



# Mobile Intel<sup>®</sup> Pentium<sup>®</sup> 4 Processor-M

Datasheet

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## Revision History

| Date       | Revision | Description   |
|------------|----------|---|
| March 2002 | 001      | Initial release of the Datasheet  |
| April 2002 | 002      | Updates include: <ul style="list-style-type: none"><li>• Added new processor speeds: 1.4 GHz, 1.5 GHz, and 1.8 GHz</li><li>• Updated PROCHOT# signal in Table 21</li><li>• Updated signal description for PROCHOT# in Table 37 and Section 6.1.2</li><li>• Updated the description of the Enhanced Intel SpeedStep Technology in sections 2.4.1 and 7.3</li><li>• Updated PWRGOOD signal in Table 3, Section 2.7, Table 14, Table 21, Table 28, Table 35, Table 36, Figure 28, and Figure 29.</li></ul> |
| June 2002  | 003      | Updates include: <ul style="list-style-type: none"><li>• Added specifications for new processor speeds: 1.90 GHz and 2 GHz</li><li>• Added die length and die width for processors based on B0-step shrink process in Table 33.</li></ul>   |

## 1. Introduction

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The Mobile Intel® Pentium® 4 Processor-M is the first Intel mobile processor with the Intel NetBurst™ micro-architecture. The Mobile Intel Pentium 4 Processor-M utilizes a 478-pin, Micro Flip-Chip Pin Grid Array (Micro-FCPGA) package and plugs into a surface-mount, Zero Insertion Force (ZIF) socket. The Mobile Intel Pentium 4 Processor-M maintains full compatibility with IA-32 software. In this document the Mobile Intel Pentium 4 Processor-M will be referred to as the “Mobile Intel Pentium 4 Processor-M” or simply “the processor”.

The Intel NetBurst micro-architecture features include hyper-pipelined technology, a rapid execution engine, a 400-MHz system bus, and an execution trace cache. The hyper pipelined technology doubles the pipeline depth in the Mobile Intel Pentium 4 Processor-M allowing the processor to reach much higher core frequencies. The rapid execution engine allows the two integer ALUs in the processor to run at twice the core frequency, which allows many integer instructions to execute in 1/2 clock tick. The 400-MHz system bus is a quad-pumped bus running off a 100-MHz system clock making 3.2 GB/sec data transfer rates possible. The execution trace cache is a first level cache that stores approximately 12-k decoded micro-operations, which removes the instruction decoding logic from the main execution path, thereby increasing performance.

Additional features within the Intel NetBurst micro-architecture include advanced dynamic execution, advanced transfer cache, enhanced floating point and multi-media unit, and Streaming SIMD Extensions 2 (SSE2). The advanced dynamic execution improves speculative execution and branch prediction internal to the processor. The advanced transfer cache is a 512 kB, on-die level 2 (L2) cache. A new floating point and multi media unit has been implemented which provides superior performance for multi-media and mathematically intensive applications. Finally, SSE2 adds 144 new instructions for double-precision floating point, SIMD integer, and memory management. Power management capabilities such as AutoHALT, Stop-Grant, Sleep, Deep Sleep, and Deeper Sleep have been incorporated.

The Streaming SIMD Extensions 2 (SSE2) enable break-through levels of performance in multimedia applications including 3-D graphics, video decoding/encoding, and speech recognition. The new packed double-precision floating-point instructions enhance performance for applications that require greater range and precision, including scientific and engineering applications and advanced 3-D geometry techniques, such as ray tracing.

The Mobile Intel Pentium 4 Processor-M's 400-MHz Intel NetBurst micro-architecture system bus utilizes a split-transaction, deferred reply protocol like the Intel Pentium 4 processor. This system bus is not compatible with the P6 processor family bus. The 400-MHz Intel NetBurst micro-architecture system bus uses Source-Synchronous Transfer (SST) of address and data to improve performance by transferring data four times per bus clock (4X data transfer rate, as in AGP 4X). Along with the 4X data bus, the address bus can deliver addresses two times per bus clock and is referred to as a “double-clocked” or 2X address bus. Working together, the 4X data bus and 2X address bus provide a data bus bandwidth of up to 3.2 Gbytes/second.

The processor, when used in conjunction with the requisite Intel® SpeedStep® technology applet or its equivalent, supports Enhanced Intel SpeedStep technology, which enables real-time dynamic switching of the voltage and frequency between two performance modes. This occurs by switching the bus ratios, core operating voltage, and core processor speeds without resetting the system.

The processor system bus uses a variant of GTL+ signalling technology called Assisted Gunning Transceiver Logic (AGTL+) signal technology. The Mobile Intel Pentium 4 Processor-M is available at the following core frequencies:

- 2 GHz (in Maximum Performance Mode at 1.30 V). This processor runs at 1.20 GHz (in Battery Optimized Mode at 1.20 V)
- 1.90 GHz (in Maximum Performance Mode at 1.30 V). This processor runs at 1.20 GHz (in Battery Optimized Mode at 1.20 V)
- 1.80 GHz (in Maximum Performance Mode at 1.30 V). This processor runs at 1.20 GHz (in Battery Optimized Mode at 1.20 V)
- 1.70 GHz (in Maximum Performance Mode at 1.30 V). This processor runs at 1.20 GHz (in Battery Optimized Mode at 1.20 V)
- 1.60 GHz (in Maximum Performance Mode at 1.30 V). This processor runs at 1.20 GHz (in Battery Optimized Mode at 1.20 V)
- 1.50 GHz (in Maximum Performance Mode at 1.30 V). This processor runs at 1.20 GHz (in Battery Optimized Mode at 1.20 V)
- 1.40 GHz (in Maximum Performance Mode at 1.30 V). This processor runs at 1.20 GHz (in Battery Optimized Mode at 1.20 V)

## 1.1 Terminology

A “#” symbol after a signal name refers to an active low signal, indicating a signal is in the active state when driven to a low level. For example, when RESET# is low, a reset has been requested. Conversely, when NMI is high, a nonmaskable interrupt has occurred. In the case of signals where the name does not imply an active state but describes part of a binary sequence (such as *address* or *data*), the “#” symbol implies that the signal is inverted. For example, D[3:0] = “HLHL” refers to a hex ‘A’, and D[3:0]# = “LHLH” also refers to a hex “A” (H= High logic level, L= Low logic level).

“System Bus” refers to the interface between the processor and system core logic (a.k.a. the chipset components). The system bus is a multiprocessing interface to processors, memory, and I/O.

### 1.1.1 Terminology

Commonly used terms are explained here for clarification:

- **Processor** — For this document, the term processor shall mean the Mobile Intel Pentium 4 Processor-M in the 478-pin package.
- **Keep out zone** — The area on or near the processor that system design can not utilize.
- **Intel® 845MP/845MZ chipsets** — Mobile chipsets that will support the Mobile Intel Pentium 4 Processor-M.
- **Processor core** — Mobile Intel Pentium 4 Processor-M core die with integrated L2 cache.
- **Micro-FCPGA package** — Micro Flip-Chip Pin Grid Array package with 50-mil pin pitch.

## 1.2 References

Material and concepts available in the following documents may be beneficial when reading this document.

**Table 1. References**

| Document  | Order Number |
|---|--------------|
| <i>Mobile Intel® Pentium® 4 Processor-M and Intel 845MP/845MZ Chipset Platform Design Guide</i> | 250688       |
| <i>Intel Architecture Software Developer's Manual</i>   | 243193       |
| <i>Volume I: Basic Architecture</i>   | 243190       |
| <i>Volume II: Instruction Set Reference</i>   | 243191       |
| <i>Volume III: System Programming Guide</i>   | 243192       |
| <i>ITP700 Debug Port Design Guide</i>   | Note 1       |

**NOTES:**

1. Contact your Intel representative for the latest revision and order number of this document.

## 2. Electrical Specifications

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### 2.1 System Bus and GTLREF

Most Mobile Intel Pentium 4 Processor-M system bus signals use Assisted Gunning Transceiver Logic (AGTL+) signalling technology. As with the Intel P6 family of microprocessors, this signalling technology provides improved noise margins and reduced ringing through low-voltage swings and controlled edge rates. The termination voltage level for the Mobile Intel Pentium 4 Processor-M AGTL+ signals is  $V_{CC}$ , which is the operating voltage of the processor core. Previous generations of Intel mobile processors utilize a fixed termination voltage known as  $V_{CCT}$ . The use of a termination voltage that is determined by the processor core allows better voltage scaling on the system bus for Mobile Intel Pentium 4 Processor-M. Because of the speed improvements to data and address bus, signal integrity and platform design methods have become more critical than with previous processor families. Design guidelines for the Mobile Intel Pentium 4 Processor-M system bus will be detailed in the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

The AGTL+ inputs require a reference voltage (GTLREF) which is used by the receivers to determine if a signal is a logical 0 or a logical 1. GTLREF must be generated on the system board.

Termination resistors are provided on the processor silicon and are terminated to its core voltage ( $V_{CC}$ ). Intel's 845MP/845MZ chipsets will also provide on-die termination, thus eliminating the need to terminate the bus on the system board for most AGTL+ signals. However, some AGTL+ signals do not include on-die termination and must be terminated on the system board. For more information, refer to the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

The AGTL+ bus depends on incident wave switching. Therefore, timing calculations for AGTL+ signals are based on flight time as opposed to capacitive deratings. Analog signal simulation of the system bus, including trace lengths, is highly recommended when designing a system.

### 2.2 Power and Ground Pins

For clean on-chip power distribution, the Mobile Intel Pentium 4 Processor-M have 85  $V_{CC}$  (power) and 181  $V_{SS}$  (ground) inputs. All power pins must be connected to  $V_{CC}$ , while all  $V_{SS}$  pins must be connected to a system ground plane. The processor  $V_{CC}$  pins must be supplied with the voltage determined by the VID (Voltage ID) pins and the loadline specifications (see [Figure 4](#) through [Figure 6](#)).

### 2.3 Decoupling Guidelines

Due to its large number of transistors and high internal clock speeds, the processor is capable of generating large average current swings between low and full power states. This may cause voltages on power planes to sag below their minimum values if bulk decoupling is not adequate. Care must be taken in the board design to ensure that the voltage provided to the processor remains within the specifications listed in [Table 6](#). Failure to do so can result in timing violations and/or

affect the long term reliability of the processor. For further information and design guidelines, refer to the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

### 2.3.1 V<sub>CC</sub> Decoupling

Regulator solutions need to provide bulk capacitance with a low Effective Series Resistance (ESR) and keep a low interconnect resistance from the regulator to the socket. Bulk decoupling for the large current swings when the part is powering on, or entering/exiting low-power states, must be provided by the voltage regulator solution. For more details on decoupling recommendations, please refer to the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

### 2.3.2 System Bus AGTL+ Decoupling

The Mobile Intel Pentium 4 Processor-M integrates signal termination on the die and incorporates high frequency decoupling capacitance on the processor package. Decoupling must also be provided by the system motherboard for proper AGTL+ bus operation. For more information, refer to the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

### 2.3.3 System Bus Clock (BCLK[1:0]) and Processor Clocking

BCLK[1:0] directly controls the system bus interface speed as well as the core frequency of the processor. As in previous generation processors, the Mobile Intel Pentium 4 Processor-M core frequency is a multiple of the BCLK[1:0] frequency. The Mobile Intel Pentium 4 Processor-M bus ratio multiplier will be set at its default ratio at manufacturing. No jumpers or user intervention is necessary, and the processor will automatically run at the speed indicated on the package.

The Mobile Intel Pentium 4 Processor-M uses a differential clocking implementation. For more information on Mobile Intel Pentium 4 Processor-M clocking, refer to *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

## 2.4 Voltage Identification and Power Sequencing

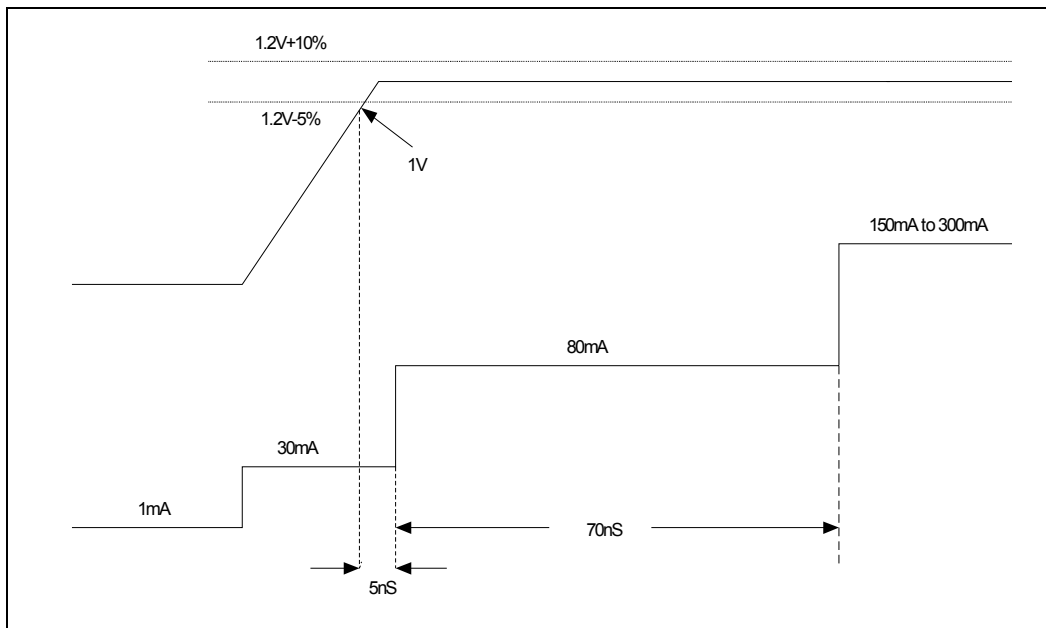
The VID specification for Mobile Intel Pentium 4 Processor-M is defined by the IMVP-III Mobile Processor Core voltage regulator specification. The voltage set by the VID pins is the nominal/typical voltage setting for the processor. A minimum voltage is provided in [Table 6](#) and changes with frequency. This allows processors running at a higher frequency to have a relaxed minimum voltage specification. The specifications have been set such that one voltage regulator can work with all supported frequencies.

The Mobile Intel Pentium 4 Processor-M uses five voltage identification pins, VID[4:0], to support automatic selection of power supply voltages. The VID pins for the Mobile Intel Pentium 4 Processor-M are open drain outputs driven by the processor VID circuitry. [Table 2](#) specifies the voltage level corresponding to the state of VID[4:0]. A “1” in this table refers to a high-voltage level and a “0” refers to low-voltage level. For more details about VR design to support the Mobile Intel Pentium 4 Processor-M power supply requirements, please refer to the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

Power source characteristics must be stable whenever the supply to the voltage regulator is stable. Refer to the [Figure 16](#) for timing details of the power up sequence. Also refer to *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide* for implementation details.

Mobile Intel Pentium 4 Processor-M's Voltage Identification circuit requires an independent 1.2 V supply. This voltage must be routed to the processor VCCVID pin. [Figure 1](#) shows the voltage and current requirements of the VCCVID pin.

**Figure 1. VCCVID Pin Voltage and Current Requirements**



**Table 2. Voltage Identification Definition (Page 1 of 2)**

| Processor Pins |      |      |      |      |                  |
|----------------|------|------|------|------|------------------|
| VID4           | VID3 | VID2 | VID1 | VID0 | V <sub>cc_</sub> |
| 1              | 1    | 1    | 1    | 1    | 0.600            |
| 1              | 1    | 1    | 1    | 0    | 0.625            |
| 1              | 1    | 1    | 0    | 1    | 0.650            |
| 1              | 1    | 1    | 0    | 0    | 0.675            |
| 1              | 1    | 0    | 1    | 1    | 0.700            |
| 1              | 1    | 0    | 1    | 0    | 0.725            |
| 1              | 1    | 0    | 0    | 1    | 0.750            |
| 1              | 1    | 0    | 0    | 0    | 0.775            |
| 1              | 0    | 1    | 1    | 1    | 0.800            |
| 1              | 0    | 1    | 1    | 0    | 0.825            |
| 1              | 0    | 1    | 0    | 1    | 0.850            |
| 1              | 0    | 1    | 0    | 0    | 0.875            |
| 1              | 0    | 0    | 1    | 1    | 0.900            |

**Table 2. Voltage Identification Definition (Page 2 of 2)**

|   |   |   |   |   |       |
|---|---|---|---|---|-------|
| 1 | 0 | 0 | 1 | 0 | 0.925 |
| 1 | 0 | 0 | 0 | 1 | 0.950 |
| 1 | 0 | 0 | 0 | 0 | 0.975 |
| 0 | 1 | 1 | 1 | 1 | 1.000 |
| 0 | 1 | 1 | 1 | 0 | 1.050 |
| 0 | 1 | 1 | 0 | 1 | 1.100 |
| 0 | 1 | 1 | 0 | 0 | 1.150 |
| 0 | 1 | 0 | 1 | 1 | 1.200 |
| 0 | 1 | 0 | 1 | 0 | 1.250 |
| 0 | 1 | 0 | 0 | 1 | 1.300 |
| 0 | 1 | 0 | 0 | 0 | 1.350 |
| 0 | 0 | 1 | 1 | 1 | 1.400 |
| 0 | 0 | 1 | 1 | 0 | 1.450 |
| 0 | 0 | 1 | 0 | 1 | 1.500 |
| 0 | 0 | 1 | 0 | 0 | 1.550 |
| 0 | 0 | 0 | 1 | 1 | 1.600 |
| 0 | 0 | 0 | 1 | 0 | 1.650 |
| 0 | 0 | 0 | 0 | 1 | 1.700 |
| 0 | 0 | 0 | 0 | 0 | 1.750 |

### 2.4.1 Enhanced Intel SpeedStep® Technology

The Mobile Intel Pentium 4 Processor-M, when used in conjunction with the requisite Intel SpeedStep® technology applet or its equivalent, supports Enhanced Intel SpeedStep technology. Enhanced Intel SpeedStep technology allows the processor to switch between two core frequencies automatically based on CPU demand, without having to reset the processor or change the system bus frequency. The processor operates in two modes, the Maximum Performance Mode or the Battery Optimized Mode. Each frequency and voltage pair identifies the operating mode. The processor drives the VID[4:0] pins with the correct VID for the current operating mode. After reset, the processor will start in the Battery Optimized Mode. Any RESET# assertion will force the processor to the Battery Optimized Mode. INIT# assertions ("soft" resets) and APIC bus INIT messages do not change the operating mode of the processor. Some electrical and thermal specifications are for a specific voltage and frequency. The Mobile Intel Pentium 4 Processor-M featuring Enhanced Intel SpeedStep technology will meet the electrical and thermal specifications specific to the current operating mode, and it is not guaranteed to meet the electrical and thermal specifications specific to the opposite operating mode. The timing specifications must be met when performing an operating mode transition.

### 2.4.2 Phase Lock Loop (PLL) Power and Filter

$V_{CCA}$  and  $V_{CCIOPLL}$  are power sources required by the PLL clock generators on the Mobile Intel Pentium 4 Processor-M silicon. Since these PLLs are analog in nature, they require quiet power supplies for minimum jitter. Jitter is detrimental to the system - it degrades external I/O timings as well as internal core timings (i.e. maximum frequency). To prevent this degradation, these supplies must be low pass filtered from  $V_{CCVID}$ . A typical filter topology is shown in [Figure 2](#).

The AC low-pass requirements, with input at  $V_{CCVID}$  and output measured across the capacitor ( $C_A$  or  $C_{IO}$  in [Figure 2](#)), is as follows:

- < 0.2 dB gain in pass band
- < 0.5 dB attenuation in pass band < 1 Hz
- > 34 dB attenuation from 1 MHz to 66 MHz
- > 28 dB attenuation from 66 MHz to core frequency

The filter requirements are illustrated in Figure 3. For recommendations on implementing the filter refer to the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

**Figure 2. Typical V<sub>CCIOPLL</sub>, V<sub>CCA</sub>, V<sub>SSA</sub> Power Distribution**

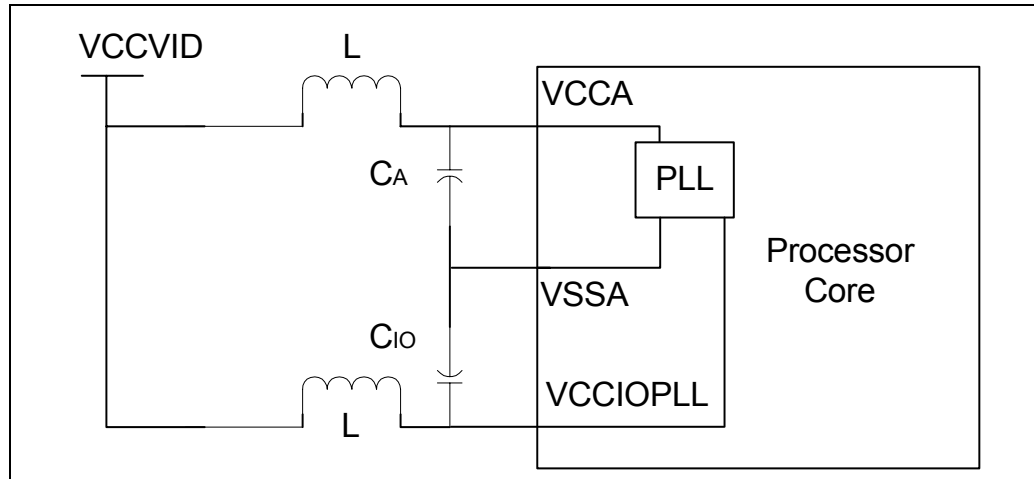
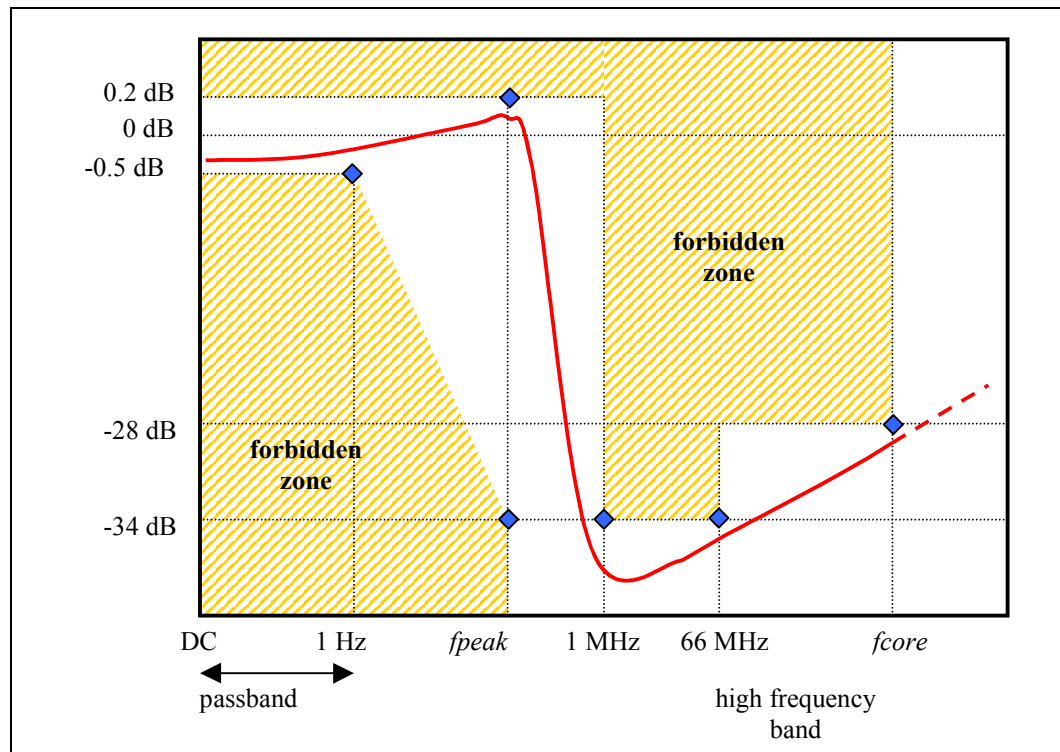


Figure 3. Phase Lock Loop (PLL) Filter Requirements

**NOTES:**

1. Diagram not to scale.
2. No specification for frequencies beyond fcore (core frequency).
3. fpeak, if existent, should be less than 0.05 MHz.

### 2.4.3 Catastrophic Thermal Protection

The Mobile Intel Pentium 4 Processor-M supports the THERMTRIP# signal for catastrophic thermal protection. Alternatively an external thermal sensor can be used to protect the processor and the system against excessive temperatures. Even with the activation of THERMTRIP#, which halts all processor internal clocks and activity, leakage current can be high enough such that the processor cannot be protected in all conditions without the removal of power to the processor. If the external thermal sensor detects a catastrophic processor temperature of 135°C (maximum), or if the THERMTRIP# signal is asserted, the VCC supply to the processor must be turned off within 500 ms to prevent permanent silicon damage due to thermal runaway of the processor. Refer to [Section 5.2](#) for more details on THERMTRIP#.

## 2.5 Signal Terminations, Unused Pins and TESTHI[10:0]

All NC pins must remain unconnected. Connection of these pins to V<sub>CC</sub>, V<sub>SS</sub>, or to any other signal (including each other) can result in component malfunction or incompatibility with future Mobile Intel Pentium 4 Processor-M. See [Section 5.2](#) for a pin listing of the processor and the location of all NC pins.

For reliable operation, always connect unused inputs or bidirectional signals that are not terminated on the die to an appropriate signal level. Note that on-die termination has been included on the Mobile Intel Pentium 4 Processor-M to allow signals to be terminated within the processor silicon. Unused active low AGTL+ inputs may be left as no connects if AGTL+ termination is provided on the processor silicon. [Table 3](#) lists details on AGTL+ signals that do not include on-die termination. Unused active high inputs should be connected through a resistor to ground ( $V_{SS}$ ). Refer to the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide* for the appropriate resistor values.

Unused outputs can be left unconnected, however, this may interfere with some TAP functions, complicate debug probing, and prevent boundary scan testing. A resistor must be used when tying bidirectional signals to power or ground. When tying any signal to power or ground, a resistor will also allow for system testability. For unused AGTL+ input or I/O signals that don't have on-die termination, use pull-up resistors of the same value in place of the on-die termination resistors ( $R_{TT}$ ). See [Table 17](#).

The TAP, Asynchronous GTL+ inputs, and Asynchronous GTL+ outputs do not include on-die termination. Inputs and used outputs must be terminated on the system board. Unused outputs may be terminated on the system board or left unconnected. Note that leaving unused outputs unterminated may interfere with some TAP functions, complicate debug probing, and prevent boundary scan testing. Signal termination for these signal types is discussed in the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*. TAP signal termination requirements are also discussed in *ITP700 Debug Port Design Guide*.

The TESTHI pins should be tied to the processor  $V_{CC}$  using a matched resistor, where a matched resistor has a resistance value within  $\pm 20\%$  of the impedance of the board transmission line traces. For example, if the trace impedance is 50  $\Omega$ , then a value between 40  $\Omega$  and 60  $\Omega$  is required.

The TESTHI pins may use individual pull-up resistors or be grouped together as detailed below. A matched resistor should be used for each group:

1. TESTHI[1:0]
2. TESTHI[5:2]
3. TESTHI[10:8]

Additionally, if the ITPCLKOUT[1:0] pins are not used then they may be connected individually to  $V_{CC}$  using matched resistors or grouped with TESTHI[5:2] with a single matched resistor. If they are being used, individual termination with 1-k $\Omega$  resistors is required. Tying ITPCLKOUT[1:0] directly to  $V_{CC}$  or sharing a pull-up resistor to  $V_{CC}$  will prevent use of debug interposers. This implementation is strongly discouraged for system boards that do not implement an onboard debug port.

As an alternative, group 2 (TESTHI[5:2]), and the ITPCLKOUT[1:0] pins may be tied directly to the processor  $V_{CC}$ . This has no impact on system functionality. TESTHI[0] may also be tied directly to processor  $V_{CC}$  if resistor termination is a problem, but matched resistor termination is recommended. In the case of the ITPCLKOUT[1:0] pins, direct tie to  $V_{CC}$  is strongly discouraged for system boards that do not implement an onboard debug port.

Tying any of the TESTHI pins together will prevent the ability to perform boundary scan testing.

Pullup/down resistor requirements for the VID[4:0] and BSEL[1:0] signals are included in the signal descriptions in [Section 5](#).

## 2.6 System Bus Signal Groups

In order to simplify the following discussion, the system bus signals have been combined into groups by buffer type. AGTL+ input signals have differential input buffers, which use GTLREF as a reference level. In this document, the term "AGTL+ Input" refers to the AGTL+ input group as well as the AGTL+ I/O group when receiving. Similarly, "AGTL+ Output" refers to the AGTL+ output group as well as the AGTL+ I/O group when driving.

With the implementation of a source synchronous data bus comes the need to specify two sets of timing parameters. One set is for common clock signals which are dependant upon the rising edge of BCLK0 (ADS#, HIT#, HITM#, etc.) and the second set is for the source synchronous signals which are relative to their respective strobe lines (data and address) as well as the rising edge of BCLK0. Asynchronous signals are still present (A20M#, IGNNE#, etc.) and can become active at any time during the clock cycle. [Table 3](#) identifies which signals are common clock, source synchronous, and asynchronous.

Table 3. System Bus Pin Groups

| Signal Group                          | Type               | Signals <sup>1</sup>  |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
|---------------------------------------|--------------------|---|---------|-------------------|----------------------------------|---------|------------------------|---------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| AGTL+ Common Clock Input              | Common clock       | BPRI#, DEFER#, RESET# <sup>2</sup> , RS[2:0]#, RSP#, TRDY#  |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| AGTL+ Common Clock I/O                | Synchronous        | AP[1:0]#, ADS#, BINIT#, BNR#, BPM[5:0]# <sup>2</sup> , BR0# <sup>2</sup> , DBSY#, DP[3:0]#, DRDY#, HIT#, HITM#, LOCK#, MCERR#   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| AGTL+ Source Synchronous I/O          | Source Synchronous | <table><tr><th>Signals</th><th>Associated Strobe</th></tr><tr><td>REQ[4:0]#, A[16:3]#<sup>5</sup></td><td>ADSTB0#</td></tr><tr><td>A[35:17]#<sup>5</sup></td><td>ADSTB1#</td></tr><tr><td>D[15:0]#, DBI0#</td><td>DSTBP0#, DSTBN0#</td></tr><tr><td>D[31:16]#, DBI1#</td><td>DSTBP1#, DSTBN1#</td></tr><tr><td>D[47:32]#, DBI2#</td><td>DSTBP2#, DSTBN2#</td></tr><tr><td>D[63:48]#, DBI3#</td><td>DSTBP3#, DSTBN3#</td></tr></table> | Signals | Associated Strobe | REQ[4:0]#, A[16:3]# <sup>5</sup> | ADSTB0# | A[35:17]# <sup>5</sup> | ADSTB1# | D[15:0]#, DBI0# | DSTBP0#, DSTBN0# | D[31:16]#, DBI1# | DSTBP1#, DSTBN1# | D[47:32]#, DBI2# | DSTBP2#, DSTBN2# | D[63:48]#, DBI3# | DSTBP3#, DSTBN3# |
| Signals                               | Associated Strobe  |   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| REQ[4:0]#, A[16:3]# <sup>5</sup>      | ADSTB0#            |   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| A[35:17]# <sup>5</sup>                | ADSTB1#            |   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| D[15:0]#, DBI0#                       | DSTBP0#, DSTBN0#   |   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| D[31:16]#, DBI1#                      | DSTBP1#, DSTBN1#   |   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| D[47:32]#, DBI2#                      | DSTBP2#, DSTBN2#   |   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| D[63:48]#, DBI3#                      | DSTBP3#, DSTBN3#   |   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| AGTL+ Strobes                         | Common Clock       | ADSTB[1:0]#, DSTBP[3:0]#, DSTBN[3:0]#   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| Asynchronous GTL+ Input <sup>4</sup>  | Asynchronous       | A20M#, DPSLP#, GHI#, IGNE#, INIT# <sup>5</sup> , LINT0/INTR, LINT1/NMI, SMI# <sup>5</sup> , SLP#, STPCLK#   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| Asynchronous GTL+ Output <sup>4</sup> | Asynchronous       | FERR#/PBE#, IERR#, THERMTRIP#, PROCHOT#   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| TAP Input <sup>4</sup>                | Synchronous to TCK | TCK, TDI, TMS, TRST#  |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| TAP Output <sup>4</sup>               | Synchronous to TCK | TDO   |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| System Bus Clock                      | N/A                | BCLK[1:0], ITP_CLK[1:0] <sup>3</sup>  |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |
| Power/Other                           | N/A                | V <sub>CC</sub> , V <sub>CCA</sub> , V <sub>CCIOPLL</sub> , VCCVID, VID[4:0], V <sub>SS</sub> , V <sub>SSA</sub> , GTLREF[3:0], COMP[1:0], NC, TESTHI[5:0], TESTHI[10:8], ITPCLKOUT[1:0], THERMDA, THERMDC, PWRGOOD, SKTOCC#, V <sub>CC_SENSE</sub> , V <sub>SS_SENSE</sub> , BSEL[1:0], DBR# <sup>3</sup>  |         |                   |                                  |         |                        |         |                 |                  |                  |                  |                  |                  |                  |                  |

**NOTES:**

1. Refer to [Section 5.2](#) for signal descriptions.
2. These AGTL+ signals do not have on-die termination. Refer to [Section 2.5](#) and the *ITP700 Debug Port Design Guide* for termination requirements.
3. In processor systems where there is no debug port implemented on the system board, these signals are used to support a debug port interposer. In systems with the debug port implemented on the system board, these signals are no connects.
4. These signal groups are not terminated by the processor. Signals not driven by the ICH3-M component must be terminated on the system board. Refer to [Section 2.5](#), the *ITP700 Debug Port Design Guide*, and the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide* for termination requirements and further details.
5. The value of these pins during the active-to-inactive edge of RESET# defines the processor configuration options. See [Section 7.1](#) for details.

## 2.7 Asynchronous GTL+ Signals

Mobile Intel Pentium 4 Processor-M does not utilize CMOS voltage levels on any signals that connect to the processor. As a result, legacy input signals such as A20M#, IGNNE#, INIT#, LINT0/INTR, LINT1/NMI, SMI#, SLP#, and STPCLK# use GTL+ input buffers. Legacy output FERR#/PBE# and other non-AGTL+ signals (THERMTRIP# and PROCHOT#) use GTL+ output buffers. All of these signals follow the same DC requirements as AGTL+ signals, however the outputs are not actively driven high (during a logical 0 to 1 transition) by the processor (the major difference between GTL+ and AGTL+). These signals do not have setup or hold time specifications in relation to BCLK[1:0]. However, all of the Asynchronous GTL+ signals are required to be asserted for at least two BCLKs in order for the processor to recognize them. See [Section 2.11](#) and [Section 2.13](#) for the DC and AC specifications for the Asynchronous GTL+ signal groups.

## 2.8 Test Access Port (TAP) Connection

Due to the voltage levels supported by other components in the Test Access Port (TAP) logic, it is recommended that the Mobile Intel Pentium 4 Processor-M be first in the TAP chain and followed by any other components within the system. A translation buffer should be used to connect to the rest of the chain unless one of the other components is capable of accepting an input of the appropriate voltage level. Similar considerations must be made for TCK, TMS, and TRST#. Two copies of each signal may be required, with each driving a different voltage level. Refer to *ITP700 Debug Port Design Guide* for more detailed information.

## 2.9 System Bus Frequency Select Signals (BSEL[1:0])

The BSEL[1:0] are output signals used to select the frequency of the processor input clock (BCLK[1:0]). [Table 4](#) defines the possible combinations of the signals and the frequency associated with each combination. The required frequency is determined by the processor, chipset, and clock synthesizer. All agents must operate at the same frequency.

The Mobile Intel Pentium 4 Processor-M currently operates at a 400-MHz system bus frequency (selected by a 100-MHz BCLK[1:0] frequency). Individual processors will only operate at their specified system bus frequency.

For more information about these pins refer to [Section 5.2](#) and the appropriate platform design guidelines.

**Table 4. BSEL[1:0] Frequency Table for BCLK[1:0]**

| BSEL1 | BSEL0 | Function |
|-------|-------|----------|
| L     | L     | 100 MHz  |
| L     | H     | RESERVED |
| H     | L     | RESERVED |
| H     | H     | RESERVED |

## 2.10 Maximum Ratings

Table 5 lists the processor's maximum environmental stress ratings. The processor should not receive a clock while subjected to these conditions. Functional operating parameters are listed in the AC and DC tables. Extended exposure to the maximum ratings may affect device reliability. Furthermore, although the processor contains protective circuitry to resist damage from Electro Static Discharge (ESD), one should always take precautions to avoid high static voltages or electric fields.

**Table 5. Processor DC Absolute Maximum Ratings**

| Symbol                     | Parameter   | Min  | Max  | Unit | Notes |
|----------------------------|---|------|------|------|-------|
| T <sub>STORAGE</sub>       | Processor storage temperature                                       | −40  | 85   | °C   | 2     |
| V <sub>CC</sub>            | Any processor supply voltage with respect to V <sub>SS</sub>        | −0.3 | 1.75 | V    | 1     |
| V <sub>inAGTL+</sub>       | AGTL+ buffer DC input voltage with respect to V <sub>SS</sub>       | −0.1 | 1.75 | V    |       |
| V <sub>inAsynch_GTL+</sub> | Asynch GTL+ buffer DC input voltage with respect to V <sub>SS</sub> | −0.1 | 1.75 | V    |       |
| I <sub>VID</sub>           | Max VID pin current   |      | 5    | mA   |       |

**NOTES:**

1. This rating applies to any processor pin.
2. Contact Intel for storage requirements in excess of one year.

## 2.11 Processor DC Specifications

The processor DC specifications in this section are defined at the processor core (pads) unless noted otherwise. See Section 5 for the pin signal definitions and signal pin assignments. Most of the signals on the processor system bus are in the AGTL+ signal group. The DC specifications for these signals are listed in Table 12.

Previously, legacy signals and Test Access Port (TAP) signals to the processor used low-voltage CMOS buffer types. However, these interfaces now follow DC specifications similar to GTL+. The DC specifications for these signal groups are listed in Table 13 and Table 14.

Table 6 through Table 16 list the DC specifications for the Mobile Intel Pentium 4 Processor-M and are valid only while meeting specifications for junction temperature, clock frequency, and input voltages. Unless specified otherwise, all specifications for the Mobile Intel Pentium 4 Processor-M are at T<sub>J</sub> = 100°C. Care should be taken to read all notes associated with each parameter.

**Table 6. Voltage and Current Specifications**

| Symbol                               | Parameter  | Min  | Typ        | Max  | Unit | Notes <sup>1</sup>      |
|--------------------------------------|--|------|------------|--|------|-------------------------|
| V <sub>CC</sub>                      | V <sub>CC</sub> for core logic<br>Maximum Performance Mode<br>Battery Optimized Mode   |      | 1.3<br>1.2 |  | V    | 2, 3, 4,<br>5, 7, 8, 11 |
| V <sub>CCVID</sub>                   | VID supply voltage   | -5%  | 1.2        | +10%   | V    | 2, 12                   |
| V <sub>CCDPRSLP</sub>                | Transient Deeper Sleep voltage   | 0.91 | 1.00       | 1.09   | V    | 2                       |
| V <sub>CCDPRSLP,DC</sub>             | Static Deeper Sleep voltage  | 0.95 | 1.00       | 1.05   | V    | 2                       |
| I <sub>CC</sub>                      | Current for V <sub>CC</sub> at core frequency<br>2 GHz & 1.3 V<br>1.90 GHz & 1.3 V<br>1.80 GHz & 1.3 V<br>1.70 GHz & 1.3 V<br>1.60 GHz & 1.3 V<br>1.50 GHz & 1.3 V<br>1.40 GHz & 1.3 V<br>1.20 GHz & 1.2 V |      |            | 33.3<br>32.2<br>31.0<br>29.9<br>28.7<br>27.5<br>26.3<br>22.1 | A    | 4, 5, 8, 9              |
| I <sub>VCCVID</sub>                  | Current for VID supply   |      |            | 300  | mA   |                         |
| I <sub>SGNT</sub> , I <sub>SLP</sub> | I <sub>CC</sub> Stop-Grant and I <sub>CC</sub> Sleep at<br>1.3 V<br>1.2 V  |      |            | 10.1<br>8.9  | A    | 6, 9                    |
| I <sub>DSL</sub>                     | I <sub>CC</sub> Deep Sleep at<br>1.3 V<br>1.2 V  |      |            | 9.0<br>8.3   | A    | 9                       |
| I <sub>DPRSLP</sub>                  | I <sub>CC</sub> Deeper Sleep at 1.0 V  |      |            | 6.9  | A    |                         |
| I <sub>TCC</sub>                     | I <sub>CC</sub> TCC active   |      |            | I <sub>CC</sub>  | A    | 8                       |
| I <sub>CC PLL</sub>                  | I <sub>CC</sub> for PLL pins   |      |            | 60   | mA   | 10                      |

**NOTES:**

1. Unless otherwise noted, all specifications in this table are based on latest post-silicon measurements available at the time of publication.
2. These voltages are targets only. A variable voltage source should exist on systems in the event that a different voltage is required. See [Section 2.4](#) and [Table 2](#) for more information. The VID bits will set the typical V<sub>CC</sub> with the minimum being defined according to current consumption at that voltage.
3. The voltage specification requirements are measured at the system board socket ball with a 100-MHz bandwidth oscilloscope, 1.5-pF maximum probe capacitance, and 1 MΩ minimum impedance. The maximum length of ground wire on the probe should be less than 5 mm. Ensure external noise from the system is not coupled in the scope probe.
4. Refer to [Table 7](#) through [Table 10](#) and [Figure 4](#) through [Figure 6](#) for the minimum, typical, and maximum V<sub>CC</sub> (measured at the system board socket ball) allowed for a given current. The processor should not be subjected to any V<sub>CC</sub> and I<sub>CC</sub> combination wherein V<sub>CC</sub> exceeds V<sub>CC\_MAX</sub> for a given current. Failure to adhere to this specification can affect the long term reliability of the processor.
5. V<sub>CC\_MIN</sub> is defined at I<sub>CC\_MAX</sub>.
6. The current specified is also for AutoHALT State.
7. Typical V<sub>CC</sub> indicates the VID encoded voltage. Voltage supplied must conform to the load line specification shown in [Table 7](#) through [Table 10](#).
8. The maximum instantaneous current the processor will draw while the thermal control circuit is active as indicated by the assertion of PROCHOT# is the same as the maximum I<sub>CC</sub> for the processor.
9. Maximum specifications for I<sub>CC</sub> Core, I<sub>CC</sub> Stop-Grant, I<sub>CC</sub> Sleep, and I<sub>CC</sub> Deep Sleep are specified at V<sub>CC</sub> Static Max. derived from the tolerances in [Table 7](#) through [Table 10](#), T<sub>J</sub> Max., and under maximum signal loading conditions.
10. The specification is defined per PLL pin.
11. The voltage response to a processor current load step (transient) must stay within the Transient Voltage Tolerance Window. The voltage surge or droop response measured in this window is typically on the order of several hundred nanoseconds to several microseconds. The Transient Voltage Tolerance Window is defined as follows:

Case a) Load Current Step Up: e.g., from  $I_{CC} = I_{leakage}$  to  $I_{CC} = I_{CC\_max}$ . Allowable  $V_{CC\_min}$  is defined as minimum transient voltage at  $I_{CC} = I_{CC\_max}$  for a period of time lasting several hundred nanoseconds to several microseconds after the transient event.

Case b) Load Current Step Down: e.g., from  $I_{CC} = I_{CC\_max}$  to  $I_{CC} = I_{leakage}$ . Allowable  $V_{CC\_max}$  is defined as the maximum transient voltage at  $I_{CC} = I_{leakage}$  for a period of time lasting several hundred nanoseconds to several microseconds after the transient event.

12. This specification applies to both static and transient components. The rising edge of VCCVID must be monotonic from 0 V to 1.1 V. See Figure 1 for current requirements. In this case, monotonic is defined as continuously increasing with less than 50 mV of peak to peak noise for any width greater than 2 nS superimposed on the rising edge.

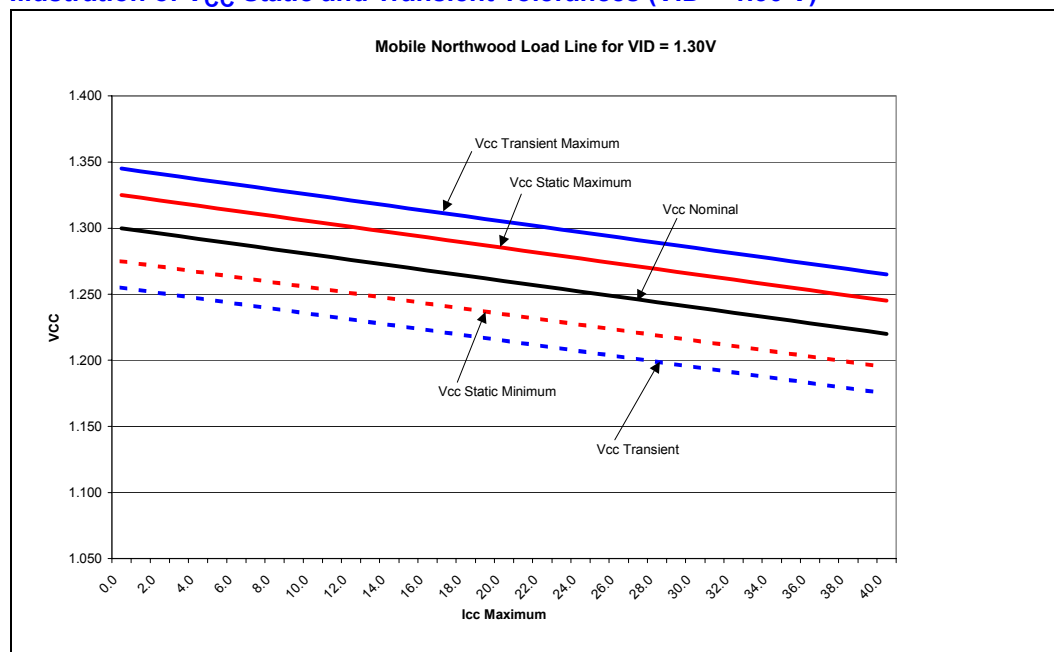
**Table 7. IMVP-III Voltage Regulator Tolerances for VID = 1.30 V Operating Mode (Maximum Performance Mode)**

| $I_{CC}$ (A) | $V_{CC}$ Nominal (V) | $V_{CC}$ Static Min (V) | $V_{CC}$ Static Max (V) | $V_{CC}$ Transient Min (V) | $V_{CC}$ Transient Max (V) |
|--------------|----------------------|-------------------------|-------------------------|----------------------------|----------------------------|
| 0.0          | 1.300                | 1.275                   | 1.325                   | 1.255                      | 1.345                      |
| 1.0          | 1.298                | 1.273                   | 1.323                   | 1.253                      | 1.343                      |
| 2.0          | 1.296                | 1.271                   | 1.321                   | 1.251                      | 1.341                      |
| 3.0          | 1.294                | 1.269                   | 1.319                   | 1.249                      | 1.339                      |
| 4.0          | 1.292                | 1.267                   | 1.317                   | 1.247                      | 1.337                      |
| 5.0          | 1.290                | 1.265                   | 1.315                   | 1.245                      | 1.335                      |
| 6.0          | 1.288                | 1.263                   | 1.313                   | 1.243                      | 1.333                      |
| 7.0          | 1.286                | 1.261                   | 1.311                   | 1.241                      | 1.331                      |
| 8.0          | 1.284                | 1.259                   | 1.309                   | 1.239                      | 1.329                      |
| 9.0          | 1.282                | 1.257                   | 1.307                   | 1.237                      | 1.327                      |
| 10.0         | 1.280                | 1.255                   | 1.305                   | 1.235                      | 1.325                      |
| 11.0         | 1.278                | 1.253                   | 1.303                   | 1.233                      | 1.323                      |
| 12.0         | 1.276                | 1.251                   | 1.301                   | 1.231                      | 1.321                      |
| 13.0         | 1.274                | 1.249                   | 1.299                   | 1.229                      | 1.319                      |
| 14.0         | 1.272                | 1.247                   | 1.297                   | 1.227                      | 1.317                      |
| 15.0         | 1.270                | 1.245                   | 1.295                   | 1.225                      | 1.315                      |
| 16.0         | 1.268                | 1.243                   | 1.293                   | 1.223                      | 1.313                      |
| 17.0         | 1.266                | 1.241                   | 1.291                   | 1.221                      | 1.311                      |
| 18.0         | 1.264                | 1.239                   | 1.289                   | 1.219                      | 1.309                      |
| 19.0         | 1.262                | 1.237                   | 1.287                   | 1.217                      | 1.307                      |
| 20.0         | 1.260                | 1.235                   | 1.285                   | 1.215                      | 1.305                      |
| 21.0         | 1.258                | 1.233                   | 1.283                   | 1.213                      | 1.303                      |
| 22.0         | 1.256                | 1.231                   | 1.281                   | 1.211                      | 1.301                      |
| 23.0         | 1.254                | 1.229                   | 1.279                   | 1.209                      | 1.299                      |
| 24.0         | 1.252                | 1.227                   | 1.277                   | 1.207                      | 1.297                      |
| 25.0         | 1.250                | 1.225                   | 1.275                   | 1.205                      | 1.295                      |
| 26.0         | 1.248                | 1.223                   | 1.273                   | 1.203                      | 1.293                      |
| 27.0         | 1.246                | 1.221                   | 1.271                   | 1.201                      | 1.291                      |
| 28.0         | 1.244                | 1.219                   | 1.269                   | 1.199                      | 1.289                      |

**Table 7. IMVP-III Voltage Regulator Tolerances for VID = 1.30 V Operating Mode (Maximum Performance Mode)**

| $I_{CC}$ (A) | $V_{CC}$ Nominal (V) | $V_{CC}$ Static Min (V) | $V_{CC}$ Static Max (V) | $V_{CC}$ Transient Min (V) | $V_{CC}$ Transient Max (V) |
|--------------|----------------------|-------------------------|-------------------------|----------------------------|----------------------------|
| 29.0         | 1.242                | 1.217                   | 1.267                   | 1.197                      | 1.287                      |
| 30.0         | 1.240                | 1.215                   | 1.265                   | 1.195                      | 1.285                      |
| 31.0         | 1.238                | 1.213                   | 1.263                   | 1.193                      | 1.283                      |
| 32.0         | 1.236                | 1.211                   | 1.261                   | 1.191                      | 1.281                      |
| 33.0         | 1.234                | 1.209                   | 1.259                   | 1.189                      | 1.279                      |
| 34.0         | 1.232                | 1.207                   | 1.257                   | 1.187                      | 1.277                      |
| 35.0         | 1.230                | 1.205                   | 1.255                   | 1.185                      | 1.275                      |
| 36.0         | 1.228                | 1.203                   | 1.253                   | 1.183                      | 1.273                      |
| 37.0         | 1.226                | 1.201                   | 1.251                   | 1.181                      | 1.271                      |
| 38.0         | 1.224                | 1.199                   | 1.249                   | 1.179                      | 1.269                      |
| 39.0         | 1.222                | 1.197                   | 1.247                   | 1.177                      | 1.267                      |
| 40.0         | 1.220                | 1.195                   | 1.245                   | 1.175                      | 1.265                      |

**Figure 4. Illustration of  $V_{CC}$  Static and Transient Tolerances (VID = 1.30 V)**



**Table 8. IMVP-III Voltage Regulator Tolerances for VID = 1.20 V Operating Mode (Battery Optimized Mode)**

| I <sub>CC</sub> (A) | V <sub>CC</sub> Nominal (V) | V <sub>CC</sub> Static Min (V) | V <sub>CC</sub> Static Max (V) | V <sub>CC</sub> Transient Min (V) | V <sub>CC</sub> Transient Max (V) |
|---------------------|-----------------------------|--------------------------------|--------------------------------|-----------------------------------|-----------------------------------|
| 0.0                 | 1.176                       | 1.151                          | 1.201                          | 1.131                             | 1.221                             |
| 1.0                 | 1.174                       | 1.149                          | 1.199                          | 1.129                             | 1.219                             |
| 2.0                 | 1.172                       | 1.147                          | 1.197                          | 1.127                             | 1.217                             |
| 3.0                 | 1.170                       | 1.145                          | 1.195                          | 1.125                             | 1.215                             |
| 4.0                 | 1.168                       | 1.143                          | 1.193                          | 1.123                             | 1.213                             |
| 5.0                 | 1.166                       | 1.141                          | 1.191                          | 1.121                             | 1.211                             |
| 6.0                 | 1.164                       | 1.139                          | 1.189                          | 1.119                             | 1.209                             |
| 7.0                 | 1.162                       | 1.137                          | 1.187                          | 1.117                             | 1.207                             |
| 8.0                 | 1.160                       | 1.135                          | 1.185                          | 1.115                             | 1.205                             |
| 9.0                 | 1.158                       | 1.133                          | 1.183                          | 1.113                             | 1.203                             |
| 10.0                | 1.156                       | 1.131                          | 1.181                          | 1.111                             | 1.201                             |
| 11.0                | 1.154                       | 1.129                          | 1.179                          | 1.109                             | 1.199                             |
| 12.0                | 1.152                       | 1.127                          | 1.177                          | 1.107                             | 1.197                             |
| 13.0                | 1.150                       | 1.125                          | 1.175                          | 1.105                             | 1.195                             |
| 14.0                | 1.148                       | 1.123                          | 1.173                          | 1.103                             | 1.193                             |
| 15.0                | 1.146                       | 1.121                          | 1.171                          | 1.101                             | 1.191                             |
| 16.0                | 1.144                       | 1.119                          | 1.169                          | 1.099                             | 1.189                             |
| 17.0                | 1.142                       | 1.117                          | 1.167                          | 1.097                             | 1.187                             |
| 18.0                | 1.140                       | 1.115                          | 1.165                          | 1.095                             | 1.185                             |
| 19.0                | 1.138                       | 1.113                          | 1.163                          | 1.093                             | 1.183                             |
| 20.0                | 1.136                       | 1.111                          | 1.161                          | 1.091                             | 1.181                             |
| 21.0                | 1.134                       | 1.109                          | 1.159                          | 1.089                             | 1.179                             |
| 22.0                | 1.132                       | 1.107                          | 1.157                          | 1.087                             | 1.177                             |
| 23.0                | 1.130                       | 1.105                          | 1.155                          | 1.085                             | 1.175                             |
| 24.0                | 1.128                       | 1.103                          | 1.153                          | 1.083                             | 1.173                             |
| 25.0                | 1.126                       | 1.101                          | 1.151                          | 1.081                             | 1.171                             |

Figure 5. Illustration of  $V_{CC}$  Static and Transient Tolerances (VID = 1.20 V)

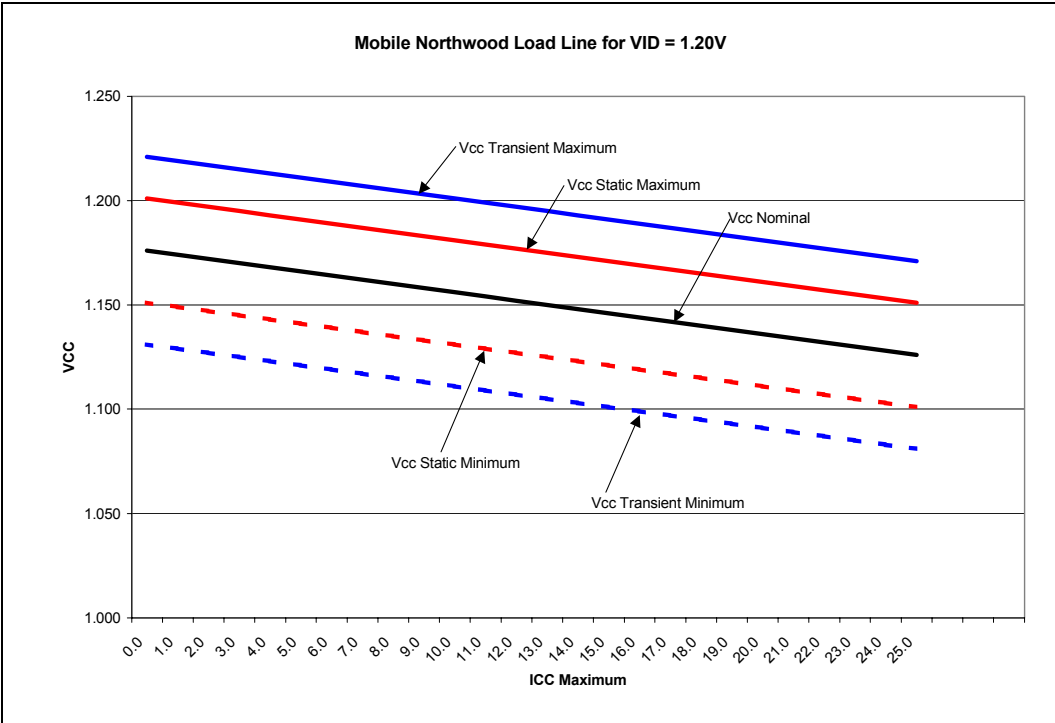


Table 9. IMVP-III Deep Sleep State Voltage Regulator Tolerances for Maximum Performance Mode (VID = 1.30 V, VID Offset = 4.62%)

| $I_{CC}$ (A) | $V_{CC}$ Nominal (V) | $V_{CC}$ Static Min (V) | $V_{CC}$ Static Max (V) | $V_{CC}$ Transient Min (V) | $V_{CC}$ Transient Max (V) |
|--------------|----------------------|-------------------------|-------------------------|----------------------------|----------------------------|
| 0.0          | 1.240                | 1.215                   | 1.265                   | 1.195                      | 1.285                      |
| 1.0          | 1.238                | 1.213                   | 1.263                   | 1.193                      | 1.283                      |
| 2.0          | 1.236                | 1.211                   | 1.261                   | 1.191                      | 1.281                      |
| 3.0          | 1.234                | 1.209                   | 1.259                   | 1.189                      | 1.279                      |
| 4.0          | 1.232                | 1.207                   | 1.257                   | 1.187                      | 1.277                      |
| 5.0          | 1.230                | 1.205                   | 1.255                   | 1.185                      | 1.275                      |
| 6.0          | 1.228                | 1.203                   | 1.253                   | 1.183                      | 1.273                      |
| 7.0          | 1.226                | 1.201                   | 1.251                   | 1.181                      | 1.271                      |
| 8.0          | 1.224                | 1.199                   | 1.249                   | 1.179                      | 1.269                      |
| 9.0          | 1.222                | 1.197                   | 1.247                   | 1.177                      | 1.267                      |
| 10.0         | 1.220                | 1.195                   | 1.245                   | 1.175                      | 1.265                      |

**Table 10. IMVP-III Deep Sleep State Voltage Regulator Tolerances for Battery Optimized Mode (VID = 1.20 V, VID Offset = 4.62%)**

| $I_{CC}$ (A) | $V_{CC}$ Nominal (V) | $V_{CC}$ Static Min (V) | $V_{CC}$ Static Max (V) | $V_{CC}$ Transient Min (V) | $V_{CC}$ Transient Max (V) |
|--------------|----------------------|-------------------------|-------------------------|----------------------------|----------------------------|
| 0.0          | 1.145                | 1.120                   | 1.170                   | 1.100                      | 1.190                      |
| 1.0          | 1.143                | 1.118                   | 1.168                   | 1.098                      | 1.188                      |
| 2.0          | 1.141                | 1.116                   | 1.166                   | 1.096                      | 1.186                      |
| 3.0          | 1.139                | 1.114                   | 1.164                   | 1.094                      | 1.184                      |
| 4.0          | 1.137                | 1.112                   | 1.162                   | 1.092                      | 1.182                      |
| 5.0          | 1.135                | 1.110                   | 1.160                   | 1.090                      | 1.180                      |
| 6.0          | 1.133                | 1.108                   | 1.158                   | 1.088                      | 1.178                      |
| 7.0          | 1.131                | 1.106                   | 1.156                   | 1.086                      | 1.176                      |
| 8.0          | 1.129                | 1.104                   | 1.154                   | 1.084                      | 1.174                      |

**Figure 6. Illustration of Deep Sleep  $V_{CC}$  Static and Transient Tolerances (VID Setting = 1.30 V)**

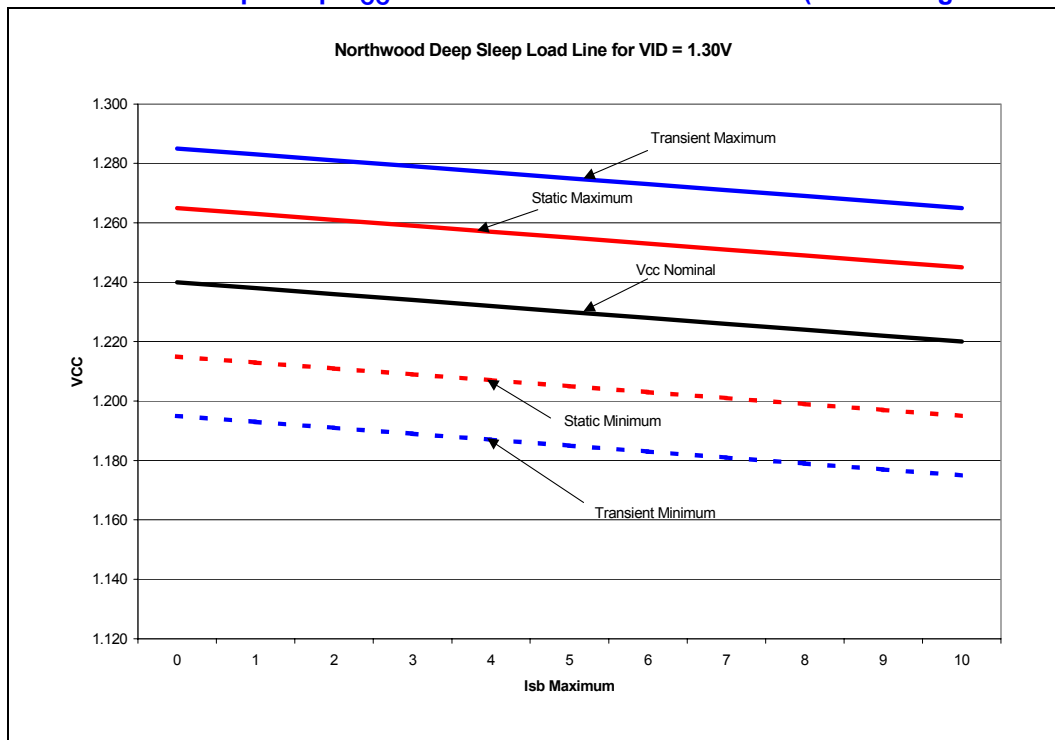


Table 11. System Bus Differential BCLK Specifications

| Symbol             | Parameter                | Min                             | Typ   | Max                             | Unit | Figure | Notes <sup>1</sup> |
|--------------------|--------------------------|---------------------------------|-------|---------------------------------|------|--------|--------------------|
| $V_L$              | Input Low Voltage        | -0.150                          | 0.000 | N/A                             | V    | 10     |                    |
| $V_H$              | Input High Voltage       | 0.660                           | 0.710 | 0.850                           | V    | 10     |                    |
| $V_{CROSS(abs)}$   | Absolute Crossing Point  | 0.250                           | N/A   | 0.550                           | V    | 10, 11 | 2,3,8              |
| $V_{CROSS(rel)}$   | Relative Crossing Point  | $0.250 + 0.5(V_{Havg} - 0.710)$ | N/A   | $0.550 + 0.5(V_{Havg} - 0.710)$ | V    | 10, 11 | 2,3,8,9            |
| $\Delta V_{CROSS}$ | Range of Crossing Points | N/A                             | N/A   | 0.140                           | V    | 10, 11 | 2,10               |
| $V_{OV}$           | Overshoot                | N/A                             | N/A   | $V_H + 0.3$                     | V    | 10     | 4                  |
| $V_{US}$           | Undershoot               | -0.300                          | N/A   | N/A                             | V    | 10     | 5                  |
| $V_{RBM}$          | Ringback Margin          | 0.200                           | N/A   | N/A                             | V    | 10     | 6                  |
| $V_{TM}$           | Threshold Margin         | $V_{CROSS} - 0.100$             | N/A   | $V_{CROSS} + 0.100$             | V    | 10     | 7                  |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. Crossing voltage is defined as the instantaneous voltage value when the rising edge of BCLK0 equals the falling edge of BCLK1.
3.  $V_{Havg}$  is the statistical average of the  $V_H$  measured by the oscilloscope.
4. Overshoot is defined as the absolute value of the maximum voltage.
5. Undershoot is defined as the absolute value of the minimum voltage.
6. Ringback Margin is defined as the absolute voltage difference between the maximum Rising Edge Ringback and the maximum Falling Edge Ringback.
7. Threshold Region is defined as a region entered around the crossing point voltage in which the differential receiver switches. It includes input threshold hysteresis.
8. The crossing point must meet the absolute and relative crossing point specifications simultaneously.
9.  $V_{Havg}$  can be measured directly using "Vtop" on Agilent\* scopes and "High" on Tektronix\* scopes.
10.  $\Delta V_{CROSS}$  is defined as the total variation of all crossing voltages as defined in note 2.

**Table 12. AGTL+ Signal Group DC Specifications**

| Symbol   | Parameter            | Min                        | Max                       | Unit          | Notes <sup>1</sup> |
|----------|----------------------|----------------------------|---------------------------|---------------|--------------------|
| GTLREF   | Reference Voltage    | $2/3 V_{CC} - 2\%$         | $2/3 V_{CC} + 2\%$        | V             |                    |
| $V_{IH}$ | Input High Voltage   | $1.10 \cdot \text{GTLREF}$ | $V_{CC}$                  | V             | 2,6                |
| $V_{IL}$ | Input Low Voltage    | 0.0                        | $0.9 \cdot \text{GTLREF}$ | V             | 3,4,6              |
| $V_{OH}$ | Output High Voltage  | N/A                        | $V_{CC}$                  | V             | 7                  |
| $I_{OL}$ | Output Low Current   | N/A                        | 50                        | mA            | 6                  |
| $I_{HI}$ | Pin Leakage High     | N/A                        | 100                       | $\mu\text{A}$ | 8                  |
| $I_{LO}$ | Pin Leakage Low      | N/A                        | 500                       | $\mu\text{A}$ | 9                  |
| $R_{ON}$ | Buffer On Resistance | 7                          | 11                        | $\Omega$      | 5                  |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2.  $V_{IL}$  is defined as the maximum voltage level at a receiving agent that will be interpreted as a logical low value.
3.  $V_{IH}$  is defined as the minimum voltage level at a receiving agent that will be interpreted as a logical high value.
4.  $V_{IH}$  and  $V_{OH}$  may experience excursions above  $V_{CC}$ . However, input signal drivers must comply with the signal quality specifications in [Section 3](#).
5. Refer to processor I/O Buffer Models for I/V characteristics.
6. The  $V_{CC}$  referred to in these specifications is the instantaneous  $V_{CC}$ .
7. Vol max of 0.450 Volts is guaranteed when driving into a test load of 50  $\Omega$  as indicated in [Figure 8](#).
8. Leakage to  $V_{SS}$  with pin held at  $V_{CC}$ .
9. Leakage to  $V_{CC}$  with pin held at 300 mV.

**Table 13. Asynchronous GTL+ Signal Group DC Specifications**

| Symbol          | Parameter                           | Min         | Max             | Unit | Notes <sup>1</sup> |
|-----------------|-------------------------------------|-------------|-----------------|------|--------------------|
| V <sub>IH</sub> | Input High Voltage<br>Asynch GTL+   | 1.10*GTLREF | V <sub>CC</sub> | V    | 3, 4, 5            |
| V <sub>IL</sub> | Input Low Voltage<br>Asynch. GTL+   | 0           | 0.9*GTLREF      | V    | 5                  |
| V <sub>OH</sub> | Output High Voltage                 | N/A         | V <sub>CC</sub> | V    | 2, 3, 4            |
| I <sub>OL</sub> | Output Low Current                  | N/A         | 50              | mA   | 6, 8               |
| I <sub>HI</sub> | Pin Leakage High                    | N/A         | 100             | μA   | 9                  |
| I <sub>LO</sub> | Pin Leakage Low                     | N/A         | 500             | μA   | 10                 |
| R <sub>on</sub> | Buffer On Resistance<br>Asynch GTL+ | 7           | 11              | Ω    | 5, 7               |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. All outputs are open-drain.
3. V<sub>IH</sub> and V<sub>OH</sub> may experience excursions above V<sub>CC</sub>. However, input signal drivers must comply with the signal quality specifications in [Section 3](#).
4. The V<sub>CC</sub> referred to in these specifications refers to instantaneous V<sub>CC</sub>.
5. This specification applies to the asynchronous GTL+ signal group.
6. The maximum output current is based on maximum current handling capability of the buffer and is not specified into the test load shown in [Figure 8](#).
7. Refer to the processor I/O Buffer Models for I/V characteristics.
8. Vol max of 0.270 Volts is guaranteed when driving into a test load of 50 Ω as indicated in [Figure 8](#) for the Asynchronous GTL+ signals.
9. Leakage to V<sub>SS</sub> with pin held at V<sub>CC</sub>.
10. Leakage to V<sub>CC</sub> with pin held at 300 mV.

**Table 14. PWRGOOD and TAP Signal Group DC Specifications**

| Symbol           | Parameter                           | Min                                 | Max                                 | Unit | Notes <sup>1</sup> |
|------------------|-------------------------------------|-------------------------------------|-------------------------------------|------|--------------------|
| V <sub>HYS</sub> | Input Hysteresis                    | 200                                 | 300                                 | mV   | 8                  |
| V <sub>T+</sub>  | Input Low to High Threshold Voltage | $1/2 \cdot (V_{CC} + V_{HYS\_MIN})$ | $1/2 \cdot (V_{CC} + V_{HYS\_MAX})$ | V    | 5                  |
| V <sub>T-</sub>  | Input High to Low Threshold Voltage | $1/2 \cdot (V_{CC} - V_{HYS\_MAX})$ | $1/2 \cdot (V_{CC} - V_{HYS\_MIN})$ | V    | 5                  |
| V <sub>OH</sub>  | Output High Voltage                 | N/A                                 | V <sub>CC</sub>                     | V    | 2,3,5              |
| I <sub>OL</sub>  | Output Low Current                  | N/A                                 | 40                                  | mA   | 6,7                |
| I <sub>HI</sub>  | Pin Leakage High                    | N/A                                 | 100                                 | μA   | 9                  |
| I <sub>LO</sub>  | Pin Leakage Low                     | N/A                                 | 500                                 | μA   | 10                 |
| R <sub>on</sub>  | Buffer On Resistance                | 8.75                                | 13.75                               | Ω    | 4                  |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. All outputs are open-drain.
3. TAP signal group must comply with the signal quality specifications in [Section 3](#).
4. Refer to I/O Buffer Models for I/V characteristics.
5. The V<sub>CC</sub> referred to in these specifications refers to instantaneous V<sub>CC</sub>.
6. The maximum output current is based on maximum current handling capability of the buffer and is not specified into the test load shown in [Figure 8](#).
7. Vol max of 0.320 Volts is guaranteed when driving into a test load of 50 Ohms as indicated in [Figure 8](#) for the TAP Signals.
8. V<sub>HYS</sub> represents the amount of hysteresis, nominally centered about 1/2 V<sub>CC</sub> for all TAP inputs.
9. Leakage to V<sub>SS</sub> with pin held at V<sub>CC</sub>.
10. Leakage to V<sub>CC</sub> with pin held at 300 mV.

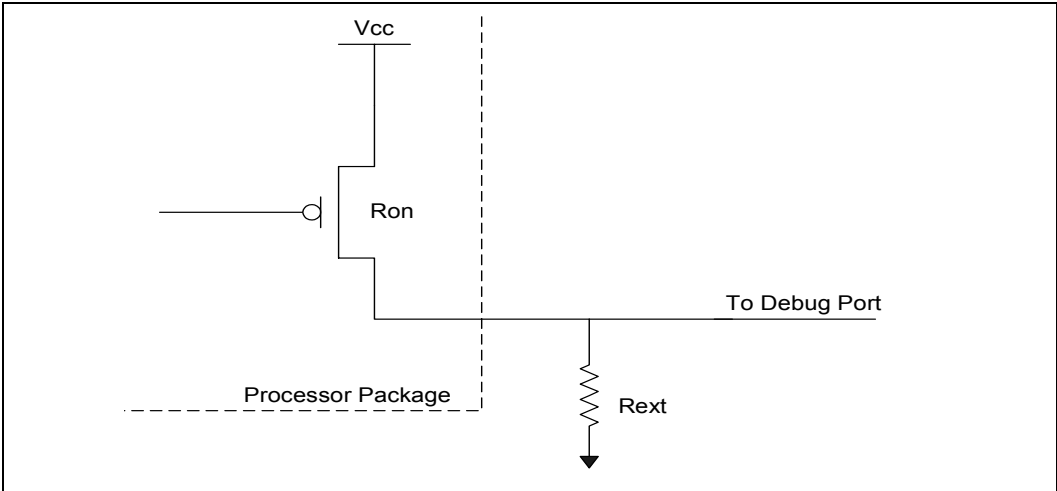
**Table 15. ITPCLKOUT[1:0] DC Specifications**

| Symbol          | Parameter            | Min | Max | Unit | Notes <sup>1</sup> |
|-----------------|----------------------|-----|-----|------|--------------------|
| R <sub>on</sub> | Buffer On Resistance | 27  | 46  | Ω    | 2,3                |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. These parameters are not tested and are based on design simulations.
3. See [Figure 7](#) for ITPCLKOUT[1:0] output buffer diagram.

Figure 7. ITPCLKOUT[1:0] Output Buffer Diagram



- NOTES:**
- 1. See Table 15 for range of Ron.
  - 2. The Vcc referred to in this figure is the instantaneous Vcc.
  - 3. Refer to the *ITP700 Debug Port Design Guide* and the appropriate platform design guidelines for the value of Rext.

Table 16. BSEL [1:0] and VID[4:0] DC Specifications

| Symbol          | Parameter            | Min | Max  | Unit | Notes <sup>1</sup> |
|-----------------|----------------------|-----|------|------|--------------------|
| Ron<br>(BSEL)   | Buffer On Resistance | 9.2 | 14.3 | Ω    | 2                  |
| Ron<br>(VID)    | Buffer On Resistance | 7.8 | 12.8 | Ω    | 2                  |
| I <sub>HI</sub> | Pin Leakage Hi       | N/A | 100  | μA   | 3                  |

- NOTES:**
- 1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
  - 2. These parameters are not tested and are based on design simulations.
  - 3. Leakage to Vss with pin held at 2.50 V.

## 2.12 AGTL+ System Bus Specifications

Routing topology recommendations may be found in the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*. Termination resistors are not required for most AGTL+ signals, as these are integrated into the processor silicon.

Valid high and low levels are determined by the input buffers which compare a signal's voltage with a reference voltage called GTLREF (known as V<sub>REF</sub> in previous documentation).

Table 17 lists the GTLREF specifications. The AGTL+ reference voltage (GTLREF) should be generated on the system board using high precision voltage divider circuits. It is important that the system board impedance is held to the specified tolerance and that the intrinsic trace capacitance

for the AGTL+ signal group traces is known and well-controlled. For more details on platform design see the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

**Table 17. AGTL+ Bus Voltage Definitions**

| Symbol    | Parameter              | Min                | Typ          | Max                | Units    | Notes <sup>1</sup> |
|-----------|------------------------|--------------------|--------------|--------------------|----------|--------------------|
| GTLREF    | Bus Reference Voltage  | $2/3 V_{CC} - 2\%$ | $2/3 V_{CC}$ | $2/3 V_{CC} + 2\%$ | V        | 2, 3, 6            |
| $R_{TT}$  | Termination Resistance | 45                 | 50           | 55                 | $\Omega$ | 4                  |
| COMP[1:0] | COMP Resistance        | 50.49              | 51           | 51.51              | $\Omega$ | 5                  |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. The tolerances for this specification have been stated generically to enable the system designer to calculate the minimum and maximum values across the range of  $V_{CC}$ .
3. GTLREF should be generated from  $V_{CC}$  by a voltage divider of 1% tolerance resistors or 1% tolerance matched resistors. Refer to the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Platform Design Guide* for implementation details.
4.  $R_{TT}$  is the on-die termination resistance measured at  $V_{OL}$  of the AGTL+ output driver. Refer to processor I/O buffer models for I/V characteristics.
5. COMP resistance must be provided on the system board with 1% tolerance resistors. See the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Platform Design Guide* for implementation details.
6. The  $V_{CC}$  referred to in these specifications is the instantaneous  $V_{CC}$ .

## 2.13 System Bus AC Specifications

The processor system bus timings specified in this section are defined at the processor core (pads). See [Section 5.2](#) for the Mobile Intel Pentium 4 Processor-M pin signal definitions.

[Table 18](#) through [Table 25](#) lists the AC specifications associated with the processor system bus.

All AGTL+ timings are referenced to GTLREF for both “0” and “1” logic levels unless otherwise specified.

AGTL+ layout guidelines are available in the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

Unless specified otherwise, all Mobile Intel Pentium 4 Processor-M AC specifications are at  $T_J = 100^\circ\text{C}$ . Care should be taken to read all notes associated with a particular timing parameter.

**Table 18. System Bus Differential Clock Specifications**

| T# Parameter                   | Min  | Nom | Max  | Unit | Figure | Notes <sup>1</sup> |
|--------------------------------|------|-----|------|------|--------|--------------------|
| System Bus Frequency           |      |     | 100  | MHz  |        |                    |
| T1: BCLK[1:0] Period           | 10.0 |     | 10.2 | ns   | 10     | 2                  |
| T2: BCLK[1:0] Period Stability |      |     | 200  | ps   |        | 3                  |
| T3: BCLK[1:0] High Time        | 3.94 | 5   | 6.12 | ns   | 10     |                    |
| T4: BCLK[1:0] Low Time         | 3.94 | 5   | 6.12 | ns   | 10     |                    |
| T5: BCLK[1:0] Rise Time        | 175  |     | 700  | ps   | 10     | 4                  |
| T6: BCLK[1:0] Fall Time        | 175  |     | 700  | ps   | 10     | 4                  |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. The period specified here is the average period. A given period may vary from this specification as governed by the period stability specification (T2).
3. In this context, period stability is defined as the worst case timing difference between successive crossover voltages. In other words, the largest absolute difference between adjacent clock periods must be less than the period stability.
4. Slew rate is measured between the 35% and 65% points of the clock swing ( $V_L$  to  $V_H$ ).

**Table 19. System Bus Common Clock AC Specifications**

| T# Parameter                         | Min  | Max  | Unit | Figure | Notes <sup>1,2,3</sup> |
|--------------------------------------|------|------|------|--------|------------------------|
| T10: Common Clock Output Valid Delay | 0.12 | 1.55 | ns   | 12     | 4                      |
| T11: Common Clock Input Setup Time   | 0.65 |      | ns   | 12     | 5                      |
| T12: Common Clock Input Hold Time    | 0.40 |      | ns   | 12     | 5                      |
| T13: RESET# Pulse Width              | 1    | 10   | ms   | 13     | 6, 7, 8                |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. Not 100% tested. Specified by design characterization.
3. All common clock AC timings for AGTL+ signals are referenced to the Crossing Voltage ( $V_{CROSS}$ ) of the BCLK[1:0] at rising edge of BCLK0. All common clock AGTL+ signal timings are referenced at GTLREF at the processor core.
4. Valid delay timings for these signals are specified into the test circuit described in [Figure 8](#) and with GTLREF at  $2/3 V_{CC} \pm 2\%$ .
5. Specification is for a minimum swing defined between AGTL+  $V_{IL\_MAX}$  to  $V_{IH\_MIN}$ . This assumes an edge rate of 0.4 V/ns to 4.0 V/ns.
6. RESET# can be asserted asynchronously, but must be deasserted synchronously.
7. This should be measured after  $V_{CC}$  and BCLK[1:0] become stable.
8. Maximum specification applies only while PWRGOOD is asserted.

Table 20. System Bus Source Synch AC Specifications AGTL+ Signal Group

| T# Parameter  | Min  | Typ | Max   | Unit | Figure | Notes <sup>1,2,3,4</sup> |
|---|------|-----|-------|------|--------|--------------------------|
| T20: Source Synchronous Data Output Valid Delay (first data/address only)     | 0.20 |     | 1.20  | ns   | 14, 15 | 5                        |
| T21: T <sub>VBD</sub> : Source Synchronous Data Output Valid Before Strobe    | 0.85 |     |       | ns   | 15     | 5, 8                     |
| T22: T <sub>VAD</sub> : Source Synchronous Data Output Valid After Strobe     | 0.85 |     |       | ns   | 15     | 5, 9                     |
| T23: T <sub>VBA</sub> : Source Synchronous Address Output Valid Before Strobe | 1.88 |     |       | ns   | 14     | 5, 8                     |
| T24: T <sub>VAA</sub> : Source Synchronous Address Output Valid After Strobe  | 1.88 |     |       | ns   | 14     | 5, 9                     |
| T25: T <sub>SUSS</sub> : Source Synchronous Input Setup Time to Strobe        | 0.21 |     |       | ns   | 14, 15 | 6                        |
| T26: T <sub>HSS</sub> : Source Synchronous Input Hold Time to Strobe          | 0.21 |     |       | ns   | 14, 15 | 6                        |
| T27: T <sub>SUCC</sub> : Source Synchronous Input Setup Time to BCLK[1:0]     | 0.65 |     |       | ns   | 14, 15 | 7                        |
| T28: T <sub>FASS</sub> : First Address Strobe to Second Address Strobe        |      | 1/2 |       | BCLK | 14     | 10                       |
| T29: T <sub>FDSS</sub> : First Data Strobe to Subsequent Strobes              |      | n/4 |       | BCLK | 15     | 11, 12                   |
| T30: Data Strobe 'n' (DSTBn#) Output valid Delay                              | 8.80 |     | 10.20 | ns   | 15     | 13                       |
| T31: Address Strobe Output Valid Delay  | 2.27 |     | 4.23  | ns   | 14     |                          |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies and cache sizes.
2. Not 100% tested. Specified by design characterization.
3. All source synchronous AC timings are referenced to their associated strobe at GTLREF. Source synchronous data signals are referenced to the falling edge of their associated data strobe. Source synchronous address signals are referenced to the rising and falling edge of their associated address strobe. All source synchronous AGTL+ signal timings are referenced to GTLREF at the processor core.
4. Unless otherwise noted these specifications apply to both data and address timings.
5. Valid delay timings for these signals are specified into the test circuit described in Figure 8 and with GTLREF at  $2/3 V_{CC} \pm 2\%$ .
6. Specification is for a minimum swing defined between AGTL+  $V_{IL\_MAX}$  to  $V_{IH\_MIN}$ . This assumes an edge rate of 0.3 V/ns to 4.0 V/ns.
7. All source synchronous signals must meet the specified setup time to BCLK as well as the setup time to each respective strobe.
8. This specification represents the minimum time the data or address will be valid before its strobe. Refer to the Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Platform Design Guide for more information on the definitions and use of these specifications.
9. This specification represents the minimum time the data or address will be valid after its strobe. Refer to the Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Platform Design Guide for more information on the definitions and use of these specifications.
10. The rising edge of ADSTB# must come approximately 1/2 BCLK period (5 ns) after the falling edge of ADSTB#.
11. For this timing parameter, n = 1, 2, and 3 for the second, third, and last data strobes respectively.
12. The second data strobe (falling edge of DSTBn#) must come approximately 1/4 BCLK period (2.5 ns) after the first falling edge of DSTBp#. The third data strobe (falling edge of DSTBp#) must come approximately 2/4 BCLK period (5 ns) after the first falling edge of DSTBp#. The last data strobe (falling edge of DSTBn#) must come approximately 3/4 BCLK period (7.5 ns) after the first falling edge of DSTBp#.
13. This specification applies only to DSTBN[3:0]# and is measured to the second falling edge of the strobe.

**Table 21. Miscellaneous Signals AC Specifications**

| T# Parameter                                    | Min | Max | Unit  | Figure | Notes <sup>1,2,3,6</sup> |
|---|-----|-----|-------|--------|--------------------------|
| T35: Asynch GTL+ Input Pulse Width              | 2   |     | BCLKs |        |                          |
| T36: PWRGOOD to RESET# Deassertion Time         | 1   | 10  | ms    | 16     |                          |
| T37: PWRGOOD Inactive Pulse Width               | 10  |     | BCLKs | 16     | 4                        |
| T38: PROCHOT# Pulse Width                       | 500 |     | μs    | 18     | 5                        |
| T39: THERMTRIP# to Vcc Removal                  |     | 0.5 | s     | 19     |                          |
| T40: FERR# Valid Delay from STPCLK# Deassertion | 0   | 5   | BCLKs | 20     |                          |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. All AC timings for the Asynch GTL+ signals are referenced to the BCLK0 rising edge at Crossing Voltage. All Asynch GTL+ signal timings are referenced at GTLREF. PWRGOOD is referenced to the BCLK0 rising edge at 0.5\*VCC.
3. These signals may be driven asynchronously.
4. Refer to the PWRGOOD definition for more details regarding the behavior of this signal.
5. Length of assertion for PROCHOT# does not equal internal clock modulation time. Time is allocated after the assertion and before the deassertion of PROCHOT# for the processor to complete current instruction execution.
6. See [Section 7.1](#) for additional timing requirements for entering and leaving the low power states.

**Table 22. System Bus AC Specifications (Reset Conditions)**

| T# Parameter  | Min | Max | Unit  | Figure | Notes |
|---|-----|-----|-------|--------|-------|
| T45: Reset Configuration Signals (A[31:3]#, BR0#, INIT#, SMI#) Setup Time | 4   |     | BCLKs | 13     | 1     |
| T46: Reset Configuration Signals (A[31:3]#, BR0#, INIT#, SMI#) Hold Time  | 2   | 20  | BCLKs | 13     | 2     |

**NOTES:**

1. Before the deassertion of RESET#.
2. After clock that deasserts RESET#.

**Table 23. TAP Signals AC Specifications**

| Parameter                      | Min  | Max  | Unit | Figure | Notes <sup>1,2,3</sup> |
|--------------------------------|------|------|------|--------|------------------------|
| T55: TCK Period                | 60.0 |      | ns   | 9      |                        |
| T56: TCK Rise Time             |      | 10.0 | ns   | 9      | 4                      |
| T57: TCK Fall Time             |      | 10.0 | ns   | 9      | 4                      |
| T58: TMS Rise Time             |      | 8.5  | ns   | 9      | 4                      |
| T59: TMS Fall Time             |      | 8.5  | ns   | 9      | 4, 9                   |
| T61: TDI Setup Time            | 0    |      | ns   | 21     | 5, 7                   |
| T62: TDI Hold Time             | 3    |      | ns   | 21     | 5, 7                   |
| T63: TDO Clock to Output Delay |      | 3.5  | ns   | 21     | 6                      |
| T64: TRST# Assert Time         | 2    |      | TCK  | 18     | 8, 9                   |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. Not 100% tested. Specified by design characterization.
3. All AC timings for the TAP signals are referenced to the TCK signal at  $0.5 \cdot V_{CC}$  at the processor pins. All TAP signal timings (TMS, TDI, etc) are referenced at  $0.5 \cdot V_{CC}$  at the processor pins.
4. Rise and fall times are measured from the 20% to 80% points of the signal swing.
5. Referenced to the rising edge of TCK.
6. Referenced to the falling edge of TCK.
7. Specifications for a minimum swing defined between TAP  $V_{T-}$  to  $V_{T+}$ . This assumes a minimum edge rate of 0.5 V/ns
8. TRST# must be held asserted for 2 TCK periods to be guaranteed that it is recognized by the processor.
9. It is recommended that TMS be asserted while TRST# is being deasserted.

**Table 24. ITPCLKOUT[1:0] AC Specifications**

| Parameter                     | Min  | Typ | Max  | Unit | Figure | Notes <sup>1,2</sup> |
|-------------------------------|------|-----|------|------|--------|----------------------|
| T65: ITPCLKOUT Delay          | 400  |     | 560  | ps   | 22     | 3                    |
| T66: Slew Rate                | 2    |     | 8    | V/ns |        |                      |
| T67: ITPCLKOUT[1:0] High Time | 3.89 | 5   | 6.17 | ns   |        |                      |
| T68: ITPCLKOUT[1:0] Low Time  | 3.89 | 5   | 6.17 | ns   |        |                      |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all processor frequencies.
2. These parameters are not tested and are based on design simulations.
3. This delay is from rising edge of BCLK0 to the falling edge of ITPCLK0.

**Table 25. Stop Grant/Sleep/Deep Sleep/Enhanced Intel SpeedStep Technology AC Specifications**

| T# Parameter  | Min | Max | Unit  | Figure | Notes |
|---|-----|-----|-------|--------|-------|
| T70: SLP# Signal Hold Time from Stop Grant Cycle Completion | 100 |     | BCLKs | 23     |       |
| T71: Input Signals Stable to SLP# Assertion                 | 10  |     | BCLKs | 23, 24 | 1     |
| T72: SLP# to DPSLP# Assertion                               | 10  |     | BCLKs | 23     |       |
| T73: Deep Sleep PLL Lock Latency                            | 0   | 30  | μs    | 23     | 2     |
| T74: SLP# Hold Time from PLL Lock                           | 0   |     | ns    | 23     |       |
| T75: STPCLK# Hold Time from SLP# Deassertion                | 10  |     | BCLKs | 23     |       |
| T76: Input Signal Hold Time from SLP# Deassertion           | 10  |     | BCLKs | 23, 24 |       |
| T77: VID[4:0] Output Valid Delay from DPSLP# Assertion      | 0   | 10  | μs    | 24     |       |

**NOTES:**

1. Input signals other than RESET# must be held constant in the Sleep state.
2. The BCLK can be stopped after DPSLP# is asserted. The BCLK must be turned on and within specification before DPSLP# is deasserted.

## 2.14 Processor AC Timing Waveforms

The following figures are used in conjunction with the AC timing tables, [Table 18](#) through [Table 25](#).

Note: For [Figure 9](#) through [Figure 24](#), the following applies:

1. All common clock AC timings for AGTL+ signals are referenced to the Crossing Voltage ( $V_{CROSS}$ ) of the BCLK[1:0] at rising edge of BCLK0. All common clock AGTL+ signal timings are referenced at GTLREF at the processor core.
2. All source synchronous AC timings for AGTL+ signals are referenced to their associated strobe (address or data) at GTLREF. Source synchronous data signals are referenced to the falling edge of their associated data strobe. Source synchronous address signals are referenced to the rising and falling edge of their associated address strobe. All source synchronous AGTL+ signal timings are referenced at GTLREF at the processor core silicon.
3. All AC timings for AGTL+ strobe signals are referenced to BCLK[1:0] at  $V_{CROSS}$ . All AGTL+ strobe signal timings are referenced at GTLREF at the processor core silicon.
4. All AC timings for the TAP signals are referenced to the TCK signal at  $0.5 \cdot V_{CC}$  at the processor pins. All TAP signal timings (TMS, TDI, etc) are referenced at  $0.5 \cdot V_{CC}$  at the processor pins.

The circuit used to test the AC specifications is shown in.

Figure 8. AC Test Circuit

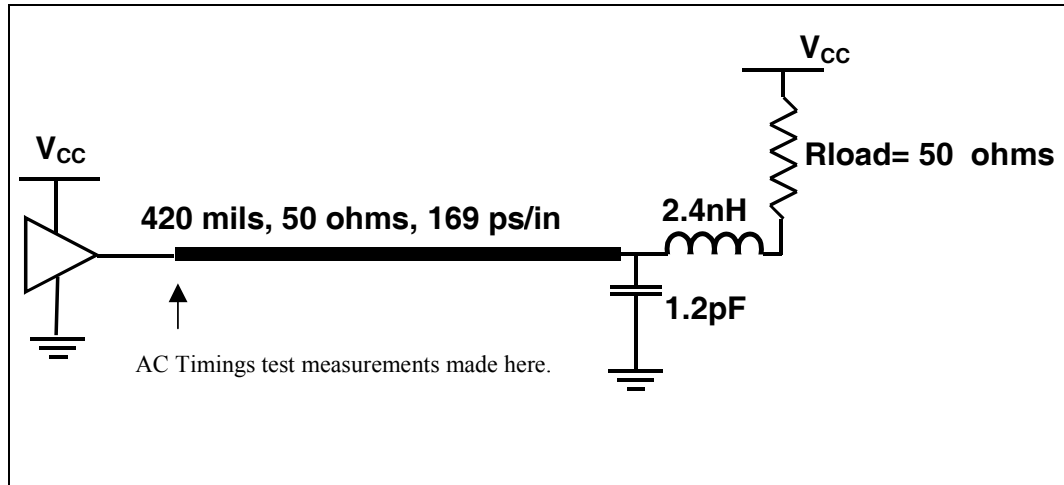


Figure 9. TCK Clock Waveform

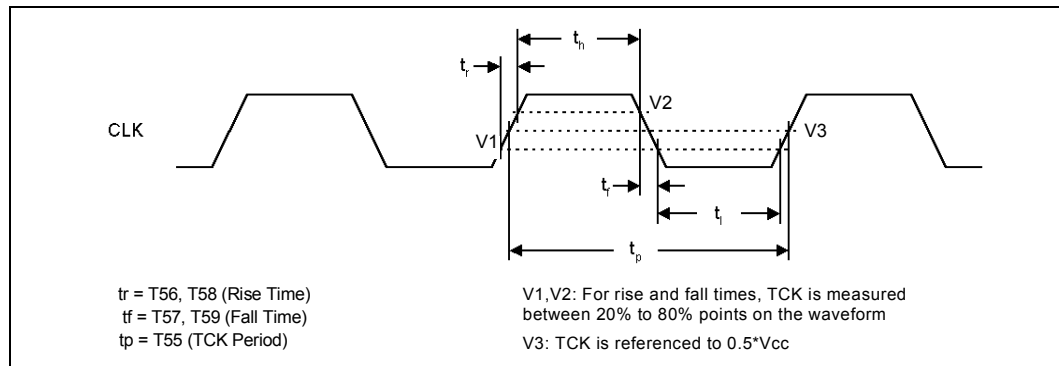


Figure 10. Differential Clock Waveform

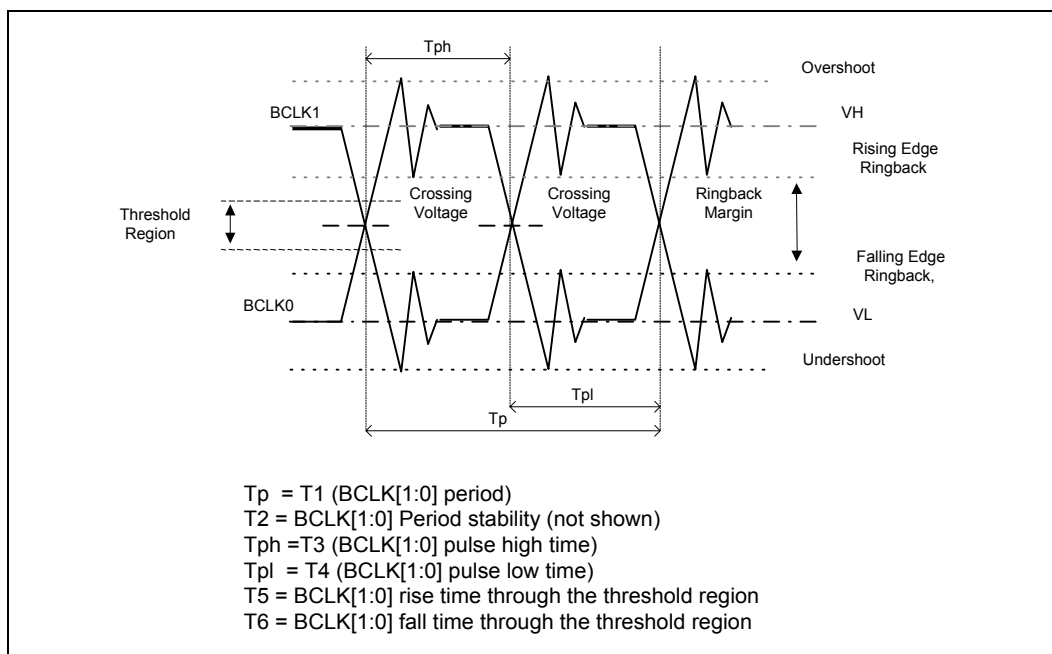


Figure 11. Differential Clock Crosspoint Specification

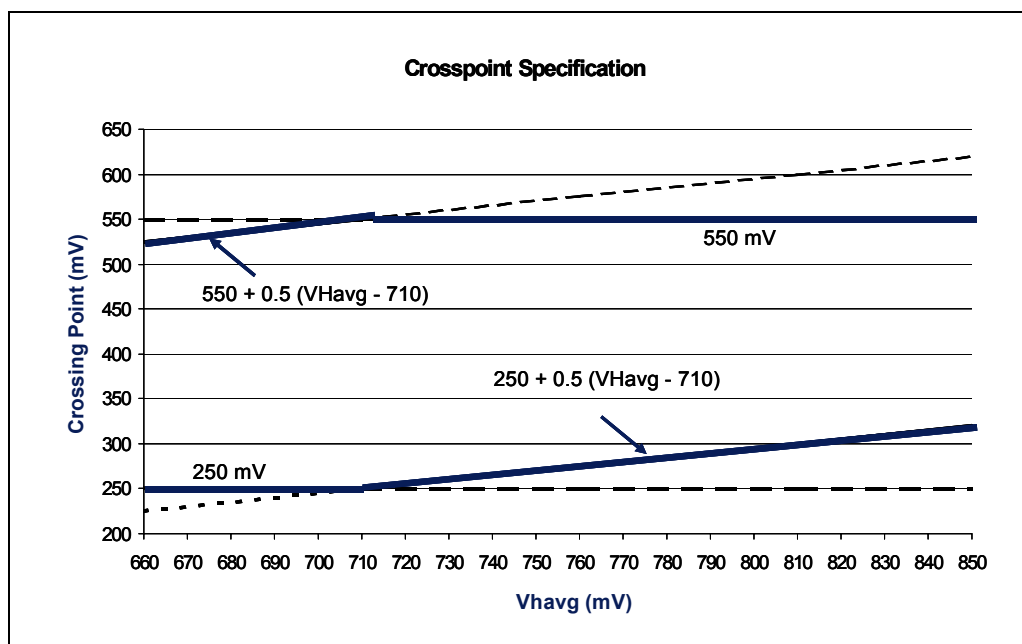


Figure 12. System Bus Common Clock Valid Delay Timings

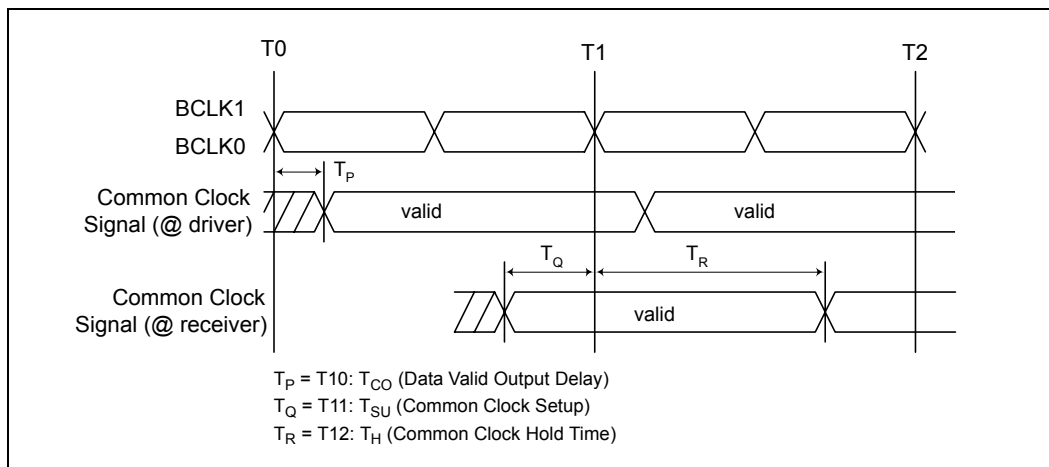


Figure 13. System Bus Reset and Configuration Timings

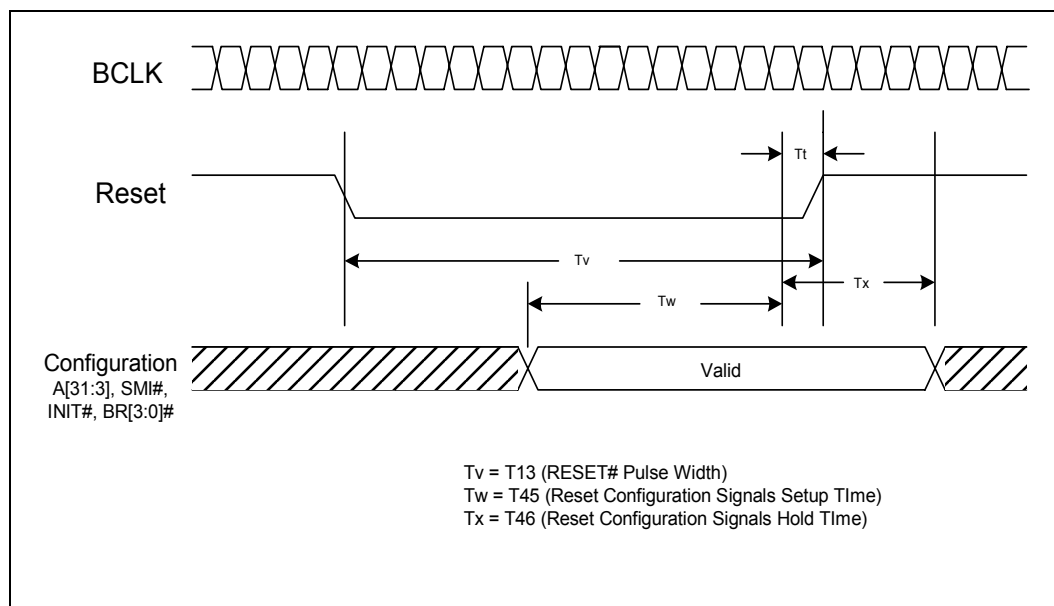


Figure 14. Source Synchronous 2X (Address) Timings

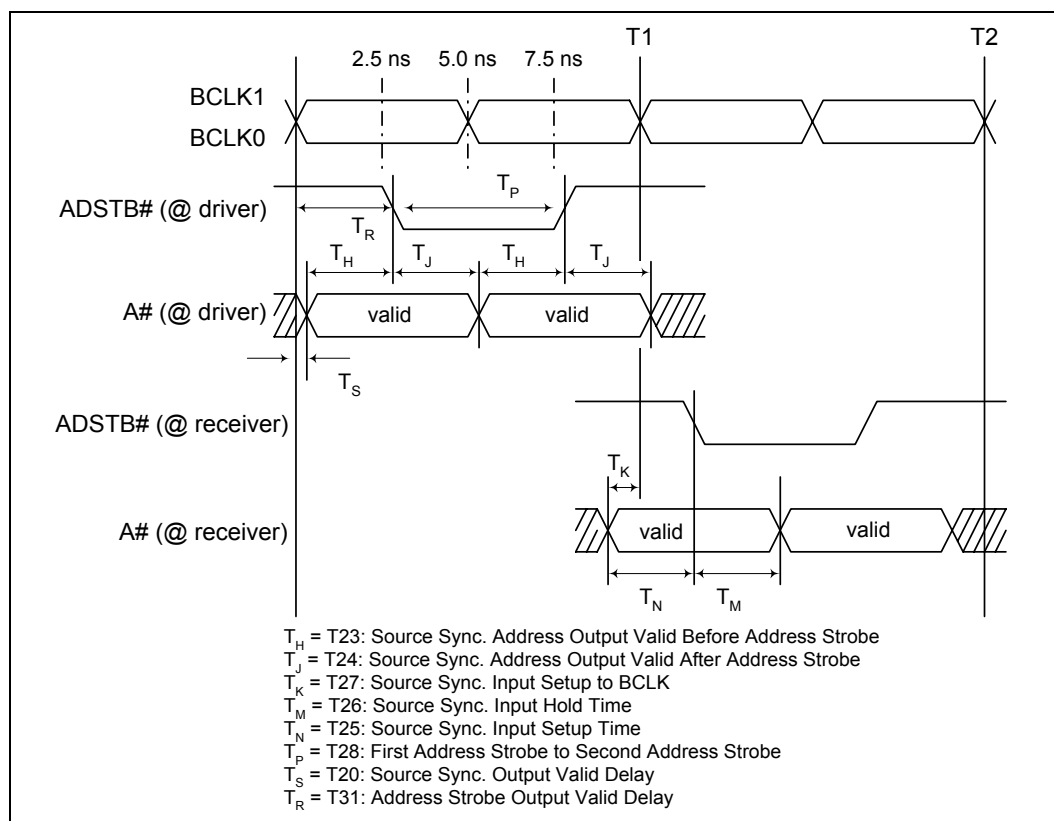


Figure 15. Source Synchronous 4X Timings

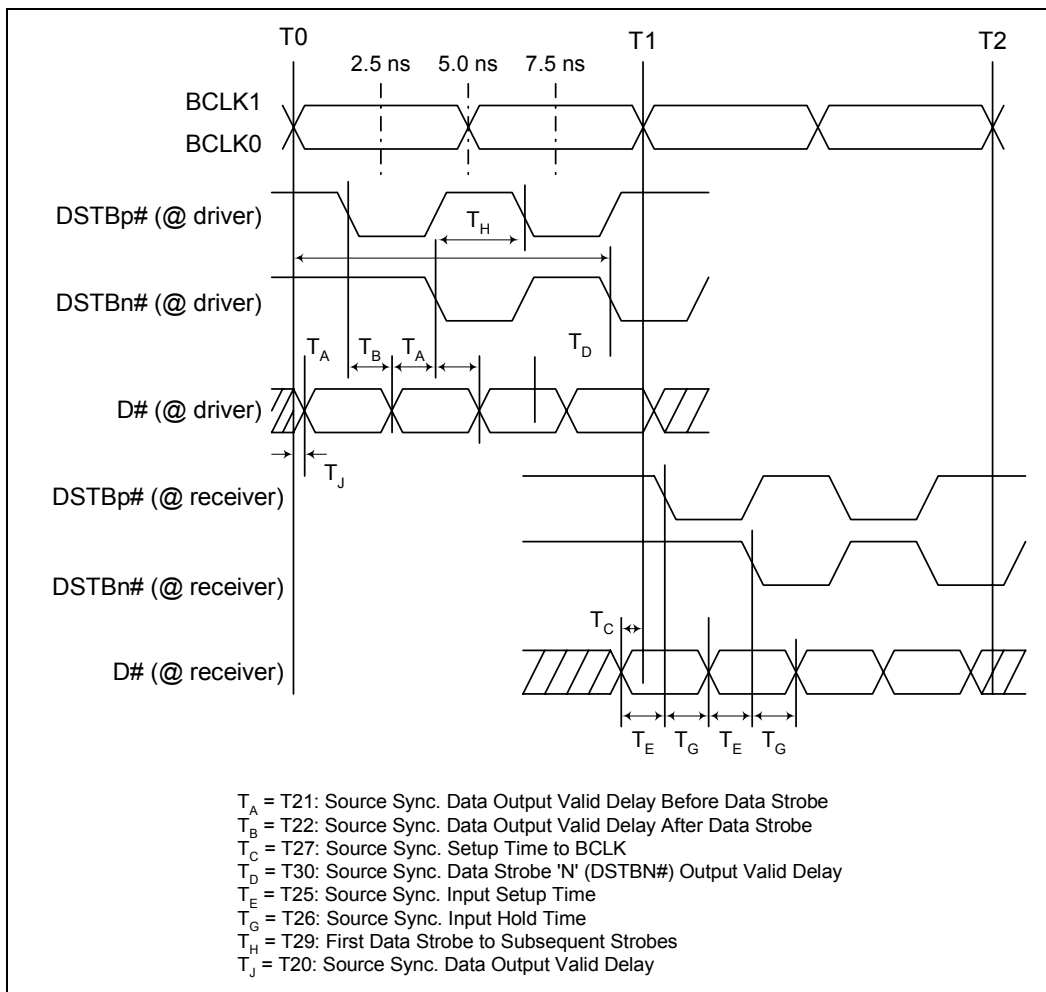


Figure 16. Power Up Sequence

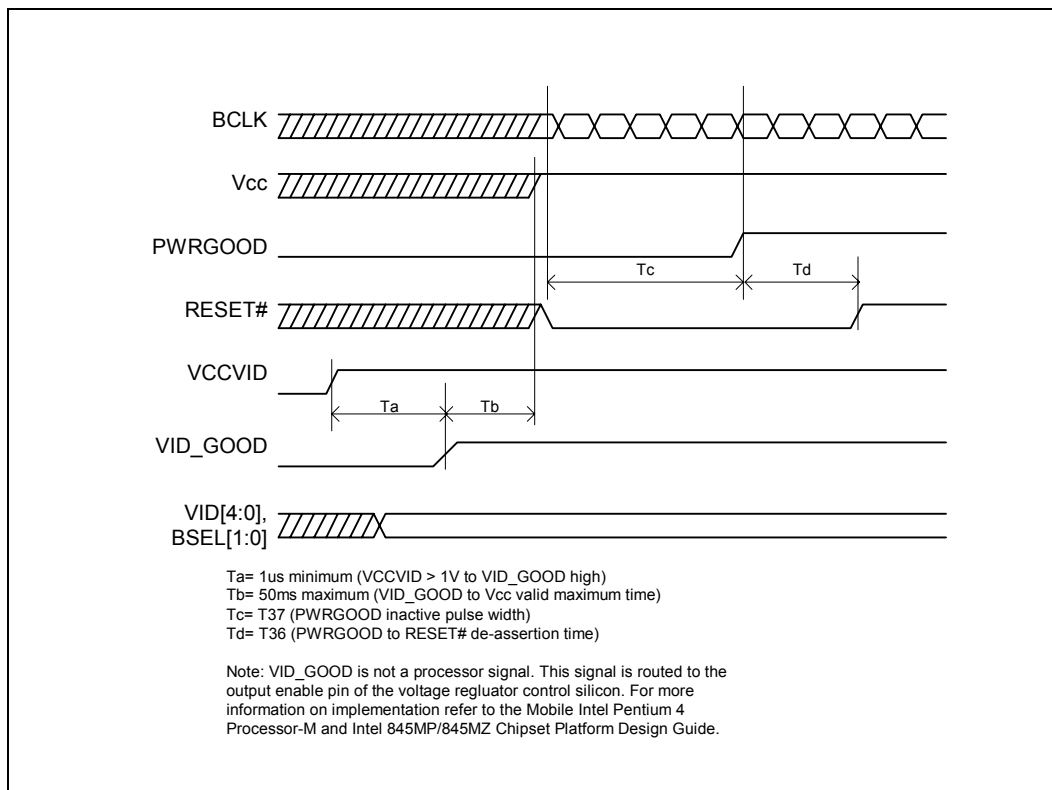


Figure 17. Power Down Sequence

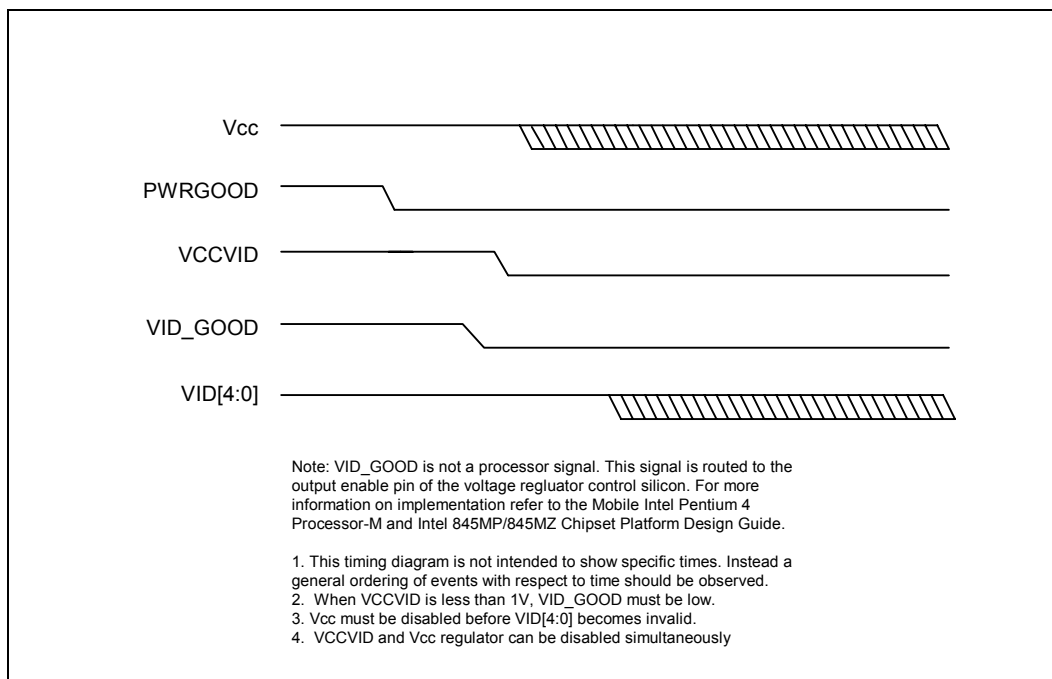


Figure 18. Test Reset Timings

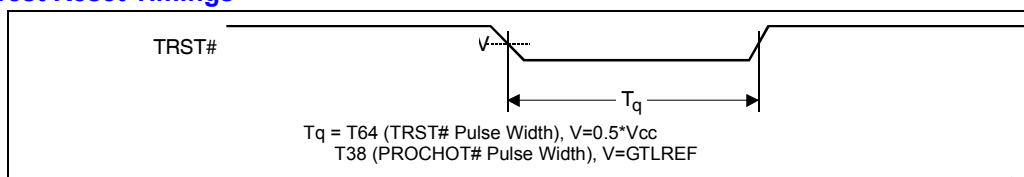


Figure 19. THERMTRIP# to Vcc Timing

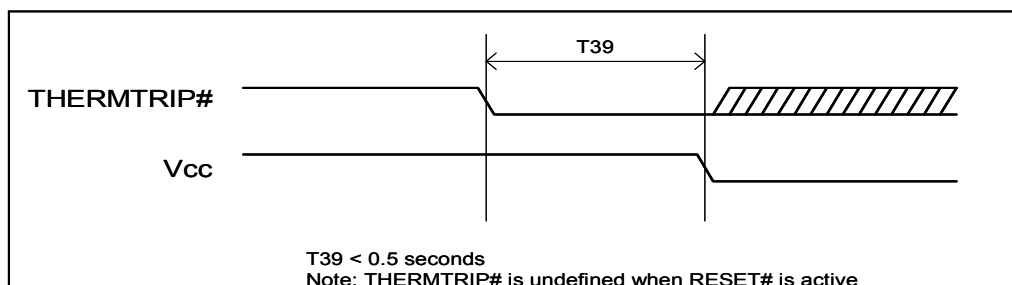


Figure 20. FERR#/PBE# Valid Delay Timing

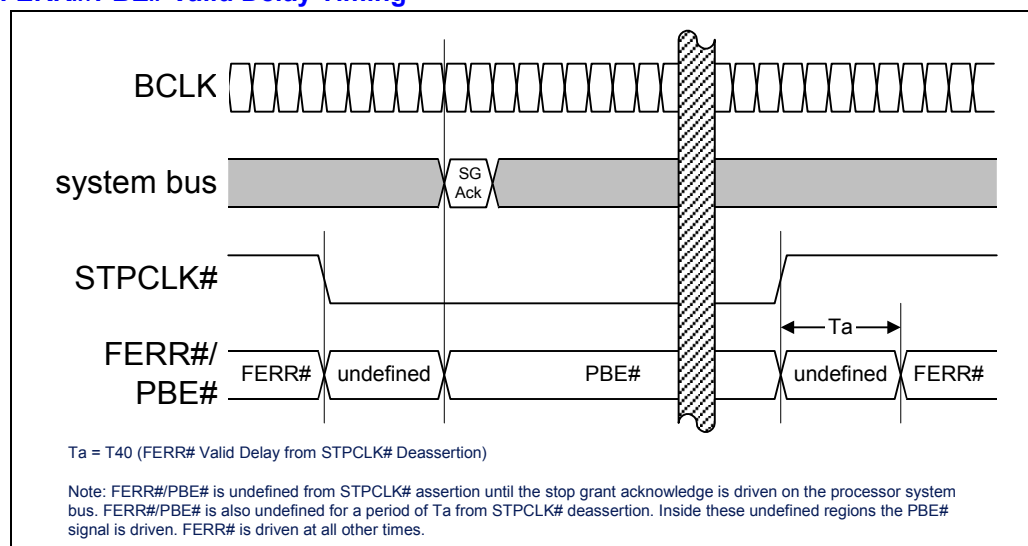


Figure 21. TAP Valid Delay Timing

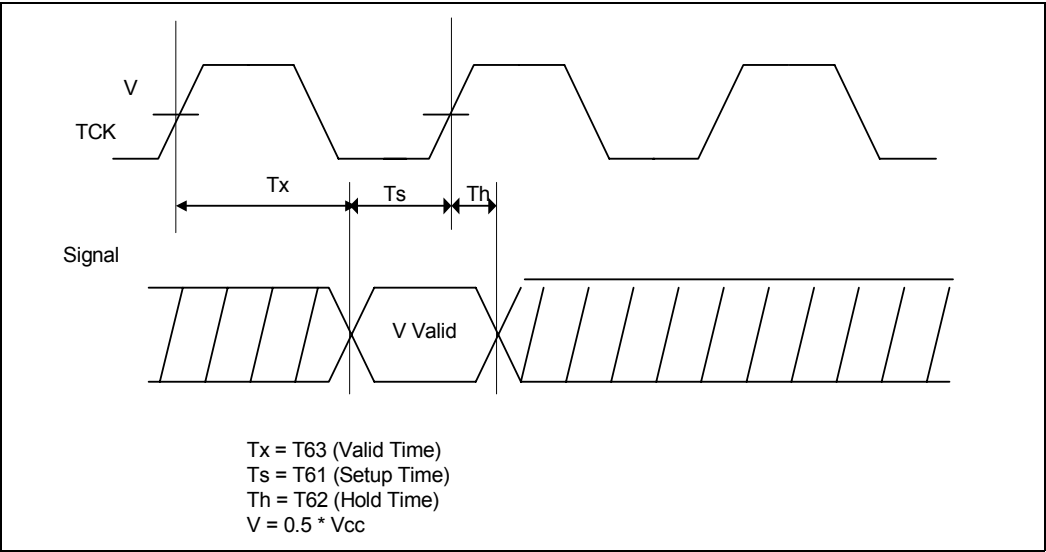


Figure 22. ITPCLKOUT Valid Delay Timing

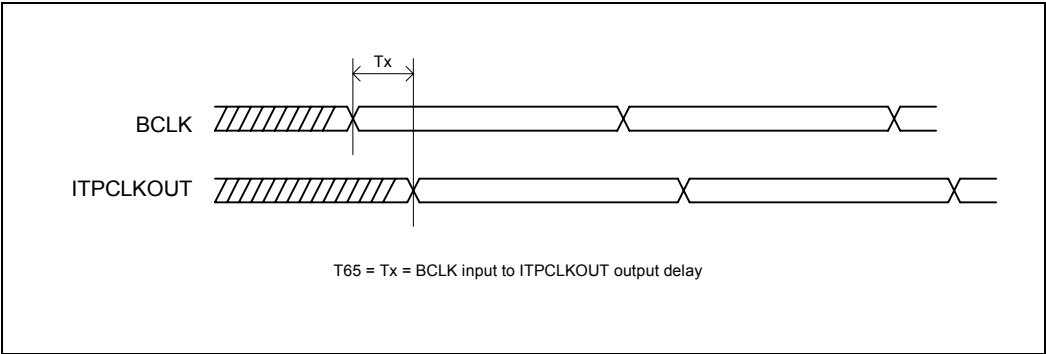


Figure 23. Stop Grant/Sleep/Deep Sleep Timing

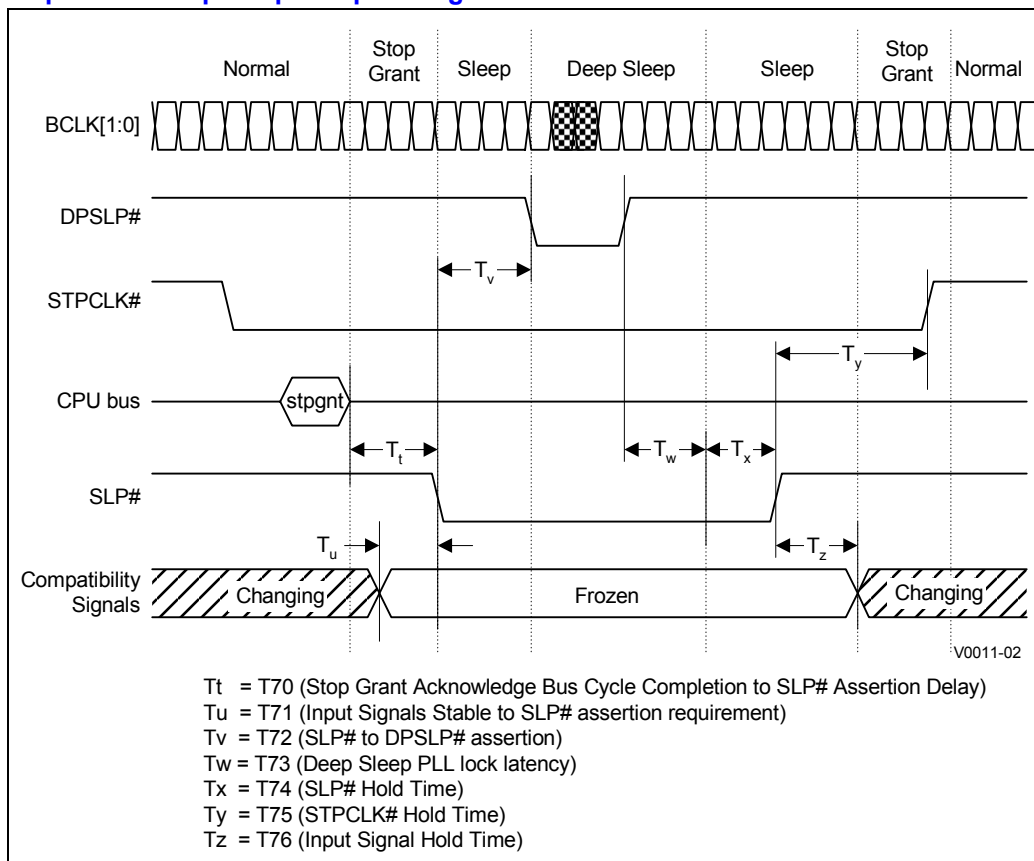
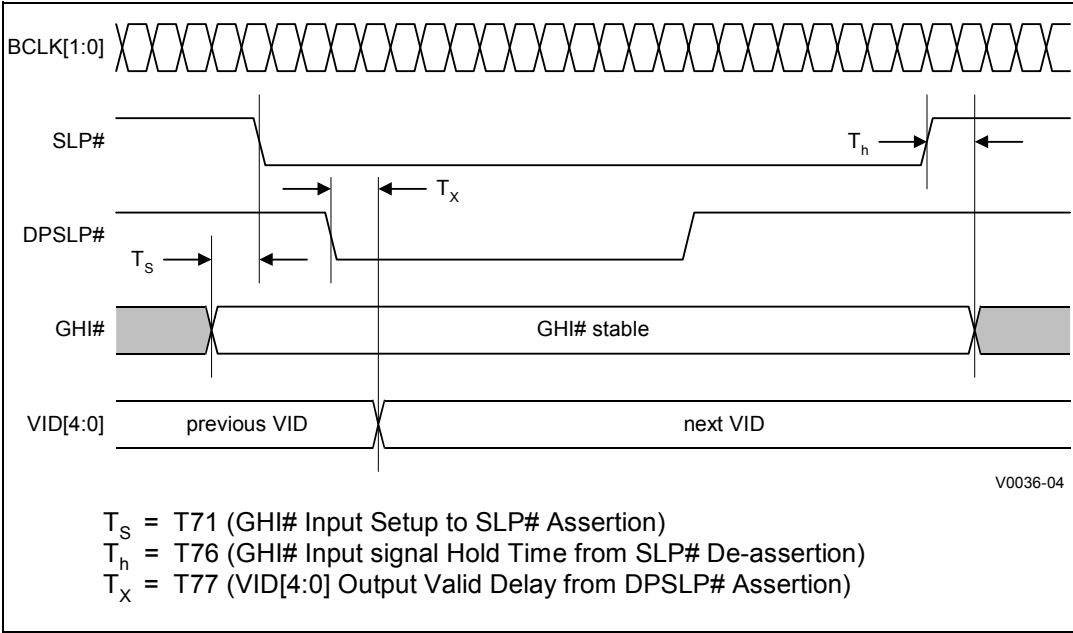


Figure 24. Enhanced Intel SpeedStep Technology/Deep Sleep Timing



## 3. System Bus Signal Quality Specifications

Source synchronous data transfer requires the clean reception of data signals and their associated strobes. Ringing below receiver thresholds, non-monotonic signal edges, and excessive voltage swing will adversely affect system timings. Ringback and signal non-monotonicity cannot be tolerated since these phenomena may inadvertently advance receiver state machines. Excessive signal swings (overshoot and undershoot) are detrimental to silicon gate oxide integrity and can cause device failure if absolute voltage limits are exceeded. Additionally, overshoot and undershoot can cause timing degradation due to the build up of inter-symbol interference (ISI) effects. For these reasons, it is important that the designer work to achieve a solution that provides acceptable signal quality across all systematic variations encountered in volume manufacturing.

This section documents signal quality metrics used to derive topology and routing guidelines through simulation and for interpreting results for signal quality measurements of actual designs.

### 3.1 System Bus Clock (BCLK) Signal Quality Specifications and Measurement Guidelines

Table 26 describes the signal quality specifications at the processor pads for the processor system bus clock (BCLK) signals. Figure 25 describes the signal quality waveform for the system bus clock at the processor pads.

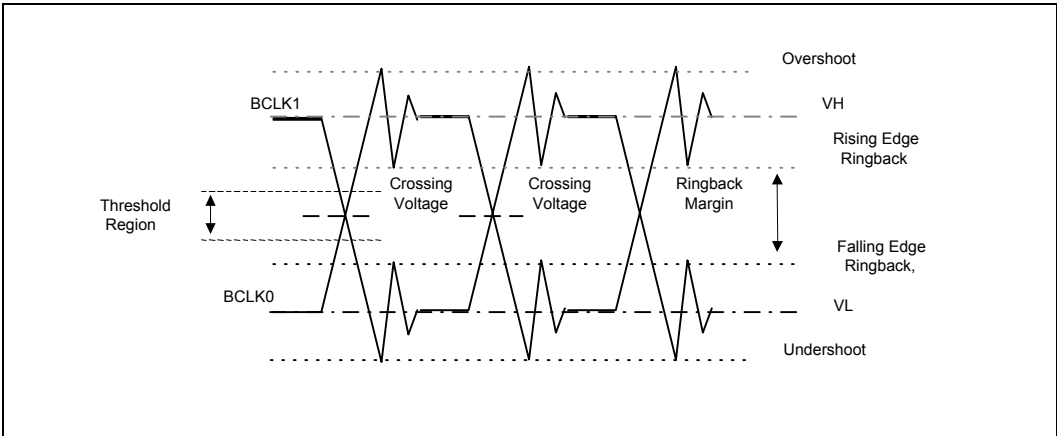
**Table 26. BCLK Signal Quality Specifications**

| Parameter                  | Min  | Max  | Unit | Figure | Notes <sup>1</sup> |
|----------------------------|------|------|------|--------|--------------------|
| BCLK[1:0] Overshoot        | N/A  | 0.30 | V    | 25     |                    |
| BCLK[1:0] Undershoot       | N/A  | 0.30 | V    | 25     |                    |
| BCLK[1:0] Ringback Margin  | 0.20 | N/A  | V    | 25     | 2                  |
| BCLK[1:0] Threshold Region | N/A  | 0.10 | V    | 25     |                    |

**NOTES:**

1. Unless otherwise noted, all specifications in this table apply to all Mobile Intel Pentium 4 Processor-M frequencies.
2. The rising and falling edge ringback voltage specified is the minimum (rising) or maximum (falling) absolute voltage the BCLK signal can dip back to after passing the  $V_{IH}$  (rising) or  $V_{IL}$  (falling) voltage limits. This specification is an absolute value.

Figure 25. BCLK Signal Integrity Waveform



### 3.2 System Bus Signal Quality Specifications and Measurement Guidelines

Various scenarios have been simulated to generate a set of AGTL+ layout guidelines which are available in the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide*.

Table 27 and Table 28 provides the signal quality specifications for all processor signals for use in simulating signal quality at the processor core silicon (pads).

Mobile Intel Pentium 4 Processor-M maximum allowable overshoot and undershoot specifications for a given duration of time are detailed in Table 29 through Table 32. Figure 26 shows the system bus ringback tolerance for low-to-high transitions and Figure 27 shows ringback tolerance for high-to-low transitions.

Table 27. Ringback Specifications for AGTL+ and Asynchronous GTL+ Signal Groups

| Signal Group | Transition | Maximum Ringback<br>(with Input Diodes Present) | Unit | Figure | Notes         |
|--------------|------------|---|------|--------|---------------|
| All Signals  | 0 → 1      | GTLREF + 10%                                    | V    | 26     | 1,2,3,4,5,6,7 |
| All Signals  | 1 → 0      | GTLREF - 10%                                    | V    | 27     | 1,2,3,4,5,6,7 |

- NOTES:**
- 1. All signal integrity specifications are measured at the processor silicon (pads).
  - 2. Unless otherwise noted, all specifications in this table apply to all Mobile Intel Pentium 4 Processor-M frequencies.
  - 3. Specifications are for the edge rate of 0.3 - 4.0 V/ns.
  - 4. All values specified by design characterization.
  - 5. Please see Section 3.3 for maximum allowable overshoot.
  - 6. Ringback between GTLREF + 10% and GTLREF - 10% is not supported.
  - 7. Intel recommends simulations not exceed a ringback value of GTLREF ± 200 mV to allow margin for other sources of system noise.

Table 28. Ringback Specifications for PWRGOOD and TAP Signal Groups

| Signal Group    | Transition | Maximum Ringback<br>(with Input Diodes Present) | Unit | Figure | Notes   |
|-----------------|------------|---|------|--------|---------|
| TAP and PWRGOOD | 0 → 1      | Vt+(max) TO Vt-(max)                            | V    | 28     | 1,2,3,4 |
| TAP and PWRGOOD | 1 → 0      | Vt-(min) TO Vt+(min)                            | V    | 29     | 1,2,3,4 |

**NOTES:**

1. All signal integrity specifications are measured at the processor silicon.
2. Unless otherwise noted, all specifications in this table apply to all Mobile Intel Pentium 4 Processor-M frequencies.
3. Please see [Section 3.3](#) for maximum allowable overshoot.
4. Please see [Section 2.11](#) for the DC specifications.

Figure 26. Low-to-High System Bus Receiver Ringback Tolerance

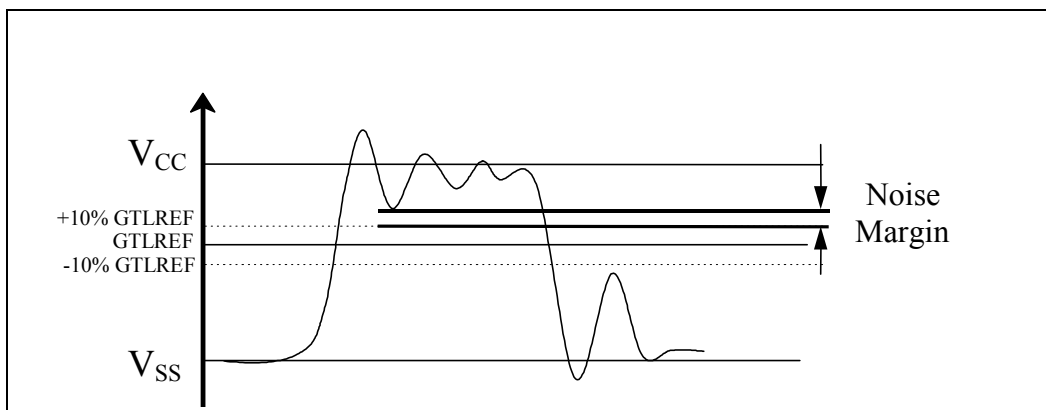
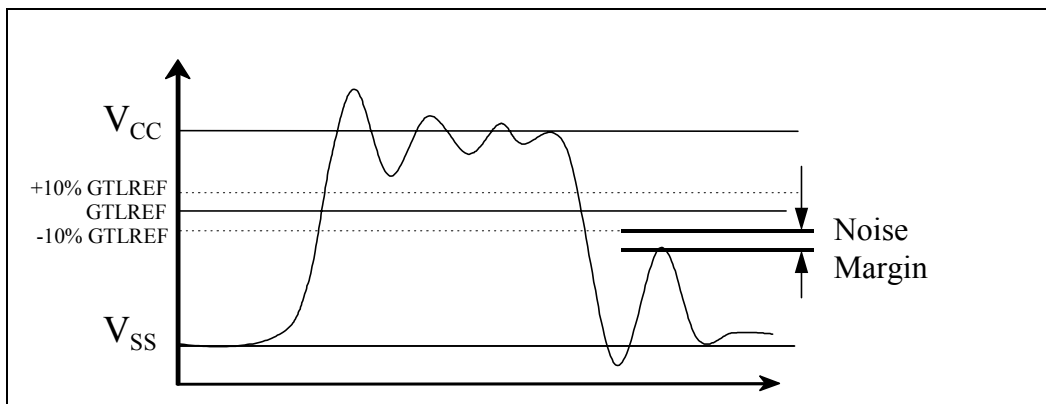
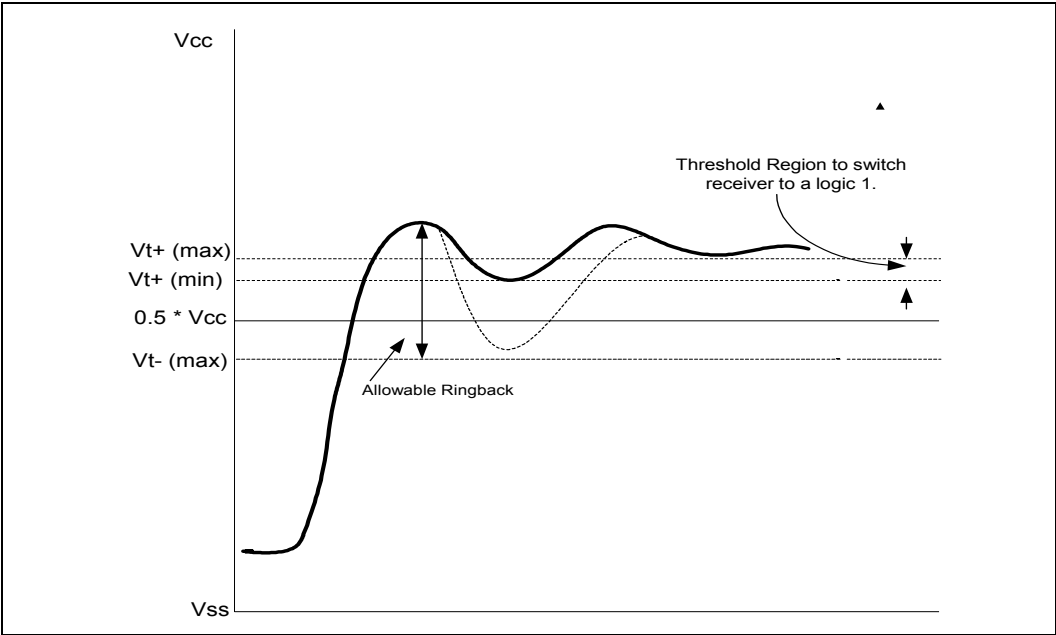


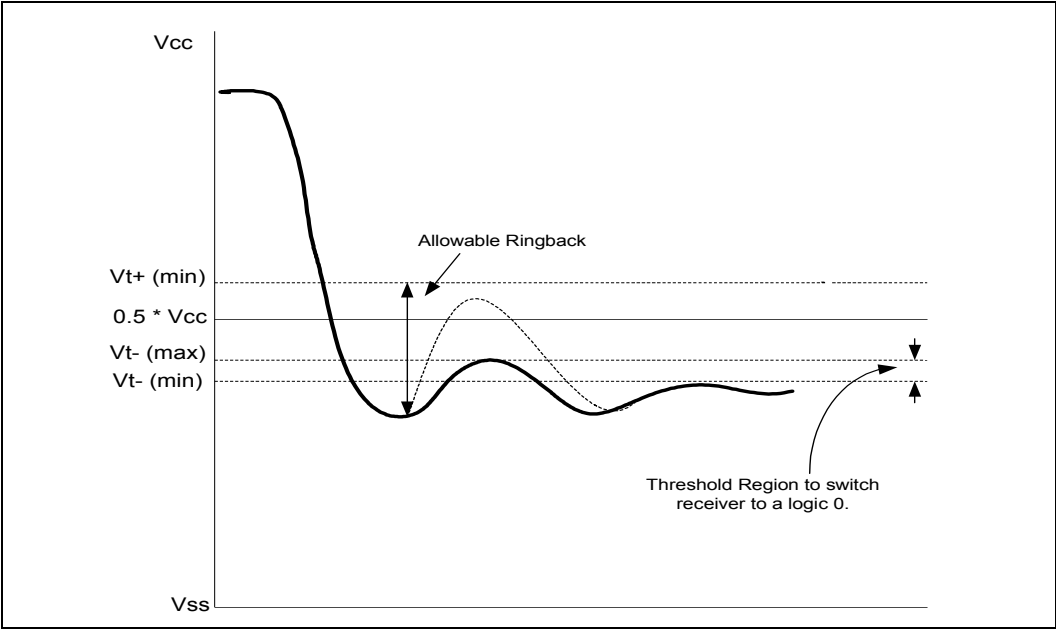
Figure 27. High-to-Low System Bus Receiver Ringback Tolerance



**Figure 28. Low-to-High System Bus Receiver Ringback Tolerance for PWRGOOD and TAP Buffers**



**Figure 29. High-to-Low System Bus Receiver Ringback Tolerance for PWRGOOD and TAP Buffers**



### 3.3 System Bus Signal Quality Specifications and Measurement Guidelines

#### 3.3.1 Overshoot/Undershoot Guidelines

Overshoot (or undershoot) is the absolute value of the maximum voltage above the nominal high voltage (or below  $V_{SS}$ ) as shown in [Figure 30](#). The overshoot guideline limits transitions beyond  $V_{CC}$  or  $V_{SS}$  due to the fast signal edge rates. The processor can be damaged by repeated overshoot or undershoot events on any input, output, or I/O buffer if the charge is large enough (i.e., if the over/undershoot is great enough). Determining the impact of an overshoot/undershoot condition requires knowledge of the magnitude, the pulse direction, and the activity factor (AF). Permanent damage to the processor is the likely result of excessive overshoot/undershoot.

When performing simulations to determine impact of overshoot and undershoot, ESD diodes must be properly characterized. ESD protection diodes do not act as voltage clamps and will not provide overshoot or undershoot protection. ESD diodes modelled within Intel I/O buffer models do not clamp undershoot or overshoot and will yield correct simulation results. If other I/O buffer models are being used to characterize the Mobile Intel Pentium 4 Processor-M system bus, care must be taken to ensure that ESD models do not clamp extreme voltage levels. Intel I/O buffer models also contain I/O capacitance characterization. Therefore, removing the ESD diodes from an I/O buffer model will impact results and may yield excessive overshoot/undershoot.

#### 3.3.2 Overshoot/Undershoot Magnitude

Magnitude describes the maximum potential difference between a signal and its voltage reference level. For the Mobile Intel Pentium 4 Processor-M both are referenced to  $V_{SS}$ . It is important to note that overshoot and undershoot conditions are separate and their impact must be determined independently.

Overshoot/undershoot magnitude levels must observe the absolute maximum specifications listed in [Table 29](#) through [Table 32](#). These specifications must not be violated at any time regardless of bus activity or system state. Within these specifications are threshold levels that define different allowed pulse durations. Provided that the magnitude of the overshoot/undershoot is within the absolute maximum specifications, the pulse magnitude, duration and activity factor must all be used to determine if the overshoot/undershoot pulse is within specifications.

#### 3.3.3 Overshoot/Undershoot Pulse Duration

Pulse duration describes the total time an overshoot/undershoot event exceeds the overshoot/undershoot reference voltage (maximum overshoot = 1.700 V, maximum undershoot = -0.400 V). The total time could encompass several oscillations above the reference voltage. Multiple overshoot/undershoot pulses within a single overshoot/undershoot event may need to be measured to determine the total pulse duration.

**Note:** Oscillations below the reference voltage can not be subtracted from the total overshoot/undershoot pulse duration.

### 3.3.4 Activity Factor

Activity Factor (AF) describes the frequency of overshoot (or undershoot) occurrence relative to a clock. Since the highest frequency of assertion of any signal is every other clock, an AF = 1 indicates that the specific overshoot (or undershoot) waveform occurs EVERY OTHER clock cycle. Thus, an AF = 0.01 indicates that the specific overshoot (or undershoot) waveform occurs one time in every 200 clock cycles.

For source synchronous signals (address, data, and associated strobes), the activity factor is in reference to the strobe edge, since the highest frequency of assertion of any source synchronous signal is every active edge of its associated strobe. An AF = 1 indicates that the specific overshoot (undershoot) waveform occurs every strobe cycle.

The specifications provided in Table 29 through Table 32 show the maximum pulse duration allowed for a given overshoot/undershoot magnitude at a specific activity factor. Each table entry is independent of all others, meaning that the pulse duration reflects the existence of overshoot/undershoot events of that magnitude ONLY. A platform with an overshoot/undershoot that just meets the pulse duration for a specific magnitude where the AF < 1, means that there can be no other overshoot/undershoot events, even of lesser magnitude (note that if AF = 1, then the event occurs at all times and no other events can occur).

**Note:** 1: Activity factor for AGTL+ signals is referenced to BCLK[1:0] frequency.

**Note:** 2: Activity factor for source synchronous (2x) signals is referenced to ADSTB[1:0]#.

**Note:** 3: Activity factor for source synchronous (4x) signals is referenced to DSTBP[3:0]# and DSTBN[3:0]#.

### 3.3.5 Reading Overshoot/Undershoot Specification Tables

The overshoot/undershoot specification for the Mobile Intel Pentium 4 Processor-M is not a simple single value. Instead, many factors are needed to determine what the over/undershoot specification is. In addition to the magnitude of the overshoot, the following parameters must also be known: the width of the overshoot (as measured above  $V_{CC}$ ) and the activity factor (AF). To determine the allowed overshoot for a particular overshoot event, the following must be done:

1. Determine the *signal group* a particular signal falls into. If the signal is an AGTL+ signal operating in the common clock domain, use Table 31. For AGTL+ signals operating in the 2x source synchronous domain, use Table 30. For AGTL+ signals operating in the 4x source synchronous domain, use Table 29. Finally, all other signals reside in the 100-MHz domain (asynchronous GTL+, TAP, etc.) and are referenced in Table 32.
2. Determine the *magnitude* of the overshoot (relative to  $V_{SS}$ )
3. Determine the *activity factor* (how often does this overshoot occur?)
4. Next, from the appropriate specification table, determine the *maximum pulse duration* (in nanoseconds) allowed.
5. Compare the specified maximum pulse duration to the signal being measured. If the pulse duration measured is less than the pulse duration shown in the table, then the signal meets the specifications.

The above procedure is similar for undershoot after the undershoot waveform has been converted to look like an overshoot. Undershoot events must be analyzed separately from overshoot events as they are mutually exclusive.

### 3.3.6 Conformance Determination to Overshoot/Undershoot Specifications

The overshoot/undershoot specifications listed in the following tables specify the allowable overshoot/undershoot for a single overshoot/undershoot event. However, most systems will have multiple overshoot and/or undershoot events that each have their own set of parameters (duration, AF and magnitude). While each overshoot on its own may meet the overshoot specification, when you add the total impact of all overshoot events, the system may fail. A guideline to ensure a system passes the overshoot and undershoot specifications is shown below.

1. Ensure no signal ever exceeds  $V_{CC}$  or  $-0.25\text{ V}$  **or**
2. If only one overshoot/undershoot event magnitude occurs, ensure it meets the over/undershoot specifications in the following tables **or**
3. If multiple overshoots and/or multiple undershoots occur, measure the worst case pulse duration for each magnitude and compare the results against the  $AF = 1$  specifications. If all of these worst case overshoot or undershoot events meet the specifications (measured time < specifications) in the table (where  $AF=1$ ), then the system passes.

The following notes apply to [Table 29](#) through [Table 32](#).

#### NOTES:

1. Absolute Maximum Overshoot magnitude of  $1.70\text{ V}$  must never be exceeded.
2. Absolute Maximum Overshoot is measured relative to  $V_{SS}$ , Pulse Duration of overshoot is measured relative to  $V_{CC}$ .
3. Absolute Maximum Undershoot and Pulse Duration of undershoot is measured relative to  $V_{SS}$ .
4. Ringback below  $V_{CC}$  can not be subtracted from overshoots/undershoots.
5. Lesser undershoot does not allocate longer or larger overshoot.
6. OEM's are strongly encouraged to follow Intel provided layout guidelines.
7. All values specified by design characterization.

**Table 29. Source Synchronous (400 MHz) AGTL+ Signal Group Overshoot/Undershoot Tolerance**

| Absolute Maximum Overshoot (V) | Absolute Maximum Undershoot (V) | Pulse Duration (ns) AF = 1 | Pulse Duration (ns) AF = 0.1 | Pulse Duration (ns) AF = 0.01 | Notes <sup>1,2</sup> |
|--------------------------------|---------------------------------|----------------------------|------------------------------|-------------------------------|----------------------|
| 1.700                          | -0.400                          | 0.11                       | 1.05                         | 5.00                          |                      |
| 1.650                          | -0.350                          | 0.24                       | 2.40                         | 5.00                          |                      |
| 1.600                          | -0.300                          | 0.53                       | 5.00                         | 5.00                          |                      |
| 1.550                          | -0.250                          | 1.19                       | 5.00                         | 5.00                          |                      |
| 1.500                          | -0.200                          | 5.00                       | 5.00                         | 5.00                          |                      |
| 1.450                          | -0.150                          | 5.00                       | 5.00                         | 5.00                          |                      |
| 1.400                          | -0.100                          | 5.00                       | 5.00                         | 5.00                          |                      |
| 1.350                          | -0.050                          | 5.00                       | 5.00                         | 5.00                          |                      |

#### NOTES:

1. These specifications are measured at the processor core silicon.
2. BCLK period is 10 ns.

**Table 30. Source Synchronous (200 MHz) AGTL+ Signal Group Overshoot/Undershoot Tolerance**

| Absolute Maximum Overshoot (V) | Absolute Maximum Undershoot (V) | Pulse Duration (ns)<br>AF = 1 | Pulse Duration (ns)<br>AF = 0.1 | Pulse Duration (ns)<br>AF = 0.01 | Notes <sup>1,2</sup> |
|--------------------------------|---------------------------------|-------------------------------|---------------------------------|----------------------------------|----------------------|
| 1.700                          | -0.400                          | 0.21                          | 2.10                            | 10.00                            |                      |
| 1.650                          | -0.350                          | 0.48                          | 4.80                            | 10.00                            |                      |
| 1.600                          | -0.300                          | 1.05                          | 10.00                           | 10.00                            |                      |
| 1.550                          | -0.250                          | 2.38                          | 10.00                           | 10.00                            |                      |
| 1.500                          | -0.200                          | 10.00                         | 10.00                           | 10.00                            |                      |
| 1.450                          | -0.150                          | 10.00                         | 10.00                           | 10.00                            |                      |
| 1.400                          | -0.100                          | 10.00                         | 10.00                           | 10.00                            |                      |
| 1.350                          | -0.050                          | 10.00                         | 10.00                           | 10.00                            |                      |

**NOTES:**

1. These specifications are measured at the processor core silicon.
2. BCLK period is 10 ns.

**Table 31. Common Clock (100 MHz) AGTL+ Signal Group Overshoot/Undershoot Tolerance**

| Absolute Maximum Overshoot (V) | Absolute Maximum Undershoot (V) | Pulse Duration (ns)<br>AF = 1 | Pulse Duration (ns)<br>AF = 0.1 | Pulse Duration (ns)<br>AF = 0.01 | Notes <sup>1,2</sup> |
|--------------------------------|---------------------------------|-------------------------------|---------------------------------|----------------------------------|----------------------|
| 1.700                          | -0.400                          | 0.42                          | 4.20                            | 20.00                            |                      |
| 1.650                          | -0.350                          | 0.96                          | 9.60                            | 20.00                            |                      |
| 1.600                          | -0.300                          | 2.10                          | 20.00                           | 20.00                            |                      |
| 1.550                          | -0.250                          | 4.76                          | 20.00                           | 20.00                            |                      |
| 1.500                          | -0.200                          | 20.00                         | 20.00                           | 20.00                            |                      |
| 1.450                          | -0.150                          | 20.00                         | 20.00                           | 20.00                            |                      |
| 1.400                          | -0.100                          | 20.00                         | 20.00                           | 20.00                            |                      |
| 1.350                          | -0.050                          | 20.00                         | 20.00                           | 20.00                            |                      |

**NOTES:**

1. These specifications are measured at the processor core silicon.
2. BCLK period is 10 ns.

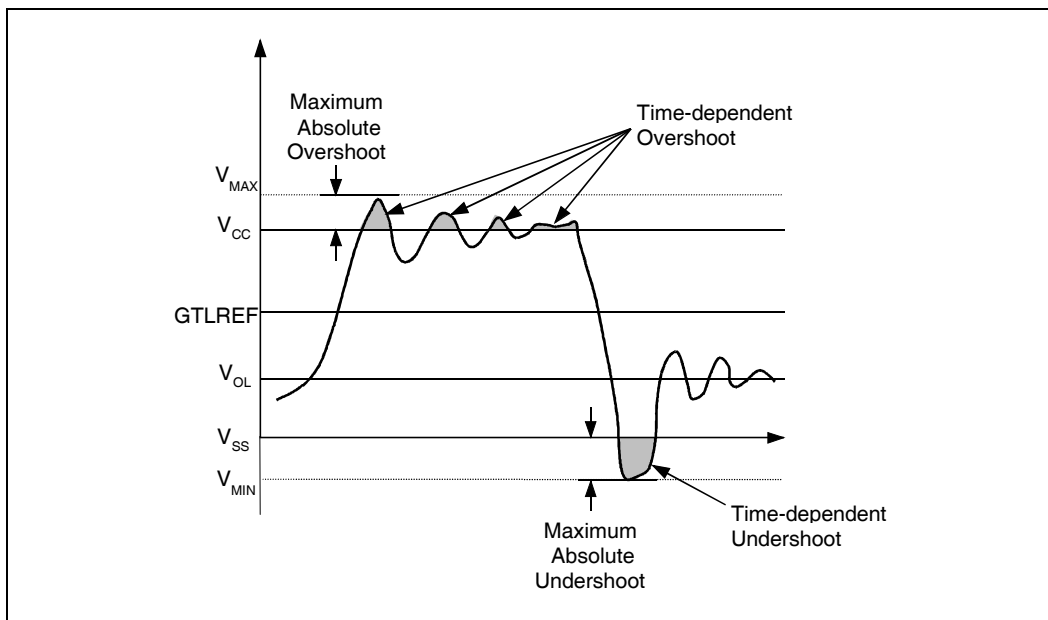
**Table 32. Asynchronous GTL+, PWRGOOD, and TAP Signal Groups Overshoot/Undershoot Tolerance**

| Absolute Maximum Overshoot (V) | Absolute Maximum Undershoot (V) | Pulse Duration (ns)<br>AF = 1 | Pulse Duration (ns)<br>AF = 0.1 | Pulse Duration (ns)<br>AF = 0.01 | Notes <sup>1,2</sup> |
|--------------------------------|---------------------------------|-------------------------------|---------------------------------|----------------------------------|----------------------|
| 1.700                          | -0.400                          | 1.26                          | 12.6                            | 60.00                            |                      |
| 1.650                          | -0.350                          | 2.88                          | 28.8                            | 60.00                            |                      |
| 1.600                          | -0.300                          | 6.30                          | 60.00                           | 60.00                            |                      |
| 1.550                          | -0.250                          | 14.28                         | 60.00                           | 60.00                            |                      |
| 1.500                          | -0.200                          | 60.00                         | 60.00                           | 60.00                            |                      |
| 1.450                          | -0.150                          | 60.00                         | 60.00                           | 60.00                            |                      |
| 1.400                          | -0.100                          | 60.00                         | 60.00                           | 60.00                            |                      |
| 1.350                          | -0.050                          | 60.00                         | 60.00                           | 60.00                            |                      |

**NOTES:**

1. These specifications are measured at the processor core silicon.
2. BCLK period is 10 ns.

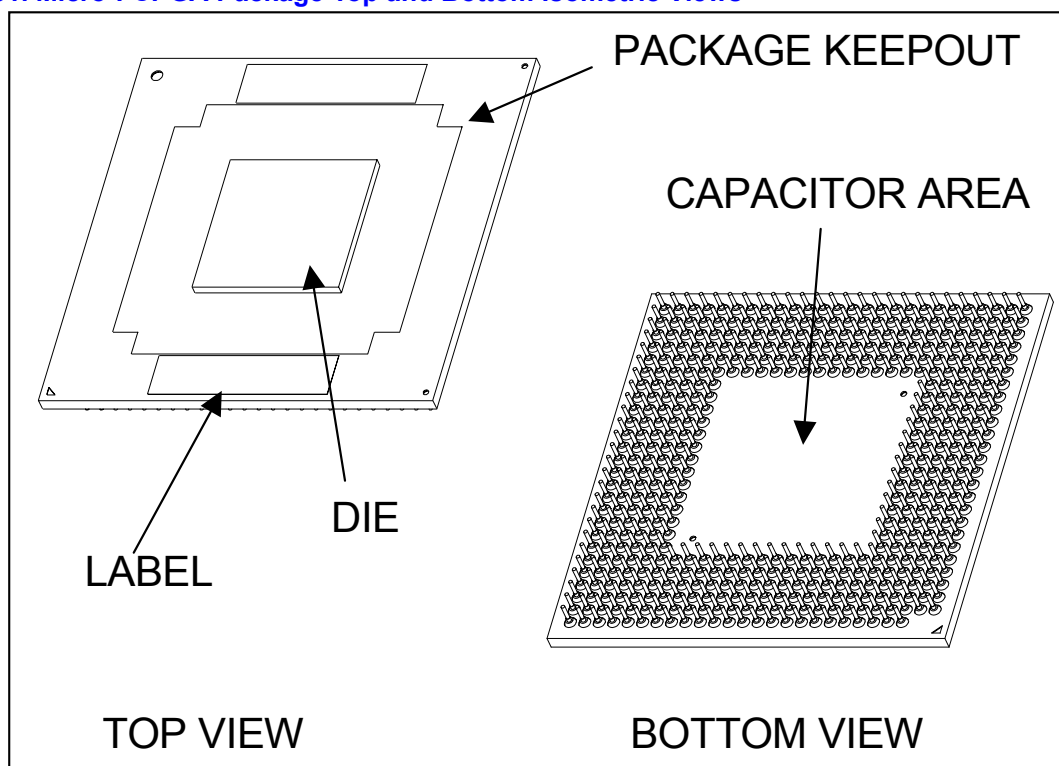
**Figure 30. Maximum Acceptable Overshoot/Undershoot Waveform**



## 4. Package Mechanical Specifications

The Mobile Intel Pentium 4 Processor-M is packaged in a 478-pin Micro-FCPGA package. Different views of the package are shown in Figure 31 through Figure 34. Package dimensions are shown in Table 33.

**Figure 31. Micro-FCPGA Package Top and Bottom Isometric Views**



**NOTE:** All dimensions in millimeters. Values shown are for reference only.

Figure 32. Micro-FCPGA Package - Top and Side Views

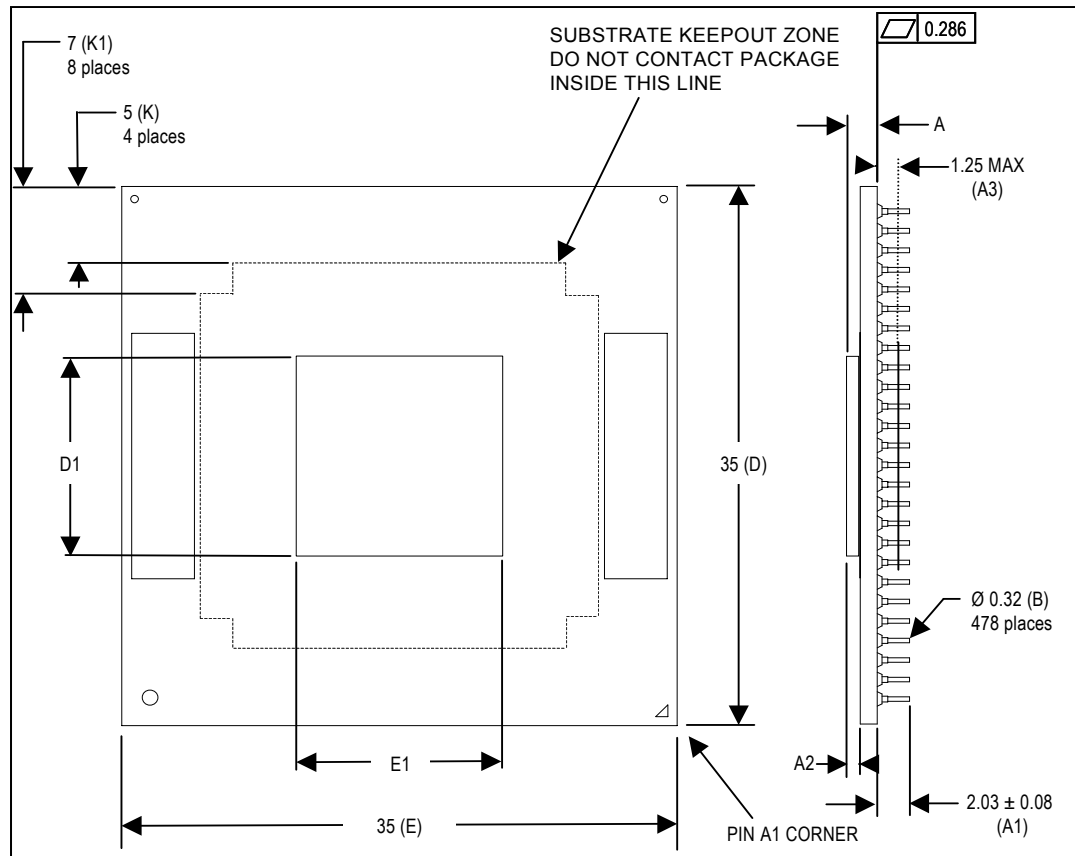



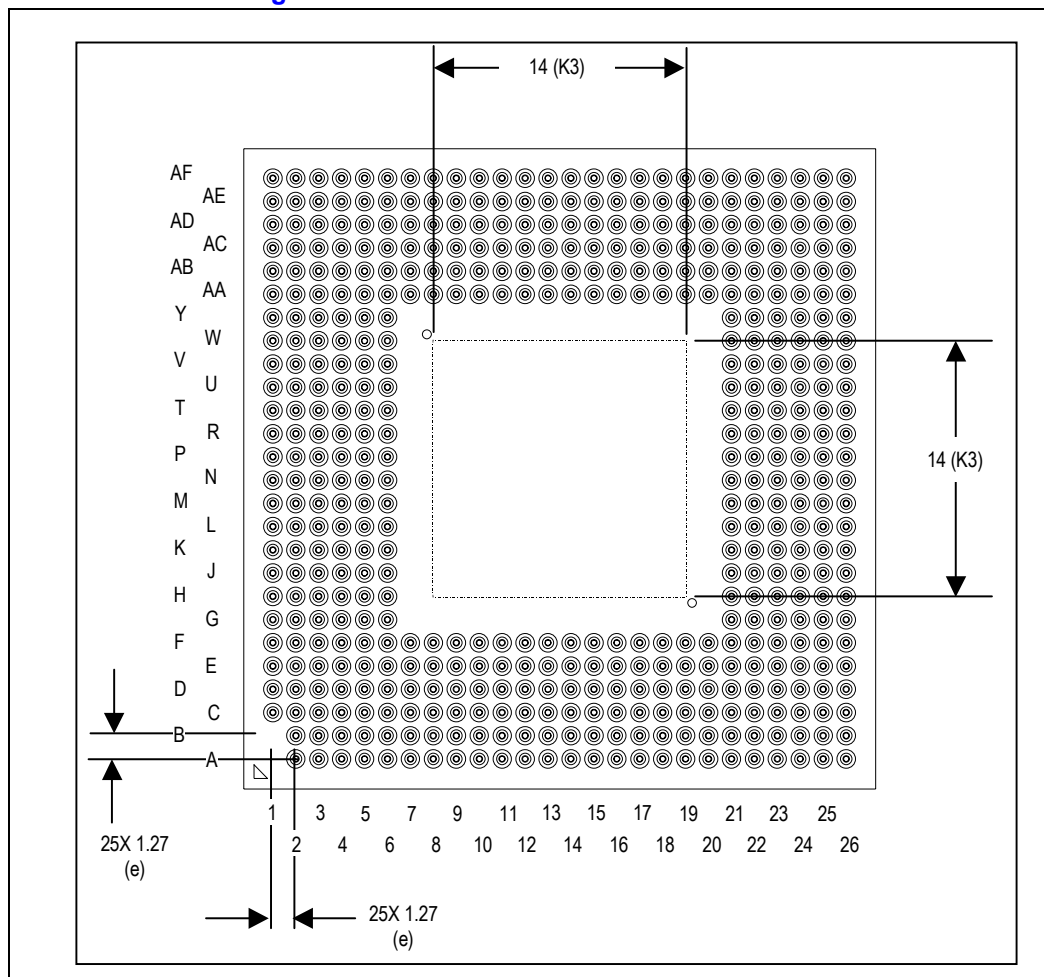
Table 33. Micro-FCPGA Package Dimensions

| Symbol  | Parameter  | Min                                       | Max  | Unit |
|---|--|---|------|------|
| A   | Overall height, top of die to package seating plane            | 1.81                                      | 2.03 | mm   |
| -   | Overall height, top of die to PCB surface, including socket(1) | 4.69                                      | 5.15 | mm   |
| A1  | Pin length   | 1.95                                      | 2.11 | mm   |
| A2  | Die height   | 0.854                                     |      | mm   |
| A3  | Pin-side capacitor height                                      | -   | 1.25 | mm   |
| B   | Pin diameter   | 0.28                                      | 0.36 | mm   |
| D   | Package substrate length                                       | 34.9                                      | 35.1 | mm   |
| E   | Package substrate width  | 34.9                                      | 35.1 | mm   |
| D1  | Die length   | 12.24 (B0 Step)<br>11.62 (B0 Step Shrink) |      | mm   |
| E1  | Die width  | 11.93 (B0 Step)<br>11.34 (B0 Step Shrink) |      | mm   |
| e   | Pin pitch  | 1.27                                      |      | mm   |
| K   | Package edge keep-out  | 5   |      | mm   |
| K1  | Package corner keep-out  | 7   |      | mm   |
| K3  | Pin-side capacitor boundary                                    | 14  |      | mm   |
| -   | Pin tip radial true position                                   | <=0.254                                   |      | mm   |
| N   | Pin count  | 478                                       |      | each |
| Pdie  | Allowable pressure on the die for thermal solution             | -   | 689  | kPa  |
| W   | Package weight   | 4.5                                       |      | g    |
|  | Package Surface Flatness                                       | 0.286                                     |      | mm   |

**NOTES:**

1. All Dimensions are subject to change. Values shown are for reference only.
2. Overall height with socket is based on design dimensions of the Micro-FCPGA package and socket with no thermal solution attached. Values were based on design specifications and tolerances. This dimension is subject to change based on socket design, OEM motherboard design, or OEM SMT process.

Figure 33. Micro-FCPGA Package - Bottom View

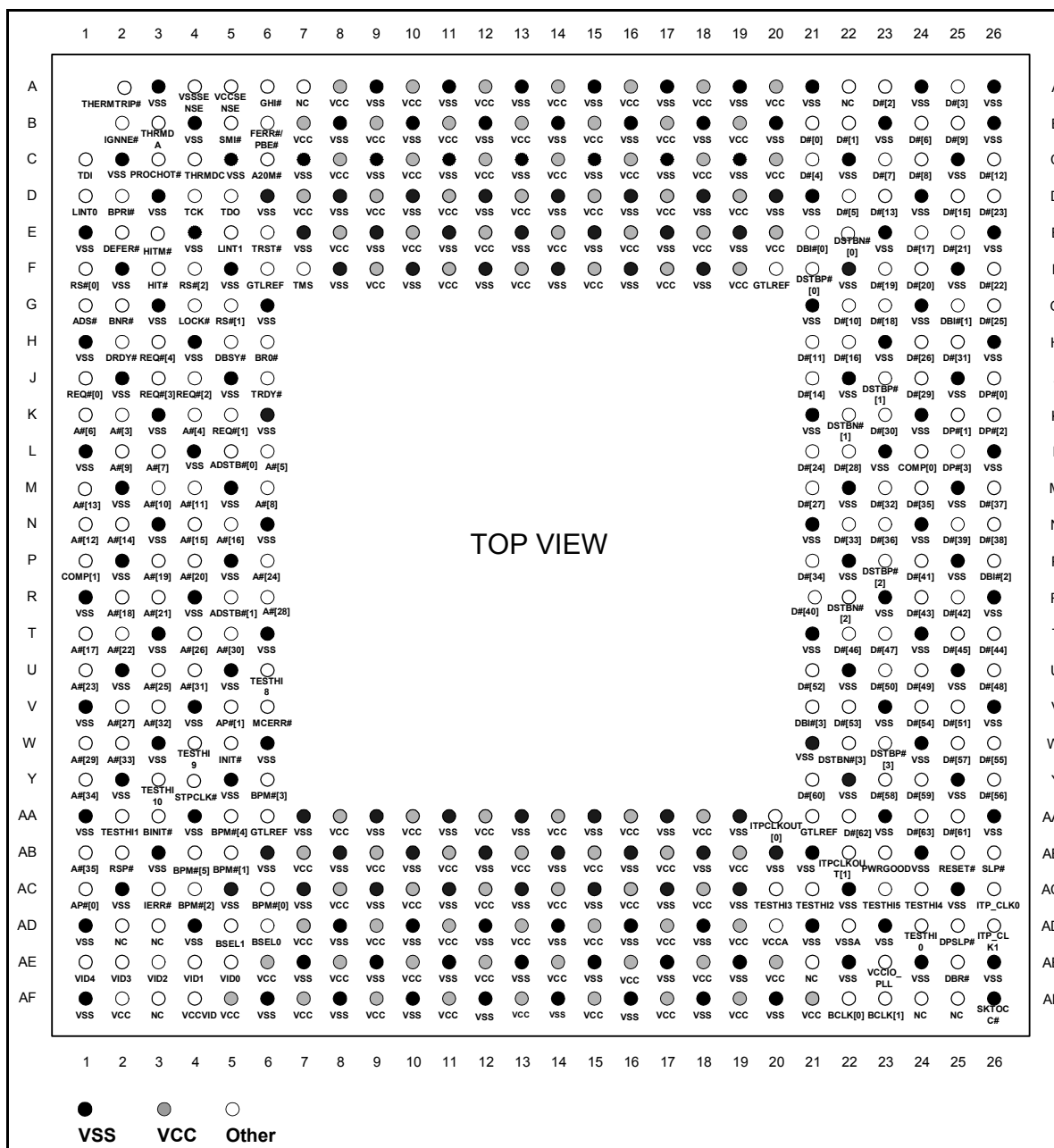


**NOTE:** All dimensions in millimeters. Values shown are for reference only.

## 4.1 Processor Pin-Out

Figure 34 shows the top view pinout of the Mobile Intel Pentium 4 Processor-M.

Figure 34. The Coordinates of the Processor Pins as Viewed From the Top of the Package.



## 5. *Pin Listing and Signal Definitions*

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### 5.1 Mobile Intel Pentium 4 Processor-M Pin Assignments

Section 5.1 contains the pin list for the Mobile Intel Pentium 4 Processor-M in [Table 34](#) and [Table 35](#). [Table 34](#) is a listing of all processor pins ordered alphabetically by pin name. [Table 35](#) is also a listing of all processor pins but ordered by pin number.

**Table 34. Pin Listing by Pin Name**

| Pin Name  | Pin Number | Signal Buffer Type | Direction    |
|-----------|------------|--------------------|--------------|
| A#[03]    | K2         | Source Synch       | Input/Output |
| A#[04]    | K4         | Source Synch       | Input/Output |
| A#[05]    | L6         | Source Synch       | Input/Output |
| A#[06]    | K1         | Source Synch       | Input/Output |
| A#[07]    | L3         | Source Synch       | Input/Output |
| A#[08]    | M6         | Source Synch       | Input/Output |
| A#[09]    | L2         | Source Synch       | Input/Output |
| A#[10]    | M3         | Source Synch       | Input/Output |
| A#[11]    | M4         | Source Synch       | Input/Output |
| A#[12]    | N1         | Source Synch       | Input/Output |
| A#[13]    | M1         | Source Synch       | Input/Output |
| A#[14]    | N2         | Source Synch       | Input/Output |
| A#[15]    | N4         | Source Synch       | Input/Output |
| A#[16]    | N5         | Source Synch       | Input/Output |
| A#[17]    | T1         | Source Synch       | Input/Output |
| A#[18]    | R2         | Source Synch       | Input/Output |
| A#[19]    | P3         | Source Synch       | Input/Output |
| A#[20]    | P4         | Source Synch       | Input/Output |
| A#[21]    | R3         | Source Synch       | Input/Output |
| A#[22]    | T2         | Source Synch       | Input/Output |
| A#[23]    | U1         | Source Synch       | Input/Output |
| A#[24]    | P6         | Source Synch       | Input/Output |
| A#[25]    | U3         | Source Synch       | Input/Output |
| A#[26]    | T4         | Source Synch       | Input/Output |
| A#[27]    | V2         | Source Synch       | Input/Output |
| A#[28]    | R6         | Source Synch       | Input/Output |
| A#[29]    | W1         | Source Synch       | Input/Output |
| A#[30]    | T5         | Source Synch       | Input/Output |
| A#[31]    | U4         | Source Synch       | Input/Output |
| A#[32]    | V3         | Source Synch       | Input/Output |
| A#[33]    | W2         | Source Synch       | Input/Output |
| A#[34]    | Y1         | Source Synch       | Input/Output |
| A#[35]    | AB1        | Source Synch       | Input/Output |
| A20M#     | C6         | Asynch GTL+        | Input        |
| ADS#      | G1         | Common Clock       | Input/Output |
| ADSTB#[0] | L5         | Source Synch       | Input/Output |
| ADSTB#[1] | R5         | Source Synch       | Input/Output |

**Table 34. Pin Listing by Pin Name**

| Pin Name | Pin Number | Signal Buffer Type | Direction    |
|----------|------------|--------------------|--------------|
| AP#[0]   | AC1        | Common Clock       | Input/Output |
| AP#[1]   | V5         | Common Clock       | Input/Output |
| BCLK[0]  | AF22       | Bus Clock          | Input        |
| BCLK[1]  | AF23       | Bus Clock          | Input        |
| BINIT#   | AA3        | Common Clock       | Input/Output |
| BNR#     | G2         | Common Clock       | Input/Output |
| BPM#[0]  | AC6        | Common Clock       | Input/Output |
| BPM#[1]  | AB5        | Common Clock       | Input/Output |
| BPM#[2]  | AC4        | Common Clock       | Input/Output |
| BPM#[3]  | Y6         | Common Clock       | Input/Output |
| BPM#[4]  | AA5        | Common Clock       | Input/Output |
| BPM#[5]  | AB4        | Common Clock       | Input/Output |
| BPRI#    | D2         | Common Clock       | Input        |
| BR0#     | H6         | Common Clock       | Input/Output |
| BSEL0    | AD6        | Power/Other        | Output       |
| BSEL1    | AD5        | Power/Other        | Output       |
| COMP[0]  | L24        | Power/Other        | Input/Output |
| COMP[1]  | P1         | Power/Other        | Input/Output |
| D#[0]    | B21        | Source Synch       | Input/Output |
| D#[01]   | B22        | Source Synch       | Input/Output |
| D#[02]   | A23        | Source Synch       | Input/Output |
| D#[03]   | A25        | Source Synch       | Input/Output |
| D#[04]   | C21        | Source Synch       | Input/Output |
| D#[05]   | D22        | Source Synch       | Input/Output |
| D#[06]   | B24        | Source Synch       | Input/Output |
| D#[07]   | C23        | Source Synch       | Input/Output |
| D#[08]   | C24        | Source Synch       | Input/Output |
| D#[09]   | B25        | Source Synch       | Input/Output |
| D#[10]   | G22        | Source Synch       | Input/Output |
| D#[11]   | H21        | Source Synch       | Input/Output |
| D#[12]   | C26        | Source Synch       | Input/Output |
| D#[13]   | D23        | Source Synch       | Input/Output |
| D#[14]   | J21        | Source Synch       | Input/Output |
| D#[15]   | D25        | Source Synch       | Input/Output |
| D#[16]   | H22        | Source Synch       | Input/Output |
| D#[17]   | E24        | Source Synch       | Input/Output |
| D#[18]   | G23        | Source Synch       | Input/Output |
| D#[19]   | F23        | Source Synch       | Input/Output |
| D#[20]   | F24        | Source Synch       | Input/Output |

Table 34. Pin Listing by Pin Name

| Pin Name | Pin Number | Signal Buffer Type | Direction    |
|----------|------------|--------------------|--------------|
| D#[21]   | E25        | Source Synch       | Input/Output |
| D#[22]   | F26        | Source Synch       | Input/Output |
| D#[23]   | D26        | Source Synch       | Input/Output |
| D#[24]   | L21        | Source Synch       | Input/Output |
| D#[25]   | G26        | Source Synch       | Input/Output |
| D#[26]   | H24        | Source Synch       | Input/Output |
| D#[27]   | M21        | Source Synch       | Input/Output |
| D#[28]   | L22        | Source Synch       | Input/Output |
| D#[29]   | J24        | Source Synch       | Input/Output |
| D#[30]   | K23        | Source Synch       | Input/Output |
| D#[31]   | H25        | Source Synch       | Input/Output |
| D#[32]   | M23        | Source Synch       | Input/Output |
| D#[33]   | N22        | Source Synch       | Input/Output |
| D#[34]   | P21        | Source Synch       | Input/Output |
| D#[35]   | M24        | Source Synch       | Input/Output |
| D#[36]   | N23        | Source Synch       | Input/Output |
| D#[37]   | M26        | Source Synch       | Input/Output |
| D#[38]   | N26        | Source Synch       | Input/Output |
| D#[39]   | N25        | Source Synch       | Input/Output |
| D#[40]   | R21        | Source Synch       | Input/Output |
| D#[41]   | P24        | Source Synch       | Input/Output |
| D#[42]   | R25        | Source Synch       | Input/Output |
| D#[43]   | R24        | Source Synch       | Input/Output |
| D#[44]   | T26        | Source Synch       | Input/Output |
| D#[45]   | T25        | Source Synch       | Input/Output |
| D#[46]   | T22        | Source Synch       | Input/Output |
| D#[47]   | T23        | Source Synch       | Input/Output |
| D#[48]   | U26        | Source Synch       | Input/Output |
| D#[49]   | U24        | Source Synch       | Input/Output |
| D#[50]   | U23        | Source Synch       | Input/Output |
| D#[51]   | V25        | Source Synch       | Input/Output |
| D#[52]   | U21        | Source Synch       | Input/Output |
| D#[53]   | V22        | Source Synch       | Input/Output |
| D#[54]   | V24        | Source Synch       | Input/Output |
| D#[55]   | W26        | Source Synch       | Input/Output |
| D#[56]   | Y26        | Source Synch       | Input/Output |
| D#[57]   | W25        | Source Synch       | Input/Output |
| D#[58]   | Y23        | Source Synch       | Input/Output |
| D#[59]   | Y24        | Source Synch       | Input/Output |

Table 34. Pin Listing by Pin Name

| Pin Name     | Pin Number | Signal Buffer Type | Direction    |
|--------------|------------|--------------------|--------------|
| D#[60]       | Y21        | Source Synch       | Input/Output |
| D#[61]       | AA25       | Source Synch       | Input/Output |
| D#[62]       | AA22       | Source Synch       | Input/Output |
| D#[63]       | AA24       | Source Synch       | Input/Output |
| DBI#[0]      | E21        | Source Synch       | Input/Output |
| DBI#[1]      | G25        | Source Synch       | Input/Output |
| DBI#[2]      | P26        | Source Synch       | Input/Output |
| DBI#[3]      | V21        | Source Synch       | Input/Output |
| DBR#         | AE25       | Power/Other        | Output       |
| DBSY#        | H5         | Common Clock       | Input/Output |
| DEFER#       | E2         | Common Clock       | Input        |
| DP#[0]       | J26        | Common Clock       | Input/Output |
| DP#[1]       | K25        | Common Clock       | Input/Output |
| DP#[2]       | K26        | Common Clock       | Input/Output |
| DP#[3]       | L25        | Common Clock       | Input/Output |
| DPSLP#       | AD25       | Asynch GTL+        | Input        |
| DRDY#        | H2         | Common Clock       | Input/Output |
| DSTBN#[0]    | E22        | Source Synch       | Input/Output |
| DSTBN#[1]    | K22        | Source Synch       | Input/Output |
| DSTBN#[2]    | R22        | Source Synch       | Input/Output |
| DSTBN#[3]    | W22        | Source Synch       | Input/Output |
| DSTBP#[0]    | F21        | Source Synch       | Input/Output |
| DSTBP#[1]    | J23        | Source Synch       | Input/Output |
| DSTBP#[2]    | P23        | Source Synch       | Input/Output |
| DSTBP#[3]    | W23        | Source Synch       | Input/Output |
| FERR#/PBE#   | B6         | Asynch AGL+        | Output       |
| GHI#         | A6         | Asynch GTL+        | Input        |
| GTLREF       | AA21       | Power/Other        | Input        |
| GTLREF       | AA6        | Power/Other        | Input        |
| GTLREF       | F20        | Power/Other        | Input        |
| GTLREF       | F6         | Power/Other        | Input        |
| HIT#         | F3         | Common Clock       | Input/Output |
| HITM#        | E3         | Common Clock       | Input/Output |
| IERR#        | AC3        | Common Clock       | Output       |
| IGNNE#       | B2         | Asynch GTL+        | Input        |
| INIT#        | W5         | Asynch GTL+        | Input        |
| ITPCLKOUT[0] | AA20       | Power/Other        | Output       |
| ITPCLKOUT[1] | AB22       | Power/Other        | Output       |
| ITP_CLK0     | AC26       | TAP                | input        |

Table 34. Pin Listing by Pin Name

| Pin Name | Pin Number | Signal Buffer Type | Direction    |
|----------|------------|--------------------|--------------|
| ITP_CLK1 | AD26       | TAP                | input        |
| LINT0    | D1         | Asynch GTL+        | Input        |
| LINT1    | E5         | Asynch GTL+        | Input        |
| LOCK#    | G4         | Common Clock       | Input/Output |
| MCERR#   | V6         | Common Clock       | Input/Output |
| NC       | A22        |                    |              |
| NC       | A7         |                    |              |
| NC       | AD2        |                    |              |
| NC       | AD3        |                    |              |
| NC       | AE21       |                    |              |
| NC       | AF3        |                    |              |
| NC       | AF24       |                    |              |
| NC       | AF25       |                    |              |
| PROCHOT# | C3         | Asynch GTL+        | Output       |
| PWRGOOD  | AB23       | Power/Other        | Input        |
| REQ#[0]  | J1         | Source Synch       | Input/Output |
| REQ#[1]  | K5         | Source Synch       | Input/Output |
| REQ#[2]  | J4         | Source Synch       | Input/Output |
| REQ#[3]  | J3         | Source Synch       | Input/Output |
| REQ#[4]  | H3         | Source Synch       | Input/Output |
| RESET#   | AB25       | Common Clock       | Input        |
| RS#[0]   | F1         | Common Clock       | Input        |
| RS#[1]   | G5         | Common Clock       | Input        |
| RS#[2]   | F4         | Common Clock       | Input        |
| RSP#     | AB2        | Common Clock       | Input        |
| SKTOCC#  | AF26       | Power/Other        | Output       |
| SLP#     | AB26       | Asynch GTL+        | Input        |
| SMI#     | B5         | Asynch GTL+        | Input        |
| STPCLK#  | Y4         | Asynch GTL+        | Input        |
| TCK      | D4         | TAP                | Input        |
| TDI      | C1         | TAP                | Input        |
| TDO      | D5         | TAP                | Output       |
| TESTHI0  | AD24       | Power/Other        | Input        |
| TESTHI1  | AA2        | Power/Other        | Input        |
| TESTHI2  | AC21       | Power/Other        | Input        |
| TESTHI3  | AC20       | Power/Other        | Input        |
| TESTHI4  | AC24       | Power/Other        | Input        |
| TESTHI5  | AC23       | Power/Other        | Input        |
| TESTHI8  | U6         | Power/Other        | Input        |

Table 34. Pin Listing by Pin Name

| Pin Name   | Pin Number | Signal Buffer Type | Direction |
|------------|------------|--------------------|-----------|
| TESTHI9    | W4         | Power/Other        | Input     |
| TESTHI10   | Y3         | Power/Other        | Input     |
| THERMDA    | B3         | Power/Other        |           |
| THERMDC    | C4         | Power/Other        |           |
| THERMTRIP# | A2         | Asynch GTL+        | Output    |
| TMS        | F7         | TAP                | Input     |
| TRDY#      | J6         | Common Clock       | Input     |
| TRST#      | E6         | TAP                | Input     |
| VCC        | A10        | Power/Other        |           |
| VCC        | A12        | Power/Other        |           |
| VCC        | A14        | Power/Other        |           |
| VCC        | A16        | Power/Other        |           |
| VCC        | A18        | Power/Other        |           |
| VCC        | A20        | Power/Other        |           |
| VCC        | A8         | Power/Other        |           |
| VCC        | AA10       | Power/Other        |           |
| VCC        | AA12       | Power/Other        |           |
| VCC        | AA14       | Power/Other        |           |
| VCC        | AA16       | Power/Other        |           |
| VCC        | AA18       | Power/Other        |           |
| VCC        | AA8        | Power/Other        |           |
| VCC        | AB11       | Power/Other        |           |
| VCC        | AB13       | Power/Other        |           |
| VCC        | AB15       | Power/Other        |           |
| VCC        | AB17       | Power/Other        |           |
| VCC        | AB19       | Power/Other        |           |
| VCC        | AB7        | Power/Other        |           |
| VCC        | AB9        | Power/Other        |           |
| VCC        | AC10       | Power/Other        |           |
| VCC        | AC12       | Power/Other        |           |
| VCC        | AC14       | Power/Other        |           |
| VCC        | AC16       | Power/Other        |           |
| VCC        | AC18       | Power/Other        |           |
| VCC        | AC8        | Power/Other        |           |
| VCC        | AD11       | Power/Other        |           |
| VCC        | AD13       | Power/Other        |           |
| VCC        | AD15       | Power/Other        |           |
| VCC        | AD17       | Power/Other        |           |
| VCC        | AD19       | Power/Other        |           |

Table 34. Pin Listing by Pin Name

| Pin Name | Pin Number | Signal Buffer Type | Direction |
|----------|------------|--------------------|-----------|
| VCC      | AD7        | Power/Other        |           |
| VCC      | AD9        | Power/Other        |           |
| VCC      | AE10       | Power/Other        |           |
| VCC      | AE12       | Power/Other        |           |
| VCC      | AE14       | Power/Other        |           |
| VCC      | AE16       | Power/Other        |           |
| VCC      | AE18       | Power/Other        |           |
| VCC      | AE20       | Power/Other        |           |
| VCC      | AE6        | Power/Other        |           |
| VCC      | AE8        | Power/Other        |           |
| VCC      | AF11       | Power/Other        |           |
| VCC      | AF13       | Power/Other        |           |
| VCC      | AF15       | Power/Other        |           |
| VCC      | AF17       | Power/Other        |           |
| VCC      | AF19       | Power/Other        |           |
| VCC      | AF2        | Power/Other        |           |
| VCC      | AF21       | Power/Other        |           |
| VCC      | AF5        | Power/Other        |           |
| VCC      | AF7        | Power/Other        |           |
| VCC      | AF9        | Power/Other        |           |
| VCC      | B11        | Power/Other        |           |
| VCC      | B13        | Power/Other        |           |
| VCC      | B15        | Power/Other        |           |
| VCC      | B17        | Power/Other        |           |
| VCC      | B19        | Power/Other        |           |
| VCC      | B7         | Power/Other        |           |
| VCC      | B9         | Power/Other        |           |
| VCC      | C10        | Power/Other        |           |
| VCC      | C12        | Power/Other        |           |
| VCC      | C14        | Power/Other        |           |
| VCC      | C16        | Power/Other        |           |
| VCC      | C18        | Power/Other        |           |
| VCC      | C20        | Power/Other        |           |
| VCC      | C8         | Power/Other        |           |
| VCC      | D11        | Power/Other        |           |
| VCC      | D13        | Power/Other        |           |
| VCC      | D15        | Power/Other        |           |
| VCC      | D17        | Power/Other        |           |
| VCC      | D19        | Power/Other        |           |

Table 34. Pin Listing by Pin Name

| Pin Name | Pin Number | Signal Buffer Type | Direction |
|----------|------------|--------------------|-----------|
| VCC      | D7         | Power/Other        |           |
| VCC      | D9         | Power/Other        |           |
| VCC      | E10        | Power/Other        |           |
| VCC      | E12        | Power/Other        |           |
| VCC      | E14        | Power/Other        |           |
| VCC      | E16        | Power/Other        |           |
| VCC      | E18        | Power/Other        |           |
| VCC      | E20        | Power/Other        |           |
| VCC      | E8         | Power/Other        |           |
| VCC      | F11        | Power/Other        |           |
| VCC      | F13        | Power/Other        |           |
| VCC      | F15        | Power/Other        |           |
| VCC      | F17        | Power/Other        |           |
| VCC      | F19        | Power/Other        |           |
| VCC      | F9         | Power/Other        |           |
| VCCA     | AD20       | Power/Other        |           |
| VCCIOPLL | AE23       | Power/Other        |           |
| VCCSENSE | A5         | Power/Other        | Output    |
| VCCVID   | AF4        | Power/Other        | Input     |
| VID0     | AE5        | Power/Other        | Output    |
| VID1     | AE4        | Power/Other        | Output    |
| VID2     | AE3        | Power/Other        | Output    |
| VID3     | AE2        | Power/Other        | Output    |
| VID4     | AE1        | Power/Other        | Output    |
| VSS      | A11        | Power/Other        |           |
| VSS      | A13        | Power/Other        |           |
| VSS      | A15        | Power/Other        |           |
| VSS      | A17        | Power/Other        |           |
| VSS      | A19        | Power/Other        |           |
| VSS      | A21        | Power/Other        |           |
| VSS      | A24        | Power/Other        |           |
| VSS      | A26        | Power/Other        |           |
| VSS      | A3         | Power/Other        |           |
| VSS      | A9         | Power/Other        |           |
| VSS      | AA1        | Power/Other        |           |
| VSS      | AA11       | Power/Other        |           |
| VSS      | AA13       | Power/Other        |           |
| VSS      | AA15       | Power/Other        |           |
| VSS      | AA17       | Power/Other        |           |

Table 34. Pin Listing by Pin Name

| Pin Name | Pin Number | Signal Buffer Type | Direction |
|----------|------------|--------------------|-----------|
| VSS      | AA19       | Power/Other        |           |
| VSS      | AA23       | Power/Other        |           |
| VSS      | AA26       | Power/Other        |           |
| VSS      | AA4        | Power/Other        |           |
| VSS      | AA7        | Power/Other        |           |
| VSS      | AA9        | Power/Other        |           |
| VSS      | AB10       | Power/Other        |           |
| VSS      | AB12       | Power/Other        |           |
| VSS      | AB14       | Power/Other        |           |
| VSS      | AB16       | Power/Other        |           |
| VSS      | AB18       | Power/Other        |           |
| VSS      | AB20       | Power/Other        |           |
| VSS      | AB21       | Power/Other        |           |
| VSS      | AB24       | Power/Other        |           |
| VSS      | AB3        | Power/Other        |           |
| VSS      | AB6        | Power/Other        |           |
| VSS      | AB8        | Power/Other        |           |
| VSS      | AC11       | Power/Other        |           |
| VSS      | AC13       | Power/Other        |           |
| VSS      | AC15       | Power/Other        |           |
| VSS      | AC17       | Power/Other        |           |
| VSS      | AC19       | Power/Other        |           |
| VSS      | AC2        | Power/Other        |           |
| VSS      | AC22       | Power/Other        |           |
| VSS      | AC25       | Power/Other        |           |
| VSS      | AC5        | Power/Other        |           |
| VSS      | AC7        | Power/Other        |           |
| VSS      | AC9        | Power/Other        |           |
| VSS      | AD1        | Power/Other        |           |
| VSS      | AD10       | Power/Other        |           |
| VSS      | AD12       | Power/Other        |           |
| VSS      | AD14       | Power/Other        |           |
| VSS      | AD16       | Power/Other        |           |
| VSS      | AD18       | Power/Other        |           |
| VSS      | AD21       | Power/Other        |           |
| VSS      | AD23       | Power/Other        |           |
| VSS      | AD4        | Power/Other        |           |
| VSS      | AD8        | Power/Other        |           |
| VSS      | AE11       | Power/Other        |           |

Table 34. Pin Listing by Pin Name

| Pin Name | Pin Number | Signal Buffer Type | Direction |
|----------|------------|--------------------|-----------|
| VSS      | AE13       | Power/Other        |           |
| VSS      | AE15       | Power/Other        |           |
| VSS      | AE17       | Power/Other        |           |
| VSS      | AE19       | Power/Other        |           |
| VSS      | AE22       | Power/Other        |           |
| VSS      | AE24       | Power/Other        |           |
| VSS      | AE26       | Power/Other        |           |
| VSS      | AE7        | Power/Other        |           |
| VSS      | AE9        | Power/Other        |           |
| VSS      | AF1        | Power/Other        |           |
| VSS      | AF10       | Power/Other        |           |
| VSS      | AF12       | Power/Other        |           |
| VSS      | AF14       | Power/Other        |           |
| VSS      | AF16       | Power/Other        |           |
| VSS      | AF18       | Power/Other        |           |
| VSS      | AF20       | Power/Other        |           |
| VSS      | AF6        | Power/Other        |           |
| VSS      | AF8        | Power/Other        |           |
| VSS      | B10        | Power/Other        |           |
| VSS      | B12        | Power/Other        |           |
| VSS      | B14        | Power/Other        |           |
| VSS      | B16        | Power/Other        |           |
| VSS      | B18        | Power/Other        |           |
| VSS      | B20        | Power/Other        |           |
| VSS      | B23        | Power/Other        |           |
| VSS      | B26        | Power/Other        |           |
| VSS      | B4         | Power/Other        |           |
| VSS      | B8         | Power/Other        |           |
| VSS      | C11        | Power/Other        |           |
| VSS      | C13        | Power/Other        |           |
| VSS      | C15        | Power/Other        |           |
| VSS      | C17        | Power/Other        |           |
| VSS      | C19        | Power/Other        |           |
| VSS      | C2         | Power/Other        |           |
| VSS      | C22        | Power/Other        |           |
| VSS      | C25        | Power/Other        |           |
| VSS      | C5         | Power/Other        |           |
| VSS      | C7         | Power/Other        |           |
| VSS      | C9         | Power/Other        |           |

Table 34. Pin Listing by Pin Name

| Pin Name | Pin Number | Signal Buffer Type | Direction |
|----------|------------|--------------------|-----------|
| VSS      | D10        | Power/Other        |           |
| VSS      | D12        | Power/Other        |           |
| VSS      | D14        | Power/Other        |           |
| VSS      | D16        | Power/Other        |           |
| VSS      | D18        | Power/Other        |           |
| VSS      | D20        | Power/Other        |           |
| VSS      | D21        | Power/Other        |           |
| VSS      | D24        | Power/Other        |           |
| VSS      | D3         | Power/Other        |           |
| VSS      | D6         | Power/Other        |           |
| VSS      | D8         | Power/Other        |           |
| VSS      | E1         | Power/Other        |           |
| VSS      | E11        | Power/Other        |           |
| VSS      | E13        | Power/Other        |           |
| VSS      | E15        | Power/Other        |           |
| VSS      | E17        | Power/Other        |           |
| VSS      | E19        | Power/Other        |           |
| VSS      | E23        | Power/Other        |           |
| VSS      | E26        | Power/Other        |           |
| VSS      | E4         | Power/Other        |           |
| VSS      | E7         | Power/Other        |           |
| VSS      | E9         | Power/Other        |           |
| VSS      | F10        | Power/Other        |           |
| VSS      | F12        | Power/Other        |           |
| VSS      | F14        | Power/Other        |           |
| VSS      | F16        | Power/Other        |           |
| VSS      | F18        | Power/Other        |           |
| VSS      | F2         | Power/Other        |           |
| VSS      | F22        | Power/Other        |           |
| VSS      | F25        | Power/Other        |           |
| VSS      | F5         | Power/Other        |           |
| VSS      | F8         | Power/Other        |           |
| VSS      | G21        | Power/Other        |           |
| VSS      | G24        | Power/Other        |           |
| VSS      | G3         | Power/Other        |           |
| VSS      | G6         | Power/Other        |           |
| VSS      | H1         | Power/Other        |           |
| VSS      | H23        | Power/Other        |           |
| VSS      | H26        | Power/Other        |           |

Table 34. Pin Listing by Pin Name

| Pin Name | Pin Number | Signal Buffer Type | Direction |
|----------|------------|--------------------|-----------|
| VSS      | H4         | Power/Other        |           |
| VSS      | J2         | Power/Other        |           |
| VSS      | J22        | Power/Other        |           |
| VSS      | J25        | Power/Other        |           |
| VSS      | J5         | Power/Other        |           |
| VSS      | K21        | Power/Other        |           |
| VSS      | K24        | Power/Other        |           |
| VSS      | K3         | Power/Other        |           |
| VSS      | K6         | Power/Other        |           |
| VSS      | L1         | Power/Other        |           |
| VSS      | L23        | Power/Other        |           |
| VSS      | L26        | Power/Other        |           |
| VSS      | L4         | Power/Other        |           |
| VSS      | M2         | Power/Other        |           |
| VSS      | M22        | Power/Other        |           |
| VSS      | M25        | Power/Other        |           |
| VSS      | M5         | Power/Other        |           |
| VSS      | N21        | Power/Other        |           |
| VSS      | N24        | Power/Other        |           |
| VSS      | N3         | Power/Other        |           |
| VSS      | N6         | Power/Other        |           |
| VSS      | P2         | Power/Other        |           |
| VSS      | P22        | Power/Other        |           |
| VSS      | P25        | Power/Other        |           |
| VSS      | P5         | Power/Other        |           |
| VSS      | R1         | Power/Other        |           |
| VSS      | R23        | Power/Other        |           |
| VSS      | R26        | Power/Other        |           |
| VSS      | R4         | Power/Other        |           |
| VSS      | T21        | Power/Other        |           |
| VSS      | T24        | Power/Other        |           |
| VSS      | T3         | Power/Other        |           |
| VSS      | T6         | Power/Other        |           |
| VSS      | U2         | Power/Other        |           |
| VSS      | U22        | Power/Other        |           |
| VSS      | U25        | Power/Other        |           |
| VSS      | U5         | Power/Other        |           |
| VSS      | V1         | Power/Other        |           |
| VSS      | V23        | Power/Other        |           |

**Table 34. Pin Listing by Pin Name**

| Pin Name | Pin Number | Signal Buffer Type | Direction |
|----------|------------|--------------------|-----------|
| VSS      | V26        | Power/Other        |           |
| VSS      | V4         | Power/Other        |           |
| VSS      | W21        | Power/Other        |           |
| VSS      | W24        | Power/Other        |           |
| VSS      | W3         | Power/Other        |           |
| VSS      | W6         | Power/Other        |           |
| VSS      | Y2         | Power/Other        |           |
| VSS      | Y22        | Power/Other        |           |
| VSS      | Y25        | Power/Other        |           |
| VSS      | Y5         | Power/Other        |           |
| VSSA     | AD22       | Power/Other        |           |
| VSSSENSE | A4         | Power/Other        | Output    |

**Table 35. Pin Listing by Pin Number**

| Pin Number | Pin Name   | Signal Buffer Type | Direction    |
|------------|------------|--------------------|--------------|
| A2         | THERMTRIP# | Asynch GTL+        | Output       |
| A3         | VSS        | Power/Other        |              |
| A4         | VSSSENSE   | Power/Other        | Output       |
| A5         | VCCSENSE   | Power/Other        | Output       |
| A6         | GHI#       | Asynch GTL+        | Input        |
| A7         | NC         |                    |              |
| A8         | VCC        | Power/Other        |              |
| A9         | VSS        | Power/Other        |              |
| A10        | VCC        | Power/Other        |              |
| A11        | VSS        | Power/Other        |              |
| A12        | VCC        | Power/Other        |              |
| A13        | VSS        | Power/Other        |              |
| A14        | VCC        | Power/Other        |              |
| A15        | VSS        | Power/Other        |              |
| A16        | VCC        | Power/Other        |              |
| A17        | VSS        | Power/Other        |              |
| A18        | VCC        | Power/Other        |              |
| A19        | VSS        | Power/Other        |              |
| A20        | VCC        | Power/Other        |              |
| A21        | VSS        | Power/Other        |              |
| A22        | NC         |                    |              |
| A23        | D#[02]     | Source Synch       | Input/Output |
| A24        | VSS        | Power/Other        |              |

**Table 35. Pin Listing by Pin Number**

| Pin Number | Pin Name      | Signal Buffer Type | Direction    |
|------------|---------------|--------------------|--------------|
| A25        | D#[03]        | Source Synch       | Input/Output |
| A26        | VSS           | Power/Other        |              |
| AA1        | VSS           | Power/Other        |              |
| AA2        | TESTH1        | Power/Other        | Input        |
| AA3        | BINIT#        | Common Clock       | Input/Output |
| AA4        | VSS           | Power/Other        |              |
| AA5        | BPM#[4]       | Common Clock       | Input/Output |
| AA6        | GTLREF        | Power/Other        | Input        |
| AA7        | VSS           | Power/Other        |              |
| AA8        | VCC           | Power/Other        |              |
| AA9        | VSS           | Power/Other        |              |
| AA10       | VCC           | Power/Other        |              |
| AA11       | VSS           | Power/Other        |              |
| AA12       | VCC           | Power/Other        |              |
| AA13       | VSS           | Power/Other        |              |
| AA14       | VCC           | Power/Other        |              |
| AA15       | VSS           | Power/Other        |              |
| AA16       | VCC           | Power/Other        |              |
| AA17       | VSS           | Power/Other        |              |
| AA18       | VCC           | Power/Other        |              |
| AA19       | VSS           | Power/Other        |              |
| AA20       | ITPCLKOUT [0] | Power/Other        | Output       |
| AA21       | GTLREF        | Power/Other        | Input        |
| AA22       | D#[62]        | Source Synch       | Input/Output |
| AA23       | VSS           | Power/Other        |              |
| AA24       | D#[63]        | Source Synch       | Input/Output |
| AA25       | D#[61]        | Source Synch       | Input/Output |
| AA26       | VSS           | Power/Other        |              |
| AB1        | A#[35]        | Source Synch       | Input/Output |
| AB2        | RSP#          | Common Clock       | Input        |
| AB3        | VSS           | Power/Other        |              |
| AB4        | BPM#[5]       | Common Clock       | Input/Output |
| AB5        | BPM#[1]       | Common Clock       | Input/Output |
| AB6        | VSS           | Power/Other        |              |
| AB7        | VCC           | Power/Other        |              |
| AB8        | VSS           | Power/Other        |              |
| AB9        | VCC           | Power/Other        |              |
| AB10       | VSS           | Power/Other        |              |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name      | Signal Buffer Type | Direction    |
|------------|---------------|--------------------|--------------|
| AB11       | VCC           | Power/Other        |              |
| AB12       | VSS           | Power/Other        |              |
| AB13       | VCC           | Power/Other        |              |
| AB14       | VSS           | Power/Other        |              |
| AB15       | VCC           | Power/Other        |              |
| AB16       | VSS           | Power/Other        |              |
| AB17       | VCC           | Power/Other        |              |
| AB18       | VSS           | Power/Other        |              |
| AB19       | VCC           | Power/Other        |              |
| AB20       | VSS           | Power/Other        |              |
| AB21       | VSS           | Power/Other        |              |
| AB22       | ITPCLKOUT [1] | Power/Other        | Output       |
| AB23       | PWRGOOD       | Power/Other        | Input        |
| AB24       | VSS           | Power/Other        |              |
| AB25       | RESET#        | Common Clock       | Input        |
| AB26       | SLP#          | Asynch GTL+        | Input        |
| AC1        | AP#[0]        | Common Clock       | Input/Output |
| AC2        | VSS           | Power/Other        |              |
| AC3        | IERR#         | Common Clock       | Output       |
| AC4        | BPM#[2]       | Common Clock       | Input/Output |
| AC5        | VSS           | Power/Other        |              |
| AC6        | BPM#[0]       | Common Clock       | Input/Output |
| AC7        | VSS           | Power/Other        |              |
| AC8        | VCC           | Power/Other        |              |
| AC9        | VSS           | Power/Other        |              |
| AC10       | VCC           | Power/Other        |              |
| AC11       | VSS           | Power/Other        |              |
| AC12       | VCC           | Power/Other        |              |
| AC13       | VSS           | Power/Other        |              |
| AC14       | VCC           | Power/Other        |              |
| AC15       | VSS           | Power/Other        |              |
| AC16       | VCC           | Power/Other        |              |
| AC17       | VSS           | Power/Other        |              |
| AC18       | VCC           | Power/Other        |              |
| AC19       | VSS           | Power/Other        |              |
| AC20       | TESTHI3       | Power/Other        | Input        |
| AC21       | TESTHI2       | Power/Other        | Input        |
| AC22       | VSS           | Power/Other        |              |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name | Signal Buffer Type | Direction |
|------------|----------|--------------------|-----------|
| AC23       | TESTHI5  | Power/Other        | Input     |
| AC24       | TESTHI4  | Power/Other        | Input     |
| AC25       | VSS      | Power/Other        |           |
| AC26       | ITP_CLK0 | TAP                | input     |
| AD1        | VSS      | Power/Other        |           |
| AD2        | NC       |                    |           |
| AD3        | NC       |                    |           |
| AD4        | VSS      | Power/Other        |           |
| AD5        | BSEL1    | Power/Other        | Output    |
| AD6        | BSEL0    | Power/Other        | Output    |
| AD7        | VCC      | Power/Other        |           |
| AD8        | VSS      | Power/Other        |           |
| AD9        | VCC      | Power/Other        |           |
| AD10       | VSS      | Power/Other        |           |
| AD11       | VCC      | Power/Other        |           |
| AD12       | VSS      | Power/Other        |           |
| AD13       | VCC      | Power/Other        |           |
| AD14       | VSS      | Power/Other        |           |
| AD15       | VCC      | Power/Other        |           |
| AD16       | VSS      | Power/Other        |           |
| AD17       | VCC      | Power/Other        |           |
| AD18       | VSS      | Power/Other        |           |
| AD19       | VCC      | Power/Other        |           |
| AD20       | VCCA     | Power/Other        |           |
| AD21       | VSS      | Power/Other        |           |
| AD22       | VSSA     | Power/Other        |           |
| AD23       | VSS      | Power/Other        |           |
| AD24       | TESTHI0  | Power/Other        | Input     |
| AD25       | DPSLP#   | Asynch GTL+        | Input     |
| AD26       | ITP_CLK1 | TAP                | input     |
| AE1        | VID4     | Power/Other        | Output    |
| AE2        | VID3     | Power/Other        | Output    |
| AE3        | VID2     | Power/Other        | Output    |
| AE4        | VID1     | Power/Other        | Output    |
| AE5        | VID0     | Power/Other        | Output    |
| AE6        | VCC      | Power/Other        |           |
| AE7        | VSS      | Power/Other        |           |
| AE8        | VCC      | Power/Other        |           |
| AE9        | VSS      | Power/Other        |           |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name | Signal Buffer Type | Direction |
|------------|----------|--------------------|-----------|
| AE10       | VCC      | Power/Other        |           |
| AE11       | VSS      | Power/Other        |           |
| AE12       | VCC      | Power/Other        |           |
| AE13       | VSS      | Power/Other        |           |
| AE14       | VCC      | Power/Other        |           |
| AE15       | VSS      | Power/Other        |           |
| AE16       | VCC      | Power/Other        |           |
| AE17       | VSS      | Power/Other        |           |
| AE18       | VCC      | Power/Other        |           |
| AE19       | VSS      | Power/Other        |           |
| AE20       | VCC      | Power/Other        |           |
| AE21       | NC       |                    |           |
| AE22       | VSS      | Power/Other        |           |
| AE23       | VCCIOPLL | Power/Other        |           |
| AE24       | VSS      | Power/Other        |           |
| AE25       | DBR#     | Asynch GTL+        | Output    |
| AE26       | VSS      | Power/Other        |           |
| AF1        | VSS      | Power/Other        |           |
| AF2        | VCC      | Power/Other        |           |
| AF3        | NC       |                    |           |
| AF4        | VCCVID   | Power/Other        | Input     |
| AF5        | VCC      | Power/Other        |           |
| AF6        | VSS      | Power/Other        |           |
| AF7        | VCC      | Power/Other        |           |
| AF8        | VSS      | Power/Other        |           |
| AF9        | VCC      | Power/Other        |           |
| AF10       | VSS      | Power/Other        |           |
| AF11       | VCC      | Power/Other        |           |
| AF12       | VSS      | Power/Other        |           |
| AF13       | VCC      | Power/Other        |           |
| AF14       | VSS      | Power/Other        |           |
| AF15       | VCC      | Power/Other        |           |
| AF16       | VSS      | Power/Other        |           |
| AF17       | VCC      | Power/Other        |           |
| AF18       | VSS      | Power/Other        |           |
| AF19       | VCC      | Power/Other        |           |
| AF20       | VSS      | Power/Other        |           |
| AF21       | VCC      | Power/Other        |           |
| AF22       | BCLK[0]  | Bus Clock          | Input     |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name   | Signal Buffer Type | Direction    |
|------------|------------|--------------------|--------------|
| AF23       | BCLK[1]    | Bus Clock          | Input        |
| AF24       | NC         |                    |              |
| AF25       | NC         |                    |              |
| AF26       | SKTOCC#    | Power/Other        | Output       |
| B2         | IGNNE#     | Asynch GTL+        | Input        |
| B3         | THERMDA    | Power/Other        |              |
| B4         | VSS        | Power/Other        |              |
| B5         | SMI#       | Asynch GTL+        | Input        |
| B6         | FERR#/PBE# | Asynch AGL+        | Output       |
| B7         | VCC        | Power/Other        |              |
| B8         | VSS        | Power/Other        |              |
| B9         | VCC        | Power/Other        |              |
| B10        | VSS        | Power/Other        |              |
| B11        | VCC        | Power/Other        |              |
| B12        | VSS        | Power/Other        |              |
| B13        | VCC        | Power/Other        |              |
| B14        | VSS        | Power/Other        |              |
| B15        | VCC        | Power/Other        |              |
| B16        | VSS        | Power/Other        |              |
| B17        | VCC        | Power/Other        |              |
| B18        | VSS        | Power/Other        |              |
| B19        | VCC        | Power/Other        |              |
| B20        | VSS        | Power/Other        |              |
| B21        | D#[0]      | Source Synch       | Input/Output |
| B22        | D#[01]     | Source Synch       | Input/Output |
| B23        | VSS        | Power/Other        |              |
| B24        | D#[06]     | Source Synch       | Input/Output |
| B25        | D#[09]     | Source Synch       | Input/Output |
| B26        | VSS        | Power/Other        |              |
| C1         | TDI        | TAP                | Input        |
| C2         | VSS        | Power/Other        |              |
| C3         | PROCHOT#   | Asynch GTL+        | Output       |
| C4         | THERMDC    | Power/Other        |              |
| C5         | VSS        | Power/Other        |              |
| C6         | A20M#      | Asynch GTL+        | Input        |
| C7         | VSS        | Power/Other        |              |
| C8         | VCC        | Power/Other        |              |
| C9         | VSS        | Power/Other        |              |
| C10        | VCC        | Power/Other        |              |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name | Signal Buffer Type | Direction    |
|------------|----------|--------------------|--------------|
| C11        | VSS      | Power/Other        |              |
| C12        | VCC      | Power/Other        |              |
| C13        | VSS      | Power/Other        |              |
| C14        | VCC      | Power/Other        |              |
| C15        | VSS      | Power/Other        |              |
| C16        | VCC      | Power/Other        |              |
| C17        | VSS      | Power/Other        |              |
| C18        | VCC      | Power/Other        |              |
| C19        | VSS      | Power/Other        |              |
| C20        | VCC      | Power/Other        |              |
| C21        | D#[04]   | Source Synch       | Input/Output |
| C22        | VSS      | Power/Other        |              |
| C23        | D#[07]   | Source Synch       | Input/Output |
| C24        | D#[08]   | Source Synch       | Input/Output |
| C25        | VSS      | Power/Other        |              |
| C26        | D#[12]   | Source Synch       | Input/Output |
| D1         | LINT0    | Asynch GTL+        | Input        |
| D2         | BPRI#    | Common Clock       | Input        |
| D3         | VSS      | Power/Other        |              |
| D4         | TCK      | TAP                | Input        |
| D5         | TDO      | TAP                | Output       |
| D6         | VSS      | Power/Other        |              |
| D7         | VCC      | Power/Other        |              |
| D8         | VSS      | Power/Other        |              |
| D9         | VCC      | Power/Other        |              |
| D10        | VSS      | Power/Other        |              |
| D11        | VCC      | Power/Other        |              |
| D12        | VSS      | Power/Other        |              |
| D13        | VCC      | Power/Other        |              |
| D14        | VSS      | Power/Other        |              |
| D15        | VCC      | Power/Other        |              |
| D16        | VSS      | Power/Other        |              |
| D17        | VCC      | Power/Other        |              |
| D18        | VSS      | Power/Other        |              |
| D19        | VCC      | Power/Other        |              |
| D20        | VSS      | Power/Other        |              |
| D21        | VSS      | Power/Other        |              |
| D22        | D#[05]   | Source Synch       | Input/Output |
| D23        | D#[13]   | Source Synch       | Input/Output |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name  | Signal Buffer Type | Direction    |
|------------|-----------|--------------------|--------------|
| D24        | VSS       | Power/Other        |              |
| D25        | D#[15]    | Source Synch       | Input/Output |
| D26        | D#[23]    | Source Synch       | Input/Output |
| E1         | VSS       | Power/Other        |              |
| E2         | DEFER#    | Common Clock       | Input        |
| E3         | HITM#     | Common Clock       | Input/Output |
| E4         | VSS       | Power/Other        |              |
| E5         | LINT1     | Asynch GTL+        | Input        |
| E6         | TRST#     | TAP                | Input        |
| E7         | VSS       | Power/Other        |              |
| E8         | VCC       | Power/Other        |              |
| E9         | VSS       | Power/Other        |              |
| E10        | VCC       | Power/Other        |              |
| E11        | VSS       | Power/Other        |              |
| E12        | VCC       | Power/Other        |              |
| E13        | VSS       | Power/Other        |              |
| E14        | VCC       | Power/Other        |              |
| E15        | VSS       | Power/Other        |              |
| E16        | VCC       | Power/Other        |              |
| E17        | VSS       | Power/Other        |              |
| E18        | VCC       | Power/Other        |              |
| E19        | VSS       | Power/Other        |              |
| E20        | VCC       | Power/Other        |              |
| E21        | DBI#[0]   | Source Synch       | Input/Output |
| E22        | DSTBN#[0] | Source Synch       | Input/Output |
| E23        | VSS       | Power/Other        |              |
| E24        | D#[17]    | Source Synch       | Input/Output |
| E25        | D#[21]    | Source Synch       | Input/Output |
| E26        | VSS       | Power/Other        |              |
| F1         | RS#[0]    | Common Clock       | Input        |
| F2         | VSS       | Power/Other        |              |
| F3         | HIT#      | Common Clock       | Input/Output |
| F4         | RS#[2]    | Common Clock       | Input        |
| F5         | VSS       | Power/Other        |              |
| F6         | GTLREF    | Power/Other        | Input        |
| F7         | TMS       | TAP                | Input        |
| F8         | VSS       | Power/Other        |              |
| F9         | VCC       | Power/Other        |              |
| F10        | VSS       | Power/Other        |              |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name  | Signal Buffer Type | Direction    |
|------------|-----------|--------------------|--------------|
| F11        | VCC       | Power/Other        |              |
| F12        | VSS       | Power/Other        |              |
| F13        | VCC       | Power/Other        |              |
| F14        | VSS       | Power/Other        |              |
| F15        | VCC       | Power/Other        |              |
| F16        | VSS       | Power/Other        |              |
| F17        | VCC       | Power/Other        |              |
| F18        | VSS       | Power/Other        |              |
| F19        | VCC       | Power/Other        |              |
| F20        | GTLREF    | Power/Other        | Input        |
| F21        | DSTBP#[0] | Source Synch       | Input/Output |
| F22        | VSS       | Power/Other        |              |
| F23        | D#[19]    | Source Synch       | Input/Output |
| F24        | D#[20]    | Source Synch       | Input/Output |
| F25        | VSS       | Power/Other        |              |
| F26        | D#[22]    | Source Synch       | Input/Output |
| G1         | ADS#      | Common Clock       | Input/Output |
| G2         | BNR#      | Common Clock       | Input/Output |
| G3         | VSS       | Power/Other        |              |
| G4         | LOCK#     | Common Clock       | Input/Output |
| G5         | RS#[1]    | Common Clock       | Input        |
| G6         | VSS       | Power/Other        |              |
| G21        | VSS       | Power/Other        |              |
| G22        | D#[10]    | Source Synch       | Input/Output |
| G23        | D#[18]    | Source Synch       | Input/Output |
| G24        | VSS       | Power/Other        |              |
| G25        | DBI#[1]   | Source Synch       | Input/Output |
| G26        | D#[25]    | Source Synch       | Input/Output |
| H1         | VSS       | Power/Other        |              |
| H2         | DRDY#     | Common Clock       | Input/Output |
| H3         | REQ#[4]   | Source Synch       | Input/Output |
| H4         | VSS       | Power/Other        |              |
| H5         | DBSY#     | Common Clock       | Input/Output |
| H6         | BR0#      | Common Clock       | Input/Output |
| H21        | D#[11]    | Source Synch       | Input/Output |
| H22        | D#[16]    | Source Synch       | Input/Output |
| H23        | VSS       | Power/Other        |              |
| H24        | D#[26]    | Source Synch       | Input/Output |
| H25        | D#[31]    | Source Synch       | Input/Output |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name  | Signal Buffer Type | Direction    |
|------------|-----------|--------------------|--------------|
| H26        | VSS       | Power/Other        |              |
| J1         | REQ#[0]   | Source Synch       | Input/Output |
| J2         | VSS       | Power/Other        |              |
| J3         | REQ#[3]   | Source Synch       | Input/Output |
| J4         | REQ#[2]   | Source Synch       | Input/Output |
| J5         | VSS       | Power/Other        |              |
| J6         | TRDY#     | Common Clock       | Input        |
| J21        | D#[14]    | Source Synch       | Input/Output |
| J22        | VSS       | Power/Other        |              |
| J23        | DSTBP#[1] | Source Synch       | Input/Output |
| J24        | D#[29]    | Source Synch       | Input/Output |
| J25        | VSS       | Power/Other        |              |
| J26        | DP#[0]    | Common Clock       | Input/Output |
| K1         | A#[06]    | Source Synch       | Input/Output |
| K2         | A#[03]    | Source Synch       | Input/Output |
| K3         | VSS       | Power/Other        |              |
| K4         | A#[04]    | Source Synch       | Input/Output |
| K5         | REQ#[1]   | Source Synch       | Input/Output |
| K6         | VSS       | Power/Other        |              |
| K21        | VSS       | Power/Other        |              |
| K22        | DSTBN#[1] | Source Synch       | Input/Output |
| K23        | D#[30]    | Source Synch       | Input/Output |
| K24        | VSS       | Power/Other        |              |
| K25        | DP#[1]    | Common Clock       | Input/Output |
| K26        | DP#[2]    | Common Clock       | Input/Output |
| L1         | VSS       | Power/Other        |              |
| L2         | A#[09]    | Source Synch       | Input/Output |
| L3         | A#[07]    | Source Synch       | Input/Output |
| L4         | VSS       | Power/Other        |              |
| L5         | ADSTB#[0] | Source Synch       | Input/Output |
| L6         | A#[05]    | Source Synch       | Input/Output |
| L21        | D#[24]    | Source Synch       | Input/Output |
| L22        | D#[28]    | Source Synch       | Input/Output |
| L23        | VSS       | Power/Other        |              |
| L24        | COMP[0]   | Power/Other        | Input/Output |
| L25        | DP#[3]    | Common Clock       | Input/Output |
| L26        | VSS       | Power/Other        |              |
| M1         | A#[13]    | Source Synch       | Input/Output |
| M2         | VSS       | Power/Other        |              |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name  | Signal Buffer Type | Direction    |
|------------|-----------|--------------------|--------------|
| M3         | A#[10]    | Source Synch       | Input/Output |
| M4         | A#[11]    | Source Synch       | Input/Output |
| M5         | VSS       | Power/Other        |              |
| M6         | A#[08]    | Source Synch       | Input/Output |
| M21        | D#[27]    | Source Synch       | Input/Output |
| M22        | VSS       | Power/Other        |              |
| M23        | D#[32]    | Source Synch       | Input/Output |
| M24        | D#[35]    | Source Synch       | Input/Output |
| M25        | VSS       | Power/Other        |              |
| M26        | D#[37]    | Source Synch       | Input/Output |
| N1         | A#[12]    | Source Synch       | Input/Output |
| N2         | A#[14]    | Source Synch       | Input/Output |
| N3         | VSS       | Power/Other        |              |
| N4         | A#[15]    | Source Synch       | Input/Output |
| N5         | A#[16]    | Source Synch       | Input/Output |
| N6         | VSS       | Power/Other        |              |
| N21        | VSS       | Power/Other        |              |
| N22        | D#[33]    | Source Synch       | Input/Output |
| N23        | D#[36]    | Source Synch       | Input/Output |
| N24        | VSS       | Power/Other        |              |
| N25        | D#[39]    | Source Synch       | Input/Output |
| N26        | D#[38]    | Source Synch       | Input/Output |
| P1         | COMP[1]   | Power/Other        | Input/Output |
| P2         | VSS       | Power/Other        |              |
| P3         | A#[19]    | Source Synch       | Input/Output |
| P4         | A#[20]    | Source Synch       | Input/Output |
| P5         | VSS       | Power/Other        |              |
| P6         | A#[24]    | Source Synch       | Input/Output |
| P21        | D#[34]    | Source Synch       | Input/Output |
| P22        | VSS       | Power/Other        |              |
| P23        | DSTBP#[2] | Source Synch       | Input/Output |
| P24        | D#[41]    | Source Synch       | Input/Output |
| P25        | VSS       | Power/Other        |              |
| P26        | DBI#[2]   | Source Synch       | Input/Output |
| R1         | VSS       | Power/Other        |              |
| R2         | A#[18]    | Source Synch       | Input/Output |
| R3         | A#[21]    | Source Synch       | Input/Output |
| R4         | VSS       | Power/Other        |              |
| R5         | ADSTB#[1] | Source Synch       | Input/Output |

Table 35. Pin Listing by Pin Number

| Pin Number | Pin Name  | Signal Buffer Type | Direction    |
|------------|-----------|--------------------|--------------|
| R6         | A#[28]    | Source Synch       | Input/Output |
| R21        | D#[40]    | Source Synch       | Input/Output |
| R22        | DSTBN#[2] | Source Synch       | Input/Output |
| R23        | VSS       | Power/Other        |              |
| R24        | D#[43]    | Source Synch       | Input/Output |
| R25        | D#[42]    | Source Synch       | Input/Output |
| R26        | VSS       | Power/Other        |              |
| T1         | A#[17]    | Source Synch       | Input/Output |
| T2         | A#[22]    | Source Synch       | Input/Output |
| T3         | VSS       | Power/Other        |              |
| T4         | A#[26]    | Source Synch       | Input/Output |
| T5         | A#[30]    | Source Synch       | Input/Output |
| T6         | VSS       | Power/Other        |              |
| T21        | VSS       | Power/Other        |              |
| T22        | D#[46]    | Source Synch       | Input/Output |
| T23        | D#[47]    | Source Synch       | Input/Output |
| T24        | VSS       | Power/Other        |              |
| T25        | D#[45]    | Source Synch       | Input/Output |
| T26        | D#[44]    | Source Synch       | Input/Output |
| U1         | A#[23]    | Source Synch       | Input/Output |
| U2         | VSS       | Power/Other        |              |
| U3         | A#[25]    | Source Synch       | Input/Output |
| U4         | A#[31]    | Source Synch       | Input/Output |
| U5         | VSS       | Power/Other        |              |
| U6         | TESTHI8   | Power/Other        | Input        |
| U21        | D#[52]    | Source Synch       | Input/Output |
| U22        | VSS       | Power/Other        |              |
| U23        | D#[50]    | Source Synch       | Input/Output |
| U24        | D#[49]    | Source Synch       | Input/Output |
| U25        | VSS       | Power/Other        |              |
| U26        | D#[48]    | Source Synch       | Input/Output |
| V1         | VSS       | Power/Other        |              |
| V2         | A#[27]    | Source Synch       | Input/Output |
| V3         | A#[32]    | Source Synch       | Input/Output |
| V4         | VSS       | Power/Other        |              |
| V5         | AP#[1]    | Common Clock       | Input/Output |
| V6         | MCERR#    | Common Clock       | Input/Output |
| V21        | DBI#[3]   | Source Synch       | Input/Output |
| V22        | D#[53]    | Source Synch       | Input/Output |

**Table 35. Pin Listing by Pin Number**

| Pin Number | Pin Name  | Signal Buffer Type | Direction    |
|------------|-----------|--------------------|--------------|
| V23        | VSS       | Power/Other        |              |
| V24        | D#[54]    | Source Synch       | Input/Output |
| V25        | D#[51]    | Source Synch       | Input/Output |
| V26        | VSS       | Power/Other        |              |
| W1         | A#[29]    | Source Synch       | Input/Output |
| W2         | A#[33]    | Source Synch       | Input/Output |
| W3         | VSS       | Power/Other        |              |
| W4         | TESTHI9   | Power/Other        | Input        |
| W5         | INIT#     | Asynch GTL+        | Input        |
| W6         | VSS       | Power/Other        |              |
| W21        | VSS       | Power/Other        |              |
| W22        | DSTBN#[3] | Source Synch       | Input/Output |
| W23        | DSTBP#[3] | Source Synch       | Input/Output |
| W24        | VSS       | Power/Other        |              |
| W25        | D#[57]    | Source Synch       | Input/Output |
| W26        | D#[55]    | Source Synch       | Input/Output |
| Y1         | A#[34]    | Source Synch       | Input/Output |
| Y2         | VSS       | Power/Other        |              |
| Y3         | TESTHI10  | Power/Other        | Input        |
| Y4         | STPCLK#   | Asynch GTL+        | Input        |
| Y5         | VSS       | Power/Other        |              |
| Y6         | BPM#[3]   | Common Clock       | Input/Output |
| Y21        | D#[60]    | Source Synch       | Input/Output |
| Y22        | VSS       | Power/Other        |              |
| Y23        | D#[58]    | Source Synch       | Input/Output |
| Y24        | D#[59]    | Source Synch       | Input/Output |
| Y25        | VSS       | Power/Other        |              |
| Y26        | D#[56]    | Source Synch       | Input/Output |

## 5.2 Alphabetical Signals Reference

Table 36. Signal Description (Page 1 of 8)

| Name                | Type              | Description   |                 |                   |                     |           |           |         |          |      |      |           |      |      |
|---------------------|-------------------|---|-----------------|-------------------|---------------------|-----------|-----------|---------|----------|------|------|-----------|------|------|
| A[35:3]#            | Input/<br>Output  | <p>A[35:3]# (Address) define a 2<sup>36</sup>-byte physical memory address space. In sub-phase 1 of the address phase, these pins transmit the address of a transaction. In sub-phase 2, these pins transmit transaction type information. These signals must connect the appropriate pins of all agents on the Mobile Intel Pentium 4 Processor-M system bus. A[35:3]# are protected by parity signals AP[1:0]#.</p> <p>A[35:3]# are source synchronous signals and are latched into the receiving buffers by ADSTB[1:0]#.</p> <p>On the active-to-inactive transition of RESET#, the processor samples a subset of the A[35:3]# pins to determine power-on configuration. See <a href="#">Section 7.1</a> for more details.</p>   |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| A20M#               | Input             | <p>If A20M# (Address-20 Mask) is asserted, the processor masks physical address bit 20 (A20#) before looking up a line in any internal cache and before driving a read/write transaction on the bus. Asserting A20M# emulates the 8086 processor's address wrap-around at the 1-Mbyte boundary. Assertion of A20M# is only supported in real mode.</p> <p>A20M# is an asynchronous signal. However, to ensure recognition of this signal following an Input/Output write instruction, it must be valid along with the TRDY# assertion of the corresponding Input/Output Write bus transaction.</p>  |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| ADS#                | Input/<br>Output  | <p>ADS# (Address Strobe) is asserted to indicate the validity of the transaction address on the A[35:3]# and REQ[4:0]# pins. All bus agents observe the ADS# activation to begin parity checking, protocol checking, address decode, internal snoop, or deferred reply ID match operations associated with the new transaction.</p>   |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| ADSTB[1:0]#         | Input/<br>Output  | <p>Address strobes are used to latch A[35:3]# and REQ[4:0]# on their rising and falling edges. Strobes are associated with signals as shown below.</p> <table><tr><th>Signals</th><th>Associated Strobe</th></tr><tr><td>REQ[4:0]#, A[16:3]#</td><td>ADSTB0#</td></tr><tr><td>A[35:17]#</td><td>ADSTB1#</td></tr></table>   | Signals         | Associated Strobe | REQ[4:0]#, A[16:3]# | ADSTB0#   | A[35:17]# | ADSTB1# |          |      |      |           |      |      |
| Signals             | Associated Strobe |   |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| REQ[4:0]#, A[16:3]# | ADSTB0#           |   |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| A[35:17]#           | ADSTB1#           |   |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| AP[1:0]#            | Input/<br>Output  | <p>AP[1:0]# (Address Parity) are driven by the request initiator along with ADS#, A[35:3]#, and the transaction type on the REQ[4:0]#. A correct parity signal is high if an even number of covered signals are low and low if an odd number of covered signals are low. This allows parity to be high when all the covered signals are high. AP[1:0]# should connect the appropriate pins of all Mobile Intel Pentium 4 Processor-M system bus agents. The following table defines the coverage model of these signals.</p> <table><tr><th>Request Signals</th><th>subphase 1</th><th>subphase 2</th></tr><tr><td>A[35:24]#</td><td>AP0#</td><td>AP1#</td></tr><tr><td>A[23:3]#</td><td>AP1#</td><td>AP0#</td></tr><tr><td>REQ[4:0]#</td><td>AP1#</td><td>AP0#</td></tr></table> | Request Signals | subphase 1        | subphase 2          | A[35:24]# | AP0#      | AP1#    | A[23:3]# | AP1# | AP0# | REQ[4:0]# | AP1# | AP0# |
| Request Signals     | subphase 1        | subphase 2  |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| A[35:24]#           | AP0#              | AP1#  |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| A[23:3]#            | AP1#              | AP0#  |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| REQ[4:0]#           | AP1#              | AP0#  |                 |                   |                     |           |           |         |          |      |      |           |      |      |
| BCLK[1:0]           | Input             | <p>The differential pair BCLK (Bus Clock) determines the system bus frequency. All processor system bus agents must receive these signals to drive their outputs and latch their inputs.</p> <p>All external timing parameters are specified with respect to the rising edge of BCLK0 crossing V<sub>CROSS</sub>.</p>   |                 |                   |                     |           |           |         |          |      |      |           |      |      |

Table 36. Signal Description (Page 2 of 8)

| Name      | Type             | Description   |
|-----------|------------------|---|
| BINIT#    | Input/<br>Output | <p>BINIT# (Bus Initialization) may be observed and driven by all processor system bus agents and if used, must connect the appropriate pins of all such agents. If the BINIT# driver is enabled during power-on configuration, BINIT# is asserted to signal any bus condition that prevents reliable future operation.</p> <p>If BINIT# observation is enabled during power-on configuration, and BINIT# is sampled asserted, symmetric agents reset their bus LOCK# activity and bus request arbitration state machines. The bus agents do not reset their IOQ and transaction tracking state machines upon observation of BINIT# activation. Once the BINIT# assertion has been observed, the bus agents will re-arbitrate for the system bus and attempt completion of their bus queue and IOQ entries.</p> <p>If BINIT# observation is disabled during power-on configuration, a central agent may handle an assertion of BINIT# as appropriate to the error handling architecture of the system.</p> |
| BNR#      | Input/<br>Output | BNR# (Block Next Request) is used to assert a bus stall by any bus agent who is unable to accept new bus transactions. During a bus stall, the current bus owner cannot issue any new transactions.   |
| BPM[5:0]# | Input/<br>Output | <p>BPM[5:0]# (Breakpoint Monitor) are breakpoint and performance monitor signals. They are outputs from the processor which indicate the status of breakpoints and programmable counters used for monitoring processor performance. BPM[5:0]# should connect the appropriate pins of all Mobile Intel Pentium 4 Processor-M system bus agents.</p> <p>BPM4# provides PRDY# (Probe Ready) functionality for the TAP port. PRDY# is a processor output used by debug tools to determine processor debug readiness.</p> <p>BPM5# provides PREQ# (Probe Request) functionality for the TAP port. PREQ# is used by debug tools to request debug operation of the processor.</p> <p>Please refer to the <i>Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide</i> and <i>ITP700 Debug Port Design Guide</i> for more detailed information.</p> <p><b>These signals do not have on-die termination and must be terminated on the system board.</b></p>                    |
| BPRI#     | Input            | BPRI# (Bus Priority Request) is used to arbitrate for ownership of the processor system bus. It must connect the appropriate pins of all processor system bus agents. Observing BPRI# active (as asserted by the priority agent) causes all other agents to stop issuing new requests, unless such requests are part of an ongoing locked operation. The priority agent keeps BPRI# asserted until all of its requests are completed, then releases the bus by deasserting BPRI#.   |
| BR0#      | Input/<br>Output | <p>BR0# drives the BREQ0# signal in the system and is used by the processor to request the bus. During power-on configuration this pin is sampled to determine the agent ID = 0.</p> <p><b>This signal does not have on-die termination and must be terminated.</b></p>   |
| BSEL[1:0] | Output           | BSEL[1:0] (Bus Select) are used to select the processor input clock frequency. Table 4 defines the possible combinations of the signals and the frequency associated with each combination. The required frequency is determined by the processor, chipset, and clock synthesizer. All agents must operate at the same frequency. The Mobile Intel Pentium 4 Processor-M operates at a 400-MHz system bus frequency (100 MHz BCLK[1:0] frequency). For more information about these pins, including termination recommendations refer to Section 2.9 and the appropriate platform design guidelines.  |
| COMP[1:0] | Analog           | COMP[1:0] must be terminated on the system board using precision resistors. Refer to the <i>Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide</i> for details on implementation.  |

Table 36. Signal Description (Page 3 of 8)

| Name       | Type              | Description  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
|------------|-------------------|--|------------|-------------------|-------|-----------|-------|-----------|-----------|-----------|-------|-----------|---|---|-----------|---|---|
| D[63:0]#   | Input/<br>Output  | <p>D[63:0]# (Data) are the data signals. These signals provide a 64-bit data path between the processor system bus agents, and must connect the appropriate pins on all such agents. The data driver asserts DRDY# to indicate a valid data transfer.</p> <p>D[63:0]# are quad-pumped signals and will thus be driven four times in a common clock period. D[63:0]# are latched off the falling edge of both DSTBP[3:0]# and DSTBN[3:0]#. Each group of 16 data signals correspond to a pair of one DSTBP# and one DSTBN#. The following table shows the grouping of data signals to data strobes and DBI#.</p> <p><b>Quad-Pumped Signal Groups</b></p> <table><tr><th>Data Group</th><th>DSTBN#/<br/>DSTBP#</th><th>DBI#</th></tr><tr><td>D[15:0]#</td><td>0</td><td>0</td></tr><tr><td>D[31:16]#</td><td>1</td><td>1</td></tr><tr><td>D[47:32]#</td><td>2</td><td>2</td></tr><tr><td>D[63:48]#</td><td>3</td><td>3</td></tr></table> <p>Furthermore, the DBI# pins determine the polarity of the data signals. Each group of 16 data signals corresponds to one DBI# signal. When the DBI# signal is active, the corresponding data group is inverted and therefore sampled active high.</p> | Data Group | DSTBN#/<br>DSTBP# | DBI#  | D[15:0]#  | 0     | 0         | D[31:16]# | 1         | 1     | D[47:32]# | 2 | 2 | D[63:48]# | 3 | 3 |
| Data Group | DSTBN#/<br>DSTBP# | DBI#   |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| D[15:0]#   | 0                 | 0  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| D[31:16]#  | 1                 | 1  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| D[47:32]#  | 2                 | 2  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| D[63:48]#  | 3                 | 3  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DBI[3:0]#  | Input/<br>Output  | <p>DBI[3:0]# (Data Bus Inversion) are source synchronous and indicate the polarity of the D[63:0]# signals. The DBI[3:0]# signals are activated when the data on the data bus is inverted. The bus agent will invert the data bus signals if more than half the bits, within the covered group, would change level in the next cycle.</p> <p><b>DBI[3:0] Assignment To Data Bus</b></p> <table><tr><th>Bus Signal</th><th>Data Bus Signals</th></tr><tr><td>DBI3#</td><td>D[63:48]#</td></tr><tr><td>DBI2#</td><td>D[47:32]#</td></tr><tr><td>DBI1#</td><td>D[31:16]#</td></tr><tr><td>DBI0#</td><td>D[15:0]#</td></tr></table>  | Bus Signal | Data Bus Signals  | DBI3# | D[63:48]# | DBI2# | D[47:32]# | DBI1#     | D[31:16]# | DBI0# | D[15:0]#  |   |   |           |   |   |
| Bus Signal | Data Bus Signals  |  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DBI3#      | D[63:48]#         |  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DBI2#      | D[47:32]#         |  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DBI1#      | D[31:16]#         |  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DBI0#      | D[15:0]#          |  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DBR#       | Output            | DBR# (Data Bus Reset) is used only in processor systems where no debug port is implemented on the system board. DBR# is used by a debug port interposer so that an in-target probe can drive system reset. If a debug port is implemented in the system, DBR# is a no connect in the system. DBR# is not a processor signal.   |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DBSY#      | Input/<br>Output  | DBSY# (Data Bus Busy) is asserted by the agent responsible for driving data on the processor system bus to indicate that the data bus is in use. The data bus is released after DBSY# is deasserted. This signal must connect the appropriate pins on all processor system bus agents.   |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DEFER#     | Input             | DEFER# is asserted by an agent to indicate that a transaction cannot be guaranteed in-order completion. Assertion of DEFER# is normally the responsibility of the addressed memory or Input/Output agent. This signal must connect the appropriate pins of all processor system bus agents.  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DP[3:0]#   | Input/<br>Output  | DP[3:0]# (Data parity) provide parity protection for the D[63:0]# signals. They are driven by the agent responsible for driving D[63:0]#, and must connect the appropriate pins of all Mobile Intel Pentium 4 Processor-M system bus agents.   |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |
| DPSLP#     | Input             | DPSLP# when asserted on the platform causes the processor to transition from the Sleep State to the Deep Sleep state. In order to return to the Sleep State, DPSLP# must be deasserted and BCLK[1:0] must be running.  |            |                   |       |           |       |           |           |           |       |           |   |   |           |   |   |

Table 36. Signal Description (Page 4 of 8)

| Name             | Type              | Description  |         |                   |                 |         |                  |         |                  |         |                  |         |
|------------------|-------------------|--|---------|-------------------|-----------------|---------|------------------|---------|------------------|---------|------------------|---------|
| DRDY#            | Input/<br>Output  | DRDY# (Data Ready) is asserted by the data driver on each data transfer, indicating valid data on the data bus. In a multi-common clock data transfer, DRDY# may be deasserted to insert idle clocks. This signal must connect the appropriate pins of all processor system bus agents.  |         |                   |                 |         |                  |         |                  |         |                  |         |
| DSTBN[3:0]#      | Input/<br>Output  | <p>Data strobe used to latch in D[63:0]#.</p> <table><tr><th>Signals</th><th>Associated Strobe</th></tr><tr><td>D[15:0]#, DBI0#</td><td>DSTBN0#</td></tr><tr><td>D[31:16]#, DBI1#</td><td>DSTBN1#</td></tr><tr><td>D[47:32]#, DBI2#</td><td>DSTBN2#</td></tr><tr><td>D[63:48]#, DBI3#</td><td>DSTBN3#</td></tr></table>  | Signals | Associated Strobe | D[15:0]#, DBI0# | DSTBN0# | D[31:16]#, DBI1# | DSTBN1# | D[47:32]#, DBI2# | DSTBN2# | D[63:48]#, DBI3# | DSTBN3# |
| Signals          | Associated Strobe |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| D[15:0]#, DBI0#  | DSTBN0#           |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| D[31:16]#, DBI1# | DSTBN1#           |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| D[47:32]#, DBI2# | DSTBN2#           |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| D[63:48]#, DBI3# | DSTBN3#           |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| DSTBP[3:0]#      | Input/<br>Output  | <p>Data strobe used to latch in D[63:0]#.</p> <table><tr><th>Signals</th><th>Associated Strobe</th></tr><tr><td>D[15:0]#, DBI0#</td><td>DSTBP0#</td></tr><tr><td>D[31:16]#, DBI1#</td><td>DSTBP1#</td></tr><tr><td>D[47:32]#, DBI2#</td><td>DSTBP2#</td></tr><tr><td>D[63:48]#, DBI3#</td><td>DSTBP3#</td></tr></table>  | Signals | Associated Strobe | D[15:0]#, DBI0# | DSTBP0# | D[31:16]#, DBI1# | DSTBP1# | D[47:32]#, DBI2# | DSTBP2# | D[63:48]#, DBI3# | DSTBP3# |
| Signals          | Associated Strobe |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| D[15:0]#, DBI0#  | DSTBP0#           |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| D[31:16]#, DBI1# | DSTBP1#           |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| D[47:32]#, DBI2# | DSTBP2#           |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| D[63:48]#, DBI3# | DSTBP3#           |  |         |                   |                 |         |                  |         |                  |         |                  |         |
| FERR#/PBE#       | Output            | FERR#/PBE# (floating point error/pending break event) is a multiplexed signal and its meaning is qualified by STPCLK#. When STPCLK# is not asserted, FERR#/PBE# indicates a floating-point error and will be asserted when the processor detects an unmasked floating-point error. When STPCLK# is not asserted, FERR#/PBE# is similar to the ERROR# signal on the INTEL 387 coprocessor, and is included for compatibility with systems using MS-DOS*-type floating-point error reporting. When STPCLK# is asserted, an assertion of FERR#/PBE# indicates that the processor has a pending break event waiting for service. The assertion of FERR#/PBE# indicates that the processor should be returned to the Normal state. When FERR#/PBE# is asserted, indicating a break event, it will remain asserted until STPCLK# is deasserted. For additional information on the pending break event functionality, including the identification of support of the feature and enable/disable information, refer to volume 3 of the <i>Intel Architecture Software Developer's Manual</i> and the <i>Intel Processor Identification and the CPUID Instruction</i> application note. |         |                   |                 |         |                  |         |                  |         |                  |         |
| GHI#             | Input             | The GHI# signal controls the selection of the operating mode bus ratio and voltage in the Mobile Intel Pentium 4 Processor-M. On the Mobile Intel Pentium 4 Processor-M featuring Enhanced Intel SpeedStep technology, this signal is latched on entry to Sleep state and is observed during the Deep Sleep state. GHI# determines which of two performance states is selected for operation. This signal is ignored when the processor is not in the Deep Sleep state. This signal should be driven with an Open-drain driver. For connection and termination guidelines refer to the <i>Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide</i> .  |         |                   |                 |         |                  |         |                  |         |                  |         |
| GTLREF           | Input             | GTLREF determines the signal reference level for AGTL+ input pins. GTLREF should be set at 2/3 V <sub>CC</sub> . GTLREF is used by the AGTL+ receivers to determine if a signal is a logical 0 or logical 1. Refer to the <i>Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide</i> for more information.   |         |                   |                 |         |                  |         |                  |         |                  |         |

Table 36. Signal Description (Page 5 of 8)

| Name               | Type                                     | Description   |
|--------------------|--|---|
| HIT#<br><br>HITM#  | Input/<br>Output<br><br>Input/<br>Output | HIT# (Snoop Hit) and HITM# (Hit Modified) convey transaction snoop operation results. Any system bus agent may assert both HIT# and HITM# together to indicate that it requires a snoop stall, which can be continued by reasserting HIT# and HITM# together.   |
| IERR#              | Output                                   | IERR# (Internal Error) is asserted by a processor as the result of an internal error. Assertion of IERR# is usually accompanied by a SHUTDOWN transaction on the processor system bus. This transaction may optionally be converted to an external error signal (e.g., NMI) by system core logic. The processor will keep IERR# asserted until the assertion of RESET#.<br><br><b>This signal does not have on-die termination and must be terminated on the system board.</b>  |
| IGNNE#             | Input                                    | IGNNE# (Ignore Numeric Error) is asserted to force the processor to ignore a numeric error and continue to execute noncontrol floating-point instructions. If IGNNE# is deasserted, the processor generates an exception on a noncontrol floating-point instruction if a previous floating-point instruction caused an error. IGNNE# has no effect when the NE bit in control register 0 (CR0) is set.<br><br>IGNNE# is an asynchronous signal. However, to ensure recognition of this signal following an Input/Output write instruction, it must be valid along with the TRDY# assertion of the corresponding Input/Output Write bus transaction. |
| INIT#              | Input                                    | INIT# (Initialization), when asserted, resets integer registers inside the processor without affecting its internal caches or floating-point registers. The processor then begins execution at the power-on Reset vector configured during power-on configuration. The processor continues to handle snoop requests during INIT# assertion. INIT# is an asynchronous signal and must connect the appropriate pins of all processor system bus agents.<br><br>If INIT# is sampled active on the active to inactive transition of RESET#, then the processor executes its Built-in Self-Test (BIST).  |
| ITPCLKOUT<br>[1:0] | Output                                   | ITPCLKOUT[1:0] is an uncompensated differential clock output that is a delayed copy of the BCLK[1:0], which is an input to the processor. This clock output can be used as the differential clock into the ITP port that is designed onto the motherboard. If ITPCLKOUT[1:0] outputs are not used, they must be terminated properly. Refer to <a href="#">Section 2.5</a> for additional details and termination requirements. Refer to the <i>ITP700 Debug Port Design Guide</i> for details on implementing a debug port.   |
| ITP_CLK[1:0]       | Input                                    | ITP_CLK[1:0] are copies of BCLK that are used only in processor systems where no debug port is implemented on the system board. ITP_CLK[1:0] are used as BCLK[1:0] references for a debug port implemented on an interposer. If a debug port is implemented in the system, ITP_CLK[1:0] are no connects in the system. These are not processor signals.   |
| LINT[1:0]          | Input                                    | LINT[1:0] (Local APIC Interrupt) must connect the appropriate pins of all APIC Bus agents. When the APIC is disabled, the LINT0 signal becomes INTR, a maskable interrupt request signal, and LINT1 becomes NMI, a nonmaskable interrupt. INTR and NMI are backward compatible with the signals of those names on the Pentium processor. Both signals are asynchronous.<br><br>Both of these signals must be software configured via BIOS programming of the APIC register space to be used either as NMI/INTR or LINT[1:0]. Because the APIC is enabled by default after Reset, operation of these pins as LINT[1:0] is the default configuration. |

Table 36. Signal Description (Page 6 of 8)

| Name      | Type             | Description   |
|-----------|------------------|---|
| LOCK#     | Input/<br>Output | <p>LOCK# indicates to the system that a transaction must occur atomically. This signal must connect the appropriate pins of all processor system bus agents. For a locked sequence of transactions, LOCK# is asserted from the beginning of the first transaction to the end of the last transaction.</p> <p>When the priority agent asserts BPRI# to arbitrate for ownership of the processor system bus, it will wait until it observes LOCK# deasserted. This enables symmetric agents to retain ownership of the processor system bus throughout the bus locked operation and ensure the atomicity of lock.</p>   |
| MCERR#    | Input/<br>Output | <p>MCERR# (Machine Check Error) is asserted to indicate an unrecoverable error without a bus protocol violation. It may be driven by all processor system bus agents.</p> <p>MCERR# assertion conditions are configurable at a system level. Assertion options are defined by the following options:</p> <ul style="list-style-type: none"> <li>Enabled or disabled.</li> <li>Asserted, if configured, for internal errors along with IERR#.</li> <li>Asserted, if configured, by the request initiator of a bus transaction after it observes an error.</li> <li>Asserted by any bus agent when it observes an error in a bus transaction.</li> </ul> <p>For more details regarding machine check architecture, please refer to the <i>IA-32 Software Developer's Manual, Volume 3: System Programming Guide</i>.</p>  |
| PROCHOT#  | Output           | The assertion of PROCHOT# (Processor Hot) indicates that the processor die temperature has reached its thermal limit. See Section 6 for more details.   |
| PWRGOOD   | Input            | <p>PWRGOOD (Power Good) is a processor input. The processor requires this signal to be a clean indication that the clocks and power supplies are stable and within their specifications. 'Clean' implies that the signal will remain low (capable of sinking leakage current), without glitches, from the time that the power supplies are turned on until they come within specification. The signal must then transition monotonically to a high state. Figure 16 illustrates the relationship of PWRGOOD to the RESET# signal. PWRGOOD can be driven inactive at any time, but clocks and power must again be stable before a subsequent rising edge of PWRGOOD. It must also meet the minimum pulse width specification in Table 21, and be followed by a 1 to 10 ms RESET# pulse.</p> <p>The PWRGOOD signal must be supplied to the processor; it is used to protect internal circuits against voltage sequencing issues. It should be driven high throughout boundary scan operation.</p> |
| REQ[4:0]# | Input/<br>Output | REQ[4:0]# (Request Command) must connect the appropriate pins of all processor system bus agents. They are asserted by the current bus owner to define the currently active transaction type. These signals are source synchronous to ADSTB0#. Refer to the AP[1:0]# signal description for details on parity checking of these signals.  |
| RESET#    | Input            | <p>Asserting the RESET# signal resets the processor to a known state and invalidates its internal caches without writing back any of their contents. For a power-on Reset, RESET# must stay active for at least one millisecond after Vcc and BCLK have reached their proper specifications. On observing active RESET#, all system bus agents will deassert their outputs within two clocks. RESET# must not be kept asserted for more than 10 ms while PWRGOOD is asserted.</p> <p>A number of bus signals are sampled at the active-to-inactive transition of RESET# for power-on configuration. These configuration options are described in the Section 7.1.</p> <p><b>This signal does not have on-die termination and must be terminated on the system board.</b></p>  |
| RS[2:0]#  | Input            | RS[2:0]# (Response Status) are driven by the response agent (the agent responsible for completion of the current transaction), and must connect the appropriate pins of all processor system bus agents.  |

Table 36. Signal Description (Page 7 of 8)

| Name                        | Type   | Description  |
|-----------------------------|--------|--|
| RSP#                        | Input  | RSP# (Response Parity) is driven by the response agent (the agent responsible for completion of the current transaction) during assertion of RS[2:0]#, the signals for which RSP# provides parity protection. It must connect to the appropriate pins of all processor system bus agents.<br><br>A correct parity signal is high if an even number of covered signals are low and low if an odd number of covered signals are low. While RS[2:0]# = 000, RSP# is also high, since this indicates it is not being driven by any agent guaranteeing correct parity.  |
| SKTOCC#                     | Output | SKTOCC# (Socket Occupied) will be pulled to ground by the processor. System board designers may use this pin to determine if the processor is present.   |
| SLP#                        | Input  | SLP# (Sleep), when asserted in Stop-Grant state, causes the processor to enter the Sleep state. During Sleep state, the processor stops providing internal clock signals to all units, leaving only the Phase-Locked Loop (PLL) still operating. Processors in this state will not recognize snoops or interrupts. The processor will only recognize the assertion of the RESET# signal, deassertion of SLP#, and assertion of DPSP# input while in Sleep state. If SLP# is deasserted, the processor exits Sleep state and returns to Stop-Grant state, restarting its internal clock signals to the bus and processor core units. If DPSP# is asserted while in the Sleep state, the processor will exit the Sleep state and transition to the Deep Sleep state. |
| SMI#                        | Input  | SMI# (System Management Interrupt) is asserted asynchronously by system logic. On accepting a System Management Interrupt, the processor saves the current state and enter System Management Mode (SMM). An SMI Acknowledge transaction is issued, and the processor begins program execution from the SMM handler.<br><br>If SMI# is asserted during the deassertion of RESET# the processor will tristate its outputs.   |
| STPCLK#                     | Input  | Assertion of STPCLK# (Stop Clock) causes the processor to enter a low power Stop-Grant state. The processor issues a Stop-Grant Acknowledge transaction, and stops providing internal clock signals to all processor core units except the system bus and APIC units. The processor continues to snoop bus transactions and service interrupts while in Stop-Grant state. When STPCLK# is deasserted, the processor restarts its internal clock to all units and resumes execution. The assertion of STPCLK# has no effect on the bus clock; STPCLK# is an asynchronous input.   |
| TCK                         | Input  | TCK (Test Clock) provides the clock input for the processor Test Bus (also known as the Test Access Port).   |
| TDI                         | Input  | TDI (Test Data In) transfers serial test data into the processor. TDI provides the serial input needed for JTAG specification support.   |
| TDO                         | Output | TDO (Test Data Out) transfers serial test data out of the processor. TDO provides the serial output needed for JTAG specification support.   |
| TESTHI[10:8]<br>TESTHI[5:0] | Input  | TESTHI[10:8] and TESTHI[5:0] must be connected to a V <sub>CC</sub> power source through a resistor for proper processor operation. See <a href="#">Section 2.5</a> for more details.  |
| THERMDA                     | Other  | Thermal Diode Anode. See Section 6.  |
| THERMDC                     | Other  | Thermal Diode Cathode. See Section 6.  |

Table 36. Signal Description (Page 8 of 8)

| Name                 | Type   | Description   |
|----------------------|--------|---|
| THERMTRIP#           | Output | Assertion of THERMTRIP# (Thermal Trip) indicates the processor junction temperature has reached a level beyond which permanent silicon damage may occur. Measurement of the temperature is accomplished through an internal thermal sensor which is configured to trip at approximately 135°C. Upon assertion of THERMTRIP#, the processor will shut off its internal clocks (thus halting program execution) in an attempt to reduce the processor junction temperature. To protect the processor, its core voltage (V <sub>CC</sub> ) must be removed following the assertion of THERMTRIP#. See Figure 19 and Table 21 for the appropriate power down sequence and timing requirements. Once activated, THERMTRIP# remains latched until RESET# is asserted. While the assertion of the RESET# signal will deassert THERMTRIP#, if the processor's junction temperature remains at or above the trip level, THERMTRIP# will again be asserted. |
| TMS                  | Input  | TMS (Test Mode Select) is a JTAG specification support signal used by debug tools.  |
| TRDY#                | Input  | TRDY# (Target Ready) is asserted by the target to indicate that it is ready to receive a write or implicit writeback data transfer. TRDY# must connect the appropriate pins of all system bus agents.   |
| TRST#                | Input  | TRST# (Test Reset) resets the Test Access Port (TAP) logic. TRST# must be driven low during power on Reset. This can be done with a 680 ohm pull-down resistor.   |
| V <sub>CCA</sub>     | Input  | V <sub>CCA</sub> provides isolated power for the internal processor core PLL's. Refer to the Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide for complete implementation details.   |
| V <sub>CCIOPLL</sub> | Input  | V <sub>CCIOPLL</sub> provides isolated power for internal processor system bus PLL's. Follow the guidelines for V <sub>CCA</sub> , and refer to the Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide for complete implementation details.  |
| V <sub>CCSENSE</sub> | Output | V <sub>CCSENSE</sub> is an isolated low impedance connection to processor core power (V <sub>CC</sub> ). It can be used to sense or measure power near the silicon with little noise.   |
| VCCVID               | Input  | Independent 1.2-V supply must be routed to VCCVID pin for the Mobile Intel Pentium 4 Processor-M's Voltage Identification circuit.  |
| VID[4:0]             | Output | VID[4:0] (Voltage ID) pins are used to support automatic selection of power supply voltages (V <sub>CC</sub> ). Unlike some previous generations of processors, these are open drain signals that are driven by the Mobile Intel Pentium 4 Processor-M and must be pulled up to 3.3V (max.) with 1Kohm resistors. The voltage supply for these pins must be valid before the VR can supply V <sub>CC</sub> to the processor. Conversely, the VR output must be disabled until the voltage supply for the VID pins becomes valid. The VID pins are needed to support the processor voltage specification variations. See Table 2 for definitions of these pins. The VR must supply the voltage that is requested by the pins, or disable itself.   |
| V <sub>SSA</sub>     | Input  | V <sub>SSA</sub> is the isolated ground for internal PLLs.  |
| V <sub>SSSENSE</sub> | Output | V <sub>SSSENSE</sub> is an isolated low impedance connection to processor core V <sub>SS</sub> . It can be used to sense or measure ground near the silicon with little noise.  |

## 6. Thermal Specifications and Design Considerations

In order to achieve proper cooling of the processor, a thermal solution (e.g., heat spreader, heat pipe, or other heat transfer system) must make firm contact to the exposed processor die. The processor die must be clean before the thermal solution is attached or the processor may be damaged.

Table 37 provides the Thermal Design Power (TDP) dissipation and the minimum and maximum  $T_J$  temperatures for the Mobile Intel Pentium 4 Processor-M. A thermal solution should be designed to ensure the junction temperature never exceeds the 100°C  $T_J$  specification while operating at the Thermal Design Power. Additionally, a secondary failsafe mechanism in hardware must be provided to shutdown the processor under catastrophic thermal conditions, as described in Section 2.4.3. TDP is a thermal design power specification based on the worst case power dissipation of the processor while executing publicly available software under normal operating conditions at nominal voltages. Contact your Intel Field Sales Representative for further information.

**Table 37. Power Specifications for the Mobile Intel Pentium 4 Processor-M**

| Symbol                              | Parameter  | Min | Typ  | Max        | Unit | Notes            |
|-------------------------------------|--|-----|--|------------|------|------------------|
| TDP                                 | Thermal Design Power at<br>2 GHz & 1.3 V<br>1.90 GHz & 1.3 V<br>1.80 GHz & 1.3 V<br>1.70 GHz & 1.3 V<br>1.60 GHz & 1.3 V<br>1.50 GHz & 1.3 V<br>1.40 GHz & 1.3 V<br>1.20 GHz & 1.2 V |     | 32.0<br>32.0<br>30.0<br>30.0<br>30.0<br>26.9<br>25.8<br>20.8 |            | W    | At 100°C, Note 1 |
| $P_{AH}$<br>$P_{SGNT}$<br>$P_{SLP}$ | Auto Halt/Stop Grant/Sleep<br>Power at<br>1.3 V<br>1.2 V   |     |  | 7.5<br>5.9 | W    | At 50°C, Note 2  |
| $P_{DRLP}$                          | Deep Sleep Power at<br>1.3 V<br>1.2 V  |     |  | 5.0<br>4.2 | W    | At 35°C, Note 2  |
| $P_{DPRSLP}$                        | Deeper Sleep Power at<br>1.0 V   |     |  | 2.9        | W    | At 35°C, Note 2  |
| $T_J$                               | Junction Temperature   | 0   |  | 100        | °C   | Note 3           |

### NOTES:

1. TDP is defined as the worst case power dissipated by the processor while executing publicly available software under normal operating conditions at nominal voltages that meet the load line specifications. The TDP number shown is a specification based on  $I_{CC}$  (maximum) at nominal voltages and indirectly tested by this  $I_{CC}$  (maximum) testing. TDP definition is synonymous with the Thermal Design Power (typical) specification. The Intel TDP specification is a recommended design point and is not representative of the absolute maximum power the processor may dissipate under worst case conditions.
2. Not 100% tested. These power specifications are determined by characterization of the processor currents at higher temperatures and extrapolating the values for the temperature indicated.
3. The maximum junction temperature ( $T_J$ ) is specified as the hottest location on the die. The Thermal Monitor's automatic mode is used to indicate that the maximum  $T_J$  has been reached. Refer to Section 6.1.1 for  $T_J$  measurement guidelines (refer to Section 6.1.2 for Thermal Monitor details).

## 6.1 Thermal Specifications

### 6.1.1 Thermal Diode

The Mobile Intel Pentium 4 Processor-M incorporates two methods of monitoring die temperature, the Thermal Monitor and the Thermal Diode. The Thermal Monitor (detailed in [Section 6.1.2](#)) must be used to determine when the maximum specified processor junction temperature has been reached. The second method, the Thermal Diode, can be read by an off-die analog/digital converter (a thermal sensor) located on the motherboard, or a stand-alone measurement kit. The thermal diode may be used to monitor the die temperature of the processor for thermal management or instrumentation purposes but cannot be used to indicate that the maximum  $T_J$  of the processor has been reached. [Table 38](#) and [Table 39](#) provides the diode interface and specifications.

**Note:** The reading of the thermal sensor connected to the thermal diode does not reflect the temperature of the hottest location on the die ( $T_J$ ). This is due to inaccuracies in the thermal diode, on-die temperature gradients between the location of the thermal diode and the hottest location on the die, and time based variations in the die temperature. Time based variations can occur since the sampling rate of the sensor is much slower than the die level temperature changes.

The offset between the thermal diode based temperature reading and the hottest location of the die (Thermal Monitor) may be characterized using the Thermal Monitor's Automatic mode activation of thermal control circuit. This temperature offset must be taken into account when using the processor thermal diode to implement power management events.

**Table 38. Thermal Diode Interface**

| Signal Name | Pin/Ball Number | Signal Description    |
|-------------|-----------------|-----------------------|
| THERMDA     | B3              | Thermal diode anode   |
| THERMDC     | C4              | Thermal diode cathode |

**Table 39. Thermal Diode Specifications**

| Symbol   | Parameter             | Min    | Typ    | Max    | Unit    | Notes   |
|----------|-----------------------|--------|--------|--------|---------|---------|
| $I_{FW}$ | Forward Bias Current  | 5      |        | 300    | $\mu A$ | 1       |
| n        | Diode Ideality Factor | 1.0012 | 1.0021 | 1.0030 |         | 2, 3, 4 |
| $R_T$    | Series Resistance     |        | 3.86   |        | ohms    | 2, 3, 5 |

**NOTES:**

- Intel does not support or recommend operation of the thermal diode under reverse bias.
- Characterized at 100°C.
- Not 100% tested. Specified by design characterization.
- The ideality factor, n, represents the deviation from ideal diode behavior as exemplified by the diode equation:  

$$I_{FW} = I_S * (e^{(qV_D/nkT)} - 1)$$
 Where  $I_S$  = saturation current, q = electronic charge,  $V_D$  = voltage across the diode, k = Boltzmann Constant, and T = absolute temperature (Kelvin).
- The series resistance,  $R_T$ , is provided to allow for a more accurate measurement of the diode junction temperature.  $R_T$  as defined includes the pins of the processor but does not include any socket resistance or board trace resistance between the socket and the external remote diode thermal sensor.  $R_T$  can be used by remote diode thermal sensors with automatic series resistance cancellation to calibrate out this error term. Another application is that a temperature offset can be manually calculated and programmed into an offset register in the remote diode thermal sensors as exemplified by the equation:  

$$T_{error} = [R_T * (N - 1) * I_{FWmin}] / [(nk/q) * \ln N]$$
 Where  $T_{error}$  = sensor temperature error, N = sensor current ratio, k = Boltzmann Constant, q = electronic charge.

## 6.1.2 Thermal Monitor

The Thermal Monitor feature found in the Mobile Intel Pentium 4 Processor-M allows system designers to design lower cost thermal solutions without compromising system integrity or reliability. By using a factory-tuned, precision on-die thermal sensor, and a fast acting thermal control circuit (TCC), the processor, without the aid of any additional software or hardware, can keep the processor's die temperature within factory specifications under nearly all conditions. Thermal Monitor thus allows the processor and system thermal solutions to be designed much closer to the power envelopes of real applications, instead of being designed to the much higher maximum processor power envelopes.

Thermal Monitor controls the processor temperature by modulating (starting and stopping) the processor core clocks. The processor clocks are modulated when the thermal control circuit (TCC) is activated. Thermal Monitor uses two modes to activate the TCC: Automatic mode and On-Demand mode. **Automatic mode is required for the processor to operate within specifications and must first be enabled via BIOS.** Once automatic mode is enabled, the TCC will activate only when the internal die temperature is very near the temperature limits of the processor. When TCC is enabled, and a high temperature situation exists (i.e. TCC is active), the clocks will be modulated by alternately turning the clocks off and on at a duty cycle specific to the processor (typically 30-50%). Cycle times are processor speed dependent and will decrease linearly as processor core frequencies increase. Once the temperature has returned to a non-critical level, modulation ceases and TCC goes inactive. A small amount of hysteresis has been included to prevent rapid active/inactive transitions of the TCC when the processor temperature is near the trip point. Processor performance will be decreased by approximately the same amount as the duty cycle when the TCC is active, however, with a properly designed and characterized thermal solution, the TCC will only be activated briefly when running the most power intensive applications in a high ambient temperature environment.

For automatic mode, the duty cycle is factory configured and cannot be modified. Also, automatic mode does not require any additional hardware, software drivers or interrupt handling routines.

The TCC may also be activated via On-Demand mode. If bit 4 of the ACPI Thermal Monitor Control Register is written to a "1" the TCC will be activated immediately, independent of the processor temperature. When using On-Demand mode to activate the TCC, the duty cycle of the clock modulation is programmable via bits 3:1 of the same ACPI Thermal Monitor Control Register. In automatic mode, the duty cycle is fixed, however in On-Demand mode, the duty cycle can be programmed from 12.5% on/ 87.5% off, to 87.5% on/12.5% off in 12.5% increments. On-Demand mode may be used at the same time Automatic mode is enabled, however, if the system tries to enable the TCC via On-Demand mode at the same time automatic mode is enabled AND a high temperature condition exists, the duty cycle of the automatic mode will override the duty cycle selected by the On-Demand mode.

An external signal, PROCHOT# (processor hot) is asserted when the processor die temperature has reached its thermal limit. If the TCC is enabled (note that the TCC must be enabled for the processor to be operating within spec), TCC will be active when the PROCHOT# signal is active. The temperature at which the thermal control circuit activates is not user configurable and is not software visible. Bus snooping and interrupt latching are active while the TCC is active.

Besides the thermal sensor and TCC, the Thermal Monitor feature also includes one ACPI register, performance monitoring logic, bits in three model specific registers (MSR), and one I/O pin (PROCHOT#). All are available to monitor and control the state of the Thermal Monitor feature. Thermal Monitor can be configured to generate an interrupt upon the assertion or deassertion of PROCHOT#.

If automatic mode is disabled the processor will be operating out of specification. Regardless of enabling of the automatic or On-Demand modes, in the event of a catastrophic cooling failure, the processor will automatically shut down when the silicon has reached a temperature of approximately 135 °C. At this point the system bus signal THERMTRIP# will go active and stay active until RESET# has been initiated. THERMTRIP# activation is independent of processor activity and does not generate any bus cycles. If THERMTRIP# is asserted, processor core voltage ( $V_{CC}$ ) must be removed within the timeframe defined in [Table 21](#).

## 7. Configuration and Low Power Features

### 7.1 Power-On Configuration Options

Several configuration options can be configured by hardware. The Mobile Intel Pentium 4 Processor-M samples its hardware configuration at reset, on the active-to-inactive transition of RESET#. For specifications on these options, please refer to [Table 40](#).

The sampled information configures the processor for subsequent operation. These configuration options cannot be changed except by another reset. All resets reconfigure the processor.

**Table 40. Power-On Configuration Option Pins**

| Configuration Option                           | Pin <sup>1</sup> |
|--|------------------|
| Output tristate                                | SMI#             |
| Execute BIST                                   | INIT#            |
| In Order Queue pipelining (set IOQ depth to 1) | A7#              |
| Disable MCERR# observation                     | A9#              |
| Disable BINIT# observation                     | A10#             |
| APIC Cluster ID (0-3)                          | A[12:11]#        |
| Disable bus parking                            | A15#             |
| Symmetric agent arbitration ID                 | BR0#             |

**NOTE:** Asserting this signal during RESET# will select the corresponding option.

### 7.2 Clock Control and Low Power States

The use of AutoHALT, Stop-Grant, Sleep, Deep Sleep and Deeper Sleep states is allowed in Mobile Intel Pentium 4 Processor-M based systems to reduce power consumption by stopping the clock to internal sections of the processor, depending on each particular state. See [Figure 35](#) for a visual representation of the processor low-power states.

#### 7.2.1 Normal State

This is the normal operating state for the processor.

#### 7.2.2 AutoHALT Powerdown State

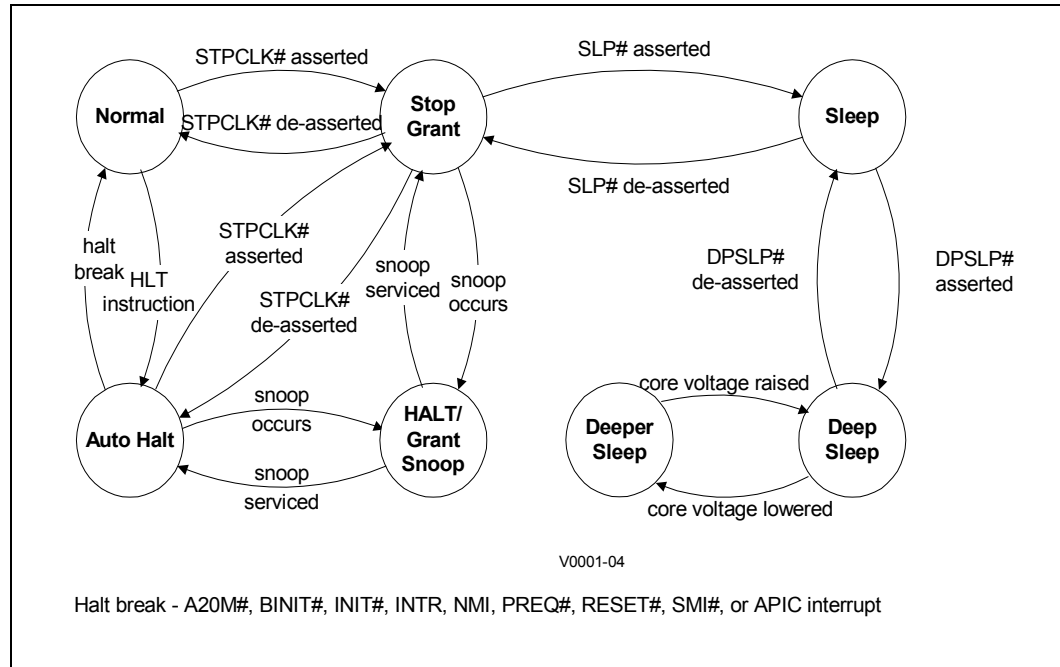
AutoHALT is a low-power state entered when the processor executes the HALT instruction. The processor will transition to the Normal state upon the occurrence of SMI#, BINIT#, INIT#, LINT[1:0] (NMI, INTR), or PSB interrupt message. RESET# will cause the processor to immediately initialize itself.

The return from a System Management Interrupt (SMI) handler can be to either Normal Mode or the AutoHALT Powerdown state. See the *Intel® Architecture Software Developer's Manual, Volume III: System Programmer's Guide* for more information.

The system can generate a STPCLK# while the processor is in the AutoHALT Powerdown state. When the system deasserts the STPCLK# interrupt, the processor will return execution to the HALT state.

While in AutoHALT Powerdown state, the processor will process bus snoops.

**Figure 35. Clock Control States**



### 7.2.3 Stop-Grant State

When the STPCLK# pin is asserted, the Stop-Grant state of the processor is entered 20 bus clocks after the response phase of the processor issued Stop Grant Acknowledge special bus cycle.

Since the AGTL+ signal pins receive power from the system bus, these pins should not be driven (allowing the level to return to  $V_{CC}$ ) for minimum power drawn by the termination resistors in this state. In addition, all other input pins on the system bus should be driven to the inactive state.

BINIT# will not be serviced while the processor is in Stop-Grant state. The event will be latched and can be serviced by software upon exit from the Stop-Grant state.

RESET# will cause the processor to immediately initialize itself, but the processor will stay in Stop-Grant state. A transition back to the Normal state will occur with the de-assertion of the STPCLK# signal. When re-entering the Stop-Grant state from the Sleep state, STPCLK# should only be de-asserted one or more bus clocks after the de-assertion of SLP#.

A transition to the HALT/Grant Snoop state will occur when the processor detects a snoop on the system bus (see [Section 7.2.4](#)). A transition to the Sleep state (see [Section 7.2.5](#)) will occur with the assertion of the SLP# signal.

While in the Stop-Grant State, SMI#, INIT#, BINIT# and LINT[1:0] will be latched by the processor, and only serviced when the processor returns to the Normal State. Only one occurrence of each event will be recognized upon return to the Normal state.

While in Stop-Grant state, the processor will process a system bus snoop.

## 7.2.4 HALT/Grant Snoop State

The processor will respond to snoop transactions on the system bus while in Stop-Grant state or in AutoHALT Power Down state. During a snoop transaction, the processor enters the HALT/Grant Snoop state. The processor will stay in this state until the snoop on the system bus has been serviced (whether by the processor or another agent on the system bus). After the snoop is serviced, the processor will return to the Stop-Grant state or AutoHALT Power Down state, as appropriate.

## 7.2.5 Sleep State

The Sleep state is a low power state in which the processor maintains its context, maintains the phase-locked loop (PLL), and has stopped all internal clocks. The Sleep state can only be entered from Stop-Grant state. Once in the Stop-Grant state, the processor will enter the Sleep state upon the assertion of the SLP# signal. The SLP# pin should only be asserted when the processor is in the Stop Grant state. SLP# assertions while the processor is not in the Stop-Grant state is out of specification and may result in unapproved operation.

Snoop events that occur while in Sleep State or during a transition into or out of Sleep state will cause unpredictable behaviour.

In the Sleep state, the processor is incapable of responding to snoop transactions or latching interrupt signals. No transitions or assertions of signals (with the exception of SLP#, DPSLP# or RESET#) are allowed on the system bus while the processor is in Sleep state. Any transition on an input signal before the processor has returned to Stop-Grant state will result in unpredictable behaviour.

If RESET# is driven active while the processor is in the Sleep state, and held active as specified in the RESET# pin specification, then the processor will reset itself, ignoring the transition through Stop-Grant State. If RESET# is driven active while the processor is in the Sleep State, the SLP# and STPCLK# signals should be deasserted immediately after RESET# is asserted to ensure the processor correctly executes the Reset sequence.

While in the Sleep state, the processor is capable of entering an even lower power state, the Deep Sleep state, by asserting the DPSLP# pin. (See [Section 7.2.6](#).) Once in the Sleep or Deep Sleep states, the SLP# pin must be de-asserted if another asynchronous system bus event needs to occur. The SLP# pin has a minimum assertion of one BCLK period.

When the processor is in Sleep state, it will not respond to interrupts or snoop transactions.

## 7.2.6 Deep Sleep State

Deep Sleep state is a very low power state the processor can enter while maintaining context. Deep Sleep state is entered by asserting the DPSLP# pin. The DPSLP# pin must be deasserted to re-enter the Sleep state. A period of 30 microseconds (to allow for PLL stabilization) must occur before the processor can be considered to be in the Sleep State. Once in the Sleep state, the SLP# pin can be deasserted to re-enter the Stop-Grant state.

The clock may be stopped when the processor is in the Deep Sleep state in order to support the ACPI S1 state. The clock may only be stopped after DPSLP# is asserted and must be restarted before DPSLP# is deasserted. To provide maximum power conservation when stopping the clock during Deep Sleep, hold the BCLK0 input at  $V_{OL}$  and the BCLK1 input at  $V_{OH}$ .

While in Deep Sleep state, the processor is incapable of responding to snoop transactions or latching interrupt signals. No transitions of signals are allowed on the system bus while the processor is in Deep Sleep state. Any transition on an input signal before the processor has returned to Stop-Grant state will result in unpredictable behaviour.

### 7.2.7 Deeper Sleep State

The Deeper Sleep State is the lowest state power the processor can enter. This state is functionally identical to the Deep Sleep state but at a lower core voltage. The control signals to the voltage regulator to initiate a transition to the Deeper Sleep state are provided on the platform. Please refer the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide* for details.

## 7.3 Enhanced Intel SpeedStep Technology

The Mobile Intel Pentium 4 Processor-M, when used in conjunction with the requisite Intel SpeedStep technology applet or its equivalent, supports Enhanced Intel SpeedStep technology. Enhanced Intel SpeedStep technology allows the processor to switch between two core frequencies automatically based on CPU demand, without having to reset the processor or change the system bus frequency. The processor has two bus ratios and voltages programmed into it instead of one and the GHI# signal controls which bus ratio and voltage is used. After reset, the processor will start in the lower of its two core frequencies, the Battery Optimized mode. An operating mode transition to the high core frequency can be made by setting GHI# low, putting the processor into the Deep Sleep state, regulating to the new VID output, and returning to the Normal state. This puts the processor into the high core frequency, or Maximum Performance operating mode. Going through these steps with GHI# set high transitions the processor back to the low core frequency operating mode. The processor will drive the VID[4:0] pins with the VID of the current operating mode and the system logic is required to regulate the core voltage within specification for the driven VID.

## 8. **Debug Tools Specifications**

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Please refer to the *ITP700 Debug Port Design Guide* and the *Mobile Intel® Pentium® 4 Processor-M and Intel® 845MP/845MZ Chipset Platform Design Guide* for information regarding debug tools specifications.

### 8.1 **Logic Analyzer Interface (LAI)**

Intel is working with two logic analyzer vendors, Tektronix\* and Agilent\*, to provide logic analyzer interfaces (LAIs) for use in debugging Mobile Intel Pentium 4 Processor-M systems. Tektronix\* and Agilent\* or other qualified vendors should be contacted to get specific information about their logic analyzer interfaces. The following information is general in nature. Specific information must be obtained from the logic analyzer vendor.

Due to the complexity of Mobile Intel Pentium 4 Processor-M systems, the LAI is critical in providing the ability to probe and capture system bus signals. There are two sets of considerations to keep in mind when designing a Mobile Intel Pentium 4 Processor-M system that can make use of an LAI: mechanical and electrical.

#### 8.1.1 **Mechanical Considerations**

The LAI is installed between the processor socket and the Mobile Intel Pentium 4 Processor-M. The LAI pins plug into the socket, while the Mobile Intel Pentium 4 Processor-M pins plug into a socket on the LAI. Cabling that is part of the LAI egresses the system to allow an electrical connection between the Mobile Intel Pentium 4 Processor-M and a logic analyzer. The maximum volume occupied by the LAI, known as the keepout volume, as well as the cable egress restrictions, should be obtained from the logic analyzer vendor. System designers must make sure that the keepout volume remains unobstructed inside the system.

#### 8.1.2 **Electrical Considerations**

The LAI will also affect the electrical performance of the system bus; therefore, it is critical to obtain electrical load models from each of the logic analyzer vendors to be able to run system level simulations to prove that their tool will work in the system. Contact the logic analyzer vendor for electrical specifications and load models for the LAI solution they provide.