



# Intel® 82801E Communications I/O Controller Hub (C-ICH)

*for Applied Computing*

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## Advance Information Datasheet

### Product Features

- Supports Intel processors, the 82815E GMCH and the 82810E GMCH
- 8-Bit Hub Interface
  - 266 Mbyte/s maximum throughput
- Two integrated LAN controllers
- USB
  - Includes one UHCI Host Controller with a total of two ports
  - USB 1.1 compliant
- PCI Bus interface
  - Supports PCI Rev 2.2 specification at 33 MHz
  - 133 Mbyte/s maximum throughput
- Low-Pincount (LPC) interface
- Firmware Hub (FWH) interface
  - Supports 8-Mbyte memory size
- Integrated IDE controller supports Ultra100 DMA, Ultra66 and Ultra33 DMA mode transfers
- Interrupt Controller
  - Two cascaded 82C59 interrupt controllers
  - Integrated I/O (x) APIC supporting 24 interrupts
  - 15 interrupts supported in 8259 mode
- Two cascaded 8237 DMA controllers
- Integrated 82C54-compatible timers
- Real-time clock with 256-byte battery-backed CMOS RAM
- System Management Bus (SMBus)
  - Compatible with most two-wire components that are also I<sup>2</sup>C compatible
  - Slave interface allows external microcontroller to access system resources
- GPIO
  - Exact number varies by configuration. Maximum: 12 inputs, eight outputs, four I/O
- Integrated 16550 compatible UARTs
  - Two UARTs
  - Serial Interrupts
- Supports IRQ1/IRQ12 emulation to avoid external keyboard controller
- 1.8 V operation with 3.3 V I/O. 5 V tolerance on many buffers, including PCI and IDE
- Package: 421 BGA

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## Revision History

| Date          | Revision | Description  |
|---------------|----------|--|
| January 2001  | 003      | Corrected XOR Chain 2. Added note to CPUSLP# signal description. |
| December 2001 | 002      | Corrected pinouts and pin list.                                  |
| December 2001 | 001      | First release of this datasheet.                                 |

# 1.0 Introduction

The Intel® 82801E Communications I/O Controller Hub (82801E C-ICH) is a highly integrated multifunctional communications I/O controller hub that provides the interface to the PCI bus and integrates many of the functions needed in today's communications applications. This document provides a detailed description of the 82801E C-ICH thermal, electrical and mechanical specifications, including signals, pinout, packaging, electrical characteristics, and testability.

Figure 1 illustrates the typical system configuration using the 82801E C-ICH. Figure 2 is a simplified block diagram of the functional units of the 82801E C-ICH.

**Figure 1. System Configuration**

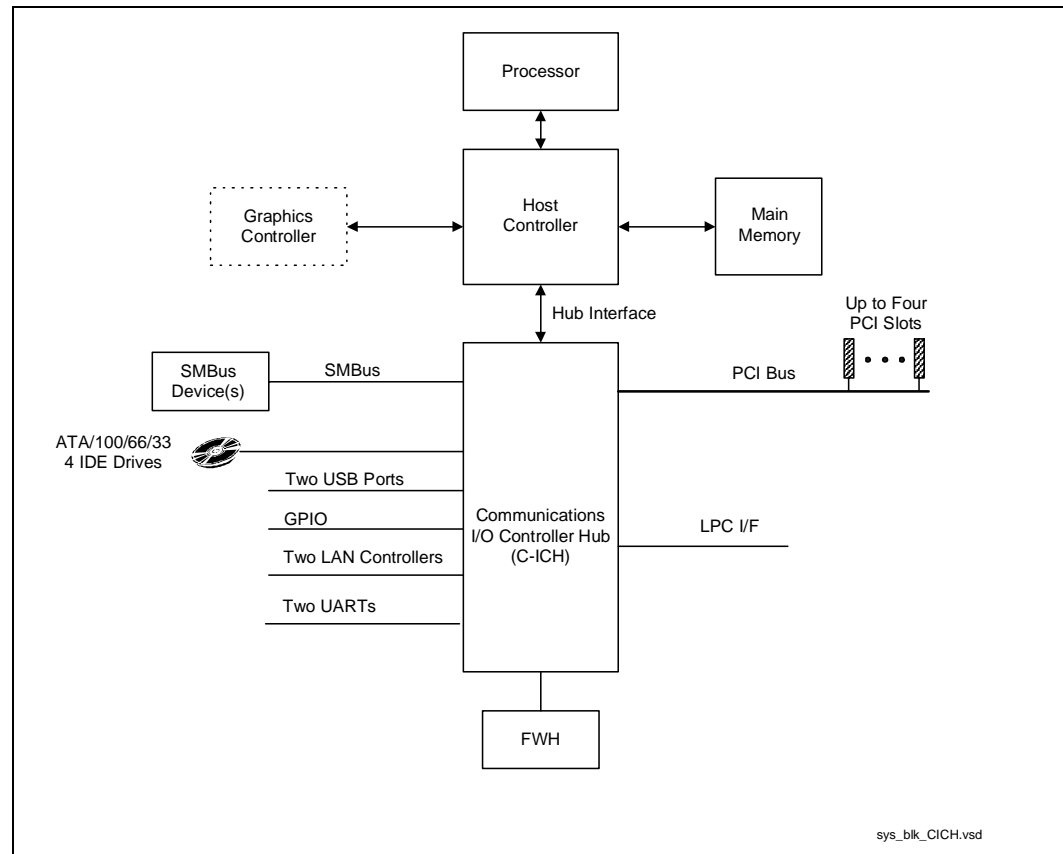
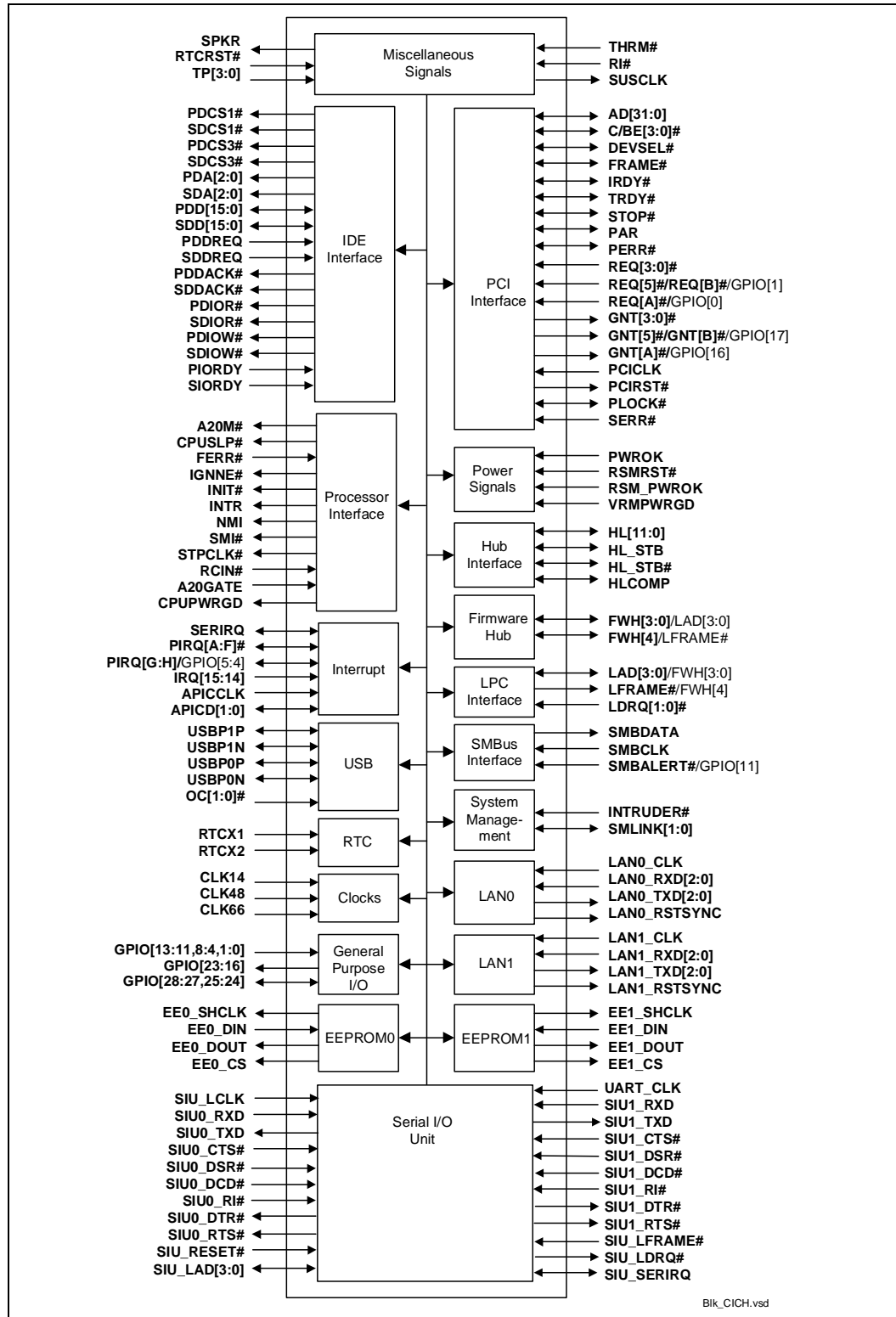


Figure 2. Intel® 82801E C-ICH Simplified Block Diagram





## 1.1 Overview

The 82801E C-ICH provides extensive I/O support. Functions and capabilities include:

- PCI Rev 2.2 compliant with support for 33 MHz PCI operations
- PCI slots support up to four Req/Gnt pairs
- Enhanced DMA Controller, Interrupt Controller, and Timer Functions
- Integrated IDE controller supports Ultra ATA100/66/33
- USB host interface with support for two USB ports; one host controller
- Two integrated LAN controllers
- System Management Bus (SMBus) with additional support for I<sup>2</sup>C devices
- Low Pin Count (LPC) interface
- Firmware Hub (FWH) interface support
- Serial I/O unit containing two UARTs

The 82801E C-ICH incorporates a variety of PCI functions that are divided into two logical devices (30 and 31) on PCI Bus 0 and one device on Bus 1. Device 30 is the Hub Interface-to-PCI bridge. Device 31 contains all the other PCI functions, except the LAN controller as shown in Table 1. The LAN controllers are located on Bus 1.

**Table 1. PCI Devices and Functions**

| Bus:Device:Function        | Function Description  |
|----------------------------|---|
| Bus 0:Device 30:Function 0 | Hub Interface to PCI Bridge   |
| Bus 0:Device 31:Function 0 | PCI to LPC Bridge<br>(includes: DMA, Timers, compatible interrupt controller, APIC, RTC, SIU, processor interface control, power management control, system management control, and GPIO control) |
| Bus 0:Device 31:Function 1 | IDE Controller  |
| Bus 0:Device 31:Function 2 | USB Controller  |
| Bus 0:Device 31:Function 3 | SMBus Controller  |
| Bus 1:Device 8:Function 0  | LAN0 Controller   |
| Bus 1:Device 9:Function 0  | LAN1 Controller   |

## 1.2 About this Document

This document is intended for original equipment manufacturers (OEMs) and BIOS vendors creating 82801E C-ICH-based products. This document contains electrical thermal and mechanical specifications for the 82801E C-ICH, including complete signal descriptions, pin maps, and testability information. For additional information, refer to the documents listed in Table 2.

**Table 2. Related Documents**

| Document   | Order Number |
|--|--------------|
| <i>Intel® 82801E Communications I/O Controller Hub (C-ICH) Developer's Manual</i>      | 273599       |
| <i>Intel® 82801E Communications I/O Controller Hub (C-ICH) Specification Update</i>    | 273645       |
| <i>Intel® 82801E Communications I/O Controller Hub (C-ICH) Platform Design Guide</i>   | 273671       |
| <i>Intel® 810E Chipset: 82810E Graphics and Memory Controller Hub (GMCH) Datasheet</i> | 290676       |
| <i>82802AB/82802AC Firmware Hub (FWH) Datasheet</i>                                    | 290658       |

This document assumes a working knowledge of the vocabulary and principles of USB, IDE, SMBus, PCI, LAN, LPC, and serial I/O. Details of these features are described in the *Intel® 82801E Communications I/O Controller Hub (C-ICH) Developer's Manual* (order number 273599) and in the industry specifications listed in Table 3.

**Table 3. Industry Specifications**

| Specification | Location  |
|---------------|---|
| LPC           | <a href="http://developer.intel.com/design/chipsets/industry/lpc.htm">http://developer.intel.com/design/chipsets/industry/lpc.htm</a> |
| WfM           | <a href="http://developer.intel.com/ial/WfM/usesite.htm">http://developer.intel.com/ial/WfM/usesite.htm</a>                           |
| SMBus         | <a href="http://www.sbs-forum.org/specs/">http://www.sbs-forum.org/specs/</a>   |
| PCI           | <a href="http://pcisig.com/">http://pcisig.com/</a>   |
| USB           | <a href="http://www.usb.org">http://www.usb.org</a>   |

## 2.0 Package Information

### 2.1 Ball Location

This section describes the 82801E C-ICH ball assignment. Figure 3 provides a 421-ball location diagram. The diagram also indicates general signal groupings. Table 4 lists the 82801E C-ICH signal assignments by ball number. Table 5 lists the assignments alphabetically by signal name.

Figure 3. Ball Diagram (Top View)

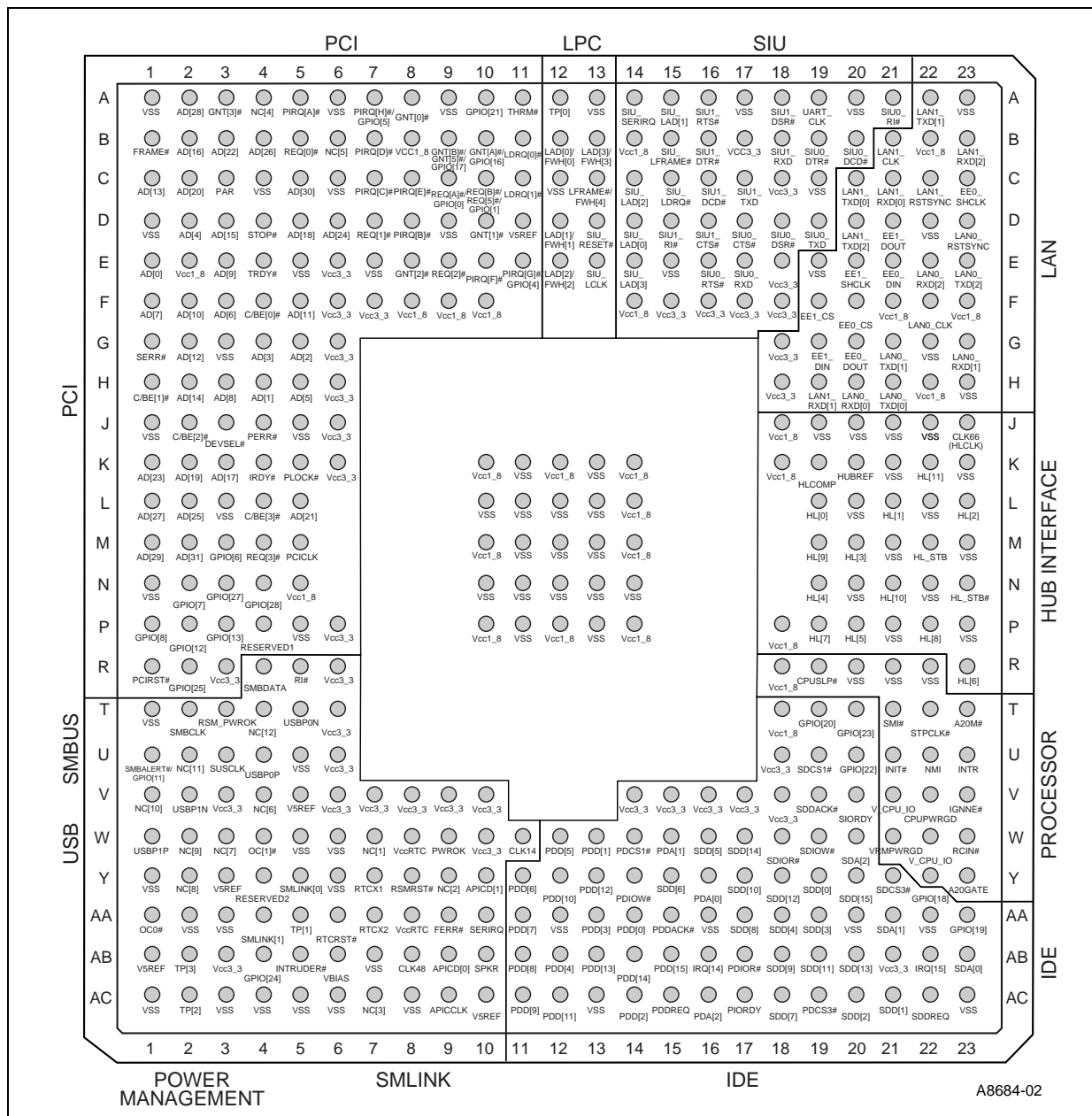


Table 4. Ball List By Number

| Ball Number | Signal Name              |
|-------------|--------------------------|
| A1          | VSS                      |
| A2          | AD[28]                   |
| A3          | GNT[3]#                  |
| A4          | NC[4]                    |
| A5          | PIRQ[A]#                 |
| A6          | VSS                      |
| A7          | PIRQ[H]#/GPIO[5]         |
| A8          | GNT[0]#                  |
| A9          | VSS                      |
| A10         | GPIO[21]                 |
| A11         | THRM#                    |
| A12         | TP[0]                    |
| A13         | VSS                      |
| A14         | SIU_SERIRQ               |
| A15         | SIU_LAD[1]               |
| A16         | SIU1_RTS#                |
| A17         | VSS                      |
| A18         | SIU1_DSR#                |
| A19         | UART_CLK                 |
| A20         | VSS                      |
| A21         | SIU0_RI#                 |
| A22         | LAN1_TXD[1]              |
| A23         | VSS                      |
| B1          | FRAME#                   |
| B2          | AD[16]                   |
| B3          | AD[22]                   |
| B4          | AD[26]                   |
| B5          | REQ[0]#                  |
| B6          | NC[5]                    |
| B7          | PIRQ[D]#                 |
| B8          | Vcc1_8                   |
| B9          | GNT[B]#/GNT[5]#/GPIO[17] |
| B10         | GNT[A]#/GPIO[16]         |
| B11         | LDRQ[0]#                 |
| B12         | LAD[0]/FWH[0]            |
| B13         | LAD[3]/FWH[3]            |
| B14         | Vcc1_8                   |
| B15         | SIU_LFRAME#              |
| B16         | SIU1_DTR#                |
| B17         | Vcc3_3                   |
| B18         | SIU1_RXD                 |
| B19         | SIU0_DTR#                |
| B20         | SIU0_DCD#                |

Table 4. Ball List By Number

| Ball Number | Signal Name             |
|-------------|-------------------------|
| B21         | LAN1_CLK                |
| B22         | Vcc1_8                  |
| B23         | LAN1_RXD[2]             |
| C1          | AD[13]                  |
| C2          | AD[20]                  |
| C3          | PAR                     |
| C4          | VSS                     |
| C5          | AD[30]                  |
| C6          | VSS                     |
| C7          | PIRQ[C]#                |
| C8          | PIRQ[E]#                |
| C9          | REQ[A]#/GPIO[0]         |
| C10         | REQ[B]#/REQ[5]#/GPIO[1] |
| C11         | LDRQ[1]#                |
| C12         | VSS                     |
| C13         | LFRAME#/FWH[4]          |
| C14         | SIU_LAD[2]              |
| C15         | SIU_LDRQ#               |
| C16         | SIU1_DCD#               |
| C17         | SIU1_TXD                |
| C18         | Vcc3_3                  |
| C19         | VSS                     |
| C20         | LAN1_TXD[0]             |
| C21         | LAN1_RXD[0]             |
| C22         | LAN1_RSTSYNC            |
| C23         | EE0_SHCLK               |
| D1          | VSS                     |
| D2          | AD[4]                   |
| D3          | AD[15]                  |
| D4          | STOP#                   |
| D5          | AD[18]                  |
| D6          | AD[24]                  |
| D7          | REQ[1]#                 |
| D8          | PIRQ[B]#                |
| D9          | VSS                     |
| D10         | GNT[1]#                 |
| D11         | V5REF                   |
| D12         | LAD[1]/FWH[1]           |
| D13         | SIU_RESET#              |
| D14         | SIU_LAD[0]              |
| D15         | SIU1_RI#                |
| D16         | SIU1_CTS#               |
| D17         | SIU0_CTS#               |
| D18         | SIU0_DSR#               |

**Table 4. Ball List By Number**

| Ball Number | Signal Name      |
|-------------|------------------|
| D19         | SIU0_TXD         |
| D20         | LAN1_TXD[2]      |
| D21         | EE1_DOUT         |
| D22         | VSS              |
| D23         | LAN0_RSTSYNC     |
| E1          | AD[0]            |
| E2          | Vcc1_8           |
| E3          | AD[9]            |
| E4          | TRDY#            |
| E5          | VSS              |
| E6          | Vcc3_3           |
| E7          | VSS              |
| E8          | GNT[2]#          |
| E9          | REQ[2]#          |
| E10         | PIRQ[F]#         |
| E11         | PIRQ[G]#/GPIO[4] |
| E12         | LAD[2]/FWH[2]    |
| E13         | SIU_LCLK         |
| E14         | SIU_LAD[3]       |
| E15         | VSS              |
| E16         | SIU0_RTS#        |
| E17         | SIU0_RXD         |
| E18         | Vcc3_3           |
| E19         | VSS              |
| E20         | EE1_SHCLK        |
| E21         | EE0_DIN          |
| E22         | LAN0_RXD[2]      |
| E23         | LAN0_TXD[2]      |
| F1          | AD[7]            |
| F2          | AD[10]           |
| F3          | AD[6]            |
| F4          | C/BE[0]#         |
| F5          | AD[11]           |
| F6          | Vcc3_3           |
| F7          | Vcc3_3           |
| F8          | Vcc1_8           |
| F9          | Vcc1_8           |
| F10         | Vcc1_8           |
| F14         | Vcc1_8           |
| F15         | Vcc3_3           |
| F16         | Vcc3_3           |
| F17         | Vcc3_3           |
| F18         | Vcc3_3           |
| F19         | EE1_CS           |

**Table 4. Ball List By Number**

| Ball Number | Signal Name   |
|-------------|---------------|
| F20         | EE0_CS        |
| F21         | Vcc1_8        |
| F22         | LAN0_CLK      |
| F23         | Vcc1_8        |
| G1          | SERR#         |
| G2          | AD[12]        |
| G3          | VSS           |
| G4          | AD[3]         |
| G5          | AD[2]         |
| G6          | Vcc3_3        |
| G18         | Vcc3_3        |
| G19         | EE1_DIN       |
| G20         | EE0_DOUT      |
| G21         | LAN0_TXD[1]   |
| G22         | VSS           |
| G23         | LAN0_RXD[1]   |
| H1          | C/BE[1]#      |
| H2          | AD[14]        |
| H3          | AD[8]         |
| H4          | AD[1]         |
| H5          | AD[5]         |
| H6          | Vcc3_3        |
| H18         | Vcc3_3        |
| H19         | LAN1_RXD[1]   |
| H20         | LAN0_RXD[0]   |
| H21         | LAN0_TXD[0]   |
| H22         | Vcc1_8        |
| H23         | VSS           |
| J1          | VSS           |
| J2          | C/BE[2]#      |
| J3          | DEVSEL#       |
| J4          | PERR#         |
| J5          | VSS           |
| J6          | Vcc3_3        |
| J18         | Vcc1_8        |
| J19         | VSS           |
| J20         | VSS           |
| J21         | VSS           |
| J22         | VSS           |
| J23         | CLK66 (HLCLK) |
| K1          | AD[23]        |
| K2          | AD[19]        |
| K3          | AD[17]        |
| K4          | IRDY#         |

Table 4. Ball List By Number

| Ball Number | Signal Name |
|-------------|-------------|
| K5          | PLOCK#      |
| K6          | Vcc3_3      |
| K10         | Vcc1_8      |
| K11         | VSS         |
| K12         | Vcc1_8      |
| K13         | VSS         |
| K14         | Vcc1_8      |
| K18         | Vcc1_8      |
| K19         | HLCOMP      |
| K20         | HUBREF      |
| K21         | VSS         |
| K22         | HL[11]      |
| K23         | VSS         |
| L1          | AD[27]      |
| L2          | AD[25]      |
| L3          | VSS         |
| L4          | C/BE[3]#    |
| L5          | AD[21]      |
| L10         | VSS         |
| L11         | VSS         |
| L12         | VSS         |
| L13         | VSS         |
| L14         | Vcc1_8      |
| L19         | HL[0]       |
| L20         | VSS         |
| L21         | HL[1]       |
| L22         | VSS         |
| L23         | HL[2]       |
| M1          | AD[29]      |
| M2          | AD[31]      |
| M3          | GPIO[6]     |
| M4          | REQ[3]#     |
| M5          | PCICLK      |
| M10         | Vcc1_8      |
| M11         | VSS         |
| M12         | VSS         |
| M13         | VSS         |
| M14         | Vcc1_8      |
| M19         | HL[9]       |
| M20         | HL[3]       |
| M21         | VSS         |
| M22         | HL_STB      |
| M23         | VSS         |
| N1          | VSS         |

Table 4. Ball List By Number

| Ball Number | Signal Name |
|-------------|-------------|
| N2          | GPIO[7]     |
| N3          | GPIO[27]    |
| N4          | GPIO[28]    |
| N5          | Vcc1_8      |
| N10         | VSS         |
| N11         | VSS         |
| N12         | VSS         |
| N13         | VSS         |
| N14         | VSS         |
| N19         | HL[4]       |
| N20         | VSS         |
| N21         | HL[10]      |
| N22         | VSS         |
| N23         | HL_STB#     |
| P1          | GPIO[8]     |
| P2          | GPIO[12]    |
| P3          | GPIO[13]    |
| P4          | RESERVED1   |
| P5          | VSS         |
| P6          | Vcc3_3      |
| P10         | Vcc1_8      |
| P11         | VSS         |
| P12         | Vcc1_8      |
| P13         | VSS         |
| P14         | Vcc1_8      |
| P18         | Vcc1_8      |
| P19         | HL[7]       |
| P20         | HL[5]       |
| P21         | VSS         |
| P22         | HL[8]       |
| P23         | VSS         |
| R1          | PCIRST#     |
| R2          | GPIO[25]    |
| R3          | Vcc3_3      |
| R4          | SMBDATA     |
| R5          | RI#         |
| R6          | Vcc3_3      |
| R18         | Vcc1_8      |
| R19         | CPUSLP#     |
| R20         | VSS         |
| R21         | VSS         |
| R22         | VSS         |
| R23         | HL[6]       |
| T1          | VSS         |

**Table 4. Ball List By Number**

| Ball Number | Signal Name                    |
|-------------|--------------------------------|
| T2          | SMBCLK                         |
| T3          | RSM_PWROK                      |
| T4          | NC[12]                         |
| T5          | USBP0N                         |
| T6          | Vcc3_3                         |
| T18         | Vcc1_8                         |
| T19         | GPIO[20]                       |
| T20         | GPIO[23]                       |
| T21         | SMI#                           |
| T22         | STPCLK#                        |
| T23         | A20M#                          |
| U1          | SMBALERT#/GPIO[11]             |
| U2          | NC[11]                         |
| U3          | SUSCLK                         |
| U4          | USBP0P                         |
| U5          | VSS                            |
| U6          | Vcc3_3                         |
| U18         | Vcc3_3                         |
| U19         | SDCS1#                         |
| U20         | GPIO[22]                       |
| U21         | INIT#                          |
| U22         | NMI                            |
| U23         | INTR                           |
| V1          | NC[10]                         |
| V2          | USBP1N                         |
| V3          | Vcc3_3                         |
| V4          | NC[6]                          |
| V5          | V5REF                          |
| V6          | Vcc3_3                         |
| V7          | Vcc3_3                         |
| V8          | Vcc3_3                         |
| V9          | Vcc3_3                         |
| V10         | Vcc3_3                         |
| V14         | Vcc3_3                         |
| V15         | Vcc3_3                         |
| V16         | Vcc3_3                         |
| V17         | Vcc3_3                         |
| V18         | Vcc3_3                         |
| V19         | SDDACK#                        |
| V20         | SIORDY (/SDRSTB/<br>SWDMARDY#) |
| V21         | V_CPU_IO                       |
| V22         | CPUPWRGD                       |
| V23         | IGNNE#                         |

**Table 4. Ball List By Number**

| Ball Number | Signal Name                    |
|-------------|--------------------------------|
| W1          | USBP1P                         |
| W2          | NC[9]                          |
| W3          | NC[7]                          |
| W4          | OC[1]#                         |
| W5          | VSS                            |
| W6          | VSS                            |
| W7          | NC[1]                          |
| W8          | VccRTC                         |
| W9          | PWROK                          |
| W10         | Vcc3_3                         |
| W11         | CLK14                          |
| W12         | PDD[5]                         |
| W13         | PDD[1]                         |
| W14         | PDCS1#                         |
| W15         | PDA[1]                         |
| W16         | SDD[5]                         |
| W17         | SDD[14]                        |
| W18         | SDIOR# (/SDWSTB/<br>SRDMARDY#) |
| W19         | SDIOW# (/SDSTOP)               |
| W20         | SDA[2]                         |
| W21         | VRMPWRGD                       |
| W22         | V_CPU_IO                       |
| W23         | RCIN#                          |
| Y1          | VSS                            |
| Y2          | NC[8]                          |
| Y3          | V5REF                          |
| Y4          | RESERVED2                      |
| Y5          | SMLINK[0]                      |
| Y6          | VSS                            |
| Y7          | RTCX1                          |
| Y8          | RSMRST#                        |
| Y9          | NC[2]                          |
| Y10         | APICD[1]                       |
| Y11         | PDD[6]                         |
| Y12         | PDD[10]                        |
| Y13         | PDD[12]                        |
| Y14         | PDIOW# (/PDSTOP)               |
| Y15         | SDD[6]                         |
| Y16         | PDA[0]                         |
| Y17         | SDD[10]                        |
| Y18         | SDD[12]                        |
| Y19         | SDD[0]                         |
| Y20         | SDD[15]                        |

Table 4. Ball List By Number

| Ball Number | Signal Name |
|-------------|-------------|
| Y21         | SDCS3#      |
| Y22         | GPIO[18]    |
| Y23         | A20GATE     |
| AA1         | OC[0]#      |
| AA2         | VSS         |
| AA3         | VSS         |
| AA4         | SMLINK[1]   |
| AA5         | TP[1]       |
| AA6         | RTCST#      |
| AA7         | RTCX2       |
| AA8         | VccRTC      |
| AA9         | FERR#       |
| AA10        | SERIRQ      |
| AA11        | PDD[7]      |
| AA12        | VSS         |
| AA13        | PDD[3]      |
| AA14        | PDD[0]      |
| AA15        | PDDACK#     |
| AA16        | VSS         |
| AA17        | SDD[8]      |
| AA18        | SDD[4]      |
| AA19        | SDD[3]      |
| AA20        | VSS         |
| AA21        | SDA[1]      |
| AA22        | VSS         |
| AA23        | GPIO[19]    |
| AB1         | V5REF       |
| AB2         | TP[3]       |
| AB3         | Vcc3_3      |
| AB4         | GPIO[24]    |
| AB5         | INTRUDER#   |
| AB6         | VBIAS       |
| AB7         | VSS         |
| AB8         | CLK48       |
| AB9         | APICD[0]    |
| AB10        | SPKR        |
| AB11        | PDD[8]      |

Table 4. Ball List By Number

| Ball Number | Signal Name                    |
|-------------|--------------------------------|
| AB12        | PDD[4]                         |
| AB13        | PDD[13]                        |
| AB14        | PDD[14]                        |
| AB15        | PDD[15]                        |
| AB16        | IRQ[14]                        |
| AB17        | PDIOR# (/PDWSTB/<br>PRDMARDY#) |
| AB18        | SDD[9]                         |
| AB19        | SDD[11]                        |
| AB20        | SDD[13]                        |
| AB21        | Vcc3_3                         |
| AB22        | IRQ[15]                        |
| AB23        | SDA[0]                         |
| AC1         | VSS                            |
| AC2         | TP[2]                          |
| AC3         | VSS                            |
| AC4         | VSS                            |
| AC5         | VSS                            |
| AC6         | VSS                            |
| AC7         | NC[3]                          |
| AC8         | VSS                            |
| AC9         | APICCLK                        |
| AC10        | V5REF                          |
| AC11        | PDD[9]                         |
| AC12        | PDD[11]                        |
| AC13        | VSS                            |
| AC14        | PDD[2]                         |
| AC15        | PDDREQ                         |
| AC16        | PDA[2]                         |
| AC17        | PIORDY (/PDRSTB/<br>PDMARDY#)  |
| AC18        | SDD[7]                         |
| AC19        | PDACS3#                        |
| AC20        | SDD[2]                         |
| AC21        | SDD[1]                         |
| AC22        | SDDREQ                         |
| AC23        | VSS                            |



**Table 5. Ball List By Signal Name**

| Signal Name | Ball Number |
|-------------|-------------|
| A20GATE     | Y23         |
| A20M#       | T23         |
| AD[0]       | E1          |
| AD[1]       | H4          |
| AD[2]       | G5          |
| AD[3]       | G4          |
| AD[4]       | D2          |
| AD[5]       | H5          |
| AD[6]       | F3          |
| AD[7]       | F1          |
| AD[8]       | H3          |
| AD[9]       | E3          |
| AD[10]      | F2          |
| AD[11]      | F5          |
| AD[12]      | G2          |
| AD[13]      | C1          |
| AD[14]      | H2          |
| AD[15]      | D3          |
| AD[16]      | B2          |
| AD[17]      | K3          |
| AD[18]      | D5          |
| AD[19]      | K2          |
| AD[20]      | C2          |
| AD[21]      | L5          |
| AD[22]      | B3          |
| AD[23]      | K1          |
| AD[24]      | D6          |
| AD[25]      | L2          |
| AD[26]      | B4          |
| AD[27]      | L1          |
| AD[28]      | A2          |
| AD[29]      | M1          |
| AD[30]      | C5          |
| AD[31]      | M2          |
| APICCLK     | AC9         |
| APICD[0]    | AB9         |
| APICD[1]    | Y10         |

**Table 5. Ball List By Signal Name**

| Signal Name              | Ball Number |
|--------------------------|-------------|
| C/BE[0]#                 | F4          |
| C/BE[1]#                 | H1          |
| C/BE[2]#                 | J2          |
| C/BE[3]#                 | L4          |
| CLK14                    | W11         |
| CLK48                    | AB8         |
| CLK66 (HLCLK)            | J23         |
| CPUPWRGD                 | V22         |
| CPUSLP#                  | R19         |
| DEVSEL#                  | J3          |
| EE0_CS                   | F20         |
| EE0_DIN                  | E21         |
| EE0_DOUT                 | G20         |
| EE0_SHCLK                | C23         |
| EE1_CS                   | F19         |
| EE1_DIN                  | G19         |
| EE1_DOUT                 | D21         |
| EE1_SHCLK                | E20         |
| FERR#                    | AA9         |
| FRAME#                   | B1          |
| GNT[0]#                  | A8          |
| GNT[1]#                  | D10         |
| GNT[2]#                  | E8          |
| GNT[3]#                  | A3          |
| GNT[A]#/GPIO[16]         | B10         |
| GNT[B]#/GNT[5]#/GPIO[17] | B9          |
| GPIO[6]                  | M3          |
| GPIO[7]                  | N2          |
| GPIO[8]                  | P1          |
| GPIO[12]                 | P2          |
| GPIO[13]                 | P3          |
| GPIO[18]                 | Y22         |
| GPIO[19]                 | AA23        |
| GPIO[20]                 | T19         |
| GPIO[21]                 | A10         |
| GPIO[22]                 | U20         |
| GPIO[23]                 | T20         |
| GPIO[24]                 | AB4         |

Table 5. Ball List By Signal Name

| Signal Name   | Ball Number |
|---------------|-------------|
| GPIO[25]      | R2          |
| GPIO[27]      | N3          |
| GPIO[28]      | N4          |
| HL[0]         | L19         |
| HL[1]         | L21         |
| HL[2]         | L23         |
| HL[3]         | M20         |
| HL[4]         | N19         |
| HL[5]         | P20         |
| HL[6]         | R23         |
| HL[7]         | P19         |
| HL[8]         | P22         |
| HL[9]         | M19         |
| HL[10]        | N21         |
| HL[11]        | K22         |
| HL_STB        | M22         |
| HL_STB#       | N23         |
| HLCOMP        | K19         |
| HUBREF        | K20         |
| IGNNE#        | V23         |
| INIT#         | U21         |
| INTR          | U23         |
| INTRUDER#     | AB5         |
| IRDY#         | K4          |
| IRQ[14]       | AB16        |
| IRQ[15]       | AB22        |
| LAD[0]/FWH[0] | B12         |
| LAD[1]/FWH[1] | D12         |
| LAD[2]/FWH[2] | E12         |
| LAD[3]/FWH[3] | B13         |
| LAN0_CLK      | F22         |
| LAN0_RSTSYNC  | D23         |
| LAN0_RXD[0]   | H20         |
| LAN0_RXD[1]   | G23         |
| LAN0_RXD[2]   | E22         |
| LAN0_TXD[0]   | H21         |
| LAN0_TXD[1]   | G21         |
| LAN0_TXD[2]   | E23         |

Table 5. Ball List By Signal Name

| Signal Name    | Ball Number |
|----------------|-------------|
| LAN1_CLK       | B21         |
| LAN1_RSTSYNC   | C22         |
| LAN1_RXD[0]    | C21         |
| LAN1_RXD[1]    | H19         |
| LAN1_RXD[2]    | B23         |
| LAN1_TXD[0]    | C20         |
| LAN1_TXD[1]    | A22         |
| LAN1_TXD[2]    | D20         |
| LDRQ[0]#       | B11         |
| LDRQ[1]#       | C11         |
| LFRAME#/FWH[4] | C13         |
| NC[1]          | W7          |
| NC[2]          | Y9          |
| NC[3]          | AC7         |
| NC[4]          | A4          |
| NC[5]          | B6          |
| NC[6]          | V4          |
| NC[7]          | W3          |
| NC[8]          | Y2          |
| NC[9]          | W2          |
| NC[10]         | V1          |
| NC[11]         | U2          |
| NC[12]         | T4          |
| NMI            | U22         |
| OC[0]#         | AA1         |
| OC[1]#         | W4          |
| PAR            | C3          |
| PCICLK         | M5          |
| PCIRST#        | R1          |
| PDA[0]         | Y16         |
| PDA[1]         | W15         |
| PDA[2]         | AC16        |
| PDCS1#         | W14         |
| PDCS3#         | AC19        |
| PDD[0]         | AA14        |
| PDD[1]         | W13         |
| PDD[2]         | AC14        |
| PDD[3]         | AA13        |

Table 5. Ball List By Signal Name

| Signal Name                    | Ball Number |
|--------------------------------|-------------|
| PDD[4]                         | AB12        |
| PDD[5]                         | W12         |
| PDD[6]                         | Y11         |
| PDD[7]                         | AA11        |
| PDD[8]                         | AB11        |
| PDD[9]                         | AC11        |
| PDD[10]                        | Y12         |
| PDD[11]                        | AC12        |
| PDD[12]                        | Y13         |
| PDD[13]                        | AB13        |
| PDD[14]                        | AB14        |
| PDD[15]                        | AB15        |
| PDDACK#                        | AA15        |
| PDDREQ                         | AC15        |
| PDIOR# (/PDWSTB/<br>PRDMARDY#) | AB17        |
| PDIOW# (/PDSTOP)               | Y14         |
| PERR#                          | J4          |
| PIORDY (/PDRSTB/<br>PWARDY#)   | AC17        |
| PIRQ[A]#                       | A5          |
| PIRQ[B]#                       | D8          |
| PIRQ[C]#                       | C7          |
| PIRQ[D]#                       | B7          |
| PIRQ[E]#                       | C8          |
| PIRQ[F]#                       | E10         |
| PIRQ[G]#/GPIO[4]               | E11         |
| PIRQ[H]#/GPIO[5]               | A7          |
| PLOCK#                         | K5          |
| PWROK                          | W9          |
| RCIN#                          | W23         |
| REQ[0]#                        | B5          |
| REQ[1]#                        | D7          |
| REQ[2]#                        | E9          |
| REQ[3]#                        | M4          |
| REQ[A]#/GPIO[0]                | C9          |
| REQ[B]#/REQ[5]#/GPIO[1]        | C10         |
| RESERVED1                      | P4          |

Table 5. Ball List By Signal Name

| Signal Name                    | Ball Number |
|--------------------------------|-------------|
| RESERVED2                      | Y4          |
| RI#                            | R5          |
| RSM_PWROK                      | T3          |
| RSMRST#                        | Y8          |
| RTCRST#                        | AA6         |
| RTCX1                          | Y7          |
| RTCX2                          | AA7         |
| SDA[0]                         | AB23        |
| SDA[1]                         | AA21        |
| SDA[2]                         | W20         |
| SDCS1#                         | U19         |
| SDCS3#                         | Y21         |
| SDD[0]                         | Y19         |
| SDD[1]                         | AC21        |
| SDD[2]                         | AC20        |
| SDD[3]                         | AA19        |
| SDD[4]                         | AA18        |
| SDD[5]                         | W16         |
| SDD[6]                         | Y15         |
| SDD[7]                         | AC18        |
| SDD[8]                         | AA17        |
| SDD[9]                         | AB18        |
| SDD[10]                        | Y17         |
| SDD[11]                        | AB19        |
| SDD[12]                        | Y18         |
| SDD[13]                        | AB20        |
| SDD[14]                        | W17         |
| SDD[15]                        | Y20         |
| SDDACK#                        | V19         |
| SDDREQ                         | AC22        |
| SDIOR# (/SDWSTB/<br>SRDMARDY#) | W18         |
| SDIOW# (/SDSTOP)               | W19         |
| SERIRQ                         | AA10        |
| SERR#                          | G1          |
| SIORDY (/SDRSTB/<br>SWDMARDY#) | V20         |
| SIU_LAD[0]                     | D14         |

Table 5. Ball List By Signal Name

| Signal Name        | Ball Number |
|--------------------|-------------|
| SIU_LAD[1]         | A15         |
| SIU_LAD[2]         | C14         |
| SIU_LAD[3]         | E14         |
| SIU_LCLK           | E13         |
| SIU_LDRQ#          | C15         |
| SIU_LFRAME#        | B15         |
| SIU_RESET#         | D13         |
| SIU_SERIRQ         | A14         |
| SIU0_CTS#          | D17         |
| SIU0_DCD#          | B20         |
| SIU0_DSR#          | D18         |
| SIU0_DTR#          | B19         |
| SIU0_RI#           | A21         |
| SIU0_RTS#          | E16         |
| SIU0_RXD           | E17         |
| SIU0_TXD           | D19         |
| SIU1_CTS#          | D16         |
| SIU1_DCD#          | C16         |
| SIU1_DSR#          | A18         |
| SIU1_DTR#          | B16         |
| SIU1_RI#           | D15         |
| SIU1_RTS#          | A16         |
| SIU1_RXD           | B18         |
| SIU1_TXD           | C17         |
| SMBALERT#/GPIO[11] | U1          |
| SMBCLK             | T2          |
| SMBDATA            | R4          |
| SMI#               | T21         |
| SMLINK[0]          | Y5          |
| SMLINK[1]          | AA4         |
| SPKR               | AB10        |
| STOP#              | D4          |
| STPCLK#            | T22         |
| SUSCLK             | U3          |
| THRM#              | A11         |
| TP[0]              | A12         |
| TP[1]              | AA5         |
| TP[2]              | AC2         |

Table 5. Ball List By Signal Name

| Signal Name | Ball Number |
|-------------|-------------|
| TP[3]       | AB2         |
| TRDY#       | E4          |
| UART_CLK    | A19         |
| USBP0N      | T5          |
| USBP0P      | U4          |
| USBP1N      | V2          |
| USBP1P      | W1          |
| V_CPU_IO    | V21         |
| V_CPU_IO    | W22         |
| V5REF       | AB1         |
| V5REF       | AC10        |
| V5REF       | D11         |
| V5REF       | V5          |
| V5REF       | Y3          |
| VBIAS       | AB6         |
| Vcc1_8      | B8          |
| Vcc1_8      | B14         |
| Vcc1_8      | B22         |
| Vcc1_8      | E2          |
| Vcc1_8      | F8          |
| Vcc1_8      | F9          |
| Vcc1_8      | F10         |
| Vcc1_8      | F14         |
| Vcc1_8      | F21         |
| Vcc1_8      | F23         |
| Vcc1_8      | H22         |
| Vcc1_8      | J18         |
| Vcc1_8      | K10         |
| Vcc1_8      | K12         |
| Vcc1_8      | K14         |
| Vcc1_8      | K18         |
| Vcc1_8      | L14         |
| Vcc1_8      | M10         |
| Vcc1_8      | M14         |
| Vcc1_8      | N5          |
| Vcc1_8      | P10         |
| Vcc1_8      | P12         |
| Vcc1_8      | P14         |

**Table 5. Ball List By Signal Name**

| Signal Name | Ball Number |
|-------------|-------------|
| Vcc1_8      | P18         |
| Vcc1_8      | R18         |
| Vcc1_8      | T18         |
| Vcc3_3      | AB3         |
| Vcc3_3      | AB21        |
| Vcc3_3      | B17         |
| Vcc3_3      | C18         |
| Vcc3_3      | E6          |
| Vcc3_3      | E18         |
| Vcc3_3      | F6          |
| Vcc3_3      | F7          |
| Vcc3_3      | F15         |
| Vcc3_3      | F16         |
| Vcc3_3      | F17         |
| Vcc3_3      | F18         |
| Vcc3_3      | G6          |
| Vcc3_3      | G18         |
| Vcc3_3      | H6          |
| Vcc3_3      | H18         |
| Vcc3_3      | J6          |
| Vcc3_3      | K6          |
| Vcc3_3      | P6          |
| Vcc3_3      | R3          |
| Vcc3_3      | R6          |
| Vcc3_3      | T6          |
| Vcc3_3      | U6          |
| Vcc3_3      | U18         |
| Vcc3_3      | V3          |
| Vcc3_3      | V6          |
| Vcc3_3      | V7          |
| Vcc3_3      | V8          |
| Vcc3_3      | V9          |
| Vcc3_3      | V10         |
| Vcc3_3      | V14         |
| Vcc3_3      | V15         |
| Vcc3_3      | V16         |
| Vcc3_3      | V17         |
| Vcc3_3      | V18         |

**Table 5. Ball List By Signal Name**

| Signal Name | Ball Number |
|-------------|-------------|
| Vcc3_3      | W10         |
| VccRTC      | W8          |
| VccRTC      | AA8         |
| VRMPWRGD    | W21         |
| VSS         | A1          |
| VSS         | A6          |
| VSS         | A9          |
| VSS         | A13         |
| VSS         | A17         |
| VSS         | A20         |
| VSS         | A23         |
| VSS         | C4          |
| VSS         | C6          |
| VSS         | C12         |
| VSS         | C19         |
| VSS         | D1          |
| VSS         | D9          |
| VSS         | D22         |
| VSS         | E5          |
| VSS         | E7          |
| VSS         | E15         |
| VSS         | E19         |
| VSS         | G3          |
| VSS         | G22         |
| VSS         | H23         |
| VSS         | J1          |
| VSS         | J5          |
| VSS         | J19         |
| VSS         | J20         |
| VSS         | J21         |
| VSS         | J22         |
| VSS         | K11         |
| VSS         | K13         |
| VSS         | K21         |
| VSS         | K23         |
| VSS         | L3          |
| VSS         | L10         |
| VSS         | L11         |

**Table 5. Ball List By Signal Name**

| Signal Name | Ball Number |
|-------------|-------------|
| VSS         | L12         |
| VSS         | L13         |
| VSS         | L20         |
| VSS         | L22         |
| VSS         | M11         |
| VSS         | M12         |
| VSS         | M13         |
| VSS         | M21         |
| VSS         | M23         |
| VSS         | N1          |
| VSS         | N10         |
| VSS         | N11         |
| VSS         | N12         |
| VSS         | N13         |
| VSS         | N14         |
| VSS         | N20         |
| VSS         | N22         |
| VSS         | P5          |
| VSS         | P11         |
| VSS         | P13         |
| VSS         | P21         |
| VSS         | P23         |
| VSS         | R20         |

**Table 5. Ball List By Signal Name**

| Signal Name | Ball Number |
|-------------|-------------|
| VSS         | R21         |
| VSS         | R22         |
| VSS         | T1          |
| VSS         | U5          |
| VSS         | W5          |
| VSS         | W6          |
| VSS         | Y1          |
| VSS         | Y6          |
| VSS         | AA2         |
| VSS         | AA3         |
| VSS         | AA12        |
| VSS         | AA16        |
| VSS         | AA20        |
| VSS         | AA22        |
| VSS         | AB7         |
| VSS         | AC1         |
| VSS         | AC3         |
| VSS         | AC4         |
| VSS         | AC5         |
| VSS         | AC6         |
| VSS         | AC8         |
| VSS         | AC13        |
| VSS         | AC23        |

## 2.2 Mechanical Specifications

Figure 4. Intel® 82801E C-ICH Package (Top View)

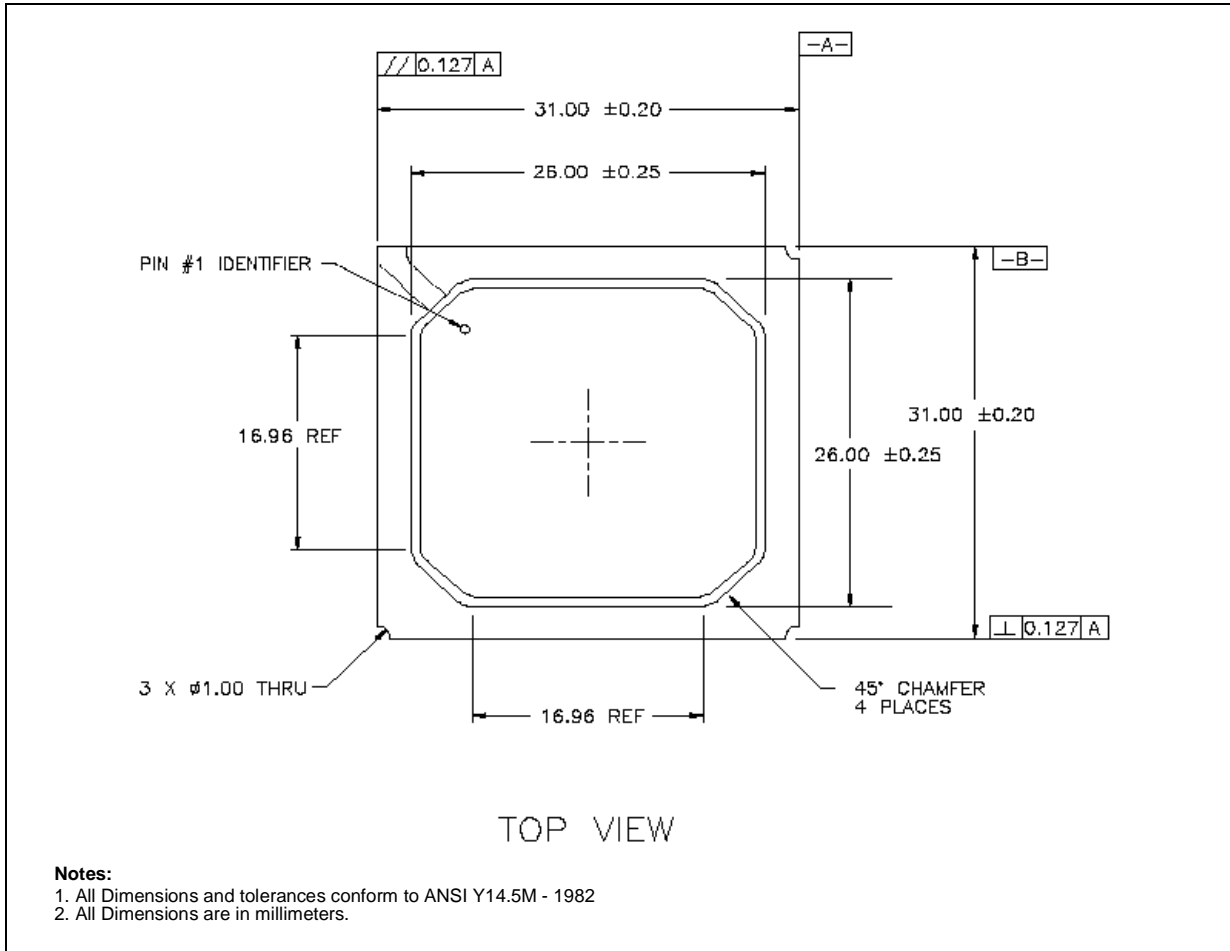


Figure 5. Intel® 82801E C-ICH Package (Side View)

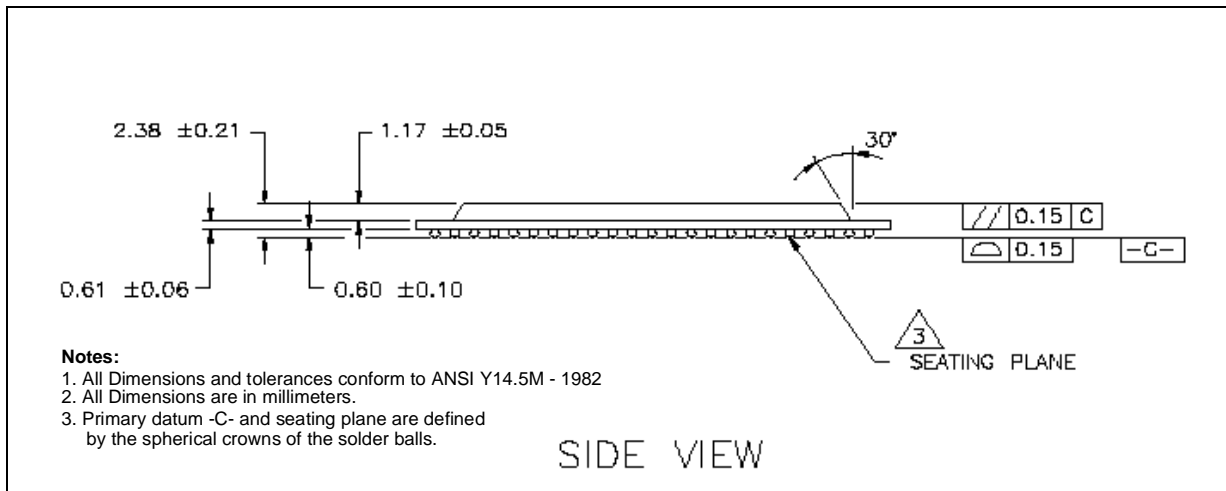
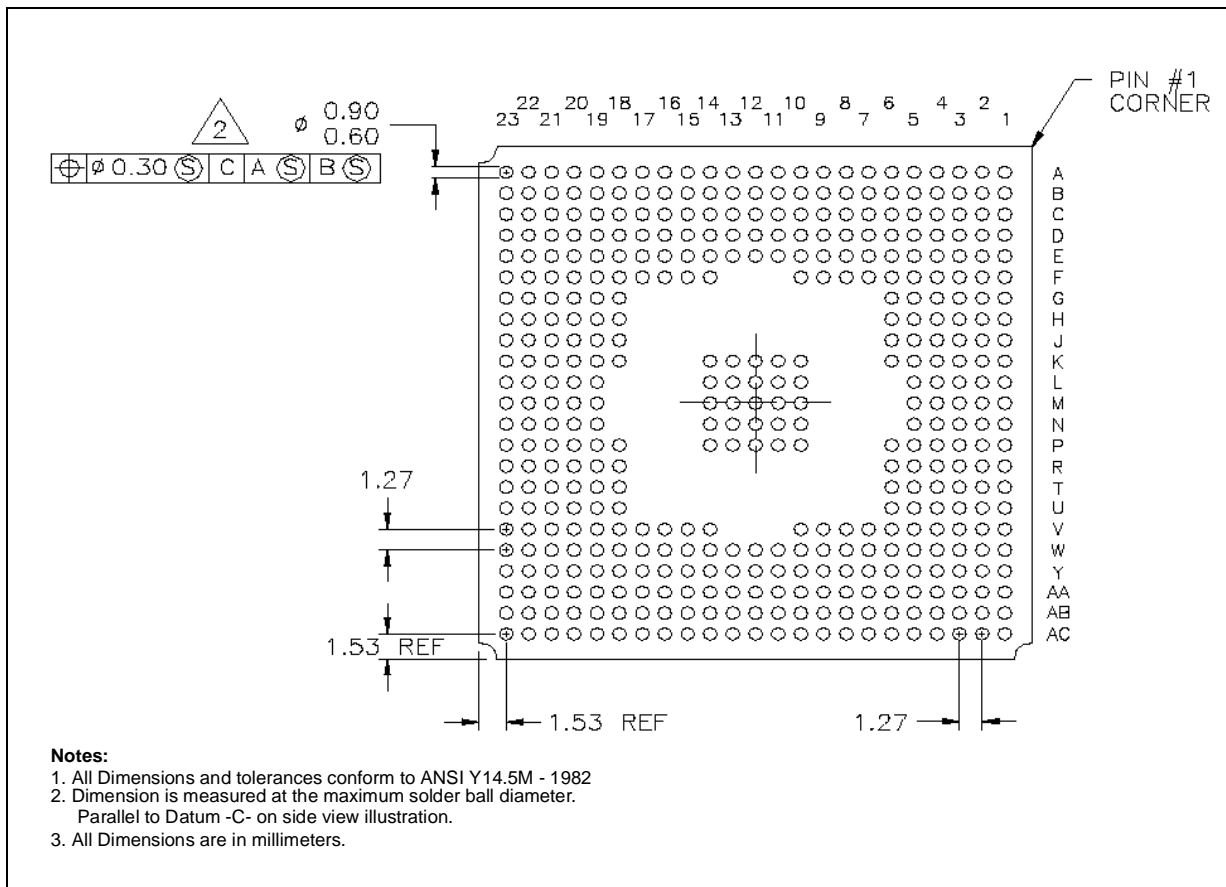


Figure 6. Intel® 82801E C-ICH Package (Bottom View)





## 3.0 Signal Descriptions

This section provides a detailed description of each signal. The signals are arranged in functional groups according to their associated interface.

The “#” symbol at the end of the signal name indicates that the active, or asserted state occurs when the signal is at a low voltage level. When “#” is not present, the signal is asserted when at the high voltage level.

The following notations are used to describe the signal type:

|            |                                 |
|------------|---------------------------------|
| <b>I</b>   | Input pin                       |
| <b>O</b>   | Output pin                      |
| <b>OD</b>  | Open drain output pin.          |
| <b>I/O</b> | Bidirectional input/output pin. |

## 3.1 Alphabetical Signal Reference

Table 6. 82801E C-ICH Signal Description (Sheet 1 of 11)

| Signal            | Type | Description  |
|-------------------|------|--|
| <b>A20GATE</b>    | I    | <b>A20 Gate:</b> This signal is from the keyboard controller. It acts as an alternative method to force the A20M# signal active. A20GATE eliminates the need for the external OR gate needed with various other PCIsets.   |
| <b>A20M#</b>      | O    | <b>Mask A20:</b> A20M# goes active based on setting the appropriate bit in the Port 92h register, or based on the A20GATE signal.<br><b>Speed Strap:</b> During the reset sequence, 82801E C-ICH drives A20M# high if the corresponding bit is set in the FREQ_STRP register.                                    |
| <b>AD[31:0]</b>   | I/O  | <b>PCI Address/Data:</b> AD[31:0] is a multiplexed address and data bus. During the first clock of a transaction, AD[31:0] contain a physical address (32 bits). During subsequent clocks, AD[31:0] contain data. The 82801E C-ICH drives all 0s on AD[31:0] during the address phase of all PCI Special Cycles. |
| <b>APICCLK</b>    | I    | <b>APIC Clock:</b> The APIC clock runs at 33.333 MHz.  |
| <b>APICD[1:0]</b> | I/OD | <b>APIC Data:</b> These bidirectional open drain signals are used to send and receive data over the APIC bus. As inputs, the data is valid on the rising edge of APICCLK. As outputs, new data is driven from the rising edge of the APICCLK.  |

Table 6. 82801E C-ICH Signal Description (Sheet 2 of 11)

| Signal                         | Type   | Description   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
|--------------------------------|--|---|------------|--------------|------|-----------------------|------|---------------|------|----------|------|-----------|------|-------------|------|--------------|------|--------------------|------|---------------------|------|----------------------|------|--|------|------------------|------|-----------------------------|
| <b>C/BE[3:0]#</b>              | I/O  | <p><b>Bus Command and Byte Enables:</b> The command and byte enable signals are multiplexed on the same PCI pins. During the address phase of a transaction, C/BE[3:0]# define the bus command. During the data phase, C/BE[3:0]# define the Byte Enables.</p> <table border="1"> <thead> <tr> <th>C/BE[3:0]#</th> <th>Command Type</th> </tr> </thead> <tbody> <tr><td>0000</td><td>Interrupt Acknowledge</td></tr> <tr><td>0001</td><td>Special Cycle</td></tr> <tr><td>0010</td><td>I/O Read</td></tr> <tr><td>0011</td><td>I/O Write</td></tr> <tr><td>0110</td><td>Memory Read</td></tr> <tr><td>0111</td><td>Memory Write</td></tr> <tr><td>1010</td><td>Configuration Read</td></tr> <tr><td>1011</td><td>Configuration Write</td></tr> <tr><td>1100</td><td>Memory Read Multiple</td></tr> <tr><td>1101</td><td>DAC Mode Address to be latched (target only)</td></tr> <tr><td>1110</td><td>Memory Read Line</td></tr> <tr><td>1111</td><td>Memory Write and Invalidate</td></tr> </tbody> </table> <p>All command encodings not shown are reserved. The 82801E C-ICH does not decode reserved values, and therefore will not respond when a PCI master generates a cycle using one of the reserved values.</p> <p>As a target, the 82801E C-ICH can support DAC mode addressing for 44 bits.</p> | C/BE[3:0]# | Command Type | 0000 | Interrupt Acknowledge | 0001 | Special Cycle | 0010 | I/O Read | 0011 | I/O Write | 0110 | Memory Read | 0111 | Memory Write | 1010 | Configuration Read | 1011 | Configuration Write | 1100 | Memory Read Multiple | 1101 | DAC Mode Address to be latched (target only) | 1110 | Memory Read Line | 1111 | Memory Write and Invalidate |
| C/BE[3:0]#                     | Command Type                                 |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0000                           | Interrupt Acknowledge                        |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0001                           | Special Cycle                                |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0010                           | I/O Read                                     |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0011                           | I/O Write                                    |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0110                           | Memory Read                                  |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0111                           | Memory Write                                 |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1010                           | Configuration Read                           |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1011                           | Configuration Write                          |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1100                           | Memory Read Multiple                         |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1101                           | DAC Mode Address to be latched (target only) |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1110                           | Memory Read Line                             |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1111                           | Memory Write and Invalidate                  |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>CLK14</b>                   | I  | <b>Oscillator Clock:</b> CLK14 is used for 8254 timers and runs at 14.31818 MHz.  |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>CLK48</b>                   | I  | <b>48 MHz Clock:</b> CLK48 is used to for the USB controller and runs at 48 MHz.  |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>CLK66 (HLCLK)</b>           | I  | <b>66 MHz Clock (HLCLK):</b> CLK66 is used for the hub interface and runs at 66 MHz.  |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>CPUPWRGD</b>                | OD   | <b>Processor Power Good:</b> This signal should be connected to the processor's PWRGOOD input. This is an open-drain output signal (external pull-up resistor required) that represents a logical AND of the 82801E C-ICH's PWROK and VRMPWRGD signals.   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>CPUSLP#</b>                 | O  | <p><b>Processor Sleep:</b> This signal puts the processor into a state that saves substantial power compared to Stop-Grant state. However, during that time, no snoops occur.</p> <p><b>NOTE:</b> The 82801E C-ICH does not support Sleep states. This signal must be pulled up through an 8.2 K<math>\Omega</math> resistor to 3.3 V.</p>  |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>DEVSEL#</b>                 | I/O  | <b>Device Select:</b> The 82801E C-ICH asserts DEVSEL# to claim a PCI transaction. As an output, the 82801E C-ICH asserts DEVSEL# when a PCI master peripheral attempts an access to an internal 82801E C-ICH address or an address destined for the hub interface (main memory or AGP). As an input, DEVSEL# indicates the response to an 82801E C-ICH-initiated transaction on the PCI bus. DEVSEL# is tri-stated from the leading edge of PCIRST#. DEVSEL# remains tri-stated by the 82801E C-ICH until driven by a target device.   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>EE0_CS<br/>EE1_CS</b>       | O  | <b>EEPROM Chip Select:</b> These signals are chip-select signals to the EEPROMs.  |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>EE0_DIN<br/>EE1_DIN</b>     | I  | <b>EEPROM Data In:</b> These signals transfer data from the EEPROMs to the 82801E C-ICH. These signals have an integrated pull-up resistor.   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>EE0_DOUT<br/>EE1_DOUT</b>   | O  | <b>EEPROM Data Out:</b> These signals transfer data from the 82801E C-ICH to the EEPROMs.   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>EE0_SHCLK<br/>EE1_SHCLK</b> | O  | <b>EEPROM Shift Clock:</b> These signals are the serial shift clock output to the EEPROMs.  |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |

**Table 6. 82801E C-ICH Signal Description (Sheet 3 of 11)**

| Signal  | Type | Description   |
|---|------|---|
| FERR#   | I    | <b>Numeric Coprocessor Error:</b> This signal is tied to the coprocessor error signal on the processor. FERR# is only used if the 82801E C-ICH coprocessor error reporting function is enabled in the General Control Register (Device 31:Function 0, Offset D0, bit 13). If FERR# is asserted, the 82801E C-ICH generates an internal IRQ13 to its interrupt controller unit. It is also used to gate the IGNNE# signal to ensure that IGNNE# is not asserted to the processor unless FERR# is active. FERR# requires an external weak pull-up to ensure a high level when the coprocessor error function is disabled. |
| FRAME#  | I/O  | <b>Cycle Frame:</b> The current Initiator asserts FRAME# to indicate the beginning and duration of a PCI transaction. While the initiator asserts FRAME#, data transfers continue. When the initiator deasserts FRAME#, the transaction is in the final data phase. FRAME# is an input to the 82801E C-ICH when the 82801E C-ICH is the target, and FRAME# is an output from the 82801E C-ICH when the 82801E C-ICH is the Initiator. FRAME# remains tri-stated by the 82801E C-ICH until driven by an Initiator.   |
| FWH[3:0]<br>/LAD[3:0]                                     | I/O  | <b>Firmware Hub Signals:</b> These signals are muxed with LPC address signals.  |
| FWH[4]<br>/LFRAME#  | I/O  | <b>Firmware Hub Signals:</b> This signal is muxed with the LPC LFRAME# signal.  |
| GNT[3:0]#<br>GNT[5]#<br>/GNT[B]#<br>/GPIO[17]#            | O    | <b>PCI Grants:</b> The 82801E C-ICH supports up to four masters on the PCI bus. GNT[5]# is muxed with PC/PCI GNT[B]# (must choose one or the other, but not both). If not needed for PCI or PC/PCI, GNT[5]# can instead be used as a GPIO.<br><br>Pull-up resistors are not required on these signals. If pullups are used, they should be tied to the Vcc3_3 power rail. GNT[B]#/GNT[5]#/GPIO[17] has an internal pull-up.   |
| GNT[A]#<br>/GPIO[16]<br>/GNT[B]#<br>/GNT[5]#<br>/GPIO[17] | O    | <b>PC/PCI DMA Acknowledges [A:B]:</b> This grant serializes an ISA-like DACK# for the purpose of running DMA/ISA master cycles over the PCI bus. This is used by devices such as PCI-based Super I/O or audio codecs which need to perform legacy 8237 DMA but have no ISA bus.<br><br>When not used for PC/PCI, these signals can be used as General Purpose Outputs. GNTB# can also be used as the fourth PCI bus master grant output. These signal have internal pull-up resistors.  |
| GPIO[1:0]   | I    | Fixed as Input only. Main Power Well. Can instead be used for PC/PCI REQ[A:B]#. GPIO[1] can also alternatively be used for PCI REQ[5]#.   |
| GPIO[3:2]   |      | Not implemented.  |
| GPIO[5:4]   | I    | Fixed as Input only. Main power well. Can be used instead as PIRQ[G:H]#.  |
| GPIO[6]   | I    | Fixed as Input only. Main power well.   |
| GPIO[7]   | I    | Fixed as Input only. Main power well. Not muxed.  |
| GPIO[8]   | I    | Fixed as Input only. Main power well. Not muxed.  |
| GPIO[10:9]  | I    | Not implemented.  |
| GPIO[11]  | I    | Fixed as Input only. Main power well. Can instead be used for SMBALERT#.  |
| GPIO[13:12]   | I    | Fixed as Input only. Main power well. Not muxed.  |
| GPIO[15:14]   | I    | Not implemented.  |
| GPIO[17:16]   | O    | Fixed as Output only. Main Power Well. Can instead be used for PC/PCI GNT[A:B]#. GPIO[17] can also alternatively be used for PCI GNT[5]#. Integrated pull-up resistor.  |
| GPIO[20:18]   | O    | Fixed as Output only. Main power well.  |
| GPIO[21]  | O    | Fixed as Output only. Main power well.  |
| GPIO[22]  | OD   | Fixed as Output only. Main power well. Open-drain output.   |
| GPIO[23]  | O    | Fixed as Output only. Main power well.  |

Table 6. 82801E C-ICH Signal Description (Sheet 4 of 11)

| Signal                       | Type | Description   |
|------------------------------|------|---|
| GPIO[24]                     | I/O  | Can be input or output. Main power well.  |
| GPIO[25]                     | I/O  | Can be input or output. Main power well. Not Muxed.   |
| GPIO[26]                     | I/O  | Not implemented.  |
| GPIO[28:27]                  | I/O  | Can be input or output. Main power well. Unmuxed.   |
| GPIO[31:29]                  | O    | Not implemented.  |
| HL[11:0]                     | I/O  | <b>Hub Interface Signals</b>  |
| HL_STB                       | I/O  | <b>Hub Interface Strobe:</b> One of two differential strobe signals used to transmit and receive data through the hub interface.  |
| HL_STB#                      | I/O  | <b>Hub Interface Strobe Complement:</b> Second of the two differential strobe signals.  |
| HLCOMP                       | I/O  | <b>Hub Interface Compensation:</b> Used for hub interface buffer compensation.  |
| HUBREF                       |      | 0.9 V reference for the hub interface.  |
| IGNNE#                       | O    | <b>Ignore Numeric Error:</b> This signal is connected to the ignore error pin on the processor. IGNNE# is only used if the 82801E C-ICH coprocessor error reporting function is enabled in the General Control Register (Device 31:Function 0, Offset D0, bit 13). When FERR# is active, indicating a coprocessor error, a write to the Coprocessor Error Register (F0h) causes the IGNNE# to be asserted. IGNNE# remains asserted until FERR# is negated. If FERR# is not asserted when the Coprocessor Error Register is written, the IGNNE# signal is not asserted.<br><b>Speed Strap:</b> During the reset sequence, 82801E C-ICH drives IGNNE# high if the corresponding bit is set in the FREQ_STRP register. |
| INIT#                        | O    | <b>Initialization:</b> INIT# is asserted by the 82801E C-ICH for 16 PCI clocks to reset the processor. 82801E C-ICH can be configured to support processor BIST. In that case, INIT# will be active when PCIRST# is active.   |
| INTR                         | O    | <b>Processor Interrupt:</b> INTR is asserted by the 82801E C-ICH to signal the processor that an interrupt request is pending and needs to be serviced. It is an asynchronous output and normally driven low.<br><b>Speed Strap:</b> During the reset sequence, 82801E C-ICH drives INTR high if the corresponding bit is set in the FREQ_STRP register.  |
| INTRUDER#                    | I    | <b>Intruder Detect:</b> This signal can be set to disable system if box detected open. This signal's status is readable, so it can be used like a GPI if the Intruder Detection is not needed.  |
| IRDY#                        | I/O  | <b>Initiator Ready:</b> IRDY# indicates the 82801E C-ICH's ability, as an Initiator, to complete the current data phase of the transaction. It is used in conjunction with TRDY#. A data phase is completed on any clock both IRDY# and TRDY# are sampled asserted. During a write, IRDY# indicates the 82801E C-ICH has valid data present on AD[31:0]. During a read, it indicates the 82801E C-ICH is prepared to latch data. IRDY# is an input to the 82801E C-ICH when the 82801E C-ICH is the Target and an output from the 82801E C-ICH when the 82801E C-ICH is an Initiator. IRDY# remains tri-stated by the 82801E C-ICH until driven by an Initiator.  |
| IRQ[14:15]                   | I    | <b>Interrupt Request 14:15:</b> These interrupt inputs are connected to the IDE drives. IRQ14 is used by the drives connected to the primary controller and IRQ15 is used by the drives connected to the secondary controller.  |
| LAD[3:0]<br>/FWH[3:0]        | I/O  | <b>LPC Multiplexed Command, Address, Data:</b> Internal pull-ups are provided.  |
| LAN0_CLK<br>LAN1_CLK         | I    | <b>LAN Interface Clock:</b> This signal is driven by the LAN Connect component. The frequency range is 0.8 MHz to 50 MHz.   |
| LAN0_RSTSYNC<br>LAN1_RSTSYNC | O    | <b>LAN Reset/Sync:</b> The LAN Connect component's Reset and Sync signals are multiplexed onto this pin.  |

Table 6. 82801E C-ICH Signal Description (Sheet 5 of 11)

| Signal                         | Type | Description   |
|--------------------------------|------|---|
| LAN0_RXD[2:0]<br>LAN1_RXD[2:0] | I    | <b>Received Data:</b> The LAN Connect component uses these signals to transfer data and control information to the integrated LAN Controller. These signals have integrated weak pull-up resistors.   |
| LAN0_TXD[2:0]<br>LAN1_TXD[2:0] | O    | <b>Transmit Data:</b> The integrated LAN Controller uses these signals to transfer data and control information to the LAN Connect component.   |
| LDRQ[1:0]#                     | I    | <b>LPC Serial DMA/Master Request Inputs:</b> These signals are used to request DMA or bus master access. Typically, they are connected to external Super I/O device. An internal pull-up resistor is provided on these signals.   |
| LFRAME#<br>/FWH[4]             | O    | <b>LPC Frame:</b> LFRAME# indicates the start of an LPC cycle, or an abort.   |
| NC[10:1]                       | —    | No Connect. Do not connect these pins.<br><b>Optional:</b> NC[10:6, 3:1] can be routed to a test point for use in manufacturing NAND tree testing.  |
| NMI                            | O    | <b>Non-Maskable Interrupt:</b> NMI is used to force a non-maskable interrupt to the processor. The 82801E C-ICH can generate an NMI when either SERR# or IOCHK# is asserted. The processor detects an NMI when it detects a rising edge on NMI. NMI is reset by setting the corresponding NMI source enable/disable bit in the NMI Status and Control Register.<br><b>Speed Strap:</b> During the reset sequence, 82801E C-ICH drives NMI high if the corresponding bit is set in the FREQ_STRP register.   |
| OC[1:0]#                       | I    | <b>Overcurrent Indicators:</b> These signals set corresponding bits in the USB controllers to indicate that an overcurrent condition has occurred.  |
| PAR                            | I/O  | <b>Calculated/Checked Parity:</b> PAR uses “even” parity calculated on 36 bits, AD[31:0] plus C/BE[3:0]#. “Even” parity means that the 82801E C-ICH counts the number of 1s within the 36 bits plus PAR and the sum is always even. The 82801E C-ICH always calculates PAR on 36 bits, regardless of the valid byte enables. The 82801E C-ICH generates PAR for address and data phases and only guarantees PAR to be valid one PCI clock after the corresponding address or data phase. The 82801E C-ICH drives and tri-states PAR identically to the AD[31:0] lines except that the 82801E C-ICH delays PAR by exactly one PCI clock. PAR is an output during the address phase (delayed one clock) for all 82801E C-ICH initiated transactions. PAR is an output during the data phase (delayed one clock) when the 82801E C-ICH is the Initiator of a PCI write transaction, and when it is the target of a read transaction. 82801E C-ICH checks parity when it is the target of a PCI write transaction. If a parity error is detected, the 82801E C-ICH sets the appropriate internal status bits, and has the option to generate an NMI# or SMI#. |
| PCICLK                         | I    | <b>PCI Clock:</b> This is a 33 MHz clock. PCICLK provides timing for all transactions on the PCI Bus.   |
| PCIRST#                        | O    | <b>PCI Reset:</b> 82801E C-ICH asserts PCIRST# to reset devices that reside on the PCI bus. The 82801E C-ICH asserts PCIRST# during power-up and when S/W initiates a hard reset sequence through the RC (CF9h) register. The 82801E C-ICH drives PCIRST# inactive a minimum of 1 ms after PWROK is driven active. The 82801E C-ICH drives PCIRST# active a minimum of 1 ms when initiated through the RC register.   |
| PDA[2:0]                       | O    | <b>Primary IDE Device Address:</b> These output signals are connected to the corresponding signals on the primary IDE connector. They are used to indicate which byte in either the ATA command block or control block is being addressed.  |
| PDCS1#                         | O    | <b>Primary IDE Device Chip Selects for 100 Range:</b> This signal is for the ATA command register block. This output signal is connected to the corresponding signal on the primary IDE connector.  |

Table 6. 82801E C-ICH Signal Description (Sheet 6 of 11)

| Signal                            | Type | Description  |
|-----------------------------------|------|--|
| PDCS3#                            | O    | <b>Primary IDE Device Chip Select for 300 Range:</b> This signal is for the ATA control register block. This output signal is connected to the corresponding signal on the primary IDE connector.  |
| PDD[15:0]                         | I/O  | <b>Primary IDE Device Data:</b> These signals directly drive the corresponding signals on the primary IDE connector. There is a weak internal pull-down resistor on PDD[7].  |
| PDDACK#                           | O    | <b>Primary IDE Device DMA Acknowledge:</b> This signal directly drives the DAK# signal on the primary IDE connector. This signal is asserted by the 82801E C-ICH to indicate to the IDE DMA slave device that a given data transfer cycle (assertion of DIOR# or DIOW#) is a DMA data transfer cycle. This signal is used in conjunction with the PCI bus master IDE function and is not associated with any AT-compatible DMA channel.  |
| PDDREQ                            | I    | <b>Primary IDE Device DMA Request:</b> This input signal is directly driven from the DRQ signal on the primary IDE connector. It is asserted by the IDE device to request a data transfer, and used in conjunction with the PCI bus master IDE function. This signal is not associated with any AT-compatible DMA channel. There is a weak internal pull-down resistor on PDDREQ.  |
| PDIOR#<br>/(PDWSTB<br>/PRDMARDY#) | O    | <b>Primary Disk I/O Read (PIO and Non-Ultra DMA):</b> This is the command to the IDE device that it may drive data on the PDD lines. Data is latched by the 82801E C-ICH on the deassertion edge of PDIOR#. The IDE device is selected either by the ATA register file chip selects (PDCS1#, PDCS3#) and the PDA lines, or the IDE DMA acknowledge (PDDAK#).<br><b>Primary Disk Write Strobe (Ultra DMA Writes to Disk):</b> PDWSTB is the data write strobe for writes to disk. When writing to disk, the 82801E C-ICH drives valid data on rising and falling edges of PDWSTB.<br><b>Primary Disk DMA Ready (Ultra DMA Reads from Disk):</b> PRDMARDY# is the DMA ready for reads from disk. When reading from disk, the 82801E C-ICH deasserts PRDMARDY# to pause burst data transfers. |
| PDIOW#<br>/(PDSTOP)               | O    | <b>Primary Disk I/O Write (PIO and Non-Ultra DMA):</b> This is the command to the IDE device that it may latch data from the PDD lines. Data is latched by the IDE device on the deassertion edge of PDIOW#. The IDE device is selected either by the ATA register file chip selects (PDCS1#, PDCS3#) and the PDA lines, or the IDE DMA acknowledge (PDDAK#).<br><b>Primary Disk Stop (Ultra DMA):</b> 82801E C-ICH asserts PDSTOP to terminate a burst.   |
| PERR#                             | I/O  | <b>Parity Error:</b> An external PCI device drives PERR# when it receives data that has a parity error. The 82801E C-ICH drives PERR# when it detects a parity error. The ICH can either generate an NMI# or SMI# upon detecting a parity error (either detected internally or reported via the PERR# signal).   |
| PIORDY<br>/(PDRSTB<br>/PDMARDY#)  | I    | <b>Primary I/O Channel Ready (PIO):</b> This signal keeps the strobe active (PDIOR# on reads, PDIOW# on writes) longer than the minimum width. It adds wait states to PIO transfers.<br><b>Primary Disk Read Strobe (Ultra DMA Reads from Disk):</b> When reading from disk, the 82801E C-ICH latches data from the disk on rising and falling edges of PDRSTB.<br><b>Primary Disk DMA Ready (Ultra DMA Writes to Disk):</b> When writing to disk, PDMARDY# is deasserted by the disk to pause burst data transfers.   |
| PIRQ[A:D]#                        | I/OD | <b>PCI Interrupt Requests:</b> In Non-APIC Mode the PIRQx# signals can be routed to interrupts 3:7, 9:12, 14, or 15 as described in the Interrupt Steering section. Each PIRQx# line has a separate Route Control Register.<br>In APIC mode, these signals are connected to the internal I/O APIC in the following fashion: PIRQ[A]# is connected to IRQ16, PIRQ[B]# to IRQ17, PIRQ[C]# to IRQ18, and PIRQ[D]# to IRQ19. This frees the ISA interrupts.  |

Table 6. 82801E C-ICH Signal Description (Sheet 7 of 11)

| Signal   | Type    | Description  |
|--|---------|--|
| PIRQ[E:F]#<br>PIRQ[G]/GPIO[4]<br>PIRQ[H]/GPIO[5]       | I/OD    | <b>PCI Interrupt Requests:</b> In Non-APIC Mode the PIRQx# signals can be routed to interrupts 3:7, 9:12, 14 or 15 as described in the Interrupt Steering section. Each PIRQx# line has a separate Route Control Register.<br>In APIC mode, these signals are connected to the internal I/O APIC in the following fashion: PIRQ[E]# is connected to IRQ20, PIRQ[F]# to IRQ21, PIRQ[G]# to IRQ22, and PIRQ[H]# to IRQ23. If not needed for interrupts, these signals can be used as GPIO. |
| PLOCK#   | I/O     | <b>PCI Lock:</b> PLOCK# indicates an exclusive bus operation and may require multiple transactions to complete. 82801E C-ICH asserts PLOCK# when it performs non-exclusive transactions on the PCI bus.  |
| PWROK  | I       | <b>Power OK:</b> When asserted, PWROK is an indication to the 82801E C-ICH that core power and PCICLK have been stable for at least 1 ms. PWROK can be driven asynchronously. When PWROK is negated, the 82801E C-ICH asserts PCIRST#.   |
| RCIN#  | I       | <b>Keyboard Controller Reset Processor:</b> The keyboard controller can generate INIT# to the processor. This saves the external OR gate with the 82801E C-ICH's other sources of INIT#. When the 82801E C-ICH detects the assertion of this signal, INIT# is generated for 16 PCI clocks.   |
| REQ[3:0]#<br>REQ[5]#<br>/REQ[B]#<br>/GPIO[1]           | I       | <b>PCI Requests:</b> The 82801E C-ICH supports up to four masters on the PCI bus. REQ[5]# is muxed with PC/PCI REQ[B]# (must choose one or the other, but not both). If not used for PCI or PC/PCI, REQ[5]#/REQ[B]# can instead be used as GPIO[1].<br><b>NOTE:</b> REQ[0]# is programmable to have improved arbitration latency for supporting PCI-based 1394 controllers.  |
| REQ[A]#<br>/GPIO[0]<br>REQ[B]#<br>/REQ[5]#<br>/GPIO[1] | I       | <b>PC/PCI DMA Request [A:B]:</b> This request serializes ISA-like DMA Requests for the purpose of running ISA-compatible DMA cycles over the PCI bus. This is used by devices such as PCI-based Super I/O or audio codecs that need to perform legacy 8237 DMA but have no ISA bus.<br>When not used for PC/PCI requests, these signals can be used as General Purpose Inputs. Instead, REQ[B]# can be used as the fourth PCI bus request.   |
| RESERVED1<br>RESERVED2                                 | —       | This signal must have an external pull up to Vcc3_3.   |
| RI#  | I       | <b>Ring Indicate:</b> From the modem interface. This signal can be enabled as a wake event; this is preserved across power failures.   |
| RSM_PWROK  | I       | <b>Resume Well Power OK:</b> When asserted, this signal is an indication to the 82801E C-ICH that the resume well power has been stable for at least 10 ms.<br><b>NOTE:</b> The 82801E C-ICH does not use the Resume Well Power OK signal.   |
| RSMRST#  | I       | <b>Resume Well Reset:</b> RSMRST# is used for resetting the resume power plane logic.<br><b>NOTE:</b> The 82801E C-ICH does not use the Resume Well Reset signal.  |
| RTCRST#  | I       | <b>RTC Reset:</b> When asserted, this signal resets register bits in the RTC well and sets the RTC_PWR_STS bit (bit 2 in GEN_PMCON3 register). This signal is also used to enter the test modes documented in "Test Signals" on page 49.<br><b>NOTE:</b> Clearing CMOS in an 82801E C-ICH-based platform can be done by using a jumper on RTCRST# or GPI, or using SAFEMODE strap. Implementations should not attempt to clear CMOS by using a jumper to pull VccRTC low.                |
| RTCX1  | Special | <b>Crystal Input 1:</b> This signal is connected to the 32.768 KHz crystal. If no external crystal is used, then RTCX1 can be driven with the desired clock rate.  |
| RTCX2  | Special | <b>Crystal Input 2:</b> This signal is connected to the 32.768 KHz crystal. If no external crystal is used, then RTCX2 should be left floating.  |

Table 6. 82801E C-ICH Signal Description (Sheet 8 of 11)

| Signal                            | Type | Description   |
|-----------------------------------|------|---|
| SDA[2:0]                          | O    | <b>Secondary IDE Device Address:</b> These output signals are connected to the corresponding signals on the secondary IDE connectors. They are used to indicate which byte in either the ATA command block or control block is being addressed.   |
| SDCS1#                            | O    | <b>Secondary IDE Device Chip Selects for 100 Range:</b> This signal is for the ATA command register block. This output signal is connected to the corresponding signal on the secondary IDE connector.  |
| SDCS3#                            | O    | <b>Secondary IDE Device Chip Select for 300 Range:</b> This signal is for the ATA control register block. This output signal is connected to the corresponding signal on the secondary IDE connector.   |
| SDD[15:0]                         | I/O  | <b>Secondary IDE Device Data:</b> These signals directly drive the corresponding signals on the secondary IDE connector. There is a weak internal pull-down resistor on SDD[7].   |
| SDDACK#                           | O    | <b>Secondary IDE Device DMA Acknowledge:</b> This signal directly drives the DAK# signal on the secondary IDE connectors. This signal is asserted by the 82801E C-ICH to indicate to the IDE DMA slave device that a given data transfer cycle (assertion of DIOR# or DIOW#) is a DMA data transfer cycle. This signal is used in conjunction with the PCI bus master IDE function and is not associated with any AT-compatible DMA channel.  |
| SDDREQ                            | I    | <b>Secondary IDE Device DMA Request:</b> This input signal is directly driven from the DRQ signals on the secondary IDE connector. It is asserted by the IDE device to request a data transfer, and used in conjunction with the PCI bus master IDE function. It is not associated with any AT-compatible DMA channel. There is a weak internal pull-down resistor on SDDREQ.   |
| SDIOR#<br>/(SDWSTB/<br>SRDMARDY#) | O    | <b>Secondary Disk I/O Read (PIO and Non-Ultra DMA):</b> This is the command to the IDE device that it may drive data on the SDD lines. Data is latched by the 82801E C-ICH on the deassertion edge of SDIOR#. The IDE device is selected either by the ATA register file chip selects (SDCS1# or SDSC3#) and the SDA lines, or the IDE DMA acknowledge (SDDAK#).<br><b>Secondary Disk Write Strobe (Ultra DMA Writes to Disk):</b> This is the data write strobe for writes to disk. When writing to disk, the 82801E C-ICH drives valid data on rising and falling edges of SDWSTB.<br><b>Secondary Disk DMA Ready (Ultra DMA Reads from Disk):</b> This is the DMA ready for reads from disk. When reading from disk, the 82801E C-ICH deasserts SRDMARDY# to pause burst data transfers. |
| SDIOW#<br>/(SDSTOP)               | O    | <b>Secondary Disk I/O Write (PIO and Non-Ultra DMA):</b> This is the command to the IDE device that it may latch data from the SDD lines. Data is latched by the IDE device on the deassertion edge of SDIOW#. The IDE device is selected either by the ATA register file chip selects (SDCS1# or SDSC3#) and the SDA lines, or the IDE DMA acknowledge (SDDAK#).<br><b>Secondary Disk Stop (Ultra DMA):</b> The 82801E C-ICH asserts SDSTOP to terminate a burst.  |
| SERIRQ                            | I/O  | <b>Serial Interrupt Request:</b> This pin implements the serial interrupt protocol.   |
| SERR#                             | I    | <b>System Error:</b> SERR# can be pulsed active by any PCI device that detects a system error condition. Upon sampling SERR# active, the 82801E C-ICH has the ability to generate an NMI, SMI#, or interrupt.   |
| SIORDY<br>/(SDRSTB<br>/SWDMARDY#) | I    | <b>Secondary I/O Channel Ready (PIO):</b> This signal keeps the strobe active (SDIOR# on reads, SDIOW# on writes) longer than the minimum width. It adds wait states to SIO transfers.<br><b>Secondary Disk Read Strobe (Ultra DMA Reads from Disk):</b> When reading from disk, the 82801E C-ICH latches data from the disk on rising and falling edges of SDRSTB.<br><b>Secondary Disk DMA Ready (Ultra DMA Writes to Disk):</b> When writing to disk, SWDMARDY# is deasserted by the disk to pause burst data transfers.   |



Table 6. 82801E C-ICH Signal Description (Sheet 9 of 11)

| Signal                 | Type | Description  |
|------------------------|------|--|
| SIU_LAD[3:0]           | I/O  | <b>SIU LPC Multiplexed Command, Address, Data:</b> Internal pull-ups are provided.   |
| SIU_LCLK               | I    | <b>SIU LPC clock input to SIU:</b> 33 MHz LPC clock.   |
| SIU_LDRQ#              | O    | <b>SIU LPC Serial DMA/Master Request Output:</b> Used by SIU devices to indicate a DMA request. These signals have weak internal pull-up resistors to avoid external glue.   |
| SIU_LFRAME#            | I    | <b>SIU LPC Frame:</b> Indicates the start of an LPC cycle, or an abort.  |
| SIU_RESET#             | I    | <b>SIU Reset:</b> This signal should be tied to PCI RESET.   |
| SIU_SERIRQ             | I/O  | <b>SIU Serial IRQ input:</b> This pin receives the serial interrupt protocol from external devices. Pull up if unused.   |
| SIU0_CTS#<br>SIU1_CTS# | I    | <b>Clear To Send:</b> Active low, this pin indicates that data can be exchanged between CICH and external interface. These pins have no effect on the transmitter.<br><b>NOTE:</b> These pins could be used as Modem Status Input whose condition can be tested by the processor by reading bit 4 (CTS) of the Modem Status register (MSR). Bit 4 is the complement of the CTS# signal. Bit 0 (DCTS) of the MSR indicates whether the CTS# input has changed state since the previous reading of the MSR. When the CTS bit of the MSR changes state an interrupt is generated if the Modem Status Interrupt is enabled.  |
| SIU0_DCD#<br>SIU1_DCD# | I    | <b>Data Carrier Detect for UART0 and UART1:</b> Active low, this pin indicates that data carrier has been detected by the external agent.<br><b>NOTE:</b> These pins are Modem Status Inputs whose condition can be tested by the processor by reading bit 7 (DCD) of the Modem Status register (MSR). Bit 7 is the complement of the DCD# signal. Bit 3 (DDCD) of the MSR indicates whether the DCD# input has changed state since the previous reading of the MSR. When the DCD bit of the MSR changes state an interrupt is generated if the Modem Status Interrupt is enabled.   |
| SIU0_DSR#<br>SIU1_DSR# | I    | <b>Data Set Ready for UART0 and UART1:</b> Active low, this pin indicates that the external agent is ready to communicate with 82801E C-ICH UARTs. These pins have no effect on the transmitter.<br><b>NOTE:</b> These pins could be used as Modem Status Inputs whose condition can be tested by the processor by reading bit 5 (DSR) of the Modem Status register. Bit 5 is the complement of the DSR# signal. Bit 1 (DDSR) of the Modem status register (MSR) indicates whether the DSR# input has changed state since the previous reading of the MSR. When the DSR bit of the MSR changes state an interrupt is generated if the Modem Status Interrupt is enabled. |
| SIU0_DTR#<br>SIU1_DTR# | O    | <b>Data Terminal Ready for UART0 and UART1:</b> When low these pins informs the modem or data set that CICH UART 0, 1 are ready to establish a communication link. The DTR#x(x=0,1) output signals can be set to an active low by programming the DTRx (x=0,1) (bit0) of the Modem control register to a logic '1'. A Reset operation sets this signal to its inactive state (logic '1'). LOOP mode operation holds this signal in its inactive state.   |
| SIU0_RI#<br>SIU1_RI#   | I    | <b>Ring Indicator for UART0 and UART1:</b> Active low, this pin indicates that a telephone ringing signal has been received by the external agent.<br><b>NOTE:</b> These pins are Modem Status Input whose condition can be tested by the processor by reading bit 6 (RI) of the Modem Status register (MSR). Bit 6 is the complement of the RI# signal. Bit 2 (TERI) of the MSR indicates whether the DCD# input has changed state since the previous reading of the MSR. When the RI bit of the MSR changes state an interrupt is generated if the Modem Status Interrupt is enabled.  |

Table 6. 82801E C-ICH Signal Description (Sheet 10 of 11)

| Signal                 | Type | Description   |
|------------------------|------|---|
| SIU0_RTS#<br>SIU1_RTS# | O    | <b>Request To Send for UART0 and UART1:</b> When low these pins inform the modem or data set that CICH UART 0, 1 are ready to establish a communication link. The RTS#x(x=0,1) output signals can be set to an active low by programming the RTSx (x=0,1) (bit1) of the Modem control register to a logic '1'. A Reset operation sets this signal to its inactive state (logic '1'). LOOP mode operation holds this signal in its inactive state. |
| SIU0_RXD<br>SIU1_RXD   | I    | <b>Serial Input for UART0 and UART1:</b> Serial data input from device pin to the receive port.   |
| SIU0_TXD<br>SIU1_TXD   | O    | <b>Serial Output for UART0 and UART1:</b> Serial data output to the communication peripheral/modem or data set. Upon reset, the TXD pins will be set to MARKING condition (logic '1' state).  |
| SMBALERT#<br>/GPIO[11] | I    | <b>SMBus Alert:</b> This signal is used to wake the system or generate an SMI#. If not used for SMBALERT#, it can be used as a GPI.   |
| SMBCLK                 | I/OD | <b>SMBus Clock:</b> External pull-up is required.   |
| SMBDATA                | I/OD | <b>SMBus Data:</b> External pull-up is required.  |
| SMI#                   | O    | <b>System Management Interrupt:</b> SMI# is an active low output synchronous to PCICLK. It is asserted by the 82801E C-ICH in response to one of many enabled hardware or software events.  |
| SMLINK[1:0]            | I/OD | <b>System Management Link:</b> These signals are an SMBus link to an optional external system management ASIC or LAN controller. External pull-ups are required.<br><b>NOTE:</b> SMLINK[0] corresponds to an SMBus Clock signal and SMLINK[1] corresponds to an SMBus Data signal.  |
| SPKR                   | O    | <b>Speaker:</b> The SPKR signal is the output of counter 2 and is internally ANDed with Port 61h bit 1 to provide Speaker Data Enable. This signal drives an external speaker driver device, which in turn drives the system speaker. Upon PCIRST#, its output state is 1.<br><b>NOTE:</b> SPKR is sampled at the rising edge of PWROK as a functional strap. See "Functional Straps" on page 49 for more details.                                |
| STOP#                  | I/O  | <b>Stop:</b> STOP# indicates that the 82801E C-ICH, as a Target, is requesting the Initiator to stop the current transaction. STOP# causes the 82801E C-ICH, as an Initiator, to stop the current transaction. STOP# is an output when the 82801E C-ICH is a target and an input when the 82801E C-ICH is an Initiator. STOP# is tri-stated from the leading edge of PCIRST#. STOP# remains tri-stated until driven by the 82801E C-ICH.          |
| STPCLK#                | O    | <b>Stop Clock Request:</b> STPCLK# is an active low output synchronous to PCICLK. It is asserted by the 82801E C-ICH in response to one of many hardware or software events. When the processor samples STPCLK# asserted, it responds by stopping its internal clock.   |
| SUSCLK                 | O    | <b>Suspend Clock:</b> This signal is an output of the RTC generator circuit and is used by other chips for the refresh clock.   |
| THRM#                  | I    | <b>Thermal Alarm:</b> THRM# is an active low signal generated by external hardware to start the hardware clock throttling mode. This signal can also generate an SMI# or an SCI.  |
| TP[3:0]                | I    | <b>Test Points:</b><br>TP0: This signal must have an external pull-up to Vcc3_3.<br>TP1: Route to a test point with option to jumper to Vcc1_8. Used for NAND tree testing. Otherwise jumper to Vcc1_8.<br>TP2 and TP3: Route to a test point with option to jumper to VSS. Used for NAND tree testing. Otherwise jumper to VSS.  |

Table 6. 82801E C-ICH Signal Description (Sheet 11 of 11)

| Signal                               | Type | Description   |
|--------------------------------------|------|---|
| TRDY#                                | I/O  | <b>Target Ready:</b> TRDY# indicates the 82801E C-ICH's ability as a Target to complete the current data phase of the transaction. TRDY# is used in conjunction with IRDY#. A data phase is completed when both TRDY# and IRDY# are sampled asserted. During a read, TRDY# indicates that the 82801E C-ICH, as a Target, has placed valid data on AD[31:0]. During a write, TRDY# indicates the 82801E C-ICH, as a Target is prepared to latch data. TRDY# is an input to the 82801E C-ICH when the 82801E C-ICH is the Initiator and an output from the 82801E C-ICH when the 82801E C-ICH is a Target. TRDY# is tri-stated from the leading edge of PCIRST#. TRDY# remains tri-stated by the 82801E C-ICH until driven by a target. |
| UART_CLK                             | I    | Input clock to the SIU. This clock is passed to the baud clock generation logic of each UART in the SIU.  |
| USBP0P<br>USBP0N<br>USBP1P<br>USBP1N | I/O  | <b>Universal Serial Bus Port 1:0 Differential:</b> These differential pairs are used to transmit Data/Address/Command signals for ports 0 and 1.  |
| V_CPU_IO                             |      | Powered by the same supply as the processor I/O voltage. This supply is used to drive the processor interface outputs.  |
| V5REF                                |      | Reference for 5 V tolerance on Core well inputs.  |
| VBIAS                                |      | RTC well bias voltage. The DC reference voltage applied to this pin sets a current that is mirrored throughout the oscillator and buffer circuitry. See "External RTC Circuitry" on page 50.  |
| Vcc1_8                               |      | 1.8 V supply for Core well logic.   |
| Vcc3_3                               |      | 3.3 V supply for Core well I/O buffers.   |
| VccRTC                               |      | 3.3 V (can drop to 2.0 V minimum in the G3 state) supply for the RTC well. This power is not expected to be shut off unless the RTC battery is removed or completely drained.<br><b>NOTE:</b> Implementations should not attempt to clear CMOS by using a jumper to pull VccRTC low. Clearing CMOS in an 82801E C-ICH-based platform can be done by using a jumper on RTCRST# or GPI, or using SAFEMODE strap.  |
| VRMPWRGD                             | I    | <b>VRM Power Good:</b> This can be considered to be the CPU's VRM power good. This signal should be ANDed with the ATX power supply's PWROK signal.   |
| Vss                                  |      | Grounds.  |

## 3.2 Signals Grouped By Type

### 3.2.1 Hub Interface to Host Controller

Table 7. Hub Interface Signals

| Name     | Type | Description   |
|----------|------|---|
| HL[11:0] | I/O  | Hub Interface Signals   |
| HL_STB   | I/O  | Hub Interface Strobe: One of two differential strobe signals used to transmit and receive data through the hub interface. |
| HL_STB#  | I/O  | Hub Interface Strobe Complement: Second of the two differential strobe signals.   |
| HLCOMP   | I/O  | Hub Interface Compensation: Used for hub interface buffer compensation.   |

### 3.2.2 Link to LAN Connect

Table 8. LAN Interface

| Name                           | Type | Description   |
|--------------------------------|------|---|
| LAN0_CLK<br>LAN1_CLK           | I    | <b>LAN Interface Clock:</b> This signal is driven by the LAN Connect component. The frequency range is 0.8 MHz to 50 MHz.   |
| LAN0_RSTSYNC<br>LAN1_RSTSYNC   | O    | <b>LAN Reset/Sync:</b> The LAN Connect component's Reset and Sync signals are multiplexed onto this pin.  |
| LAN0_RXD[2:0]<br>LAN1_RXD[2:0] | I    | <b>Received Data:</b> The LAN Connect component uses these signals to transfer data and control information to the integrated LAN Controller. These signals have integrated weak pull-up resistors. |
| LAN0_TXD[2:0]<br>LAN1_TXD[2:0] | O    | <b>Transmit Data:</b> The integrated LAN Controller uses these signals to transfer data and control information to the LAN Connect component.   |

### 3.2.3 EEPROM Interface

Table 9. EEPROM Interface

| Name                   | Type | Description   |
|------------------------|------|---|
| EE0_CS<br>EE1_CS       | O    | <b>EEPROM Chip Select:</b> These signals are chip-select signals to the EEPROMs.  |
| EE0_DIN<br>EE1_DIN     | I    | <b>EEPROM Data In:</b> These signals transfer data from the EEPROMs to the 82801E C-ICH. These signals have an integrated pull-up resistor. |
| EE0_DOUT<br>EE1_DOUT   | O    | <b>EEPROM Data Out:</b> These signals transfer data from the 82801E C-ICH to the EEPROMs.   |
| EE0_SHCLK<br>EE1_SHCLK | O    | <b>EEPROM Shift Clock:</b> These signals are the serial shift clock output to the EEPROMs.  |

### 3.2.4 Firmware Hub Interface

**Table 10. Firmware Hub Interface Signals**

| Name                         | Type | Description  |
|------------------------------|------|--|
| <b>FWH[3:0]</b><br>/LAD[3:0] | I/O  | <b>Firmware Hub Signals:</b> These signals are muxed with LPC address signals. |
| <b>FWH[4]</b><br>/LFRAME#    | I/O  | <b>Firmware Hub Signals:</b> This signal is muxed with the LPC LFRAME# signal. |

### 3.2.5 PCI Interface

**Table 11. PCI Interface Signals (Sheet 1 of 3)**

| Name              | Type   | Description   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
|-------------------|--|---|------------|--------------|------|-----------------------|------|---------------|------|----------|------|-----------|------|-------------|------|--------------|------|--------------------|------|---------------------|------|----------------------|------|--|------|------------------|------|-----------------------------|
| <b>AD[31:0]</b>   | I/O  | <b>PCI Address/Data:</b> AD[31:0] is a multiplexed address and data bus. During the first clock of a transaction, AD[31:0] contain a physical address (32 bits). During subsequent clocks, AD[31:0] contain data. The 82801E C-ICH drives all 0s on AD[31:0] during the address phase of all PCI Special Cycles.  |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>C/BE[3:0]#</b> | I/O  | <p><b>Bus Command and Byte Enables:</b> The command and byte enable signals are multiplexed on the same PCI pins. During the address phase of a transaction, C/BE[3:0]# define the bus command. During the data phase, C/BE[3:0]# define the Byte Enables.</p> <table border="0"> <thead> <tr> <th>C/BE[3:0]#</th> <th>Command Type</th> </tr> </thead> <tbody> <tr> <td>0000</td> <td>Interrupt Acknowledge</td> </tr> <tr> <td>0001</td> <td>Special Cycle</td> </tr> <tr> <td>0010</td> <td>I/O Read</td> </tr> <tr> <td>0011</td> <td>I/O Write</td> </tr> <tr> <td>0110</td> <td>Memory Read</td> </tr> <tr> <td>0111</td> <td>Memory Write</td> </tr> <tr> <td>1010</td> <td>Configuration Read</td> </tr> <tr> <td>1011</td> <td>Configuration Write</td> </tr> <tr> <td>1100</td> <td>Memory Read Multiple</td> </tr> <tr> <td>1101</td> <td>DAC Mode Address to be latched (target only)</td> </tr> <tr> <td>1110</td> <td>Memory Read Line</td> </tr> <tr> <td>1111</td> <td>Memory Write and Invalidate</td> </tr> </tbody> </table> <p>All command encodings not shown are reserved. The 82801E C-ICH does not decode reserved values, and therefore will not respond if a PCI master generates a cycle using one of the reserved values.</p> <p>As a target, the 82801E C-ICH can support DAC mode addressing for 44 bits.</p> | C/BE[3:0]# | Command Type | 0000 | Interrupt Acknowledge | 0001 | Special Cycle | 0010 | I/O Read | 0011 | I/O Write | 0110 | Memory Read | 0111 | Memory Write | 1010 | Configuration Read | 1011 | Configuration Write | 1100 | Memory Read Multiple | 1101 | DAC Mode Address to be latched (target only) | 1110 | Memory Read Line | 1111 | Memory Write and Invalidate |
| C/BE[3:0]#        | Command Type                                 |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0000              | Interrupt Acknowledge                        |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0001              | Special Cycle                                |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0010              | I/O Read                                     |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0011              | I/O Write                                    |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0110              | Memory Read                                  |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 0111              | Memory Write                                 |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1010              | Configuration Read                           |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1011              | Configuration Write                          |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1100              | Memory Read Multiple                         |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1101              | DAC Mode Address to be latched (target only) |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1110              | Memory Read Line                             |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| 1111              | Memory Write and Invalidate                  |   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |
| <b>DEVSEL#</b>    | I/O  | <b>Device Select:</b> The 82801E C-ICH asserts DEVSEL# to claim a PCI transaction. As an output, the 82801E C-ICH asserts DEVSEL# when a PCI master peripheral attempts an access to an internal 82801E C-ICH address or an address destined for the hub interface (main memory or AGP). As an input, DEVSEL# indicates the response to an 82801E C-ICH-initiated transaction on the PCI bus. DEVSEL# is tri-stated from the leading edge of PCIRST#. DEVSEL# remains tri-stated by the 82801E C-ICH until driven by a target device.   |            |              |      |                       |      |               |      |          |      |           |      |             |      |              |      |                    |      |                     |      |                      |      |  |      |                  |      |                             |

Table 11. PCI Interface Signals (Sheet 2 of 3)

| Name   | Type | Description   |
|--|------|---|
| <b>FRAME#</b>  | I/O  | <b>Cycle Frame:</b> The current Initiator drives FRAME# to indicate the beginning and duration of a PCI transaction. While the initiator asserts FRAME#, data transfers continue. When the initiator negates FRAME#, the transaction is in the final data phase. FRAME# is an input to the 82801E C-ICH when the 82801E C-ICH is the target, and FRAME# is an output from the 82801E C-ICH when the 82801E C-ICH is the Initiator. FRAME# remains tri-stated by the 82801E C-ICH until driven by an Initiator.  |
| <b>IRDY#</b>   | I/O  | <b>Initiator Ready:</b> IRDY# indicates the 82801E C-ICH's ability, as an Initiator, to complete the current data phase of the transaction. It is used in conjunction with TRDY#. A data phase is completed on any clock both IRDY# and TRDY# are sampled asserted. During a write, IRDY# indicates the 82801E C-ICH has valid data present on AD[31:0]. During a read, it indicates the 82801E C-ICH is prepared to latch data. IRDY# is an input to the 82801E C-ICH when the 82801E C-ICH is the Target and an output from the 82801E C-ICH when the 82801E C-ICH is an Initiator. IRDY# remains tri-stated by the 82801E C-ICH until driven by an Initiator.  |
| <b>TRDY#</b>   | I/O  | <b>Target Ready:</b> TRDY# indicates the 82801E C-ICH's ability as a Target to complete the current data phase of the transaction. TRDY# is used in conjunction with IRDY#. A data phase is completed when both TRDY# and IRDY# are sampled asserted. During a read, TRDY# indicates that the 82801E C-ICH, as a Target, has placed valid data on AD[31:0]. During a write, TRDY# indicates the 82801E C-ICH, as a Target is prepared to latch data. TRDY# is an input to the 82801E C-ICH when the 82801E C-ICH is the Initiator and an output from the 82801E C-ICH when the 82801E C-ICH is a Target. TRDY# is tri-stated from the leading edge of PCIRST#. TRDY# remains tri-stated by the 82801E C-ICH until driven by a target.   |
| <b>STOP#</b>   | I/O  | <b>Stop:</b> STOP# indicates that the 82801E C-ICH, as a Target, is requesting the Initiator to stop the current transaction. STOP# causes the 82801E C-ICH, as an Initiator, to stop the current transaction. STOP# is an output when the 82801E C-ICH is a target and an input when the 82801E C-ICH is an Initiator. STOP# is tri-stated from the leading edge of PCIRST#. STOP# remains tri-stated until driven by the 82801E C-ICH.  |
| <b>PAR</b>   | I/O  | <b>Calculated/Checked Parity:</b> PAR uses "even" parity calculated on 36 bits, AD[31:0] plus C/BE[3:0]#. "Even" parity means that the 82801E C-ICH counts the number of 1s within the 36 bits plus PAR and the sum is always even. The 82801E C-ICH always calculates PAR on 36 bits, regardless of the valid byte enables. The 82801E C-ICH generates PAR for address and data phases and only guarantees PAR to be valid one PCI clock after the corresponding address or data phase. The 82801E C-ICH drives and tri-states PAR identically to the AD[31:0] lines except that the 82801E C-ICH delays PAR by exactly one PCI clock. PAR is an output during the address phase (delayed one clock) for all 82801E C-ICH initiated transactions. PAR is an output during the data phase (delayed one clock) when the 82801E C-ICH is the Initiator of a PCI write transaction, and when it is the target of a read transaction. 82801E C-ICH checks parity when it is the target of a PCI write transaction. If a parity error is detected, the 82801E C-ICH sets the appropriate internal status bits, and has the option to generate an NMI# or SMI#. |
| <b>PERR#</b>   | I/O  | <b>Parity Error:</b> An external PCI device drives PERR# when it receives data that has a parity error. The 82801E C-ICH drives PERR# when it detects a parity error. The ICH can either generate an NMI# or SMI# upon detecting a parity error (either detected internally or reported via the PERR# signal).  |
| <b>REQ[3:0]#</b><br>/REQ[5]#<br>/REQ[B]#<br>/GPIO[1] | I    | <b>PCI Requests:</b> The 82801E C-ICH supports up to five masters on the PCI bus. REQ[5]# is muxed with PC/PCI REQ[B]# (must choose one or the other, but not both). If not used for PCI or PC/PCI, REQ[5]#/REQ[B]# can instead be used as GPIO[1].<br><br><b>NOTE:</b> REQ[0]# is programmable to have improved arbitration latency for supporting PCI-based 1394 controllers.   |

Table 11. PCI Interface Signals (Sheet 3 of 3)

| Name   | Type | Description   |
|--|------|---|
| <b>GNT[3:0]#</b><br>/GNT[5]#<br>/GNT[B]#<br>/GPIO[17]#                 | O    | <b>PCI Grants:</b> The 82801E C-ICH supports up to four masters on the PCI bus. Pull-up resistors are not required on these signals. If pullups are used, they should be tied to the Vcc3_3 power rail. GNT[B]#/GNT[5]#/GPIO[17] has an internal pull-up.   |
| <b>PCICLK</b>  | I    | <b>PCI Clock:</b> This is a 33 MHz clock. PCICLK provides timing for all transactions on the PCI Bus.   |
| <b>PCIRST#</b>   | O    | <b>PCI Reset:</b> 82801E C-ICH asserts PCIRST# to reset devices that reside on the PCI bus. The 82801E C-ICH asserts PCIRST# during power-up and when S/W initiates a hard reset sequence through the RC (CF9h) register. The 82801E C-ICH drives PCIRST# inactive a minimum of 1 ms after PWROK is driven active. The 82801E C-ICH drives PCIRST# active a minimum of 1 ms when initiated through the RC register.   |
| <b>PLOCK#</b>  | I/O  | <b>PCI Lock:</b> PLOCK# indicates an exclusive bus operation and may require multiple transactions to complete. 82801E C-ICH asserts PLOCK# when it performs non-exclusive transactions on the PCI bus.   |
| <b>SERR#</b>   | I    | <b>System Error:</b> SERR# can be pulsed active by any PCI device that detects a system error condition. Upon sampling SERR# active, the 82801E C-ICH has the ability to generate an NMI, SMI#, or interrupt.   |
| <b>REQ[A]#</b><br>/GPIO[0]<br><b>REQ[B]#</b><br>/REQ[5]#<br>/GPIO[1]   | I    | <b>PC/PCI DMA Request [A:B]:</b> This request serializes ISA-like DMA Requests for the purpose of running ISA-compatible DMA cycles over the PCI bus. This is used by devices such as PCI-based Super I/O or audio codecs that need to perform legacy 8237 DMA but have no ISA bus.<br><br>When not used for PC/PCI requests, these signals can be used as General Purpose Inputs. Instead, REQ[B]# can be used as the fifth PCI bus request.   |
| <b>GNT[A]#</b><br>/GPIO[16]<br><b>GNT[B]#</b><br>/GNT[5]#<br>/GPIO[17] | O    | <b>PC/PCI DMA Acknowledges [A:B]:</b> This grant serializes an ISA-like DACK# for the purpose of running DMA/ISA master cycles over the PCI bus. This is used by devices such as PCI-based Super/I/O or audio codecs which need to perform legacy 8237 DMA but have no ISA bus.<br><br>When not used for PC/PCI, these signals can be used as General Purpose Outputs. GNTB# can also be used as the fifth PCI bus master grant output. These signal have internal pull-up resistors. |

### 3.2.6 IDE Interface

Table 12. IDE Interface Signals

| Name   | Type | Description  |
|--|------|--|
| PDCS1#<br>SDCS1#   | O    | <b>Primary and Secondary IDE Device Chip Selects for 100 Range:</b> These signals are for the ATA command register block. This output signal is connected to the corresponding signal on the primary or secondary IDE connector.   |
| PDCS3#<br>SDCS3#   | O    | <b>Primary and Secondary IDE Device Chip Select for 300 Range:</b> These signals are for the ATA control register block. This output signal is connected to the corresponding signal on the primary or secondary IDE connector.  |
| PDA[2:0]<br>SDA[2:0]   | O    | <b>Primary and Secondary IDE Device Address:</b> These output signals are connected to the corresponding signals on the primary or secondary IDE connectors. They are used to indicate which byte in either the ATA command block or control block is being addressed.   |
| PDD[15:0]<br>SDD[15:0]   | I/O  | <b>Primary and Secondary IDE Device Data:</b> These signals directly drive the corresponding signals on the primary or secondary IDE connector. There is a weak internal pull-down resistor on PDD[7] and SDD[7].  |
| PDDREQ<br>SDDREQ   | I    | <b>Primary and Secondary IDE Device DMA Request:</b> These input signals are directly driven from the DRQ signals on the primary or secondary IDE connector. It is asserted by the IDE device to request a data transfer, and used in conjunction with the PCI bus master IDE function. They are not associated with any AT-compatible DMA channel. There is a weak internal pull-down resistor on these signals.  |
| PDDACK#<br>SDDACK#   | O    | <b>Primary and Secondary IDE Device DMA Acknowledge:</b> These signals directly drive the DAK# signals on the primary and secondary IDE connectors. Each signal is asserted by the 82801E C-ICH to indicate to the IDE DMA slave devices that a given data transfer cycle (assertion of DIOR# or DIOW#) is a DMA data transfer cycle. This signal is used in conjunction with the PCI bus master IDE function and are not associated with any AT-compatible DMA channel.   |
| PDIOR#<br>/(PDWSTB<br>/PRDMARDY#)<br>SDIOR#<br>/(SDWSTB<br>/SRDMARDY#) | O    | <b>Primary and Secondary Disk I/O Read (PIO and Non-Ultra DMA):</b> This is the command to the IDE device that it may drive data on the PDD or SDD lines. Data is latched by the 82801E C-ICH on the deassertion edge of PDIOR# or SDIOR#. The IDE device is selected either by the ATA register file chip selects (PDCS1# or SDCS1#, PDCS3# or SDCS3#) and the PDA or SDA lines, or the IDE DMA acknowledge (PDDAK# or SDDAK#).<br><b>Primary and Secondary Disk Write Strobe (Ultra DMA Writes to Disk):</b> This is the data write strobe for writes to disk. When writing to disk, 82801E C-ICH drives valid data on rising and falling edges of PDWSTB or SDWSTB.<br><b>Primary and Secondary Disk DMA Ready (Ultra DMA Reads from Disk):</b> This is the DMA ready for reads from disk. When reading from disk, 82801E C-ICH deasserts PRDMARDY# or SRDMARDY# to pause burst data transfers. |
| PDIOW#<br>/(PDSTOP)<br>SDIOW#<br>/(SDSTOP)                             | O    | <b>Primary and Secondary Disk I/O Write (PIO and Non-Ultra DMA):</b> This is the command to the IDE device that it may latch data from the PDD or SDD lines. Data is latched by the IDE device on the deassertion edge of PDIOW# or SDIOW#. The IDE device is selected either by the ATA register file chip selects (PDCS1# or SDCS1#, PDCS3# or SDCS3#) and the PDA or SDA lines, or the IDE DMA acknowledge (PDDAK# or SDDAK#).<br><b>Primary and Secondary Disk Stop (Ultra DMA):</b> 82801E C-ICH asserts this signal (PDSTOP, SDSTOP) to terminate a burst.   |
| PIORDY<br>/(PDRSTB<br>/PWDMARDY#)<br>SIORDY<br>/(SDRSTB<br>/SWDMARDY#) | I    | <b>Primary and Secondary I/O Channel Ready (PIO):</b> This signal keeps the strobe active (PDIOR# or SDIOR# on reads, PDIOW# or SDIOW# on writes) longer than the minimum width. It adds wait states to PIO transfers.<br><b>Primary and Secondary Disk Read Strobe (Ultra DMA Reads from Disk):</b> When reading from disk, 82801E C-ICH latches data on rising and falling edges of this signal from the disk.<br><b>Primary and Secondary Disk DMA Ready (Ultra DMA Writes to Disk):</b> When writing to disk, this is deasserted by the disk to pause burst data transfers.  |



### 3.2.7 LPC Interface

**Table 13. LPC Interface Signals**

| Name                  | Type | Description   |
|-----------------------|------|---|
| LAD[3:0]<br>/FWH[3:0] | I/O  | <b>LPC Multiplexed Command, Address, Data:</b> Internal pull-ups are provided.  |
| LFRAME#<br>/FWH[4]    | O    | <b>LPC Frame:</b> LFRAME# indicates the start of an LPC cycle, or an abort.   |
| LDRQ[1:0]#            | I    | <b>LPC Serial DMA/Master Request Inputs:</b> These signals are used to request DMA or bus master access. Typically, they are connected to external Super I/O device. An internal pull-up resistor is provided on these signals. |

### 3.2.8 Interrupt Interface

**Table 14. Interrupt Signals**

| Name   | Type | Description   |
|--|------|---|
| SERIRQ   | I/O  | <b>Serial Interrupt Request:</b> This pin implements the serial interrupt protocol.   |
| PIRQ[A:D]#   | I/OD | <b>PCI Interrupt Requests:</b> In Non-APIC Mode the PIRQx# signals can be routed to interrupts 3:7, 9:12, 14, or 15 as described in the Interrupt Steering section. Each PIRQx# line has a separate Route Control Register.<br>In APIC mode, these signals are connected to the internal I/O APIC in the following fashion: PIRQ[A]# is connected to IRQ16, PIRQ[B]# to IRQ17, PIRQ[C]# to IRQ18, and PIRQ[D]# to IRQ19. This frees the ISA interrupts.   |
| PIRQ[E:F]#<br>PIRQ[G]#/GPIO[4]<br>PIRQ[H]#/GPIO[5] | I/OD | <b>PCI Interrupt Requests:</b> In Non-APIC Mode the PIRQx# signals can be routed to interrupts 3:7, 9:12, 14 or 15 as described in the Interrupt Steering section. Each PIRQx# line has a separate Route Control Register.<br>In APIC mode, these signals are connected to the internal I/O APIC in the following fashion: PIRQ[E]# is connected to IRQ20, PIRQ[F]# to IRQ21, PIRQ[G]# to IRQ22, and PIRQ[H]# to IRQ23. This frees the ISA interrupts. If not needed for interrupts, PIRQ[H:G] can be used as GPIO. |
| IRQ[14:15]   | I    | <b>Interrupt Request 14:15:</b> These interrupt inputs are connected to the IDE drives. IRQ14 is used by the drives connected to the primary controller and IRQ15 is used by the drives connected to the secondary controller.  |
| APICCLK  | I    | <b>APIC Clock:</b> The APIC clock runs at 33.333 MHz.   |
| APICD[1:0]   | I/OD | <b>APIC Data:</b> These bidirectional open drain signals are used to send and receive data over the APIC bus. As inputs, the data is valid on the rising edge of APICCLK. As outputs, new data is driven from the rising edge of the APICCLK.   |

### 3.2.9 USB Interface

Table 15. USB Interface Signals

| Name                                 | Type | Description  |
|--------------------------------------|------|--|
| USBP0P<br>USBP0N<br>USBP1P<br>USBP1N | I/O  | <b>Universal Serial Bus Port 1:0 Differential:</b> These differential pairs are used to transmit Data/Address/Command signals for ports 0 and 1.   |
| OC[1:0]#                             | I    | <b>Overcurrent Indicators:</b> These signals set corresponding bits in the USB controllers to indicate that an overcurrent condition has occurred. |

### 3.2.10 Power Signals

Table 16. Power Signals

| Name      | Type | Description  |
|-----------|------|--|
| PWROK     | I    | <b>Power OK:</b> When asserted, PWROK is an indication to the 82801E C-ICH that core power and PCICLK have been stable for at least 1 ms. PWROK can be driven asynchronously. When PWROK is negated, the 82801E C-ICH asserts PCIRST#.     |
| RSM_PWROK | I    | <b>Resume Well Power OK:</b> When asserted, this signal is an indication to the 82801E C-ICH that the resume well power has been stable for at least 10 ms.<br><b>NOTE:</b> The 82801E C-ICH does not use the resume well power OK signal. |
| RSMRST#   | I    | <b>Resume Well Reset:</b> RSMRST# is used for resetting the resume power plane logic.<br><b>NOTE:</b> The 82801E C-ICH does not use the resume well reset signal.  |
| VRMPWRGD  | I    | <b>VRM Power Good:</b> VRMPWRGD should be connected to be the processor's VRM Power Good.  |

### 3.2.11 Processor Interface

**Table 17. Processor Interface Signals (Sheet 1 of 2)**

| Name    | Type | Description  |
|---------|------|--|
| A20M#   | O    | <p><b>Mask A20:</b> A20M# goes active based on setting the appropriate bit in the Port 92h register, or based on the A20GATE signal.</p> <p><b>Speed Strap:</b> During the reset sequence, 82801E C-ICH drives A20M# high if the corresponding bit is set in the FREQ_STRP register.</p>   |
| CPUSLP# | O    | <p><b>Processor Sleep:</b> This signal puts the processor into a state that saves substantial power compared to Stop-Grant state. However, during that time, no snoops occur. The 82801E C-ICH can optionally assert the CPUSLP# signal when going to the S1 state.</p> <p><b>NOTE:</b> The 82801E C-ICH does not support Sleep states. This signal must be pulled up through an 8.2 KΩ resistor to 3.3 V.</p>   |
| FERR#   | I    | <p><b>Numeric Coprocessor Error:</b> This signal is tied to the coprocessor error signal on the processor. FERR# is only used if the 82801E C-ICH coprocessor error reporting function is enabled in the General Control Register (Device 31:Function 0, Offset D0, bit 13). If FERR# is asserted, the 82801E C-ICH generates an internal IRQ13 to its interrupt controller unit. It is also used to gate the IGNNE# signal to ensure that IGNNE# is not asserted to the processor unless FERR# is active. FERR# requires an external weak pull-up to ensure a high level when the coprocessor error function is disabled.</p>   |
| IGNNE#  | O    | <p><b>Ignore Numeric Error:</b> This signal is connected to the ignore error pin on the processor. IGNNE# is only used if the 82801E C-ICH coprocessor error reporting function is enabled in the General Control Register (Device 31:Function 0, Offset D0, bit 13). If FERR# is active, indicating a coprocessor error, a write to the Coprocessor Error Register (F0h) causes the IGNNE# to be asserted. IGNNE# remains asserted until FERR# is negated. If FERR# is not asserted when the Coprocessor Error Register is written, the IGNNE# signal is not asserted.</p> <p><b>Speed Strap:</b> During the reset sequence, 82801E C-ICH drives IGNNE# high if the corresponding bit is set in the FREQ_STRP register.</p> |
| INIT#   | O    | <p><b>Initialization:</b> INIT# is asserted by the 82801E C-ICH for 16 PCI clocks to reset the processor. 82801E C-ICH can be configured to support processor BIST. In that case, INIT# will be active when PCIRST# is active.</p>   |
| INTR    | O    | <p><b>Processor Interrupt:</b> INTR is asserted by the 82801E C-ICH to signal the processor that an interrupt request is pending and needs to be serviced. It is an asynchronous output and normally driven low.</p> <p><b>Speed Strap:</b> During the reset sequence, 82801E C-ICH drives INTR high if the corresponding bit is set in the FREQ_STRP register.</p>  |
| NMI     | O    | <p><b>Non-Maskable Interrupt:</b> NMI is used to force a non-maskable interrupt to the processor. The 82801E C-ICH can generate an NMI when either SERR# or IOCHK# is asserted. The processor detects an NMI when it detects a rising edge on NMI. NMI is reset by setting the corresponding NMI source enable/disable bit in the NMI Status and Control Register.</p> <p><b>Speed Strap:</b> During the reset sequence, 82801E C-ICH drives NMI high if the corresponding bit is set in the FREQ_STRP register.</p>   |
| SMI#    | O    | <p><b>System Management Interrupt:</b> SMI# is an active low output synchronous to PCICLK. It is asserted by the 82801E C-ICH in response to one of many enabled hardware or software events.</p>  |
| STPCLK# | O    | <p><b>Stop Clock Request:</b> STPCLK# is an active low output synchronous to PCICLK. It is asserted by the 82801E C-ICH in response to one of many hardware or software events. When the processor samples STPCLK# asserted, it responds by stopping its internal clock.</p>   |

Table 17. Processor Interface Signals (Sheet 2 of 2)

| Name     | Type | Description  |
|----------|------|--|
| RCIN#    | I    | <b>Keyboard Controller Reset Processor:</b> The keyboard controller can generate INIT# to the processor. This saves the external OR gate with the 82801E C-ICH's other sources of INIT#. When the 82801E C-ICH detects the assertion of this signal, INIT# is generated for 16 PCI clocks. |
| A20GATE  | I    | <b>A20 Gate:</b> This signal is from the keyboard controller. It acts as an alternative method to force the A20M# signal active. A20GATE saves the external OR gate needed with various other PCIsets.   |
| CPUPWRGD | OD   | <b>Processor Power Good:</b> This signal should be connected to the processor's PWRGOOD input. This is an open-drain output signal (external pull-up resistor required) that represents a logical AND of the 82801E C-ICH's PWROK and VRMPWRGD signals.                                    |

### 3.2.12 SMBus Interface

Table 18. SMBus Interface Signals

| Name                   | Type | Description   |
|------------------------|------|---|
| SMBDATA                | I/OD | <b>SMBus Data:</b> External pull-up is required.  |
| SMBCLK                 | I/OD | <b>SMBus Clock:</b> External pull-up is required.   |
| SMBALERT#<br>/GPIO[11] | I    | <b>SMBus Alert:</b> This signal is used to wake the system or generate an SMI#. If not used for SMBALERT#, it can be used as a GPI. |

### 3.2.13 System Management Interface

Table 19. System Management Interface Signals

| Name        | Type | Description  |
|-------------|------|--|
| INTRUDER#   | I    | <b>Intruder Detect:</b> This signal can be set to disable system if box detected open. This signal's status is readable, so it can be used like a GPI if the Intruder Detection is not needed.   |
| SMLINK[1:0] | I/OD | <b>System Management Link:</b> These signals are an SMBus link to an optional external system management ASIC or LAN controller. External pull-ups are required.<br><b>NOTE:</b> SMLINK[0] corresponds to an SMBus Clock signal and SMLINK[1] corresponds to an SMBus Data signal. |

### 3.2.14 Real Time Clock Interface

Table 20. Real Time Clock Interface

| Name  | Type    | Description   |
|-------|---------|---|
| RTCX1 | Special | <b>Crystal Input 1:</b> This signal is connected to the 32.768 KHz crystal. If no external crystal is used, then RTCX1 can be driven with the desired clock rate. |
| RTCX2 | Special | <b>Crystal Input 2:</b> This signal is connected to the 32.768 KHz crystal. If no external crystal is used, then RTCX2 should be left floating.                   |

### 3.2.15 Other Clocks

Table 21. Other Clocks

| Name          | Type | Description  |
|---------------|------|--|
| CLK14         | I    | <b>Oscillator Clock:</b> CLK14 is used for 8254 timers and runs at 14.31818 MHz.     |
| CLK48         | I    | <b>48 MHz Clock:</b> CLK48 is used to for the USB controller and runs at 48 MHz.     |
| CLK66 (HLCLK) | I    | <b>66 MHz Clock (HLCLK):</b> CLK66 is used for the hub interface and runs at 66 MHz. |

### 3.2.16 Universal Asynchronous Receive and Transmit (UART 0,1)

Table 22. Universal Asynchronous Receive And Transmit (UART 0, 1) (Sheet 1 of 2)

| Signal Name            | Type | Description   |
|------------------------|------|---|
| UART_CLK               | I    | Input clock to the SIU. This clock is passed to the baud clock generation logic of each UART in the SIU.  |
| SIU0_CTS#<br>SIU1_CTS# | I    | <b>Clear to Send:</b> Active low, this pin indicates that data can be exchanged between CICH and external interface. These pins have no effect on the transmitter.<br><b>NOTE:</b> These pins could be used as Modem Status Inputs whose condition can be tested by the processor by reading bit 4 (CTS) of the Modem Status register (MSR). Bit 4 is the complement of the CTS# signal. Bit 0 (DCTS) of the MSR indicates whether the CTS# input has changed state since the previous reading of the MSR. When the CTS bit of the MSR changes state an interrupt is generated if the Modem Status Interrupt is enabled.  |
| SIU0_DCD#<br>SIU1_DCD# | I    | <b>Data Carrier Detect for UART0 and UART1:</b> Active low, this pin indicates that data carrier has been detected by the external agent.<br><b>NOTE:</b> These pins are Modem Status Inputs whose condition can be tested by the processor by reading bit 7 (DCD) of the Modem Status register (MSR). Bit 7 is the complement of the DCD# signal. Bit 3 (DDCD) of the MSR indicates whether the DCD# input has changed state since the previous reading of the MSR. When the DCD bit of the MSR changes state an interrupt is generated if the Modem Status Interrupt is enabled.  |
| SIU0_DSR#<br>SIU1_DSR# | I    | <b>Data Set Ready for UART0 and UART1:</b> Active low, this pin indicates that the external agent is ready to communicate with 82801E C-ICH UARTs. These pins have no effect on the transmitter.<br><b>NOTE:</b> These pins could be used as Modem Status Input whose condition can be tested by the processor by reading bit 5 (DSR) of the Modem Status register. Bit 5 is the complement of the DSR# signal. Bit 1 (DDSR) of the Modem status register (MSR) indicates whether the DSR# input has changed state since the previous reading of the MSR. When the DSR bit of the MSR changes state an interrupt is generated if the Modem Status Interrupt is enabled. |
| SIU0_DTR#<br>SIU1_DTR# | O    | <b>Data Terminal Ready for UART0 and UART1:</b> When low these pins informs the modem or data set that 82801E C-ICH UART0 and UART1 are ready to establish a communication link. The DTR#x(x=0,1) output signals can be set to an active low by programming the DTRx (x=0,1) (bit0) of the Modem control register to a logic '1'. A Reset operation sets this signal to its inactive state (logic '1'). LOOP mode operation holds this signal in its inactive state.  |

Table 22. Universal Asynchronous Receive And Transmit (UART 0, 1) (Sheet 2 of 2)

| Signal Name            | Type | Description   |
|------------------------|------|---|
| SIU0_RI#<br>SIU1_RI#   | I    | <b>Ring Indicator for UART0 and UART1:</b> Active low, this pin indicates that a telephone ringing signal has been received by the external agent.<br><b>NOTE:</b> These pins are Modem Status Input whose condition can be tested by the processor by reading bit 6 (RI) of the Modem Status register (MSR). Bit 6 is the complement of the RI# signal. Bit 2 (TERI) of the MSR indicates whether the DCD# input has changed state since the previous reading of the MSR. When the RI bit of the MSR changes state an interrupt is generated if the Modem Status Interrupt is enabled. |
| SIU0_RTS#<br>SIU1_RTS# | O    | <b>Request to Send for UART0 and UART1:</b> When low these pins informs the modem or data set that 82801E C-ICH UART0 and UART1 are ready to establish a communication link. The RTS# <sub>x</sub> (x=0,1) output signals can be set to an active low by programming the RTS <sub>x</sub> (x=0,1) (bit1) of the Modem control register to a logic '1'. A Reset operation sets this signal to its inactive state (logic '1'). LOOP mode operation holds this signal in its inactive state.   |
| SIU0_RXD<br>SIU1_RXD   | I    | <b>Serial Inputs for UART0 and UART1:</b> Serial data input from device pin to the receive port.  |
| SIU0_TXD<br>SIU1_TXD   | O    | <b>Serial Output for UART0 and UART1:</b> Serial data output to the communication peripheral/modem or data set. Upon reset, the TXD pins will be set to MARKING condition (logic '1' state).  |

### 3.2.17 SIU LPC Interface

Table 23. SIU Interface

| Signal Name  | Type | Description  |
|--------------|------|--|
| SIU_LAD[3:0] | I/O  | <b>SIU LPC Multiplexed Command, Address, Data:</b> Internal pull-ups are provided.   |
| SIU_LCLK     | I    | <b>SIU LPC clock input to SIU:</b> 33 MHz LPC clock.   |
| SIU_LDRQ#    | O    | <b>SIU LPC Serial DMA/Master Request Output:</b> Used by SIU devices to indicate a DMA request.<br><b>NOTE:</b> These signals have weak internal pull-up resistors to avoid external glue. |
| SIU_LFRAME#  | I    | <b>SIU LPC Frame:</b> Indicates the start of an LPC cycle, or an abort.  |
| SIU_RESET#   | I    | <b>SIU RESET:</b> This signal should be tied to PCI RESET.   |
| SIU_SERIRQ   | I/O  | <b>SIU Serial IRQ input:</b> This pin receives the serial interrupt protocol from external devices. Pull up if unused.   |

### 3.2.18 Miscellaneous Signals

**Table 24. Miscellaneous Signals**

| Name                   | Type | Description  |
|------------------------|------|--|
| HL[11]                 | I    | No pull-up required. Use a no-stuff or a test point for NAND tree testing.   |
| RTCST#                 | I    | <b>RTC Reset:</b> When asserted, this signal resets register bits in the RTC well and sets the RTC_PWR_STS bit (bit 2 in GEN_PMC0N3 register). This signal is also used to enter the test modes documented in "Test Signals" on page 49.<br><b>NOTE:</b> Clearing CMOS in an 82801E C-ICH-based platform can be done by using a jumper on RTCST# or GPI, or using SAFEMODE strap. Implementations should not attempt to clear CMOS by using a jumper to pull VccRTC low. |
| SPKR                   | O    | <b>Speaker:</b> The SPKR signal is the output of counter 2 and is internally ANDed with Port 61h bit 1 to provide Speaker Data Enable. This signal drives an external speaker driver device, which in turn drives the system speaker. Upon PCIRST#, its output state is 1.<br><b>NOTE:</b> SPKR is sampled at the rising edge of PWROK as a functional strap. See "Functional Straps" on page 49 for more details.   |
| TP0                    | I    | <b>Test Point 0:</b> This signal must have an external pull-up to Vcc3_3.  |
| THRM#                  | I    | <b>Thermal Alarm:</b> THRM# is an active low signal generated by external hardware to start the hardware clock throttling mode. This signal can also generate an SMI# or an SCI.   |
| RI#                    | I    | <b>Ring Indicate:</b> From the modem interface. This signal can be enabled as a wake event; this is preserved across power failures.   |
| RESERVED1<br>RESERVED2 | —    | This signal must have an external pull up to Vcc3_3.   |
| SUSCLK                 | O    | <b>Suspend Clock:</b> This signal is an output of the RTC generator circuit and is used by other chips for the refresh clock.  |
| TP1                    | I    | <b>Test Point 1:</b> Route to a test point with option to jumper to Vcc1_8. Used for NAND tree testing. Otherwise jumper to Vcc1_8.  |
| TP2                    | I    | <b>Test Point 2:</b> Route to a test point with option to jumper to V <sub>SS</sub> . Used for NAND tree testing. Otherwise jumper to V <sub>SS</sub> .  |
| TP3                    | I    | <b>Test Point 3:</b> Route to a test point with option to jumper to V <sub>SS</sub> . Used for NAND tree testing. Otherwise jumper to V <sub>SS</sub> .  |

### 3.2.19 General Purpose I/O

**Table 25. General Purpose I/O Signals (Sheet 1 of 2)**

| Name        | Type | Description   |
|-------------|------|---|
| GPIO[31:29] | O    | Not implemented.  |
| GPIO[28:27] | I/O  | Can be input or output. Main power well. Unmuxed.         |
| GPIO[26]    | I/O  | Not implemented.  |
| GPIO[25]    | I/O  | Can be input or output. Main power well. Not Muxed.       |
| GPIO[24]    | I/O  | Can be input or output. Main power well.                  |
| GPIO[23]    | O    | Fixed as Output only. Main power well.                    |
| GPIO[22]    | OD   | Fixed as Output only. Main power well. Open-drain output. |

Table 25. General Purpose I/O Signals (Sheet 2 of 2)

| Name               | Type | Description  |
|--------------------|------|--|
| <b>GPIO[21]</b>    | O    | Fixed as Output only. Main power well.   |
| <b>GPIO[20:18]</b> | O    | Fixed as Output only. Main power well.   |
| <b>GPIO[17:16]</b> | O    | Fixed as Output only. Main Power Well. Can instead be used for PC/PCI GNT[A:B]#. GPIO[17] can also alternatively be used for PCI GNT[5]#. Integrated pull-up resistor. |
| <b>GPIO[15:14]</b> | I    | Not implemented.   |
| <b>GPIO[13:12]</b> | I    | Fixed as Input only. Main Power Well. Not muxed.   |
| <b>GPIO[11]</b>    | I    | Fixed as Input only. Main Power Well. Can instead be used for SMBALERT#.   |
| <b>GPIO[10:9]</b>  | I    | Not implemented.   |
| <b>GPIO[8]</b>     | I    | Fixed as Input only. Main Power Well. Not muxed.   |
| <b>GPIO[7]</b>     | I    | Fixed as Input only. Main power well. Not muxed.   |
| <b>GPIO[6]</b>     | I    | Fixed as Input only. Main power well.  |
| <b>GPIO[5:4]</b>   | I    | Fixed as Input only. Main power well. Can be used instead as PIRQ[G:H]#.   |
| <b>GPIO[3:2]</b>   |      | Reserved.  |
| <b>GPIO[1:0]</b>   | I    | Fixed as Input only. Main Power Well. Can instead be used for PC/PCI REQ[A:B]#. GPIO[1] can also alternatively be used for PCI REQ[5]#.                                |

### 3.2.20 Power and Ground

Table 26. Power and Ground Signals

| Name            | Description   |
|-----------------|---|
| <b>HUBREF</b>   | 0.9 V reference for the hub interface.  |
| <b>V5REF</b>    | Reference for 5 V tolerance on Core well inputs.  |
| <b>VBIAS</b>    | RTC well bias voltage. The DC reference voltage applied to this pin sets a current that is mirrored throughout the oscillator and buffer circuitry. See “External RTC Circuitry” on page 50.  |
| <b>Vcc1_8</b>   | 1.8 V supply for Core well logic.   |
| <b>Vcc3_3</b>   | 3.3 V supply for Core well I/O buffers.   |
| <b>VccRTC</b>   | 3.3 V (can drop to 2.0 V min. in G3 state) supply for the RTC well. This power is not expected to be shut off unless the RTC battery is removed or completely drained.<br><b>NOTE:</b> Implementations should not attempt to clear CMOS by using a jumper to pull VccRTC low. Clearing CMOS in an 82801E C-ICH-based platform can be done by using a jumper on RTCRST# or GPI, or using SAFEMODE strap. |
| <b>V_CPU_IO</b> | Powered by the same supply as the processor I/O voltage. This supply is used to drive the processor interface outputs.  |
| <b>Vss</b>      | Ground.   |



## 3.3 Pin Straps

### 3.3.1 Functional Straps

The following signals are used for static configuration. They are sampled at the rising edge of PWROK to select configurations and then revert later to their normal usage. To invoke the associated mode, the signal should be driven at least four PCI clocks prior to the time it is sampled.

**Table 27. Functional Strap Definitions**

| Signal             | Usage                       | When Sampled             | Comment  |
|--------------------|-----------------------------|--------------------------|--|
| EE0_DOUT, EE1_DOUT | Reserved                    |                          | System designers should include a placeholder for a pull-down resistor on EE <sub>n</sub> _DOUT but <i>do not populate the resistor</i> .  |
| GNT[A]#            | Top-Swap Override           | Rising Edge of PWROK     | The signal has a weak internal pull-up. If the signal is sampled low, the system is strapped to the “Top-Swap” mode (82801E C-ICH will invert A16 for all cycles targeting FWH BIOS space). The status of this strap is readable via the Top-Swap bit (bit 13, D31: F0, Offset D4h). Note that software will not be able to clear the Top-Swap bit until the system is rebooted without GNT[A]# being pulled down. |
| HLCOMP             | Enhanced Hub Interface Mode | During PCIRST# assertion | If this signal is sampled high (via an external pull-up to VCC1_8), the normal hub interface buffer mode will be selected. If this signal is sampled low (via an external pull-down), the enhanced hub interface buffer mode will be selected.<br>See the specific platform design guide for resistor values and routing guidelines for each hub interface mode.   |
| SPKR               | No Reboot                   | Rising Edge of PWROK     | The signal has a weak internal pull-up. If the signal is sampled low, the system is strapped to the “No Reboot” mode (82801E C-ICH will disable the TCO Timer system reboot feature). The status of this strap is readable via the NO_REBOOT bit (bit 1, D31: F0, Offset D4h).   |

### 3.3.2 Test Signals

#### 3.3.2.1 Test Mode Selection

When PWROK is active (high), driving RTCRST# low for a number of PCI clocks (33 MHz) will activate a particular test mode as specified in Table 28.

**Note:** RTCRST# may be driven low any time after PCIRST is inactive. Refer to “Testability” on page 77 for a detailed description of the 82801E C-ICH test modes.

**Table 28. Test Mode Selection**

| Number of PCI Clocks RTCRST# driven low after PWROK active | Test Mode             |
|--|-----------------------|
| <4   | No Test Mode Selected |
| 4  | XOR Chain 1           |
| 5  | XOR Chain 2           |
| 6  | XOR Chain 3           |
| 7  | XOR Chain 4           |

Table 28. Test Mode Selection

| Number of PCI Clocks RTCRST# driven low after PWROK active | Test Mode                |
|--|--------------------------|
| 8  | All "Z"                  |
| 9–24   | Reserved. DO NOT ATTEMPT |
| >24  | No Test Mode Selected    |

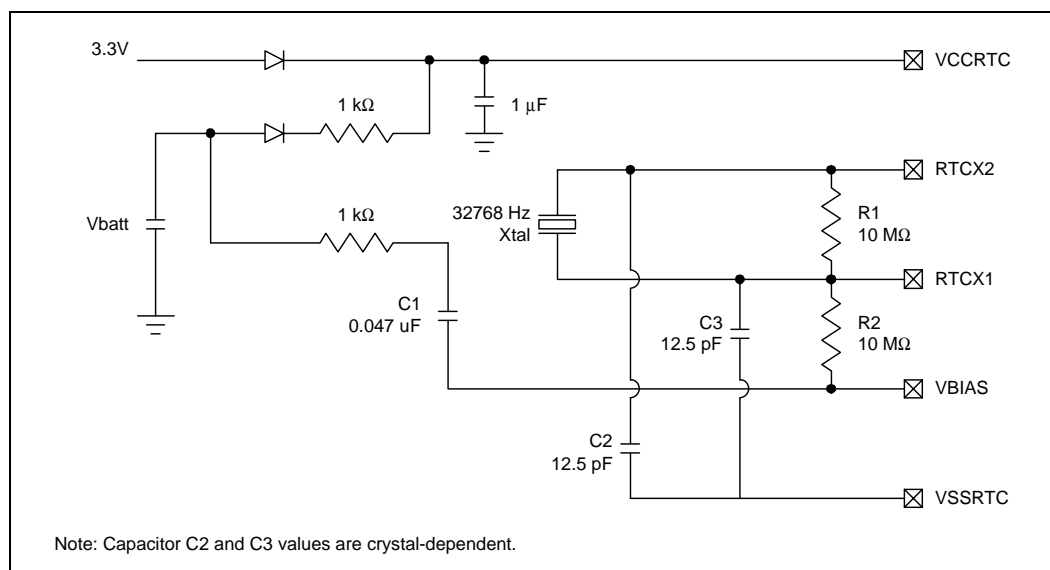
### 3.3.2.2 Test Straps

- The 82801E C-ICH's TP[0] (Test Point) signal must be pulled to Vcc3\_3 with an external pull-up resistor.
- The 82801E C-ICH's TP[1] must be routed to a test point with an option to jumper to Vcc1\_8. This test point is used for NAND tree testing. Otherwise jumper to Vcc1\_8.
- The 82801E C-ICH's TP[2] must be routed to a test point with an option to jumper to V<sub>SS</sub>. This test point is used for NAND tree testing. Otherwise jumper to V<sub>SS</sub>.
- The 82801E C-ICH's TP[3] must be routed to a test point with an option to jumper to V<sub>SS</sub>. This test point is used for NAND tree testing. Otherwise jumper to V<sub>SS</sub>.

### 3.3.3 External RTC Circuitry

To reduce RTC well power consumption, the 82801E C-ICH implements an internal oscillator circuit that is sensitive to step voltage changes in VccRTC and VBIAS. Figure 7 shows a schematic diagram of the circuitry required to condition these voltages to ensure correct operation of the 82801E C-ICH RTC.

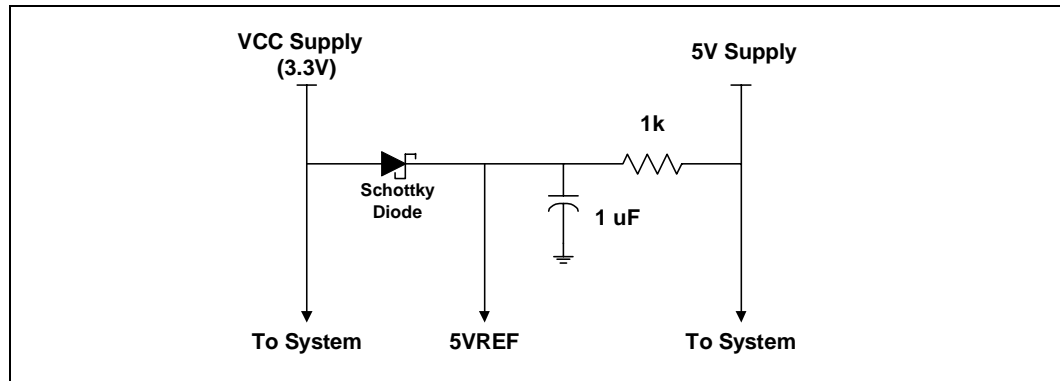
Figure 7. Required External RTC Circuit



### 3.3.4 V5REF/Vcc3\_3 Sequencing Requirements

V5REF is the reference voltage for 5 V tolerance on inputs to the 82801E C-ICH. V5REF must power up before or simultaneous to Vcc3\_3, and must power down after or simultaneous to Vcc3\_3. Refer to Figure 8 for an example circuit schematic that may be used to ensure proper V5REF sequencing.

Figure 8. Example V5REF Sequencing Circuit



## 3.4 Power Planes and Pin States

### 3.4.1 Power Planes

Table 29. 82801E C-ICH Power Planes

| Plane                             | Description  |
|-----------------------------------|--|
| Main I/O (3.3 V)                  | <b>Vcc3_3:</b> Powered by the main power supply.   |
| Main Logic (1.8 V)                | <b>Vcc1_8:</b> Powered by the main power supply.   |
| Processor Interface (1.3 ~ 2.5 V) | <b>V_CPU_IO:</b> Powered by the main power supply via processor voltage regulator.   |
| RTC                               | <b>VccRTC:</b> When other power is available (from the main supply), external diode coupling will provide power to reduce the drain on the RTC battery. Assumed to operate from 3.3 V down to 2.0 V. |

### 3.4.2 Integrated Pull-Ups and Pull-Downs

**Table 30. Integrated Pull-Up and Pull-Down Resistors**

| Signal                        | Resistor Type | Nominal Value  | Notes |
|-------------------------------|---------------|----------------|-------|
| EE0_DIN, EE1_DIN              | pull-up       | 24 K $\Omega$  | 1     |
| EE0_DOUT, EE1_DOUT            | pull-up       | 24 K $\Omega$  | 1     |
| GNT[A:B]#/GNT[5]#/GPIO[17:16] | pull-up       | 24 K $\Omega$  | 1     |
| LAD[3:0]#/FWH[3:0]#           | pull-up       | 24 K $\Omega$  | 1     |
| LDRQ[1:0]                     | pull-up       | 24 K $\Omega$  | 1     |
| SPKR                          | pull-up       | 24 K $\Omega$  | 1, 4  |
| LAN0_RXD[2:0], LAN1_RXD[2:0]  | pull-up       | 9 K $\Omega$   | 2     |
| PDD[7]/SDD[7]                 | pull-down     | 5.9 K $\Omega$ | 3     |
| PDDREQ/SDDREQ                 | pull-down     | 5.9 K $\Omega$ | 3     |

**NOTES:**

1. Simulation data shows that these resistor values can range from 18 K $\Omega$  to 42 K $\Omega$ .
2. Simulation data shows that these resistor values can range from 6 K $\Omega$  to 14 K $\Omega$ .
3. Simulation data shows that these resistor values can range from 4.3 K $\Omega$  to 20 K $\Omega$ .
4. The pull-up or pull-down on this signal is only enabled at boot/reset for strapping function.

### 3.4.3 IDE Integrated Series Termination Resistors

Table 31 shows the 82801E C-ICH IDE signals that have integrated series termination resistors.

**Table 31. IDE Series Termination Resistors**

| Signal   | Integrated Series Termination Resistor Value |
|--|--|
| PDD[15:0], SDD[15:0], PDIOW#, SDIOW#, PDIOR#, PDIOW#, PDREQ, SDREQ, PDDACK#, SDDACK#, PIORDY, SIORDY, PDA[2:0], SDA[2:0], PDCS1#, SDCS1#, PDCS3#, SDCS3#, IRQ14, IRQ15 | approximately 33 $\Omega$ (See Note)         |

**NOTE:** Simulation data indicates that the integrated series termination resistors are a nominal 33  $\Omega$  but can range from 31  $\Omega$  to 43  $\Omega$ .

### 3.4.4 Output and I/O Signals Planes and States

Table 32 shows the power plane associated with the output and I/O signals, as well as the state at various times. Within the table, the following terms are used:

|             |  |
|-------------|--|
| “High-Z”    | Tri-state. 82801E C-ICH not driving the signal high or low.                            |
| “High”      | The 82801E C-ICH is driving the signal to a logic ‘1’.                                 |
| “Low”       | The 82801E C-ICH is driving the signal to a logic ‘0’.                                 |
| “Defined”   | The signal is driven to a level that is defined by the function (will be high or low). |
| “Undefined” | The 82801E C-ICH is driving the signal, but the value is indeterminate.                |
| “Running”   | The clock is toggling or signal is transitioning because function not stopping.        |
| “Off”       | The power plane is off; the 82801E C-ICH is not driving.                               |

**Table 32. Power Plane and States for Output and I/O Signals (Sheet 1 of 3)**

| Signal Name                             | Power Plane | Reset Signal | During Reset | Immediately after Reset |
|---|-------------|--------------|--------------|-------------------------|
| <b>PCI Bus</b>                          |             |              |              |                         |
| AD[31:0]                                | Main I/O    | PCIRST#      | High-Z       | Undefined               |
| C/BE#[3:0]                              | Main I/O    | PCIRST#      | High-Z       | Undefined               |
| DEVSEL#                                 | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| FRAME#                                  | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| GNT[3:0]#, GNT[5]#                      | Main I/O    | PCIRST#      | High         | High                    |
| GNT[A:B]#                               | Main I/O    | PCIRST#      | High-Z       | High                    |
| IRDY#, TRDY#                            | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| PAR                                     | Main I/O    | PCIRST#      | High-Z       | Undefined               |
| PCIRST#                                 | Main I/O    | RSMRST#      | Low          | High                    |
| PERR#                                   | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| PLOCK#                                  | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| STOP#                                   | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| <b>LPC Interface</b>                    |             |              |              |                         |
| LAD[3:0]                                | Main I/O    | PCIRST#      | High         | High                    |
| LFRAME#                                 | Main I/O    | PCIRST#      | High         | High                    |
| <b>LAN Connect and EEPROM Interface</b> |             |              |              |                         |
| EE0_CS, EE1_CS                          | LAN I/O     | RSM_PWROK    | Low          | Running                 |

**NOTES:**

1. The 82801E C-ICH sets these signals at reset for processor frequency strap.
2. I GPIO[18] will toggle at a frequency of approximately 1 Hz when the 82801E C-ICH comes out of reset
3. CPUPWRGD is an open-drain output that represents a logical AND of the VRMPWRGD and PWROK signals and, thus, are driven low by 82801E C-ICH when either VRMPWRGD or PWROK are inactive. During boot, or during a hard reset with power cycling, CPUPWRGD will be expected to transition from low to High-Z.
4. GPIO[24:25, 27:28]: These signals remain tri-stated for up to 110 ms after RSMRST# deassertion. At this point, they will be driven to their default (High) state.

Table 32. Power Plane and States for Output and I/O Signals (Sheet 2 of 3)

| Signal Name                       | Power Plane | Reset Signal | During Reset | Immediately after Reset |
|-----------------------------------|-------------|--------------|--------------|-------------------------|
| EE0_DOUT,<br>EE1_DOUT             | LAN I/O     | RSM_PWROK    | High         | Running                 |
| EE0_SHCLK,<br>EE1_SHCLK           | LAN I/O     | RSM_PWROK    | Low          | Running                 |
| LAN0_RSTSYNC,<br>LAN1_RSTSYNC     | LAN I/O     | RSM_PWROK    | High         | Defined                 |
| LAN0_TXD[2:0],<br>LAN1_TXD[2:0]   | LAN I/O     | RSM_PWROK    | Low          | Defined                 |
| <b>IDE Interface</b>              |             |              |              |                         |
| PDA[2:0], SDA[2:0]                | Main I/O    | PCIRST#      | Low          | Undefined               |
| PDCS1#, PDCS3#                    | Main I/O    | PCIRST#      | High         | High                    |
| PDD[15:0], SDD[15:0]              | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| PDDACK#, SDDACK#                  | Main I/O    | PCIRST#      | High         | High                    |
| PDIOR#, PDIOW#                    | Main I/O    | PCIRST#      | High         | High                    |
| SDCS1#, SDCS3#                    | Main I/O    | PCIRST#      | High         | High                    |
| SDIOR#, SDIOW#                    | Main I/O    | PCIRST#      | High         | High                    |
| <b>Interrupts</b>                 |             |              |              |                         |
| PIRQ[A:H]#                        | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| SERIRQ                            | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| APICD[1:0]                        | Main I/O    | PCIRST#      | High-Z       | High-Z                  |
| <b>USB Interface</b>              |             |              |              |                         |
| USBP0P, USBP0N,<br>USBP1P, USBP1N | Main I/O    | RSMRST#      | High-Z       | High-Z                  |
| <b>Processor Interface</b>        |             |              |              |                         |
| A20M#                             | CPU I/O     | PCIRST#      | See Note 1   | High                    |
| CPUPWRGD                          | Main I/O    | PCIRST#      | See Note 3   | High-Z                  |
| CPUSLP#                           | CPU I/O     | PCIRST#      | High         | High                    |
| IGNNE#                            | CPU I/O     | PCIRST#      | See Note 1   | High                    |
| INIT#                             | CPU I/O     | PCIRST#      | High         | High                    |
| INTR                              | CPU I/O     | PCIRST#      | See Note 1   | Low                     |
| NMI                               | CPU I/O     | PCIRST#      | See Note 1   | Low                     |
| SMI#                              | CPU I/O     | PCIRST#      | High         | High                    |

**NOTES:**

- The 82801E C-ICH sets these signals at reset for processor frequency strap.
- I GPIO[18] will toggle at a frequency of approximately 1 Hz when the 82801E C-ICH comes out of reset
- CPUPWRGD is an open-drain output that represents a logical AND of the VRMPWRGD and PWROK signals and, thus, are driven low by 82801E C-ICH when either VRMPWRGD or PWROK are inactive. During boot, or during a hard reset with power cycling, CPUPWRGD will be expected to transition from low to High-Z.
- GPIO[24:25, 27:28]: These signals remain tri-stated for up to 110 ms after RSMRST# deassertion. At this point, they will be driven to their default (High) state.

**Table 32. Power Plane and States for Output and I/O Signals (Sheet 3 of 3)**

| Signal Name                        | Power Plane | Reset Signal | During Reset                 | Immediately after Reset |
|------------------------------------|-------------|--------------|------------------------------|-------------------------|
| STPCLK#                            | CPU I/O     | PCIRST#      | High                         | High                    |
| <b>SMBus Interface</b>             |             |              |                              |                         |
| SMBCLK, SMBDATA                    | Main I/O    | RSMRST#      | High-Z                       | High-Z                  |
| <b>System Management Interface</b> |             |              |                              |                         |
| SMLINK[1:0]                        | Main I/O    | RSMRST#      | High-Z                       | High-Z                  |
| <b>Miscellaneous Signals</b>       |             |              |                              |                         |
| SPKR                               | Main I/O    | PCIRST#      | High-Z with internal pull-up | Low                     |
| SUSCLK                             | Main I/O    | RSMRST#      | Running                      |                         |
| <b>Unmuxed GPIO Signals</b>        |             |              |                              |                         |
| GPIO[18]                           | Main I/O    | PCIRST#      | High                         | See Note 2              |
| GPIO[19:20]                        | Main I/O    | PCIRST#      | High                         | High                    |
| GPIO[21]                           | Main I/O    | PCIRST#      | High                         | High                    |
| GPIO[22]                           | Main I/O    | PCIRST#      | High-Z                       | High-Z                  |
| GPIO[23]                           | Main I/O    | PCIRST#      | Low                          | Low                     |
| GPIO[24]                           | Main I/O    | RSMRST#      | High-Z                       | High                    |
| GPIO[25]                           | Main I/O    | RSMRST#      | High-Z                       | High                    |
| GPIO[27:28]                        | Main I/O    | RSMRST#      | High-Z                       | High                    |

**NOTES:**

- The 82801E C-ICH sets these signals at reset for processor frequency strap.
- GPIO[18] will toggle at a frequency of approximately 1 Hz when the 82801E C-ICH comes out of reset.
- CPUPWRGD is an open-drain output that represents a logical AND of the VRMPWRGD and PWROK signals and, thus, are driven low by 82801E C-ICH when either VRMPWRGD or PWROK are inactive. During boot, or during a hard reset with power cycling, CPUPWRGD will be expected to transition from low to High-Z.
- GPIO[24:25, 27:28]: These signals remain tri-stated for up to 110 ms after RSMRST# deassertion. At this point, they will be driven to their default (High) state.

### 3.4.5 Power Planes for Input Signals

Table 33 shows the power plane associated with each input signal, as well as what device drives the signal at various times. Valid states include:

- High
- Low
- Static: Will be high or low, but will not change
- Driven: Will be high or low, and is allowed to change
- Running: For input clocks

Table 33. Power Plane for Input Signals

| Signal Name                     | Power Well | Driver During Reset      |
|---------------------------------|------------|--------------------------|
| A20GATE                         | Main I/O   | External Microcontroller |
| APICCLK                         | Main I/O   | Clock Generator          |
| CLK14                           | Main I/O   | Clock Generator          |
| CLK48                           | Main I/O   | Clock Generator          |
| CLK66                           | Main Logic | Clock Generator          |
| EE0_DIN,<br>EE1_DIN             | LAN I/O    | EEPROM component         |
| FERR#                           | Main I/O   | CPU                      |
| INTRUDER#                       | RTC        | External Switch          |
| IRQ[15:14]                      | Main I/O   | IDE                      |
| LAN0_CLK,<br>LAN1_CLK           | LAN I/O    | LAN Connect component    |
| RSM_PWROK                       | Main I/O   | External RC Circuit      |
| LAN0_RXD[2:0],<br>LAN1_RXD[2:0] | LAN I/O    | LAN Connect component    |
| LDRQ[0]#                        | Main I/O   | LPC Devices              |
| LDRQ[1]#                        | Main I/O   | LPC Devices              |
| OC[1:0]#                        | Main I/O   | External Pull-Ups        |
| PCICLK                          | Main I/O   | Clock Generator          |
| PDDREQ                          | Main I/O   | IDE Device               |
| PIORDY                          | Main I/O   | IDE Device               |
| PWROK                           | Main I/O   | System Power Supply      |
| RCIN#                           | Main I/O   | External Microcontroller |
| REQ[3:0]#,<br>REQ[5]#           | Main I/O   | PCI Master               |
| REQ[B:A]#                       | Main I/O   | PC/PCI Devices           |
| RI#                             | Main I/O   | Serial Port Buffer       |
| RSMRST#                         | RTC        | External RC circuit      |
| RTCST#                          | RTC        | External RC circuit      |
| SDDREQ                          | Main I/O   | IDE Drive                |
| SERR#                           | Main I/O   | PCI Bus Peripherals      |
| SIORDY                          | Main I/O   | IDE Drive                |
| SMBALERT#                       | Main I/O   | External pull-up         |
| THRM#                           | Main I/O   | Thermal Sensor           |
| VRMPWRGD                        | Main I/O   | CPU Voltage Regulator    |



## 4.0 Electrical Characteristics

**Note:** This document contains information on products in the sampling and initial production phases of development. The specifications are subject to change without notice. Verify with your local Intel sales office that you have the latest datasheet before finalizing a design.

### 4.1 Absolute Maximum Ratings

**Table 34. Absolute Maximum Ratings**

|  |                                  |
|--|----------------------------------|
| Case Temperature under Bias  | 0° C to +109° C                  |
| Storage Temperature  | -55° C to +150° C                |
| Voltage on Any 3.3 V Pin with Respect to Ground                                | -0.5 to V <sub>CC</sub> + 0.3 V  |
| Voltage on Any 5 V Tolerant Pin with Respect to Ground (V <sub>REF</sub> =5 V) | -0.5 to V <sub>REF</sub> + 0.3 V |
| 1.8 V Supply Voltage with Respect to V <sub>SS</sub>                           | -0.5 to +2.7V                    |
| 3.3 V Supply Voltage with Respect to V <sub>SS</sub>                           | -0.5 to +4.6 V                   |
| 5.0 V Supply Voltage (V <sub>ref</sub> ) with Respect to V <sub>SS</sub>       | -0.5 to +5.5 V                   |
| Maximum Power Dissipation  | 2.0 W                            |

**Note:** A non-condensing environment is required to maintain RTC accuracy.

**Warning:** Stressing the device beyond the “Absolute Maximum Ratings” may cause permanent damage. These are stress ratings only. See Section 4.2 for the Functional Operating Range of the 82801E C-ICH.

### 4.2 Functional Operating Range

All of the AC and DC Characteristics specified in this document assume that the 82801E C-ICH component is operating within the Functional Operating Range given in this section. Operation outside of the Functional Operating Range is not recommended, and extended exposure outside of the Functional Operating Range may affect component reliability.

**Table 35. Functional Operating Range**

|  |                    |
|--|--------------------|
| Case Temperature under Bias  | 0° C to +109° C    |
| 1.8 V Supply Voltage (V <sub>CC1_8</sub> ) with respect to V <sub>SS</sub> | 1.7 V to 1.9 V     |
| 3.3 V Supply Voltage (V <sub>CC3_3</sub> ) with respect to V <sub>SS</sub> | 3.102 V to 3.498 V |
| 5 V Supply Voltage (V <sub>5REF</sub> ) with respect to V <sub>SS</sub>    | 4.75 V to 5.25 V   |

## 4.3 DC Characteristics

**Table 36. 82801E C-ICH Power Consumption Measurements**

| Power Plane                              | Maximum Sustain Supply Current $I_{CC}$ (max) |
|--|---|
| 1.8 V Core                               | 300 mA  |
| 3.3 V I/O                                | 410 mA  |
| 1.8 V LAN                                | 30 mA   |
| 3.3 V LAN<br>(LAN+LAN Connect Component) | 186 mA  |

**Table 37. DC Characteristic Input Signal Association**

| Symbol                              | Associated Signals  |
|-------------------------------------|---|
| $V_{IH1}/V_{IL1}$<br>(5 V Tolerant) | <p><b>PCI Signals:</b> AD[31:0], C/BE[3:0]#, DEVSEL#, FRAME#, IRDY#, TRDY#, STOP#, PAR, PERR#, PLOCK#, SERR#, REQ[4:0]#</p> <p><b>PC/PCI Signals:</b> REQ[A]#/GPIO[0], REQ[B]#/REQ[5]#/GPIO[1]</p> <p><b>IDE Signals:</b> PDD[15:0], SDD[15:0], PDDREQ, PIORDY, SDDREQ, SIORDY</p> <p><b>Interrupt Signals:</b> IRQ[15:14], SERIRQ, PIRQ[D:A]#, PIRQ[H]#, PIRQ[F:G]#/GPIO[4:3], PIRQ[E]#</p> <p><b>Legacy Signals:</b> RCIN#, A20GATE</p> <p><b>USB Signals:</b> OC[1:0]#</p> <p><b>GPIO Signals:</b> GPIO[7:6, 4:3, 1:0]</p> |
| $V_{IH2}/V_{IL2}$                   | <p><b>Clock Signals:</b> CLK66, CLK48, CLK14, LAN_CLK, PCCLK</p>  |
| $V_{IH3}/V_{IL3}$                   | <p><b>LPC/FWH Signals:</b> LDRQ[1:0]#, LAD[3:0]/FWH[3:0].</p> <p><b>System Management Signals:</b> SMBALERT#/GPIO[11]</p> <p><b>EEPROM Signals:</b> EE_DIN</p> <p><b>Power Management Signals:</b> PME#, PWRBTN#, RI#, RSM_PWROK, RTCRST#, THRM#, VRMPWRGD</p> <p><b>GPIO Signals:</b> GPIO[25:24, 13:12, 8]</p>  |
| $V_{IH4}/V_{IL4}$                   | <p><b>Clock Signals:</b> APICCLK</p>  |
| $V_{IH5}/V_{IL5}$                   | <p><b>SMBus Signals:</b> SMBCLK, SMBDATA</p> <p><b>System Management Signals:</b> INTRUDER#, SMLINK[1:0]</p> <p><b>Power Management Signals:</b> RSMRST#, PWROK,</p> <p><b>GPIO Signals:</b> GPIO[28:27]</p>  |
| $V_{IL6}/V_{IH6}$                   | <p><b>LAN Signals:</b> LAN0_RXD[2:0], LAN1_RXD[2:0]</p>   |
| $V_{IL7}/V_{IH7}$                   | <p><b>Processor Signals:</b> FERR#, APICD[1:0]</p>  |
| $V_{IL8}/V_{IH8}$                   | <p><b>Hub Interface Signals:</b> HL[11:0], HL_STB#, HL_STB</p>  |
| $V_{DI}/V_{CM}/V_{SE}$              | <p><b>USB Signals:</b> USBP0P, USBP0N, USBP1P, USBP1N</p>   |
| $V_{IL9}/V_{IH9}$                   | <p>RTCX1</p>  |

**Table 38. DC Input Characteristics**

| Symbol    | Parameter                       | Min.          | Max           | Unit | Notes         |
|-----------|---------------------------------|---------------|---------------|------|---------------|
| $V_{IL1}$ | Input Low Voltage               | -0.5          | 0.8           | V    |               |
| $V_{IH1}$ | Input High Voltage              | 2.0           | V5REF + 0.5   | V    |               |
| $V_{IL2}$ | Input Low Voltage               | -0.5          | 0.8           | V    |               |
| $V_{IH2}$ | Input High Voltage              | 2.0           | Vcc3_3 + 0.5  | V    |               |
| $V_{IL3}$ | Input Low Voltage               | -0.5          | 0.3Vcc3_3     | V    |               |
| $V_{IH3}$ | Input High Voltage              | 0.5 Vcc3_3    | Vcc3_3 + 0.5  | V    |               |
| $V_{IL4}$ | Input Low Voltage               | -0.5          | 0.7           | V    |               |
| $V_{IH4}$ | Input High Voltage              | 1.7           | 2.625         | V    |               |
| $V_{IL5}$ | Input Low Voltage               | -0.5          | 0.6           | V    |               |
| $V_{IH5}$ | Input High Voltage              | 2.1           | Vcc3_3 + 0.5  | V    |               |
| $V_{IL6}$ | Input Low Voltage               | -0.5          | 0.3Vcc3_3     | V    |               |
| $V_{IH6}$ | Input High Voltage              | 0.6 Vcc3_3    | Vcc3_3 + 0.5  | V    |               |
| $V_{IL7}$ | Input Low Voltage               | -0.5          | 0.6           | V    |               |
| $V_{IH7}$ | Input High Voltage              | 1.2           | Vcc3_3 + 0.5  | V    |               |
| $V_{IL8}$ | Input Low Voltage               | -0.5          | HUBREF - 0.15 | V    | Normal Mode   |
|           |                                 |               | HUBREF - 0.20 |      | Enhanced Mode |
| $V_{IH8}$ | Input High Voltage              | HUBREF + 0.15 | Vcc1_8 + 0.5  | V    | Normal Mode   |
|           |                                 | HUBREF + 0.20 |               |      | Enhanced Mode |
| $V_{DI}$  | Differential Input Sensitivity  | 0.2           |               | V    | Note 1        |
| $V_{CM}$  | Differential Common Mode Range  | 0.8           | 2.5           | V    | Note 2        |
| $V_{SE}$  | Single-Ended Receiver Threshold | 0.8           | 2.0           | V    |               |
| $V_{IL9}$ | Input Low Voltage               | -0.5          | 0.10          | V    |               |
| $V_{IH9}$ | Input High Voltage              | 0.40          | 2.0           | V    |               |

**NOTES:**

- $V_{DI} = | \text{USBPx[P]} - \text{USBPx[N]} |$
- Includes  $V_{DI}$  range.

**Table 39. DC Characteristic Output Signal Association (Sheet 1 of 2)**

| Symbol            | Associated Signals   |
|-------------------|--|
| $V_{OH1}/V_{OL1}$ | <b>IDE Signals:</b> PDD[15:0], SDD[15:0], PDIOW#/PDSTOP, SDIOW#/SDSTOP, PDIOR#/PDWSTB/PRDMARDY#, SDIOR#/STWSTB/SRDMARDY#, PDDACK#, SDDACK#, PDA[2:0], SDA[2:0], PDCS[3,1]#, SDCS[3,1]#                 |
| $V_{OH2}/V_{OL2}$ | <b>Processor Signals:</b> A20M#, CPUPWRGD, CPUSLP#, IGNNE#, INIT#, INTR, NMI, SMI#, STPCLK#  |
| $V_{OH3}/V_{OL3}$ | <b>PCI Signals:</b> AD[31:0], C/BE[3:0]#, PCIRST#, GNT[5, 3:0]#, PAR, DEVSEL#, PERR#, PLOCK#, STOP#, TRDY#, IRDY#, FRAME#, SERR#<br><b>Interrupt Signals:</b> SERIRQ, PIRQ[A:F]#, PIRQ[G:H]#/GPIO[5:4] |

Table 39. DC Characteristic Output Signal Association (Sheet 2 of 2)

| Symbol            | Associated Signals   |
|-------------------|--|
| $V_{OH4}/V_{OL4}$ | <b>PCI Signals:</b> GNT[5]#/GNT[B]#/GPIO[17], GNT[A]#/GPIO[16]<br><b>LPC/FWH Signals:</b> LAD[3:0]/FWH[3:0], LFRAME#/FWH[4]<br><b>LAN Signals:</b> LAN0_RSTSYNC, LAN1_RSTSYNC, LAN0_TXD[2:0], LAN1_TXD[2:0]<br><b>GPIO Signals:</b> GPIO[21] |
| $V_{OL5}/V_{OH5}$ | <b>SMBus Signals:</b> SMBCLK, SMBDATA<br><b>System Management Signals:</b> SMLINK[1:0]<br><b>Interrupt Signals:</b> APICD[1:0]   |
| $V_{OL6}/V_{OH6}$ | <b>EEPROM Signals:</b> EE0_CS, EE1_CS, EE0_DOUT, EE1_DOUT, EE0_SHCLK, EE1_SHCLK<br><b>Other Signals:</b> SPKR<br><b>GPIO Signals:</b> GPIO[28:27, 25:22, 20:18]  |
| $V_{OL7}/V_{OH7}$ | <b>USB Signals:</b> USBP0P, USBP0N, USBP1P, USBP1N   |
| $V_{OL8}/V_{OH8}$ | <b>Hub Signals:</b> HL[11:0], HL_STB#, HL_STB  |

Table 40. DC Output Characteristics

| Symbol    | Parameter           | Min.                      | Max                       | Unit | $I_{OL} / I_{OH}$ | Notes         |
|-----------|---------------------|---------------------------|---------------------------|------|-------------------|---------------|
| $V_{OL1}$ | Output Low Voltage  |                           | 0.5                       | V    | 4 mA              |               |
| $V_{OH1}$ | Output High Voltage | 2.4                       |                           | V    | -0.4 mA           |               |
| $V_{OL2}$ | Output Low Voltage  |                           | 0.4                       | V    | 4.0 mA            |               |
| $V_{OH2}$ | Output High Voltage | $V_{CPU\_IO} - 0.13V$     |                           | V    | -0.5 mA           | Note 1        |
| $V_{OL3}$ | Output Low Voltage  |                           | 0.55                      | V    | 6 mA              |               |
| $V_{OH3}$ | Output High Voltage | 2.4                       |                           | V    | -2 mA             | Note 1        |
| $V_{OL4}$ | Output Low Voltage  |                           | 0.1 Vcc                   | V    | 1.5 mA            |               |
| $V_{OH4}$ | Output High Voltage | 0.9 Vcc                   |                           | V    | -0.5 mA           | Note 1        |
| $V_{OL5}$ | Output Low Voltage  |                           | 0.4                       | V    | 3.0 mA            |               |
| $V_{OH5}$ | Output High Voltage | N/A                       |                           | V    |                   | Note 1        |
| $V_{OL6}$ | Output Low Voltage  |                           | 0.4                       | V    | 4.0 mA            |               |
| $V_{OH6}$ | Output High Voltage | $V_{cc3\_3} - 0.5$        |                           | V    | -2.0 mA           | Note 1        |
| $V_{OL7}$ | Output Low Voltage  |                           | 0.4                       | V    | 5 mA              |               |
| $V_{OH7}$ | Output High Voltage | $V_{cc} - 0.5$            |                           | V    | -2 mA             |               |
| $V_{OL8}$ | Output Low Voltage  |                           | $0.1 \times (V_{cc1\_8})$ | V    | 1 mA              | Normal Mode   |
|           |                     |                           | 0.8                       | V    | 20 mA             | Enhanced Mode |
| $V_{OH8}$ | Output High Voltage | $0.9 \times (V_{cc1\_8})$ |                           | V    | -1 mA             | Normal Mode   |
|           |                     | 1.6                       |                           | V    | -1.5 mA           | Enhanced Mode |

**NOTES:**

- The CPUPWRGD, SERR#, PIRQ[A:H], GPIO22/CPUPERF, APIC[1:0], SMBDATA, SMBCLK and SMLINK[1:0] signals have an open drain driver, and the VOH specification does not apply. These signals must have external pull-up resistors.

**Table 41. Other DC Characteristics**

| Symbol           | Parameter                             | Min.                      | Max                       | Unit | Notes                          |
|------------------|---------------------------------------|---------------------------|---------------------------|------|--------------------------------|
| V5REF            | ICH2 Core Well Reference Voltage      | 4.75                      | 5.25                      | V    |                                |
| VCC3_3           | I/O Buffer Voltage                    | 3.102                     | 3.498                     | V    |                                |
| VCC1_8           | Internal Logic Voltage                | 1.7                       | 1.9                       | V    |                                |
| HUBREF           | Hub Interface Reference Voltage       | $0.48 \times (V_{cc1.8})$ | $0.52 \times (V_{cc1.8})$ | V    | Normal Mode                    |
|                  |                                       | $0.64 \times (V_{cc1.8})$ | $0.70 \times (V_{cc1.8})$ | V    | Enhanced Mode                  |
| Vcc(RTC)         | Battery Voltage                       | 2.0                       | 3.6                       | V    |                                |
| V <sub>IT+</sub> | Hysteresis Input Rising Threshold     | 1.9                       |                           | V    | Applied to USBP[1:0][P:N]      |
| V <sub>IT-</sub> | Hysteresis Input Falling Threshold    |                           | 1.3                       | V    | Applied to USBP[1:0][P:N]      |
| V <sub>DI</sub>  | Differential Input Sensitivity        | 0.2                       |                           | V    | {(USBPx+,USBPx-)}              |
| V <sub>CM</sub>  | Differential Common Mode Range        | 0.8                       | 2.5                       | V    | Includes V <sub>DI</sub>       |
| V <sub>CRS</sub> | Output Signal Crossover Voltage       | 1.3                       | 2.0                       | V    |                                |
| V <sub>SE</sub>  | Single Ended Rcvr Threshold           | 0.8                       | 2.0                       | V    |                                |
| I <sub>LI1</sub> | Input Leakage Current                 | -1.0                      | +1.0                      | μA   |                                |
| I <sub>LI2</sub> | Hi-Z State Data Line Leakage          | -10                       | +10                       | μA   | (0 V < V <sub>IN</sub> < 3.3V) |
| I <sub>LI3</sub> | Input Leakage Current - Clock signals | -100                      | +100                      | μA   | See Note                       |
| C <sub>IN</sub>  | Input Capacitance - Hub interface     |                           | 8                         | pF   | F <sub>C</sub> = 1 MHz         |
|                  | Input Capacitance - All Other         |                           | 12                        | pF   |                                |
| C <sub>OUT</sub> | Output Capacitance                    |                           | 12                        | pF   | F <sub>C</sub> = 1 MHz         |
| C <sub>I/O</sub> | I/O Capacitance                       |                           | 12                        | pF   | F <sub>C</sub> = 1 MHz         |
| C <sub>L</sub>   | Crystal Load Capacitance              |                           |                           | pF   | 2.5 – 6 pF Typical             |

**NOTES:**

1. Includes APICCLK, CLK14, CLK48, CLK66, LAN\_CLK and PCICLK

## 4.4 AC Characteristics

Table 42. Clock Timings (Sheet 1 of 2)

| Sym                             | Parameter           | Min   | Max   | Unit | Notes | Figure |
|---------------------------------|---------------------|-------|-------|------|-------|--------|
| <b>PCI Clock (PCICLK)</b>       |                     |       |       |      |       |        |
| t1                              | Period              | 30    | 33.3  | ns   |       | 9      |
| t2                              | High Time           | 12    |       | ns   |       | 9      |
| t3                              | Low Time            | 12    |       | ns   |       | 9      |
| t4                              | Rise Time           |       | 3     | ns   |       | 9      |
| t5                              | Fall Time           |       | 3     | ns   |       | 9      |
| <b>Oscillator Clock (OSC)</b>   |                     |       |       |      |       |        |
| t6                              | Period              | 67    | 70    | ns   |       | 9      |
| t7                              | High Time           | 20    |       |      |       | 9      |
| t8                              | Low time            | 20    |       | ns   |       | 9      |
| <b>USB Clock (USBCLK)</b>       |                     |       |       |      |       |        |
| f <sub>clk48</sub>              | Operating Frequency | 48    |       | MHz  |       |        |
| t9                              | Frequency Tolerance |       | 500   | ppm  | 1     |        |
| t10                             | High Time           | 7     |       | ns   |       | 9      |
| t11                             | Low time            | 7     |       | ns   |       | 9      |
| t12                             | Rise Time           |       | 1.2   | ns   |       | 9      |
| t13                             | Fall Time           |       | 1.2   | ns   |       | 9      |
| <b>Suspend Clock (SUSCLK)</b>   |                     |       |       |      |       |        |
| f <sub>susclk</sub>             | Operating Frequency | 32    |       | KHz  | 4     |        |
| t14                             | High time           | 10    |       | μs   | 4     | 9      |
| t15                             | Low Time            | 10    |       | μs   | 4     | 9      |
| <b>SMBus Clock (SMBCLK)</b>     |                     |       |       |      |       |        |
| f <sub>smb</sub>                | Operating Frequency | 10    | 16    | KHz  |       |        |
| t18                             | High time           | 4.0   | 50    | μs   | 2     | 24     |
| t19                             | Low time            | 4.7   |       | μs   |       | 24     |
| t20                             | Rise time           |       | 1000  | ns   |       | 24     |
| t21                             | Fall time           |       | 300   | ns   |       | 24     |
| <b>I/O APIC Clock (APICCLK)</b> |                     |       |       |      |       |        |
| f <sub>ioap</sub>               | Operating Frequency | 14.32 | 33.33 | MHz  |       |        |

**NOTES:**

1. The USBCLK is a 48 MHz that expects a 40/60% duty cycle. The source of this PPM is external to this component.
2. The maximum high time (t18 Max) provide a simple guaranteed method for devices to detect bus idle conditions.
3. This specification includes pin-to-pin skew from the clock generator as well as board skew.
4. SUSCLK duty cycle can range from 30% minimum to 70% maximum.

**Table 42. Clock Timings (Sheet 2 of 2)**

| Sym                        | Parameter           | Min  | Max | Unit | Notes | Figure |
|----------------------------|---------------------|------|-----|------|-------|--------|
| t22                        | High time           | 12   | 36  | ns   |       | 9      |
| t23                        | Low time            | 12   | 36  | ns   |       | 9      |
| t24                        | Rise time           | 1.0  | 5.0 | ns   |       | 9      |
| t25                        | Fall time           | 1.0  | 5.0 | ns   |       | 9      |
| <b>Hub Interface Clock</b> |                     |      |     |      |       |        |
| f <sub>hl</sub>            | Operating Frequency | 66   |     |      |       |        |
| t31                        | High time           | 6.0  |     | ns   |       | 9      |
| t32                        | Low time            | 6.0  |     | ns   |       | 9      |
| t33                        | Rise time           | 0.25 | 1.2 | ns   |       | 9      |
| t34                        | Fall time           | 0.25 | 1.2 | ns   |       | 9      |
| t35                        | CLK66 leads PCICLK  | 1.0  | 4.5 |      | 3     |        |

**NOTES:**

1. The USBCLK is a 48 MHz that expects a 40/60% duty cycle. The source of this PPM is external to this component.
2. The maximum high time (t18 Max) provide a simple guaranteed method for devices to detect bus idle conditions.
3. This specification includes pin-to-pin skew from the clock generator as well as board skew.
4. SUSCLK duty cycle can range from 30% minimum to 70% maximum.

**Table 43. Clock Timings - UART\_CLK**

| Sym   | Parameter           | Min     | Max  | Units | Notes | Fig |
|-------|---------------------|---------|------|-------|-------|-----|
| t1a   | Operating Frequency | 14.7456 | 48   | MHz   |       |     |
| t9a   | Frequency Tolerance |         | 2500 | PPM   |       |     |
| t10a  | High Time           | 7       |      | ns    |       | 9   |
| t11a  | Low time            | 7       |      | ns    |       | 9   |
| t12a  | Rise Time           |         | 3    | ns    |       | 9   |
| t155a | Fall Time           |         | 3    | ns    |       | 9   |

**Table 44. PCI Interface Timing (Sheet 1 of 2)**

| Sym | Parameter  | Min | Max | Units | Notes                 | Figure |
|-----|--|-----|-----|-------|-----------------------|--------|
| t40 | AD[31:0] Valid Delay   | 2   | 11  | ns    | Min: 0pF<br>Max: 50pF | 10     |
| t41 | AD[31:0] Setup Time to PCICLK Rising   | 7   |     | ns    |                       | 11     |
| t42 | AD[31:0] Hold Time from PCICLK Rising  | 0   |     | ns    |                       | 11     |
| t43 | C/BE[3:0]#, FRAME#, TRDY#, IRDY#, STOP#, PAR, PERR#, PLOCK#, DEVSEL# Valid Delay from PCICLK Rising                | 2   | 11  | ns    | Min: 0pF<br>Max: 50pF | 10     |
| t44 | C/BE[3:0]#, FRAME#, TRDY#, IRDY#, STOP#, PAR, PERR#, PLOCK#, IDSEL, DEVSEL# Output Enable Delay from PCICLK Rising | 2   |     | ns    |                       | 14     |

Table 44. PCI Interface Timing (Sheet 2 of 2)

| Sym | Parameter   | Min | Max | Units | Notes | Figure |
|-----|---|-----|-----|-------|-------|--------|
| t45 | C/BE[3:0]#, FRAME#, TRDY#, IRDY#, STOP#, PERR#, PLOCK#, DEVSEL#, GNT[A:B]# Float Delay from PCICLK Rising | 2   | 28  | ns    |       | 12     |
| t46 | C/BE[3:0]#, FRAME#, TRDY#, IRDY#, STOP#, SERR#, PERR#, DEVSEL#, Setup Time to PCICLK Rising               | 7   |     | ns    |       | 11     |
| t47 | C/BE[3:0]#, FRAME#, TRDY#, IRDY#, STOP#, SERR#, PERR#, DEVSEL#, REQ[A:B]# Hold Time from PCLKIN Rising    | 0   |     | ns    |       | 11     |
| t48 | PCIRST# Low Pulse Width   | 1   |     | ms    |       | 13     |
| t49 | GNT[A:B]#, GNT[5, 3:0]# Valid Delay from PCICLK Rising  | 2   | 12  | ns    |       |        |
| t50 | REQ[A:B]#, REQ[5, 3:0]# Setup Timer to PCICLK Rising  | 12  |     | ns    |       |        |

Table 45. IDE PIO &amp; Multiword DMA Mode Timing (Sheet 1 of 2)

| Sym | Parameter   | Min | Max | Units | Notes | Figure |
|-----|---|-----|-----|-------|-------|--------|
| t60 | PDIOR#/PDIOW#/SDIOR#/SDIOW# Active From CLK66 Rising    | 2   | 20  | ns    |       | 15, 16 |
| t61 | PDIOR#/PDIOW#/SDIOR#/SDIOW# Inactive From CLK66 Rising  | 2   | 20  | ns    |       | 15, 16 |
| t62 | PDA[2:0]/SDA[2:0] Valid Delay From CLK66 Rising         | 2   | 30  | ns    |       | 15     |
| t63 | PDCS1#/SDCS1#, PDCS3#/SDCS3# Active From CLK66 Rising   | 2   | 30  | ns    |       | 15     |
| t64 | PDCS1#/SDCS1#, PDCS3#/SDCS3# Inactive From CLK66 Rising | 2   | 30  | ns    |       | 15     |
| t65 | PDDACK#/SDDACK# Active From CLK66 Rising                | 2   | 20  | ns    |       | 16     |
| t66 | PDDACK#/SDDACK# Inactive From CLK66 Rising              | 2   | 20  | ns    |       |        |
| t67 | PDDREQ/SDDREQ Setup Time to CLK66 Rising                | 7   |     | ns    |       | 16     |
| t68 | PDDREQ/SDDREQ Hold From CLK66 Rising                    | 7   |     | ns    |       | 16     |
| t69 | PDD[15:0]/SDD[15:0] Valid Delay From CLK66 Rising       | 2   | 30  | ns    |       | 15, 16 |
| t70 | PDD[15:0]/SDD[15:0] Setup Time to CLK66 Rising          | 10  |     | ns    |       | 15, 16 |
| t71 | PDD[15:0]/SDD[15:0] Hold From CLK66 Rising              | 7   |     | ns    |       | 15, 16 |
| t72 | PIORDY/SIORDY Setup Time to CLK66 Rising                | 7   |     | ns    | 1     | 15     |
| t73 | PIORDY/SIORDY Hold From CLK66 Rising                    | 7   |     | ns    | 1     | 15     |

**NOTES:**

1. IORDY is internally synchronized. This timing is to guarantee recognition on the next clock.
2. PIORDY sample point from DIOx# assertion and PDIOx# active pulse width is programmable from 2-5 PCI clocks when the drive mode is Mode 2 or greater. Refer to the ISP field in the IDE Timing Register
3. PIORDY sample point from DIOx# assertion, PDIOx# active pulse width and PDIOx# inactive pulse width cycle time is the compatible timing when the drive mode is Mode 0/1. Refer to the TIM0/1 field in the IDE timing register.
4. PDIOx# inactive pulse width is programmable from 1-4 PCI clocks when the drive mode is Mode 2 or greater. Refer to the RCT field in the IDE Timing Register.



**Table 45. IDE PIO & Multiword DMA Mode Timing (Sheet 2 of 2)**

| Sym | Parameter                                    | Min | Max | Units | Notes | Figure |
|-----|--|-----|-----|-------|-------|--------|
| t74 | PIORDY/SIORDY Inactive Pulse Width           | 48  |     | ns    |       | 15     |
| t75 | PDIOR#/PDIOW#/SDIOR#/SDIOW# Pulse Width Low  |     |     |       | 2,3   | 15, 16 |
| t76 | PDIOR#/PDIOW#/SDIOR#/SDIOW# Pulse Width High |     |     |       | 3,4   | 15, 16 |

**NOTES:**

1. IORDY is internally synchronized. This timing is to guarantee recognition on the next clock.
2. PIORDY sample point from DIOx# assertion and PDIOx# active pulse width is programmable from 2-5 PCI clocks when the drive mode is Mode 2 or greater. Refer to the ISP field in the IDE Timing Register
3. PIORDY sample point from DIOx# assertion, PDIOx# active pulse width and PDIOx# inactive pulse width cycle time is the compatible timing when the drive mode is Mode 0/1. Refer to the TIM0/1 field in the IDE timing register.
4. PDIOx# inactive pulse width is programmable from 1-4 PCI clocks when the drive mode is Mode 2 or greater. Refer to the RCT field in the IDE Timing Register.

**Table 46. Ultra ATA Timing (Mode 0, Mode 1, Mode 2)**

| Sym | Parameter (1)                    | Mode 0 (ns) |     | Mode 1 (ns) |     | Mode 2 (ns) |     | Figure    |
|-----|----------------------------------|-------------|-----|-------------|-----|-------------|-----|-----------|
|     |                                  | Min         | Max | Min         | Max | Min         | Max |           |
| t80 | Sustained Cycle Time (T2cyc)tp)  | 240         |     | 160         |     | 120         |     |           |
| t81 | Cycle Time (Tcyc)                | 112         |     | 73          |     | 54          |     | 18        |
| t82 | Two Cycle Time (T2cyc)           | 230         |     | 154         |     | 115         |     | 18        |
| t83 | Data Setup Time (Tds)            | 15          |     | 10          |     | 7           |     | 18        |
| t84 | Data Hold Time (Tdh)             | 5           |     | 5           |     | 5           |     | 18        |
| t85 | Data Valid Setup Time (Tdvs)     | 70          |     | 48          |     | 30          |     | 18        |
| t86 | Data Valid Hold Time (Tdvh)      | 6           |     | 6           |     | 6           |     | 18        |
| t87 | Limited Interlock Time (Tli)     | 0           | 150 | 0           | 150 | 0           | 150 | 20        |
| t88 | Interlock Time w/ Minimum (Tmli) | 20          |     | 20          |     | 20          |     | 20        |
| t89 | Envelope Time (Tenv)             | 20          | 70  | 20          | 70  | 20          | 70  | 17        |
| t90 | Ready to Pause Time (Trp)        | 160         |     | 125         |     | 100         |     | 19        |
| t91 | DMACK setup/hold Time (Tack)     | 20          |     | 20          |     | 20          |     | 17,<br>20 |

**NOTE:**

1. The specification symbols in parentheses correspond to the Ultra ATA specification name.

Table 47. Ultra ATA Timing (Mode 3, Mode 4, Mode 5)

| Sym | Parameter (1)                                 | Mode 3 (ns) |     | Mode 4 (ns) |     | Mode 5 (ns) |     | Figure    |
|-----|---|-------------|-----|-------------|-----|-------------|-----|-----------|
|     |   | Min         | Max | Min         | Max | Min         | Max |           |
| t80 | Sustained Cycle Time (T2cyc <sub>typ</sub> )  | 90          |     | 60          |     | 40          |     |           |
| t81 | Cycle Time (T <sub>cyc</sub> ) (2)            | 39          |     | 25          |     | 16.8        |     | 18        |
| t82 | Two Cycle Time (T2cyc)                        | 86          |     | 57          |     | 38          |     | 18        |
| t83 | Data Setup Time (T <sub>ds</sub> )            | 7           |     | 5           |     | 4.0         |     | 18        |
| t84 | Data Hold Time (T <sub>dh</sub> )             | 5           |     | 5           |     | 4.6         |     | 18        |
| t85 | Data Valid Setup Time (T <sub>dvs</sub> )     | 20          |     | 6           |     | 6.0         |     | 18        |
| t86 | Data Valid Hold Time (T <sub>dvh</sub> )      | 6           |     | 6           |     | 6.0         |     | 18        |
| t87 | Limited Interlock Time (T <sub>li</sub> )     | 0           | 100 | 0           | 100 | 0           | 75  | 20        |
| t88 | Interlock Time w/ Minimum (T <sub>mli</sub> ) | 20          |     | 20          |     |             | 20  | 20        |
| t89 | Envelope Time (T <sub>env</sub> )             | 20          | 55  | 20          | 55  | 20          | 50  | 17        |
| t90 | Ready to Pause Time (T <sub>rp</sub> )        | 100         |     | 100         |     | 85          |     | 19        |
| t91 | DMACK setup/hold Time (T <sub>ack</sub> )     | 20          |     | 20          |     | 20          |     | 17,<br>20 |

**Table 48. Universal Serial Bus Timing**

| Sym                               | Parameter   | Min          | Max        | Units    | Notes   | Fig |
|-----------------------------------|---|--------------|------------|----------|---|-----|
| <b>Full Speed Source (Note 7)</b> |   |              |            |          |   |     |
| t122                              | USBPx+, USBPx- Driver Rise Time   | 4            | 20         | ns       | 1, C <sub>L</sub> = 50 pF                                 | 21  |
| t123                              | USBPx+, USBPx- Driver Fall Time   | 4            | 20         | ns       | 1, C <sub>L</sub> = 50 pF                                 | 21  |
| t102                              | Source Differential Driver Jitter<br>To Next Transition<br>For Paired Transitions | -3.5<br>-4   | 3.5<br>4   | ns<br>ns | 2, 3  | 22  |
| t103                              | Source SE0 interval of EOP  | 160          | 175        | ns       | 4   | 23  |
| t104                              | Source Jitter for Differential Transition to<br>SE0 Transition                    | -2           | 5          | ns       | 5   |     |
| t105                              | Receiver Data Jitter Tolerance<br>To Next Transition<br>For Paired Transitions    | -18.5<br>-9  | 18.5<br>9  | ns<br>ns | 3   | 22  |
| t106                              | EOP Width: Must accept as EOP   | 82           |            | ns       | 4   | 23  |
| t107                              | Width of SE0 interval during differential<br>transition                           |              | 14         | ns       |   |     |
| <b>Low Speed Source (Note 8)</b>  |   |              |            |          |   |     |
| t122                              | USBPx+, USBPx- Driver Rise Time   | 75           | 300        | ns<br>ns | 1, 6<br>C <sub>L</sub> = 50 pF<br>C <sub>L</sub> = 350 pF | 21  |
| t123                              | USBPx+, USBPx- Driver Fall Time   | 75           | 300        | ns<br>ns | 1,6<br>C <sub>L</sub> = 50 pF<br>C <sub>L</sub> = 350 pF  | 21  |
| t110                              | Source Differential Driver Jitter<br>To Next Transition<br>For Paired Transitions | -25<br>-14   | 25<br>14   | ns<br>ns | 2, 3  | 22  |
| t111                              | Source SE0 interval of EOP  | 1.25         | 1.50       | μs       | 4   | 23  |
| t112                              | Source Jitter for Differential Transition to<br>SE0 Transition                    | -40          | 100        | ns       | 5   |     |
| t113                              | Receiver Data Jitter Tolerance<br>To Next Transition<br>For Paired Transitions    | -152<br>-200 | 152<br>200 | ns<br>ns | 3   | 22  |
| t114                              | EOP Width: Must accept as EOP   | 670          |            | ns       | 4   | 23  |
| t115                              | Width of SE0 Interval during Differential<br>Transition                           |              | 210        | ns       | 5   |     |

**NOTES:**

1. Driver output resistance under steady state drive is specified at 28 ohms at minimum and 43 ohms at maximum
2. Timing difference between the differential data signals
3. Measured at crossover point of differential data signals
4. Measured at 50% swing point of data signals
5. Measured from last crossover point to 50% swing point of data line at leading edge of EOP
6. Measured from 10% to 90% of the data signal
7. Full Speed Data Rate has minimum of 11.97 Mbps and maximum of 12.03 Mbps
8. Low Speed Data Rate has a minimum of 1.48 Mbps and a maximum of 1.52 Mbps

Table 49. IOAPIC Bus Timing

| Sym  | Parameter                                    | Min | Max  | Units | Notes | Fig |
|------|--|-----|------|-------|-------|-----|
| t120 | APICCD[1:0]# Valid Delay from APICCLK Rising | 3.0 | 12.0 | ns    |       | 10  |
| t121 | APICCD[1:0]# Setup Time to APICCLK Rising    | 8.5 |      | ns    |       | 11  |
| t122 | APICCD[1:0]# Hold Time from APICCLK Rising   | 3.0 |      | ns    |       | 11  |

Table 50. SMBus Timing

| Sym  | Parameter  | Min | Max | Units | Notes | Fig |
|------|--|-----|-----|-------|-------|-----|
| t130 | Bus Tree Time Between Stop and Start Condition   | 4.7 |     | μs    |       | 24  |
| t131 | Hold Time after (repeated) Start Condition. After this period, the first clock is generated. | 4.0 |     | μs    |       | 24  |
| t132 | Repeated Start Condition Setup Time  | 4.7 |     | μs    |       | 24  |
| t133 | Stop Condition Setup Time  | 4.0 |     | μs    |       | 24  |
| t134 | Data Hold Time   | 300 |     | ns    |       | 24  |
| t135 | Data Setup Time  | 250 |     | ns    |       | 24  |
| t136 | Device Time Out  | 25  | 35  | ms    | 1     |     |
| t137 | Cumulative Clock Low Extend Time (slave device)  |     | 25  | ms    | 2     | 25  |
| t138 | Cumulative Clock Low Extend Time (master device)   |     | 10  | ms    | 3     | 25  |

**NOTES:**

1. A device will time out when any clock low exceeds this value.
2. t137 is the cumulative time a slave device is allowed to extend the clock cycles in one message from the initial start to stop. If a slave device exceeds this time, it is expected to release both its clock and data lines and reset itself.
3. t138 is the cumulative time a master device is allowed to extend its clock cycles within each byte of a message as defined from start-to-ack, ack-to-ack or ack-to-stop.

Table 51. SIU LPC and Serial IRQ Timings

| Sym   | Parameter  | Min | Max | Units | Notes | Fig |
|-------|--|-----|-----|-------|-------|-----|
| t150a | SIU_LAD[3:0]/SIU_SERIRQ Valid Delay from SIU_LCLK Rising         | 2   | 11  | ns    |       | 10  |
| t151a | SIU_LAD[3:0]/SIU_SERIRQ Output Enable Delay from SIU_LCLK Rising | 2   |     | ns    |       | 14  |
| t152a | SIU_LAD[3:0]/SIU_SERIRQ Float Delay from SIU_LCLK Rising         |     | 28  | ns    |       | 12  |
| t153a | SIU_LAD[3:0]/SIU_SERIRQ Setup Time to SIU_LCLK Rising            | 7   |     | ns    |       | 11  |
| t154a | SIU_LAD[3:0]/SIU_SERIRQ Hold Time from SIU_LCLK Rising           | 0   |     | ns    |       | 11  |
| t155a | SIU_LDRQ# Valid Delay from SIU_LCLK Rising                       | 2   | 11  | ns    |       | 10  |
| t157a | SIU_LFRAME# Setup Time to SIU_LCLK Rising                        | 7   |     | ns    |       | 11  |
| t157b | SIU_LAD[3:0] Hold Time from SIU_LCLK Rising                      | 0   |     | ns    |       | 11  |

**Table 52. UART Timings**

| Sym   | Parameter   | Min | Max | Units | Notes | Fig |
|-------|---|-----|-----|-------|-------|-----|
| t150a | SIU0_TXD, SIU1_TXD Valid Delay from UART_CLK Rising   | 2   | 13  | ns    |       | 10  |
| t150a | SIU0_DTR#, SIU0_RTS#, SIU1_DTR#, and SIU1_RTS# Valid Delay from SIU_LCLK Rising   | 2   | 11  | ns    |       | 10  |
| t153a | SIU0_RXD, SIU0_CTS#, SIU0_DSR#, SIU0_DCD#, SIU0_RI#, SIU1_RXD, SIU1_CTS#, SIU1_DSR#, SIU1_DCD#, and SIU1_RI# Setup Time to SIU_LCLK Rising  | 7   |     | ns    |       | 11  |
| t154a | SIU0_RXD, SIU0_CTS#, SIU0_DSR#, SIU0_DCD#, SIU0_RI#, SIU1_RXD, SIU1_CTS#, SIU1_DSR#, SIU1_DCD#, and SIU1_RI# Hold Time from SIU_LCLK Rising | 0   |     | ns    |       | 11  |
| t10a  | SIU0_CTS#, SIU0_DSR#, SIU0_DCD#, SIU0_RI#, SIU1_CTS#, SIU1_DSR#, SIU1_DCD#, and SIU1_RI# high time  | 100 |     |       |       | 9   |
| t11a  | SIU0_CTS#, SIU0_DSR#, SIU0_DCD#, SIU0_RI#, SIU1_CTS#, SIU1_DSR#, SIU1_DCD#, and SIU1_RI# low time   | 100 |     |       |       | 9   |

**Table 53. LPC Timing**

| Sym  | Parameter                                       | Min | Max | Units | Notes | Fig |
|------|---|-----|-----|-------|-------|-----|
| t150 | LAD[3:0] Valid Delay from PCICLK Rising         | 2   | 11  | ns    |       | 10  |
| t151 | LAD[3:0] Output Enable Delay from PCICLK Rising | 2   |     | ns    |       | 14  |
| t152 | LAD[3:0] Float Delay from PCICLK Rising         |     | 28  | ns    |       | 12  |
| t153 | LAD[3:0] Setup Time to PCICLK Rising            | 7   |     | ns    |       | 11  |
| t154 | LAD[3:0] Hold Time from PCICLK Rising           | 0   |     | ns    |       | 11  |
| t155 | LDRQ[1:0]# Setup Time to PCICLK Rising          | 12  |     | ns    |       | 11  |
| t156 | LDRQ[1:0]# Hold Time from PCICLK Rising         | 0   |     | ns    |       | 11  |
| t157 | LFRAME# Valid Delay from PCICLK Rising          | 2   | 12  | ns    |       | 10  |

**Table 54. Miscellaneous Timings**

| Sym  | Parameter                                 | Min | Max | Units   | Notes | Fig |
|------|---|-----|-----|---------|-------|-----|
| t160 | SERIRQ Setup Time to PCICLK Rising        | 7   |     | ns      |       | 11  |
| t161 | SERIRQ Hold Time from PCICLK Rising       | 0   |     | ns      |       | 11  |
| t162 | RI#, EXTSMI#, GPI, USB Resume Pulse Width | 2   |     | RTCCCLK |       | 13  |
| t163 | SPKR Valid Delay from OSC Rising          |     | 200 | ns      |       | 10  |
| t164 | SERR# Active to NMI Active                |     | 200 | ns      |       |     |
| t165 | IGNNE# Inactive from FERR# Inactive       |     | 230 | ns      |       |     |

Table 55. Power Sequencing and Reset Signal Timings

| Sym  | Parameter                                     | Min   | Max | Units | Notes | Fig    |
|------|---|-------|-----|-------|-------|--------|
| t170 | VccRTC active to RTCRST# inactive             | 5     | -   | ms    |       | 26     |
| t171 | VccRTC supply active to Vcc supplies active   | 0     | -   | ms    | 3     | 26     |
| t172 | V5Ref active to Vcc3_3, Vcc1_8 active         | 0     | -   | ms    | 1, 2  | 26, 27 |
| t173 | Vcc supplies active to PWROK, VRMPWRGD active | 10    | -   | ms    | 2     | 26, 27 |
| t174 | AC_RST# active low pulse width                | 1     |     | μs    |       |        |
| t175 | AC_RST# inactive to BIT_CLK startup delay     | 162.8 |     | ns    |       |        |

**NOTES:**

1. The V5Ref supply must power up before or simultaneous with its associated 3.3 V supply, and must power down simultaneous with or after the 3.3V supply. See Section 3.3.4 for details.
2. The associated 3.3 V and 1.8 V supplies are assumed to power up or down together. The difference between the levels of the 3.3 V and 1.8 V supplies must never be greater than 2.0V.
3. The Vcc supplies must **never** be active while the VccRTC supply is inactive.

## 4.5 Timing Diagrams

Figure 9. Clock Timing

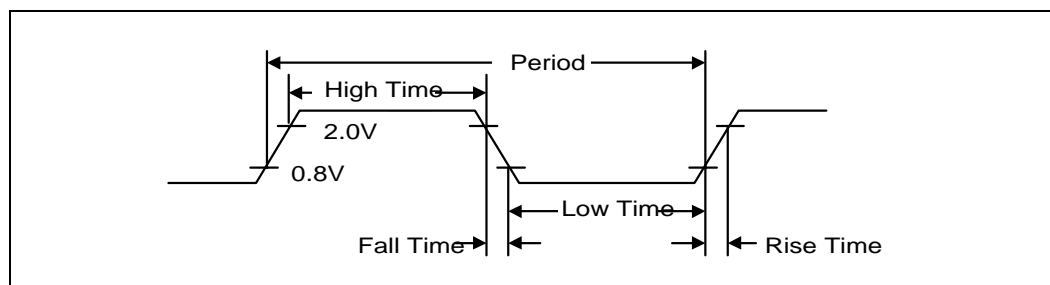


Figure 10. Valid Delay From Rising Clock Edge

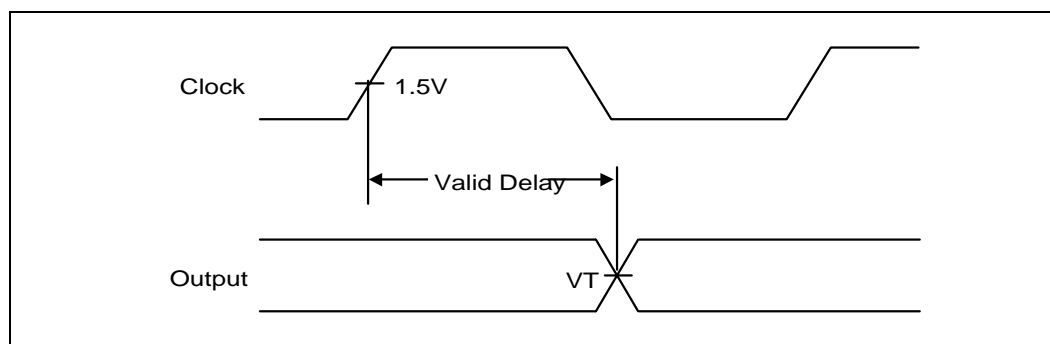


Figure 11. Setup And Hold Times

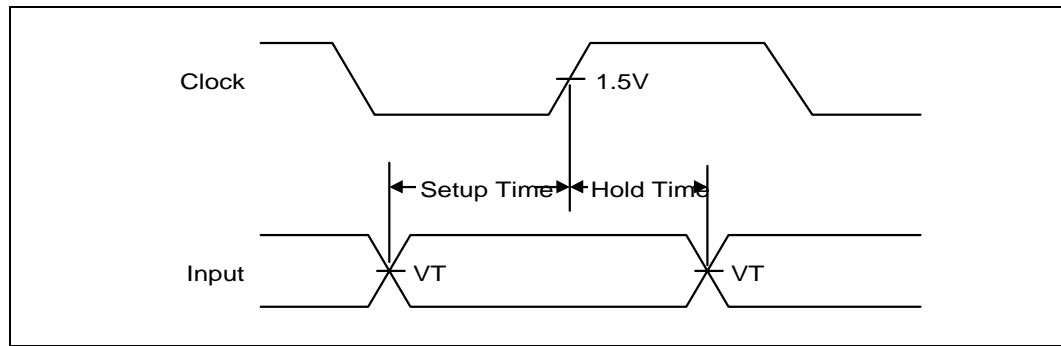


Figure 12. Float Delay

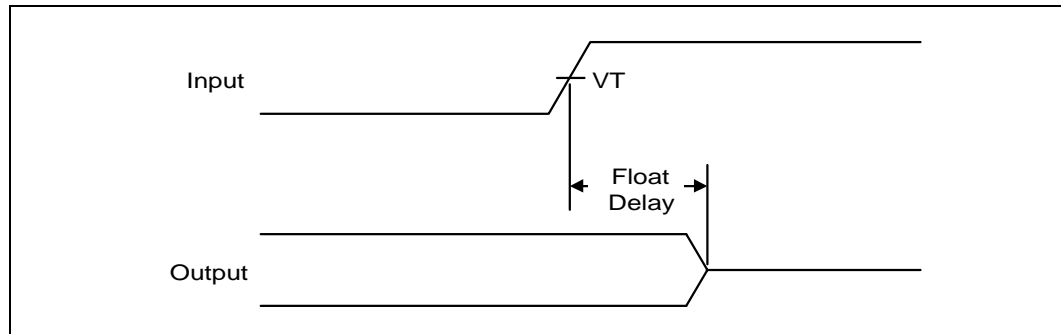


Figure 13. Pulse Width

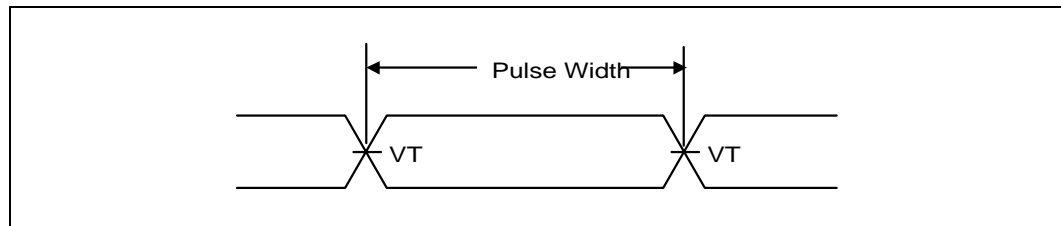


Figure 14. Output Enable Delay

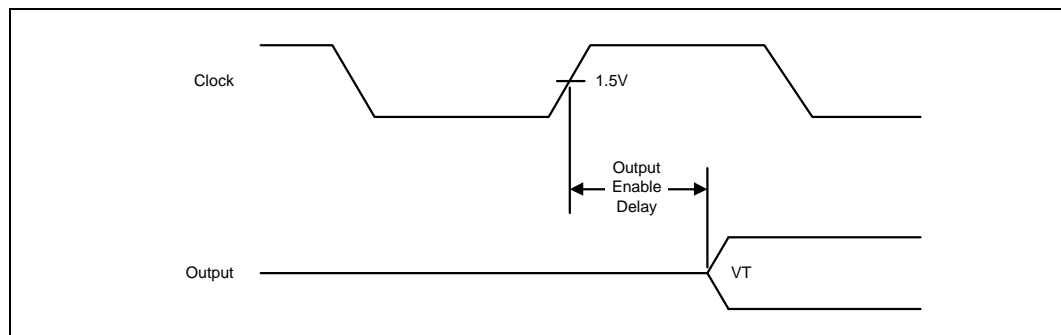


Figure 15. IDE PIO Mode

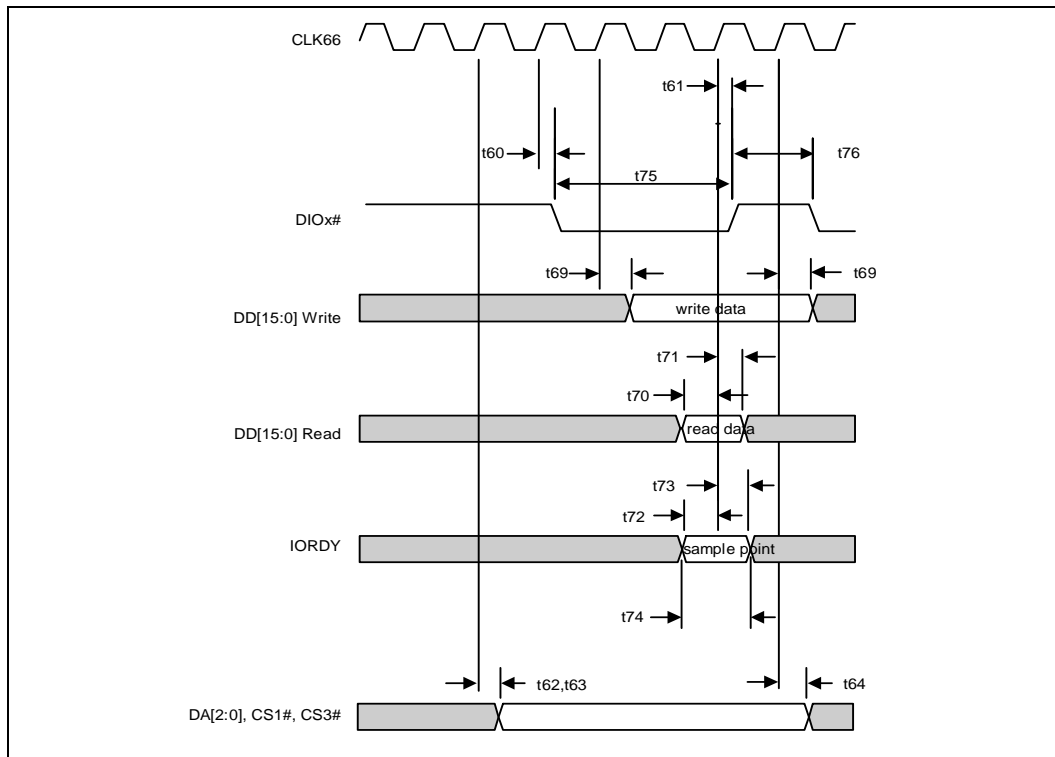


Figure 16. IDE Multiword DMA

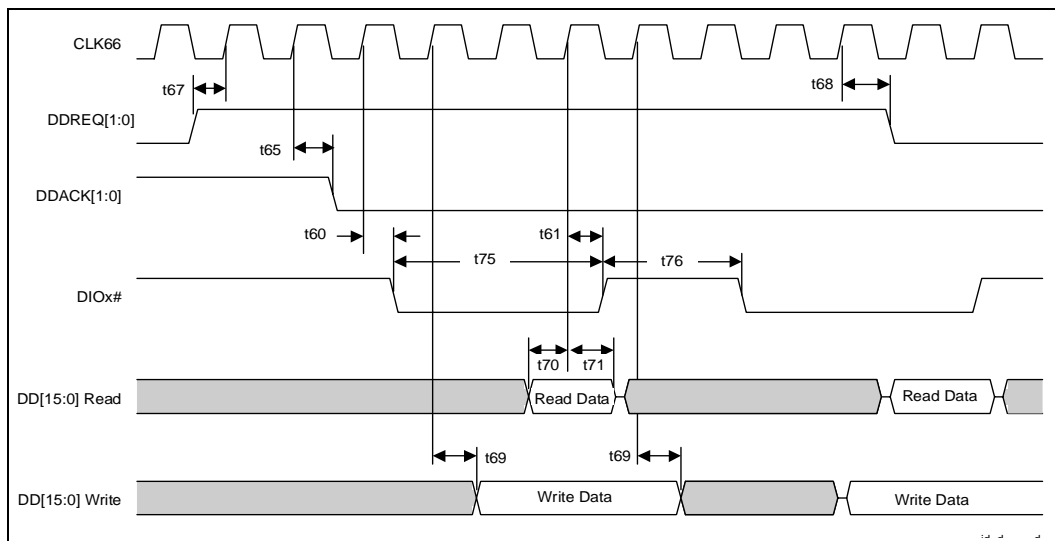




Figure 17. Ultra ATA Mode (Drive Initiating a Burst Read)

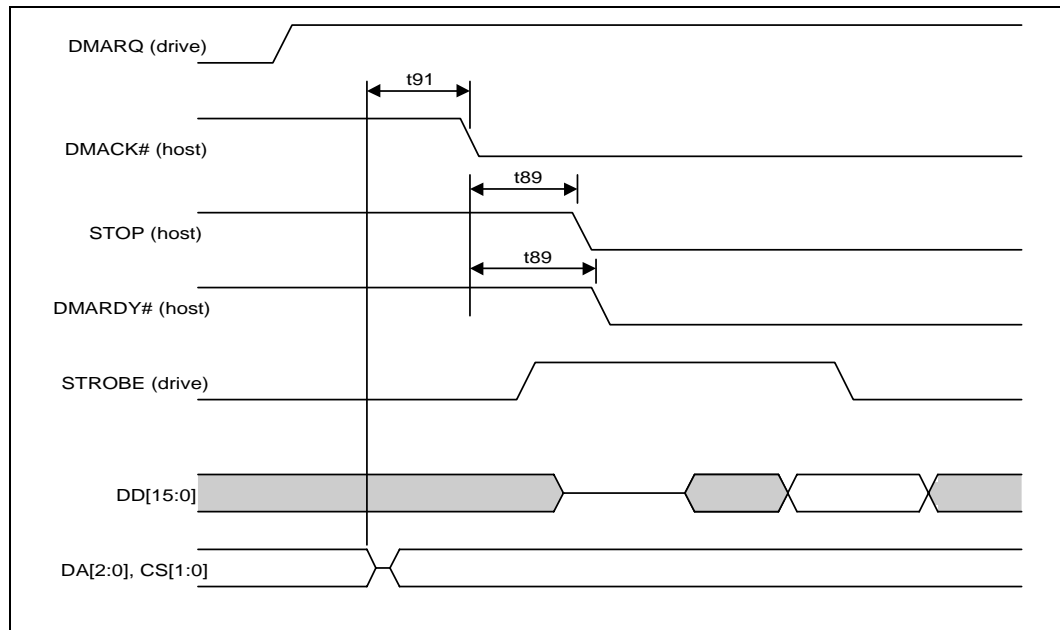


Figure 18. Ultra ATA Mode (Sustained Burst)

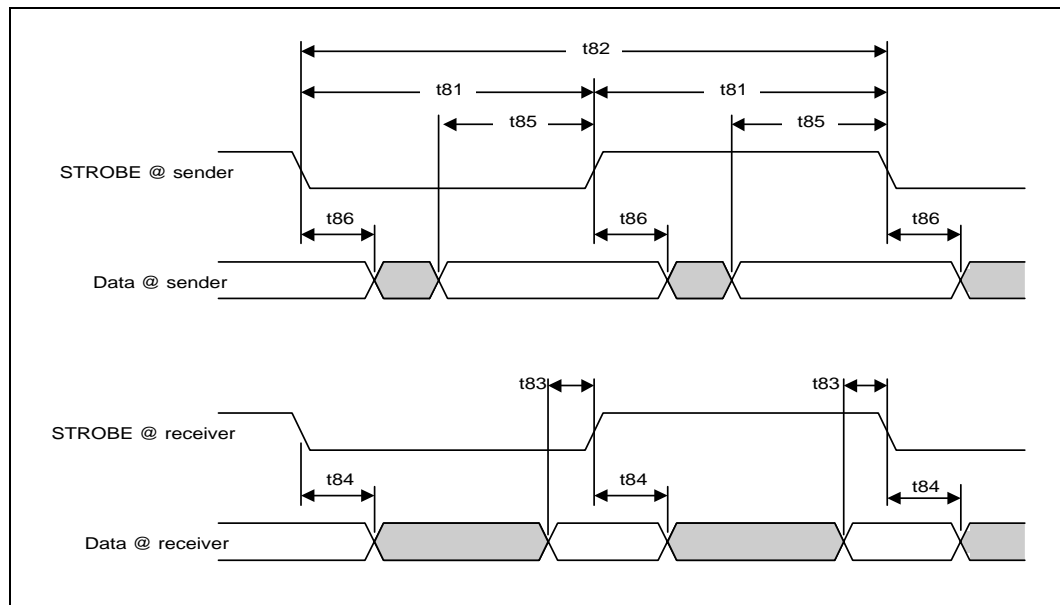


Figure 19. Ultra ATA Mode (Pausing a DMA Burst)

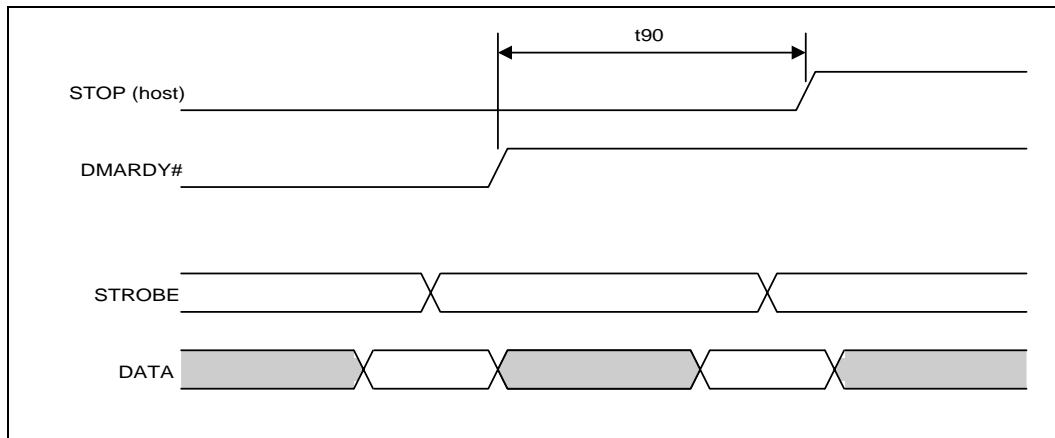


Figure 20. Ultra ATA Mode (Terminating a DMA Burst)

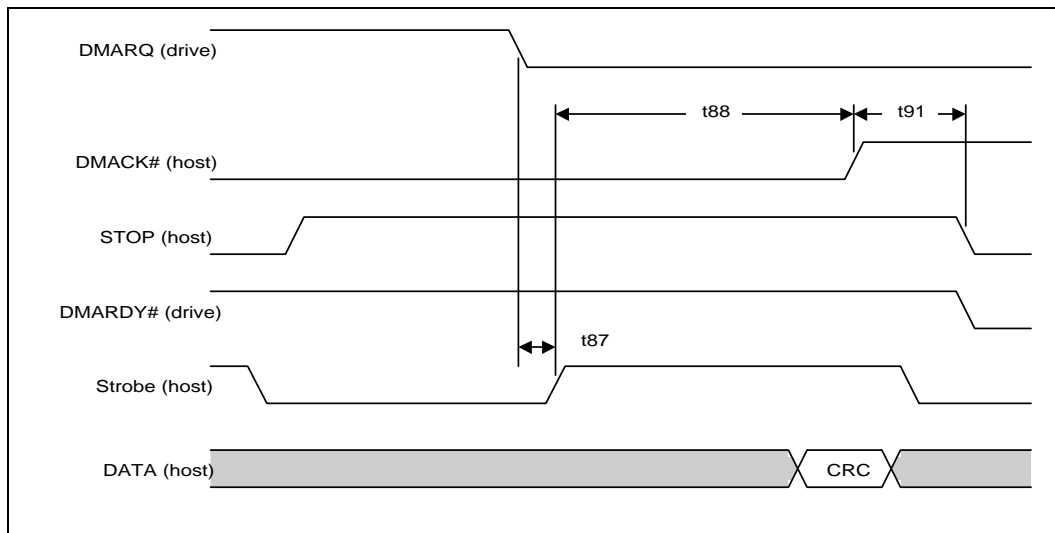


Figure 21. USB Rise and Fall Times

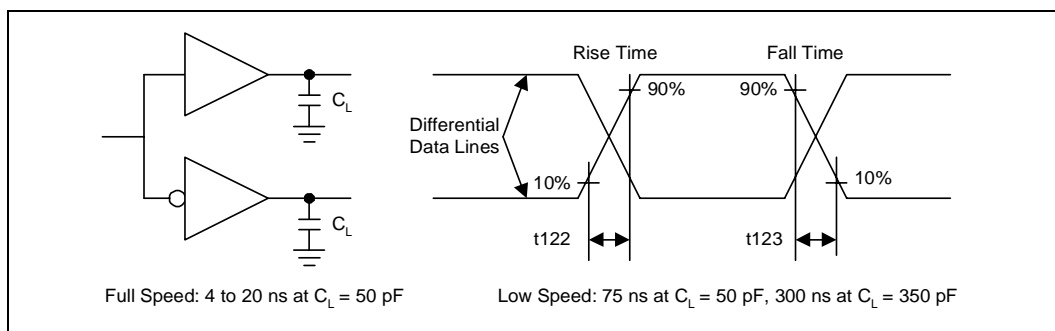


Figure 22. USB Jitter

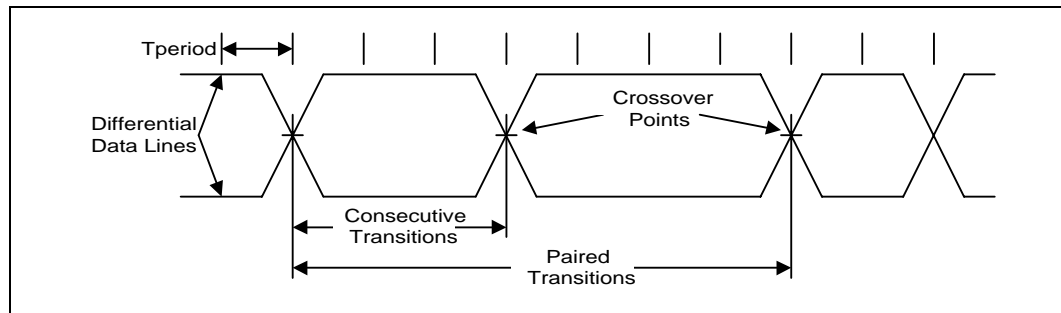


Figure 23. USB EOP Width

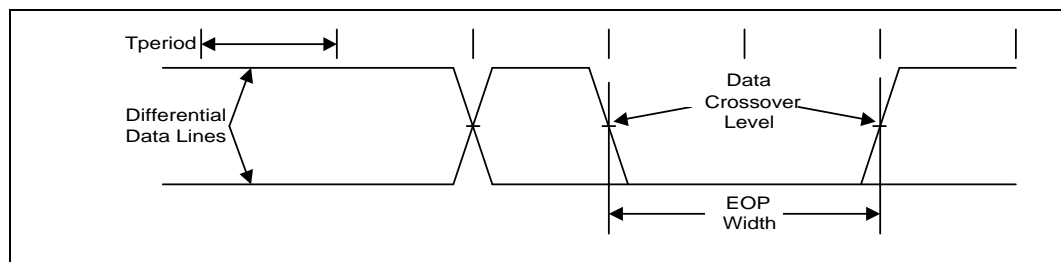


Figure 24. SMBus Transaction

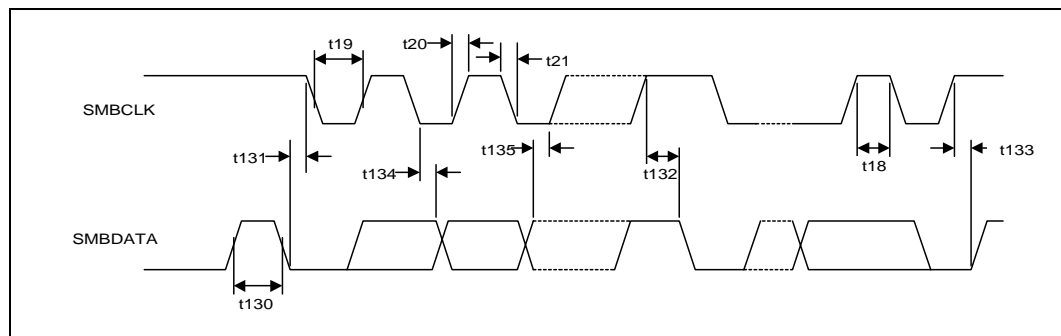


Figure 25. SMBus Time-out

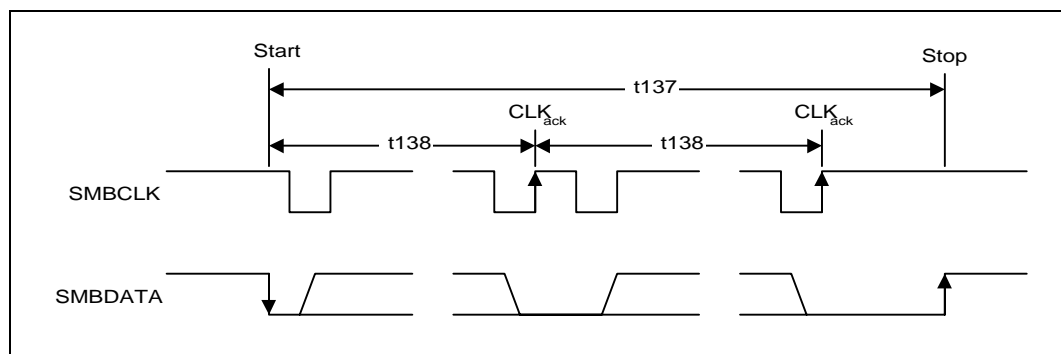


Figure 26. Power Sequencing and Reset Signal Timings

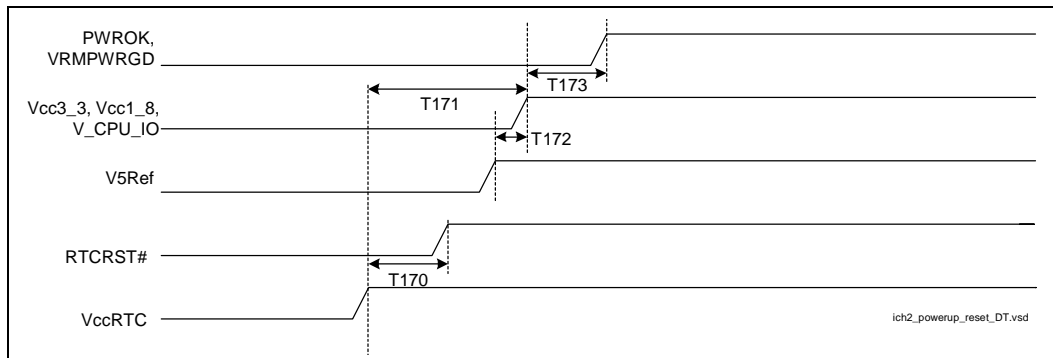


Figure 27. 1.8 V/3.3 V Power Sequencing

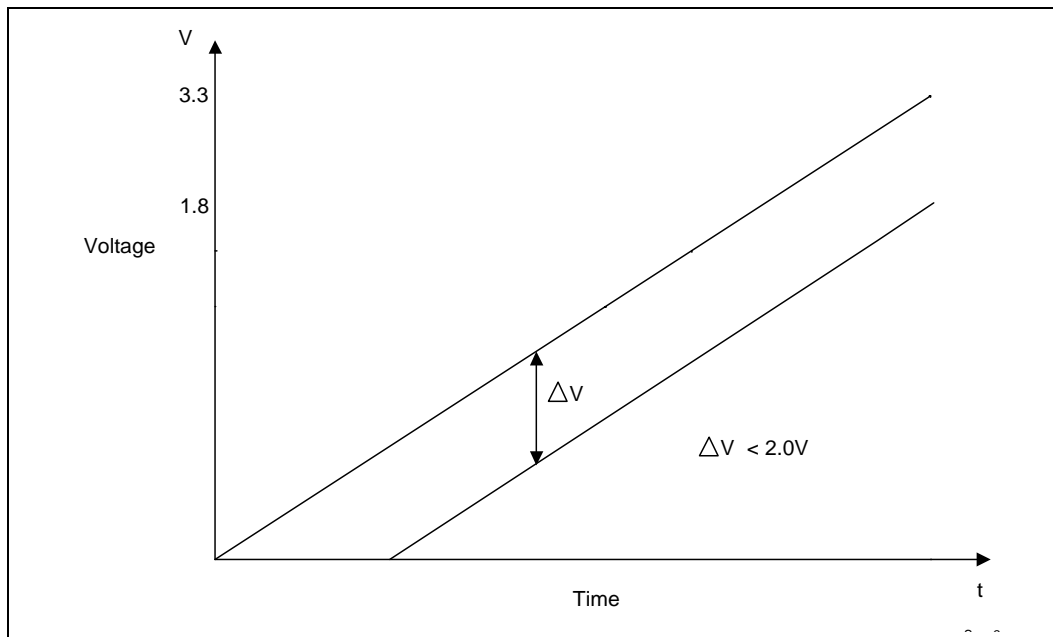
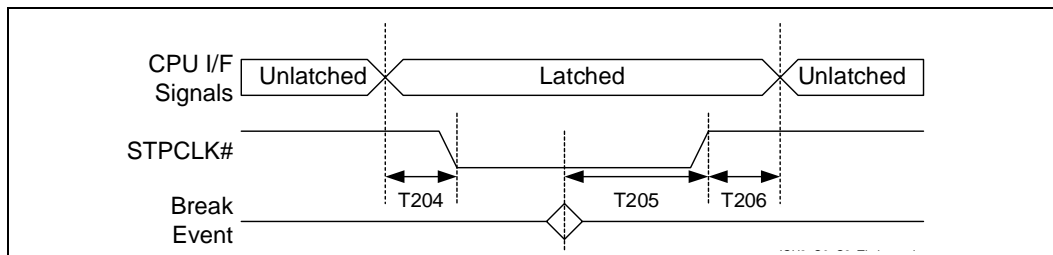


Figure 28. C0 to C2 to C0 Timings



## 5.0 Testability

### 5.1 Test Mode Description

The 82801E C-ICH supports two types of test modes, a tri-state test mode and an XOR Chain test mode. Driving RTCRST# low for a specific number of PCI clocks while PWROK is high activates a particular test mode as described in Table 56.

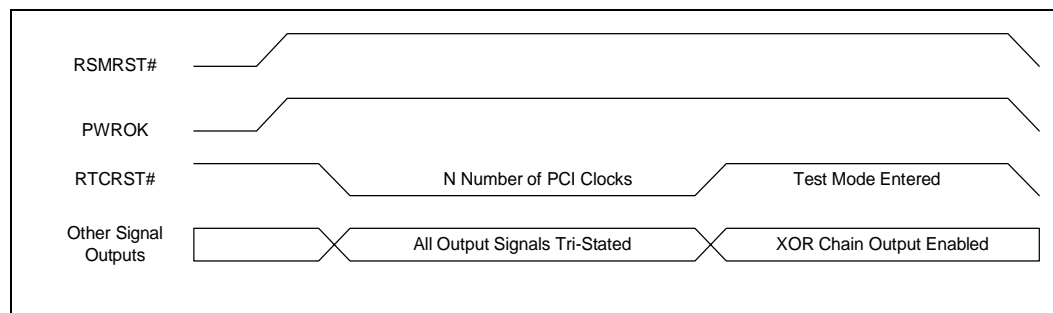
*Note:* RTCRST# can be driven low any time after PCIRST# is inactive.

**Table 56. Test Mode Selection**

| Number of PCI Clocks RTCRST# Driven Low After PWROK Active | Test Mode                |
|--|--------------------------|
| <4   | No Test Mode Selected    |
| 4  | XOR Chain 1              |
| 5  | XOR Chain 2              |
| 6  | XOR Chain 3              |
| 7  | XOR Chain 4              |
| 8  | All "Z"                  |
| 9 - 24   | Reserved. DO NOT ATTEMPT |
| >24  | No Test Mode Selected    |

Figure 29 illustrates the entry into a test mode. A particular test mode is entered upon the rising edge of the RTCRST# after being asserted for a specific number of PCI clocks while PWROK is active. To change test modes, the same sequence should be followed again. To restore the 82801E C-ICH to normal operation, execute the sequence with RTCRST# being asserted so that no test mode is selected as specified in Table 56.

**Figure 29. Test Mode Entry (XOR Chain Example)**



## 5.2 Tri-state Mode

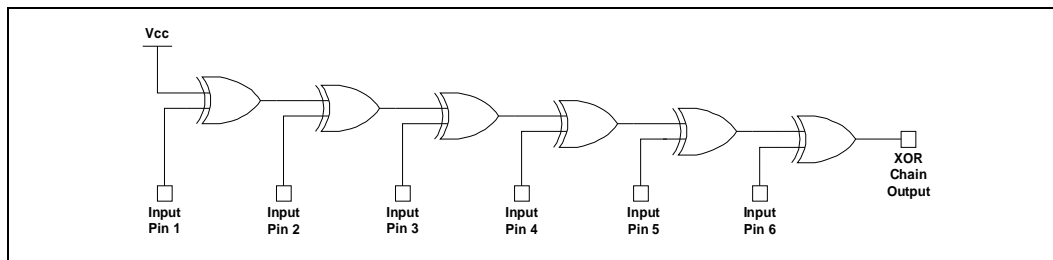
When in the tri-state mode, all outputs and bidirectional pin are tri-stated, including the XOR Chain outputs.

## 5.3 XOR Chain Mode

In the 82801E C-ICH, provisions for Automated Test Equipment (ATE) board level testing are implemented with XOR Chains. The 82801E C-ICH signals are grouped into four independent XOR chains which are enabled individually. When an XOR chain is enabled, all output and bidirectional buffers within that chain are tri-stated, except for the XOR chain output. Every signal in the enabled XOR chain (except for the XOR chain's output) functions as an input. All output and bidirectional buffers for pins not in the selected XOR chain are tri-stated. Figure 30 is a schematic example of XOR chain circuitry.

Table 57 - Table 60 list each XOR chain pin ordering, with the first value being the first input and the last value being the XOR chain output. Table 61 lists the signal pins not included in any XOR chain.

**Figure 30. Example XOR Chain Circuitry**



**Table 57. XOR Chain #1**  
(RTCST# Asserted for four PCI Clocks while PWROK Active)

| Pin Name         | Ball # | Notes                |
|------------------|--------|----------------------|
| SIU0_RXD         | E17    | Top of XOR Chain 1   |
| SIU0_TXD         | D19    | Second signal in XOR |
| SIU0_CTS#        | D17    |                      |
| SIU0_DSR#        | D18    |                      |
| SIU0_DCD#        | B20    |                      |
| SIU0_RI#         | A21    |                      |
| SIU0_DTR#        | B19    |                      |
| SIU0_RTS#        | E16    |                      |
| SIU1_RXD         | B18    |                      |
| SIU1_TXD         | C17    |                      |
| SIU1_CTS#        | D16    |                      |
| SIU1_DSR#        | A18    |                      |
| SIU1_DCD#        | C16    |                      |
| SIU1_RI#         | D15    |                      |
| SIU1_DTR#        | B16    |                      |
| SIU1_RTS#        | A16    |                      |
| SIU_LDRQ#        | C15    |                      |
| SIU_LAD[3]       | E14    |                      |
| SIU_LFRAME#      | B15    |                      |
| SIU_LAD[0]       | D14    |                      |
| SIU_LAD[1]       | A15    |                      |
| SIU_LAD[2]       | C14    |                      |
| SIU_SERIRQ       | A14    |                      |
| SIU_RESET#       | D13    |                      |
| LFRAME#<br>/FWH4 | C13    |                      |
| FWH3<br>/LAD3    | B13    |                      |
| TP0              | A12    |                      |
| FWH0<br>/LAD0    | B12    |                      |
| FWH1<br>/LAD1    | D12    |                      |
| FWH2<br>/LAD2    | E12    |                      |
| THRM#            | A11    |                      |

**Table 57. XOR Chain #1**  
(RTCST# Asserted for four PCI Clocks while PWROK Active)

| Pin Name                   | Ball # | Notes               |
|----------------------------|--------|---------------------|
| LDRQ0#                     | B11    |                     |
| LDRQ1#                     | C11    |                     |
| GPIO[21]                   | A10    |                     |
| GNTA#<br>/GPIO16           | B10    |                     |
| REQB#<br>/REQ5#<br>/GPIO1  | C10    |                     |
| GNTB#<br>/GNT5#<br>/GPIO17 | B9     |                     |
| GNT1#                      | D10    |                     |
| GNT0#                      | A8     |                     |
| REQA#<br>/GPIO0            | C9     |                     |
| PIRQH#                     | A7     |                     |
| PIRQG#<br>/GPIO4           | E11    |                     |
| PIRQF#<br>/GPIO3           | E10    |                     |
| PIRQE#<br>/GPIO2           | C8     |                     |
| PIRQD#                     | B7     |                     |
| PIRQA#                     | A5     |                     |
| PIRQB#                     | D8     |                     |
| PIRQC#                     | C7     |                     |
| REQ0#                      | B5     |                     |
| REQ1#                      | D7     |                     |
| REQ2#                      | E9     |                     |
| GNT2#                      | E8     |                     |
| GNT3#                      | A3     |                     |
| AD_26                      | B4     |                     |
| AD_30                      | C5     |                     |
| AD_24                      | D6     |                     |
| AD_28                      | A2     |                     |
| TP[2]                      | AC2    | XOR Chain #1 Output |

**Table 58. XOR Chain #2; Chain 2-1 and Chain 2-2**

(RTCRST# Asserted for Five PCI Clocks while PWROK Active)

| Pin Name | Ball # | Notes                |
|----------|--------|----------------------|
| AD_18    | D5     | Top of XOR Chain 2   |
| AD_22    | B3     | Second signal in XOR |
| AD_16    | B2     |                      |
| STOP#    | D4     |                      |
| PAR      | C3     |                      |
| FRAME#   | B1     |                      |
| AD_20    | C2     |                      |
| AD_15    | D3     |                      |
| TRDY#    | E4     |                      |
| AD_11    | F5     |                      |
| AD_13    | C1     |                      |
| AD_4     | D2     |                      |
| AD_9     | E3     |                      |
| C/BE[0]# | F4     |                      |
| AD_2     | G5     |                      |
| AD_6     | F3     |                      |
| AD_3     | G4     |                      |
| AD_0     | E1     |                      |
| AD_5     | H5     |                      |
| AD_10    | F2     |                      |
| AD_7     | F1     |                      |
| AD_1     | H4     |                      |
| AD_12    | G2     |                      |
| AD_8     | H3     |                      |
| SERR#    | G1     |                      |
| AD_14    | H2     |                      |
| PERR#    | J4     |                      |
| C/BE[1]# | H1     |                      |
| DEVSEL#  | J3     |                      |
| PLOCK#   | K5     |                      |
| C/BE[2]# | J2     |                      |
| IRDY#    | K4     |                      |
| AD_17    | K3     |                      |
| AD_19    | K2     |                      |
| AD_23    | K1     |                      |
| AD_21    | L5     |                      |
| C/BE[3]# | L4     |                      |
| AD_25    | L2     |                      |

**Table 58. XOR Chain #2; Chain 2-1 and Chain 2-2**

(RTCRST# Asserted for Five PCI Clocks while PWROK Active)

| Pin Name          | Ball # | Notes                            |
|-------------------|--------|----------------------------------|
| AD_27             | L1     |                                  |
| AD_29             | M1     |                                  |
| AD_31             | M2     |                                  |
| REQ3#             | M4     |                                  |
| GPIO[6]           | M3     |                                  |
| GPIO[7]           | N2     | Out XOR Chain 2-1                |
| GPIO[27]          | N3     | In XOR Chain 2-2                 |
| GPIO[28]          | N4     |                                  |
| GPIO[8]           | P1     |                                  |
| GPIO[12]          | P2     |                                  |
| GPIO[13]          | P3     |                                  |
| PCIRST#           | R1     |                                  |
| RESERVED1         | P4     |                                  |
| GPIO[25]          | R2     |                                  |
| SMBCLK            | T2     |                                  |
| SMBDATA           | R4     |                                  |
| SMBALERT# /GPIO11 | U1     |                                  |
| NC[11]            | U2     |                                  |
| NC[12]            | T4     |                                  |
| NC[10]            | V1     |                                  |
| SUSCLK            | U3     |                                  |
| USBP0P            | U4     |                                  |
| USBP0N            | T5     |                                  |
| USBP1P            | W1     |                                  |
| USBP1N            | V2     |                                  |
| NC[9]             | W2     |                                  |
| NC[6]             | V4     |                                  |
| NC[7]             | W3     |                                  |
| NC[8]             | Y2     |                                  |
| OC1#              | W4     |                                  |
| VSS               | AB2    |                                  |
| RESERVED2         | Y4     |                                  |
| TP[1]             | AA5    | XOR Chain #2 Output, (Chain 2-2) |



**Table 59. XOR Chain #3; Chain 3-1 and Chain 3-2**  
(RTCRST# Asserted for Six PCI Clocks While PWROK Active)

| Pin Name | Ball # | Notes                |
|----------|--------|----------------------|
| SMLINK1  | AA4    | Top of XOR Chain 3   |
| SMLINK0  | Y5     | Second signal in XOR |
| NC       | W7     |                      |
| GPIO[24] | AB4    | Out XOR Chain 3-1    |
| NC       | Y9     | In XOR Chain 3-2     |
| NC       | AC7    |                      |
| FERR#    | AA9    |                      |
| APICD_0  | AB9    |                      |
| APCID_1  | Y10    |                      |
| SERIRQ   | AA10   |                      |
| SPKR     | AB10   |                      |
| PDD_6    | Y11    |                      |
| PDD_7    | AA11   |                      |
| PDD_8    | AB11   |                      |
| PDD_9    | AC11   |                      |
| PDD_5    | W12    |                      |
| PDD_10   | Y12    |                      |
| PDD_4    | AB12   |                      |
| PDD_11   | AC12   |                      |
| PDD_13   | AB13   |                      |
| PDD_3    | AA13   |                      |
| PDD_12   | Y13    |                      |
| PDD_1    | W13    |                      |
| PDD_2    | AC14   |                      |
| PDD_14   | AB14   |                      |
| PDD_0    | AA14   |                      |
| PDDREQ   | AC15   |                      |

**Table 59. XOR Chain #3; Chain 3-1 and Chain 3-2**  
(RTCRST# Asserted for Six PCI Clocks While PWROK Active)

| Pin Name   | Ball #    | Notes                                   |
|------------|-----------|---|
| PDIOW#     | Y14       |   |
| PDD_15     | AB15      |   |
| PDDACK#    | AA15      |   |
| PDA_2      | AC16      |   |
| IRQ14      | AB16      |   |
| SDD_6      | Y15       |   |
| PIORDY     | AC17      |   |
| PDCS1#     | W14       |   |
| PDIOR#     | AB17      |   |
| PDA_0      | Y16       |   |
| SDD_8      | AA17      |   |
| SDD_9      | AB18      |   |
| PDA_1      | W15       |   |
| SDD_7      | AC18      |   |
| SDD_5      | W16       |   |
| SDD_10     | Y17       |   |
| SDD_4      | AA18      |   |
| PDCS3#     | AC19      |   |
| SDD_11     | AB19      |   |
| SDD_2      | AC20      |   |
| SDD_12     | Y18       |   |
| SDD_3      | AA19      |   |
| SDD_13     | AB20      |   |
| SDD_1      | AC21      |   |
| SDD_14     | W17       |   |
| SDD_0      | Y19       |   |
| <b>Rl#</b> | <b>R5</b> | <b>XOR Chain #3 Output, (Chain 3-2)</b> |

**Table 60. XOR Chain #4; Chain 4-1 and Chain 4-2**

(RTCRST# Asserted for Seven PCI Clocks While PWROK Active)

| Pin Name | Ball # | Notes |
|----------|--------|-------|
| SDIOR#   | W18    |       |
| SDDREQ   | AC22   |       |
| SDIOW#   | W19    |       |
| SDD_15   | Y20    |       |
| SDA_1    | AA21   |       |
| SDDACK#  | V19    |       |
| IRQ15    | AB22   |       |
| SIORDY   | V20    |       |
| SDA_2    | W20    |       |
| SDCS3#   | Y21    |       |
| SDA_0    | AB23   |       |
| SDCS1#   | U19    |       |
| VRMPWRGD | W21    |       |
| GPIO[18] | Y22    |       |
| GPIO[19] | AA23   |       |
| GPIO[20] | T19    |       |
| GPIO[22] | U20    |       |
| GPIO[23] | T20    |       |
| A20GATE  | Y23    |       |
| RCIN#    | W23    |       |
| CPUPWRGD | V22    |       |
| INIT#    | U21    |       |
| SMI#     | T21    |       |
| CPUSLP#  | R19    |       |
| IGNNE#   | V23    |       |
| NMI      | U22    |       |
| INTR     | U23    |       |
| A20M#    | T23    |       |
| STPCLK#  | T22    |       |
| HL7      | P19    |       |
| HL5      | P20    |       |
| HL6      | R23    |       |
| HL4      | N19    |       |
| H1REQM   | P22    |       |

**Table 60. XOR Chain #4; Chain 4-1 and Chain 4-2**

(RTCRST# Asserted for Seven PCI Clocks While PWROK Active)

| Pin Name     | Ball # | Notes                            |
|--------------|--------|----------------------------------|
| H1STOP       | N21    | See Section 5.3.1.1              |
| HL_STR#      | N23    |                                  |
| HL_STR       | M22    | See Section 5.3.1.1              |
| H1REQI       | M19    |                                  |
| HL3          | M20    |                                  |
| HL2          | L23    |                                  |
| HL1          | L21    |                                  |
| HL0          | L19    |                                  |
| H1PAR        | K22    |                                  |
| HLCOMP       | K19    | Out XOR Chain 4-1                |
| LAN1_RXD[1]  | G23    | In XOR Chain 4-2                 |
| LAN1_TXD[0]  | H21    |                                  |
| LAN1_TXD[1]  | G21    |                                  |
| LAN1_TXD[2]  | E23    |                                  |
| LAN1_RXD[0]  | H20    |                                  |
| EE1_DOUT     | G20    |                                  |
| LAN1_RXD[2]  | E22    |                                  |
| LAN1_RSTSYNC | D23    |                                  |
| EE1_SHCLK    | C23    |                                  |
| EE1_DIN      | E21    |                                  |
| EE1_CS       | F20    |                                  |
| LAN0_RXD[1]  | H19    |                                  |
| LAN0_RXD[2]  | B23    |                                  |
| LAN0_RSTSYNC | C22    |                                  |
| EE0_DOUT     | D21    |                                  |
| EE0_SHCLK    | E20    |                                  |
| EE0_CS       | F19    |                                  |
| EE0_DIN      | G19    |                                  |
| LAN0_RXD[0]  | C21    |                                  |
| LAN0_TXD[2]  | D20    |                                  |
| LAN0_TXD[1]  | A22    |                                  |
| LAN0_TXD[0]  | C20    |                                  |
| OC0#         | AA1    | XOR Chain #4 Output, (Chain 4-2) |

**Table 61. Signals Not in XOR Chain**

| Pin Name    | Ball # | Notes |
|-------------|--------|-------|
| APICCLK     | AC9    |       |
| CLK14       | W11    |       |
| CLK48       | AB8    |       |
| CLK66(HCLK) | J23    |       |
| PCICLK      | M5     |       |
| SIU_LCLK    | E13    |       |
| UART_CLK    | A19    |       |
| LAN1_CLK    | B21    |       |
| LAN0_CLK    | F22    |       |
| INTRUDER#   | AB5    |       |

**Table 61. Signals Not in XOR Chain**

| Pin Name  | Ball # | Notes |
|-----------|--------|-------|
| PWROK     | W9     |       |
| RSMRST#   | Y8     |       |
| RTCX1     | Y7     |       |
| RTCX2     | AA7    |       |
| RTCST#    | AA6    |       |
| TP[2]     | AC2    |       |
| RSM_PWROK | T3     |       |
| TP[1]     | AA5    |       |
| OC0#      | AA1    |       |
| RI#       | R5     |       |

### 5.3.1 XOR Chain Testability Algorithm Example

XOR chain testing allows motherboard manufacturers to check component connectivity (e.g., opens and shorts to VCC or GND). An example algorithm to do this is shown in Table 62.

**Table 62. XOR Test Pattern Example**

| Vector | Input Pin 1 | Input Pin 2 | Input Pin 3 | Input Pin 4 | Input Pin 5 | Input Pin 6 | XOR Output |
|--------|-------------|-------------|-------------|-------------|-------------|-------------|------------|
| 1      | 0           | 0           | 0           | 0           | 0           | 0           | 1          |
| 2      | 1           | 0           | 0           | 0           | 0           | 0           | 0          |
| 3      | 1           | 1           | 0           | 0           | 0           | 0           | 1          |
| 4      | 1           | 1           | 1           | 0           | 0           | 0           | 0          |
| 5      | 1           | 1           | 1           | 1           | 0           | 0           | 1          |
| 6      | 1           | 1           | 1           | 1           | 1           | 0           | 0          |
| 7      | 1           | 1           | 1           | 1           | 1           | 1           | 1          |

In this example, Vector 1 applies all “0s” to the chain inputs. The outputs being non-inverting, will consistently produce a “1” at the XOR output on a good board. One short to Vcc (or open floating to Vcc) will result in a “0” at the chain output, signaling a defect.

Likewise, applying Vector 7 (all “1s”) to the chain inputs (given that there are an even number of input signals in the chain), will consistently produce a “1” at the XOR chain output on a good board. One short to Vss (or open floating to Vss) will result in a “0” at the chain output, signaling a defect. It is important to note that the number of inputs pulled to “1” will affect the expected chain output value. If the number of chain inputs pulled to “1” is even, then expect “1” at the output. If the number of chain inputs pulled to “1” is odd, expect “0” at the output.

Continuing with the example in Table 62, as the input pins are driven to “1” across the chain in sequence, the XOR Output will toggle between “0” and “1.” Any break in the toggling sequence (e.g., “1011”) will identify the location of the short or open.

#### 5.3.1.1 Test Pattern Consideration for XOR Chain 4

When the 82801E C-ICH is operated with the Hub Interface in “Normal” mode (See “Functional Straps” on page 49), the HL\_STB and HL\_STB# signals must always be driven to complementary logic levels. For example, if a “1” is driven on HL\_STB, then a “0” must be driven on HL\_STB# and vice versa. This will need to be considered in applying test patterns to this chain.

When the 82801E C-ICH is operated with the Hub Interface in “Enhanced” mode there are no restrictions on the values that may be driven onto the HL\_STB and HL\_STB# signals.