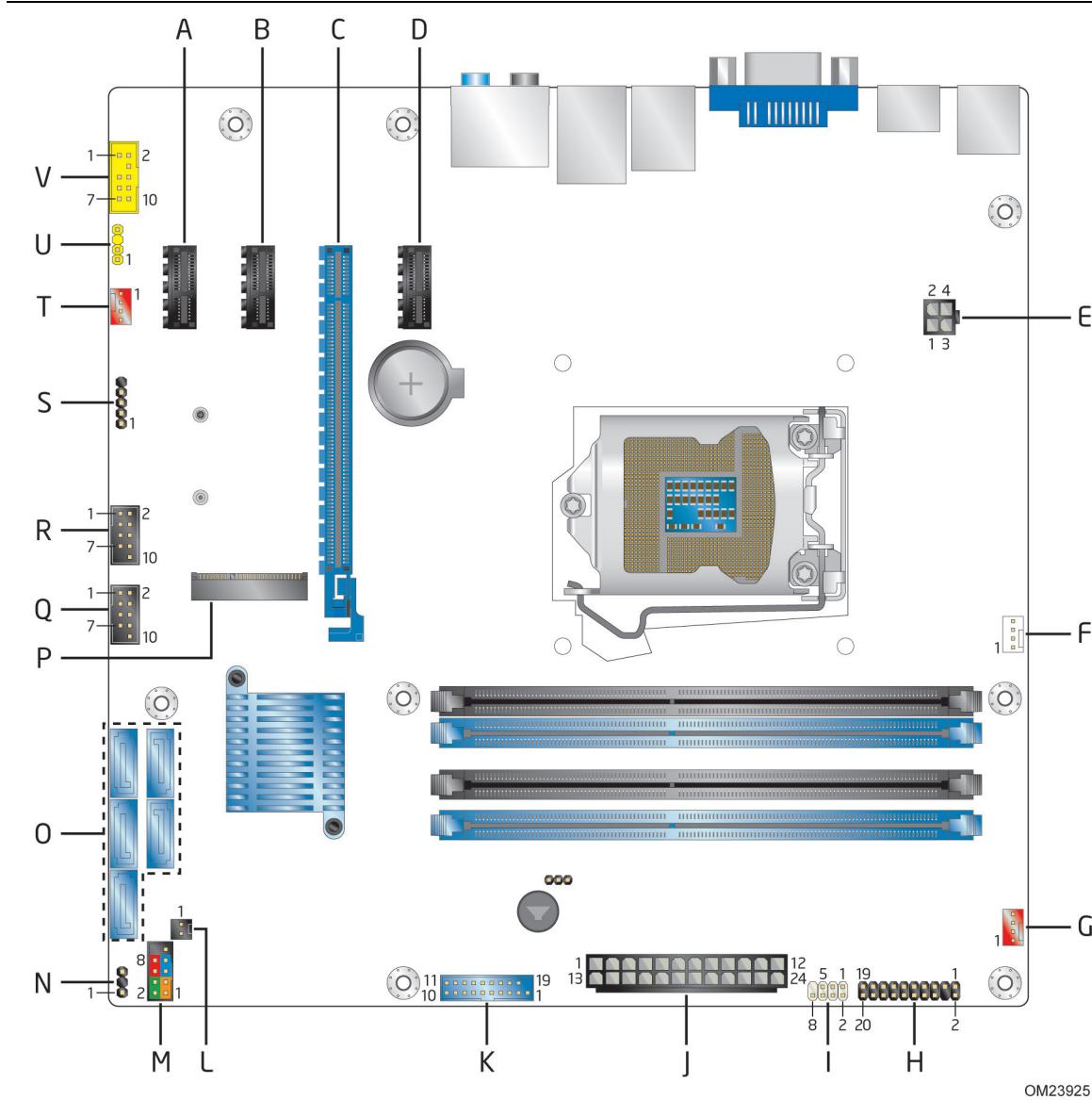


Figure 9. Component-side Connectors and Headers

Table 13 lists the component-side connectors and headers identified in Figure 9.

Table 13. Component-side Connectors and Headers Shown in Figure 9

| Item/callout from Figure 9 | Description |
|----------------------------|--|
| A | PCI Express x1 add-in card connector |
| B | PCI Express x1 add-in card connector |
| C | PCI Express x16 add-in card connector |
| D | PCI Express x1 add-in card connector |
| E | Processor core power connector (2 x 2) |
| F | Processor fan header |
| G | Front fan header |
| H | TPM header |
| I | Consumer IR receiver (input) header |
| J | Main power connector (2 x 12) |
| K | Front panel USB 3.0 connector |
| L | Chassis intrusion header |
| M | Front panel header |
| N | Alternate front panel power/sleep LED header |
| O | SATA 6.0 Gb/s connectors |
| P | PCI Express Full-/Half-Mini Card slot |
| Q | Front panel dual-port USB 2.0 connector |
| R | Front panel dual-port USB 2.0 connector |
| S | Front panel single-port USB 2.0 header |
| T | Rear chassis fan header |
| U | S/PDIF out header |
| V | Front panel audio connector |

2.2.2.1 Signal Tables for the Connectors and Headers

Table 14. Front Panel Audio Connector for Intel HD Audio

| Pin | Signal Name | Pin | Signal Name |
|------------|-----------------------------|------------|----------------------------|
| 1 | [Port 1] Left channel | 2 | Ground |
| 3 | [Port 1] Right channel | 4 | PRESENCE# (Dongle present) |
| 5 | [Port 2] Right channel | 6 | [Port 1] SENSE_RETURN |
| 7 | SENSE_SEND (Jack detection) | 8 | Key (no pin) |
| 9 | [Port 2] Left channel | 10 | [Port 2] SENSE_RETURN |

Table 15. Front Panel Audio Connector for AC '97 Audio

| Pin | Signal Name | Pin | Signal Name |
|------------|-----------------------------|------------|-----------------------|
| 1 | MIC | 2 | AUD_GND |
| 3 | MIC_BIAS | 4 | PRESENCE# |
| 5 | [Port 2] Right channel | 6 | [Port 1] SENSE_RETURN |
| 7 | SENSE_SEND (Jack detection) | 8 | Key (no pin) |
| 9 | [Port 2] Left channel | 10 | [Port 2] SENSE_RETURN |

Table 16. Dual-Port Front Panel USB 2.0 Header

| Pin | Signal Name | Pin | Signal Name |
|------------|--------------------|------------|--------------------|
| 1 | +5 V DC | 2 | +5 V DC |
| 3 | D- | 4 | D- |
| 5 | D+ | 6 | D+ |
| 7 | Ground | 8 | Ground |
| 9 | KEY (no pin) | 10 | No Connect |

Notes: The +5 V DC power on the USB headers is fused.

The Serial POST pin is reserved for compatibility with future POST debug cards

Table 17. Front Panel Single-Port USB 2.0 Header

| Pin | Signal Name |
|------------|--------------------|
| 1 | +5 V DC |
| 2 | D- |
| 3 | D+ |
| 4 | Ground |
| 5 | Key (no pin) |

Table 18. Front Panel USB 3.0 Connector

| Pin | Signal Name | Description |
|------------|--------------------|--------------------------------------|
| 1 | Vbus | Power |
| 2 | IntA_P1_SSRX- | USB 3 ICC Port1 SuperSpeed Rx- |
| 3 | IntA_P1_SSRX+ | USB 3 ICC Port1 SuperSpeed Rx+ |
| 4 | GND | Ground |
| 5 | IntA_P1_SSTX- | USB 3 ICC Port1 SuperSpeed Tx- |
| 6 | IntA_P1_SSTX+ | USB 3 ICC Port1 SuperSpeed Tx+ |
| 7 | GND | Ground |
| 8 | IntA_P1_D- | USB 3 ICC Port1 D- (USB 2 Signal D-) |
| 9 | IntA_P1_D+ | USB 3 ICC Port1 D+ (USB 2 Signal D+) |
| 10 | ID | Over Current Protection |
| 11 | IntA_P2_D+ | USB 3 ICC Port2 D+ (USB 2 Signal D+) |
| 12 | IntA_P2_D- | USB 3 ICC Port2 D- (USB 2 Signal D-) |
| 13 | GND | Ground |
| 14 | IntA_P2_SSTX+ | USB 3 ICC Port2 SuperSpeed Tx+ |
| 15 | IntA_P2_SSTX- | USB 3 ICC Port2 SuperSpeed Tx- |
| 16 | GND | Ground |
| 17 | IntA_P2_SSRX+ | USB 3 ICC Port2 SuperSpeed Rx+ |
| 18 | IntA_P2_SSRX- | USB 3 ICC Port2 SuperSpeed Rx+ |
| 19 | Vbus | Power |
| 20 | Key (no pin) | No connect |

Table 19. SATA Connectors

| Pin | Signal Name |
|------------|--------------------|
| 1 | Ground |
| 2 | TXP |
| 3 | TXN |
| 4 | Ground |
| 5 | RXN |
| 6 | RXP |
| 7 | Ground |

Table 20. S/PDIF Header

| Pin | Signal Name |
|------------|--------------------|
| 1 | Ground |
| 2 | S/PDIF out |
| 3 | Key (no pin) |
| 4 | +5 V DC |

**Table 21. Processor, Front, and Rear Chassis
(4-Pin) Fan Headers**

| Pin | Signal Name |
|------------|--------------------|
| 1 | Ground (Note) |
| 2 | +12 V |
| 3 | FAN_TACH |
| 4 | FAN_CONTROL |

Note: These fan headers use Pulse Width Modulation control for fan speed.

Table 22. Front Panel CIR Receiver (Input) Header

| Pin | Signal Name |
|------------|--------------------|
| 1 | Ground |
| 2 | LED |
| 3 | NC |
| 4 | Learn-in |
| 5 | 5 V standby |
| 6 | VCC |
| 7 | Key (no pin) |
| 8 | CIR Input |

Table 23. Chassis Intrusion Header

| Pin | Signal Name |
|------------|--------------------|
| 1 | Intruder# |
| 2 | Ground |

Table 24. TPM Header

| Pin | Signal Name | Pin | Signal Name |
|------------|--------------------|------------|--------------------|
| 1 | PCICLK | 2 | GND |
| 3 | FRAME | 4 | Key (no pin) |
| 5 | PCIRST | 6 | N/C |
| 7 | LAD3 | 8 | LAD2 |
| 9 | VCC3 | 10 | LAD1 |
| 11 | LAD0 | 12 | GND |
| 13 | N/C | 14 | N/C |
| 15 | 3VSB | 16 | SERIRQ |
| 17 | GND | 18 | CLKRUN |
| 19 | PWRDWN | 20 | N/C |

Table 25. PCI Express Full-/Half-Mini Card Connector

| Pin | Signal Name | Additional Signal Name | Pin | Signal Name |
|------------|--------------------|-------------------------------|------------|--------------------|
| 1 | WAKE# | | 2 | 3.3 V |
| 3 | Reserved | | 4 | GND |
| 5 | Reserved | | 6 | 1.5 V |
| 7 | CLKREQ# | | 8 | Reserved |
| 9 | GND | | 10 | Reserved |
| 11 | REFCLK- | | 12 | Reserved |
| 13 | REFCLK+ | | 14 | Reserved |
| 15 | GND | | 16 | Reserved |
| 17 | Reserved | | 18 | GND |
| 19 | Reserved | | 20 | Reserved |
| 21 | GND | | 22 | PERST# |
| 23 | PERn0 | | 24 | +3.3 V aux |
| 25 | PERp0 | | 26 | GND |
| 27 | GND | | 28 | +1.5 V |
| 29 | GND | | 30 | SMB_CLK |
| 31 | PETn0 | | 32 | SMB_DATA |
| 33 | PETp0 | | 34 | GND |
| 35 | GND | | 36 | USB_D- |
| 37 | GND | (mSATA) GND | 38 | USB_D+ |
| 39 | +3.3 V aux | (mSATA) 3.3 V | 40 | GND |
| 41 | +3.3 V aux | (mSATA) 3.3 V | 42 | LED_WWAN# |
| 43 | Reserved | (mSATA indicator) | 44 | LED_WLAN# |
| 45 | Reserved | (mSATA) Vendor | 46 | LED_WPAN# |
| 47 | Reserved | (mSATA) Vendor | 48 | +1.5 V |
| 49 | Reserved | (mSATA) DA/DSS | 50 | GND |
| 51 | Reserved | (mSATA) Presence Detection | 52 | _3.3 V |

2.2.2.2 Add-in Card Connectors

The board has the following add-in card connectors:

- One PCI Express x16 (3.0/2.x/1.x)
- Three PCI Express x1 (2.x/1.x)
- One PCI Express Full-/Half-Mini Card (with support for mSATA)

2.2.2.3 Power Supply Connectors

The board has the following power supply connectors:

- **Main power** – a 2 x 12 connector. This connector is compatible with 2 x 10 connectors previously used on Intel Desktop boards. The board supports the use of ATX12V power supplies with either 2 x 10 or 2 x 12 main power cables. When using a power supply with a 2 x 10 main power cable, attach that cable to the main power connector, leaving pins 11, 12, 23, and 24 unconnected.
- **Processor core power** – a 2 x 2 connector. This connector provides power directly to the processor voltage regulator and must always be used. Failure to do so will prevent the board from booting.

Table 26. Processor Core Power Connector

| Pin | Signal Name | Pin | Signal Name |
|-----|-------------|-----|-------------|
| 1 | Ground | 2 | Ground |
| 3 | +12 V | 4 | +12 V |

Table 27. Main Power Connector

| Pin | Signal Name | Pin | Signal Name |
|-----|--------------------------------|-----|-------------------------------------|
| 1 | +3.3 V | 13 | +3.3 V |
| 2 | +3.3 V | 14 | -12 V |
| 3 | Ground | 15 | Ground |
| 4 | +5 V | 16 | PS-ON# (power supply remote on/off) |
| 5 | Ground | 17 | Ground |
| 6 | +5 V | 18 | Ground |
| 7 | Ground | 19 | Ground |
| 8 | PWRGD (Power Good) | 20 | No connect |
| 9 | +5 V (Standby) | 21 | +5 V |
| 10 | +12 V | 22 | +5 V |
| 11 | +12 V (Note) | 23 | +5 V (Note) |
| 12 | 2 x 12 connector detect (Note) | 24 | Ground (Note) |

Note: When using a 2 x 10 power supply cable, this pin will be unconnected.

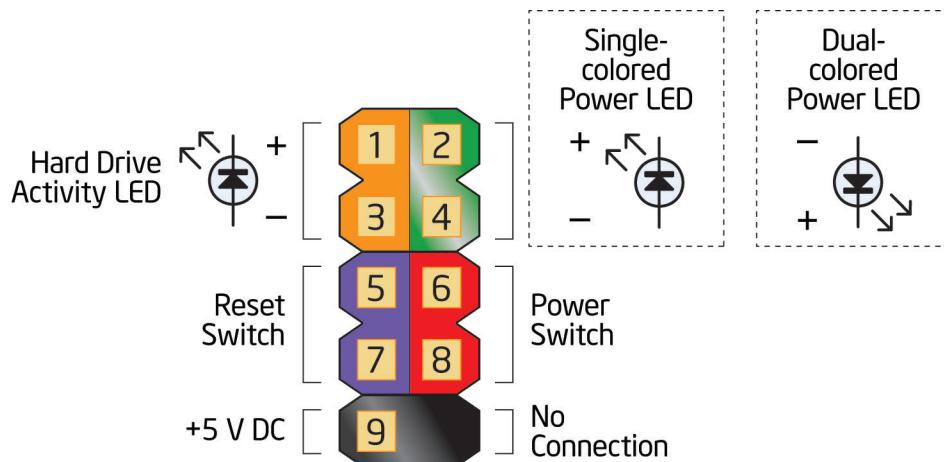
| For information about | Refer to |
|-----------------------------|--------------------------|
| Power supply considerations | Section 2.5.1 on page 56 |

2.2.2.4 Front Panel Connector

This section describes the functions of the front panel header. Table 28 lists the signal names of the front panel header. Figure 10 is a connection diagram for the front panel header.

Table 28. Front Panel Connector

| Pin | Signal Name | Description | Pin | Signal Name | Description |
|-----|---------------|----------------------------------|-----|----------------|------------------------------------|
| 1 | HDD_POWER_LED | Pull-up resistor (750 Ω) to +5 V | 2 | POWER_LED_MAIN | [Out] Front panel LED (main color) |
| 3 | HDD_LED# | [Out] Hard disk activity LED | 4 | POWER_LED_ALT | [Out] Front panel LED (alt color) |
| 5 | GROUND | Ground | 6 | POWER_SWITCH# | [In] Power switch |
| 7 | RESET_SWITCH# | [In] Reset switch | 8 | GROUND | Ground |
| 9 | +5 V_DC | Power | 10 | Key | No pin |



OM20472

Figure 10. Connection Diagram for Front Panel Header

2.2.2.4.1 Hard Drive Activity LED

Pins 1 and 3 can be connected to an LED to provide a visual indicator that data is being read from or written to a hard drive. Proper LED function requires a SATA hard drive or optical drive connected to an onboard SATA connector.

2.2.2.4.2 Reset Switch

Pins 5 and 7 can be connected to a momentary single pole, single throw (SPST) type switch that is normally open. When the switch is closed, the board resets and runs the POST.

2.2.2.4.3 Power/Sleep LED

Pins 2 and 4 can be connected to a one- or two-color LED. Table 29 shows the possible states for a one-color LED. Table 30 shows the possible states for a two-color LED.

Table 29. States for a One-Color Power LED

| LED State | Description |
|--------------|--------------------|
| Off | Power off/sleeping |
| Steady Green | Running |

Table 30. States for a Two-Color Power LED

| LED State | Description |
|---------------|-------------|
| Off | Power off |
| Steady Green | Running |
| Steady Yellow | Sleeping |

**NOTE**

The colors listed in Table 29 and Table 30 are suggested colors only. Actual LED colors are chassis-specific.

2.2.2.4.4 Power Switch Header

Pins 6 and 8 can be connected to a front panel momentary-contact power switch. The switch must pull the SW_ON# pin to ground for at least 50 ms to signal the power supply to switch on or off. (The time requirement is due to internal debounce circuitry on the board.) At least two seconds must pass before the power supply will recognize another on/off signal.

2.2.2.5 Alternate Front Panel Power/Sleep LED Header

Pins 1 and 3 of this header duplicate the signals on pins 2 and 4 of the front panel header.

Table 31. Alternate Front Panel Power/Sleep LED Header

| Pin | Signal Name | Description |
|-----|----------------|------------------------------------|
| 1 | POWER_LED_MAIN | [Out] Front panel LED (main color) |
| 2 | Key (no pin) | |
| 3 | POWER_LED_ALT | [Out] Front panel LED (alt color) |

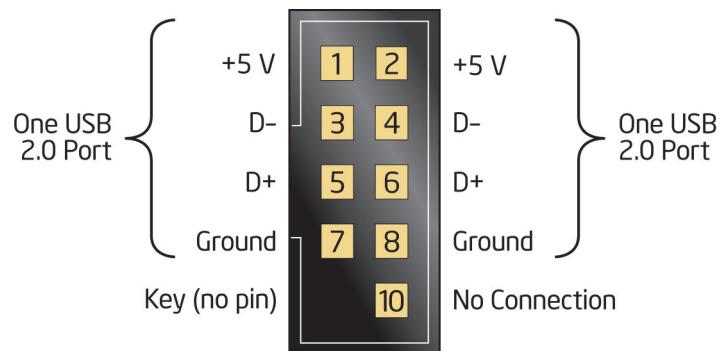
2.2.2.6 Front Panel Connectors and Headers

Figure 11, Figure 12, and Figure 13 are connection diagrams for the front panel USB connectors and headers.



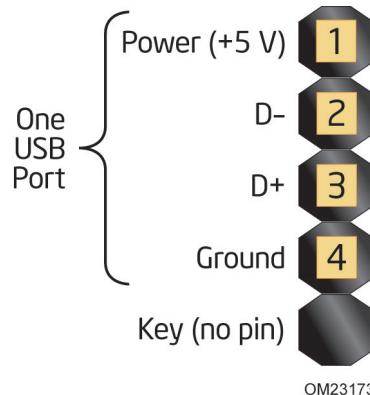
NOTE

- The +5 V DC power on the USB connectors is fused.*
- Use only a front panel USB connector that conforms to the USB 2.0 specification for high-speed USB devices.*



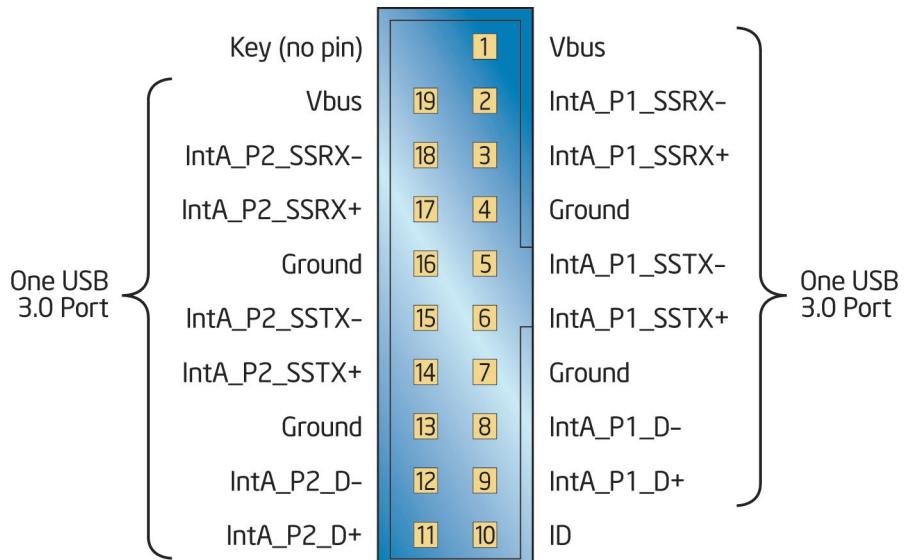
OM23948

Figure 11. Connection Diagram for the Front Panel Dual-Port USB 2.0 Connectors



OM23173

Figure 12. Connection Diagram for the Front Panel USB 2.0 Single-Port Header



OM23934

Figure 13. Connection Diagram for the Front Panel USB 3.0 Connector

2.2.2.7 Consumer Infrared (CIR) Header

The Consumer Infrared (CIR) header provides features that are designed to comply with Microsoft Consumer Infrared usage models.

The CIR feature is made up of the receiving (receiver) header. The receiving header consists of a filtered translated infrared input compliant with Microsoft CIR specifications.

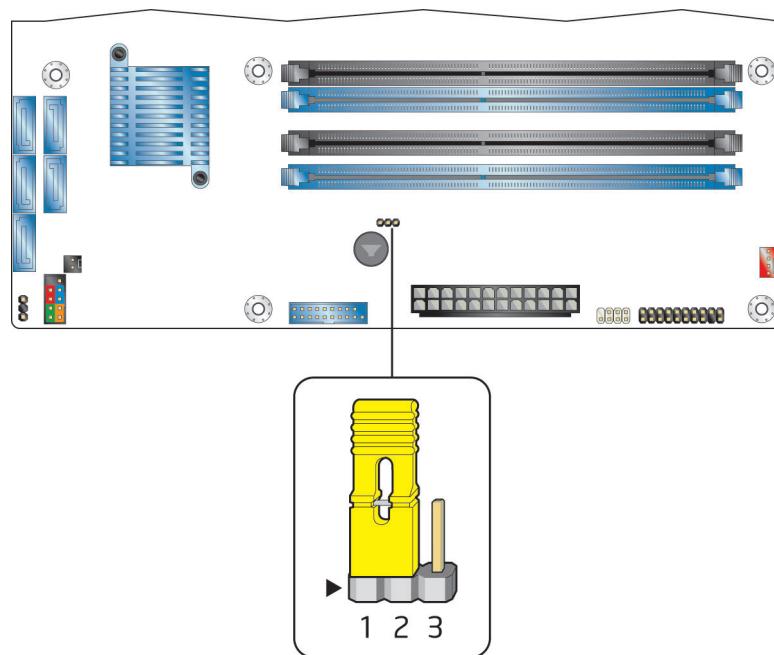
Customers are required to buy or create their own interface modules to connect to Intel Desktop Boards for this feature to work.

2.3 BIOS Security Jumper

⚠ CAUTION

Do not move the jumper with the power on. Always turn off the power and unplug the power cord from the computer before changing a jumper setting. Otherwise, the board could be damaged.

Figure 14 shows the location of the jumper. The 3-pin jumper determines the BIOS Security program's mode. Table 32 describes the jumper settings for the three modes: normal, lockdown, and configuration.



OM23928

Figure 14. Location of the Jumper

Table 32. BIOS Setup Security Jumper Settings

| Function/Mode | Jumper Setting | Configuration |
|----------------------|-----------------------|---|
| Normal | 1-2 | The BIOS uses current configuration information and passwords for booting. |
| Lockdown | 2-3 | <p>The BIOS uses current configuration information and passwords for booting, except:</p> <ul style="list-style-type: none"> • All POST Hotkeys are suppressed (prompts are not displayed and keys are not accepted. For example, F2 for Setup, F10 for the Boot Menu). • Power Button Menu is not available (see Section 3.9.3 Power Button Menu). <p>BIOS updates are not available except for automatic Recovery due to flash corruption.</p> |
| Configuration Mode | None | <p>BIOS Recovery Update process if a matching *.bio file is found. Recovery Update can be cancelled by pressing the Esc key.</p> <p>If the Recovery Update was cancelled or a matching *.bio file was not found, a Config Menu will be displayed. The Config Menu consists of the following (followed by the Power Button Menu selections):</p> <ul style="list-style-type: none"> [1] Suppress this menu until the BIOS Security Jumper is replaced. [2] Clear BIOS User and Supervisor Passwords. [3] Reset Intel AMT to default factory settings. [4] Clear Trusted Platform Module. <p>See Section 3.9.3 Power Button Menu.</p> |

2.4 Mechanical Considerations

2.4.1 Form Factor

The board is designed to fit into an ATX-form-factor chassis. Figure 15 illustrates the mechanical form factor for the board. Dimensions are given in inches [millimeters]. The outer dimensions are 9.60 inches by 9.60 inches [243.84 millimeters by 243.84 millimeters]. Location of the I/O connectors and mounting holes are in compliance with the ATX specification.

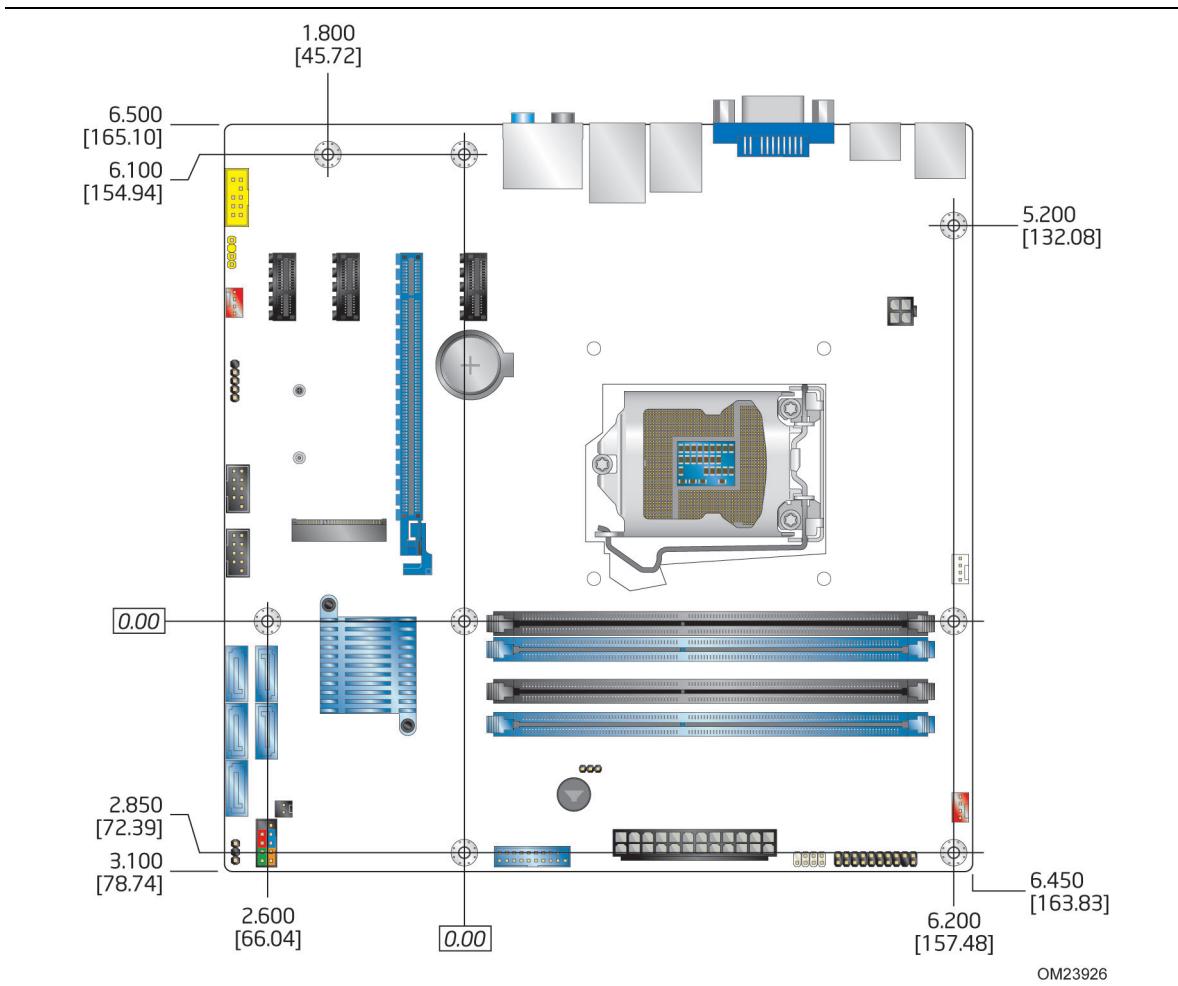


Figure 15. Board Dimensions

2.5 Electrical Considerations

2.5.1 Power Supply Considerations



CAUTION

The +5 V standby line from the power supply must be capable of providing adequate +5 V standby current. Failure to do so can damage the power supply. The total amount of standby current required depends on the wake devices supported and manufacturing options.

Additional power required will depend on configurations chosen by the integrator.

Due to improvements in 4th generation Intel Core processor power efficiency, the requirements for the processor's power supply have changed. More specifically, the latest Power Supply Design Guide rev 1.3 has indicated a minimum current of 0.05A on +12 V2DC and recommends 0A. This is to prevent Power Supply Unit (PSU) protection from triggering during minimum loading.

Intel recommends that system integrators and builders check the latest list of tested PSUs to find out which are capable of supporting the 4th generation Intel Core processor. This list may be found at: <http://www.intel.com/go/powersupplies/>. From the filters at the top right of the page, set **12V2 Min Load 0A** to "Yes" to see which PSUs are capable of supporting the processor's new power requirements.

The power supply must comply with the indicated parameters of the ATX form factor specification.

- The potential relation between 3.3 V DC and +5 V DC power rails
- The current capability of the +5 V_{STBY} line
- All timing parameters
- All voltage tolerances

For example, for a high power system consisting of a supported 95 W processor (see Section 1.3 on page 16 for a list of supported processors), 4 GB DDR3 RAM, one high end video card, one hard disk drive, one optical drive, and all board peripherals enabled, the minimum recommended power supply is 460 W.

For example, for a low power system consisting of a supported 45 W processor (see Section 1.3 on page 16 for a list of supported processors), 2 GB DDR3 RAM, integrated graphics, one SSD, one optical drive, and no extra onboard peripherals enabled, the minimum recommended power supply is a 320 W.

| For information about | Refer to |
|--|---|
| Selecting an appropriate power supply | http://support.intel.com/support/motherboards/desktop/sb/CS-026472.htm |
| Selecting a power supply capable of supporting the 4th generation Intel Core processor | http://www.intel.com/go/powersupplies/ |

2.5.2 Fan Header Current Capability



CAUTION

The processor fan must be connected to the processor fan header, not to a chassis fan header. Connecting the processor fan to a chassis fan header may result in onboard component damage that will halt fan operation.

Table 33 lists the current capability of the fan headers.

Table 33. Fan Header Current Capability

| Fan Header | Maximum Available Current |
|-------------------|---------------------------|
| Processor fan | 2.0 A |
| Front chassis fan | 1.5 A |
| Rear chassis fan | 1.5 A |

2.5.3 Add-in Board Considerations

The board is designed to provide 2 A (average) of current for each add-in board from the +5 V rail. The total +5 V current draw for add-in boards for a fully loaded board (all three expansion slots filled) must not exceed the system's power supply +5 V maximum current or 14 A in total.

2.6 Thermal Considerations



CAUTION

A chassis with a maximum internal ambient temperature of 38 °C at the processor fan inlet is a requirement. Use a processor heat sink that provides omni-directional airflow to maintain required airflow across the processor voltage regulator area.



CAUTION

Failure to ensure appropriate airflow may result in reduced performance of both the processor and/or voltage regulator or, in some instances, damage to the board. For a list of chassis that have been tested with Intel desktop boards please refer to the following website:

http://www3.intel.com/cd/channel/reseller/asmo-na/eng/tech_reference/53211.htm

All responsibility for determining the adequacy of any thermal or system design remains solely with the reader. Intel makes no warranties or representations that merely following the instructions presented in this document will result in a system with adequate thermal performance.



CAUTION

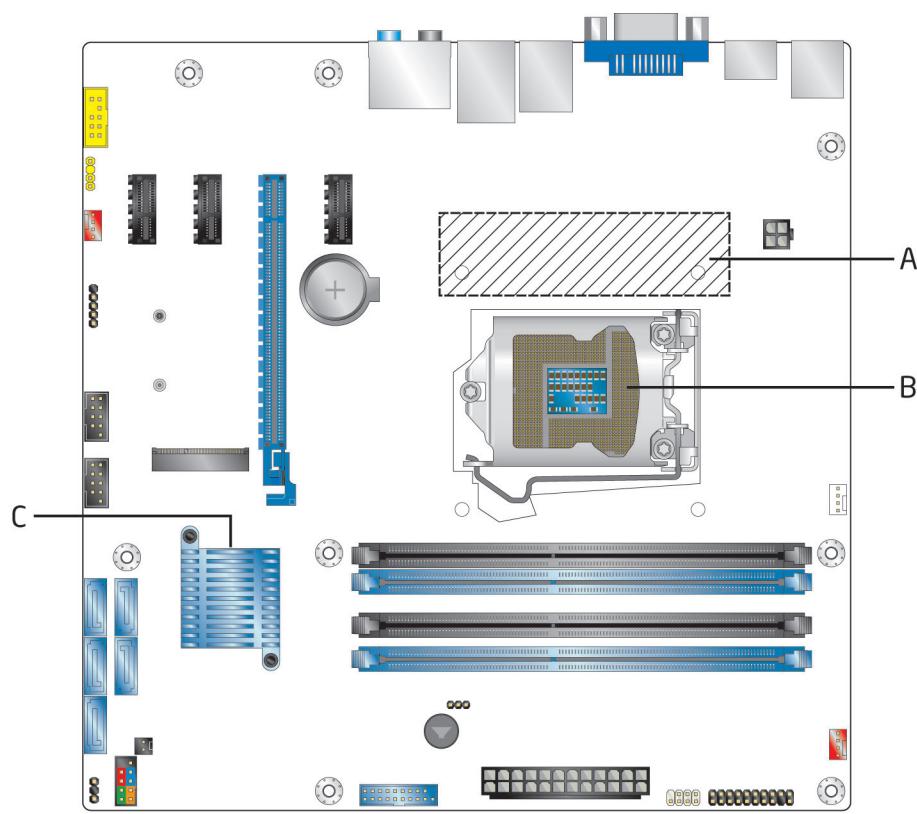
Ensure that the ambient temperature does not exceed the board's maximum operating temperature. Failure to do so could cause components to exceed their maximum case temperature and malfunction. For information about the maximum operating temperature, see the environmental specifications in Section 2.8.



CAUTION

Ensure that proper airflow is maintained in the processor voltage regulator circuit. Failure to do so may result in damage to the voltage regulator circuit. The processor voltage regulator area (shown in Figure 16) can reach a temperature of up to 120 °C in an open chassis.

Figure 16 shows the locations of the localized high temperature zones.



| Item | Description |
|------|----------------------------------|
| A | Processor voltage regulator area |
| B | Processor |
| C | Intel H87 Express Chipset |

Figure 16. Localized High Temperature Zones

Table 34 provides maximum case temperatures for the components that are sensitive to thermal changes. The operating temperature, current load, or operating frequency could affect case temperatures. Maximum case temperatures are important when considering proper airflow to cool the board.

Table 34. Thermal Considerations for Components

| Component | Maximum Case Temperature |
|---------------------------|--|
| Processor | For processor case temperature, see processor datasheets and processor specification updates |
| Intel H87 Express Chipset | 104 °C |

To ensure functionality and reliability, the component is specified for proper operation when Case Temperature is maintained at or below the maximum temperature listed in Table 34. This is a requirement for sustained power dissipation equal to Thermal Design Power (TDP is specified as the maximum sustainable power to be dissipated by the components). When the component is dissipating less than TDP, the case temperature should be below the Maximum Case Temperature. The surface temperature at the geometric center of the component corresponds to Case Temperature.

It is important to note that the temperature measurement in the system BIOS is a value reported by embedded thermal sensors in the components and does not directly correspond to the Maximum Case Temperature.

| For information about | Refer to |
|--|---|
| Processor datasheets and specification updates | Section 1.2, page 16 |
| Intel H87 Express Chipset | http://www.intel.com/products/desktop/chipsets/ |

2.7 Reliability

The Mean Time Between Failures (MTBF) prediction is calculated using a parts count method. The calculation is based on the Telcordia SR-332, Issue 2; Method I Case 3 50% electrical stress, 55 °C ambient. The MTBF prediction is used to estimate repair rates and spare parts requirements. The MTBF data is calculated from predicted data at 55 °C. The MTBF for the Intel Desktop Board DH87RL is 356,510 hours.

2.8 Environmental

Table 35 lists the environmental specifications for the board.

Table 35. Environmental Specifications

| Parameter | Specification | | |
|--------------------|---|--------------------|--|
| Temperature | | | |
| Non-Operating | -20 °C to +70 °C ^(Note) | | |
| Operating | 0 °C to +55 °C The operating temperature of the board may be determined by measuring the air temperature from within 1 inch of the edge of the chipset/PCH heatsink and 1 inch above the board, in a closed chassis, while the system is in operation. | | |
| Shock | | | |
| Unpackaged | 50 g trapezoidal waveform | | |
| | Velocity change of 170 inches/s ² | | |
| Packaged | Half sine 2 millisecond | | |
| | Product Weight (pounds) | Free Fall (inches) | Velocity Change (inches/s ²) |
| | <20 | 36 | 167 |
| | 21-40 | 30 | 152 |
| | 41-80 | 24 | 136 |
| | 81-100 | 18 | 118 |
| Vibration | | | |
| Unpackaged | 5 Hz to 20 Hz: 0.01 g ² Hz sloping up to 0.02 g ² Hz | | |
| | 20 Hz to 500 Hz: 0.02 g ² Hz (flat) | | |
| Packaged | 5 Hz to 40 Hz: 0.015 g ² Hz (flat) | | |
| | 40 Hz to 500 Hz: 0.015 g ² Hz sloping down to 0.00015 g ² Hz | | |

Note: Before attempting to operate this board, the overall temperature of the board must be above the minimum operating temperature specified. It is recommended that the board temperature be at least room temperature before attempting to power on the board.

3 Overview of BIOS Features

3.1 Introduction

The board uses an Intel Visual BIOS that is stored in the Serial Peripheral Interface Flash Memory (SPI Flash) and can be updated using a disk-based program. The SPI Flash contains the Visual BIOS Setup program, POST, the PCI auto-configuration utility, LAN EEPROM information, and Plug and Play support.

The BIOS displays a message during POST identifying the type of BIOS and a revision code. The initial production BIOSs are identified as RLH8710H.86A.

When the BIOS Setup configuration jumper is set to configure mode and the computer is powered-up, the BIOS compares the CPU version and the microcode version in the BIOS and reports if the two match.

The BIOS Setup program can be used to view and change the BIOS settings for the computer. The BIOS Setup program is accessed by pressing the <F2> key after the POST memory test begins and before the operating system boot begins.

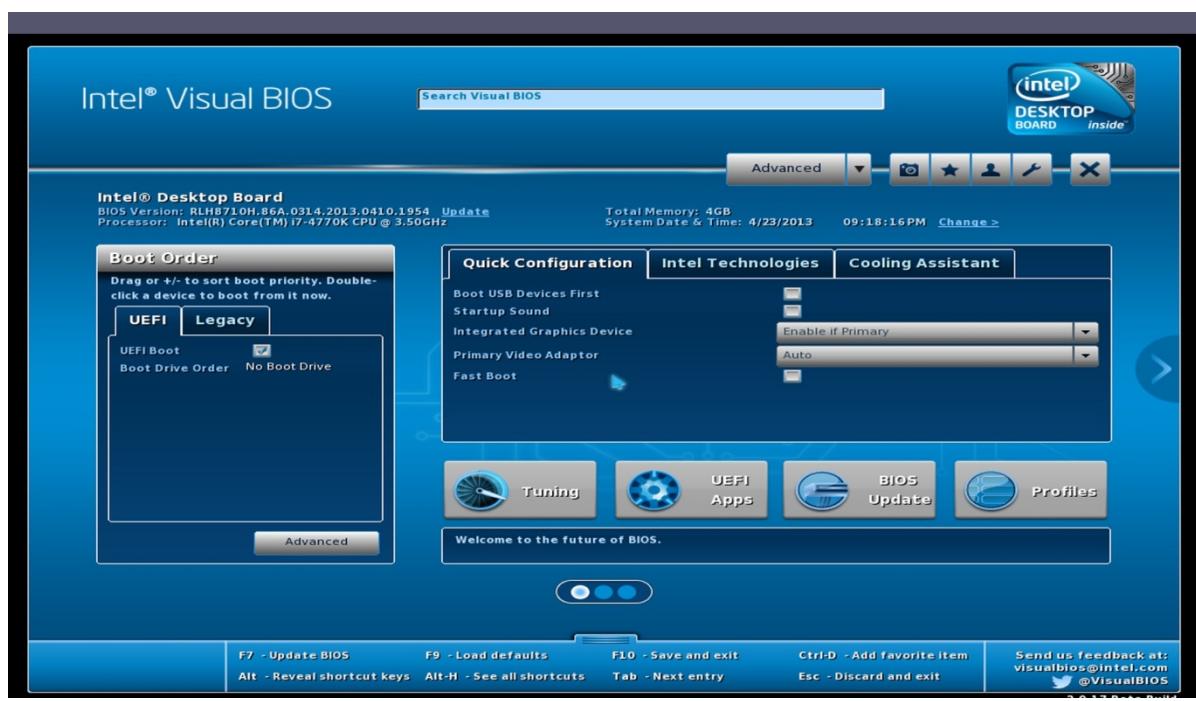


Figure 17. Intel Visual BIOS Screen

Table 36 lists the BIOS Setup program menu features.

Table 36. Intel Visual BIOS Setup Display Areas

| Home 1 | Home 2 | Home 3 | Main | Devices & Peripherals | Cooling |
|--|--|---|--|---|--|
| Displays processor, graphics, memory, and configuration with quick launch to tuning, UEFI apps, BIOS update, and system profiles | Environmental monitoring display and attached SATA devices | System, desktop board, chassis, and processor information | Displays processor, memory, configuration, event log, date, and time | Configures advanced features available through the chipset and other discrete controllers | Real-time system monitoring, adjust fan speeds, set temperature set points, and define system voltage settings |

continued

Table 36. Intel Visual BIOS Setup Display Areas (continued)

| Performance | Security | Power | Boot | Exit |
|--|--------------------------------------|--|---|--|
| Displays and Configures Memory, Graphics, Bus, and Processor overrides | Sets passwords and security features | Configures power management features and power supply controls | Selects boot options and boot display options | Saves or discards changes to Setup program options |

Table 37 lists the function keys available for menu screens.

Table 37. BIOS Setup Program Function Keys

| BIOS Setup Program Function Key | Description |
|--|--|
| <<-> or <-> | Selects a different menu screen (Moves the cursor left or right) |
| < [↑] > or < [↓] > | Selects an item (Moves the cursor up or down) |
| <Tab> | Selects a field (Not implemented) |
| Mouse | Allows control of all options and slider controls in Intel Visual BIOS |
| <Enter> | Executes command or selects the submenu |
| <F9> | Load the default configuration values for the current menu |
| <F10> | Save the current values and exits the BIOS Setup program |
| <Esc> | Exits the menu |

3.2 BIOS Flash Memory Organization

The Serial Peripheral Interface Flash Memory (SPI Flash) includes a 96 Mb (12288 KB) flash memory device.

3.3 Resource Configuration

3.3.1 PCI Express Autoconfiguration

The BIOS can automatically configure PCI Express devices. PCI Express devices may be onboard or add-in cards. Autoconfiguration lets a user insert or remove PCI Express cards without having to configure the system. When a user turns on the system after adding a PCI Express card, the BIOS automatically configures interrupts, the I/O space, and other system resources. Any interrupts set to Available in Setup are considered to be available for use by the add-in card.

3.4 System Management BIOS (SMBIOS)

SMBIOS is a Desktop Management Interface (DMI) compliant method for managing computers in a managed network.

The main component of SMBIOS is the Management Information Format (MIF) database, which contains information about the computing system and its components. Using SMBIOS, a system administrator can obtain the system types, capabilities, operational status, and installation dates for system components. The MIF database defines the data and provides the method for accessing this information. The BIOS enables applications such as third-party management software to use SMBIOS. The BIOS stores and reports the following SMBIOS information:

- BIOS data, such as the BIOS revision level
- Fixed-system data, such as peripherals, serial numbers, and asset tags
- Resource data, such as memory size, cache size, and processor speed
- Dynamic data, such as event detection and error logging

Non-Plug and Play operating systems require an additional interface for obtaining the SMBIOS information. The BIOS supports an SMBIOS table interface for such operating systems. Using this support, an SMBIOS service-level application running on a non-Plug and Play operating system can obtain the SMBIOS information. Additional board information can be found in the BIOS under the Additional Information header under the Main BIOS page.

3.5 Legacy USB Support

Legacy USB support enables USB devices to be used even when the operating system's USB drivers are not yet available. Legacy USB support is used to access the BIOS Setup program, and to install an operating system that supports USB. By default, Legacy USB support is set to Enabled.

Legacy USB support operates as follows:

1. When you apply power to the computer, legacy support is disabled.
2. POST begins.
3. Legacy USB support is enabled by the BIOS allowing you to use a USB keyboard to enter and configure the BIOS Setup program and the maintenance menu.
4. POST completes.

5. The operating system loads. While the operating system is loading, USB keyboards and mice are recognized and may be used to configure the operating system. (Keyboards and mice are not recognized during this period if Legacy USB support was set to Disabled in the BIOS Setup program.)
6. After the operating system loads the USB drivers, all legacy and non-legacy USB devices are recognized by the operating system, and Legacy USB support from the BIOS is no longer used.
7. Additional USB legacy feature options can be accessed by using Intel® Integrator Toolkit version 5.

To install an operating system that supports USB, verify that Legacy USB support in the BIOS Setup program is set to Enabled and follow the operating system's installation instructions.

3.6 BIOS Updates

The BIOS can be updated using either of the following utilities, which are available on the Intel World Wide Web site (see Section 1.2 on page 16):

- Intel® Express BIOS Update utility, which enables automated updating while in the Windows environment. Using this utility, the BIOS can be updated from a file on a hard disk, a USB drive (a flash drive or a USB hard drive), or a CD-ROM, or from the file location on the Web.
- Intel® Flash Memory Update Utility, which requires booting from DOS. Using this utility, the BIOS can be updated from a file on a hard disk, a USB drive (a flash drive or a USB hard drive), or a CD-ROM.
- Intel® F7 switch allows a user to select where the BIOS .bio file is located and perform the update from that location/device. Similar to performing a BIOS Recovery without removing the BIOS configuration jumper.
- Intel Visual BIOS Update Utility allows the user to select the BIOS .bio file from the internet, USB device, hard disk drive, or other media.

Both utilities verify that the updated BIOS matches the target system to prevent accidentally installing an incompatible BIOS.



NOTE

Review the instructions distributed with the upgrade utility before attempting a BIOS update.

| For information about | Refer to |
|------------------------------|---|
| BIOS update utilities | http://support.intel.com/support/motherboards/desktop/sb/CS-022312.htm |

3.6.1 Language Support

The BIOS Setup program and help messages are supported in US English.

3.6.2 Custom Splash Screen

During POST, an Intel® splash screen is displayed by default. This splash screen can be augmented with a custom splash screen. The Intel Integrator's Toolkit version 5 that is available from Intel can be used to create a custom splash screen.



NOTE

If you add a custom splash screen, it will share space with the Intel branded logo.

| For information about | Refer to |
|--------------------------|---|
| Intel Integrator Toolkit | http://www.intel.com/go/itk |

3.7 BIOS Recovery

It is unlikely that anything will interrupt a BIOS update; however, if an interruption occurs, the BIOS could be damaged. Table 38 lists the drives and media types that can and cannot be used for BIOS recovery. The BIOS recovery media does not need to be made bootable.

Table 38. Acceptable Drives/Media Types for BIOS Recovery

| Media Type | Can be used for BIOS recovery? |
|--|--------------------------------|
| CD-ROM drive connected to the SATA interface | Yes |
| USB removable drive (a USB Flash Drive, for example) | Yes |
| USB diskette drive (with a 1.44 MB diskette) | No |
| USB hard disk drive | No |

| For information about | Refer to |
|-----------------------|---|
| BIOS recovery | http://www.intel.com/support/motherboards/desktop/sb/cs-023360.htm |

3.8 Boot Options

In the BIOS Setup program, the user can choose to boot from a hard drive, optical drive, removable drive, or the network. The default setting is for the optical drive to be the first boot device, the hard drive second, removable drive third, and the network fourth.

3.8.1 Optical Drive Boot

Booting from the optical drive is supported in compliance to the El Torito bootable CD-ROM format specification. Under the Boot menu in the BIOS Setup program, the optical drive is listed as a boot device. Boot devices are defined in priority order. Accordingly, if there is not a bootable CD in the optical drive, the system will attempt to boot from the next defined drive.

3.8.2 Network Boot

The network can be selected as a boot device. This selection allows booting from the onboard LAN or a network add-in card with a remote boot ROM installed.

Pressing the <F12> key during POST automatically forces booting from the LAN. To use this key during POST, the User Access Level in the BIOS Setup program's Security menu must be set to Full.

3.8.3 Booting Without Attached Devices

For use in embedded applications, the BIOS has been designed so that after passing the POST, the operating system loader is invoked even if the following devices are not present:

- Video adapter
- Keyboard
- Mouse

3.8.4 Changing the Default Boot Device During POST

Pressing the <F10> key during POST causes a boot device menu to be displayed. This menu displays the list of available boot devices. Table 39 lists the boot device menu options.

Table 39. Boot Device Menu Options

| Boot Device Menu Function Keys | Description |
|---------------------------------------|--|
| < \uparrow > or < \downarrow > | Selects a default boot device |
| <Enter> | Exits the menu and boots from the selected device |
| <Esc> | Exits the menu and boots according to the boot priority defined through BIOS setup |

3.9 Adjusting Boot Speed

These factors affect system boot speed:

- Selecting and configuring peripherals properly
- Optimizing BIOS boot parameters
- Enabling the Fast Boot feature

3.9.1 Peripheral Selection and Configuration

The following techniques help improve system boot speed:

- Choose a hard drive with parameters such as “power-up to data ready” in less than eight seconds that minimizes hard drive startup delays.
- Select a CD-ROM drive with a fast initialization rate. This rate can influence POST execution time.
- Eliminate unnecessary add-in adapter features, such as logo displays, screen repaints, or mode changes in POST. These features may add time to the boot process.
- Try different monitors. Some monitors initialize and communicate with the BIOS more quickly, which enables the system to boot more quickly.

3.9.2 BIOS Boot Optimizations

Use of the following BIOS Setup program settings reduces the POST execution time:

- In the Boot menu, enable the settings for Fast Boot. This option will allow the BIOS to skip through various stages of POST and boot quickly to the last detected boot device.
- In the Boot Menu, set the hard disk drive as the first boot device. As a result, the POST does not first seek a diskette drive, which saves about one second from the POST execution time.
- In the Peripheral Configuration submenu, disable the LAN device if it will not be used. This can reduce option ROM boot time by up to four seconds.



NOTE

It is possible to optimize the boot process to the point where the system boots so quickly that the Intel logo screen (or a custom logo splash screen) will not be seen. Monitors and hard disk drives with minimum initialization times can also contribute to a boot time that might be so fast that necessary logo screens and POST messages cannot be seen.

This boot time may be so fast that some drives might not be initialized at all. If this condition should occur, it is possible to introduce a programmable delay ranging from zero to 30 seconds by 5 second increments (using the Hard Disk Pre-Delay feature of the Advanced Menu in the Drive Configuration Submenu of the BIOS Setup program).

3.9.3 Power Button Menu

The Power Button Menu can be accessed during power on if the user presses the power button and holds it down until three short beep sounds are emitted by the board piezoelectric speaker. The BIOS will display the following prompt and wait for a keystroke:

- [ESC] Normal Boot
- [F2] Intel® Visual BIOS
- [F3] Disable Fast Boot
- [F4] BIOS Recovery
- [F7] Update BIOS
- [F10] Enter Boot Menu
- [F12] Network Boot

If an unrecognized key is pressed, the BIOS will beep and wait for another keystroke. If one of the listed hotkeys is pressed, the BIOS will follow the indicated boot path. Password requirements must still be honored.

If Disable Fast Boot is selected, the BIOS will disable all Fast Boot optimizations and reset the system.

3.10 Hard Disk Drive Password Security Feature

The Hard Disk Drive Password Security feature blocks read and write accesses to the hard disk drive until the correct password is given. Hard Disk Drive Passwords are set in BIOS SETUP and are prompted for during BIOS POST. For convenient support of S3 resume, the system BIOS will automatically unlock drives on resume from S3. Valid password characters are A-Z, a-z, and 0-9. Passwords may be up to 16 characters in length.

The User hard disk drive password, when installed, will be required upon each power-cycle until the Master Key or User hard disk drive password is submitted.

The Master Key hard disk drive password, when installed, will not lock the drive. The Master Key hard disk drive password exists as an unlock override in the event that the User hard disk drive password is forgotten. Only the installation of the User hard disk drive password will cause a hard disk to be locked upon a system power-cycle.

Table 40 shows the effects of setting the Hard Disk Drive Passwords.

Table 40. Master Key and User Hard Drive Password Functions

| Password Set | Password During Boot |
|---------------------|-----------------------------|
| Neither | None |
| Master only | None |
| User only | User only |
| Master and User Set | Master or User |

During every POST, if a User hard disk drive password is set, POST execution will pause with the following prompt to force the user to enter the Master Key or User hard disk drive password:

Enter Hard Disk Drive Password:

Upon successful entry of the Master Key or User hard disk drive password, the system will continue with normal POST.

If the hard disk drive password is not correctly entered, the system will go back to the above prompt. The user will have three attempts to correctly enter the hard disk drive password. After the third unsuccessful hard disk drive password attempt, the system will halt with the message:

Hard Disk Drive Password Entry Error

A manual power cycle will be required to resume system operation.



NOTE

As implemented on DH87RL, Hard Disk Drive Password Security is only supported on SATA port 0. The passwords are stored on the hard disk drive so if the drive is relocated to another SATA port or computer that does not support Hard Disk Drive Password Security feature, the drive will not be accessible.



NOTE

Hard Disk Drive Password Security is not supported in PCH RAID mode. Secured hard disk drives attached to the system when the system is in PCH RAID mode will not be accessible due to the disabling of BIOS Hard Disk Drive Password support.

3.11 BIOS Security Features

The BIOS includes security features that restrict access to the BIOS Setup program and who can boot the computer. A supervisor password and a user password can be set for the BIOS Setup program and for booting the computer, with the following restrictions:

- The supervisor password gives unrestricted access to view and change all the Setup options in the BIOS Setup program. This is the supervisor mode.
- The user password gives restricted access to view and change Setup options in the BIOS Setup program. This is the user mode.
- If only the supervisor password is set, pressing the <Enter> key at the password prompt of the BIOS Setup program allows the user restricted access to Setup.
- If both the supervisor and user passwords are set, users can enter either the supervisor password or the user password to access Setup. Users have access to Setup respective to which password is entered.
- Setting the user password restricts who can boot the computer. The password prompt will be displayed before the computer is booted. If only the supervisor password is set, the computer boots without asking for a password. If both passwords are set, the user can enter either password to boot the computer.

- For enhanced security, use different passwords for the supervisor and user passwords.
- Valid password characters are A-Z, a-z, and 0-9. Passwords may be up to 19 characters in length.

Table 41 shows the effects of setting the supervisor password and user password. This table is for reference only and is not displayed on the screen.

Table 41. Supervisor and User Password Functions

| Password Set | Supervisor Mode | User Mode | Setup Options | Password to Enter Setup | Password During Boot |
|-------------------------|-------------------------------|--|---------------------------------------|--------------------------------|-----------------------------|
| Neither | Can change all options (Note) | Can change all options (Note) | None | None | None |
| Supervisor only | Can change all options | Can change a limited number of options | Supervisor Password | Supervisor | None |
| User only | N/A | Can change all options | Enter Password Clear User Password | User | User |
| Supervisor and user set | Can change all options | Can change a limited number of options | Supervisor Password Enter Password | Supervisor or user | Supervisor or user |

Note: If no password is set, any user can change all Setup options.

**NOTE**

The BIOS complies with NIST Special Publication 800-147 BIOS Protection Guidelines / Recommendations of the National Institute of Standards and Technology. Refer to <http://csrc.nist.gov/publications/nistpubs/800-147/NIST-SP800-147-April2011.pdf> for more information.

3.12 BIOS Performance Features

The BIOS includes the following options to provide custom performance enhancements when using 4th generation Intel Core processors in an LGA1150 socket.

- Processor maximum non-turbo ratio (processor multiplier can only be adjusted down)
- Processor turbo ratio adjustment
- Host clock frequency
- Various other processor adjustments
- Memory multiplier adjustment
- Memory voltage adjustment
- Memory latency adjustments
- Graphics multiplier adjustment
- Graphics voltage adjustment

4 BIOS Error Codes and Messages

4.1 BIOS Error Codes

The BIOS provides two types of Error Code indications during POST:

- Beep codes
- Blink codes

4.1.1 BIOS Beep Codes

Whenever a recoverable error occurs during POST, the BIOS causes the board's speaker (Figure 1, U) to beep an error code describing the problem (see Table 42).

Table 42. BIOS Beep Codes

| Type | Pattern | Frequency |
|-------------------------------|--|--|
| F2 Setup/F10 Boot Menu Prompt | One 0.5 second beep when BIOS is ready to accept keyboard input | 932 Hz |
| BIOS update in progress | None | |
| Video error | On-off (1.0 second each) two times, then 2.5-second pause (off), entire pattern repeats (beeps and pause) once and the BIOS will continue to boot. | 932 Hz When no VGA option ROM is found. |
| Memory error | On-off (1.0 second each) three times, then 2.5-second pause (off), entire pattern repeats (beeps and pause) until the system is powered off. | 932 Hz |
| Thermal trip warning | Alternate high and low beeps (1.0 second each) for eight beeps, followed by system shut down. | High beep 2000 Hz Low beep 1500 Hz |

4.1.2 Front-panel Power LED Blink Codes

Whenever a recoverable error occurs during POST, the BIOS causes the board's front panel power LED to blink an error code describing the problem (see Table 43).

Table 43. Front-panel Power LED Blink Codes

| Type | Pattern | Note |
|-------------------------------|---|----------------------------------|
| F2 Setup/F10 Boot Menu Prompt | None | |
| BIOS update in progress | Off when the update begins, then on for 0.5 seconds, then off for 0.5 seconds. The pattern repeats until the BIOS update is complete. | |
| Video error | On-off (1.0 second each) two times, then 2.5-second pause (off), entire pattern repeats (blink and pause) until the system is powered off. | When no VGA option ROM is found. |
| Memory error | On-off (1.0 second each) three times, then 2.5-second pause (off), entire pattern repeats (blinks and pause) until the system is powered off. | |
| Thermal trip warning | Each beep will be accompanied by the following blink pattern: .25 seconds on, .25 seconds off, .25 seconds on, .25 seconds off. This will result in a total of 16 blinks. | |

4.2 BIOS Error Messages

The BIOS also displays error messages during POST. Table 44 lists the error messages and provides a brief description of each.

Table 44. BIOS Error Messages

| Error Message | Explanation |
|--------------------------|--|
| CMOS Battery Low | The battery may be losing power. Replace the battery soon. |
| CMOS Checksum Bad | The CMOS checksum is incorrect. CMOS memory may have been corrupted. Run Setup to reset values. |
| Memory Size Decreased | Memory size has decreased since the last boot. If no memory was removed, then memory may be bad. |
| No Boot Device Available | System did not find a device to boot. |

5 Regulatory Compliance and Battery Disposal Information

5.1 Regulatory Compliance

This section contains the following regulatory compliance information for Intel Desktop Board DH87RL:

- Safety standards
- European Union Declaration of Conformity statement
- Product Ecology statements
- Electromagnetic Compatibility (EMC) standards
- Product certification markings

5.1.1 Safety Standards

Intel Desktop Board DH87RL complies with the safety standards stated in Table 45 when correctly installed in a compatible host system.

Table 45. Safety Standards

| Standard | Title |
|-----------------|---|
| CSA/UL 60950-1 | Information Technology Equipment – Safety - Part 1: General Requirements (USA and Canada) |
| EN 60950-1 | Information Technology Equipment – Safety - Part 1: General Requirements (European Union) |
| IEC 60950-1 | Information Technology Equipment – Safety - Part 1: General Requirements (International) |

5.1.2 European Union Declaration of Conformity Statement

We, Intel Corporation, declare under our sole responsibility that the product Intel® Desktop Board DH87RL is in conformity with all applicable essential requirements necessary for CE marking, following the provisions of the European Council Directive 2004/108/EC (EMC Directive), 2006/95/EC (Low Voltage Directive), and 2002/95/EC (ROHS Directive).

The product is properly CE marked demonstrating this conformity and is for distribution within all member states of the EU with no restrictions.



This product follows the provisions of the European Directives 2004/108/EC, 2006/95/EC, and 2002/95/EC.

Cesťina Tento výrobek odpovídá požadavkům evropských směrnic 2004/108/EC, 2006/95/EC a 2002/95/EC.

Dansk Dette produkt er i overensstemmelse med det europæiske direktiv 2004/108/EC, 2006/95/EC & 2002/95/EC.

Dutch Dit product is in navolging van de bepalingen van Europees Directief 2004/108/EC, 2006/95/EC & 2002/95/EC.

Eesti Antud toode vastab Euroopa direktiivides 2004/108/EC, ja 2006/95/EC ja 2002/95/EC kehtestatud nõuetele.

Suomi Tämä tuote noudattaa EU-direktiivin 2004/108/EC, 2006/95/EC & 2002/95/EC määräyksiä.

Français Ce produit est conforme aux exigences de la Directive Européenne 2004/108/EC, 2006/95/EC & 2002/95/EC.

Deutsch Dieses Produkt entspricht den Bestimmungen der Europäischen Richtlinie 2004/108/EC, 2006/95/EC & 2002/95/EC.

Ελληνικά Το παρόν προϊόν ακολουθεί τις διατάξεις των Ευρωπαϊκών Οδηγιών 2004/108/EC, 2006/95/EC και 2002/95/EC.

Magyar E termék megfelel a 2004/108/EC, 2006/95/EC és 2002/95/EC Európai Irányelv előírásainak.

Icelandic Þessi vara stenst reglugerð Evrópska Efnahags Bandalagsins númer 2004/108/EC, 2006/95/EC, & 2002/95/EC.

Italiano Questo prodotto è conforme alla Direttiva Europea 2004/108/EC, 2006/95/EC & 2002/95/EC.

Latviešu Šis produkts atbilst Eiropas Direktīvu 2004/108/EC, 2006/95/EC un 2002/95/EC noteikumiem.

Lietuvių Šis produktas atitinka Europos direktyvų 2004/108/EC, 2006/95/EC, ir 2002/95/EC nuostatas.

Malta Dan il-prodott hu konformi mal-provvedimenti tad-Direttivi Ewropej 2004/108/EC, 2006/95/EC u 2002/95/EC.

Norsk Dette produktet er i henhold til bestemmelsene i det europeiske direktivet 2004/108/EC, 2006/95/EC & 2002/95/EC.

Polski Niniejszy produkt jest zgodny z postanowieniami Dyrektyw Unii Europejskiej 2004/108/EC, 2006/95/EC i 2002/95/EC.

Portuguese Este produto cumpre com as normas da Diretiva Européia 2004/108/EC, 2006/95/EC & 2002/95/EC.

Español Este producto cumple con las normas del Directivo Europeo 2004/108/EC, 2006/95/EC & 2002/95/EC.

Slovensky Tento produkt je v súlade s ustanoveniami európskych direktív 2004/108/EC, 2006/95/EC a 2002/95/EC.

Slovenščina Izdelek je skladen z določbami evropskih direktiv 2004/108/EC, 2006/95/EC in 2002/95/EC.

Svenska Denna produkt har tillverkats i enlighet med EG-direktiv 2004/108/EC, 2006/95/EC & 2002/95/EC.

Türkçe Bu ürün, Avrupa Birliği'nin 2004/108/EC, 2006/95/EC ve 2002/95/EC yönnergelerine uyar.

5.1.3 Product Ecology Statements

The following information is provided to address worldwide product ecology concerns and regulations.

5.1.3.1 Disposal Considerations

This product contains the following materials that may be regulated upon disposal: printed wiring board assembly and lithium battery.

5.1.4 China RoHS

Intel Desktop Board DH87RL is a China RoHS-compliant product.

The China Ministry of Information Industry (MII) stipulates that a material Self Declaration Table (SDT) must be included in a product's user documentation. The SDT for Intel Desktop Board DH87RL is shown in Figure 18.

关于符合中国《电子信息产品污染控制管理办法》的声明

Management Methods on Control of Pollution from Electronic Information Products (China RoHS declaration)

产品中有毒有害物质的名称及含量

| 部件名称 (Parts) | 有毒有害物质或元素 | | | | | |
|---|-----------|-----------|-----------|---------------|---------------|-----------------|
| | 铅 (Pb) | 汞 (Hg) | 镉 (Cd) | 六价铬 (Cr6+) | 多溴联苯 (PBB) | 多溴二苯醚 (PBDE) |
| 主板组件 Motherboard Assembly | × | ○ | ○ | ○ | ○ | ○ |
| ○ : 表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006 标准规定的限量要求以下。 | | | | | | |
| ○ : Indicates that this hazardous substance contained in all homogeneous materials of this part is below the limit requirement in SJ/T 11363-2006. | | | | | | |
| × : 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006 标准规定的限量要求。 | | | | | | |
| × : Indicates that this hazardous substance contained in at least one of the homogeneous materials of this part is above the limit requirement in SJ/T 11363-2006. | | | | | | |
| 对销售之日的所售产品,本表显示我公司供应链的电子信息产品可能包含这些物质。注意:在所售产品中可能会也可能不会含有所有所列的部件。 | | | | | | |
| This table shows where these substances may be found in the supply chain of our electronic information products, as of the date of sale of the enclosed product. Note that some of the component types listed above may or may not be a part of the enclosed product. | | | | | | |

Figure 18. Intel Desktop Board DH87RL China RoHS Material Self Declaration Table

5.1.5 EMC Regulations

Intel Desktop Board DH87RL complies with the EMC regulations stated in Table 46 when correctly installed in a compatible host system.

Table 46. EMC Regulations

| Regulation | Title |
|-------------------------------|---|
| FCC 47 CFR Part 15, Subpart B | Title 47 of the Code of Federal Regulations, Part 15, Subpart B, Radio Frequency Devices. (USA) |
| ICES-003 | Interference-Causing Equipment Standard, Digital Apparatus. (Canada) |
| EN55022 | Limits and methods of measurement of Radio Interference Characteristics of Information Technology Equipment. (European Union) |
| EN55024 | Information Technology Equipment – Immunity Characteristics Limits and methods of measurement. (European Union) |
| EN55022 | Australian Communications Authority, Standard for Electromagnetic Compatibility. (Australia and New Zealand) |
| CISPR 22 | Limits and methods of measurement of Radio Disturbance Characteristics of Information Technology Equipment. (International) |
| CISPR 24 | Information Technology Equipment – Immunity Characteristics – Limits and Methods of Measurement. (International) |
| VCCI V-3, V-4 | Voluntary Control for Interference by Information Technology Equipment. (Japan) |
| KN-22, KN-24 | Korean Communications Commission – Framework Act on Telecommunications and Radio Waves Act (South Korea) |
| CNS 13438 | Bureau of Standards, Metrology, and Inspection (Taiwan) |

FCC Declaration of Conformity

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

For questions related to the EMC performance of this product, contact:

Intel Corporation, 5200 N.E. Elam Young Parkway, Hillsboro, OR 97124
1-800-628-8686

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.

- Connect the equipment to an outlet on a circuit other than the one to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Any changes or modifications to the equipment not expressly approved by Intel Corporation could void the user's authority to operate the equipment.

Tested to comply with FCC standards for home or office use.

Canadian Department of Communications Compliance Statement

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la classe B prescrites dans le Règlement sur le brouillage radioélectrique édicté par le ministère des Communications du Canada.

Japan VCCI Statement

Japan VCCI Statement translation: This is a Class B product based on the standard of the Voluntary Control Council for Interference from Information Technology Equipment (VCCI). If this is used near a radio or television receiver in a domestic environment, it may cause radio interference. Install and use the equipment according to the instruction manual.

この装置は、情報処理装置等電波障害自主規制協議会（VCCI）の基準に基づくクラスB情報技術装置です。この装置は、家庭環境で使用することを目的としていますが、この装置がラジオやテレビジョン受信機に近接して使用されると、受信障害を引き起こすことがあります。
取扱説明書に従って正しい取り扱いをして下さい。

Korea Class B Statement

Korea Class B Statement translation: This equipment is for home use, and has acquired electromagnetic conformity registration, so it can be used not only in residential areas, but also other areas.

이 기기는 가정용(B급)으로 전자파적합등록을 한 기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다.

5.1.6 e-Standby and ErP Compliance

Intel Desktop Board DH87RL allows for a compliant system built to meet the following program requirements, including appropriate selection of an efficient power supply:

- EPEAT*
- Korea e-Standby
- European Union Energy-related Products Directive (ErP) Lot 6, Tier 2

| For information about | Refer to |
|---|---|
| Electronic Product Environmental Assessment Tool (EPEAT) | http://www.epeat.net/ |
| Korea e-Standby Program | http://www.kemco.or.kr/new_eng/pg02/pg02100300.asp |
| European Union Energy-related Products Directive 2009 (ErP) | http://ec.europa.eu/enterprise/policies/sustainable-business/sustainable-product-policy/ecodesign/index_en.htm |

5.1.7 Regulatory Compliance Marks (Board Level)

Intel Desktop Board DH87RL has the regulatory compliance marks shown in Table 47.

Table 47. Regulatory Compliance Marks

| Description | Mark |
|--|---|
| UL joint US/Canada Recognized Component mark. Includes adjacent UL file number for Intel Desktop Boards: E210882. |  |
| FCC Declaration of Conformity logo mark for Class B equipment. |  |
| CE mark. Declaring compliance to the European Union (EU) EMC directive, Low Voltage directive, and RoHS directive. |  |
| Australian Communications Authority (ACA) and New Zealand Radio Spectrum Management (NZ RSM) C-tick mark. Includes adjacent Intel supplier code number, N-232. |  |
| Japan VCCI (Voluntary Control Council for Interference) mark. |  |
| Korea Certification mark. Includes an adjacent KCC (Korean Communications Commission) certification number: KCC-REM-CPU-DH87RL. |  |
| Taiwan BSMI (Bureau of Standards, Metrology and Inspections) mark. Includes adjacent Intel company number, D33025. |  |
| Printed wiring board manufacturer's recognition mark. Consists of a unique UL recognized manufacturer's logo, along with a flammability rating (solder side). | V-0 |
| China RoHS/Environmentally Friendly Use Period Logo: This is an example of the symbol used on Intel Desktop Boards and associated collateral. The color of the mark may vary depending upon the application. The Environmental Friendly Usage Period (EFUP) for Intel Desktop Boards has been determined to be 10 years. |  |

5.2 Battery Disposal Information



CAUTION

Risk of explosion if the battery is replaced with an incorrect type. Batteries should be recycled where possible. Disposal of used batteries must be in accordance with local environmental regulations.



PRÉCAUTION

Risque d'explosion si la pile usagée est remplacée par une pile de type incorrect. Les piles usagées doivent être recyclées dans la mesure du possible. La mise au rebut des piles usagées doit respecter les réglementations locales en vigueur en matière de protection de l'environnement.



FORHOLDSREGEL

Eksplorationsfare, hvis batteriet erstattes med et batteri af en forkert type. Batterier bør om muligt genbruges. Bortskaffelse af brugte batterier bør foregå i overensstemmelse med gældende miljølovgivning.



OBS!

Det kan oppstå eksplorationsfare hvis batteriet skiftes ut med feil type. Brukte batterier bør kastes i henhold til gjeldende miljølovgivning.



VIKTIGT!

Risk för explosion om batteriet ersätts med felaktig batterityp. Batterier ska kasseras enligt de lokala miljövårdsbestämmelserna.



VARO

Räjähdyksvaara, jos pariston tyyppi on väärä. Paristot on kierrätettävä, jos se on mahdollista. Käytetyt paristot on hävitettävä paikallisten ympäristömäärysten mukaisesti.



VORSICHT

Bei falschem Einsetzen einer neuen Batterie besteht Explosionsgefahr. Die Batterie darf nur durch denselben oder einen entsprechenden, vom Hersteller empfohlenen Batterietyp ersetzt werden. Entsorgen Sie verbrauchte Batterien den Anweisungen des Herstellers entsprechend.



AVVERTIMENTO

Esiste il pericolo di un esplosione se la pila non viene sostituita in modo corretto. Utilizzare solo pile uguali o di tipo equivalente a quelle consigliate dal produttore. Per disfarsi delle pile usate, seguire le istruzioni del produttore.



PRECAUCIÓN

Existe peligro de explosión si la pila no se cambia de forma adecuada. Utilice solamente pilas iguales o del mismo tipo que las recomendadas por el fabricante del equipo. Para deshacerse de las pilas usadas, siga igualmente las instrucciones del fabricante.



WAARSCHUWING

Er bestaat ontploffingsgevaar als de batterij wordt vervangen door een onjuist type batterij. Batterijen moeten zoveel mogelijk worden gerecycled. Houd u bij het weggooien van gebruikte batterijen aan de plaatselijke milieuwetgeving.



ATENÇÃO

Haverá risco de explosão se a bateria for substituída por um tipo de bateria incorreto. As baterias devem ser recicladas nos locais apropriados. A eliminação de baterias usadas deve ser feita de acordo com as regulamentações ambientais da região.



АСЦИАРОŽЗНАСĆ

Існуе ризыка выбуху, калі заменены акумулятар неправільнага тыпу. Акумулятары павінны, па магчымасці, перепрацоўвацца. Пазбаўляцца ад старых акумулятараў патрэбна згодна з мясцовым заканадаўствам па экалогіі.



UPOZORNÍNÍ

V případě výměny baterie za nesprávný druh může dojít k výbuchu. Je-li to možné, baterie by měly být recyklovány. Baterie je třeba zlikvidovat v souladu s místními předpisy o životním prostředí.



Προσοχή

Υπάρχει κίνδυνος για έκρηξη σε περίπτωση που η μπαταρία αντικατασταθεί από μία λανθασμένου τύπου. Οι μπαταρίες θα πρέπει να ανακυκλώνονται όταν κάτι τέτοιο είναι δυνατό. Η απόρριψη των χρησιμοποιημένων μπαταριών πρέπει να γίνεται σύμφωνα με τους κατά τόπο περιβαλλοντικούς κανονισμούς.



VIGYÁZAT

Ha a telepet nem a megfelelő típusú telepre cseréli, az felrobbanhat. A telepeket lehetőség szerint újra kell hasznosítani. A használt telepeket a helyi környezetvédelmi előírásoknak megfelelően kell kiselejtezni.



注意

異なる種類の電池を使用すると、爆発の危険があります。リサイクルが可能な地域であれば、電池をリサイクルしてください。使用後の電池を破棄する際には、地域の環境規制に従ってください。

**AWAS**

Risiko letupan wujud jika bateri digantikan dengan jenis yang tidak betul. Bateri sepatutnya dikitar semula jika boleh. Pelupusan bateri terpakai mestilah mematuhi peraturan alam sekitar tempatan.

**OSTRZEŻENIE**

Istnieje niebezpieczeństwo wybuchu w przypadku zastosowania niewłaściwego typu baterii. Zużyté baterie należy w miarę możliwości utylizować zgodnie z odpowiednimi przepisami ochrony środowiska.

**PRECAUȚIE**

Risc de explozie, dacă bateria este înlocuită cu un tip de baterie necorespunzător. Bateriile trebuie reciclate, dacă este posibil. Depozitarea bateriilor uzate trebuie să respecte reglementările locale privind protecția mediului.

**ВНИМАНИЕ**

При использовании батареи несоответствующего типа существует риск ее взрыва. Батареи должны быть утилизированы по возможности. Утилизация батарей должна проводится по правилам, соответствующим местным требованиям.

**UPOZORNENIE**

Ak batériu vymeníte za nesprávny typ, hrozí nebezpečenstvo jej výbuchu. Batérie by sa mali podľa možnosti vždy recyklovať. Likvidácia použitých batérií sa musí vykonávať v súlade s miestnymi predpismi na ochranu životného prostredia.

**POZOR**

Zamenjava baterije z baterijo drugega tipa lahko povzroči eksplozijo. Če je mogoče, baterije reciklirajte. Rabljene baterije zavrzite v skladu z lokalnimi okoljevarstvenimi predpisi.

**คำเตือน**

ระวังการระเบิดที่เกิดจากเปลี่ยนแบตเตอรี่ด้วยประเภท หากเป็นไปได้ ควรนำแบตเตอรี่ไปรีไซเคิล การทิ้งแบตเตอรี่ชั่นแล้วต้องเป็นไปตามกฎหมายศบด้านสิ่งแวดล้อมของท้องถิ่น.

**UYARI**

Yanlış türde pil takıldığında patlama riski vardır. Piller mümkün olduğunda geri dönüştürülmelidir. Kullanılmış piller, yerel çevre yasalarına uygun olarak atılmalıdır.

**ОСТОРОГА**

Використовуйте батареї правильного типу, інакше існуватиме ризик вибуху. Якщо можливо, використані батареї слід утилізувати. Утилізація використаних батарей має бути виконана згідно місцевих норм, що регулюють охорону довкілля.



小心

如果更換的電池類型不正確，可能會有爆炸的危險。請盡可能將電池送至回收處。請依照當地的環保規範來處理使用過的電池。



주의

배터리를 잘못된 종류로 교체할 경우 폭발 위험이 있습니다. 가능한 경우 배터리는 재활용해야 하며, 수명이 다한 배터리를 폐기할 때는 각 지역의 환경법을 따라야 합니다.



THẬN TRỌNG

Có nguy cơ xảy ra nổ nếu thay pin không đúng loại. Pin cần được tái chế nếu có thể thực hiện được. Việc thải bỏ pin đã sử dụng phải tuân theo các quy định của địa phương về môi trường.



UPOZORNĚNÍ

V případě výměny baterie za nesprávný druh může dojít k výbuchu. Je-li to možné, baterie by měly být recyklovány. Baterie je třeba zlikvidovat v souladu s místními předpisy o životním prostředí.



ETTEVAATUST

Kui patarei asendatakse uue ebasobivat tüüpi patareiga, võib tekkida plahvatusoht. Tühjad patareid tuleb võimaluse korral viia vastavasse kogumispunkti. Tühjade patareide äraviiskamisel tuleb järgida kohalikke keskkonnakaitse alaseid reegleid.



FIGYELMEZTETÉS

Ha az elemet nem a megfelelő típusúra cseréli, felrobbanhat. Az elemeket lehetőség szerint újra kell hasznosítani. A használt elemeket a helyi környezetvédelmi előirásoknak megfelelően kell kiselejtezni.



UZMANĪBU

Pastāv eksplozijas risks, ja baterijas tiek nomainītas ar nepareiza veida baterijām. Ja iespējams, baterijas vajadzētu nodot attiecīgos pieņemšanas punktos. Bateriju izmēšanai atkritumos jānotiek saskaņā ar vietējiem vides aizsardzības noteikumiem.



DĒMESIO

Naudojant netinkamo tipo baterijas ierenginys gali sprogti. Kai tik īmanoma, baterijas reikia naudoti pakartotinai. Panaudotas baterijas išmesti būtina pagal vietinius aplinkos apsaugos nuostatus.



ATTENZJONI

Riskju ta' splużjoni jekk il-batterija tinbidel b'tip ta' batterija mhux korrett. Il-batteriji għandhom jiġu riċiklati fejn hu possibbli. Ir-rimi ta' batteriji użati għandu jsir skond ir-regolamenti ambientali lokali.



OSTRZEŻENIE

Ryzyko wybuchu w przypadku wymiany na baterie niewłaściwego typu. W miarę możliwości baterie należy poddać recyklingowi. Zużytych baterii należy pozbywać się zgodnie z lokalnie obowiązującymi przepisami w zakresie ochrony środowiska.