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### Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1.15</td>
<td>Digital Display Interfaces (DDI) - Module Type 6 and 10</td>
<td>18</td>
</tr>
<tr>
<td>4.1.16</td>
<td>General Purpose Serial Interface</td>
<td>18</td>
</tr>
<tr>
<td>4.1.17</td>
<td>I2C Bus</td>
<td>18</td>
</tr>
<tr>
<td>4.1.18</td>
<td>Power and System Management</td>
<td>19</td>
</tr>
<tr>
<td>4.1.19</td>
<td>Thermal Protection</td>
<td>19</td>
</tr>
<tr>
<td>4.1.20</td>
<td>SM Bus</td>
<td>19</td>
</tr>
<tr>
<td>4.1.21</td>
<td>General Purpose Input Output</td>
<td>19</td>
</tr>
<tr>
<td>4.1.22</td>
<td>SDIO</td>
<td>19</td>
</tr>
<tr>
<td>4.1.23</td>
<td>Module Type Definition</td>
<td>20</td>
</tr>
<tr>
<td>4.1.24</td>
<td>eDP - Embedded DisplayPort</td>
<td>20</td>
</tr>
<tr>
<td>4.1.25</td>
<td>CAN Bus</td>
<td>20</td>
</tr>
<tr>
<td>4.2</td>
<td>COM Express EEPROMs</td>
<td>20</td>
</tr>
<tr>
<td>4.2.1</td>
<td>COM Express Module EEPROM</td>
<td>21</td>
</tr>
<tr>
<td>4.2.2</td>
<td>COM Express Carrier Board EEPROM</td>
<td>21</td>
</tr>
<tr>
<td>4.3</td>
<td>Watchdog Timer</td>
<td>21</td>
</tr>
<tr>
<td>5</td>
<td>Mechanical Specifications</td>
<td>22</td>
</tr>
<tr>
<td>5.1</td>
<td>Module Size – Mini Module</td>
<td>22</td>
</tr>
<tr>
<td>5.2</td>
<td>Module Size - Compact Module</td>
<td>23</td>
</tr>
<tr>
<td>5.3</td>
<td>Module Size - Basic Module</td>
<td>24</td>
</tr>
<tr>
<td>5.4</td>
<td>Module Size - Extended Module</td>
<td>25</td>
</tr>
<tr>
<td>5.5</td>
<td>Module Connector</td>
<td>25</td>
</tr>
<tr>
<td>5.6</td>
<td>Carrier Board Connector</td>
<td>26</td>
</tr>
<tr>
<td>5.7</td>
<td>Heat-Spreader</td>
<td>27</td>
</tr>
<tr>
<td>6</td>
<td>Electrical Specifications</td>
<td>32</td>
</tr>
<tr>
<td>6.1</td>
<td>Input Power - General Considerations</td>
<td>32</td>
</tr>
<tr>
<td>7</td>
<td>Appendix</td>
<td>33</td>
</tr>
<tr>
<td>7.1</td>
<td>Mounting positions and connector location for Carrier Boards</td>
<td>33</td>
</tr>
</tbody>
</table>
List of Tables

Table 3.1: Module Pin-out Type Overview.................................................................13
Table 3.2: Module Pin-out - Required and Optional Features A-B Connector ..............14
Table 3.3: Module Pin-out - Required and Optional Features C-D Connector ...............15
Table 4.1: Module Type Signals, Pin Types, and Descriptions......................................20
Contents

List of Figures

Figure 5-1: Mini Module Form Factor ......................................................................................22
Figure 5-2: Compact Module Form Factor ..............................................................................23
Figure 5-3: Basic Module Form Factor ....................................................................................24
Figure 5-4: Extended Module Form Factor .............................................................................25
Figure 5-5: Module Receptacle ...............................................................................................26
Figure 5-6: Carrier Board Plug ...............................................................................................27
Figure 5-7: Overall Height for Heat-Spreader in Mini, Compact, Basic and Extended Modules27
Figure 5-8: Mini Module Heat-Spreader ..................................................................................28
Figure 5-9: Compact Module Heat-Spreader .........................................................................29
Figure 5-10: Basic Module Heat-Spreader ..............................................................................30
Figure 5-11: Heat-Spreader Specification for Extended Module .............................................31
Figure 7-1: Carrier Board mounting positions .........................................................................33
1 Introduction

NOTE: Section, Table and Figure numbers in this Short Form Specification are likely to be different from those in the full specification.

A Computer-On-Module, or COM, is a Module with all components necessary for a bootable host computer, packaged as a super component. A COM requires a Carrier Board to bring out I/O and to power up. COMs are used to build single board computer solutions and offer OEMs fast time-to-market with reduced development cost. Like integrated circuits, they provide OEMs with significant freedom in meeting form-fit-function requirements. For all these reasons the COM methodology has gained much popularity with OEMs in the embedded industry.

COM Express® is an open industry standard for Computer-On-Modules. It is designed to be future proof and to provide a smooth transition path from legacy parallel interfaces to LVDS (Low Voltage Differential Signaling) interfaces. These include the PCI bus and parallel ATA on the one hand and PCI Express and Serial ATA on the other hand.

Key features include:

- Rich complement of contemporary high bandwidth serial interfaces, including PCI Express, Serial ATA, USB, and Gigabit Ethernet
- 32-bit PCI, LPC and Parallel ATA options preserved for easy interface to a range of peripherals
- Extended power-management capabilities
- Robust thermal and mechanical concept
- Cost-effective design
- Legacy-free design (no Super I/O, PS2 keyboard or mouse)
- Small Module size with multiple footprint options to satisfy a range of performance requirements
- High-performance mezzanine connector with several pin-out types to satisfy a range of applications
- Extensive video port support, including VGA, LVDS, SDVO, DP, eDP, DVI and HDMI terminal drivers plus x16 PEG port to Carrier Board graphics controller

The COM Express® specification has been created to appeal to a range of vertical embedded markets. It has also been formulated to be applicable to a broad range of form factors, from floor-installed to bench-top to handheld.

Markets and applications include but are not limited to:

- Healthcare - clinical diagnostic imaging systems, patient bedside monitors, etc.
- Retail & advertising - electronic shopping carts, billboards, kiosks, POS systems, etc.
- Test & measurement - scientific and industrial test and measurement instruments
- Gaming & entertainment - simulators, slot machines, etc.
- Industrial automation - industrial robots, vision systems, etc.
- Security - digital CCTV, luggage scanners, intrusion detectors, etc.
- Defense & government - unmanned vehicles, rugged laptops, wearable computers, etc.
Systems based on the COM Express® Specification require the implementation of an application-specific Carrier Board that accepts the Module. User-specific features such as external connector choices and locations and peripheral circuits can be tailored to suit the application. The OEM can focus on application-specific features rather than CPU board design. The OEM also benefits from a wide choice of Modules providing a scalable range of price and performance upgrade options.

1.1 COM.0 R2.1 Changes from R2.0

**Mini form factor**
Added definitions for Mini 84x55mm form factor
Section 5.1 'Module Size – Mini Module’
Section 5.7 'Heat-Spreader’
Section Figure 5-8: Mini Module Heat-Spreader’
Section 7.1 'Mounting positions and connector location for Carrier Boards'

**I/Os**
Added CAN Bus for Type 6 and Type 10 in Section 4.1.25 'CAN Bus'
Added USB 3.0 for Type 10
Added a pin for USB Client Host detection for Type 10
Added option for eDP overlayed on LVDS Channel A for Type 6 and Type 10 Modules

**Power**
Allowed for wide input voltage range for Mini size Module

**Updates**
Updated Section Error: Reference source not found 'Error: Reference source not found'
Corrected SDIO Section 4.1.22 'SDIO', Error: Reference source not found 'Error: Reference source not found' and Error: Reference source not found 'Error: Reference source not found'

2 Module Overview

2.1 Module Configuration
Four Module sizes are defined: the Mini Module, Compact Module, Basic Module and the Extended Module. The primary difference between the different size Modules is the over-all physical size and the performance envelope supported by each. The Extended Module is larger and can support larger processor and memory solutions. The Compact Module, Basic Module and Extended Module use the same connectors and pin-outs whereas the 84x55 Mini Module targets but is not limited to use the COM Express A-B connector, Type 10 and Type 1 pin-outs. In addition, the Mini Module allows for wide range power supply operation. The different size Modules share several common mounting hole positions. This
level of compatibility allows that a Carrier Board can be designed to accommodate multiple Module sizes.

Up to 440 pins of connectivity are available between COM Express Modules and the Carrier Board. Legacy buses such as PCI, parallel ATA, LPC, AC'97 can be supported as well as new high-speed serial interconnects such as PCI Express, Serial ATA or SAS, USB 2.0 / 3.0 and Gigabit Ethernet. To enhance interoperability between COM Express Modules and Carrier Boards, seven common signaling configurations (Pin-out Types) have been defined to ease system integration. Some Pin-out Types definitions require only a single 220-pin connector and others require both 220-pin connectors to supply all the defined signaling.

2.2 Feature Overview - Size

2.2.1 Mini Module

The Mini Module targets the next generation of mobile applications that require energy saving processors, high-end graphics combined with longer battery life. Key features of the Mini Module include:

- Module size: 84mm x 55mm
- 5mm and 8mm stack height options (Module bottom to Carrier Board top)
- Wide-range power supply input (4.75-20V)
- Suggested pin-out: single 220 pin connector, Type 10
- Reduced Z height for components (optional)

Although not a requirement, Mini Modules are often implemented with memory and SSD storage soldered down on the Module. This facilitates their use in ruggedized, small form factor mobile systems.

2.2.2 Compact Module

The Compact Module is intended for mobile systems and space-constrained stationary systems. Key features of the Compact Module include:

- Module size: 95mm x 95mm
- 5mm and 8mm stack height options (Module bottom to Carrier Board top)
- 18mm 'z' height with heat-spreader (using the 5mm stack option)
- Accommodates a single (or two stacked) horizontal mount SO-DIMM
- Single 220 pin or dual 220 pin connectors for up to 440 pins

2.2.3 Basic Module

The Basic Module is intended for mobile systems and space-constrained stationary systems. Key features of the Basic Module include:

- Module size: 125mm x 95mm
- 5mm and 8mm stack height options (Module bottom to Carrier Board top)
- 18mm 'z' height with heat-spreader (using the 5mm stack option)
- Accommodates a single (or two stacked) horizontal mount SO-DIMM
- Single 220 pin or dual 220 pin connectors for up to 440 pins
2.2.4 Extended Module

The Extended Module, which targets OEM applications that require larger amounts of system memory, features a larger Module size to accommodate full size DIMMs and larger chipset and CPU packages.

The key features of the Extended Module include:
- Module size: 155mm x 110mm
- 5mm and 8mm stack height options (Module bottom to Carrier Board top)
- 18mm 'z' height with heat-spreader (using the 5mm stack option)
- Accommodates 2 full-size DIMM or mini DIMM memories or 2 horizontal mount or vertical mount SO-DIMMs
- Single 220 pin or dual 220 pin connectors for up to 440 pins
- Allows for the use of higher performance CPUs that cannot be supported on the Compact Module or Basic Module

2.3 Feature Overview - Pin-out Types

2.3.1 Pin-out Type 1
- Single 220 pin connector (A-B connector)
- Up to 8 USB 2.0 ports; 4 shared over-current lines
- Up to 4 Serial ATA or SAS ports
- Up to 6 PCI Express Gen1/Gen2 signaling lanes
- Support pins for up to 2 ExpressCards
- Dual 24-bit LVDS channels
- Analog VGA
- AC '97 / HDA digital audio interface (external CODEC(s) required)
- Single Ethernet interface with integrated PHY – pinned for Gigabit Ethernet
- LPC interface
- SPI\(^1\)
- 8 GPIO pins
- 68W maximum input power over Module connector pins
- +12V primary power supply input
- +5V standby and 3.3V RTC power supply inputs

2.3.2 Pin-out Type 10

The type 10\(^2\) Pin-out was introduced with COM Express Rev. 2.0.
- Single 220 pin connector (A-B connector)
- Up to 8 USB 2.0 ports; 4 shared over-current lines
- USB 3.0 support
- USB Client support
- Up to 2 Serial ATA or SAS ports
- Up to 4 PCI Express Gen1/Gen2 signaling lanes
- Support pins for up to 2 ExpressCards
- Single 24-bit LVDS channel with option to overlay with eDP
- One Digital Display Interface configurable as SDVO, DP, or TMDS

\(^1\) SPI support starts with COM.0 R2.0
\(^2\) Pin-out Type 10 is not compatible to Type 1-6
- AC '97 / HDA digital audio interface (external CODEC(s) required)
- Single Ethernet interface with integrated PHY – pinned for Gigabit Ethernet
- LPC interface
- Two TX/RX serial pairs with option to overlay CAN interface
- Fan control
- TPM support
- 8 GPIO pins
- 68W maximum input power over Module connector pins
- +12V primary power supply input for Compact, Basic and Extended form factor
- Wide input voltage range for Mini form factor
- +5V standby and 3.3V RTC power supply inputs

### 2.3.3 Pin-out Type 2

All Pin-out Type 1 features plus the following:
- Dual 220 pin connectors (A-B and C-D, 440 pins total)
- 32 bit PCI interface
- IDE port (to support legacy ATA devices such as CD-ROM drives and Compact Flash storage cards)
- Up to 22 PCI Express lanes (up to 6 on A-B and up to 16 on C-D)
- 16 of 22 PCI Express lanes commonly used for PCI Express Graphics
- SDVO option (pins shared with PCI Express Graphics)
- Maximum Module input power capability extended to 137W

### 2.3.4 Pin-out Type 3

All Pin-out Type 2 features with the exception of the following:
- IDE pins are reallocated to provide additional Gigabit Ethernet capability: no IDE
- Up to 3 Gigabit Ethernet channels

### 2.3.5 Pin-out Type 4

All Pin-out Type 2 features with the exception of the following:
- PCI pins are reallocated to provide additional PCI Express lanes: no PCI
- Up to 32 PCI Express lanes

### 2.3.6 Pin-out Type 5

All Pin-out Type 2 features with the exception of the following:
- Both IDE and PCI pins are reallocated: no IDE and no PCI
- Up to 32 PCI Express lanes
- Up to 3 Gigabit Ethernet channels

### 2.3.7 Pin-out Type 6

All Pin-out Type 2 features with the exception of the following:
- Both IDE and PCI pins are reallocated: no IDE and no PCI
- Up to 24 PCI Express lanes (16 on the PEG port)
- Reserved 16 pins to support the two extra differential pairs required for SuperSpeed USB 3.0. The 16 pins will allow SuperSpeed USB 3.0 support on up to four of the eight USB 2.0 ports. At this point in time, there is not enough information and silicon available for this subcommittee to determine the appropriate trace length and routing rules for SuperSpeed USB 3.0.
- Up to 3 Digital Display Interfaces
• Allow eDP overlay of LVDS Channel A
• Two TX/RX serial pairs with option to overlay CAN interface

3 Required and Optional Features

3.1 Module Pin-out Type Definitions

Seven pin-out types are defined. Pin-out Type 1 and Type 10 Modules have a single 220-pin connector, the A-B connector. Module Pin-out Types 2 through 6 use a pair of 220 pin connectors, designated A-B and C-D, for a total of 440 pins. The variations in Pin-out Type definitions are summarized in the table below.

<table>
<thead>
<tr>
<th>Table 3.1: Module Pin-out Type Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Type 1</td>
</tr>
<tr>
<td>Type 2</td>
</tr>
<tr>
<td>Type 3</td>
</tr>
<tr>
<td>Type 4</td>
</tr>
<tr>
<td>Type 5</td>
</tr>
<tr>
<td>Type 6</td>
</tr>
<tr>
<td>Type 10</td>
</tr>
</tbody>
</table>

For Module Pin-out Types 2 through 6, a subset of the PCI Express lanes are commonly used as PCI Express Graphics (PEG) lanes. SDVO functions may be pin-shared with PEG lanes on Types 2-5. In Type 6 SDVO is moved from the PEG to DDI 1. Type 10 does feature one DDI but no PEG lanes.

Type 1 Modules allow for a minimal possible feature set using two of the four available connector rows. Type 1 represents a basic feature set with the benefit of simplified routing of the Carrier Board to allow a lower layer count board.

Type 10 Modules are similar but not completely compatible to Type 1 Modules. These Modules feature less PCI Express and SATA interfaces. Type 10 Modules support a single 24 bit LVDS panel interface, a single DDI and an eDP overlayed on LVDS Channel A and an option to allow a CAN bus to share SER1 pins. 2 of the 8 USB ports can be used as USB 3.0.

Type 2 Modules include PCI and IDE interfaces. These Modules either use on board graphics capabilities or may use 16 PEG lanes to connect to an external video controller. In case of on board graphics, PEG pins may be alternatively used for two SDVO ports.

Type 3 Modules trade IDE port pins for two additional LAN ports, allowing up to three GBE interfaces.

Type 4 Modules drop the PCI interface, to allow up to 32 PCI Express lanes for applications with large I/O bandwidth requirements. IDE support is still available.

³ The SuperSpeed USB ports are not in addition to the USB 2.0 ports. Up to 4 of the USB 2.0 ports can support SuperSpeed USB.
**Type 5** Modules trade IDE and PCI pins for up to 32 PCI Express lanes and up to three GBE interfaces. These Modules are intended for applications with large I/O bandwidth requirements.

**Type 6** Modules trade IDE and PCI pins for up to 8 PCI Express lanes, up to three DDIs and 4 of the 8 USB ports can be used as USB 3.0. Type 6 Modules support a single or dual channel 18/24 bit LVDS panel interface, three DDIs and an eDP overlayed on LVDS Channel A and an option to allow a CAN bus to share SER1 pins.

### 3.2 Module Pin-out Types 1-6 & 10 - Required and Optional Features

COM Express Required and Optional features are summarized in the following table. The features identified as Minimum (Min.) shall be implemented by all Modules. Features identified up to Maximum (Max) may be additionally implemented by a Module.

#### Change Key:
- **Green** = Generic R2.0
- **Blue** = Type 10 only
- **Violet** = Type 10 & Type 6 only
- **Red** = Type 6 only

#### Table 3.2: Module Pin-out - Required and Optional Features A-B Connector

<table>
<thead>
<tr>
<th>Connector</th>
<th>Feature</th>
<th>Type 10 (Single connector)</th>
<th>Type 1 (Single connector)</th>
<th>Type 2 (IDE + PCI)</th>
<th>Type 3 (No IDE)</th>
<th>Type 4 (No PCI)</th>
<th>Type 5 (No IDE, No PCI)</th>
<th>Type 6 (No IDE or PCI, add DDI + USB3)</th>
<th>System I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-B</td>
<td>PCI Express Lanes 0 - 5</td>
<td>1 / 4</td>
<td>1 / 6</td>
<td>1 / 6</td>
<td>1 / 6</td>
<td>1 / 6</td>
<td>1 / 6</td>
<td>1 / 6</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>LVDS Channel A</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>LVDS Channel B</td>
<td>NA</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>eDP on LVDS CH A pins</td>
<td>0 / 1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>VGA Port</td>
<td>NA</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
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</tr>
<tr>
<td>A-B</td>
<td>TV-Out</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
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<td>A-B</td>
<td>DDI 0</td>
<td>0 / 1</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Serial Ports 1 - 2</td>
<td>0 / 2</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0 / 2</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>CAN interface on SER1</td>
<td>0 / 1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>SATA / SAS Ports</td>
<td>1 / 2</td>
<td>1 / 4</td>
<td>1 / 4</td>
<td>1 / 4</td>
<td>1 / 4</td>
<td>1 / 4</td>
<td>1 / 4</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>AC’97 / HDA Digital Interface</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>USB Client</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
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<tr>
<td>A-B</td>
<td>USB 3.0 Ports</td>
<td>0 / 2</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>A-B</td>
<td>LAN Port 0</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
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</tr>
<tr>
<td>A-B</td>
<td>Express Card Support</td>
<td>0 / 2</td>
<td>1 / 2</td>
<td>1 / 2</td>
<td>1 / 2</td>
<td>1 / 2</td>
<td>1 / 2</td>
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</tr>
<tr>
<td>A-B</td>
<td>LPC Bus</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
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<td>1 / 1</td>
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<tr>
<td>A-B</td>
<td>SPI</td>
<td>1 / 2</td>
<td>1 / 2</td>
<td>1 / 2</td>
<td>1 / 2</td>
<td>1 / 2</td>
<td>1 / 2</td>
<td>1 / 2</td>
<td></td>
</tr>
</tbody>
</table>

* 4 Indicates 12V-tolerant features on former VCC_12V signals.
<table>
<thead>
<tr>
<th>Connector</th>
<th>Feature</th>
<th>Type 10 (Single connector)</th>
<th>Type 1 (Single connector)</th>
<th>Type 2 (IDE + PCI)</th>
<th>Type 3 (No IDE)</th>
<th>Type 4 (No PCI)</th>
<th>Type 5 (No IDE, No PCI)</th>
<th>Type 6 (No IDE or PCI, add DDI + USB3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-B</td>
<td>SDIO (muxed on GPIO)</td>
<td>0 / 1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>General Purpose I/O</td>
<td>8 / 8</td>
<td>8 / 8</td>
<td>8 / 8</td>
<td>8 / 8</td>
<td>8 / 8</td>
<td>8 / 8</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>SMBus</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>I2C</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Watchdog Timer</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Speaker Out</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>External BIOS ROM Support</td>
<td>0 / 2</td>
<td>0 / 2</td>
<td>0 / 2</td>
<td>0 / 2</td>
<td>0 / 2</td>
<td>0 / 2</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Reset Functions</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Thermal Protection</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Battery Low Alarm</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td>0 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Suspend/Wake Signals</td>
<td>0 / 3</td>
<td>0 / 3</td>
<td>0 / 3</td>
<td>0 / 3</td>
<td>0 / 3</td>
<td>0 / 3</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Power Button Support</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Power Good</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Sleep Input</td>
<td>0 / 1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Lid Input</td>
<td>0 / 1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Fan Control Signals</td>
<td>0 / 2</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Trusted Platform Modules</td>
<td>0 / 1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>Power Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-B</td>
<td>VCC_12V Contacts</td>
<td>12 / 12</td>
<td>12 / 12</td>
<td>12 / 12</td>
<td>12 / 12</td>
<td>12 / 12</td>
<td>12 / 12</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.3: Module Pin-out - Required and Optional Features C-D Connector

<table>
<thead>
<tr>
<th>Connector</th>
<th>Feature</th>
<th>Type 10 (Single connector)</th>
<th>Type 1 (Single connector)</th>
<th>Type 2 (IDE + PCI)</th>
<th>Type 3 (No IDE)</th>
<th>Type 4 (No PCI)</th>
<th>Type 5 (No IDE, No PCI)</th>
<th>Type 6 (No IDE or PCI, add DDI + USB3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-D</td>
<td>System I/O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-D5</td>
<td>PCI Express Lanes 16 - 31</td>
<td>NA</td>
<td>NA</td>
<td>0 / 16</td>
<td>0 / 16</td>
<td>0 / 16</td>
<td>0 / 16</td>
<td></td>
</tr>
<tr>
<td>C-D5</td>
<td>PCI Express Graphics (PEG)</td>
<td>NA</td>
<td>NA</td>
<td>0 / 16</td>
<td>0 / 16</td>
<td>0 / 16</td>
<td>0 / 16</td>
<td></td>
</tr>
<tr>
<td>C-D5</td>
<td>Muxed SDVO Channels 1 - 2</td>
<td>NA</td>
<td>NA</td>
<td>0 / 2</td>
<td>0 / 2</td>
<td>0 / 2</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>C-D5</td>
<td>PCI Express Lanes 6 - 15</td>
<td>NA</td>
<td>NA</td>
<td>0 / 10</td>
<td>0 / 10</td>
<td>0 / 2</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>C-D5</td>
<td>PCI Bus - 32 Bit</td>
<td>NA</td>
<td>NA</td>
<td>0 / 2</td>
<td>NA</td>
<td>0 / 2</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>C-D5</td>
<td>PATA Port</td>
<td>NA</td>
<td>NA</td>
<td>1 / 1</td>
<td>NA</td>
<td>1 / 1</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>C-D5</td>
<td>LAN Ports 1 - 2</td>
<td>NA</td>
<td>NA</td>
<td>0 / 2</td>
<td>NA</td>
<td>0 / 2</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DDIs 1 - 3</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0 / 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>USB 3.0 Ports</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0 / 4</td>
<td></td>
</tr>
</tbody>
</table>

5 Cells in the connected columns spanning rows provide a rough approximation of features sharing connector pins.
### 3.3 EAPI - Embedded Application Programming Interface

All COM Express Modules *should* support the Revision 1.1 of the PICMG defined Software API EAPI. This API allows for an easier interoperability of COM Express Modules.

Addressed functions are:

- System information
- Watchdog timer
- I2C Bus
- Flat Panel brightness control
- User storage area
- GPIO

### 4 Signal Descriptions

#### 4.1 Signal List

COM Express signal descriptions are described in the following table. The Pin Availability column in the table indicates in which Pin-out Types the signal is available. Module Pin-out Types 1 through 6 and 10 are designated T1, T2, T3, T4, T5, T6, T10 in the Pin Availability column. A notation of “All” indicates that the signal is available to all Module Pin-out Types.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-D</td>
<td>VCC_12V Contacts</td>
<td>12 / 12</td>
</tr>
</tbody>
</table>

#### 4.1.1 AC97 Audio / High Definition Audio

The AC ’97 audio codec interface is limited to support a single AC ’97 link. High Definition Audio *may* be supported.

#### 4.1.2 Ethernet

Up to 3 Gigabit Ethernet ports are defined, designated GBE0 through GBE2. The ports *may* operate in 10, 100, or 1000 Mbit/sec modes. Magnetics are assumed to be on the Carrier Board. All COM Express Modules *shall* implement at least one Ethernet port on the GBE0 pin slot and this *should* be capable of at least 10/100 mode.

#### 4.1.3 IDE

Parallel ATA support for up to 2 devices in a master/slave configuration. This signaling interface is limited to ATA100 speeds. Higher (ATA133) speeds are not defined. PATA signal pins are reused in Pin-out Type 3 and 5 Modules for 2 additional GB Ethernet interfaces; and for USB3.0 interfaces in Type 6.
4.1.4 **Serial ATA**
Serial ATA links for support of existing SATA-150 and SATA-300 devices. Alternatively, this interface may be used for Serial Attached SCSI (SAS).

4.1.5 **General Purpose PCI Express Lanes**
The number of available PCI Express lanes varies with the Module Pin-out Type. If the Module supports off-Module x16 PCI Express Graphics, then PCI Express Lanes 16-31 shall be used to implement this.

4.1.6 **PEG PCI Express Lanes**
These signals may be multiplexed with SDVO signals or defined as ordinary PCI Express signals on Module Types 2-5. Type 6 provides dedicated PEG and SDVO channels. The PEG lanes are the same lanes as PCI Express lanes 16-31.

4.1.7 **ExpressCard**
ExpressCard is a small form factor expansion card for mobile systems that uses PCI Express or USB as the interface. It is similar in concept and scope to CardBus. COM Express Modules shall provide support functions for at least one ExpressCard. This does not mean that a Module PCI Express lane or USB link are specifically allocated to ExpressCard use, but it does mean that the Module pins for ExpressCard detection and support are present.

4.1.8 **PCI Bus**
The PCI bus interface is specified to be a 32-bit PCI 2.3 compliant bus with speed options of 33MHz or 66MHz.

4.1.9 **USB**
All USB interfaces shall be USB 2.0 compliant. The minimum of 4 USB channels provides support for keyboard, mouse, CD/DVD drive, and one additional device. Up to four of the eight USB 2.0 ports may support the extended signaling for SuperSpeed USB 3.0. USB7 may optionally be configured as a USB client.

4.1.10 **LVDS Flat Panel**
Low voltage differential signaling flat-panel interface. The Module pin-out allows one single channel display interface (1 pixel per clock) with up to 24 bit color. Alternatively, one dual channel display (2 pixels per clock) with up to 24 bit color, 48 bits per clock is allowed. Includes panel backlight control and EDID support. The LVDS A channel and the control signals are pin shared with eDP signals. Refer to Section 4.1.24 'eDP - Embedded DisplayPort'

4.1.11 **LPC Interface**
The LPC bus provides legacy I/O support on a Carrier Board via a Super I/O and system management devices.

4.1.12 **SPI Interface**
The SPI bus is used to support SPI-compatible flash devices. The SPI flash device can be up to 16 MB (128 Mb). The SPI bus is clocked at either 20 MHz,
25 MHz, 33 MHz or 50 MHz. SPI devices selected should support one of these frequencies. SPI support is introduced in COM.0 R2.0 for all Types.

**SPI Power**

Introducing a SPI_POWER pin is desirable because some Module implementations will have the SPI power domain in power state S0 and others in S5. It is easier for Carrier Board designers to take the Carrier SPI power from a pin on the Module.

**4.1.13 Analog VGA**

Analog RGB interface for CRT monitor and DDC support.

**4.1.14 PEG Multiplexed SDVO**

Serial Digital Video Output to LVDS or TMDS transmitters on the Carrier Board. These signals, if implemented, shall be multiplexed with PEG signals on Types 2-5.

**4.1.15 Digital Display Interfaces (DDI) - Module Type 6 and 10**

Module Types 6 and 10 use Digital Display Interfaces (DDI) to provide DisplayPort, HDMI/DVI, and SDVO interfaces. Type 10 Modules can contain a single DDI (DDI[0]) that can support DisplayPort, HDMI/DVI, and SDVO. Type 6 Modules can contain up to 3 DDIs (DDI[1:3]) of which DDI[1:3] can support DisplayPort, HDMI/DVI and DDI[1] can support DisplayPort, HDMI/DVI, and SDVO. The main difference is that SDVO is only supported on DDI[0] for Type 10 Modules and DDI[1] for Type 6 Modules.

**4.1.16 General Purpose Serial Interface**

Two TTL compatible two wire ports are available on Module Types 6 and 10. This feature is introduced in COM.0 Revision 2 and uses pins on the A-B connector that have been re-claimed from the A-B VCC_12V pool. As such, it is possible that if a Type 6 or 10 Module is deployed in an R1.0 Carrier Board for Module Types 1,2,3,4,5 then the Module TTL level serial pins may be exposed to the 12V supply, and Module designers must plan for this. Similarly, an R1.0 Module deployed on an R2.0 Carrier may bridge 12V to the serial pins and Carrier designers must plan for this.

**4.1.17 I2C Bus**

The I2C port shall be available in addition to the SMBus. The I2C clock shall support 100kHz and should support 400kHz operation. The I2C interface should support multi-master operation. This capability will allow a Carrier to read an optional Module EEPROM before powering up the Module.

**4.1.18 Power and System Management**

Signals PWR_OK, SYS_RESET#, and CB_RESET# shall be supported for all Module pin-out types. Signal PCI_RESET# shall be supported for pin-out types 2 and 3. Signal IDE_RESET# shall be supported for pin-out types 2 and 4.

---

[6] I2C multi-master support starts with COM Express Rev. 2.0
Additionally, signal PWR_OK indicates that all the power supplies to the Module are stable within specified ranges and can be used to enable Module internal power supplies.

4.1.19 Thermal Protection

This port provides thermal signaling to protect critical components on the Module and the Carrier Board.

4.1.20 SM Bus

The SMBus port is specified for system management functions. It is used on the Module to manage system functions such as reading the DRAM SPD EEPROM and setting clock synthesizer parameters.

4.1.21 General Purpose Input Output

GPI and GPO pins may be implemented as GPIO (Module specific). GPI and GPO pins may be implemented as SDIO (refer to Section 4.1.22 'SDIO'). If SDIO is supported the BIOS may be used to set the default state (SDIO or GPIO) of the GPIO.

4.1.22 SDIO

Support for an SDIO interface is optional and added in R2.0. The SDIO signals are piggy-backed on the existing COM.0 General Purpose IO (GPIO) signals (refer to Section 4.1.21 'General Purpose Input Output'). An EEPROM bit is added so that the Carrier Board can define if the GPIO are used as GPIO or SDIO.

4.1.23 Module Type Definition

Table 4.1: Module Type Signals, Pin Types, and Descriptions

<table>
<thead>
<tr>
<th>Module Type Definition</th>
<th>Pin Type</th>
<th>Pwr Rail / Tolerance</th>
<th>Description</th>
<th>Pin Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE[0:2]#</td>
<td>PDS</td>
<td></td>
<td>The TYPE pins indicate to the Carrier Board the Pin-out Type that is implemented on the Module. The pins are tied on the Module to either ground (GND) or are no-connects (NC). For Pin-out Type 1 and Type 10, these pins are not present (X). The Carrier Board should implement combinatorial logic that monitors the Module TYPE pins and keeps power off (e.g. deactivates the ATX_ON signal for an ATX power supply) if an incompatible Module pin-out type is detected. The Carrier Board logic may also implement a fault indicator such as an LED.</td>
<td>T2, T3, T4, T5, T6</td>
</tr>
<tr>
<td>TYPE2#</td>
<td>X</td>
<td>X</td>
<td>Pin-out Type 1</td>
<td></td>
</tr>
<tr>
<td>TYPE1#</td>
<td>X</td>
<td>X</td>
<td>Pin-out Type 2</td>
<td></td>
</tr>
<tr>
<td>TYPE0#</td>
<td>X</td>
<td>X</td>
<td>Pin-out Type 3 (no IDE)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC</td>
<td>NC</td>
<td>Pin-out Type 4 (no PCI)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC</td>
<td>GND</td>
<td>Pin-out Type 5 (no IDE, no PCI)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC</td>
<td>GND</td>
<td>Pin-out Type 6 (no IDE, no PCI)</td>
<td></td>
</tr>
<tr>
<td>TYPE10#</td>
<td>PDS</td>
<td></td>
<td>Dual use pin. Indicates to the Carrier Board that a Type 10 Module is installed. Indicates to the Carrier that a Rev 1.0/2.0 Module is installed</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>NC</td>
<td>Pin-out R2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PD</td>
<td>Pin-out Type 10 pull down to ground with 47K resistor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12V</td>
<td>Pin-out R1.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This pin is reclaimed from the VCC_12V pool. In R1.0 Modules this pin will connect to other VCC_12V pins. In R2.0 this pin is defined as a no connect for types 1-6. A Carrier can detect a R1.0 Module by the presence of 12V on this pin. R2.0 Module types 1-6 will no connect this pin. Type 10 Modules shall pull this pin to ground through a 47K resistor.

4.1.24 eDP - Embedded DisplayPort

Type 6 and Type 10 Modules allow the LVDS channel A signals (refer to Section 4.1.10 'LVDS Flat Panel') to be alternatively used for eDP. The manner in which LVDS or eDP operation is chosen is vendor dependent.

4.1.25 CAN Bus

CAN Bus Operation Over SER1 Lines

The SER1_TX and SER1_RX asynchronous serial port lines defined for COM.0 Types 6 and 10 may be used alternatively to carry CMOS 3.3V logic level CAN (Controller Area Network) bus signals from a COM Express Module based CAN protocol controller. The CAN bus is an asynchronous, message based protocol widely used in the automotive and industrial control sectors. It is defined by ISO 11519, ISO 11898, and SAEJ2411. Data rates on a CAN bus may be as high as 1 MBit/s, although lower rates in the range from 10 kBit/s to 125 kBit/s are more common.

4.2 COM Express EEPROMs

The COM Express EEPROM content is defined in the PICMG COM Express companion document EeeP(Embedded EEPROM) Specification. The COM Express R1.0 Carrier Board configuration EEPROM content and layout is superseded by the EeeP Specification. All new designs implementing either the Module or Carrier EEPROM shall exclusively use the new EeeP styled layout.

4.2.1 COM Express Module EEPROM

The Module Board should implement a serial EEPROM that Identifies the Module using the Unique Device Id.

The Module EEPROM allows the COM Express Carrier Board to set up any software configurable Carrier Board features in a way that is appropriate for the Module board.

4.2.2 COM Express Carrier Board EEPROM

The Carrier Board should implement a serial EEPROM that identifies the Carrier using the Unique Device Id and describe the expected PCI Express link configuration. In addition, this EEPROM may describe the expected link presence for SATA, SAS, Express Card, USB, DDI, VGA, LAN, audio, and the expected presence of miscellaneous I/O signals.

The Carrier EEPROM allows the COM Express Module BIOS to set up any software configurable Module features in a way that is appropriate for the Carrier Board.
4.3 Watchdog Timer

COM Express Modules *may* implement a watchdog timer output to the Carrier Board.

5 Mechanical Specifications

5.1 Module Size – Mini Module

The PCB size for the Mini Module *shall* be 84mm x 55mm. The PCB thickness *should* be 2mm to allow high layer count stack-ups and facilitate a standard ‘z’ dimension between the Carrier Board and the top of the heat-spreader (refer to Section 25 “Heat-Spreader”).

The holes shown in this drawing are intended for mounting the Module / heat-spreader combination to the Carrier Board. An independent, implementation specific set of holes and spacers *shall* be used to attach the heat-spreader to the Module.

![Figure 5-1: Mini Module Form Factor](image)

All dimensions are shown in millimeters.

5.2 Module Size - Compact Module

The PCB size for the Compact Module *shall* be 95mm x 95mm. The PCB thickness *should* be 2mm to allow high layer count stack-ups and facilitate a standard ‘z’ dimension between the Carrier Board and the top of the heat-spreader (refer to Section 25 “Heat-Spreader”).

The holes shown in this drawing are intended for mounting the Module / heat-spreader combination to the Carrier Board. An independent, implementation specific set of holes and spacers *shall* be used to attach the heat-spreader to the Module.
5.3 Module Size - Basic Module

The PCB size for the Basic Module shall be 125mm x 95mm. The PCB thickness should be 2mm to allow high layer count stack-ups and facilitate a standard ‘z’ dimension between the Carrier Board and the top of the heat-spreader. (refer to Section 25 “Heat-Spreader”).

The holes shown in this drawing are intended for mounting the Module / heat-spreader combination to the Carrier Board. An independent, implementation specific set of holes and spacers shall be used to attach the heat-spreader to the Module.
All dimensions are shown in millimeters.

5.4 Module Size - Extended Module

The PCB size for the Extended Module **shall** be 155mm x 110mm. The PCB thickness **should** be 2mm to allow high layer count stack-ups and facilitate a standard ‘z’ dimension between the Carrier Board and the top of the heat-spreader. (refer to Section 25 “Heat-Spreader”).

The holes shown in this drawing are intended for mounting the Module / heat-spreader combination to the Carrier Board. An independent, implementation specific set of holes and spacers **shall** be used to attach the heat-spreader to the Module.
All dimensions are shown in millimeters.

5.5 Module Connector

The Module connector for Pin-out Types 2 through 6 shall be a 440-pin receptacle that is composed of 2 pieces of a 220-pin, 0.5 mm pitch receptacle. The pair of connectors may be held together by a plastic carrier during assembly to allow handling by automated assembly equipment. Module Pin-out Type 1 or 10 shall use a single 220-pin, 0.5 mm pitch receptacle. The connectors shall be qualified for LVDS operation up to 6.25GHz, to support PCI Express Generation 2 signaling speeds.

The Module connector is a receptacle by virtue of the vendor’s technical definition of a receptacle, and to some users it looks like a plug.
5.6 Carrier Board Connector

The Carrier Board connector for Module Pin-out Types 2 through 6 shall be a 440-pin plug that is composed of 2 pieces of a 220-pin, 0.5 mm pitch plug. The pair of connectors may be held together by a plastic carrier during assembly to allow handling by automated assembly equipment. Carrier Boards intended only for use with Pin-out Type 1 or 10 Modules may use a single 220-pin, 0.5 mm pitch plug. The connectors shall be qualified for LVDS operation up to 6.25GHz, to support PCI Express Generation 2 signaling speeds. The Carrier Board plugs are available in a variety of heights. The Carrier Board shall use either the 5mm or 8mm heights.

The Carrier Board connector is a plug by virtue of the vendor’s technical definition of a plug, and to some users it looks like a receptacle.
5.7 Heat-Spreader

Modules *should* be equipped with a heat-spreader. This heat-spreader by itself does not constitute the complete thermal solution for a Module but provides a common interface between Modules and implementation-specific thermal solutions.

If implemented, a heat-spreader for the Compact, Basic and Extended form factor *shall* use and the Mini form factor *may* use an implementation specific set of holes and spacers to attach the heat-spreader to the Module. These implementation specific holes are in addition to the Module mounting holes specified in Sections 5.2, 5.3 or 5.4.

For the Compact, Basic and Extended form factor a heat-spreader *should not* use the Module mounting holes as the only attachment points to a Module. The intent is to be able to provide a Module and heat-spreader as an assembly that can then be mounted to a Carrier without having to break the thermal interface between the Module components and the heat-spreader.

![Figure 5-7: Overall Height for Heat-Spreader in Mini, Compact, Basic and Extended Modules](image)

All dimensions in mm.

Figure 5-7 shows a cross section of a Module and heat-spreader assembled to a Carrier Board using the 5mm stack height option. If 8mm Carrier Board connectors are used, the overall assembly height increases from 18.00mm to 21.00mm.
Figure 5-8: Mini Module Heat-Spreader

Thickness ‘T’ is implementation specific and may be 3mm. Height ‘H’ (which includes PCB thickness) shall be 13.00mm.

Drill to suit standoffs

4x 4.5mm Standoffs are threaded(M2.5) or clear(2.7mm)

All dimensions are in mm.
Figure 5-9: Compact Module Heat-Spreader

4X 4.5mm Standoffs are threaded (M2.5) or clear (2.7mm)

Thickness ‘T’ is implementation specific and may be 3mm.
Height ‘H’ (which includes PCB thickness) shall be 13.00mm

All dimensions are in mm.
Figure 5-10: Basic Module Heat-Spreader

5X 4.5mm
Standoffs are threaded (M2.5) or clear (2.7mm)

Thickness ‘T’ is implementation specific and may be 3mm.
Height ‘H’ (which includes PCB thickness) shall be 13.00mm

Drill to suit standoffs
5X

All dimensions are in mm.
Figure 5-11: Heat-Spreader Specification for Extended Module

All dimensions are in mm.
6 Electrical Specifications

6.1 Input Power - General Considerations

The Compact, Basic and Extended Module Modules shall use a single main power rail with a nominal value of +12V.

The Mini Module shall support a wide range power supply of 4.75V to 20.0V.

In addition, the Mini Module shall be optimized for 5V operation and Module vendors should report Module power figures at 5V, 12V and 18V input voltages.

Two additional rails are specified: a +5V standby power rail and a +3V battery input to power the Module Real-time Clock (RTC) circuit in the absence of other power sources. The +5V standby rail may be left unconnected on the Carrier Board if the standby functions are not required by the application. Likewise, the +3V battery input may be left open if the application does not require the RTC to keep time in the absence of the main and standby sources. There may be Module specific concerns regarding storage of system setup parameters that may be affected by the absence of the +5V standby and/or the +3V battery.

The rationale for this power-delivery scheme is:

- Module pins are scarce. It is more pin-efficient to bring power in on a higher voltage rail.
- Single supply operation is attractive to many users.
- Lithium ion battery packs for mobile systems are most prevalent with a +14.4V output. This is well suited for the +12V main power rail.
- Contemporary chipsets have no power requirements for +5V other than to provide a reference voltage for +5V tolerant inputs. No COM Express Module pins are allocated to accept +5V except for the +5V standby pins. In the case of an ATX supply, the switched (non standby) +5V line would not be used for the COM Express Module, but it might be used elsewhere on the Carrier Board.
7 Appendix

7.1 Mounting positions and connector location for Carrier Boards

Figure 7-1: Carrier Board mounting positions

All dimensions are shown in millimeters.