National Semiconductor

October 2002
Revision 1.2

# PC87372
# LPC SuperI/O with Glue Functions

## General Description

The National Semiconductor® PC87372 Advanced I/O product is a member of the PC8737x SuperI/O family. All PC8737x devices are highly integrated and are pin and software compatible, thus providing drop-in interchangeability and enabling a variety of assembly options using only a single motherboard and BIOS.

PC87372 integration allows for a smaller system board size and saves on total system cost.

The PC87372 includes legacy SuperI/O functions, system glue functions, fan monitoring and control, commonly used functions such as GPIO, and ACPI-compliant Power Management support.

The PC87372 integrates miscellaneous analog and digital system glue functions to reduce the number of discrete components required. The host communicates with the functions integrated in the PC87372 device through an LPC Bus Interface.

The PC87372 Legacy functions are: a serial port (UART), a fully compliant IEEE 1284 Parallel Port, a Floppy Disk Controller (FDC) and a Keyboard/Mouse Controller (KBC).

The Fan Speed Monitor (FSM) module allows the system to monitor two fans.

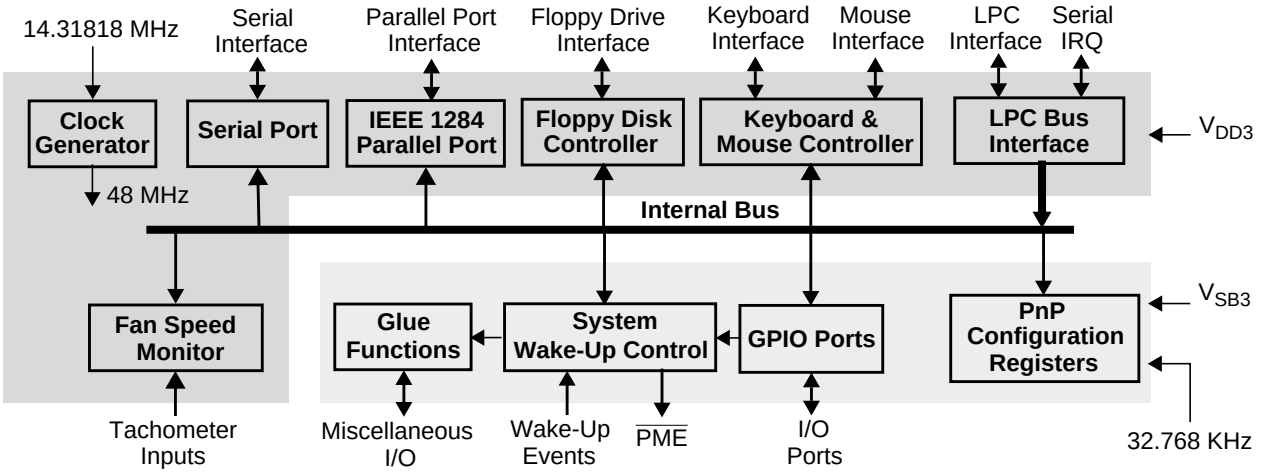
The PC87372 extended wake-up support complements the ACPI controller in the chipset. The System Wake-Up Control (SWC) module, powered by $V_{SB3}$, supports a flexible wake-up mechanism.

There are 13 General-Purpose Input/Output (GPIO) ports; these allow system control and wake-up on system events.

## Outstanding Features

- Legacy modules: Parallel Port, Floppy Disk Controller (FDC), Serial Port and a Keyboard and Mouse Controller (KBC)
- Glue functions to complement the South Bridge functionality
- Fan Speed monitoring of two fans
- $V_{SB3}$-powered Power Management with 20 wake-up sources
- Controls three LED indicators
- 13 GPIO ports with a variety of wake-up options
- LPC interface, based on Intel's *LPC Interface Specification Revision 1.0, September 29th, 1997*
- *PC01 Revision 1.0* and *Advanced Configuration and Power Interface (ACPI) Specification Revision 2.0* compliant
- 128-pin PQFP package

## Block Diagram




National Semiconductor and TRI-STATE are registered trademarks of National Semiconductor Corporation. All other brand or product names are trademarks or registered trademarks of their respective holders.

© 2002 National Semiconductor Corporation

# Features

## Bus Interface

- LPC Bus Interface
  - Based on Intel's *LPC Interface Specification Revision 1.0, September 29, 1997*
  - Synchronous cycles using up to 33 MHz bus clock
  - 8-bit I/O read and write cycles
  - Up to four 8-bit DMA channels
  - Serial IRQ (SERIRQ)
  - Reset input ($\overline{\text{PCI_RESET}}$)
  - Optional power-down support ($\overline{\text{LPCPD}}$)
- Configuration Control
  - PnP Configuration Register structure
  - Compliant with *PC01 Specification Revision 1.0, 1999-2000*
  - Base Address strap ($\overline{\text{BADDR}}$) to setup the address of the Index-Data register pair (defaults to 2Eh/2Fh)
  - Flexible resource allocation for all logical devices:
    - Relocatable base address
    - 15 IRQ routing options to serial IRQ
    - Up to four optional 8-bit DMA channels
  - Configurable feature sets:
    - Software selectable
    - $V_{SB3}$-powered pin multiplexing

## Legacy Modules

- Serial Port
  - Software compatible with the NS16550A and the NS16450
  - Supports shadow register for write-only bit monitoring
  - Data rates up to 1.5 Mbaud
- IEEE 1284-compliant Parallel Port
  - ECP, with Level 2 (14 mA sink and source output buffers)
  - Software or hardware control
  - Enhanced Parallel Port (EPP) compatible with EPP 1.7 and EPP 1.9
  - Supports EPP as mode 4 of the Extended Control Register (ECR)
  - Selection of internal pull-up or pull-down resistor for Paper End (PE) pin
  - Supports a demand DMA mode mechanism and a DMA fairness mechanism for improved bus utilization
  - Protection circuit that prevents damage to the parallel port when a printer connected to it is powered up or is operated at high voltages (in both cases, even if the PC87372 is in power-down state)
- Floppy Disk Controller (FDC)
  - Software compatible with the PC8477 (the PC8477 contains a superset of the FDC functions in the µDP8473, NEC µPD765A/B and N82077 devices)
  - Error-free handling of data overrun and underrun
  - Programmable write protect
  - Supports FM and MFM modes
  - Supports Enhanced mode command for three-mode Floppy Disk Drive (FDD)
  - Perpendicular recording drive support for 2.88 MBytes
  - Burst (16-byte FIFO) and Non-Burst modes
  - Full support for IBM Tape Drive Register (TDR) implementation of AT and PS/2 drive types
  - High-performance digital separator
  - Supports fast tape drives (2 Mbps) and standard tape drives (1 Mbps, 500 Kbps and 250 Kbps)
- Keyboard and Mouse Controller (KBC)
  - 8-bit microcontroller, software compatible with 8042AH and PC87911
  - Standard interface (60h, 64h, IRQ1 and IRQ12)
  - Supports two external swapable PS/2 interfaces for keyboard and mouse
  - Programmable, dedicated quasi-bidirectional I/O lines (GA20/P21, $\overline{\text{KBRST}}$/P20)

## General-Purpose Modules

- General-Purpose I/O (GPIO) Ports
  - 13 GPIO ports powered by $V_{SB3}$
  - Each pin individually configured as input or output
  - Programmable features for each output pin:
    - Drive type (open-drain, push-pull or TRI-STATE®)
    - TRI-STATE on detection of falling $V_{DD3}$ for $V_{SB3}$-powered pins driving $V_{DD}$-supplied devices
  - Programmable option for internal pull-up resistor on each input pin
  - Lock option for the configuration and data of each output pin
  - 12 GPIO ports generate IRQ/$\overline{\text{SIOPME}}$ for wake-up events; each GPIO has separate:
    - Enable control of event status routing to IRQ
    - Enable control of event status routing to $\overline{\text{SIOPME}}$
    - Polarity and edge/level selection
    - Programmable debouncing
- Glue Functions
  - Software selectable alternative functionality, through pin multiplexing
  - Generates the power-related signals:
    - Main Power good
    - Power distribution control (for switching between Main and Standby regulators)
    - Resume reset (Master Reset) according to the 5V standby supply status
    - Main power supply turn on ($\overline{\text{PS_ON}}$)
    - Rambus SCK clock gating
  - Voltage translation between 3.3V levels (DDC) and 5V levels (VGA) for the SMBus serial clock and data signals
  - Isolation circuitry for the SMBus serial clock and data signals
  - Buffers $\overline{\text{PCI_RESET}}$ to generate three reset output signals

## Features (Continued)

- — Generates “highest active supply” reference voltage
  - ❑ Based on 3.3V and 5V Main supplies
  - ❑ Based on 3.3V and 5V Standby supplies
- — High-current LED driver control for Hard Disk Drive activity indication
- — CNR downstream codec, dynamic control

■ Fan Speed Monitor (FSM)
- — Supports tachometers with one or two pulses per revolution
- — Speed monitoring for two fans, including:
  - ❑ Digital filtering of the tachometer input signal
  - ❑ 16-bit fan speed data
  - ❑ Alarm for fan speed slower than programed threshold
  - ❑ Alarm for fan stopped

### Power Management

■ Supports *ACPI Specification Revision 2.0b, July 27, 2000*

■ System Wake-Up Control (SWC)
- — Optional routing of events to generate SCI ($\overline{\text{SIOPME}}$) on detection of:
  - ❑ Keyboard or Mouse events
  - ❑ Ring Indication $\overline{\text{RI}}$ on the serial port
  - ❑ General-Purpose Input Events from the 12 GPIO pins
  - ❑ IRQs of the Keyboard and Mouse Controller
  - ❑ IRQs of the other internal modules
- — Optional routing of the SCI ($\overline{\text{SIOPME}}$) to generate IRQ (SERIRQ)
- — Implements the GPE1_BLK of the ACPI General Purpose (Generic) Register blocks with “child” events
- — $V_{SB3}$-powered event detection and event-logic configuration

■ Enhanced Power Management (PM), including:
- — Special configuration registers for power down
- — Low-leakage pins
- — Low-power CMOS technology
- — Ability to disable all modules
- — High-current LED drivers control (two LEDs) for power status indication with:
  - ❑ Standard blinking, controlled by software
  - ❑ Advanced blinking, controlled by power supply status, sleep state or software

■ Keyboard Events
- — Wake-up on any key
- — Supports programmable 8-byte sequence “Password” or “Special Keys” for Power Management
- — Simultaneous recognition of three programmable keys (sequences): “Power”, “Sleep” and “Resume”
- — Wake-up on mouse movement and/or button click

### Clocking, Supply, and Package Information

■ Clocks
- — LPC (PCI) clock input (up to 33 MHz)
- — Low-frequency 32.768 KHz clock input, active also in S3-S5 (when $V_{DD3}$ is off), for:
  - ❑ System Wake-Up Control (SWC) wake-up timing
  - ❑ LED blink timing
  - ❑ Glue Functions timing
- — On-chip Clock Generator:
  - ❑ Generates 48 MHz for the SuperI/O modules and FSM
  - ❑ Based on the 14.31818 MHz clock input
  - ❑ $V_{DD3}$ powered

■ Protection
- — All device pins are 5V tolerant and back-drive protected (except LPC bus pins
- — High ESD protection of all the device pins
- — Pin multiplexing selection lock
- — Configuration register lock

■ Testability
- — XOR tree structure
  - ❑ Includes all the device pins (except the supply and the analog pins)
  - ❑ Selected at power-up by strap input ($\overline{\text{TEST}}$)
- — TRI-STATE device pins, selected at power-up by strap input ($\overline{\text{TRIS}}$)

■ Power Supply
- — 3.3V supply operation
- — Separate pin pairs for main ($V_{DD3}$) and standby ($V_{SB3}$) power supplies
- — Low standby power consumption

■ Package
- — 128-pin PQFP

# Datasheet Revision Record

| Revision Date | Status | Comments |
|---|---|---|
| January 2002 | Preliminary Datasheet | First issue - Rev 1.0 |
| May 2002 | Datasheet | Second issue - Rev 1.1 |
| October 2002 | Datasheet | Third issue - Rev 1.2 |

# Table of Contents


## 1.0 Signal/Pin Connection and Description

1.1 CONNECTION DIAGRAMS ..... 11
1.2 BUFFER TYPES AND SIGNAL/PIN DIRECTORY ..... 12
1.3 PIN MULTIPLEXING ..... 13
1.4 DETAILED SIGNAL/PIN DESCRIPTIONS ..... 14
1.4.1 LPC Interface ..... 14
1.4.2 Serial Port (UART) ..... 15
1.4.3 Parallel Port ..... 16
1.4.4 Floppy Disk Controller (FDC) ..... 17
1.4.5 Keyboard and Mouse Controller (KBC) ..... 18
1.4.6 General-Purpose I/O (GPIO) ..... 18
1.4.7 Fan Speed Monitor (FSM) ..... 18
1.4.8 System Wake-Up Control (SWC) ..... 19
1.4.9 Clocks ..... 19
1.4.10 Glue Functions ..... 20
1.4.11 Configuration Straps and Testing ..... 21
1.4.12 Power and Ground ..... 22
1.5 INTERNAL PULL-UP AND PULL-DOWN RESISTORS ..... 22

## 2.0 Power, Reset and Clocks

2.1 POWER ..... 24
2.1.1 Power Planes ..... 24
2.1.2 Power States ..... 24
2.1.3 Power Connection and Layout Guidelines ..... 25
2.2 RESET SOURCES AND TYPES ..... 26
2.2.1 VSB Power-Up Reset ..... 26
2.2.2 VDD Power-Up Reset ..... 27
2.2.3 Hardware Reset ..... 27
2.2.4 Software Reset ..... 27
2.3 CLOCK DOMAINS ..... 27
2.3.1 LPC Domain ..... 27
2.3.2 48 MHz Domain ..... 28
2.3.3 32 KHz Domain ..... 28
2.4 TESTABILITY SUPPORT ..... 28
2.4.1 ICT ..... 28
2.4.2 XOR Tree Testing ..... 29

## 3.0 Device Architecture and Configuration

3.1 OVERVIEW ..... 30
3.2 CONFIGURATION STRUCTURE AND ACCESS ..... 30
3.2.1 The Index-Data Register Pair ..... 30
3.2.2 Banked Logical Device Registers Structure ..... 31
3.2.3 Standard Configuration Register Definitions ..... 32
3.2.4 Standard Configuration Registers ..... 34
3.2.5 Default Configuration Setup ..... 35

## Table of Contents (Continued)


3.3 MODULE CONTROL ..... 36
3.3.1 Module Enable/Disable ..... 36
3.3.2 Floating Module Output ..... 37
3.4 INTERNAL ADDRESS DECODING ..... 37
3.5 PROTECTION ..... 38
3.5.1 Multiplexed Pins Configuration Lock ..... 38
3.5.2 GPIO Ports Configuration Lock ..... 38
3.5.3 Fast Disable Configuration Lock ..... 38
3.5.4 Clock Control Lock ..... 38
3.5.5 GPIO Ports Lock ..... 38
3.5.6 Fan Speed Configuration Lock ..... 38
3.5.7 SWC Configuration Lock ..... 38
3.6 REGISTER TYPE ABBREVIATIONS ..... 39
3.7 PC87372 CONFIGURATION REGISTERS ..... 39
3.7.1 SuperI/O ID Register (SID) ..... 39
3.7.2 SuperI/O Configuration 1 Register (SIOCF1) ..... 40
3.7.3 SuperI/O Configuration 2 Register (SIOCF2) ..... 41
3.7.4 SuperI/O Configuration 6 Register (SIOCF6) ..... 41
3.7.5 SuperI/O Revision ID Register (SRID) ..... 42
3.7.6 Clock Generator Control Register (CLOCKCF) ..... 42
3.8 FLOPPY DISK CONTROLLER (FDC) CONFIGURATION ..... 44
3.8.1 General Description ..... 44
3.8.2 Logical Device 0 (FDC) Configuration ..... 44
3.8.3 FDC Configuration Register ..... 45
3.8.4 Drive ID Register ..... 46
3.9 PARALLEL PORT (PP) CONFIGURATION ..... 47
3.9.1 General Description ..... 47
3.9.2 Logical Device 1 (PP) Configuration ..... 47
3.9.3 Parallel Port Standard Configuration Register ..... 48
3.9.4 Parallel Port Modified Configuration Register ..... 49
3.10 SERIAL PORT CONFIGURATION ..... 50
3.10.1 General Description ..... 50
3.10.2 Logical Device 3 (SP) Configuration ..... 50
3.10.3 Serial Port Configuration Register ..... 51
3.11 SYSTEM WAKE-UP CONTROL (SWC) CONFIGURATION ..... 52
3.11.1 General Description ..... 52
3.11.2 Logical Device 4 (SWC) Configuration ..... 52
3.12 KEYBOARD AND MOUSE CONTROLLER (KBC) CONFIGURATION ..... 53
3.12.1 General Description ..... 53
3.12.2 Logical Devices 5 and 6 (Mouse and Keyboard) Configuration ..... 53
3.12.3 KBC Configuration Register ..... 54
3.13 GENERAL-PURPOSE INPUT/OUTPUT (GPIO) PORTS CONFIGURATION ..... 55
3.13.1 General Description ..... 55
3.13.2 Logical Device 7 (GPIO) Configuration ..... 56
3.13.3 GPIO Pin Select Register (GPSEL) ..... 57

## Table of Contents (Continued)


3.13.4 GPIO Pin Configuration Register 1 (GPCFG1) ..... 57
3.13.5 GPIO Event Routing Register (GPEVR) ..... 58
3.13.6 GPIO Pin Configuration Register 2 (GPCFG2) ..... 59
3.13.7 GPIO Mode Select Register (GPMODE) ..... 59
3.14 FAN SPEED MONITOR (FSM) CONFIGURATION ..... 60
3.14.1 General Description ..... 60
3.14.2 Logical Device 9 (FSM) Configuration ..... 60
3.14.3 Fan Speed Monitor Configuration Register (FSMCF) ..... 61

**4.0 LPC Bus Interface**

4.1 OVERVIEW ..... 62
4.2 LPC TRANSACTIONS ..... 62
4.3 $\overline{\text{LPCPD}}$ FUNCTIONALITY ..... 62
4.4 INTERRUPT SERIALIZER ..... 62

**5.0 General-Purpose Input/Output (GPIO) Ports**

5.1 OVERVIEW ..... 63
5.2 BASIC FUNCTIONALITY ..... 64
5.2.1 Configuration Options ..... 64
5.2.2 Operation ..... 65
5.3 EVENT HANDLING AND SYSTEM NOTIFICATION ..... 65
5.3.1 Event Configuration ..... 65
5.3.2 System Notification ..... 66
5.4 GPIO PORT REGISTERS ..... 67
5.4.1 GPIO Pin Configuration Registers Structure ..... 67
5.4.2 GPIO Port Runtime Register Map ..... 67
5.4.3 GPIO Data Out Register (GPDO) ..... 68
5.4.4 GPIO Data In Register (GPDI) ..... 68
5.4.5 GPIO Event Enable Register (GPEVEN) ..... 69
5.4.6 GPIO Event Status Register (GPEVST) ..... 69
5.4.7 GPIO Data In/Out Register (GPDIO) ..... 69

**6.0 System Wake-Up Control (SWC)**

6.1 OVERVIEW ..... 70
6.2 FUNCTIONAL DESCRIPTION ..... 71
6.2.1 External Events ..... 71
6.2.2 Internal Events ..... 74
6.2.3 Sleep States ..... 74
6.2.4 SCI and IRQ Interrupts ..... 74
6.2.5 LED Control ..... 75
6.3 SWC REGISTERS ..... 77
6.3.1 SWC Register Map ..... 77
6.3.2 Standard LED Control Register (SLEDCTL) ..... 78
6.3.3 SWC Miscellaneous Control Register (SWC_CTL) ..... 79
6.3.4 Advanced LED Control Register (ALEDCTL) ..... 80
6.3.5 LED Blink Control Register (LEDBLNK) ..... 81

## Table of Contents (Continued)


6.3.6 Keyboard Wake-Up Control Register (KBDWKCTL) ..... 82
6.3.7 PS2 Protocol Control Register (PS2CTL) ..... 83
6.3.8 Keyboard Data Shift Register (KDSR) ..... 84
6.3.9 Mouse Data Shift Register (MDSR) ..... 84
6.3.10 PS2 Keyboard Key Data 0 to 7 Registers (PS2KEY0-7) ..... 84
6.4 ACPI REGISTERS ..... 85
6.4.1 ACPI Register Map ..... 85
6.4.2 General-Purpose Status 1 Register (GPE1_STS) ..... 86
6.4.3 General-Purpose Enable 1 Register (GPE1_EN) ..... 86
6.4.4 General-Purpose Status 1 Register 0 (GPE1_STS_0) ..... 87
6.4.5 General-Purpose Status 1 Register 1 (GPE1_STS_1) ..... 87
6.4.6 General-Purpose Status 1 Register 2 (GPE1_STS_2) ..... 88
6.4.7 General-Purpose Status 1 Register 3 (GPE1_STS_3) ..... 89
6.4.8 General-Purpose Enable 1 Register 0 (GPE1_EN_0) ..... 90
6.4.9 General-Purpose Enable 1 Register 1 (GPE1_EN_1) ..... 90
6.4.10 General-Purpose Enable 1 Register 2 (GPE1_EN_2) ..... 91
6.4.11 General-Purpose Enable 1 Register 3 (GPE1_EN_3) ..... 92
6.5 SYSTEM WAKE-UP CONTROL REGISTER BITMAP ..... 93

**7.0 Fan Speed Monitor**

7.1 OVERVIEW ..... 95
7.2 FUNCTIONAL DESCRIPTION ..... 95
7.3 FAN SPEED MONITOR REGISTERS ..... 97
7.3.1 Fan Speed Monitor Register Map ..... 97
7.3.2 Fan Speed Monitor Threshold Low Register (FMTHRL) ..... 97
7.3.3 Fan Speed Monitor Threshold High Register (FMTHRH) ..... 98
7.3.4 Fan Speed Monitor Speed Low Register (FMSPRL) ..... 98
7.3.5 Fan Speed Monitor Speed High Register (FMSPRH) ..... 99
7.3.6 Fan Speed Monitor Control and Status Register (FMCSR) ..... 99
7.4 FAN SPEED MONITOR REGISTER BITMAP ..... 100

**8.0 Glue Functions**

8.1 OVERVIEW ..... 101
8.2 FUNCTIONAL DESCRIPTION ..... 101
8.2.1 Highest Active Main Supply Reference ..... 101
8.2.2 Highest Active Standby Supply Reference ..... 103
8.2.3 Resume Reset ..... 105
8.2.4 Main Power Good ..... 106
8.2.5 Rambus SCK Clock Gate Control ..... 106
8.2.6 Power Distribution Control ..... 107
8.2.7 Main Power Supply Control ..... 107
8.2.8 CNR Downstream Codec Dynamic Control ..... 108
8.2.9 Hard-Disk LED Indicator Control ..... 108
8.2.10 SMBus Voltage Translation ..... 108
8.2.11 SMBus Isolation ..... 109

## Table of Contents (Continued)


**9.0 Legacy Functional Blocks**

9.1 FLOPPY DISK CONTROLLER (FDC) ..... 110
9.1.1 General Description ..... 110
9.1.2 FDC Bitmap Summary ..... 111
9.2 PARALLEL PORT ..... 112
9.2.1 General Description ..... 112
9.2.2 Parallel Port Register Map ..... 112
9.2.3 Parallel Port Bitmap Summary ..... 113
9.3 UART FUNCTIONALITY (SERIAL PORT) ..... 115
9.3.1 General Description ..... 115
9.3.2 UART Register Bank Overview ..... 115
9.3.3 SP Register Maps ..... 115
9.3.4 SP Bitmap Summary ..... 117
9.4 KEYBOARD AND MOUSE CONTROLLER (KBC) ..... 119
9.4.1 General Description ..... 119
9.4.2 KBC Register Map ..... 120
9.4.3 KBC Bitmap Summary ..... 120

**10.0 Device Characteristics**

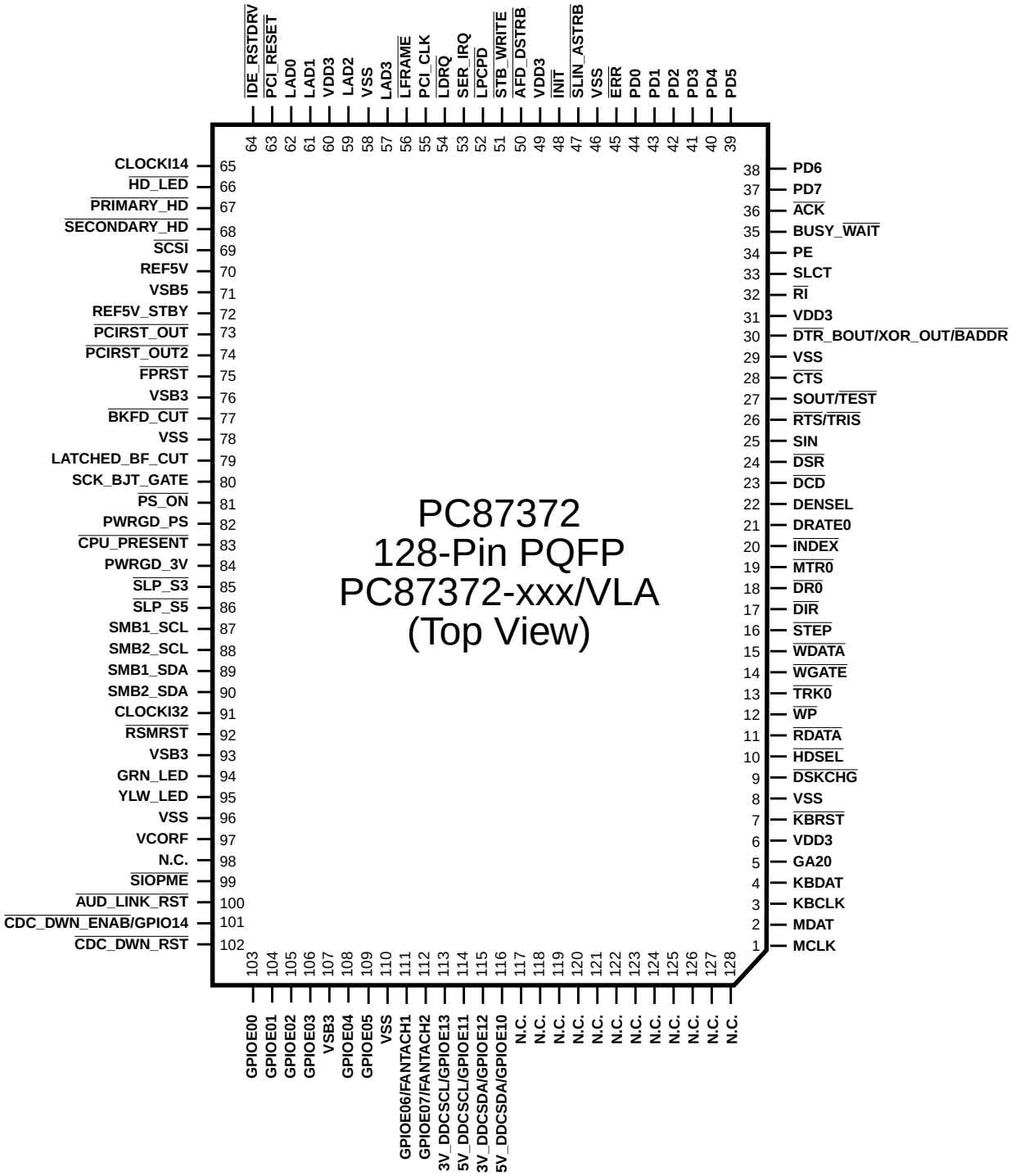
10.1 GENERAL DC ELECTRICAL CHARACTERISTICS ..... 121
10.1.1 Recommended Operating Conditions ..... 121
10.1.2 Absolute Maximum Ratings ..... 121
10.1.3 Capacitance ..... 121
10.1.4 Power Consumption under Recommended Operating Conditions ..... 122
10.1.5 Voltage Thresholds ..... 122
10.2 DC CHARACTERISTICS OF PINS, BY I/O BUFFER TYPES ..... 123
10.2.1 Input, TTL Compatible ..... 123
10.2.2 Input, TTL Compatible, with Schmitt Trigger ..... 123
10.2.3 Input, TTL Compatible, with 400 mV Schmitt Trigger ..... 123
10.2.4 Input, PCI 3.3V Compatible ..... 124
10.2.5 Analog Input ..... 124
10.2.6 Output, TTL/CMOS Compatible, Push-Pull Buffer ..... 124
10.2.7 Output, TTL/CMOS Compatible, Open-Drain Buffer ..... 124
10.2.8 Output, PCI 3.3V Compatible ..... 125
10.2.9 Analog Output ..... 125
10.2.10 Input/Output Switch, SMBus Compatible ..... 125
10.2.11 Exceptions ..... 125
10.2.12 Terminology ..... 126
10.3 INTERNAL RESISTORS ..... 127
10.3.1 Pull-Up Resistor ..... 127
10.3.2 Pull-Down Resistor ..... 127
10.4 AC ELECTRICAL CHARACTERISTICS ..... 128
10.4.1 AC Test Conditions ..... 128
10.4.2 Reset Timing ..... 129
10.4.3 Clock Timing ..... 131

## Table of Contents (Continued)

10.4.4 LPC Interface Timing ..... 133
10.4.5 FDC Timing ..... 135
10.4.6 Parallel Port Timing ..... 137
10.4.7 Serial Port Timing ..... 139
10.4.8 Glue Function Timing ..... 140
10.4.9 SWC Timing ..... 143

# 1.0 Signal/Pin Connection and Description

## 1.1 CONNECTION DIAGRAMS




**Plastic Quad Flatpack (PQFP), JEDEC**
**Order Number PC87372-xxx/VLA**
**See NS Package Number VLA128A**

N.C. = Not Connected
xxx = Three-character identifier for National data, and keyboard ROM and/or customer identification code

# 1.0 Signal/Pin Connection and Description (Continued)

## 1.2 BUFFER TYPES AND SIGNAL/PIN DIRECTORY

The signal DC characteristics of the pins described in Section 1.4 on page 14 are denoted by buffer type symbols, which are defined in Table 1 and described in further detail in Section 10.2 on page 123. The pin multiplexing information refers to two different types of multiplexing:

- Multiplexed, denoted by a slash (/) between pins in the diagrams in Section 1.1. Pins are shared between two different functions. Each function is associated with different board connectivity. Normally, the function selection is determined by the board design and cannot be changed dynamically. The multiplexing options must be configured by the BIOS on power-up in order to comply with the board implementation.
- Multiple Mode, denoted by an underscore (_) between pins in the diagrams in Section 1.1. Pins have two or more modes of operation within the same function. These modes are associated with the same external (board) connectivity. Mode selection may be controlled by the device driver through the registers of the functional block and do not require a special BIOS setup on power-up. These pins are not considered multiplexed pins from the PC87372 configuration perspective. The mode selection method (registers and bits), as well as the signal specification in each mode, are described within the functional description of the relevant functional block.

**Table 1. Buffer Types**

| Symbol | Description |
|---|---|
| $IN_T$ | Input, TTL compatible |
| $IN_{TS}$ | Input, TTL compatible, with Schmitt Trigger |
| $IN_{TS4}$ | Input, TTL compatible, with 400 mV Schmitt Trigger |
| $IN_{PCI}$ | Input, PCI 3.3V compatible |
| $IN_{ULR}$ | Input, power, resistor protected (not characterized) |
| AI | Input, analog (0-5.5V tolerant) |
| $O_{p/n}$ | Output, TTL/CMOS compatible, push-pull buffer capable of sourcing *p* mA and sinking *n* mA |
| $OD_n$ | Output, TTL/CMOS compatible, open-drain buffer capable of sinking *n* mA |
| $O_{PCI}$ | Output, PCI 3.3V compatible, |
| AO | Output, analog (0-5.5V tolerant) |
| $SW_{SM}$ | Input/Output switch, SMBus compatible |
| PWR | Power pin |
| GND | Ground pin |

# 1.0 Signal/Pin Connection and Description (Continued)

## 1.3 PIN MULTIPLEXING

Table 2 shows only multiplexed pins, their associated functional blocks and the configuration bits for the selection of the multiplexed options used in the PC87372.

**Table 2. Pin Multiplexing Configuration**

| Pin | Default Signal | Function Block | Alternate Signal | Function Block | Alternate Signal | Function Block | Configuration Select | Strap or Wake-Up | Function Block |
|---|---|---|---|---|---|---|---|---|---|
| 30 | $\overline{\text{DTR_BOUT1}}$ | Serial Port | XOR_OUT | Config | | | $\overline{\text{TEST}}$ (strap) | $\overline{\text{BADDR}}$ | Config (Straps) |
| 26 | $\overline{\text{RTS}}$ | | | | | | | $\overline{\text{TRIS}}$ | |
| 27 | SOUT | | | | | | | $\overline{\text{TEST}}$ | |
| 32 | $\overline{\text{RI}}$ | | | | | | | $\overline{\text{RI}}$ | SWC |
| 3 | KBCLK | KBC | | | | | | KBCLK | |
| 4 | KBDAT | | | | | | | KBDAT | |
| 1 | MCLK | | | | | | | MCLK | |
| 2 | MDAT | | | | | | | MDAT | |
| 103 | GPIOE00 | GPIO | | | | | | GPIOE00 | |
| 104 | GPIOE01 | | | | | | | GPIOE01 | |
| 105 | GPIOE02 | | | | | | | GPIOE02 | |
| 106 | GPIOE03 | | | | | | | GPIOE03 | |
| 108 | GPIOE04 | | | | | | | GPIOE04 | |
| 109 | GPIOE05 | | | | | | | GPIOE05 | |
| 111 | GPIOE06 | | FANTACH1 | FSM | | | SIOCF2.TACH1EN | GPIOE06 | |
| 112 | GPIOE07 | | FANTACH2 | | | | SIOCF2.TACH2EN | GPIOE07 | |
| 116 | 5V_DDCSDA | Glue Functions | GPIOE10 | GPIO | | | SIOCF2.GPIO03EN | GPIOE10 | |
| 114 | 5V_DDCSCL | | GPIOE11 | | | | | GPIOE11 | |
| 115 | 3V_DDCSDA | | GPIOE12 | | | | | GPIOE12 | |
| 113 | 3V_DDCSCL | | GPIOE13 | | | | | GPIOE13 | |
| 101 | $\overline{\text{CDC_DWN_ENAB}}$ | | GPIO14 | | | | Note[1] | | |

1. Both $\overline{\text{CDC_DWN_ENAB}}$ and GPIO14 are simultaneously available at the device pin.

# 1.0 Signal/Pin Connection and Description (Continued)

## 1.4 DETAILED SIGNAL/PIN DESCRIPTIONS

This section describes all signals of the PC87372 device. The signals are organized by functional group.

### 1.4.1 LPC Interface

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| LAD3-0 | 57,59 61,62 | I/O | $IN_{PCI}/O_{PCI}$ | $V_{DD3}$ | **LPC Address-Data.** Multiplexed command, address bi-directional data and cycle status. |
| PCI_CLK | 55 | I | $IN_{PCI}$ | $V_{DD3}$ | **LPC Clock.** PCI clock used for the LPC bus (up to 33 MHz). |
| $\overline{\text{LFRAME}}$ | 56 | I | $IN_{PCI}$ | $V_{DD3}$ | **LPC Frame.** Low pulse indicates the beginning of a new LPC cycle or termination of a broken cycle. |
| $\overline{\text{LDRQ}}$ | 54 | O | $O_{PCI}$ | $V_{DD3}$ | **LPC DMA Request.** Encoded DMA request for LPC interface. |
| $\overline{\text{PCI_RESET}}$ | 63 | I | $IN_{PCI}$ | $V_{DD3}$ | **LPC Reset.** PCI system reset used for the LPC bus (Hardware Reset). |
| SER_IRQ | 53 | I/O | $IN_{PCI}/O_{PCI}$ | $V_{DD3}$ | **Serial IRQ.** The interrupt requests are serialized over a single pin, where each IRQ level is delivered during a designated time slot. |
| $\overline{\text{LPCPD}}$ | 52 | I | $IN_{PCI}$ | $V_{DD3}$ | **Power Down.** Indicates that power to the LPC interface is about to be turned off. When $\overline{\text{LPCPD}}$ functionality is not required, an internal pull-up resistor allows this pin to be left floating. |
| $\overline{\text{PCIRST_OUT}}$ | 73 | O | $O_{14/14}$ | $V_{SB3}$ | **PCI Reset Output.** PCI system reset. $\overline{\text{PCIRST_OUT}}$ is a buffered copy of $\overline{\text{PCI_RESET}}$ when $V_{DD3}$ is on, and it is held at low level when $V_{DD3}$ is off. |
| $\overline{\text{PCIRST_OUT2}}$ | 74 | O | $O_{14/14}$ | $V_{SB3}$ | **PCI Reset Output 2.** PCI system reset (same behavior as $\overline{\text{PCIRST_OUT}}$ above). |
| $\overline{\text{IDE_RSTDRV}}$ | 64 | O | $OD_6$ | $V_{DD3}$ | **IDE Reset Output.** IDE drive reset. $\overline{\text{IDE_RSTDRV}}$ is a buffered copy of $\overline{\text{PCI_RESET}}$ when $V_{DD3}$ is on, and it is floating when $V_{DD3}$ is off. |

## 1.0 Signal/Pin Connection and Description (Continued)

### 1.4.2 Serial Port (UART)

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| $\overline{CTS}$ | 28 | I | $IN_{TS}$ | $V_{DD3}$ | **Clear to Send.** When low, indicates that the modem or other data transfer device is ready to exchange data. |
| $\overline{DCD}$ | 23 | I | $IN_{TS}$ | $V_{DD3}$ | **Data Carrier Detected.** When low, indicates that the modem or other data transfer device has detected the data carrier. |
| $\overline{DSR}$ | 24 | I | $IN_{TS}$ | $V_{DD3}$ | **Data Set Ready.** When low, indicates that the data transfer device, e.g., modem, is ready to establish a communications link. |
| $\overline{DTR}$_BOUT | 30 | O | $O_{3/6}$ | $V_{DD3}$ | **Data Terminal Ready.** When low, indicates to the modem or other data transfer device that the UART is ready to establish a communications link. After a system reset, these pins provide the $\overline{DTR}$ function and set these signals to inactive high. Loopback operation holds them inactive.<br>**Baud Output.** Provides the associated serial channel baud rate generator output signal if test mode is selected, i.e., bit 7 of EXCR1 register is set. |
| $\overline{RI}$ | 32 | I | $IN_{TS}$ | $V_{DD3}$ | **Ring Indicator.** When low, indicates that a telephone ring signal was received by the modem. These pins are monitored during $V_{DD}$ power-off for wake-up event detection. |
| $\overline{RTS}$ | 26 | O | $O_{3/6}$ | $V_{DD3}$ | **Request to Send.** When low, indicates to the modem or other data transfer device that the corresponding UART is ready to exchange data. A system reset sets these signals to inactive high, and loopback operation holds them inactive. |
| SIN | 25 | I | $IN_{TS}$ | $V_{DD3}$ | **Serial Input.** Receives composite serial data from the communications link (peripheral device, modem or other data transfer device). |
| SOUT | 27 | O | $O_{3/6}$ | $V_{DD3}$ | **Serial Output.** Sends composite serial data to the communications link (peripheral device, modem or other data transfer device). These signals are set active high after a system reset. |

# 1.0 Signal/Pin Connection and Description (Continued)

## 1.4.3 Parallel Port

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| $\overline{ACK}$ | 36 | I | $IN_T$ | $V_{DD3}$ | **Acknowledge.** Pulsed low by the printer to indicate that it has received data from the parallel port. |
| $\overline{AFD}$_DSTRB | 50 | O | $OD_{14}$, $O_{14/14}$ | $V_{DD3}$ | **$\overline{AFD}$ - Automatic Feed.** When low, instructs the printer to automatically feed a line after printing each line. This pin is in TRI-STATE after a 0 is loaded into the corresponding control register bit. An external 4.7 KΩ pull-up resistor must be connected to this pin.<br>**$\overline{DSTRB}$ - Data Strobe (EPP).** Active low; used in EPP mode to denote a data cycle. When the cycle is aborted, $\overline{DSTRB}$ becomes inactive (high). |
| BUSY_$\overline{WAIT}$ | 35 | I | $IN_T$ | $V_{DD3}$ | **Busy.** Set high by the printer when it cannot accept another character.<br>**Wait.** In EPP mode, the parallel port device uses this active low signal to extend its access cycle. |
| $\overline{ERR}$ | 45 | I | $IN_T$ | $V_{DD3}$ | **Error.** Set active low by the printer when it detects an error. |
| $\overline{INIT}$ | 48 | O | $OD_{14}$, $O_{14/14}$ | $V_{DD3}$ | **Initialize.** When low, initializes the printer. This signal is in TRI-STATE after a 1 is loaded into the corresponding control register bit. An external 4.7 KΩ pull-up resistor must be connected to this pin. |
| PD7-0 | 37-44 | I/O | $IN_T/O_{14/14}$ | $V_{DD3}$ | **Parallel Port Data.** Transfers data to and from the peripheral data bus and the appropriate parallel port data register. These signals have a high current drive capability. |
| PE | 34 | I | $IN_T$ | $V_{DD3}$ | **Paper End.** Set high by the printer when it is out of paper. This pin has an internal weak pull-up or pull-down resistor. |
| SLCT | 33 | I | $IN_T$ | $V_{DD3}$ | **Select.** Set active high by the printer when the printer is selected. |
| $\overline{SLIN}$_ASTRB | 47 | O | $OD_{14}$, $O_{14/14}$ | $V_{DD3}$ | **$\overline{SLIN}$ - Select Input.** When low, selects the printer. This signal is in TRI-STATE after a 0 is loaded into the corresponding control register bit. An external 4.7 KΩ pull-up resistor must be connected to this pin.<br>**$\overline{ASTRB}$ - Address Strobe (EPP).** Active low, used in EPP mode to denote an address or data cycle. When the cycle is aborted, $\overline{ASTRB}$ becomes inactive (high). |
| $\overline{STB}$_WRITE | 51 | O | $OD_{14}$, $O_{14/14}$ | $V_{DD3}$ | **$\overline{STB}$ - Data Strobe.** When low, Indicates to the printer that valid data is available at the printer port. This signal is in TRI-STATE after a 0 is loaded into the corresponding control register bit. An external 4.7 KΩ pull-up resistor must be connected to this pin.<br>**$\overline{WRITE}$ - Write Strobe.** Active low, used in EPP mode to denote an address or data cycle. When the cycle is aborted, $\overline{WRITE}$ becomes inactive (high). |

## 1.0 Signal/Pin Connection and Description (Continued)

### 1.4.4 Floppy Disk Controller (FDC)

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| DENSEL | 22 | O | $OD_{12}$, $O_{2/12}$ | $V_{DD3}$ | **Density Select.** Indicates that a high FDC density data rate (500 Kbps, 1 Mbps or 2 Mbps) or a low density data rate (250 or 300 Kbps) is selected. |
| $\overline{DIR}$ | 17 | O | $OD_{12}$, $O_{2/12}$ | $V_{DD3}$ | **Direction.** Determines the direction of the Floppy Disk Drive (FDD) head movement (active = step in; inactive = step out) during a seek operation. |
| $\overline{DR0}$ | 18 | O | $OD_{12}$, $O_{2/12}$ | $V_{DD3}$ | **Drive Select.** Active low signal controlled by bit 0 of the Digital Output Register (DOR). |
| DRATE0 | 21 | O | $OD_{12}$, $O_{2/12}$ | $V_{DD3}$ | **Data Rate.** Reflects the value of bit 0 of either Configuration Control Register (CCR) or Data Rate Select Register (DSR), whichever was written to last. |
| $\overline{DSKCHG}$ | 9 | I | $IN_{TS}$ | $V_{DD3}$ | **Disk Change.** Indicates that the drive door was opened. |
| $\overline{HDSEL}$ | 10 | O | $OD_{12}$, $O_{2/12}$ | $V_{DD3}$ | **Head Select.** Selects which side of the FDD is accessed. Active (low) selects side 1; inactive selects side 0. |
| $\overline{INDEX}$ | 20 | I | $IN_{TS}$ | $V_{DD3}$ | **Index.** Indicates the beginning of an FDD track. |
| $\overline{MTR0}$ | 19 | O | $OD_{12}$, $O_{2/12}$ | $V_{DD3}$ | **Motor Select.** Active low motor enable signal for drive 0, controlled by bit D4 of the Digital Output Register (DOR). |
| $\overline{RDATA}$ | 11 | I | $IN_{TS}$ | $V_{DD3}$ | **Read Data.** Raw serial input data stream read from the FDD. |
| $\overline{STEP}$ | 16 | O | $OD_{12}$, $O_{2/12}$ | $V_{DD3}$ | **Step.** Issues pulses to the disk drive at a software programmable rate to move the head during a seek operation. |
| $\overline{TRK0}$ | 13 | I | $IN_{TS}$ | $V_{DD3}$ | **Track 0.** Indicates to the controller that the head of the selected floppy disk drive is at track 0. |
| $\overline{WDATA}$ | 15 | O | $OD_{12}$, $O_{2/12}$ | $V_{DD3}$ | **Write Data.** Carries out the pre-compensated serial data that is written to the FDD. Pre-compensation is software selectable. |
| $\overline{WGATE}$ | 14 | O | $OD_{12}$, $O_{2/12}$ | $V_{DD3}$ | **Write Gate.** Enables the write circuitry of the selected FDD. $\overline{WGATE}$ is designed to prevent glitches during power-up and power-down. This prevents writing to the disk when power is cycled. |
| $\overline{WP}$ | 12 | I | $IN_{TS}$ | $V_{DD3}$ | **Write Protected.** Indicates that the disk in the selected drive is write protected. |

# 1.0 Signal/Pin Connection and Description (Continued)

### 1.4.5 Keyboard and Mouse Controller (KBC)

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| KBCLK | 3 | I/O | $IN_{TS}/OD_{14}$ | $V_{DD3}$ | **Keyboard Clock.** Keyboard clock signal. External pull-up resistor is required for PS/2 compliance. This pin is monitored during $V_{DD3}$ power-off for wake-up event detection. |
| KBDAT | 4 | I/O | $IN_{TS}/OD_{14}$ | $V_{DD3}$ | **Keyboard Data.** Keyboard data signal. External pull-up resistor is required for PS/2 compliance. This pin is monitored during $V_{DD3}$ power-off for wake-up event detection. |
| MCLK | 1 | I/O | $IN_{TS}/OD_{14}$ | $V_{DD3}$ | **Mouse Clock.** Mouse clock signal. External pull-up resistor is required for PS/2 compliance. This pin is monitored during $V_{DD3}$ power-off for wake-up event detection. |
| MDAT | 2 | I/O | $IN_{TS}/OD_{14}$ | $V_{DD3}$ | **Mouse Data.** Mouse data signal. External pull-up resistor is required for PS/2 compliance. This pin is monitored during $V_{DD3}$ power-off for wake-up event detection. |
| $\overline{KBRST}$ | 7 | I/O | $IN_T/OD_8$, $O_{4/8}$ | $V_{DD3}$ | **KBD Reset.** Keyboard reset (P20) quasi-bidirectional output. |
| GA20 | 5 | I/O | $IN_T/OD_8$, $O_{4/8}$ | $V_{DD3}$ | **Gate A20.** KBC gate A20 (P21) quasi-bidirectional output. |

### 1.4.6 General-Purpose I/O (GPIO)

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| GPIOE00-07<br>GPIOE10-13 | 103-106, 108-109, 111-112<br>116, 114, 115, 113 | I/O | $IN_{TS}$/ $OD_8$, $O_{4/8}$ | $V_{SB3}$ | **General-Purpose I/O Ports.** Each pin is configured independently as input or I/O, with or without static pull-up and with either open-drain or push-pull output type. These pins have event detection capability to generate a wake-up event or an interrupt. |
| GPIO14 | 101 | I/O | $IN_{TS}$/ $OD_{12}$, $O_{2/12}$ | | **General-Purpose I/O Port.** This pin is configured independently as input or I/O with or without static pull-up and with either open-drain or push-pull output type. |

### 1.4.7 Fan Speed Monitor (FSM)

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| FANTACH1<br>FANTACH2 | 111,<br>112 | I | $IN_{TS}$ | $V_{DD3}$ | **Fan Tachometer Inputs.** Input to the Fan Speed Monitor for the fan tachometer pulse. The rising edge indicates the completion of either a half or full fan revolution. |

## 1.0 Signal/Pin Connection and Description (Continued)

### 1.4.8 System Wake-Up Control (SWC)

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| GPIOE00-07, GPIOE10-13 | 103-106, 108-109, 111-116 | I | $IN_{TS}$ | $V_{SB3}$ | **Wake-Up Inputs.** Generates a wake-up event. These pins have programmable debouncing. When GPIOE functionality of a pin is not required, the internal pull-up resistor must be enabled to allow the pin to be left floating. |
| $\overline{RI}$ | 32 | I | $IN_{TS}$ | $V_{SB3}$ | **Ring Indicator Wake-Up.** When low, generates a wake-up event, indicating that a telephone ring signal was received by the modem. |
| KBCLK | 3 | I | $IN_{TS}$ | $V_{SB3}$ | **Keyboard Clock Wake-Up.** Generates a wake-up event, when a specific keyboard sequence is detected. |
| KBDAT | 4 | I | $IN_{TS}$ | $V_{SB3}$ | **Keyboard Data Wake-Up.** Generates a wake-up event, when a specific keyboard sequence is detected. |
| MCLK | 1 | I | $IN_{TS}$ | $V_{SB3}$ | **Mouse Clock Wake-Up.** Generates a wake-up event, when a specific mouse action is detected. |
| MDAT | 2 | I | $IN_{TS}$ | $V_{SB3}$ | **Mouse Data Wake-Up.** Generates a wake-up event, when a specific mouse action is detected. |
| $\overline{SIOPME}$ | 99 | O | $OD_6$, $O_{3/6}$ | $V_{SB3}$ | **Power Management Event (SCI).** Active level indicates that a wake-up event occurred, causing the system to exit its current sleep state. This signal has programmable polarity (default is active low). |
| $\overline{SLP_S3}$, $\overline{SLP_S5}$ | 85<br>86 | I | $IN_{TS4}$ | $V_{SB3}$ | **Sleep States 3 to 5.** Active (low) level indicates the system is in one of the sleep states S3 or S5. These signals are generated by an external ACPI controller.<br>**Pins**<br>**$\overline{SLPS3}$ $\overline{SLPS5}$ Functionality**<br>1 1: Working state (S0) or Sleep states S1 or S2<br>0 1: Sleep state S3<br>0 0: Sleep state S5<br>1 0: Illegal combination |
| YLW_LED, GRN_LED | 95, 94 | O | $OD_{24}$ | $V_{SB3}$ | **Power LEDs.** Yellow and green LED drivers. Each indicates the Main power status or blinks under software control. |

### 1.4.9 Clocks

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| CLOCKI32 | 91 | I | $IN_{TS}$ | $V_{SB3}$ | **Low-Frequency Clock Input.** 32.768 KHz clock for the SWC and Glue Functions timing. |
| CLOCKI14 | 65 | I | $IN_{TS}$ | $V_{DD3}$ | **High-Frequency Clock Input.** 14.31818 MHz clock for the on-chip, 48 MHz Clock Generator (for the Legacy modules and FSM). |

# 1.0 Signal/Pin Connection and Description (Continued)

## 1.4.10 Glue Functions

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| REF5V | 70 | O | AO | $V_{SB3}$ | **Main Highest Active Supply, Reference Output.** Reference voltage equal to the highest voltage between $V_{DD5}$ and $V_{DD3}$. External pull-up resistor to $V_{DD5}$ is required. |
| REF5V_STBY | 72 | O | AO | $V_{SB3}$ | **Standby Highest Active Supply, Reference Output.** Reference voltage equal to the highest voltage between $V_{SB5}$ and $V_{SB3}$. External pull-up resistor to $V_{SB5}$ is required. |
| $\overline{\text{PS_ON}}$ | 81 | O | $OD_6$ | $V_{SB3}$ | **Main Power Supply On/Off Control.** Active (low) level turns the main power supply ($V_{DD}$) on. External pull-up resistor to $V_{SB5}$ is required. |
| PWRGD_PS | 82 | I | $IN_{TS4}$ | $V_{SB3}$ | **Power Good Signal from the Power Supply.** Active level indicates the Main power supply voltage is valid. |
| PWRGD_3V | 84 | O | $O_{3/6}$ | $V_{SB3}$ | **Power Good Output.** Active level indicates the Main supply voltage is valid and the reset button is not pressed. |
| $\overline{\text{CPU_PRESENT}}$ | 83 | I | $IN_{TS4}$ | $V_{SB3}$ | **CPU Present.** Active (low) level indicates a processor is currently plugged in. |
| $\overline{\text{BKFD_CUT}}$ | 77 | O | $OD_6$ | $V_{SB3}$ | **Backfeed-Cut Control.** Power distribution control (when switching between main and standby regulators) for system transition into and out of the S3 sleep state. External pull-up resistor to $V_{DD5}$ is required. |
| LATCHED_BF_ CUT | 79 | O | $O_{14/14}$ | $V_{SB3}$ | **Latched Backfeed-Cut.** Power distribution control (when switching between main and standby regulators) for system transition into and out of the S5 sleep state. |
| $\overline{\text{FPRST}}$ | 75 | I | $IN_{TS4}$ | $V_{SB3}$ | **Front Panel Reset.** Active (low) level indicates that the reset button on the front panel is pressed. |
| $V_{SB5}$ | 71 | I | AI | $V_{SB3}$ | **Standby 5V Power Supply.** Used for Resume Reset generation (Range: 0-5.5V, Backdrive protected). |
| $\overline{\text{RSMRST}}$ | 92 | O | $O_{3/6}$ | $V_{SB3}$ | **Resume Reset.** Power-Up reset signal based on the $V_{SB5}$ supply voltage. |
| SCK_BJT_GATE | 80 | O | $OD_6$ | $V_{SB3}$ | **Rambus SCK Clock Gate Control.** Gates an external circuit that disables the SCK clock to the Rambus socket when the Main supply voltage is invalid. External pull-up resistor to $V_{SB5}$ is required. |
| $\overline{\text{PRIMARY_HD}}$ | 67 | I | $IN_{TS4}$ | $V_{DD3}$ | **Primary Drive.** Active (low) level indicates that the primary IDE drive is active. |
| $\overline{\text{SECONDARY_HD}}$ | 68 | I | $IN_{TS4}$ | $V_{DD3}$ | **Secondary Drive.** Active (low) level indicates that the secondary IDE drive is active. |
| $\overline{\text{SCSI}}$ | 69 | I | $IN_{TS4}$ | $V_{DD3}$ | **SCSI Drive.** Active (low) level indicates that the SCSI drive is active. |
| $\overline{\text{HD_LED}}$ | 66 | O | $OD_{12}$ | $V_{DD3}$ | **Hard Drive LED.** Red LED driver. When low, indicates that at least one drive is active. |
| $\overline{\text{AUD_LINK_RST}}$ | 100 | I | $IN_T$ | $V_{SB3}$ | **Audio Link Reset.** Controls the downstream codec. |
| $\overline{\text{CDC_DWN_ENAB}}$ | 101 | I | $IN_T$ | $V_{SB3}$ | **Downstream Codec Enable.** Controls the downstream codec. The GPIO14 signal is also connected to this pin, allowing the software to control both this input and external input pins connected to it. |
| $\overline{\text{CDC_DWN_RST}}$ | 102 | O | $O_{2/12}$ | $V_{SB3}$ | **Downstream Codec Reset.** Enables the audio CNR Board. |

## 1.0 Signal/Pin Connection and Description (Continued)

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| 3V_DDCSCL | 113 | I/O | $SW_{SM}$ | $V_{SB3}$ | **3.3V Level DDC Serial Clock.** SMBus serial clock signal with 3.3V logic levels for Data Display Channel interface. External pull-up resistor to $V_{DD3}$ is required. |
| 5V_DDCSCL | 114 | I/O | $SW_{SM}$ | $V_{SB3}$ | **5V Level DDC Serial Clock.** SMBus serial clock signal with 5V logic levels for VGA monitor interface. External pull-up resistor to $V_{DD5}$ is required. |
| 3V_DDCSDA | 115 | I/O | $SW_{SM}$ | $V_{SB3}$ | **3.3V Level DDC Serial Data.** SMBus serial data signal with 3.3V logic levels for Data Display Channel interface. External pull-up resistor to $V_{DD3}$ is required. |
| 5V_DDCSDA | 116 | I/O | $SW_{SM}$ | $V_{SB3}$ | **5V Level DDC Serial Data.** SMBus serial data signal with 5V logic levels for VGA monitor interface. External pull-up resistor to $V_{DD5}$ is required. |
| SMB1_SCL | 87 | I/O | $SW_{SM}$ | $V_{SB3}$ | **Bus 1 Serial Clock.** Serial clock signal of SMBus 1 (3.3V logic levels). External pull-up resistor to the 3.3V supply is required. |
| SMB2_SCL | 88 | I/O | $SW_{SM}$ | $V_{SB3}$ | **Bus 2 Serial Clock.** Serial clock signal of SMBus 2 (3.3V logic levels). External pull-up resistor to the 3.3V supply is required. |
| SMB1_SDA | 89 | I/O | $SW_{SM}$ | $V_{SB3}$ | **Bus 1 Serial Data.** Serial data signal of SMBus 1 (3.3V logic levels). External pull-up resistor to the 3.3V supply is required. |
| SMB2_SDA | 90 | I/O | $SW_{SM}$ | $V_{SB3}$ | **Bus 2 Serial Data.** Serial data signal of SMBus 2 (3.3V logic levels). External pull-up resistor to the 3.3V supply is required. |

### 1.4.11 Configuration Straps and Testing

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| $\overline{BADDR}$ | 30 | I | $IN_{TS}$ | $V_{DD3}$ | **Base Address.** Sampled at $V_{DD}$ Power-Up reset to determine the base address of the configuration Index-Data register pair, as follows:<br>– No pull-down resistor (default) - 2Eh-2Fh<br>– 10 K$\Omega$[1] external pull-down resistor - 4Eh-4Fh<br>The external pull-down resistor must be connected to $V_{SS}$. |
| $\overline{TRIS}$ | 26 | I | $IN_{TS}$ | $V_{DD3}$ | **TRI-STATE Device.** Sampled at $V_{DD}$ Power-Up reset to force the device to float all its output and I/O pins.<br>No pull-down resistor (default) - normal pin operation<br>– 10 K$\Omega$[1] external pull-down resistor - floating device pins<br>– The external pull-down resistor must be connected to $V_{SS}$.<br>When $\overline{TRIS}$ is set to 0 (by an external pull-down resistor), $\overline{TEST}$ must be 1 (left unconnected). |
| $\overline{TEST}$ | 27 | I | $IN_{TS}$ | $V_{DD3}$ | **XOR Tree Test Mode.** Sampled at $V_{DD}$ Power-Up reset to force the device pins into a XOR tree configuration.<br>– No pull-down resistor (default) - normal device operation<br>– 10 K$\Omega$[1] external pull-down resistor - pins configured as XOR tree.<br>The external pull-down resistor must be connected to $V_{SS}$.<br>When $\overline{TEST}$ is set to 0 (by an external pull-down resistor), $\overline{TRIS}$ must be 1 (left unconnected). |

# 1.0 Signal/Pin Connection and Description (Continued)

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| XOR_OUT | 30 | O | $O_{3/6}$ | $V_{DD3}$ | **XOR Tree Output.** All the device pins (except power type and analog type pins) are internally connected in a XOR tree structure. |

1. Because the strap function is multiplexed with the Serial Port pins, a CMOS transceiver device is recommended for Serial Port functionality; in this case, the value of the external pull-down resistor is 10 KΩ. If, however, a TTL transceiver device is used, the value of the external pull-down resistor must be 470Ω, and since the Serial Port pins are not able to drive this load, the external pull-down resistor must be disconnected $t_{EPLV}$ after $V_{DD3}$ power-up (see "VDD Power-Up Reset" on page 130).

### 1.4.12 Power and Ground

| Signal | Pin(s) | I/O | Buffer Type | Power Well | Description |
|---|---|---|---|---|---|
| $V_{SS}$ | 8, 29, 46, 58, 78, 96, 110 | I | GND | | **Ground.** Ground connection for both core logic and I/O buffers, for the Main and Standby power supplies. |
| $V_{DD3}$ | 6, 31, 49, 60 | I | PWR | | **Main 3.3V Power Supply.** Powers the I/O buffers of the legacy peripherals and the LPC interface. |
| $V_{SB3}$ | 76, 93, 107 | I | PWR | | **Standby 3.3V Power Supply.** Powers the I/O buffers of the GPIO ports, SWC, Glue Functions and the on-chip Core power converter. |
| $V_{CORF}$ | 97 | I/O | PWR | | **On-chip Core Power Converter Filter.** On-chip Core power converter output. Powers the core logic of all the device modules. An external 1 µF ceramic filter capacitor must be connected between this pin and $V_{SS}$. |

## 1.5 INTERNAL PULL-UP AND PULL-DOWN RESISTORS

The signals listed in Table 3 have internal pull-up (PU) and/or pull-down (PD) resistors. The internal resistors are optional for those signals indicated as "Programmable". See Section 10.3 on page 127 for the values of each resistor type.

**Table 3. Internal Pull-Up and Pull-Down Resistors**

| Signal | Pin(s) | Power Well | Type | Comments |
|---|---|---|---|---|
| **LPC Interface** | | | | |
| $\overline{LPCPD}$ | 52 | $V_{DD3}$ | $PU_{30}$ | |
| **Parallel Port** | | | | |
| $\overline{ACK}$ | 36 | $V_{DD3}$ | $PU_{220}$ | |
| $\overline{AFD_DSTRB}$ | 50 | $V_{DD3}$ | $PU_{440}$ | |
| BUSY_$\overline{WAIT}$ | 35 | $V_{DD3}$ | $PD_{120}$ | |
| $\overline{ERR}$ | 45 | $V_{DD3}$ | $PU_{220}$ | |
| $\overline{INIT}$ | 48 | $V_{DD3}$ | $PU_{440}$ | |
| PE | 34 | $V_{DD3}$ | $PU_{220}$/ $PD_{120}$ | Programmable |
| SLCT | 33 | $V_{DD3}$ | $PD_{120}$ | |
| $\overline{SLIN_ASTRB}$ | 47 | $V_{DD3}$ | $PU_{440}$ | |
| $\overline{STB_WRITE}$ | 51 | $V_{DD3}$ | $PU_{440}$ | |

## 1.0 Signal/Pin Connection and Description (Continued)

**Table 3. Internal Pull-Up and Pull-Down Resistors (Continued)**

| Signal | Pin(s) | Power Well | Type | Comments |
|---|---|---|---|---|
| **Keyboard and Mouse Controller (KBC)** | | | | |
| $\overline{\text{KBRST}}$ | 7 | $V_{DD3}$ | $PU_{30}$ | |
| GA20 | 5 | $V_{DD3}$ | $PU_{30}$ | |
| **System Wake-Up Control (SWC)** | | | | |
| $\overline{\text{SIOPME}}$ | 99 | $V_{SB3}$ | $PU_{30}$ | Programmable[1] |
| **General-Purpose Input/Output (GPIO) Ports** | | | | |
| GPIOE00-07 | 106-103, 108, 109, 111, 112 | $V_{SB3}$ | $PU_{30}$ | Programmable[2] |
| GPIOE10-13 | 116, 114, 115, 113 | $V_{SB3}$ | $PU_{30}$ | Programmable[2] |
| GPIO14 | 101 | $V_{SB3}$ | $PU_{30}$ | Programmable[2] |
| **Glue Functions** | | | | |
| PWRGD_PS | 82 | $V_{SB3}$ | $PU_{90}$ | |
| $\overline{\text{CPU_PRESENT}}$ | 83 | $V_{SB3}$ | $PU_{90}$ | |
| $\overline{\text{FPRST}}$ | 75 | $V_{SB3}$ | $PU_{90}$ | |
| $\overline{\text{PRIMARY_HD}}$ | 67 | $V_{DD3}$ | $PU_{90}$ | |
| $\overline{\text{SECONDARY_HD}}$ | 68 | $V_{DD3}$ | $PU_{90}$ | |
| $\overline{\text{SCSI}}$ | 69 | $V_{DD3}$ | $PU_{90}$ | |
| **Strap Configuration** | | | | |
| $\overline{\text{BADDR}}$ | 30 | $V_{DD3}$ | $PU_{30}$ | Strap[3] |
| $\overline{\text{TRIS}}$ | 26 | $V_{DD3}$ | $PU_{30}$ | Strap[3] |
| $\overline{\text{TEST}}$ | 27 | $V_{DD3}$ | $PU_{30}$ | Strap[3] |

1. Enabled only when the $OD_6$ buffer type is selected ($OD_6$ is the default at reset).
2. Default at reset: disabled.
3. Active only during $V_{DD}$ Power-Up reset.

# 2.0 Power, Reset and Clocks

## 2.1 POWER

### 2.1.1 Power Planes

The PC87372 device has three power planes (wells), as shown in the table below:

**Table 4. Power Planes**

| Power Plane | Description | Power Pins | Ground Pins |
|---|---|---|---|
| Main | Powers the I/O buffers for the external signals[1] of the Legacy modules (Serial Port, Parallel Port, FDC, KBC), on-chip High-Frequency Clock Generator, FSM and the LPC interface, including the buffered reset outputs | $V_{DD3}$ | $V_{SS}$ |
| Standby | Powers the I/O buffers for the external signals[1] of the GPIO ports, SWC, Glue Functions and the on-chip Core power converter | $V_{SB3}$ | $V_{SS}$ |
| Core | Powers the internal (core) logic of all the device modules | $V_{CORF}$[2] | $V_{SS}$ |

1. See the tables in Section 1.4 (pages 14–22), specifically the *Power Well* column.
2. $V_{CORF}$ is generated from $V_{SB3}$ by an on-chip power converter.

For correct operation, $V_{SB3}$ must be applied before $V_{DD3}$.

### 2.1.2 Power States

The PC87372 device has three power states:

- **Power Fail** - Main, Standby and Core power planes are powered off ($V_{DD3}$, $V_{SB3}$ and $V_{CORF}$ are inactive).
- **Power Off** - Main power plane is powered off; the Standby and Core power planes are on ($V_{DD3}$ is inactive; $V_{SB3}$ and $V_{CORF}$ are active).
- **Power On** - Main, Standby and Core power planes are powered on ($V_{DD3}$, $V_{SB3}$ and $V_{CORF}$ are active).

The following power state is illegal:

- The Main power plane is powered on and the Standby and Core power planes are off (i.e., $V_{DD3}$ is active; $V_{SB}$ and $V_{CORF}$ are inactive). Operation is not guaranteed; however, at power-on/off, the device may temporarily enter this power state due to the different rise/fall times of the $V_{DD3}$ and $V_{SB3}$ power supplies.

Table 5 summarizes the power states described above.

**Table 5. Power States and Related Power Planes**

| Power State | Main ($V_{DD3}$) | Standby ($V_{SB3}$) | Core ($V_{CORF}$)[1] |
|---|---|---|---|
| Power Fail | Off | Off | Off |
| Power Off | Off | On | On |
| Power On | On | On | On |
| Illegal[2] | On | Off | Off |

1. $V_{CORF}$ is generated from $V_{SB3}$; therefore both voltages are on or off at approximately the same time.
2. Operation is not guaranteed and register data may be corrupted.

## 2.0 Power, Reset and Clocks (Continued)

Figure 1 shows the power state transitions:

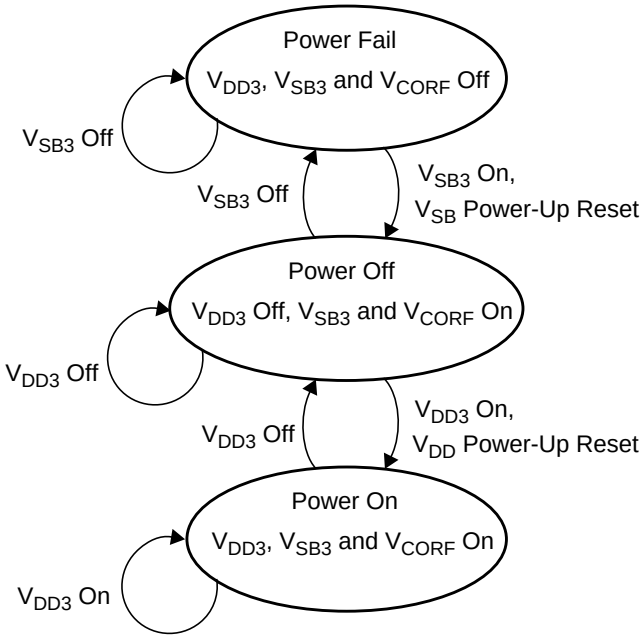



**Figure 1. Power State Transitions**

### 2.1.3 Power Connection and Layout Guidelines

The PC87372 requires a power supply voltage of 3.3V ± 10% for both the $V_{DD3}$ and $V_{SB3}$ supplies. The on-chip Core power converter generates a voltage below 3V for the internal logic.

$V_{DD3}$, $V_{SB3}$ and $V_{CORF}$ use a common ground return marked $V_{SS}$.

To obtain the best performance, bear in mind the following recommendations.

**Ground Connection.** The following items must be connected to the ground layer ($V_{SS}$) as close to the device as possible:

- The ground return ($V_{SS}$) pins
- The decoupling capacitors of the Main power supply ($V_{DD3}$) pins
- The decoupling capacitors of the Standby power supply ($V_{SB3}$) pins
- The decoupling capacitor of the Standby 5V supply ($V_{SB5}$) pin
- The decoupling capacitor of the on-chip Core power converter ($V_{CORF}$) pin

Note that a low-impedance ground layer also improves noise isolation.

**Decoupling Capacitors.** The following decoupling capacitors must be used in order to reduce EMI and ground bounce:

- Main power supply ($V_{DD3}$): Place one capacitor of 0.1 µF on each $V_{DD3}$-$V_{SS}$ pin pair as close to the pin as possible. In addition, place one 10–47 µF tantalum capacitor on the common net as close to the chip as possible.
- Standby power supply ($V_{SB3}$): Place one capacitor of 0.1 µF on each $V_{SB3}$-$V_{SS}$ pin pair as close to the pin as possible. In addition, place one 10–47 µF tantalum capacitor on the common net as close to the chip as possible.
- Standby 5V supply ($V_{SB5}$): Place one capacitor of 0.1 µF on the $V_{SB5}$-$V_{SS}$ pin pair as close to the pin as possible.
- On-chip Core power converter ($V_{CORF}$): Place one 1 µF ceramic capacitor on the $V_{CORF}$-$V_{SS}$ pin pair as close to the pin as possible.

## 2.0 Power, Reset and Clocks (Continued)

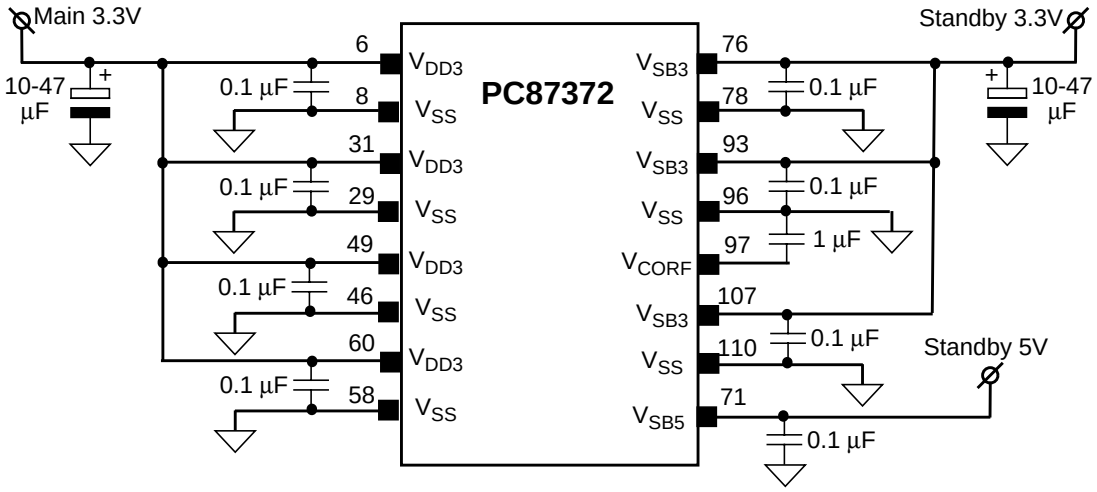



**Figure 2. Decoupling Capacitors Connection**

## 2.2 RESET SOURCES AND TYPES

The PC87372 device has four reset sources:

- **$V_{SB}$ Power-Up Reset** - activated when $V_{SB3}$ is powered up.
- **$V_{DD}$ Power-Up Reset** - activated when $V_{DD3}$ is powered up.
- **Hardware Reset** - activated when the $\overline{\text{PCI_RESET}}$ input is asserted (low).
- **Software Reset** - triggered by SWRST bit in SIOCF1 register (see Section 3.7.2 on page 40); SWRST bit is set by the host through the LPC interface.

Unless otherwise noted, reset references throughout the modules of the PC87372 devices default to the following resets:

- For $V_{SB3}$-powered functions (GPIO ports, SWC, Glue Functions and some Configuration Control): $V_{SB}$ Power-Up reset (within the limitations described in Section 2.2.1).
- For $V_{DD3}$-powered functions (Legacy modules, LPC, on-chip Clock Generator, FSM and some Configuration Control): $V_{DD}$ Power-Up reset, Hardware Reset or Software Reset (within the limitations described in Sections 2.2.2, 2.2.3 and 2.2.4).

The following sections detail the sources and effects of the various PC87372 resets.

### 2.2.1 $V_{SB}$ Power-Up Reset

$V_{SB}$ Power-Up reset is generated by an internal circuit when $V_{SB3}$ power is applied. The $V_{SB}$ Power-Up reset time ($t_{IRST}$) lasts either 17 cycles of the 32 KHz clock domain or until the $\overline{\text{PCI_RESET}}$ signal is de-asserted, whichever occurs first. External devices must wait at least $t_{IRST}$ before accessing the PC87372 device.

Note that the 32 KHz clock domain starts toggling $t_{32KW} + t_{32KVAL}$ after $V_{SB3}$ power-up. This delay must be added to the 17 clock cycles (see *Low-Frequency Clock Timing on page 132*).

$V_{SB}$ Power-Up reset performs the actions listed below and all the actions performed by $V_{DD}$ Power-Up reset (see Section 2.2.2). Note that $V_{DD3}$ must be active during $V_{SB3}$ power-up for all $V_{DD}$ Power-Up reset actions to be performed:

- Resets all lock bits in configuration registers and SWC
- Loads default values to VDDLOAD bits in the GPIO configuration registers
- Loads default values to the $V_{SB3}$-powered bits in the configuration registers, SWC and GPIO
- Sets up the pull-up option and the default source for the $V_{SB3}$-powered multiplexed output pins

## 2.0 Power, Reset and Clocks (Continued)

### 2.2.2 $V_{DD}$ Power-Up Reset

$V_{DD}$ Power-Up reset is generated by an internal circuit when $V_{DD3}$ power is turned on. $V_{DD}$ Power-Up reset time ($t_{IRST}$) lasts until the PCI_RESET signal is de-asserted. The Hardware reset (PCI_RESET) must be asserted for a minimum of 10 ms to ensure that the PC87372 device operates correctly.

External devices must wait at least $t_{IRST}$ before accessing the PC87372. If the host processor accesses the PC87372 during this time, the PC87372 LPC interface ignores the transaction (that is, it does not return a SYNC handshake).

$V_{DD}$ Power-Up reset performs the following actions:

- Puts pins with strap options into TRI-STATE and enables their internal pull-up resistors
- Samples the logic levels of the strap pins
- Executes all the actions performed by the Hardware reset (see Section 2.2.3)

### 2.2.3 Hardware Reset

Hardware reset is activated by the assertion (low) of the PCI_RESET input while $V_{DD3}$ is "good". When $V_{DD3}$ power is off, the PC87372 device ignores the level of the PCI_RESET input. However, the PCIRST_OUT and PCIRST_OUT2 outputs reflect the PCI_RESET input and thus are active (low). In addition, the Hardware reset (PCI_RESET) must be asserted after $V_{SB}$ power-up, as described in Section 2.2.1.

Hardware reset performs the following actions:

- Resets all lock bits in configuration registers and SWC
- Sets up the pull-up option and the default source for the $V_{DD3}$-powered multiplexed output pins
- Executes all the actions performed by the Software reset (see Section 2.2.4)

### 2.2.4 Software Reset

The Software reset is triggered by the host setting SWRST bit in SIOCF1 register (see Section 3.7.2 on page 40) via the LPC interface. The Host Software reset performs the following actions:

- Loads default values to the $V_{DD3}$-powered unlocked bits in the Configuration Control.
- Loads default values to the $V_{SB3}$-powered unlocked GPIO Configuration and Data bits for those GPIO ports with VDDLOAD = 1. VDDLOAD bit is not affected.
- Resets all the $V_{DD3}$-powered Legacy logical devices.
- Loads default values to all the $V_{DD3}$-powered Legacy module registers.

## 2.3 CLOCK DOMAINS

The PC87372 device has three clock domains, as shown in Table 6.

**Table 6. Clock Domains of the PC87372**

| Clock Domain | Frequency | Power Plane | Source | Usage |
|---|---|---|---|---|
| **LPC** | Up to 33 MHz | $V_{DD3}$ | LPC clock input (PCI_CLK) | LPC bus Interface and Configuration Registers |
| **48 MHz** | 48 MHz | $V_{DD3}$ | On-chip Clock Generator | Legacy functions (Serial Port, Parallel Port, FDC, KBC) and FSM |
| **32 KHz** | 32.768 KHz | $V_{SB3}$ | Clock input (CLOCKI32) | SWC, GPIO and Glue Functions |

The LPC and 48 MHz clock domains, and the modules using them, are supplied by the Main power plane. Therefore, these two clock domains are active only when the $V_{DD3}$ power supply is on.

### 2.3.1 LPC Domain

The LPC clock signal at the PCI_CLK pin must become valid (to the extent specified in *PCI_CLK and PCI_RESET* on page 133) before the end of the $V_{DD}$ Power-Up reset (see Section 2.2.2).

## 2.0 Power, Reset and Clocks (Continued)

### 2.3.2 48 MHz Domain

The 48 MHz clock domain is sourced by the on-chip Clock Generator (supplied by the Main power plane).

Following a $V_{DD}$ Power-Up reset, the software waits a period of $t_{14MW} + t_{14MVAL}$ until a valid 14.31818 MHz clock signal is available at the CLOCKI14 pin. Then, the software can set the HFCGEN bit in the CLOCKCF register to 1. This bit enables the operation of the Clock Generator.

After the Clock Generator is enabled for operation, its output clock is frozen to a low level until the generator provides an internal clock signal that meets all requirements. When the requirements are met, the 48 MHz clock domain starts toggling. The status of the Clock Generator output clock is indicated by CKVALID bit in CLOCKCF register. While the Clock Generator is stabilizing, this bit is 0, indicating a 48 MHz clock domain frozen at low level. After $t_{48MD}$, the 48 MHz clock domain starts toggling and this bit is set to 1. The software must wait for CKVALID bit to be set before it enables the FSM or the Legacy functions (Serial Port, Parallel Port, FDC, KBC).

The on-chip Clock Generator multiplies the frequency of the clock signal (received through the CLOCKI14 pin) by a constant value to obtain the 48 MHz output frequency.

Figure 3 shows a simplified diagram of the 32 KHz and the 48 MHz clock domains.

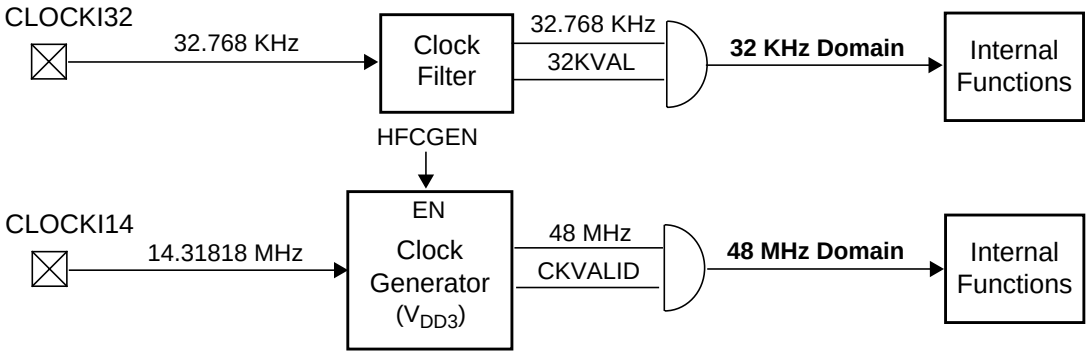



**Figure 3. 32 KHz and 48 MHz Clock Domains (Simplified Diagram)**

### 2.3.3 32 KHz Domain

The 32 KHz clock domain, and the modules using it, are supplied by the Standby and Core power planes. Therefore, this clock domain is active whenever the $V_{SB3}$ and $V_{CORF}$ power supplies are on.

The 32 KHz clock domain is sourced by the CLOCKI32 pin. The clock signal from the CLOCKI32 pin passes through a Clock Filter. The 32 KHz clock domain signal is held low by the 32KVAL output of the Clock Filter until a valid 32.768 KHz clock is available at the CLOCKI32 pin. The 32 KHz clock domain signal starts toggling $t_{32KW} + t_{32KVAL}$ after $V_{SB3}$ Power-Up (*Low-Frequency Clock Timing on page 132*).

## 2.4 TESTABILITY SUPPORT

The PC87372 device supports two testing techniques:

- In-Circuit Testing (ICT)
- XOR Tree Testing

### 2.4.1 ICT

The In-Circuit Testing (ICT) technique, also known as “bed-of-nails”, injects logic patterns to the input pins of the devices mounted on the tested board. It then checks their outputs for the correct logic levels.

The PC87372 supports this testing technique by floating (putting in TRI-STATE) all the device pins. This prevents “back-driving” the PC87372 pins by the ICT tester when a device normally controlled by PC87372 is tested (device inputs are driven by the ICT tester).

To enter TRI-STATE mode, the $\overline{\text{TRIS}}$ pin must be pulled low (by a 10 KΩ resistor to $V_{SS}$), and the $\overline{\text{TEST}}$ pin must be left unconnected after both $V_{DD3}$ and $V_{SB3}$ power supplies are turned on. In addition, the $\overline{\text{PCI_RESET}}$ pin must be held low for at least 10 ms (see *VSB Power-Up Reset* on page 129 and *VDD Power-Up Reset* on page 130). After $\overline{\text{PCI_RESET}}$ is de-asserted, all the device output and I/O pins are floated (put in TRI-STATE); exceptions to this are the power supply pins ($V_{DD3}$, $V_{SB3}$, $V_{SS}$, $V_{CORF}$), analog pins ($V_{SB5}$, REF5V, REF5V_STBY), $\overline{\text{RSMRST}}$ and all “not connected” (N.C.) pins, which do not float in TRI-STATE mode.

## 2.0 Power, Reset and Clocks (Continued)

### 2.4.2 XOR Tree Testing

When the PC87372 device is mounted on a board, it can be tested using the XOR Tree technique. This test also checks the correct connection of the device pins to the board.

To enter XOR Tree mode, the $\overline{\text{TEST}}$ pin must be pulled low (by a 10 KΩ resistor to $V_{SS}$), and the $\overline{\text{TRIS}}$ pin must be left unconnected after both $V_{DD3}$ and $V_{SB3}$ power supplies are turned on. In addition, the $\overline{\text{PCI_RESET}}$ pin must be held low for at least 10 ms (see *VSB Power-Up Reset* on page 129 and *VDD Power-Up Reset* on page 130). After $\overline{\text{PCI_RESET}}$ is de-asserted, the device pins (including the $\overline{\text{PCI_RESET}}$, $\overline{\text{TRIS}}$ and $\overline{\text{TEST}}$ pins) are connected in a XOR Tree configuration and are isolated from the internal PC87372 functions.

In XOR Tree mode, all PC87372 device pins are configured as inputs, except the last pin in the tree, which is the XOR_OUT output. The buffer type of the input pins participating in the XOR tree, is $IN_T$ (Input, TTL compatible), regardless of the buffer type of these pins in normal device operation mode (see Section 1.4 on page 14). The input pins are chained through XOR gates, as shown in Figure 4. The power supply pins ($V_{DD3}$, $V_{SB3}$, $V_{SS}$, $V_{CORF}$), the analog pins ($V_{SB5}$, REF5V, REF5V_STBY), $\overline{\text{RSMRST}}$ and all “not connected” pins (N.C.) are excluded from the XOR tree.

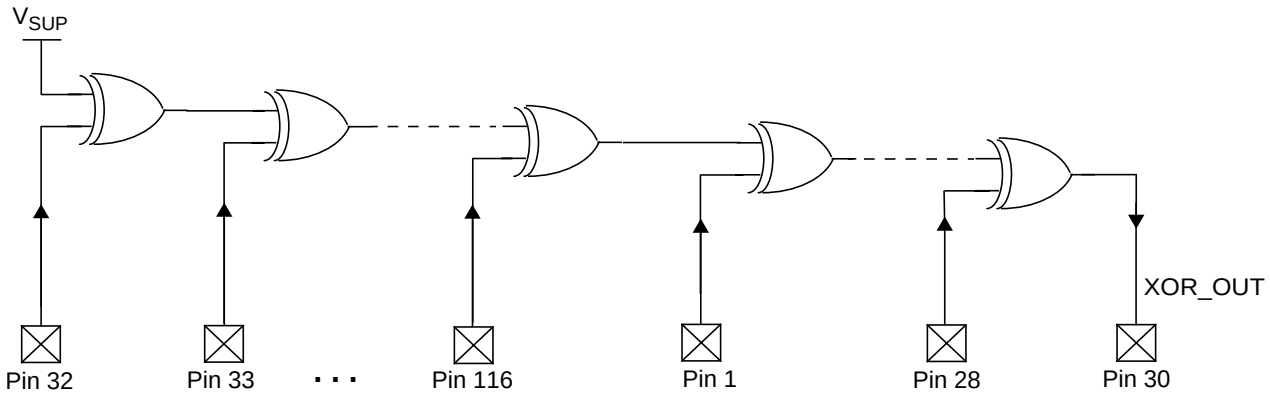



**Figure 4. XOR Tree (Simplified Diagram)**

The XOR tree starts with pin 32, continues incrementally with pin 33 (the next pin in ascending order) through pins 116, 1, and 28, and ends with pin 30 (XOR_OUT).

The maximum propagation delay through the XOR tree, from pin 32 to XOR_OUT is 200 ns.

# 3.0 Device Architecture and Configuration

The PC87372 device includes a collection of legacy and proprietary functional blocks. Each functional block is described in a separate chapter. This chapter describes the structure of the PC87372 device and provides all logical device specific information, including specific implementation of generic blocks, system interface and device configuration.

## 3.1 OVERVIEW

The PC87372 consists of the following: up to eight logical devices, the host interface, the Glue Functions and a central set of configuration registers. All of these components are built around a central internal bus. The internal bus is similar to an 8-bit ISA bus protocol. See the Block Diagram on page 1, which illustrates the blocks and the internal bus.

The host, via the LPC Bus interface, can access the modules connected to the internal bus. This interface supports 8-bit I/O Read/Write and 8-bit DMA transactions of the LPC bus (see Section 4.2 on page 62).

The central configuration register set is ACPI compliant and supports PnP configuration. The configuration registers are structured as a subset of the Plug and Play Standard registers, defined in Appendix A of the *Plug and Play ISA Specification, Revision 1.0a* by Intel® and Microsoft®. All system resources assigned to the functional blocks (I/O address space, IRQ numbers and DMA channels) are configured in and managed by the central configuration register set. In addition, some function-specific parameters are configurable through the configuration registers and distributed to the functional blocks through special control signals.

## 3.2 CONFIGURATION STRUCTURE AND ACCESS

The configuration structure is based on a set of banked registers that are accessed via a pair of specialized registers.

### 3.2.1 The Index-Data Register Pair

Access to the PC87372 configuration registers is via an Index-Data register pair, using only two system I/O byte locations. The base address of this register pair is determined during reset according to the state of the hardware strapping option on the $\overline{\text{BADDR}}$ pin. Table 7 shows the selected base addresses as a function of $\overline{\text{BADDR}}$.

**Table 7. $\overline{\text{BADDR}}$ Strapping Options**

| $\overline{\text{BADDR}}$ | I/O Address | |
|---|---|---|
| | Index Register | Data Register |
| 1 (default) | 2Eh | 2Fh |
| 0 | 4Eh | 4Fh |

The Index register is an 8-bit read/write register located at the selected base address (Base+0). It is used as a pointer to the configuration register file and holds the index of the configuration register that is currently accessible via the Data register. Reading the Index register returns the last value written to it (or the default of 00h after reset).

The Data register is an 8-bit register (Base+1) used as a data path to any configuration register. Accessing the Data register actually accesses the configuration register that is currently pointed to by the Index register.

## 3.0 Device Architecture and Configuration (Continued)

### 3.2.2 Banked Logical Device Registers Structure

Each functional block is associated with a Logical Device Number (LDN). The configuration registers are grouped into banks, where each bank holds the standard configuration registers of the corresponding logical device. Table 8 shows the LDN values of the PC87372 functional blocks. Any value not listed is reserved.

Figure 5 shows the structure of the standard configuration register file. The LDN and PC87372 configuration registers are not banked and are accessed by the Index-Data register pair only, as described above. However, the device control and device configuration registers are duplicated over eight banks, corresponding to the eight logical devices. Therefore, accessing a specific register in a specific bank is performed by two-dimensional indexing, where the LDN register selects the bank (or logical device) and the Index register selects the register within the bank. Accessing the Data register while the Index register holds a value of 30h or higher actually accesses the configuration registers of the logical device selected by the LDN register and pointed to by the Index register.

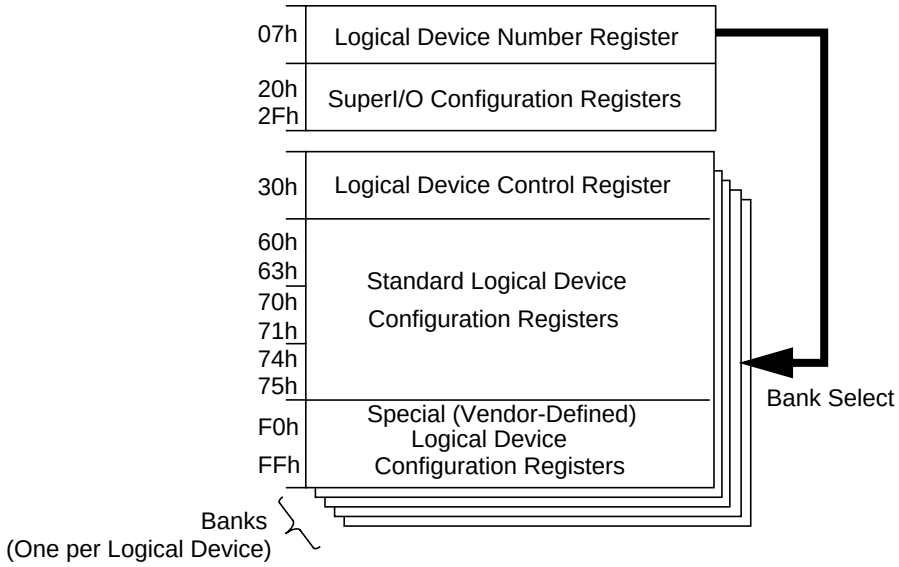



**Figure 5. Structure of Standard Configuration Register File**

**Table 8. Logical Device Number (LDN) Assignments**

| LDN | Functional Block |
|---|---|
| 00h | Floppy Disk Controller (FDC) |
| 01h | Parallel Port (PP) |
| 03h | Serial Port (SP) |
| 04h | System Wake-Up Control (SWC) |
| 05h | Keyboard and Mouse Controller (KBC) - Mouse Interface |
| 06h | Keyboard and Mouse Controller (KBC) - Keyboard Interface |
| 07h | General-Purpose I/O (GPIO) Ports |
| 09h | Fan Speed Monitor (FSM) |

Write accesses to unimplemented registers (i.e., accessing the Data register while the Index register points to a non-existing register) are ignored. Read accesses return 00h on all addresses, except for 74h and 75h (DMA configuration registers), which returns 04h (indicating no DMA channel). The configuration registers are accessible immediately after reset.

# 3.0 Device Architecture and Configuration (Continued)

## 3.2.3 Standard Configuration Register Definitions

In the registers below, any undefined bit is reserved. Unless otherwise noted, the following definitions also hold true:

- All registers are read/write.
- All reserved bits return 0 on reads, except where noted otherwise. To prevent unpredictable results, do not modify these bits. Use read-modify-write to prevent the values of reserved bits from being changed during write.
- Write-only registers must not use read-modify-write during updates.

**Table 9. Standard General Configuration Registers**

| Index | Register Name | Description |
|---|---|---|
| 07h | Logical Device Number | This register selects the current logical device. See Table 8 for valid numbers. All other values are reserved. |
| 20h-2Fh | PC87372 Configuration | PC87372 configuration registers and ID registers. |

**Table 10. Logical Device Activate Register**

| Index | Register Name | Description |
|---|---|---|
| 30h | Activate | Bits 7-1: Reserved<br>Bit 0: Logical device activation control (see Section 3.3 on page 36)<br>0: Disabled<br>1: Enabled |

**Table 11. I/O Space Configuration Registers**

| Index | Register Name | Description |
|---|---|---|
| 60h | I/O Port Base Address Bits 15–8 Descriptor 0 | Indicates selected I/O lower limit address bits 15–8 for I/O Descriptor 0. |
| 61h | I/O Port Base Address Bits 7–0 Descriptor 0 | Indicates selected I/O lower limit address bits 7–0 for I/O Descriptor 0. |
| 62h | I/O Port Base Address Bits 15–8 Descriptor 1 | Indicates selected I/O lower limit address bits 15–8 for I/O Descriptor 1. |
| 63h | I/O Port Base Address Bits 7–0 Descriptor 1 | Indicates selected I/O lower limit address bits 7–0 for I/O Descriptor 1. |

## 3.0 Device Architecture and Configuration (Continued)

**Table 12. Interrupt Configuration Registers**

| Index | Register Name | Description |
|---|---|---|
| 70h | Interrupt Number and Wake-Up on IRQ Enable | Indicates selected interrupt number.<br>Bits 7-5: Reserved.<br>Bit 4: Enables a Power Management event ($\overline{\text{SIOPME}}$) from the IRQ of the logical device. When enabled, IRQ assertion sets the respective *XXX*_IRQ_STS bit (*XXX* is MOD, MS or KBD) in the GPE1_STS_3 register (see Section 6.4.7 on page 89).<br>0: Disabled (default)<br>1: Enabled<br>**Note:** If the BIOS routine that sets IRQ does not use a Read-Modify-Write sequence, it might reset bit 4. To ensure that the system wakes up, the BIOS must set bit 4 before the system goes to sleep.<br>Bits 3-0: These bits select the interrupt number. A value of 1 selects IRQ1. A value of 15 selects IRQ15. IRQ0 is not a valid interrupt selection and represents no interrupt selection.<br>**Note:** Avoid selecting the same interrupt number (except 0) for different Logical Devices, as it causes the PC87372 device to behave unpredictably. |
| 71h | Interrupt Request Type Select | Indicates the type and polarity of the interrupt request number selected in the previous register. If a logical device supports only one type of interrupt, the corresponding bit is read only.<br>Bits 7-2: Reserved.<br>Bit 1: Polarity of interrupt request selected in previous register<br>0: Low polarity<br>1: High polarity<br>Bit 0: Type of interrupt request selected in previous register<br>0: Edge<br>1: Level |

**Table 13. DMA Configuration Registers**

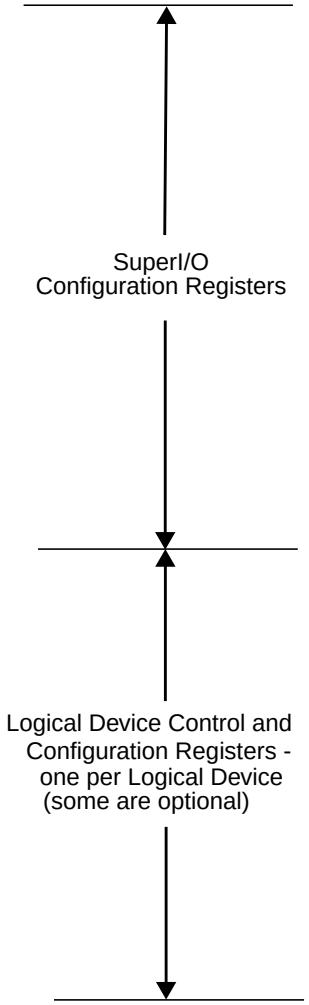
| Index | Register Name | Description |
|---|---|---|
| 74h | DMA Channel Select 0 | Indicates selected DMA channel for DMA 0 of the logical device (0 is the first DMA channel if more than one DMA channel is used).<br>Bits 7-3: Reserved.<br>Bits 2-0: These select the DMA channel for DMA 0. The valid choices are 3-0, where:<br>- A value of 0 selects DMA channel 0, 1 selects channel 1, etc.<br>- A value of 4 indicates that no DMA channel is active.<br>- The values 5-7 are reserved.<br>**Note:** Avoid selecting the same DMA channel (except 4) for different logical devices, as it causes the PC87372 device to behave unpredictably. |
| 75h | DMA Channel Select 1 | Indicates selected DMA channel for DMA 1 of the logical device (1 is the second DMA channel if more than one DMA channel is used).<br>Bits 7-3: Reserved.<br>Bits 2-0: These select the DMA channel for DMA 1. The valid choices are 3-0, where:<br>- A value of 0 selects DMA channel 0, 1 selects channel 1, etc.<br>- A value of 4 indicates that no DMA channel is active.<br>- The values 5–7 are reserved.<br>**Note:** Avoid selecting the same DMA channel (except 4) for different logical devices, as it causes the PC87372 device to behave unpredictably. |

# 3.0 Device Architecture and Configuration (Continued)

**Table 14. Special Logical Device Configuration Registers**

| Index | Register Name | Description |
|---|---|---|
| F0h-FFh | Logical Device Configuration | Special (vendor-defined) configuration options. |

### 3.2.4 Standard Configuration Registers




| Index | Register Name |
|---|---|
| 07h | Logical Device Number |
| 20h | SuperI/O ID |
| 21h | SuperI/O Configuration 1 |
| 22h | SuperI/O Configuration 2 |
| 23h | Reserved |
| 24h | Reserved |
| 25h | Reserved |
| 26h | SuperI/O Configuration 6 |
| 27h | SuperI/O Revision ID |
| 28h | Reserved |
| 29h | Clock Generator Control |
| 2Ah-2Fh | Reserved exclusively for National use |
| 30h | Logical Device Control (Activate) |
| 60h | I/O Base Address Descriptor 0 Bits 15-8 |
| 61h | I/O Base Address Descriptor 0 Bits 7-0 |
| 62h | I/O Base Address Descriptor 1 Bits 15-8 |
| 63h | I/O Base Address Descriptor 1 Bits 7-0 |
| 70h | Interrupt Number and Wake-Up on IRQ Enable |
| 71h | IRQ Type Select |
| 74h | DMA Channel Select 0 |
| 75h | DMA Channel Select 1 |
| F0h-FFh | Vendor-Defined Logical Device Configuration |

**Figure 6. Configuration Register Map**

#### SuperI/O Configuration Registers

The PC87372 configuration registers at indexes 20h (SuperI/O ID) and 27h (SuperI/O Revision ID) are used for part identification. The other configuration registers are used for global power management and selecting pin multiplexing options. For details, see Section 3.7 on page 39.

#### Logical Device Control and Configuration Registers

A subset of these registers is implemented for each logical device. See functional block descriptions in the following sections.

## 3.0 Device Architecture and Configuration (Continued)

### Control Registers

The only implemented control register for each logical device is the Activate register at index 30h. Bit 0 of the Activate register controls the activation of the associated functional block. Activation enables access to the functional block's runtime registers and attaches its system resources, which are unassigned as long as it is not activated. Other effects may apply on a function-specific basis (such as clock enable and active pinout signaling). Access to the configuration register of the logical device is enabled even when the logical device is not activated.

### Standard Configuration Registers

The standard configuration registers manage the PnP resource allocation to the functional blocks. The I/O port base address descriptor 0 is a pair of registers at Index 60–61h that hold the first 16-bit base address for the register set of the functional block. An optional 16-bit second base-address (descriptor 1) at index 62–63h is used for logical devices with more than one continuous register set. Interrupt Number and Wake-Up on IRQ Enable (index 70h) and IRQ Type Select (index 71h) allocate an IRQ line to the block and control its type. DMA Channel Select 0 (index 74h) allocates a DMA channel to the block, where applicable. DMA Channel Select 1 (index 75h) allocates a second DMA channel, where applicable.

### Vendor-Defined Logical Device Configuration Register

The vendor-defined logical device registers start at index F0h and control function-specific parameters such as operation modes, power saving modes, pin TRI-STATE, clock rate selection and non-standard extensions to generic functions.

### 3.2.5 Default Configuration Setup

The default configuration setup of the PC87372 device is determined by the four reset types described in Section 2.2 on page 26. See the specific register descriptions for the bits affected by each reset source.

In the event of a $V_{SB}$ Power-Up reset, the following default configuration is set up:

- All lock bits in the configuration registers are reset (the protected bits are unlocked).
- All the unlocked bits in the configuration registers powered by the $V_{SB3}$ plane are reset to their default values.

In the event of a $V_{DD}$ Power-Up (also induced by $V_{SB}$ Power-Up reset) or Hardware reset, the PC87372 device wakes up with the following default configuration setup:

- The configuration base address is 2Eh or 4Eh, according to the $\overline{\text{BADDR}}$ strap pin value, as shown in Table 7 on page 30.
- All lock bits in the configuration registers are reset (the protected bits are unlocked).
- All the actions performed by the Software reset are executed.

If a Software reset occurs, the PC87372 device wakes up with the following default configuration setup:

- All the unlocked bits in the configuration registers powered by the $V_{DD3}$ plane are reset to their default values.
- All logical devices are disabled (the Activation bit is reset) and the $V_{SB}$-powered logical devices (GPIO and SWC) remain functional but their registers cannot be accessed by the host.
- Standard configuration registers of all logical devices are set to their default values.
- National Semiconductor proprietary functions are not assigned with any default resources, and the default values of their base addresses are all 00h.
- All Legacy devices (Serial Port, Parallel Port, Floppy Disk Controller, Keyboard and Mouse Controller) and the FSM device are reset. Default values are loaded into the Legacy module runtime registers.

# 3.0 Device Architecture and Configuration (Continued)

## 3.3 MODULE CONTROL

Module control is performed primarily through the Activation bit (bit 0 of index 30h) of each logical device.

### 3.3.1 Module Enable/Disable

Module control is performed primarily through the Activation bit (bit 0 of index 30h) of each logical device. The operation of each module can be controlled by the host through the LPC bus.

Module enable/disable by the host through the LPC bus is controlled by the following bits:

- Activation bit (bit 0) in index 30h of the Standard configuration registers (see Section 3.2.3 on page 32)
- Fast Disable bit in SIOCF6 register; for the FDC, Parallel Port and Serial Port modules only (see Section 3.7.4 on page 41)
- Global Enable bit (GLOBEN) in SIOCF1 register (see Section 3.7.2 on page 40)

A module is enabled only if all of these bits are set to their “enable” value.

When a $V_{DD3}$-powered module (FDC, Parallel Port, Serial Port, KBC, FSM) is disabled, the following takes place:

- The host system resources of the logical device (IRQ, DMA and runtime address range) are unassigned.
- Access to the standard- and device-specific Logical Device configuration registers through the LPC bus remains enabled.
- Access to the module’s runtime registers through the LPC bus is disabled (transactions are ignored; SYNC cycle is not generated).
- The module’s internal clock is disabled (the module is not functional) to lower the power consumption.

When a $V_{SB3}$-powered module (GPIO and SWC) is disabled, the following takes place:

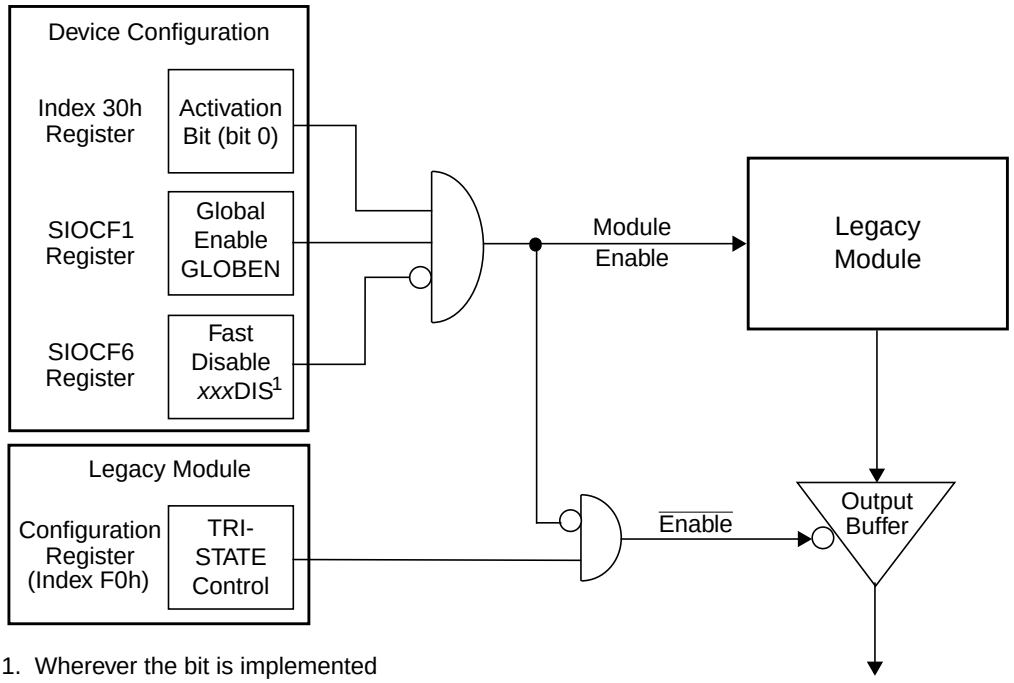
- The host system resources of the logical device (IRQ and runtime address range) are unassigned.
- Access to the standard and device specific Logical Device configuration registers through the LPC bus remains enabled.
- Access to the module’s runtime registers through the LPC bus is disabled (transactions are ignored; SYNC cycle is not generated).
- The module is functional.

## 3.0 Device Architecture and Configuration (Continued)

### 3.3.2 Floating Module Output

The pins of the Legacy modules (Serial Port, Parallel Port, Floppy Disk Controller, Keyboard and Mouse Controller) can be floated. When the TRI-STATE Control bit (bit 0) is set in the specific module configuration register (at index F0h of the specific Logical Device in the configuration space) **and** the module is disabled (see Section 3.3.1), the module output signals are floated and the I/O signals are configured as inputs (note that the logic level at the inputs is ignored by the module, which is disabled).

Figure 7 shows the control mechanism for floating the pins of a Legacy module.




1. Wherever the bit is implemented

**Figure 7. Control of Floating Legacy Module Pins**

## 3.4 INTERNAL ADDRESS DECODING

A full 16-bit address decoding is applied when accessing the configuration I/O space as well as the registers of the functional blocks. However, the number of configurable bits in the base address registers varies for each logical device.

The lower 1, 2, 3, 4 or 5 address bits are decoded in the functional block to determine the offset of the accessed register within the logical device's I/O range of 2, 4, 8, 16 or 32 bytes, respectively. The rest of the bits are matched with the base address register to decode the entire I/O range allocated to the logical device. Therefore, the lower bits of the base address register are forced to 0 (read only), and the base address is forced to be 2, 4, 8, 16 or 32 byte-aligned, according to the size of the I/O range.

The base address of the FDC, Serial Port and KBC are limited to the I/O address range of 00h to 7FXh only (bits 15-11 are forced to 0). The Parallel Port base address is limited to the I/O address range of 00h to 3F8h. The addresses all of the non-legacy logical devices, including the FSM, SWC and GPIO, are configurable within the full 16-bit address range (up to FFFXh).

In some special cases, other address bits are used for internal decoding (such as bit 2 in the KBC and bit 10 in the Parallel Port). The KBC has two I/O base addresses with some implied dependency between them. For more details, see the description of the base address register for each logical device.

# 3.0 Device Architecture and Configuration (Continued)

## 3.5 PROTECTION

The PC87372 device provides features to protect the hardware configuration from changes made by application software running on the host.

The protection is activated by the software setting a “sticky” lock bit. Each lock bit protects a group of configuration bits located either in the same register or in different registers. When the lock bit is set, the lock bit and all the protected bits become read only and cannot be further modified by the host through the LPC bus. All the lock bits are reset by Power-Up reset, thus unlocking the protected configuration bits.

The bit locking protection mechanism is optional.

The protected groups of configuration bits are described below.

### 3.5.1 Multiplexed Pins Configuration Lock

Protects the configuration of all the multiplexed device pins.

Lock bit: LOCKMCF in SIOCF1 register (Device Configuration).

Protected bits: IOWAIT in SIOCF1 register and all bits of the SIOCF2 register (Device Configuration).

### 3.5.2 GPIO Ports Configuration Lock

Protects the configuration (but not the data) of all the GPIO Ports.

Lock bit: LOCKGCF in SIOCF1 register (Device Configuration).

Protected bits for each GPIO Port: All bits of GPCFG1, GPEVR, GPCFG2 and GPMODE registers except LOCKCFP bit (Device Configuration).

### 3.5.3 Fast Disable Configuration Lock

Protects the Fast Disable bits for all the Legacy modules.

Lock bit: LOCKFDS in SIOCF6 register (Device Configuration).

Protected bits: All bits of the SIOCF6 register, except General-Purpose Scratch bits and GLOBEN bit in SIOCF1 register (Device Configuration).

### 3.5.4 Clock Control Lock

Protects the Clock Generator control bits.

Lock bit: HFCGEN in CLOCKCF register (Device Configuration).

Protected bits: All bits of the CLOCKCF register (Device Configuration).

### 3.5.5 GPIO Ports Lock

Protects the configuration **and** data of all the GPIO Ports.

Lock bit: LOCKCFP in GPCFG1 register, for each GPIO Port (Device Configuration).

Protected bits for each GPIO Port: PUPCTL, OUTTYPE and OUTENA in GPCFG1 register; all bits of the GPCFG2 register (Device Configuration); the corresponding bit (to the port pin) in GPDO and GPDIO registers (GPIO Ports).

### 3.5.6 Fan Speed Configuration Lock

Protects the Fan Speed Monitor configuration bits.

Lock bit: LOCKFCF in FSMCF register (Device Configuration).

Protected bits: All bits of the FSMCF register (Device Configuration).

### 3.5.7 SWC Configuration Lock

Protects the configuration of the SWC module, including the Keyboard and Mouse wake-up configuration.

Lock bit: LOCKSCF in SWC_CTL register (System Wake-Up Control).

Protected bits: BLINK and GRN_YLW bits in the SLEDCTL register;
all bits of the SWC_CTL, ALEDCTL, LEDBLNK, KBDWKCTL, PS2CTL and PS2KEY0–7 registers (System Wake-Up Control).

# 3.0 Device Architecture and Configuration (Continued)

## 3.6 REGISTER TYPE ABBREVIATIONS

The following abbreviations are used to indicate the Register Type:

- R/W = Read/Write.
- R = Read from register (data written to this address is sent to a different register).
- W = Write (see above).
- RO = Read Only.
- WO = Write Only. Reading from the bit returns 0.
- R/W1C = Read/Write 1 to Clear. Writing 1 to a bit clears it to 0. Writing 0 has no effect.
- R/W1S = Read/Write 1 to Set. Writing 1 to a bit sets its value to 1. Writing 0 has no effect.

In the registers below, use one of the following methods to handle the reserved bits:

- Write 0 to reserved bits, unless another “required value” is specified. This method can be used for registers containing bits of all types.
- Use read-modify-write to preserve the values of the reserved bits. This method can be used only for registers containing bits of R/W, RO, R/W1C and R/W1S types.

## 3.7 PC87372 CONFIGURATION REGISTERS

This section describes the PC87372 configuration and ID registers (i.e., registers with first level indexes in the range of 20h–2Fh). See Table 15 for a summary and directory of these registers.

**Table 15. SuperI/O Configuration Registers**

| Index | Mnemonic | Register Name | Power Well | Type | Section |
|---|---|---|---|---|---|
| 20h | SID | SuperI/O ID | $V_{SB3}$ | RO | 3.7.13.7.1 |
| 21h | SIOCF1 | SuperI/O Configuration 1 | $V_{DD3}$ | Varies per bit | 3.7.2 |
| 22h | SIOCF2 | SuperI/O Configuration 2 | $V_{SB3}$ | R/W or RO | 3.7.3 |
| 23h-25h | Reserved | | | | |
| 26h | SIOCF6 | SuperI/O Configuration 6 | $V_{DD3}$ | Varies per bit | 3.7.4 |
| 27h | SRID | SuperI/O Revision ID | $V_{SB3}$ | RO | 3.7.5 |
| 28h | Reserved | | | | |
| 29h | CLOCKCF | Clock Generator Control | $V_{SB3}$ | Varies per bit | 3.7.6 |
| 2Ah-2Fh | Reserved for National use | | | | |

### 3.7.1 SuperI/O ID Register (SID)

This register contains the identity number of the device family. The PC87372 family is identified by the value F0h.

Power Well: $V_{SB3}$

Location: Index 20h

Type: RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Family ID** | | | | | | | |
| Reset | F0h | | | | | | | |

| Bit | Description |
|---|---|
| 7–0 | **Family ID.** Identifies a family of devices with similar functionality but with different implemented options. |

# 3.0 Device Architecture and Configuration (Continued)

## 3.7.2 SuperI/O Configuration 1 Register (SIOCF1)

Power Well: $V_{DD3}$

Location: Index 21h

Type: Varies per bit

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **LOCKMCF** | **LOCKGCF** | **Reserved (must be '01')** | | **IOWAIT** | | **SWRST** | **GLOBEN** |
| Reset | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |

| Bit | Type | Description |
|---|---|---|
| 7 | R/W1S | **LOCKMCF (Lock Multiplexing Configuration).** When set to 1, this bit locks the configuration of registers SIOCF1 and SIOCF2 by disabling writing to all bits in these registers (including the LOCKMCF bit itself), except for the LOCKGCF, SWRST and GLOBEN bits in SIOCF1. Once set, this bit can be cleared by $V_{DD3}$ Power-Up reset (or Hardware reset).<br>0: R/W bits are enabled for write (default)<br>1: All bits are RO |
| 6 | R/W1S | **LOCKGCF (Lock GPIO Pins Configuration).** When set to 1, this bit locks the configuration registers of all GPIO pins (see Section 3.13.2 on page 56) by disabling writes to all their bits (including the LOCKGCF bit itself). The locked registers include the GPCFG1 (except LOCKCFP bit), GPEVR, GPCFG2 and GPMODE registers of all GPIO pins. Once set, this bit can be cleared by $V_{DD3}$ Power-Up reset (or Hardware reset).<br>0: R/W bits are enabled for write (default)<br>1: All bits are RO |
| 5-4 | – | **Reserved.** These bits must be '01'. |
| 3-2 | R/W or RO | **IOWAIT (Number of I/O Wait States).** These bits set the number of wait states for I/O transactions through the LPC bus.<br>**Bits 3 2 Number of Wait States**<br>0 0: 0 (default)<br>0 1: 2<br>1 0: 6<br>1 1: 12 |
| 1 | R/W | **SWRST (Software Reset).** When set to 1, this bit triggers the Software reset sequence (see Section 2.2.4 on page 27), after which it returns to 0. Read always returns 0. This bit is not influenced by the value of LOCKMCF.<br>0: Inactive (default)<br>1: Trigger the Software reset sequence |
| 0 | R/W or RO | **GLOBEN (Global Device Enable).** This bit makes it possible to disable all logical devices by setting a single bit (to 0). In addition, when the bit is set to 1, it enables the operation of all the logical devices of the PC87372, as long as the logical device is itself enabled (see Table 8 on page 31). The behavior of the different devices is explained in Section 3.3 on page 36.<br>0: All logical devices in the PC87372 device are forced to be disabled and their resources are released.<br>1: Enables each PC87372 logical device that is itself enabled (default); see Section 3.3.1 on page 36. |

## 3.0 Device Architecture and Configuration (Continued)

### 3.7.3 SuperI/O Configuration 2 Register (SIOCF2)

Power Well: $V_{SB3}$

Location: Index 22h

Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **PMEPOL** | **PMETYPE** | **TACH2EN** | **TACH1EN** | **Reserved** | | | **GPIO03EN** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7 | **PMEPOL ($\overline{\text{SIOPME}}$ Polarity).** Selects the polarity of the $\overline{\text{SIOPME}}$ signal.<br>0: $\overline{\text{SIOPME}}$ is active low (default)<br>1: $\overline{\text{SIOPME}}$ is active high |
| 6 | **PMETYPE ($\overline{\text{SIOPME}}$ Buffer Type).** Selects the output buffer type of the $\overline{\text{SIOPME}}$ pin.<br>0: Output is open-drain and the pull-up resistor is enabled (default)<br>1: Output is push-pull (the pull-up resistor is disabled) |
| 5 | **TACH2EN (FANTACH2 Multiplex Control).** Selects the function connected to pin 112.<br>0: GPIOE07 port: GPIO (default)<br>1: FANTACH2: FSM |
| 4 | **TACH1EN (FANTACH1 Multiplex Control).** Selects the function connected to pin 111.<br>0: GPIOE06 port: GPIO (default)<br>1: FANTACH1: FSM |
| 3-1 | **Reserved.** |
| 0 | **GPIO03EN (GPIOE10-GPIOE13 Multiplex Control).** Selects the functions connected to pins 113-116.<br>0: 5V_DDCSDA, 5V_DDCSCL, 3V_DDCSDA, 3V_DDCSCL: Glue Functions (default)<br>1: GPIOE10-GPIOE13 ports: GPIO |

### 3.7.4 SuperI/O Configuration 6 Register (SIOCF6)

This register provides a fast way to disable one or more modules without having to access the Activate register of each (see Section 3.3.1 on page 36).

Power Well: $V_{DD3}$

Location: Index 26h

Type: Varies per bit

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **LOCKFDS** | **General-Purpose Scratch** | | **Reserved** | **SERDIS** | **Reserved** | **PARPDIS** | **FDCDIS** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Type | Description |
|---|---|---|
| 7 | R/W1S | **LOCKFDS (Lock Fast Disable Configuration).** When set to 1, this bit locks itself, SERDIS, PARPDIS and FDCDIS bits in this register and GLOBEN bit in SIOCF1 register by disabling writing to all of these bits. Once set, this bit can be cleared by $V_{DD3}$ Power-Up reset (or Hardware reset).<br>0: R/W bits are enabled for write (default)<br>1: All bits are RO |
| 6-5 | R/W | **General-Purpose Scratch.** |
| 4 | – | **Reserved.** |

## 3.0 Device Architecture and Configuration (Continued)

| Bit | Type | Description |
|---|---|---|
| 3 | R/W or RO | **SERDIS (Serial Port Disable).** When set to 1, this bit forces the Serial Port module to be disabled (and its resources released) regardless of the actual setting of its Activation bit (index 30).<br>0: Enabled or Disabled, according to Activation bit (default)<br>1: Disabled |
| 2 | – | **Reserved.** |
| 1 | R/W or RO | **PARPDIS (Parallel Port Disable).** When set to 1, this bit forces the Parallel Port module to be disabled (and its resources released) regardless of the actual setting of its Activation bit (index 30).<br>0: Enabled or Disabled, according to Activation bit (default)<br>1: Disabled |
| 0 | R/W or RO | **FDCDIS (Floppy Disk Controller Disable).** When set to 1, this bit forces the Floppy Disk Controller module to be disabled (and its resources released) regardless of the actual setting of its Activation bit (index 30).<br>0: Enabled or Disabled, according to Activation bit (default)<br>1: Disabled |

### 3.7.5 SuperI/O Revision ID Register (SRID)

This register contains the ID number of the specific family member (Chip ID) and the chip revision number (Chip Rev). The PC87372 is identified by the value '000'. The Chip Rev is incremented on each revision.

Power Well: $V_{SB3}$

Location: Index 27h

Type: RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Chip ID** | | | **Chip Rev** | | | | |
| Reset | 0 | 0 | 0 | X | X | X | X | X |

| Bit | Description |
|---|---|
| 7-5 | **Chip ID.** These bits identify a specific device of a family. |
| 4-0 | **Chip Rev.** These bits identify the device revision. |

# 3.0 Device Architecture and Configuration (Continued)

## 3.7.6 Clock Generator Control Register (CLOCKCF)

Power Well: $V_{SB3}$

Location: Index 29h

Type: Varies per bit

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **HFCGEN** | **Reserved** | | **CKVALID** | **Reserved** | | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Type | Description |
|---|---|---|
| 7 | R/W1S | **HFCGEN (Clock Generator Enable).** When set to 1, this bit enables the operation of the Clock Generator, and locks the configuration register CLOCKCF by disabling writing to all its bits (including to the HFCGEN bit itself). Once set, this bit can be cleared by $V_{DD3}$ Power-Up reset (or Hardware reset).<br>0: Clock Generator disabled; the R/W bits are enabled for write (default).<br>1: Clock Generator enabled; all the bits are RO. |
| 6-5 | – | **Reserved.** |
| 4 | RO | **CKVALID (Valid Clock Generator, Clock Status).** This bit indicates the status of the on-chip, 48 MHz Clock Generator and controls the generator output clock signal. The PC87372 modules using this clock may be enabled (see Section 3.3.1 on page 36) only after this bit is read high (generator clock is valid).<br>0: Generator output clock frozen (default)<br>1: Generator output clock active (stable and toggling) |
| 3-0 | – | **Reserved.** |

# 3.0 Device Architecture and Configuration (Continued)

## 3.8 FLOPPY DISK CONTROLLER (FDC) CONFIGURATION

### 3.8.1 General Description

The generic FDC is a standard FDC with a digital data separator and is DP8473 and N82077 software compatible. The PC87372 FDC supports 14 of the 17 standard FDC signals described in the generic Floppy Disk Controller (FDC) chapter, including the following (see Section 9.1 on page 110):

- FM and MFM modes are supported. To select either mode, set bit 6 of the first command byte when writing to/reading from a diskette, where:
  0 = FM mode
  1 = MFM mode
- A logic 1 is returned during LPC I/O read cycles by all register bits reflecting the state of floating (TRI-STATE) FDC pins.

Exceptions to standard FDC are:

- Automatic media sense using MSEN0 and MSEN1 signals is not supported.
- DRATE1 is not supported.
- $\overline{DR1}$ is not supported.
- $\overline{MTR1}$ is not supported.

The FDC functional block registers are shown in Section 9.1 on page 110. All of these registers are $V_{DD3}$ powered.

### 3.8.2 Logical Device 0 (FDC) Configuration

Table 16 lists the configuration registers that affect the FDC. Only the last two registers (F0h and F1h) are described here. See Section 3.2.3 on page 32 for descriptions of the other configuration registers. All of these registers are $V_{DD3}$ powered.

**Table 16. FDC Configuration Register**

| Index | Configuration Register or Action | Type | Power Well | Reset |
|---|---|---|---|---|
| 30h | Activate (see Section 3.3.1 on page 36) | R/W | $V_{DD3}$ | 00h |
| 60h | Base Address MSB register. Bits 7-3 (for A15-11) are read only, ‘00000’. | R/W | $V_{DD3}$ | 03h |
| 61h | Base Address LSB register. Bits 2 and 0 (for A2 and A0) are read only, ‘00’. | R/W | $V_{DD3}$ | F2h |
| 70h | Interrupt Number and Wake-Up on IRQ Enable register | R/W | $V_{DD3}$ | 06h |
| 71h | Interrupt Type. Bit 1 is read/write; other bits are read only. | R/W | $V_{DD3}$ | 03h |
| 74h | DMA Channel Select | R/W | $V_{DD3}$ | 02h |
| 75h | Report no second DMA assignment | RO | $V_{DD3}$ | 04h |
| F0h | FDC Configuration register | R/W | $V_{DD3}$ | 24h |
| F1h | Drive ID register | R/W | $V_{DD3}$ | 00h |
| F8h | FDC Configuration register (mirror of the register at index F0h) | R/W | $V_{DD3}$ | 24h |

# 3.0 Device Architecture and Configuration (Continued)

## 3.8.3 FDC Configuration Register

This register is reset to 24h.

Power Well: $V_{DD3}$

Location: Indexes F0h and F8h

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | **TDR Register Mode** | **DENSEL Polarity Control** | **FDC 2Mbps Enable** | **Write Protect** | **PC-AT or PS/2 Drive Mode Select** | **Reserved** | **TRI-STATE Control** |
| Reset | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |

| Bit | Description |
|---|---|
| 7 | **Reserved.** |
| 6 | **TDR Register Mode.**<br>0: PC-AT-Compatible Drive mode; i.e., bits 7-2 of the TDR are '111111' (default)<br>1: Enhanced Drive mode |
| 5 | **DENSEL Polarity Control.**<br>0: Active low for 500 Kbps or 1 or 2 Mbps data rates<br>1: Active high for 500 Kbps or 1 or 2 Mbps data rates (default) |
| 4 | **FDC 2Mbps Enable.** This bit is set only when a 2 Mbps drive is used.<br>0: 2 Mbps disabled and the FDC clock is 24 MHz (default)<br>1: 2 Mbps enabled and the FDC clock is 48 MHz |
| 3 | **Write Protect.** This bit enables forcing of write protect functionality by software. When set, writes to the floppy disk drive are disabled. This effect is identical to an active $\overline{WP}$ signal.<br>0: Write protected according to $\overline{WP}$ signal (default)<br>1: Write protected regardless of value of $\overline{WP}$ signal |
| 2 | **PC-AT or PS/2 Drive Mode Select.**<br>0: PS/2 Drive mode<br>1: PC-AT Drive mode (default) |
| 1 | **Reserved.** |
| 0 | **TRI-STATE Control.** When this bit is set to 1 and the logical device is inactive, the logical device output pins are in TRI-STATE (see Section 3.3.2 on page 37).<br>0: Normal outputs (default)<br>1: TRI-STATE outputs when the logical device is inactive |

# 3.0 Device Architecture and Configuration (Continued)

## 3.8.4 Drive ID Register

This register is reset to 00h. This register controls bits 5 and 4 of the TDR register in Enhanced mode.

Power Well: $V_{DD3}$
Location: Index F1h
Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | **Drive 1 ID** | | **Drive 0 ID** | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-4 | **Reserved.** |
| 3-2 | **Drive 1 ID.** When drive 1 is accessed, these bits are reflected on bits 5-4 of the TDR register, respectively. |
| 1-0 | **Drive 0 ID.** When drive 0 is accessed, these bits are reflected on bits 5-4 of the TDR register, respectively. |

**Usage Hints:** Some BIOS implementations support FDDs with automatic media sense; in this case, bit 5 of TDR register in Enhanced mode is interpreted as valid media sense when it is cleared to 0. If drive 0 and/or drive 1 do not support automatic media sense, bits 1 and/or 3 of the Drive ID register must be set to 1 (to indicate non-valid media sense). When Drive 0 or Drive 1 is selected, the Drive ID bit is reflected on bit 5 of TDR register in Enhanced mode.

# 3.0 Device Architecture and Configuration (Continued)

## 3.9 PARALLEL PORT (PP) CONFIGURATION

### 3.9.1 General Description

The PC87372 Parallel Port supports all IEEE1284 standard communication modes: Compatibility (also known as Standard or SPP), Bi-directional (known also as PS/2), FIFO, EPP (also known as mode 4) and ECP (with an optional Extended ECP mode).

The Parallel Port includes two groups of runtime registers (see Section 9.2 on page 112):

- A group of 21 registers at first level offset, sharing 14 entries. Three of these registers (at offsets 403h, 404h and 405h) are used only in Extended ECP mode.
- A group of four registers, used only in Extended ECP mode, is accessed by a second level offset.

The desired mode is selected by the ECR runtime register (offset 402h). The selected mode determines which runtime registers are used and which address bits are used for the base address. The Parallel Port functional block registers are shown in Section 9.2 on page 112. All of these registers are $V_{DD3}$ powered.

### 3.9.2 Logical Device 1 (PP) Configuration

Table 17 lists the configuration registers that affect the Parallel Port. Only the last register (F0h) is described here. See Section 3.2.3 on page 32 for descriptions of the other configuration registers. All of these registers are $V_{DD3}$ powered.

**Table 17. Parallel Port Configuration Registers**

| Index | Configuration Register or Action | Type | Power Well | Reset |
|---|---|---|---|---|
| 30h | Activate (see Section 3.3.1 on page 36) | R/W | $V_{DD3}$ | 00h |
| 60h | Base Address MSB register. Bits 7-3 (for A15-11) are read only, '00000'. Bit 2 (for A10) must be '0'. | R/W | $V_{DD3}$ | 02h |
| 61h | Base Address LSB register. Bits 1 and 0 (A1 and A0) are read only, '00'. For ECP mode 4 (EPP) or when using Extended registers, bit 2 (A2) must also be '0'. | R/W | $V_{DD3}$ | 78h |
| 70h | Interrupt Number and Wake-Up on IRQ Enable register | R/W | $V_{DD3}$ | 07h |
| 71h | Interrupt Type:<br>- Bits 7-2 are read only.<br>- Bit 1 is a read/write bit.<br>- Bit 0 is read only. It reflects the interrupt type dictated by the Parallel Port operation mode. This bit is set to 1 (level interrupt) in Extended mode and cleared (edge interrupt) in all other modes. | R/W | $V_{DD3}$ | 02h |
| 74h | DMA Channel Select | R/W | $V_{DD3}$ | 04h |
| 75h | Report no second DMA assignment | RO | $V_{DD3}$ | 04h |
| F0h | Parallel Port Standard Configuration register | R/W | $V_{DD3}$ | F2h |
| F8h | Parallel Port Modified Configuration register | R/W | $V_{DD3}$ | 07h |

# 3.0 Device Architecture and Configuration (Continued)

## 3.9.3 Parallel Port Standard Configuration Register

This register is reset to F2h.

Power Well: $V_{DD3}$

Location: Index F0h

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Parallel Port Mode Select** | | | **Extended Register Access** | **Reserved** | | **Power Mode Control** | **TRI-STATE Control** |
| Reset | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |

| Bit | Description |
|---|---|
| 7-5 | **Parallel Port Mode Select.** The mode selected by writing to these bits, is reflected by bits 3-0 in the Parallel Port Modified Configuration Register (see Section 3.9.4 on page 49).<br>**Bits 7 6 5 Mode**<br>0 0 0: SPP-Compatible mode. PD7-0 are always output signals<br>0 0 1: SPP Extended mode. PD7-0 direction is controlled by software<br>0 1 0: EPP 1.7 mode<br>0 1 1: EPP 1.9 mode<br>1 0 0: ECP mode (IEEE1284 register set), with no support for EPP mode<br>1 0 1: Reserved<br>1 1 0: Reserved<br>1 1 1: ECP mode (IEEE1284 register set), with EPP mode selectable as mode “100” (default)<br>Selection of EPP 1.7 or 1.9 in ECP mode “100” is controlled by bit 4 of the Control2 configuration register of the Parallel Port at offset 02h.<br>**Note**: Before setting bits 7-5, enable the Parallel Port and set CTR/DCR (at base address + 2) to C4h. |
| 4 | **Extended Register Access.**<br>0: Registers at base (address) + 403h, base + 404h and base + 405h are not accessible (reads and writes are ignored)<br>1: Registers at base (address) + 403h, base + 404h and base + 405h are accessible. This option supports runtime configuration within the Parallel Port address space (default). |
| 3-2 | **Reserved.** |
| 1 | **Power Mode Control.** When the logical device is active:<br>0: Parallel Port clock disabled. ECP modes and EPP time-out are not functional when the logical device is active. Registers are maintained.<br>1: Parallel Port clock enabled. All operation modes are functional when the logical device is active (default). |
| 0 | **TRI-STATE Control.** When this bit is set to 1 and the logical device is inactive, the logical device output pins are in TRI-STATE (see Section 3.3.2 on page 37).<br>0: Normal outputs (default)<br>1: TRI-STATE outputs when the logical device is inactive |

## 3.0 Device Architecture and Configuration (Continued)

### 3.9.4 Parallel Port Modified Configuration Register

This register is reset to 07h.

Power Well: $V_{DD3}$

Location: Index F8h

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | **Parallel Port Mode Select** | | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |

| Bit | Description |
|---|---|
| 7-4 | **Reserved.** |
| 3-0 | **Parallel Port Mode Select.** The mode selected by writing to these bits, is reflected by bits 7-5 in the Parallel Port Standard Configuration Register (see Section 3.9.3 on page 48).<br>**Bits 3 2 1 0 Mode**<br>0 0 0 1: SPP Extended mode. PD7-0 direction is controlled by software<br>0 0 1 0: EPP 1.9 mode<br>0 1 0 0: ECP mode (IEEE1284 register set), with no support for EPP mode<br>1 0 0 0: SPP-Compatible mode. PD7-0 are always output signals<br>0 1 1 1: ECP mode (IEEE1284 register set), with EPP mode selectable as mode “0100” (default)<br>1 0 1 0: EPP 1.7 mode<br>Other: Reserved (writing a reserved value causes unpredictable behavior of the Parallel Port)<br>Selection of EPP 1.7 or 1.9 in ECP mode “0100” is controlled by bit 4 of Control2 configuration register of the Parallel Port at offset 02h.<br>**Note**: Before setting bits 3-0, enable the Parallel Port and set CTR/DCR (at base address + 2) to C4h. |

# 3.0 Device Architecture and Configuration (Continued)

## 3.10 SERIAL PORT CONFIGURATION

### 3.10.1 General Description

The Serial Port provides UART functionality by supporting serial data communication with a remote peripheral device or a modem. The functional blocks can function as a standard 16450 or 16550 or as an Extended UART.

The Serial Port includes four register banks, each containing eight runtime registers, as shown in Section 9.3 on page 115. All the registers are $V_{DD3}$ powered.

### 3.10.2 Logical Device 3 (SP) Configuration

Table 18 lists the configuration registers that affect the Serial Port. Only the last register (F0h) is described here. See Section 3.2.3 on page 32 for descriptions of the other configuration registers. All these registers are $V_{DD3}$ powered.

**Table 18. Serial Port Configuration Registers**

| Index | Configuration Register or Action | Type | Power Well | Reset |
|---|---|---|---|---|
| 30h | Activate (see Section 3.3.1 on page 36) | R/W | $V_{DD3}$ | 00h |
| 60h | Base Address MSB register. Bits 7-3 (for A15-11) are read only, '00000'. | R/W | $V_{DD3}$ | 03h |
| 61h | Base Address LSB register. Bits 2-0 (for A2-0) are read only, '000'. | R/W | $V_{DD3}$ | F8h |
| 70h | Interrupt Number and Wake-Up on IRQ Enable register | R/W | $V_{DD3}$ | 04h |
| 71h | Interrupt Type. Bit 1 is R/W; other bits are read only. | R/W | $V_{DD3}$ | 03h |
| 74h | Report no DMA Assignment | RO | $V_{DD3}$ | 04h |
| 75h | Report no DMA Assignment | RO | $V_{DD3}$ | 04h |
| F0h | Serial Port Configuration register | R/W | $V_{DD3}$ | 02h |

## 3.0 Device Architecture and Configuration (Continued)

### 3.10.3 Serial Port Configuration Register

This register is reset to 02h.

Power Well: $V_{DD3}$

Location: Index F0h

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Bank Select Enable** | **Reserved** | | | | **Busy Indicator** | **Power Mode Control** | **TRI-STATE Control** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

| Bit | Description |
|---|---|
| 7 | **Bank Select Enable**. Enables bank switching for the Serial Port.<br>0: All attempts to access the extended registers in the Serial Port are ignored (default)<br>1: Enables bank switching for the Serial Port |
| 6-3 | **Reserved.** |
| 2 | **Busy Indicator.** This read-only bit can be used by power management software to decide when to power down the Serial Port logical device.<br>0: No transfer in progress (default)<br>1: Transfer in progress |
| 1 | **Power Mode Control.** The logical device can be active in two modes:<br>0: Low Power mode: When the logical device is active in Low Power mode,<br>- The Low Serial Port clock is disabled.<br>- The output signals are set to their default states.<br>- The $\overline{RI}$ input signal can be programed to generate an interrupt.<br>- Registers are maintained (unlike the activation bit in Index 30h, which also prevents access to the Serial Port registers).<br>1: Normal Power mode: When the logical device is active in Normal Power mode,<br>- Serial Port clock enabled.<br>- Serial Port is functional when the logical device is active (default). |
| 0 | **TRI-STATE Control.** When this bit is set to 1 and the logical device is inactive, the logical device output pins are in TRI-STATE (see Section 3.3.2 on page 37).<br>0: Normal outputs (default)<br>1: TRI-STATE outputs when the logical device is inactive |

# 3.0 Device Architecture and Configuration (Continued)

## 3.11 SYSTEM WAKE-UP CONTROL (SWC) CONFIGURATION

### 3.11.1 General Description

System Wake-Up Control provides wake-up and power management functionality according to the ACPI specification (see Section 6.1 on page 70). Its registers are $V_{SB3}$ powered.

### 3.11.2 Logical Device 4 (SWC) Configuration

Table 19 lists the configuration registers that affect the SWC. See Section 3.2.3 on page 32 for a detailed description of these registers. All these registers are $V_{DD3}$ powered.

**Table 19. System Wake-Up Control (SWC) Configuration Registers**

| Index | Configuration Register or Action | Type | Power Well | Reset |
|---|---|---|---|---|
| 30h | Activate. When bit 0 is cleared, the runtime registers of this logical device are not accessible (see Section 3.3.1 on page 36).[1] | R/W | $V_{DD3}$ | 00h |
| 60h | SWC Base Address MSB register | R/W | $V_{DD3}$ | 00h |
| 61h | SWC Base Address LSB register. Bits 3-0 (for A3-0) are read only, '0000'. | R/W | $V_{DD3}$ | 00h |
| 62h | GPE1_BLK Base Address MSB register | R/W | $V_{DD3}$ | 00h |
| 63h | GPE1_BLK Base Address LSB register. Bits 3-0 (for A3-0) are read only, '0000'. | R/W | $V_{DD3}$ | 00h |
| 70h | Interrupt Number | R/W | $V_{DD3}$ | 00h |
| 71h | Interrupt Type. Bit 1 is read/write. Other bits are read only | R/W | $V_{DD3}$ | 03h |
| 74h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |
| 75h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |

1. The logical device runtime registers are maintained and all wake-up detection mechanisms are functional.

# 3.0 Device Architecture and Configuration (Continued)

## 3.12 KEYBOARD AND MOUSE CONTROLLER (KBC) CONFIGURATION

### 3.12.1 General Description

The KBC is implemented physically as a single hardware module and houses two separate logical devices: a Mouse controller (Logical Device 5) and a Keyboard controller (Logical Device 6). The KBC is functionally equivalent to the industry standard 8042A Keyboard controller. Technical references for the standard 8042A Keyboard Controller may serve as detailed technical references for the KBC.

The Keyboard and Mouse Controller runtime registers are described in Section 9.4 on page 119. All the registers are $V_{DD3}$ powered.

### 3.12.2 Logical Devices 5 and 6 (Mouse and Keyboard) Configuration

Tables 20 and 21 list the configuration registers that affect the Mouse and Keyboard logical devices. Only the last register (F0h) is described here. See Section 3.2.3 on page 32 for descriptions of the other configuration registers. The KBC module is activated and the access to the runtime registers (pointed at by the base addresses at indexes 60h-63h) is enabled when either the Mouse logical device (5) or the Keyboard logical device (6) is activated (by setting the activation bit at index 30h). Because the IRQ configuration resources are separate for each logical device (Mouse or Keyboard), the specific logical device must be activated to enable its IRQ resources. All of these registers are $V_{DD3}$ powered, with the exception of the KBC Configuration register (F0h), which is both $V_{DD3}$ and $V_{SB3}$ powered.

**Table 20. Mouse Configuration Registers**

| Index | Mouse Configuration Register or Action | Type | Power Well | Reset |
|---|---|---|---|---|
| 30h | Activate (see Section 3.2.3 on page 32). When the Mouse of the KBC is inactive, the IRQ selected by the Mouse Interrupt Number and Wake-Up on IRQ Enable register (index 70h) are not asserted. | R/W | $V_{DD3}$ | 00h |
| 70h | Mouse Interrupt Number and Wake-Up on IRQ Enable register | R/W | $V_{DD3}$ | 0Ch |
| 71h | Mouse Interrupt Type. Bits 1,0 are read/write; other bits are read only. | R/W | $V_{DD3}$ | 02h |
| 74h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |
| 75h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |

**Table 21. Keyboard Configuration Registers**

| Index | Keyboard Configuration Register or Action | Type | Power Well | Reset |
|---|---|---|---|---|
| 30h | Activate (see Section 3.2.3 on page 32). When the Keyboard of the KBC is inactive, the IRQ selected by the Keyboard Interrupt Number and Wake-Up on IRQ Enable register (index 70h) are not asserted. | R/W | $V_{DD3}$ | 00h |
| 60h | Base Address MSB register. Bits 7-3 (for A15-11) are read only, '00000'. | R/W | $V_{DD3}$ | 00h |
| 61h | Base Address LSB register. Bits 2-0 (for A2-0) are read-only, '000'. | R/W | $V_{DD3}$ | 60h |
| 62h | Command Base Address MSB register. Bits 7-3 (for A15-11) are read only, '00000'. | R/W | $V_{DD3}$ | 00h |
| 63h | Command Base Address LSB. Bits 2-0 (for A2-0) are read-only, '100'. | R/W | $V_{DD3}$ | 64h |
| 70h | KBD Interrupt Number and Wake-Up on IRQ Enable register | R/W | $V_{DD3}$ | 01h |
| 71h | KBD Interrupt Type. Bits 1,0 are read/write; others are read only. | R/W | $V_{DD3}$ | 02h |
| 74h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |
| 75h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |
| F0h | KBC Configuration register | R/W | $V_{DD3}/V_{SB3}$ | 40h |

# 3.0 Device Architecture and Configuration (Continued)

## 3.12.3 KBC Configuration Register

This register is reset to 40h.

Power Well: $V_{DD3}$ and $V_{SB3}$ (see Note 1)

Location: Index F0h

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **KBC Clock Source** | | **Reserved** | | **SWAP[1]** | **Reserved** | | **TRI-STATE Control** |
| Reset | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Required | | | | | | 0 | | |

1. This bit is powered from the $V_{SB3}$ well and is reset by $V_{SB3}$ Power-Up reset.

| Bit | Description |
|---|---|
| 7-6 | **KBC Clock Source.** The clock source can be changed only when the KBC is inactive (disabled).<br>**Bits 7 6 Source**<br>0 0: 8 MHz<br>0 1: 12 MHz (default)<br>1 0: 16 MHz<br>1 1: Reserved |
| 5-4 | **Reserved.** |
| 3 | **SWAP (Swap Keyboard and Mouse Inputs).** When this bit is set, the keyboard signals (KBCLK and KBDAT) are swapped with the mouse signals (MCLK and MDAT). This bit is used both by the KBC module and by the Keyboard/Mouse Wake-Up Detector in the SWC module. This bit is reset to the default value by $V_{SB3}$ Power-Up reset only.<br>0: No swapping (default)<br>1: Swaps the keyboard and mouse signals |
| 2-1 | **Reserved.** |
| 0 | **TRI-STATE Control**. When this bit is set, the Keyboard pins (KBCLK, KBDAT) and the Mouse pins (MCLK, MDAT) are in TRI-STATE (see Section 3.3.2 on page 37), if both the Keyboard and the Mouse logical devices are inactive.<br>0: Normal outputs (default)<br>1: TRI-STATE outputs when the Keyboard and the Mouse logical devices are inactive |

**Usage Hints:**

1. To change the clock frequency of the KBC:
   a. Disable the KBC logical devices.
   b. Change the frequency setting.
   c. Enable the KBC logical devices.
2. Before swapping between the Keyboard and Mouse Interface pins, disable the KBC logical devices and their pins. After swapping, the software must issue a synchronization command to the Keyboard and Mouse through the KBC to regain synchronization with these devices.

# 3.0 Device Architecture and Configuration (Continued)

## 3.13 GENERAL-PURPOSE INPUT/OUTPUT (GPIO) PORTS CONFIGURATION

### 3.13.1 General Description

The GPIO functional block includes 13 pins arranged in two ports:

- Port 0 contains eight GPIOE pins (i.e., GPIO pins with event detection).
- Port 1 contains four GPIOE pins and one GPIO pin.

The pins of Ports 0 and 1 have full event detection capability (see Section 1.3 on page 13), enabling them to trigger an IRQ. In addition, through the SWC functional block, the pins of Ports 0 and 1 can trigger the $\overline{\text{SIOPME}}$ signal. An exception is the GPIO14 pin of Port 1, which has no event detection and therefore cannot trigger IRQ or $\overline{\text{SIOPME}}$.

All 13 GPIO pins are powered from the $V_{SB3}$ well. The 10 runtime registers associated with the two ports are arranged in the GPIO address space as shown in Table 22. Each GPIO port with wake-up event detection capability has five runtime registers. The GPIO base address is 32-byte aligned. Address bits 4-0 are used to indicate the register offset.

The specific runtime registers implemented in the PC87372 devices are shown in Table 22. All of these registers are $V_{SB3}$ powered.

**Table 22. Runtime Registers in GPIO Address Space**

| Offset | Mnemonic | Register Name | Port | Power Well | Type | |
|---|---|---|---|---|---|---|
| | | | | | SEPDIO[1] = 1 | SEPDIO = 0 |
| 00h | GPDO0 | GPIO Data Out 0 | 0 | $V_{SB3}$ | R/W | RO |
| 01h | GPDI0 | GPIO Data In 0 | | $V_{SB3}$ | RO | RO |
| 02h | GPEVEN0 | GPIO Event Enable 0 | | $V_{SB3}$ | R/W | RO |
| 03h | GPEVST0 | GPIO Event Status 0 | | $V_{SB3}$ | R/W1C | RO |
| 04h | GPDO1 | GPIO Data Out 1 | 1 | $V_{SB3}$ | R/W | RO |
| 05h | GPDI1 | GPIO Data In 1 | | $V_{SB3}$ | RO | RO |
| 06h | GPEVEN1 | GPIO Event Enable 1 | | $V_{SB3}$ | R/W | RO |
| 07h | GPEVST1 | GPIO Event Status 1 | | $V_{SB3}$ | R/W1C | RO |
| 15h | GPDIO0 | GPIO Data In/Out 0 | 0 | $V_{SB3}$ | R/W | R/W |
| 16h | GPDIO1 | GPIO Data In/Out 1 | 1 | $V_{SB3}$ | R/W | R/W |

1. See Section 3.13.7 on page 59

# 3.0 Device Architecture and Configuration (Continued)

## 3.13.2 Logical Device 7 (GPIO) Configuration

Table 23 lists the configuration registers that affect the GPIO. Only the last five registers (F0h-F3h and F8h) are described here. See Section 3.2.3 on page 32 for a detailed description of the other configuration registers. The standard configuration registers are powered by $V_{DD3}$; however, the specific configuration registers are powered by $V_{SB3}$.

**Table 23. GPIO Configuration Register**

| Index | Configuration Register or Action | Type | Power Well | Reset |
|---|---|---|---|---|
| 30h | Activate (see Section 3.2.3 on page 32) | R/W | $V_{DD3}$ | 00h |
| 60h | Base Address MSB register | R/W | $V_{DD3}$ | 00h |
| 61h | Base Address LSB register. Bits 4-0 (for A4-0) are read-only, '00000'. | R/W | $V_{DD3}$ | 00h |
| 70h | Interrupt Number and Wake-Up on IRQ Enable register | R/W | $V_{DD3}$ | 00h |
| 71h | Interrupt Type. Bit 1 is read/write. Other bits are read only. | R/W | $V_{DD3}$ | 03h |
| 74h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |
| 75h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |
| F0h | GPIO Pin Select register (GPSEL) | R/W | $V_{SB3}$ | 00h |
| F1h | GPIO Pin Configuration register 1 (GPCFG1) | Varies per bit | $V_{SB3}$ | 00h |
| F2h | GPIO Pin Event Routing register (GPEVR) | R/W or RO | $V_{SB3}$ | 00h |
| F3h | GPIO Pin Configuration register 2 (GPCFG2) | R/W or RO | $V_{SB3}$ | 00h |
| F8h | GPIO Mode Select register (GPMODE) | R/W or RO | $V_{SB3}$ | 01h |

Figure 8 shows the organization of registers GPCFG1-2, GPEVR and GPMODE:

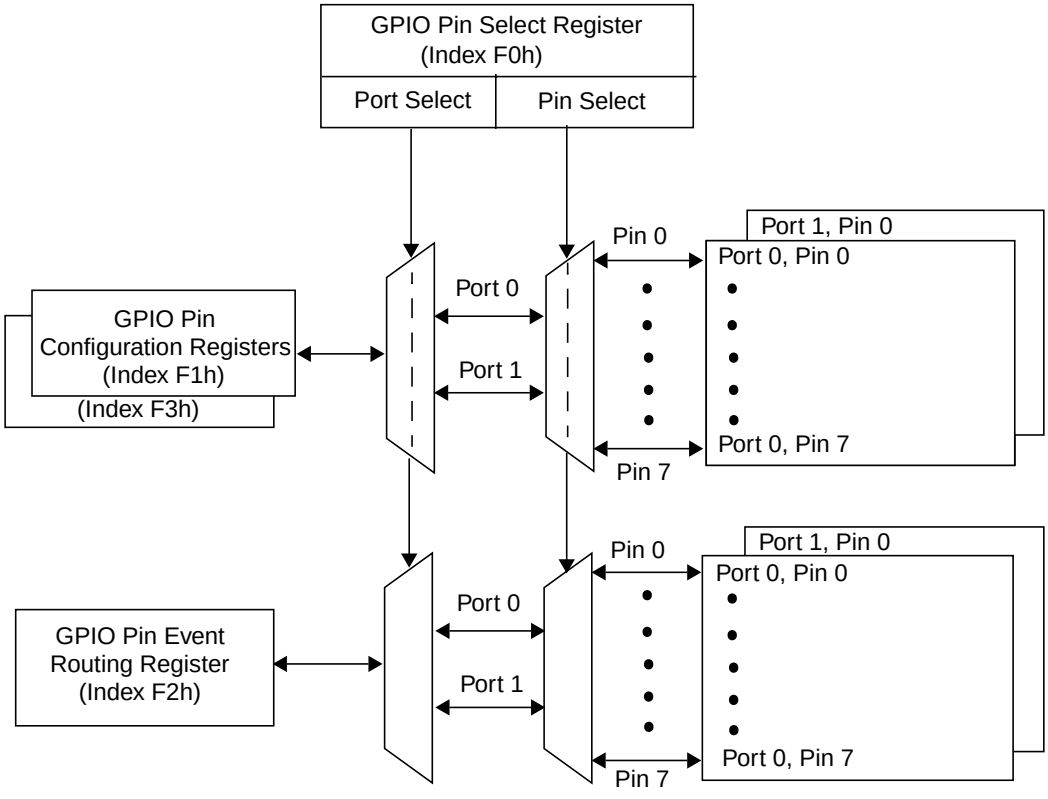



**Figure 8. Organization of GPIO Pin Registers GPCFG1-2, GPEVR and GPMODE**

## 3.0 Device Architecture and Configuration (Continued)

### 3.13.3 GPIO Pin Select Register (GPSEL)

This register selects the GPIO pin (port number and bit number) to be configured (i.e., which register is accessed via the GPIO pin configuration registers). GPSEL is reset to 00h.

Power Well: $V_{SB3}$

Location: Index F0h

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | **PORTSEL** | | **Reserved** | **PINSEL** | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-6 | **Reserved.** |
| 5-4 | **PORTSEL (Port Select).** These bits select the GPIO port to be configured:<br>00: Port 0 (default)<br>01: Port 1 (all other values are reserved) |
| 3 | **Reserved.** |
| 2-0 | **PINSEL (Pin Select).** These bits select the GPIO pin of the selected port to be configured:<br>000: Pin 0 (default)<br>001-111: Binary value of pin numbers 1-7, respectively |

### 3.13.4 GPIO Pin Configuration Register 1 (GPCFG1)

This register reflects, for both read and write, the register currently selected by the GPIO Pin Select register. All of the GPIO pin configuration registers have a common bit structure, as shown below. An exception to this is GPIO14 pin of Port 1, which lacks the EVDBNC, EVPOL and EVTYPE bits (the bits are reserved). All of the GPCFG1 registers are reset to 00h.

Power Well: $V_{SB3}$

Location: Index F1h

Type: Varies per bit

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | **EVDBNC[1]** | **EVPOL[1]** | **EVTYPE[1]** | **LOCKCFP** | **PUPCTL** | **OUTTYPE** | **OUTENA** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1. This bit is reserved for the GPIO14 pin in Port 1.

| Bit | Type | Description |
|---|---|---|
| 7 | – | **Reserved.** |
| 6 | R/W or RO | **EVDBNC (Event Debounce Enable).** This bit enables the debounce circuit in the event input path of the selected GPIO pin. The event is detected after a predetermined debouncing period (see Section 5.3 on page 65).<br>0: Disabled (default)<br>1: Enabled |
| 5 | R/W or RO | **EVPOL (Event Polarity).** This bit defines the polarity of the wake-up signal that issues an event from the selected GPIO pin (see Section 5.3 on page 65).<br>0: Falling edge or low level input (default)<br>1: Rising edge or high level input |

| Bit | Type | Description |
|---|---|---|
| 4 | R/W or RO | **EVTYPE (Event Type).** This bit defines the type of the wake-up signal that issues an event from the selected GPIO pin (see Section 5.3 on page 65).<br>0: Edge input (default)<br>1: Level input |
| 3 | R/W1S | **LOCKCFP (Lock Configuration of Pin)**. When set to 1, this bit locks the GPIO pin configuration and data (see also Section 5.4 on page 67) by disabling writing to itself, to GPCFG1 register bits PUPCTL, OUTTYPE and OUTENA, to all of the bits of GPCFG2 register and to the corresponding bit in GPDO and GPDIO registers. Once set, this bit can be cleared by $V_{DD3}$ Power-Up reset (or Hardware reset).<br>0: R/W bits are enabled for write (default)<br>1: All bits are RO |
| 2 | R/W or RO | **PUPCTL (Pull-Up Control**). This bit controls the internal pull-up resistor of the selected GPIO pin (see Section 5.2 on page 64).<br>0: Disabled (default)<br>1: Enabled |
| 1 | R/W or RO | **OUTTYPE (Output Type).** This bit controls the output buffer type of the selected GPIO pin (see Section 5.2 on page 64).<br>0: Open-drain (default)<br>1: Push-pull |
| 0 | R/W or RO | **OUTENA (Output Enable).** This bit controls the output buffer of the selected GPIO pin (see Section 5.2 on page 64).<br>0: TRI-STATE (default)<br>1: Output buffer enabled |

### 3.13.5 GPIO Event Routing Register (GPEVR)

This register enables the routing of the GPIO event (see Section 5.3.2 on page 66) to an IRQ. An exception to this is GPIO14 pin of Port 1, which lacks the GPEVR register (the register is reserved). GPEVR is reset to 00h.

Power Well: $V_{SB3}$

Location: Index F2h

Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | | | | **EV2IRQ** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-1 | **Reserved.** |
| 0 | **EV2IRQ (Event to IRQ Routing).** Controls the routing of the event from the selected GPIO pin to IRQ (see Section 5.3.2 on page 66).<br>0: Disabled (default)<br>1: Enabled |

# 3.0 Device Architecture and Configuration (Continued)

## 3.13.6 GPIO Pin Configuration Register 2 (GPCFG2)

This register controls the connection of the GPIO pin to a $V_{DD}$-powered load. An exception to this is GPIO14 pin of Port 1, which lacks the GPCFG2 configuration register (the register is reserved and the pin is configured for $V_{SB3}$-powered load). GPCFG2 is reset to 00h.

Power Well: $V_{SB3}$
Location: Index F3h
Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | **VDDLOAD** | **Reserved** | | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-5 | **Reserved.** |
| 4 | **VDDLOAD ($V_{DD3}$-Powered Load).** This bit indicates that the selected GPIO pin is connected to a device powered by $V_{DD3}$. The input and output buffers (including the internal pull-up) of the selected GPIO pin are disabled whenever $V_{DD3}$ power to the PC87372 device falls below a certain value (see Section 10.1.5 on page 122).<br>0: GPIO pin connected to a $V_{SB3}$-powered load (default): The configuration and data of the GPIO pin are reset by $V_{SB}$ Power-Up reset (see Section 2.2 on page 26).<br>1: GPIO pin connected to a $V_{DD3}$-powered load: The configuration (excepting the VDDLOAD bit) and data of the GPIO pin are reset by $V_{DD}$ Power-Up reset, Hardware reset or Software reset (see Section 2.2 on page 26). |
| 3-0 | **Reserved.** |

## 3.13.7 GPIO Mode Select Register (GPMODE)

This register controls the operation mode of the GPIO runtime registers (see Section 5.1 on page 63). GPMODE is reset to 01h.

Power Well: $V_{SB3}$
Location: Index F8h
Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | | | | **SEPDIO** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit | Description |
|---|---|
| 7-1 | **Reserved.** |
| 0 | **SEPDIO (Separate Data I/O Select).** This bit selects the operation mode of the GPIO runtime registers by controlling the GPDO*n*, GPEVEN*n* and GPEVST*n* runtime registers to read-only (*n* is the Port number, 0 or 1).<br>0: Common Data I/O mode (GPDO*n*, GPEVEN*n* and GPEVST*n* registers are read-only, and data written to them is ignored)<br>1: Separate Data I/O mode (default) |

# 3.0 Device Architecture and Configuration (Continued)

## 3.14 FAN SPEED MONITOR (FSM) CONFIGURATION

### 3.14.1 General Description

This module includes two Fan Speed Monitor units (see Section 7 on page 95). The 10 runtime registers of the two functional blocks are arranged in the address space shown in Table 24. The base address is 32-byte aligned. Address bits 0–4 are used to indicate the register offset.

**Table 24. Runtime Registers in FSM Address Space**

| Offset | Mnemonic | Register Name | Function |
|---|---|---|---|
| 00h | FMTHRL1 | Fan Monitor 1 Threshold Low | Fan Speed Monitor 1 |
| 01h | FMTHRH1 | Fan Monitor 1 Threshold High | |
| 02h | FMSPRL1 | Fan Monitor 1 Speed Low | |
| 03h | FMSPRH1 | Fan Monitor 1 Speed High | |
| 04h | FMCSR1 | Fan Monitor 1 Control & Status | |
| 05h | FMTHRL2 | Fan Monitor 2 Threshold Low | Fan Speed Monitor 2 |
| 06h | FMTHRH2 | Fan Monitor 2 Threshold High | |
| 07h | FMSPRL2 | Fan Monitor 2 Speed Low | |
| 08h | FMSPRH2 | Fan Monitor 2 Speed High | |
| 09h | FMCSR2 | Fan Monitor 2 Control & Status | |
| 0Ah-1Fh | Reserved | | |

### 3.14.2 Logical Device 9 (FSM) Configuration

Table 25 lists the configuration registers that affect the Fan Speed Monitor. Only the last register (F0h) is described here. See Section 3.2.3 on page 32 for a detailed description of the other registers.

**Table 25. FSM Configuration Registers**

| Index | Configuration Register or Action | Type | Power Well | Reset |
|---|---|---|---|---|
| 30h | Activate. When bit 0 is cleared, the runtime registers of this logical device are not accessible (see Section 3.3.1 on page 36).[1] | R/W | $V_{DD3}$ | 00h |
| 60h | FSM Base Address MSB register | R/W | $V_{DD3}$ | 00h |
| 61h | FSM Base Address LSB register. Bits 4-0 (for A4-0) are read only, '00000'. | R/W | $V_{DD3}$ | 00h |
| 70h | Interrupt Number and Wake-Up on IRQ Enable register | R/W | $V_{DD3}$ | 00h |
| 71h | Interrupt Type. Bit 1 is read/write. Other bits are read only. | R/W | $V_{DD3}$ | 03h |
| 74h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |
| 75h | Report no DMA assignment | RO | $V_{DD3}$ | 04h |
| F0h | Fan Speed Monitor Configuration register (FSMCF) | R/W | $V_{DD3}$ | 00h |

1. The logical device runtime registers are maintained and all detection mechanisms are functional.

# 3.0 Device Architecture and Configuration (Continued)

## 3.14.3 Fan Speed Monitor Configuration Register (FSMCF)

This register is reset to 00h.

Power Well: $V_{DD3}$

Location: Index F0h

Type: Varies per bit

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **LOCKFCF** | **Reserved** | | **FANMON_EN2** | **Reserved** | | **FANMON_EN1** | **Reserved** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Type | Description |
|---|---|---|
| 7 | R/W1S | **LOCKFCF (Lock Fan Speed Configuration).** When set to 1, this bit locks the bits of the FSMCF register by disabling writing to them (including the LOCKFCF bit itself). Once set, this bit can be cleared by $V_{DD3}$ Power-Up reset (or Hardware reset).<br>0: R/W bits are enabled for write (default)<br>1: All bits are RO |
| 6-5 | – | **Reserved.** |
| 4 | R/W or RO | **FANMON_EN2 (Fan Monitor Enable 2).** When this bit is set to 1, the Fan Speed Monitor 2 is enabled and the rate of pulses received at the FANTACH2 tachometer input is measured.<br>0: Disabled (default)<br>1: Enabled |
| 3-2 | – | **Reserved.** |
| 1 | R/W or RO | **FANMON_EN1 (Fan Monitor Enable 1).** When this bit is set to 1, the Fan Speed Monitor 1 is enabled and the rate of pulses received at the FANTACH1 tachometer input is measured.<br>0: Disabled (default)<br>1: Enabled |
| 0 | – | **Reserved.** |

# 4.0 LPC Bus Interface

With the exception of the Glue Functions, the host can access all the functional blocks of the PC87372 device through the LPC bus.

## 4.1 OVERVIEW

The LPC host interface supports 8-bit I/O Read, 8-bit I/O Write and 8-bit DMA transactions, as defined in Intel's *LPC Interface Specification, Revision 1.0*.

## 4.2 LPC TRANSACTIONS

The LPC interface of the PC87372 device responds to the following LPC transactions:

- 8-bit I/O read and write cycles
- 8-bit DMA read and write cycles
- DMA request cycles

## 4.3 $\overline{\text{LPCPD}}$ FUNCTIONALITY

The PC87372 device supports $\overline{\text{LPCPD}}$ functionality. $\overline{\text{LPCPD}}$ is used when the $V_{DD3}$ power supply is not shared by all the devices connected to the LPC bus. The $\overline{\text{LPCPD}}$ signal conforms with Intel's *LPC Interface Specification, Revision 1.00.* Note that if the PC87372 power supply is on while $\overline{\text{LPCPD}}$ is active (indicating the LPC bus is powered down), the PC87372 does not have to be reset when $\overline{\text{LPCPD}}$ is de-asserted (indicating that power is returned to the LPC bus).

When the $\overline{\text{LPCPD}}$ functionality is not required, the $\overline{\text{LPCPD}}$ pin must be left unconnected. Connecting the $\overline{\text{LPCPD}}$ pin to the $V_{DD3}$ power supply is not recommended.

## 4.4 INTERRUPT SERIALIZER

The Interrupt Serializer translates parallel interrupt request (PIRQ) signals received from internal IRQ sources into serial interrupt request data transmitted over the SERIRQ bus. This enables devices that support only parallel IRQs to be integrated into a system that supports only serial IRQs like the LPC bus.

Each internal IRQ is fed into a Mapping, Enable and Polarity Control block, which maps the IRQ to its associated IRQ numbers (see Table 12 on page 33). The resulting IRQs are then fed into the Interrupt Serializer, where they are translated into serial data and then transmitted over the SERIRQ bus. Each interrupt number is assigned a time slot in the SERIRQ frame. Different IRQ sources in the PC87372 device cannot share the same interrupt number and thus cannot share the same time slot in the SERIRQ frame.

When a transition is detected on an IRQ source, the new value of the IRQ source is transmitted over the SERIRQ bus during the corresponding IRQ slot. For example, when a transition on the Serial Port IRQ is detected, the new value of the Serial Port IRQ is transmitted during time slot n of the SERIRQ bus.

# 5.0 General-Purpose Input/Output (GPIO) Ports

This chapter describes one 8-bit port. A device may include a combination of several ports with different implementations. For device specific implementation, see Section 3.13 on page 55.

## 5.1 OVERVIEW

The GPIO port is an 8-bit port, connected to eight pins. It features:

- Software capability to control and read pin levels.
- Flexible system notification by several means, based on the pin level or level transition.
- Ability to capture and route events and their associated status.
- Back-drive protected pins.

GPIO port operation is associated with two sets of registers:

- Pin Configuration registers mapped in the Device Configuration space. These registers are used to configure the logical behavior of each pin. There are three registers for each GPIO pin: GPIO Pin Configuration registers 1 and 2 (GPCFG1, GPCFG2) and the GPIO Pin Event Routing register (GPEVR).
- Four 8-bit runtime registers: GPIO Data Out (GPDO), GPIO Data In (GPDI), GPIO Event Enable (GPEVEN) and GPIO Event Status (GPEVST). These registers are mapped in the GPIO device I/O space (which is determined by the base address registers in the GPIO Device Configuration). They are used to control and/or read the pin values and to handle system notification. Each runtime register corresponds to the 8-pin port, such that bit 'n' in each one of the four registers is associated with GPIOXn pin, where 'X' is the port number.
- An additional optional runtime register: GPIO Data In/Out (GPDIO). This register is also mapped in the GPIO device I/O space, but at a separate location from the above group of four runtime registers. It contains the same data-out value as the GPDO register and the same data-in value as the GPDI register.

Each GPIO pin is associated with configuration bits and the corresponding bit slice of the four runtime registers, as shown in Figure 9.

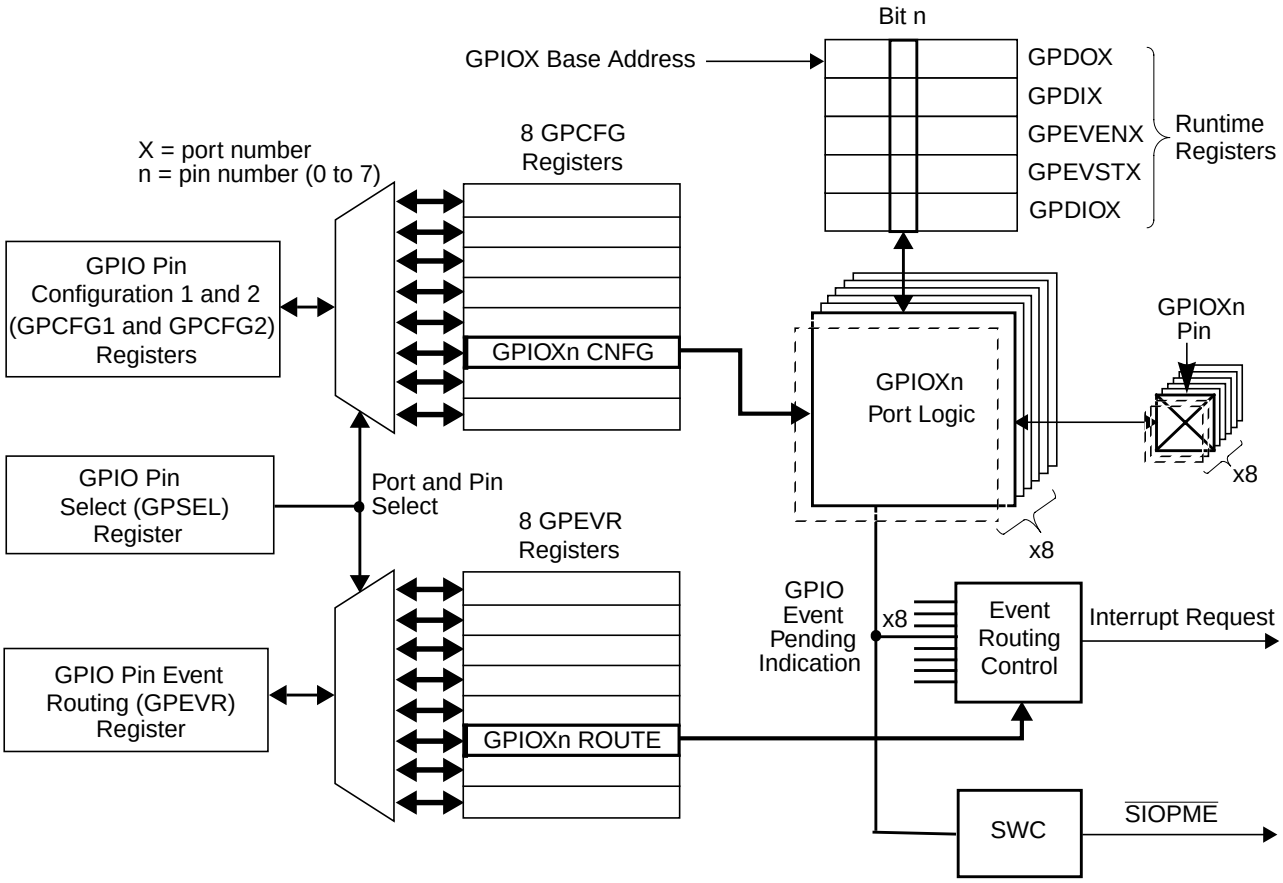



**Figure 9. GPIO Port Architecture**

## 5.0 General-Purpose Input/Output (GPIO) Ports (Continued)

The functionality of the GPIO port is divided into:

- Basic functionality: Includes configuration of, writing to and reading from the GPIO pins (described in Section 5.2)
- Enhanced functionality: Includes wake-up event detection and system notification (described in Section 5.3)

In addition, the GPIO port can be operated in one of the following modes:

- Separate Data I/O: Separate registers are available for Data In (GPDI) and for Data Out (GPDO) in addition to the Data In/Out register (GPDIO) and to the enhanced functionality registers (GPEVST and GPEVEN).
- Common Data I/O: Only the Data In/Out register (GPDIO) is available.

### 5.2 BASIC FUNCTIONALITY

The basic functionality of each GPIO pin is based on four configuration bits and a bit slice of runtime registers GPDO and GPDI (or GPDIO). The configuration and operation of a single pin GPIOXn (pin 'n' in port 'X') is shown in Figure 10.

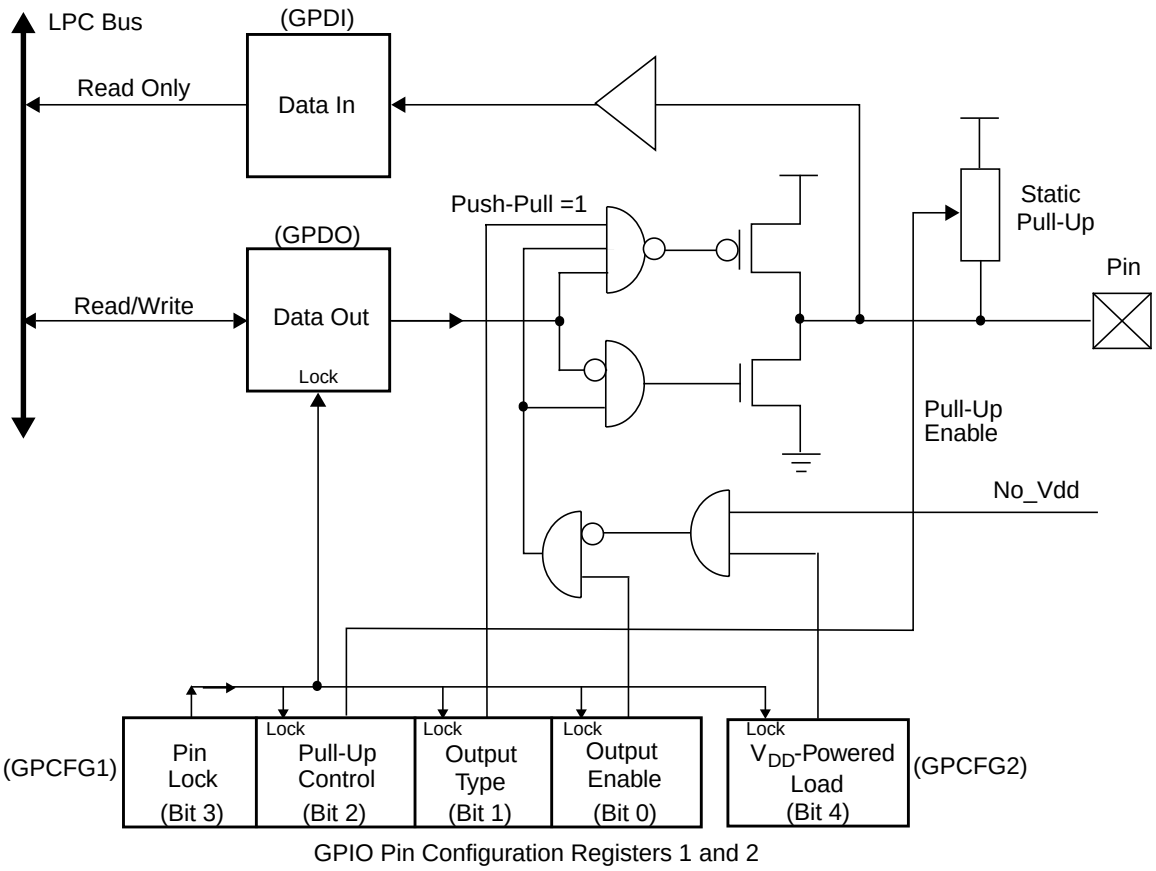



**Figure 10. GPIO Basic Functionality**

#### 5.2.1 Configuration Options

The GPCFG1 register controls the following basic configuration options, as shown in Figure 10:

- Port Direction: Controlled by Output Enable (bit 0).
- Output Type: Push-pull vs. open-drain; it is controlled by Output Buffer Type (bit 1) by enabling/disabling the upper transistor of the output buffer.
- Static Pull-Up: May be added to any type of port (input, open-drain or push-pull). It is controlled by Pull-Up Control (bit 2).
- Pin Lock: GPIO pin may be locked to prevent any changes in the output value and/or the output configuration. The lock is controlled by bit 3. It disables writes to GPDO and GPDIO registers bits, to bits 3–0 of GPCFG1 register (including the Lock bit itself) and to bit 4 of GPCFG2 register.

## 5.0 General-Purpose Input/Output (GPIO) Ports (Continued)

The GPCFG2 register controls the Load Protection configuration option:

- $V_{DD}$-Powered Load: Disables the Output Buffer (if enabled), the Static Pull-Up (if enabled) and the Input Buffer if the specific GPIO pin is connected to a $V_{DD}$-powered device and $V_{DD3}$ power to the PC87372 is not present (No_Vdd). This function is controlled by the $V_{DD}$-powered Load bit (bit 4).

### 5.2.2 Operation

If the output is enabled, the value that is written to the GPDO or GPDIO registers is driven to the pin. Reading from the GPDO register returns its contents regardless of the actual pin value or the port configuration.

The GPDI register is a read-only register. Reading from the GPDI register returns the actual pin value regardless of its source (the port itself or an external device). Writing to this register is ignored.

Reading from the GPDIO register returns the actual pin value regardless of its source.

Activation of the GPIO module is controlled by device-specific configuration bits. When this module is inactive, access through the LPC bus to the runtime registers (GPDI, GPDO and GPDIO) is disabled; however, there is no change in the GPDO and GPDIO values and therefore there is no effect on the outputs of the pins.

The configuration and data registers of each GPIO pin are reset according to the setting of VDDLOAD bit in GPCFG2 register (see Section 3.13.6 on page 59).

## 5.3 EVENT HANDLING AND SYSTEM NOTIFICATION

The enhanced GPIO port (GPIOE) supports system notification based on event detection. This functionality is based on configuration bits and a bit slice of runtime registers GPEVEN and GPEVST. The configuration and operation of the event detection capability is shown in Figure 11. System notification is described in Section 5.3.2.

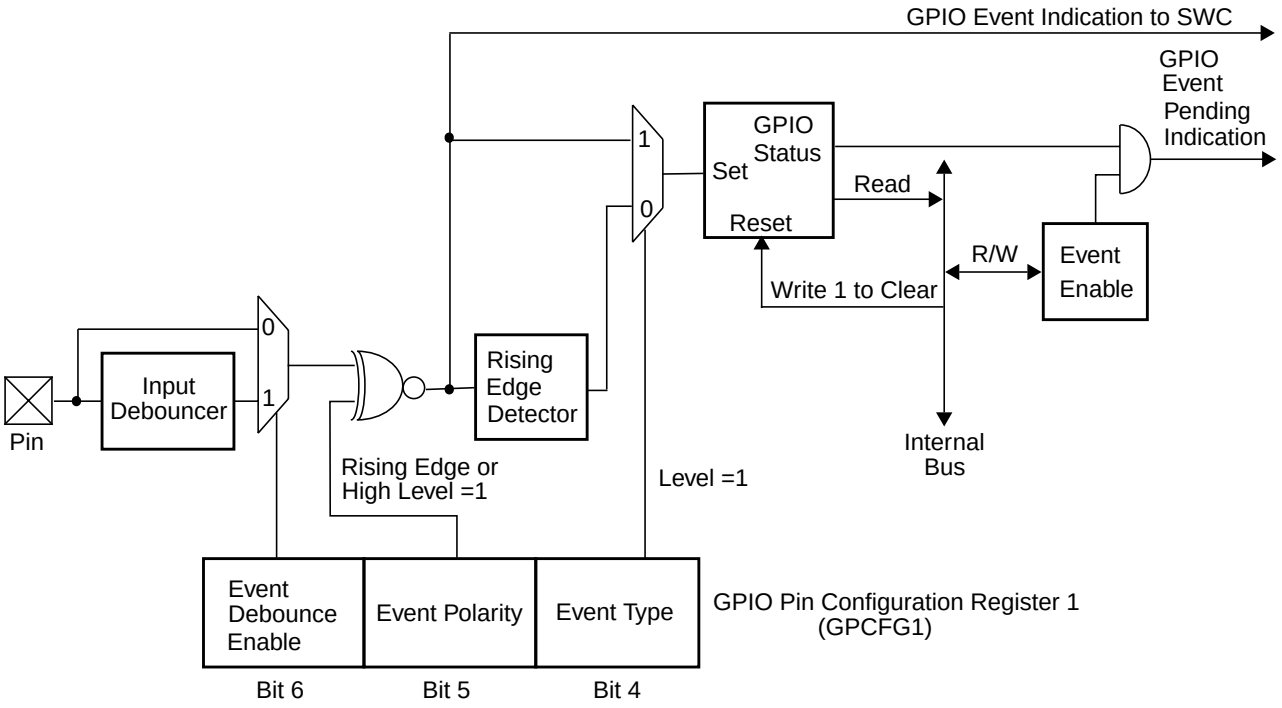



**Figure 11. Event Detection**

### 5.3.1 Event Configuration

Each pin in the GPIO port is a potential input event source. The event detection can trigger a system notification upon predetermined behavior of the source pin. The GPCFG1 register determines the event detection trigger type for system notification.

#### Event Debounce Enable

The input signal can be debounced for at least 16 ms, before entering the detector. To ensure that the signal is stable, the signal state is transferred to the event detector only after a debouncing period during which the signal has no transitions. The debouncer adds a delay equal to the debouncing period to both assertion and de-assertion of the event pending indicator (IRQ, SCI). The debounce is controlled by Event Debounce Enable (bit 6 of GPCFG1 register).

# 5.0 General-Purpose Input/Output (GPIO) Ports (Continued)

### Event Type and Polarity

Two trigger types of event detection are supported: edge and level. An edge event may be detected on a source pin transition either from high to low or low to high. A level event may be detected when the source pin is either at high or low level. The trigger type is determined by Event Type (bit 4 of GPCFG1 register). The direction of the transition (for edge) or the polarity of the active level (for level) is determined by Event Polarity (bit 5 of GPCFG1 register).

*Active edge* refers to a change in a GPIO pin level that matches the Event Polarity bit (1 for rising edge and 0 for falling edge). *Active level* refers to the GPIO pin level that matches the Event Polarity bit (1 for high level and 0 for low level). The corresponding bit in GPEVST register is set by hardware whenever an active edge or an active level is detected regardless of the GPEVEN register setting. Writing 1 to the Status bit clears it to 0. Writing 0 is ignored.

A GPIO pin is in event pending state if an active event has occurred (the corresponding bit in GPEVST register is set) and the corresponding bit in GPEVEN register is set.

## 5.3.2 System Notification

System notification on GPIO-triggered events is achieved by asserting an interrupt request via the Interrupt Serializer in the LPC Bus Interface.

The system notification for each GPIO pin is controlled by the corresponding bit in GPEVEN register together with bit 0 of GPEVR register. System notification by a GPIO pin is enabled if the corresponding bit of GPEVEN register is set to 1. The event routing mechanism is shown in Figure 12.

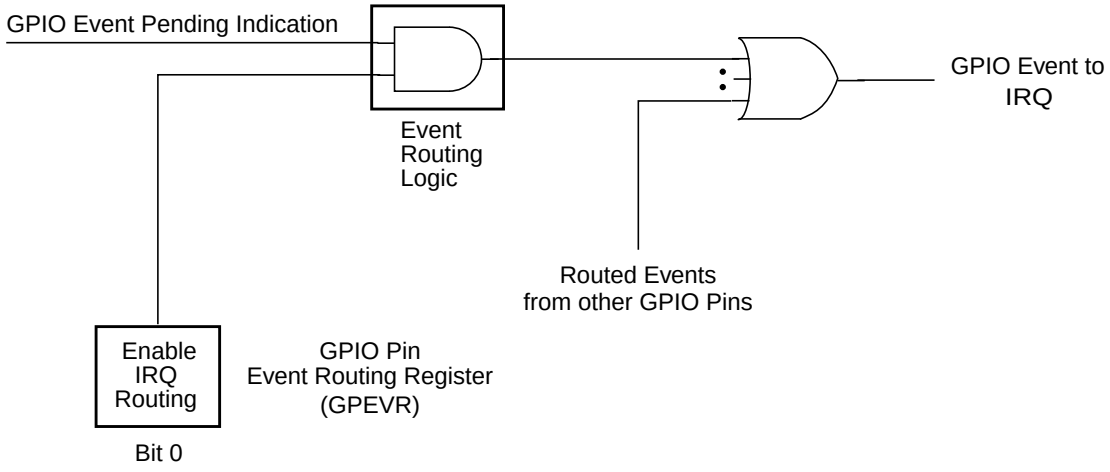



**Figure 12. GPIO Event Routing Mechanism for System Notification**

The system notification to the target is asserted if at least one GPIO pin is in event pending state.

The selection of the target (for system notification) is determined by the GPEVR register. The specific IRQ number is determined by the IRQ selection procedure of the device configuration. The assertion of IRQ (as a means of system notification) is disabled either when the GPIO functional block is deactivated or when $V_{DD3}$ power is off.

System notification through IRQ or SCI (see Section 6.2.4 on page 74) can be initiated by software by writing to the Data Out bit (in GPDO or GPDIO register) of a GPIO pin. This is possible only if the output of the corresponding GPIO pin is enabled, pin multiplexing is selected for the GPIO function (see Section 1.3 on page 13) and the GPIO event is routed to IRQ or SCI. System notification is asserted according to the actual level at the GPIO pin driven by the GPIO output and/or by external circuitry. The level driven by the GPIO output should not cause a contention with the level driven by the external circuitry.

A pending edge event may be cleared by clearing the corresponding GPEVST bit. However, a level event source may not be released by software (except for disabling the source) as long as the pin is at active level. When level event is used, it is also recommended to disable the input debouncer.

Upon deactivation of the GPIO functional block and while $V_{DD3}$ power is off, access through the LPC bus to the runtime registers (GPEVST and GPEVEN) is disabled. All means of system notification that include the target IRQ number are detached from the GPIO and de-asserted.

When $V_{DD3}$ power is off, the status bits of the GPIO pins connected to a $V_{DD}$-powered device (VDDLOAD = 1) are cleared, however the status bits of the GPIO pins connected to a $V_{SB}$-powered device (VDDLOAD = 0) are not affected.

Before enabling any system notification, it is recommended to set the desired event configuration and then verify that the status registers are cleared.

# 5.0 General-Purpose Input/Output (GPIO) Ports (Continued)

## 5.4 GPIO PORT REGISTERS

The following abbreviations are used to indicate the Register Type:

- R/W = Read/Write.
- R = Read from register (data written to this address is sent to a different register).
- W = Write (see above).
- RO = Read Only.
- WO = Write Only. Reading from the bit returns 0.
- R/W1C = Read/Write 1 to Clear. Writing 1 to a bit clears it to 0. Writing 0 has no effect.
- R/W1S = Read/Write 1 to Set. Writing 1 to a bit sets its value to 1. Writing 0 has no effect.

### 5.4.1 GPIO Pin Configuration Registers Structure

For each GPIO Port, there is a group of eight identical sets of configuration registers. Each set is associated with one GPIO pin. The entire group is mapped to the PnP configuration space. The mapping scheme is based on the GPSEL register (see Section 3.13.3 on page 57), which functions as an index register for the pin, and the selected GPCFG1, GPEVR and GPCFG2 registers, which reflect the configuration of the currently selected pin (see Table 26). All of these registers are $V_{SB3}$ powered.

**Table 26. GPIO Configuration Registers**

| Index | Configuration Register or Action | Type | Power Well | Reset |
|---|---|---|---|---|
| F0h | GPIO Pin Select register (GPSEL) | R/W | $V_{SB3}$ | 00h |
| F1h | GPIO Pin Configuration register 1 (GPCFG1) | Varies per bit | $V_{SB3}$ | 40h |
| F2h | GPIO Pin Event Routing register (GPEVR) | R/W or RO | $V_{SB3}$ | 01h |
| F3h | GPIO Pin Configuration register 2 (GPCFG2) | R/W or RO | $V_{SB3}$ | 00h |
| F8h | GPIO Mode Select register (GPMODE) | R/W or RO | $V_{SB3}$ | 01h |

### 5.4.2 GPIO Port Runtime Register Map

All of these registers are $V_{SB3}$ powered.

**Table 27. GPIO Port Runtime Register Map**

| Offset | Mnemonic | Register Name | Type | | Power Well | Reset | Section |
|---|---|---|---|---|---|---|---|
| | | | SEPDIO[1] = 1 | SEPDIO = 0 | | | |
| Device specific[2] | GPDO | GPIO Data Out | R/W | RO | $V_{SB3}$ | FFh | 5.4.3 |
| Device specific[2] | GPDI | GPIO Data In | RO | RO | $V_{SB3}$ | – | 5.4.4 |
| Device specific[2] | GPEVEN | GPIO Event Enable | R/W | RO | $V_{SB3}$ | 00h | 5.4.5 |
| Device specific[2] | GPEVST | GPIO Event Status | R/W1C | RO | $V_{SB3}$ | 00h | 5.4.6 |
| Device specific[2] | GPDIO | GPIO Data In/Out | R/W | R/W | $V_{SB3}$ | FFh[3] | 5.4.7 |

1. See Section 3.13.7 on page 59
2. The location of this register is defined in Section 3.13.1 on page 55.
3. The data read from this register after reset is undefined.

# 5.0 General-Purpose Input/Output (GPIO) Ports (Continued)

## 5.4.3 GPIO Data Out Register (GPDO)

Power Well: $V_{SB3}$

Location: Device specific

Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **DATAOUT** | | | | | | | |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit | Description |
|---|---|
| 7-0 | **DATAOUT (Data Out).** Bits 7-0 correspond to pins 7-0 of the specific Port. The value of each bit determines the value driven on the corresponding GPIO pin when its output buffer is enabled. Writing to the bit latches the written data unless the bit is locked by the GPCFG register Lock bit. Reading the bit returns its value regardless of the pin value and configuration.<br>0: Corresponding pin driven to low<br>1: Corresponding pin driven or released (according to buffer type selection) to high (default) |

## 5.4.4 GPIO Data In Register (GPDI)

Power Well: $V_{SB3}$

Location: Device specific

Type: RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **DATAIN** | | | | | | | |
| Reset | X | X | X | X | X | X | X | X |

| Bit | Description |
|---|---|
| 7-0 | **DATAIN (Data In).** Bits 7-0 correspond to pins 7-0 of the specific Port. Reading each bit returns the value of the corresponding GPIO pin. Pin configuration and the GPDO register value may influence the pin value. Write is ignored.<br>0: Corresponding pin level low<br>1: Corresponding pin level high |

# 5.0 General-Purpose Input/Output (GPIO) Ports (Continued)

## 5.4.5 GPIO Event Enable Register (GPEVEN)

Power Well: $V_{SB3}$

Location: Device specific

Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **EVTENA** | | | | | | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-0 | **EVTENA (Event Enable).** Bits 7-0 correspond to pins 7-0 of the specific Port. Each bit enables system notification by the corresponding GPIO pin. The bit has no effect on the corresponding Status bit in GPEVST register.<br>0: Event pending by corresponding GPIO pin masked<br>1: Event pending by corresponding GPIO pin enabled |

## 5.4.6 GPIO Event Status Register (GPEVST)

Power Well: $V_{SB3}$

Location: Device specific

Type: R/W1C or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **EVTSTAT** | | | | | | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7–0 | **EVTSTAT (Event Status).** Bits 7–0 correspond to pins 7–0 of the specific Port. The setting of each bit is independent of the Event Enable bit in GPEVEN register. An active event sets the Status bit, which may be cleared only by software writing 1 to the bit.<br>0: No active edge or level detected since last cleared<br>1: Active edge or level detected |

## 5.4.7 GPIO Data In/Out Register (GPDIO)

Power Well: $V_{SB3}$

Location: Device specific

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **DATAINOUT** | | | | | | | |
| Reset Write | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Reset Read | X | X | X | X | X | X | X | X |

| Bit | Description |
|---|---|
| 7-0 | **DATAINOUT (Data In/Out).** Bits 7-0 correspond to pins 7-0 of the specific Port. The value of each bit determines the value driven on the corresponding GPIO pin when its output buffer is enabled. Writing to the bit latches the written data unless the bit is locked by the GPCFG register Lock bit. Reading each bit returns the value of the corresponding GPIO pin. Pin configuration and the data-out value may influence the pin value.<br>0: Corresponding pin driven to low; pin level read low.<br>1: Corresponding pin driven or released (according to buffer type selection) to high; pin level read high (default). |

# 6.0 System Wake-Up Control (SWC)

## 6.1 OVERVIEW

The System Wake-Up Control (SWC) supports the *ACPI Specification, Revision 2.0, Feb. 2, 1999.*

The SWC functional block receives external events from the system; it also receives internal events from the functional blocks of the PC87372 device. Based on these events, the SWC generates the Power Management SCI interrupt ($\overline{\text{SIOPME}}$) and the system interrupt (IRQ). In addition, it controls two LED indicators.

The SWC receives the following external events:

- 12 $V_{SB}$-powered General-Purpose Input/Output events (GPIOE13-10 and GPIOE07-00).
- Modem Ring event ($\overline{\text{RI}}$).
- Mouse movement and button pressing events (via MCLK and MDAT).
- Advanced key pressing events from the Keyboard (via KBCLK and KBDAT).

The SWC receives the following internal events:

- Keyboard and Mouse interrupt event (IRQ).
- Module interrupt (IRQ) event from the Fan Speed Monitor or the Legacy functional blocks (FDC, Parallel Port and Serial Port).

The SWC implements the ACPI generic register group (General-Purpose Event 1 group) with “child” events.

The SWC generates the Power Management Event signal (the ACPI interrupt, $\overline{\text{SIOPME}}$) and the system interrupt (IRQ) based on the external and internal events and on the routing information written into the General-Purpose Event 1 register group. The ACPI-compatible SCI interrupt ($\overline{\text{SIOPME}}$) and the system interrupt (IRQ) are independent of the current sleep state.

The SWC receives sleep state information via the $\overline{\text{SLP_S3}}$ and $\overline{\text{SLP_S5}}$ pins from an external ACPI controller.

In addition, the SWC controls two LED indicators. The Standard LED Control option is used to provide blinking or constantly lit LEDs. The Advanced LED Control option provides programmable blink based on the current sleep state information or on the status of the $V_{SB3}$ and $V_{DD3}$ power supplies.

The SWC module is powered by $V_{SB3}$.

Figure 13 shows the simplified block diagram of the SWC functional block.

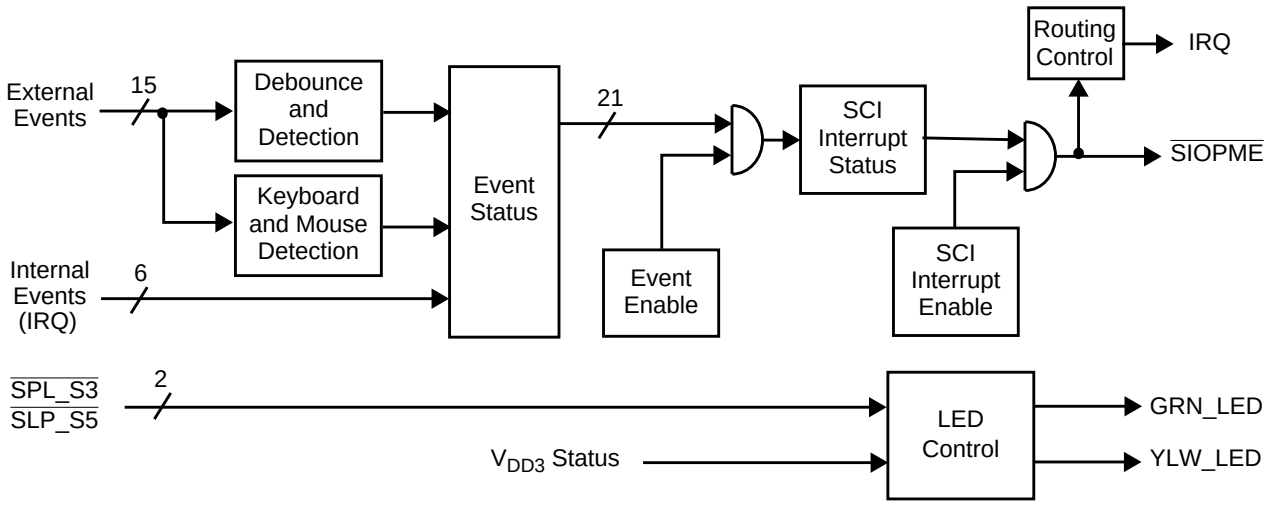



**Figure 13. SWC Block Diagram**

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.2 FUNCTIONAL DESCRIPTION

### 6.2.1 External Events

#### General-Purpose Input/Output Events

The PC87372 device supports 12 $V_{SB3}$-powered General-Purpose Input/Output events through ports GPIOE00-07 and GPIOE10-13. $V_{DD3}$- and $V_{SB3}$-powered signals can be connected to the GPIO pins to become sources of external events. A $V_{DD3}$-powered signal, when used to generate an event, is internally disabled for event generation while $V_{DD3}$ power is off. It is also disabled for event generation for $t_{EWIV}$ after $V_{DD3}$ power is restored (see *Wake-Up Inputs at VDD3 Power Switching* on page 143), which prevents the detection of false events during power transitions and while the signal driver is unpowered. For the same reasons, a $V_{SB3}$-powered signal used to generate an event is enabled only $t_{EWIV}$ after $V_{SB3}$ power is on. (When $V_{SB3}$ is off, the whole SWC module is disabled.)

Each GPIOE pin has both programmable polarity and an optional debouncer (see Figure 14). The debouncer is enabled after the reset but can be disabled by software. The debouncing time is longer than 16 ms.

A GPIO event can generate the system interrupt (IRQ) if the event is both enabled and routed to IRQ. The status, event enable and pending event routing bits to IRQ are implemented in the GPIO Port module (see Section 5.3 on page 65). The status bit is set when an event of the programed type (edge or level) is detected.

A GPIO event can also generate the Power Management SCI interrupt ($\overline{\text{SIOPME}}$). The status and event enable bits are implemented in the SWC module (see Figures 14 and 15).

An active level-type event sets the status bit in registers GPE1_STS_0 for ports GPIOE07-00 and GPE1_STS_1 for ports GPIOE13-10 (see Sections 6.4.4 and 6.4.5 on page 87). The status bit remains set even after the event becomes inactive. The status bit is cleared only when the software writes 1 to the bit. If the event is still active when software writes 1, the status bit remains set.

After changing the GPIOE1x pin multiplexing, clear the relevant bits in the GPE1_STS_1 register, to prevent false events (caused by the pin multiplexing switch) from generating a wake-up event.

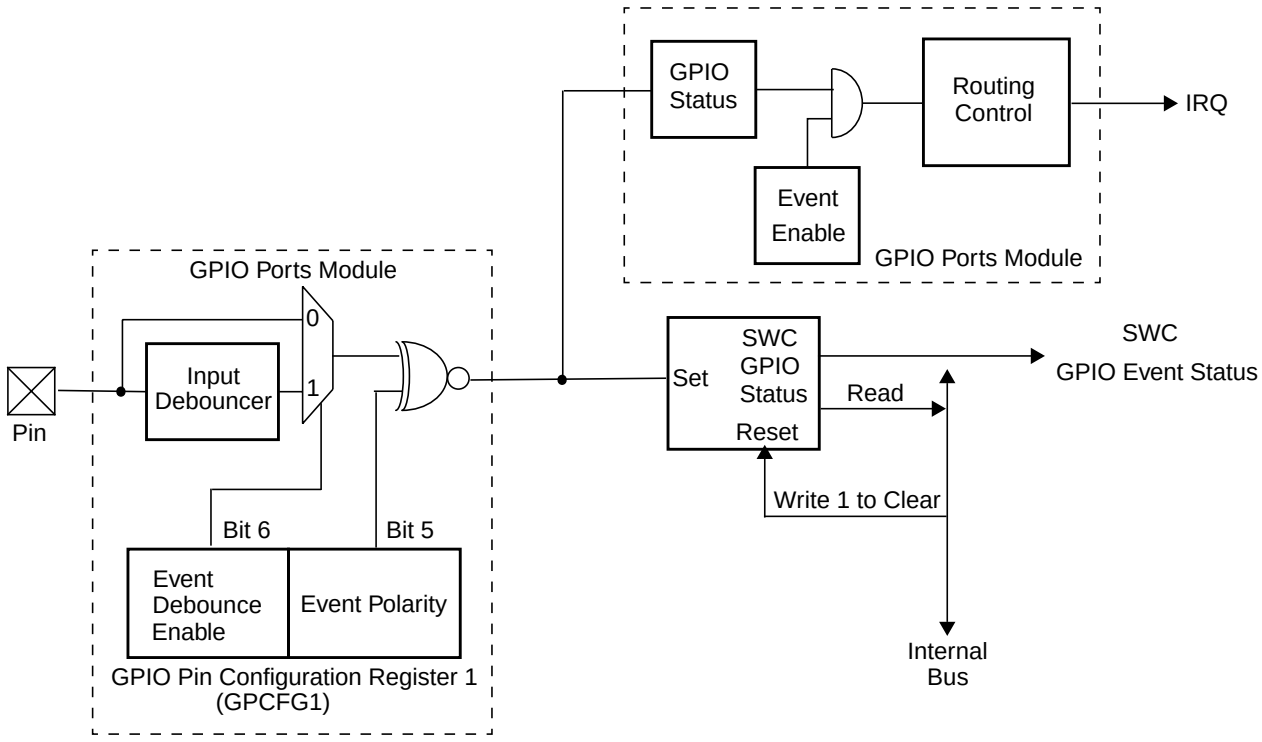



**Figure 14. GPIO Events**

## 6.0 System Wake-Up Control (SWC) (Continued)

### Modem Ring Event

High-to-low transitions on $\overline{RI}$ indicate the detection of a ring signal by an external modem connected to the Serial Port. The transitions on $\overline{RI}$ are detected by the RI Wake-Up Detector powered by $V_{SB3}$, which works independently of the Serial Port module (powered by $V_{DD3}$).

A detected $\overline{RI}$ transition sets the RI_EVT_STS status bit in GPE1_STS_2 register (see Section 6.4.6 on page 88). The status bit is cleared only when the software writes 1 to it.

The transition detection from $\overline{RI}$ is enabled (for event generation) $t_{EWIV}$ after $V_{SB3}$ power is on (see *Wake-Up Inputs at VSB3 Power Switching* on page 143). This prevents the detection of false events during $V_{SB3}$ power-On transitions.

### Mouse Wake-Up Event

A mouse wake-up event is detected by the Keyboard/Mouse Wake-Up Detector, which monitors the MCLK and MDAT signals. Since the detection mechanisms for keyboard and mouse events are independent, they can be operated simultaneously. Moreover, the Keyboard signals may be swapped with the Mouse signals by setting SWAP bit in KBC Configuration register (see Section 3.12.3 on page 54). The Keyboard/Mouse Wake-Up Detector is powered by $V_{SB3}$ and works independently of the Keyboard Controller module (powered by $V_{DD3}$).

The mouse event detection mechanism can be programed to detect either a mouse click or movement, a specific mouse click (left or right) or a double-click. To program which mouse action causes an event detection, set MSEVCFG field in PS2CTL register to the required value (see Section 6.3.7 on page 83).

A detected mouse event sets the MS_EVT_STS status bit in GPE1_STS_2 register (see Section 6.4.6 on page 88). The status bit is cleared only when the software writes 1 to it.

Mouse event detection from MCLK and MDAT is enabled (for event generation) $t_{EWIV}$ after $V_{SB3}$ power is on (see *Wake-Up Inputs at VSB3 Power Switching* on page 143). This prevents the detection of false Mouse events during $V_{SB3}$ power-On transitions.

### Keyboard Wake-Up Events

Keyboard wake-up events are also detected by the Keyboard/Mouse Wake-Up Detector, which monitors the KBCLK and KBDAT signals. Since the detection mechanisms for keyboard and mouse events are independent, they can be operated simultaneously. Moreover, the Keyboard signals may be swapped with the Mouse signals, by setting SWAP bit in KBC Configuration register (see Section 3.12.3 on page 54). The Keyboard/Mouse Wake-Up Detector is powered by $V_{SB3}$ and works independently of the Keyboard Controller module (powered by $V_{DD3}$).

The keyboard event detection mechanism can be programed to detect:

- Any keystroke (Fast Any-Key or Special Key Sequence modes).
- A specific programmable sequence of up to eight alphanumeric keystrokes (Password mode).
- Any programmable sequence of up to eight bytes of data received from the keyboard (Special Key Sequence mode).
- Up to three programmable Power Management keys concurrently available, each including a sequence of up to three bytes of data received from the keyboard (Power Management Keys mode).

The Keyboard/Mouse Wake-Up Detector has four operation modes:

- Fast Any-Key mode
- Password mode
- Special Key Sequence mode
- Power Management Keys mode

Up to eight Keyboard Data registers (PS2KEY0-7) are used to define which keyboard data string generates an event. Since the same set of registers is used by three of the four operation modes, only one mode can be selected at a time.

For modes involving more than one keystroke, the maximum delay allowed between pressing two consecutive keys is 4 seconds. A longer delay is interpreted by the Wake-Up Detector as the beginning of a new sequence of keystrokes, which causes the present sequence to be discarded. In all operation modes, pressing a wrong key requires a recovery time of 4 seconds, before a new (correct) sequence may be recognized.

**Fast Any-Key Mode.** In this mode, pressing any key on the keyboard is identified as a keyboard event and, as a result, KBD_ANYK_STS bit in GPE1_STS_2 register is set (see Section 6.4.6 on page 88). The status bit is cleared only when the software writes 1 to it. The key data contained in the PS2KEY0-7 registers is ignored. To program the Keyboard/Mouse Wake-Up Detector to operate in Fast Any-Key mode, set KBDMODE field in KBDWKCTL register to '01' (see Section 6.3.6 on page 82).

## 6.0 System Wake-Up Control (SWC) (Continued)

**Password Mode.** In this mode, the "Break" bytes transmitted by the keyboard are discarded, and only the "Make" keystroke bytes are compared with those programed in the PS2KEY0-7 registers. If the two sets are identical, a keyboard event that sets KBD_EVT1_STS bit in GPE1_STS_2 register is detected (see Section 6.4.6 on page 88). The status bit is cleared only when the software writes 1 to it. Only keys with a "Make" keystroke data of one byte can be included in the sequence to be detected. To program the Keyboard/Mouse Wake-Up Detector to operate in Password mode:

1. Set KBDMODE field in KBDWKCTL register to '00' (see Section 6.3.6 on page 82).
2. Set KBEVCFG field in PS2CTL register to a value that indicates the desired number of alphanumeric keystrokes in the sequence. The programed value = the number of keystrokes + 7. For example, to detect a sequence of two keys, set KBEVCFG to 09h.
3. Program the appropriate subset of the PS2KEY0-7 registers, in sequential order, with the "Make" data bytes of the keys in the sequence. For example, if there are three keys in the sequence and the "Make" keystroke data of these keys are 05h (first), 50h (second) and 44h (third), program PS2KEY0 to 05h, PS2KEY1 to 50h and PS2KEY2 to 44h (the scan codes are only examples).

**Special Key Sequence Mode.** In this mode, all the bytes transmitted by the keyboard (including "Make" and "Break" bytes) are compared with those programed in the PS2KEY0-7 registers. If the two sets are identical, a keyboard event is detected, as explained in *Password Mode*, above. Special Key Sequence mode enables the detection of any sequence of keystrokes, including "Shift", "Alt" and "Ctl" keys. To program the Keyboard/Mouse Wake-Up Detector to operate in Special Key Sequence mode:

1. Set KBDMODE field in KBDWKCTL register to '00' (see Section 6.3.6 on page 82).
2. Set KBEVCFG field in PS2CTL register to a value that indicates the total number of bytes ("Make" and "Break") in the sequence, minus 1 (i.e., the programed value = the number of bytes - 1). For example, to detect a sequence of three received bytes (i.e., one keystroke), set KBEVCFG to 02h. The minimum value of the KBEVCFG field is 1 (i.e., two bytes).
3. Program the appropriate subset of the PS2KEY0-7 registers, in sequential order, with the data bytes that comprise the sequence. For example, if the number of bytes in the sequence is four, and the values of these bytes are E0h (first), 5Bh (second), E0h (third) and DBh (fourth), program PS2KEY0 to E0h, PS2KEY1 to 5Bh, PS2KEY2 to E0h and PS2KEY3 to DBh (the byte values are only examples).

Special Key Sequence mode also enables detection of any single keystroke. To program the Keyboard/Mouse Wake-Up Detector to wake-up on any single keystroke:

1. Set KBDMODE field in KBDWKCTL register to '00' (see Section 6.3.6 on page 82).
2. Set KBEVCFG field in PS2CTL register to '0001'.
3. Program the PS2KEY0 and PS2KEY1 registers to 00h. This forces the detector to ignore the values of incoming data, thus causing it to detect a keyboard event caused by a single keystroke.

**Power Management Mode.** In this mode, the PS2KEY0-7 register bank is divided into three groups of registers: PS2KEY0-2, PS2KEY3-5 and PS2KEY6-7. Each group can be programed with different data bytes, allowing the bytes transmitted by the keyboard to be compared simultaneously with three keystroke sequences. If the bytes transmitted by the keyboard (including Make and Break) are identical to the data bytes in one register group, the related keyboard event is detected. The detection of Keyboard Event 1 (data in PS2KEY0-2) sets KBD_EVT1_STS bit; the detection of Keyboard Event 2 (data in PS2KEY3-5) sets KBD_EVT2_STS bit; the detection of Keyboard Event 3 (data in PS2KEY6-7) sets KBD_EVT3_STS bit. All three status bits are in GPE1_STS_2 register (see Section 6.4.6 on page 88). Each status bit is cleared only when the software writes 1 to the bit. This mode enables the detection of any sequence of keys.

To program the Keyboard/Mouse Wake-Up Detector to operate in Power Management Keys mode, proceed as follows:

1. Set KBDMODE field in KBDWKCTL register to '10' (see Section 6.3.6 on page 82).
2. Set each event configuration field (EVT1CFG, EVT2CFG and EVT3CFG) in KBDWKCTL register to a value that indicates the desired number of keystroke data bytes ("Make" and "Break" bytes) in the sequence, for each event. For example, to detect a sequence of two received bytes, set EVTxCFG to 02h.
3. Program each group of the PS2KEY0-7 registers, in sequential order, with the data bytes of the keys in the sequence for each event.

**Event Generation.** Keyboard event detection from KBCLK and KBDAT is enabled, for event generation, $t_{EWIV}$ after $V_{SB3}$ power is on (see *Wake-Up Inputs at VSB3 Power Switching* on page 143). This prevents the detection of false Keyboard events during $V_{SB3}$ power-On transitions.

**Usage Hints:**

1. After changing the operation mode of the Keyboard/Mouse Wake-Up Detector, clear the KBD_EVT3_STS, KBD_EVT2_STS, KBD_EVT1_STS, and KBD_ANYK_STS status bits in GPE1_STS_2 register (see Section 6.4.6 on page 88).
2. If a byte sequence that is a "subset" of the byte sequence of another ("superset") Power Management key event is used, the "superset" Power Management key event will never be detected. (The subset sequence has fewer bytes, set by EVTxCFG fields in KBDWKCTL register, than the superset sequence; however, the bytes contained in the subset sequence, as programed in the PS2KEY0-7 registers, are identical to the respective bytes of the superset sequence.)

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.2.2 Internal Events

### Keyboard and Mouse IRQ Events

Keyboard and Mouse IRQ events are detected when either the Keyboard IRQ or Mouse IRQ is asserted.

To enable the IRQ of a logical device to generate an IRQ event, the associated Enable bit (bit 4 of the configuration register at index 70h; see Section 3.2.3 on page 32) must be set to 1. Since the Keyboard Controller (KBC) functional block is powered by $V_{DD3}$, a Keyboard or Mouse IRQ event can occur only when $V_{DD3}$ is present.

An active (level-type) Keyboard IRQ event sets KBD_IRQ_STS status bit; an active Mouse IRQ event sets MS_IRQ_STS status bit. Both status bits are in GPE1_STS_3 register (see Section 6.4.7 on page 89). A status bit is cleared only when the software writes 1 to it. If the IRQ event is active when software writes 1 to the status bit, the status bit remains set.

The ROM code used for the Keyboard Controller generates active high Keyboard and Mouse interrupts, which are used by the SWC module.

### Module IRQ Event

A Module IRQ event is detected when one of the Legacy modules (FDC, Parallel Port, Serial Port) or the Fan Speed Monitor, asserts its IRQ.

To enable the IRQ of a logical device to generate an IRQ event, the associated Enable bit (bit 4 of the configuration register at index 70h; see Section 3.2.3 on page 32) must be set to 1. Since the Legacy modules and the Fan Speed Monitor are powered by $V_{DD3}$, they can assert IRQ only when $V_{DD3}$ is present.

MOD_IRQ_STS status bit in GPE1_STS_3 register is set by an IRQ that is asserted by one of the Legacy modules or the Fan Speed Monitor (see Section 6.4.7 on page 89). The status bit is cleared only when the software writes 1 to it. If the Module IRQ event is active when software writes 1 to the status bit, the status bit remains set.

## 6.2.3 Sleep States

The PC87372 identifies the current system sleep state, by decoding the levels of the $\overline{\text{SLP_S3}}$ and $\overline{\text{SLP_S5}}$ pins. The levels of these pins are generated by the system ACPI controller located in an external device. Table 28 shows the decoding of the logic levels of the $\overline{\text{SLP_S3}}$ and $\overline{\text{SLP_S5}}$ pins.

**Table 28. $\overline{\text{SLP_S3}}$, $\overline{\text{SLP_S5}}$ Decoding**

| $\overline{\text{SLP_S3}}$ | $\overline{\text{SLP_S5}}$ | System Sleep State |
|---|---|---|
| 1 | 1 | S0, S1 or S2 |
| 0 | 1 | S3 |
| 0 | 0 | S5 |
| 1 | 0 | Illegal combination |

## 6.2.4 SCI and IRQ Interrupts

The SCI ($\overline{\text{SIOPME}}$) pin is the Power Management interrupt defined by ACPI.

All external and internal events are exclusively processed by the SWC to generate the Power Management interrupt, SCI. Each active event sets a status bit in GPE1_STS_0 to GPE1_STS_3 registers (see Sections 6.4.4 to 6.4.7 on page 87).

For each status bit, the SWC holds an enable bit in GPE1_EN_0 to GPE1_EN_3 registers. A set status bit can set PME_STS bit in GPE1_STS register (see Section 6.4.2 on page 86) only when its related enable bit is set. A set PME_STS bit can cause the assertion of the SCI interrupt only when PME_EN bit in GPE1_EN register is set (see Section 6.4.3 on page 86).

The SCI interrupt is independent of the system sleep state.

The $\overline{\text{SIOPME}}$ signal can be inverted to generate an active high SCI interrupt. In addition, the output buffer of the $\overline{\text{SIOPME}}$ pin can be configured as either push-pull or open-drain, to allow sharing with external SCI interrupt sources.

Figure 15 shows SCI generation.

## 6.0 System Wake-Up Control (SWC) (Continued)

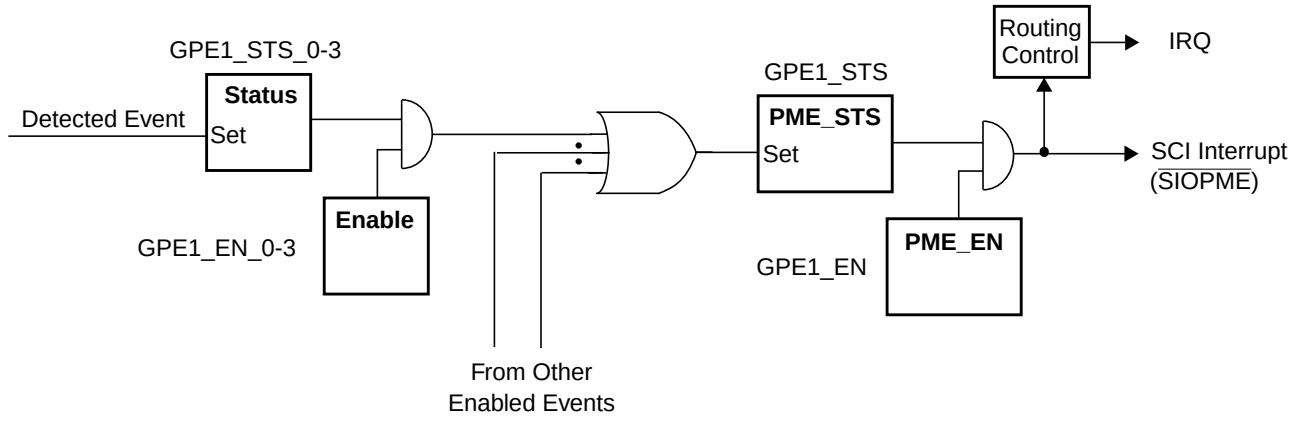


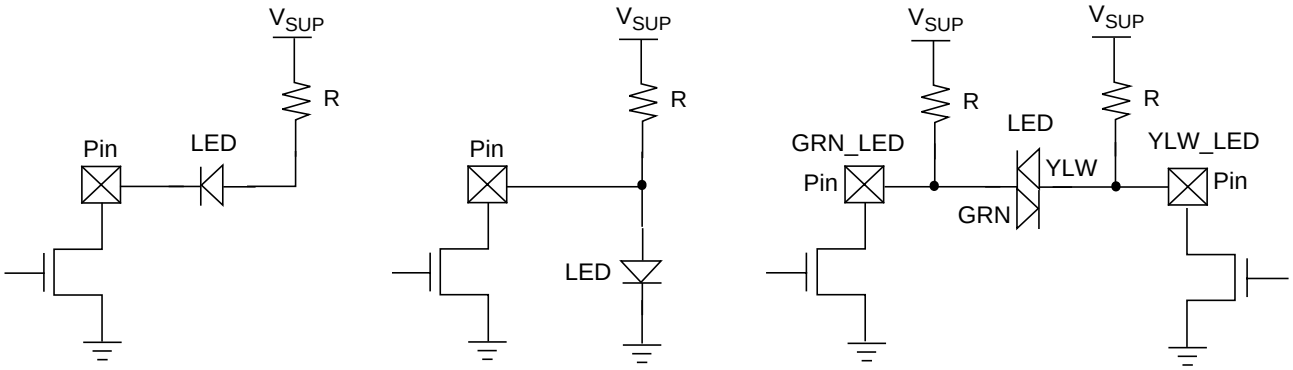

**Figure 15. SCI Generation**

The SCI interrupt ($\overline{\text{SIOPME}}$) is routed to the system interrupt (IRQ) by setting the Interrupt Number value, in the Interrupt Number register, located at index 70h in the SWC Configuration (see Section 3.11.2 on page 52).

### 6.2.5 LED Control

The PC87372 device controls the operation of two LED indicators. The two open-drain buffers allow the connection of either two regular LEDs or one dual-color LED.

The LEDs can be connected to PC87372 using one of the configurations shown in Figure 16.




**a. Active Low** **b. Active High** **c. Dual-Color**

**Figure 16. LED Connection Configurations**

The LED pins are named GRN_LED (Green LED) and YLW_LED (Yellow LED), although other LED colors can be used.

The PC87372 allows two LED control options, which are selected by LED_OPT bit in SWC_CTL register (see Section 6.3.3 on page 79):

- Standard LED control: On/Off and Blink controlled by software or by S5 sleep state
- Advanced LED control: On/Off and Blink controlled by software, by S3 or S5 sleep states, or by the $V_{DD3}$ power supply status

From the base address of the SWC registers, the register for Standard LED Control is located at offset 00h, and the two registers for Advanced LED Control are located at offsets 02h and 03h (see Section 6.3.1 on page 77). The active control registers are selected by LED_OPT bit.

The blink rate and duty cycle of both LED control options are based on a clock, which is obtained by dividing the frequency of the 32 KHz clock domain.

# 6.0 System Wake-Up Control (SWC) (Continued)

## Standard LED Control

The Standard LED control is the default LED control option. Two regular LEDs must be connected to the GRN_LED and the YLW_LED pins, according to configuration “b” (Active High) in Figure 16.

In this option, LED operation is controlled by the bits of SLEDCTL register (at offset 00h; see Section 6.3.2 on page 78) and by the $\overline{SLP_S5}$ pin. When the system is in sleep state S5 ($\overline{SLP_S5}$ = 0), both LEDs are off. GRN_YLW bit selects the active LED (on or blinking) of the two; the other LED is off. BLINK bit selects the operation mode of the active LED as either constantly on or blinking at 0.667 Hz with a duty cycle of 41.7% (on time percent of the blink cycle).

Table 31 on page 78 shows the states of the GRN_LED and YLW_LED pins. The LEDs are connected according to configuration “b” (see Figure 16); therefore, a LED is on when the pin is floated and off when the pin is at low level (0).

## Advanced LED Control

In the Advanced LED control option, one dual-color LED or two regular LEDs can be connected to the GRN_LED and the YLW_LED pins, using any of the configurations shown in Figure 16. LEDCFG and LEDPOL bits in ALEDCTL register (at offset 02h; see Section 6.3.4 on page 80) must be set to reflect the connection configuration of the LEDs.

LEDCFG bit selects either configurations “a” and “b” (two regular LEDs are connected between each pin and ground or $V_{SUPP}$) or configuration “c” (one dual-color LED is connected between the GRN_LED and YLW_LED pins). LEDPOL bit selects the polarity of the On state at both pins (GRN_LED and YLW_LED). Table 29, shows the value of LEDCFG and LEDPOL bits for each LED connection configuration in Figure 16, and also the state of the GRN_LED and YLW_LED pins for which the LED(s) are On.

**Table 29. LEDs “On” Polarity as a Function of LEDCFG and LEDPOL**

| LEDCFG | LEDPOL | GRN_LED | YLW_LED | Connection (See Figure 16) |
|---|---|---|---|---|
| 0 | 0 | TRI-STATE | 0 | “c”, Green anode to GRN_LED pin |
| 0 | 1 | 0 | TRI-STATE | “c”, Yellow anode to GRN_LED pin |
| 1 | 0 | TRI-STATE | TRI-STATE | “b” |
| 1 | 1 | 0 | 0 | “a” |

The LEDMOD field controls the operation mode of GRN_LED and YLW_LED pins in each system power state (see Table 32 on page 80). The system power state is identified either by the status of the $V_{DD3}$ power supply or by the current system sleep state:

- ‘00’ – The behavior of the GRN_LED and YLW_LED pins is controlled solely by software by the setting of the GRNBLNK and YLWBLNK fields.
- ‘01’ – The behavior of the GRN_LED and YLW_LED pins is controlled by the status of the $V_{DD3}$ supply and by software.
  In the Power Off state ($V_{DD3}$ off), the GRN_LED behaves according to the setting of the GRNBLNK field, but the YLW_LED blinks at a 1 Hz rate with a 50% duty cycle;
  In the Power On state ($V_{DD3}$ on), each LED behaves according to the setting of its xxxBLNK field.
- ‘10’ – The behavior of the GRN_LED and YLW_LED pins is controlled by the S5 sleep state and by software.
  In S5 sleep state, both LEDs are off;
  In S3 - S0 sleep states, each LED behaves according to the setting of its xxxBLNK field.
- ‘11’ – The behavior of the GRN_LED and YLW_LED pins is controlled by the status of the $V_{DD3}$ supply and by software.
  In the Power Off state ($V_{DD3}$ off), both LEDs are off;
  In Power On state ($V_{DD3}$ on), each LED behaves according to the setting of its xxxBLNK field.

The status of the $V_{DD3}$ power supply is detected by internal circuits, which identify the Power Off and Power On states (see Section 2.1.2 on page 24).

The current system sleep state is decoded from the levels of the $\overline{SLP_S3}$ and $\overline{SLP_S5}$ pins (see Section 6.2.3 on page 74). Only sleep state S5 is relevant.

The GRNBLNK and YLWBLNK fields in LEDBLNK register (at offset 03h; see Section 6.3.5 on page 81) control the On/Off state or the blinking rate of the GRN_LED and YLW_LED pins, respectively. For each LED pin, a different blink rate can be selected. Different blink rates can also be selected for the dual-color LED mode (LEDCFG = 0).

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.3 SWC REGISTERS

The offsets of the SWC registers are related to the base address determined by the SWC Base Address register at indexes 60h-61h in the SWC Logical Device configuration.

The following abbreviations are used to indicate the Register Type:

- R/W = Read/Write.
- R = Read from register (data written to this address is sent to a different register).
- W = Write (see above).
- RO = Read Only.
- WO = Write Only. Reading from the bit returns 0.
- R/W1C = Read/Write 1 to Clear. Writing 1 to a bit clears it to 0. Writing 0 has no effect.
- R/W1S = Read/Write 1 to Set. Writing 1 to a bit sets its value to 1. Writing 0 has no effect.

### 6.3.1 SWC Register Map

The following table lists the SWC registers. For the SWC register bitmap, see Section 6.5 on page 93. The SWC registers are $V_{SB3}$ powered.

**Table 30. SWC Register Map**

| Offset | Option[1] | Mnemonic | Register Name | Type | Power Well | Section |
|---|---|---|---|---|---|---|
| 00h | LED_OPT = 1 | SLEDCTL | Standard LED Control | R/W or RO | $V_{SB3}$ | 6.3.2 |
| | LED_OPT = 0 | Reserved | | | | |
| 01h | | SWC_CTL | SWC Miscellaneous Control | Varies per bit | $V_{SB3}$ | 6.3.3 |
| 02h | LED_OPT = 1 | Reserved | | | | |
| | LED_OPT = 0 | ALEDCTL | Advanced LED Control | R/W or RO | $V_{SB3}$ | 6.3.4 |
| 03h | LED_OPT = 1 | Reserved | | | | |
| | LED_OPT = 0 | LEDBLNK | LED Blinking Control | R/W or RO | $V_{SB3}$ | 6.3.5 |
| 04h | | KBDWKCTL | Keyboard Wake-Up Control | R/W or RO | $V_{SB3}$ | 6.3.6 |
| 05h | | PS2CTL | PS2 Protocol Control | R/W or RO | $V_{SB3}$ | 6.3.7 |
| 06h | | KDSR | Keyboard Data Shift-Register | RO | $V_{SB3}$ | 6.3.8 |
| 07h | | MDSR | Mouse Data Shift-Register | RO | $V_{SB3}$ | 6.3.9 |
| 08h | | PS2KEY0 | PS2 Keyboard Key Data 0 | R/W, RO | $V_{SB3}$ | 6.3.10 |
| 09h | | PS2KEY1 | PS2 Keyboard Key Data 1 | R/W, RO | $V_{SB3}$ | 6.3.10 |
| 0Ah | | PS2KEY2 | PS2 Keyboard Key Data 2 | R/W, RO | $V_{SB3}$ | 6.3.10 |
| 0Bh | | PS2KEY3 | PS2 Keyboard Key Data 3 | R/W, RO | $V_{SB3}$ | 6.3.10 |
| 0Ch | | PS2KEY4 | PS2 Keyboard Key Data 4 | R/W, RO | $V_{SB3}$ | 6.3.10 |
| 0Dh | | PS2KEY5 | PS2 Keyboard Key Data 5 | R/W, RO | $V_{SB3}$ | 6.3.10 |
| 0Eh | | PS2KEY6 | PS2 Keyboard Key Data 6 | R/W, RO | $V_{SB3}$ | 6.3.10 |
| 0Fh | | PS2KEY7 | PS2 Keyboard Key Data 7 | R/W, RO | $V_{SB3}$ | 6.3.10 |

1. Selected by LED_OPT bit in SWC_CTL register.

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.3.2 Standard LED Control Register (SLEDCTL)

This register configures the standard LED control of the two LEDs connected to pins GRN_LED and YLW_LED of the PC87372 device. It is reset to 03h.

Power Well: $V_{SB3}$

Location: Offset 00h, when LED_OPT = 1 in the SWC_CTL register

Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | | | **BLINK** | **GRN_YLW** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

| Bit | Description |
|---|---|
| 7-2 | **Reserved.** |
| 1 | **BLINK (LEDs Blink Control).** This bit controls the operation mode (either blinking or constantly on) of the LED selected by GRN_YLW bit. Blinking rate is 0.667 Hz with a duty cycle of 41.7%. When the system is in sleep state S5, both LEDs are forced off regardless of BLINK and GRN_YLW bit values; see Table 31.<br>0: Selected LED blinking<br>1: Selected LED constantly on (default) |
| 0 | **GRN_YLW (Green-Yellow LED Select).** This bit selects which of the two LEDs (GRN_LED or YLW_LED) is active. The LED which is not active is off; see Table 31.<br>0: Yellow LED (connected to YLW_LED pin) selected<br>1: Green LED (connected to GRN_LED pin) selected (default) |

**Table 31. GRN_LED and YLW_LED States**

| $\overline{\text{SLP_S5}}$ pin | GRN_YLW bit | BLINK bit | GRN_LED pin | YLW_LED pin |
|---|---|---|---|---|
| 0[1] | X[2] | X | 0 | 0 |
| 1 | 0 | 0 | 0 | Blink |
| 1 | 0 | 1 | 0 | TRI-STATE |
| 1 | 1 | 0 | Blink | 0 |
| 1 | 1 | 1 | TRI-STATE | 0 |

1. $\overline{\text{SLP_S5}}$ = 0: System is in sleep state S5.
2. X is either logic “0” or logic “1”.

## 6.0 System Wake-Up Control (SWC) (Continued)

### 6.3.3 SWC Miscellaneous Control Register (SWC_CTL)

This register contains control and status bits for the SWC module. It is reset to 01h.

Power Well: $V_{SB3}$

Location: Offset 01h

Type: Varies per bit

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **LOCKSCF** | **Reserved** | | | | | | **LED_OPT** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit | Type | Description |
|---|---|---|
| 7 | R/W1S | **LOCKSCF (Lock SWC Configuration).** When set to 1, this bit locks the BLINK and GRN_YLW bits in SLEDCTL register, and all bits of SWC_CTL, ALEDCTL, LEDBLNK, KBDWKCTL, PS2CTL and PS2KEY0–7 registers by disabling writing to them (including to the LOCKSCF bit itself). Once set, this bit can be cleared by $V_{DD3}$ Power-Up reset (or Hardware reset).<br>0: R/W bits are enabled for write (default)<br>1: All bits are RO |
| 6-1 | | **Reserved.** |
| 0 | R/W or RO | **LED_OPT (LED Control Option Select).** Selects either the Standard or the Advanced LED control option for the two power LEDs.<br>0: Advanced: LEDs controlled by the ALEDCTL and LEDBLNK registers at offsets 02h and 03h, respectively<br>1: Standard: LEDs controlled by the SLEDCTL register at offset 00h (default) |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.3.4 Advanced LED Control Register (ALEDCTL)

This register configures the advanced LED control of the two LEDs connected to pins GRN_LED and YLW_LED of the PC87372 device. It is reset to 00h.

Power Well: $V_{SB3}$

Location: Offset 02h, when LED_OPT = 0 in the SWC_CTL register

Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | **LEDCFG** | **LEDPOL** | **Reserved** | | **LEDMOD** | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-6 | **Reserved.** |
| 5 | **LEDCFG (LED Configuration).** This bit enables the use of either two regular LEDs, connected to the GRN_LED and YLW_LED pins or one dual-colored LED, connected between the two pins (see Figure 16 on page 75).<br>0: One dual-colored LED (default)<br>1: Two regular LEDs |
| 4 | **LEDPOL (LED Polarity).** This bit determines the polarity of GRN_LED and YLW_LED outputs. An active output, according to this bit setting, turns the LED on. For the dual-colored LED configuration, changing the polarity reverses the LED colors. The configurations described here apply to the “two regular LEDs” option only; see Table 29 on page 76).<br>0: Active high: for connection configuration “b” in Figure 16 on page 75 (default)<br>1: Active low: for connection configuration “a” in Figure 16 on page 75 |
| 3-2 | **Reserved.** |
| 1-0 | **LEDMOD (LED Operation Mode).** These bits control the operation mode of GRN_LED and YLW_LED in each power state. Table 32 shows the behavior of the two LED outputs as a function of the system power state. |

**Table 32. GRN_LED and YLW_LED as a Function of the Power State**

| LEDMOD | $V_{DD3}$ Off[1] | $V_{DD3}$ On[1] | State S5[2] | State S3[2] | States S0 - S2[2] | GRN_LED | YLW_LED |
|---|---|---|---|---|---|---|---|
| 00 (default) | X[3] | X | X | X | X | S/W_GRN[4] | S/W_YLW[5] |
| 01 | Yes | | X | X | X | S/W_GRN | Blink[6] |
| | | Yes | X | X | X | S/W_GRN | S/W_YLW |
| 10 | X | X | Yes | | | Off | Off |
| | X | X | | Yes | | S/W_GRN | S/W_YLW |
| | X | X | | | Yes | S/W_GRN | S/W_YLW |
| 11 | Yes | | X | X | X | Off | Off |
| | | Yes | X | X | X | S/W_GRN | S/W_YLW |

1. See Section 2.1.2 on page 24.
2. See Section 6.2.3 on page 74.
3. In this table, X is “Irrelevant”.
4. Controlled by the value of GRNBLNK in the LEDBLNK register.
5. Controlled by the value of YLWBLNK in the LEDBLNK register.
6. Blink rate is 1 Hz with a duty cycle of 50%.

## 6.0 System Wake-Up Control (SWC) (Continued)

### 6.3.5 LED Blink Control Register (LEDBLNK)

This register controls the advanced blinking rate of the two LEDs connected to pins GRN_LED and YLW_LED of the PC87372 device. It is reset to 70h.

Power Well: $V_{SB3}$

Location: Offset 03h, when LED_OPT = 0 in the SWC_CTL register

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | **GRNBLNK** | | | **Reserved** | **YLWBLNK** | | |
| Reset | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7 | **Reserved.** |
| 6-4 | **GRNBLNK (Green LED Blink Rate).** These bits control the blinking rate of GRN_LED output.<br>**Bits 6 5 4 — Rate (Hz) — Duty Cycle**<br>0 0 0: Off — Always inactive<br>0 0 1: 0.25 — 12.5%<br>0 1 0: 0.5 — 25%<br>0 1 1: 1 — 50%<br>1 0 0: 2 — 50%<br>1 0 1: 3 — 50%<br>1 1 0: 4 — 50%<br>1 1 1: On — Always active (default) |
| 3 | **Reserved.** |
| 2-0 | **YLWBLNK (Yellow LED Blink Rate).** These bits control the blinking rate of YLW_LED output.<br>**Bits 2 1 0 — Rate (Hz) — Duty Cycle**<br>0 0 0: Off — Always inactive (default)<br>0 0 1: 0.25 — 12.5%<br>0 1 0: 0.5 — 25%<br>0 1 1: 1 — 50%<br>1 0 0: 2 — 50%<br>1 0 1: 3 — 50%<br>1 1 0: 4 — 50%<br>1 1 1: On — Always active |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.3.6 Keyboard Wake-Up Control Register (KBDWKCTL)

This register configures the keyboard events detected by the Keyboard/Mouse Wake-Up Detector. It is reset to 40h.

Power Well: $V_{SB3}$

Location: Offset 04h

Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **KBDMODE** | | **EVT3CFG** | | **EVT2CFG** | | **EVT1CFG** | |
| Reset | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-6 | **KBDMODE (Keyboard Mode Select).** This field selects one of the keyboard wake-up modes for the Keyboard/Mouse Wake-Up Detector.<br>**Bits 7 6 — Keyboard Wake-Up Mode**<br>0 0: Special Key Sequence or Password: Configured by bits 3-0 of PS2CTL register<br>0 1: Fast Any-Key: Indicates that any key was pressed on the keyboard (default)<br>1 0: Power Management Keys: Configured by bits 5-0 of KBDWKCTL register<br>1 1: Reserved |
| 5-4 | **EVT3CFG (Keyboard Event 3 Configuration).** These bits configure the keyboard data sequence for Keyboard Event 3, which indicates that “PM Key 3” was pressed on the keyboard. The setting of the EVT3CFG field is relevant only if the Keyboard/Mouse Wake-Up Detector is in Power Management Keys mode (KBDMODE = 10). The keyboard data sequence used to detect Keyboard Event 3 is stored in registers PS2KEY6-7, starting with PS2KEY6.<br>**Bits 5 4 — Sequence Length**<br>0 0: 0 bytes: Keyboard Event 3 disabled (default)<br>0 1: 1 byte: PS2KEY6<br>1 0: 2 bytes: PS2KEY6, PS2KEY7<br>1 1: Reserved |
| 3-2 | **EVT2CFG (Keyboard Event 2 Configuration).** These bits configure the keyboard data sequence for Keyboard Event 2, which indicates that “PM Key 2” was pressed on the keyboard. The setting of the EVT2CFG field is relevant only if the Keyboard/Mouse Wake-Up Detector is in Power Management Keys mode (KBDMODE = 10). The keyboard data sequence used to detect Keyboard Event 2 is stored in registers PS2KEY3-5, starting with PS2KEY3.<br>**Bits 3 2 — Sequence Length**<br>0 0: 0 bytes: Keyboard Event 2 disabled (default)<br>0 1: 1 byte: PS2KEY3<br>1 0: 2 bytes: PS2KEY3, PS2KEY4<br>1 1: 3 bytes: PS2KEY3, PS2KEY4, PS2KEY5 |
| 1-0 | **EVT1CFG (Keyboard Event 1 Configuration).** These bits configure the keyboard data sequence for Keyboard Event 1, which indicates that “PM Key 1” was pressed on the keyboard. The setting of the EVT1CFG field is relevant only if the Keyboard/Mouse Wake-Up Detector is in Power Management Keys mode (KBDMODE = 10). The keyboard data sequence used to detect Keyboard Event 1 is stored in registers PS2KEY0-2, starting with PS2KEY0.<br>**Bits 1 0 — Sequence Length**<br>0 0: 0 bytes: Keyboard Event 1 disabled (default)<br>0 1: 1 byte: PS2KEY0<br>1 0: 2 bytes: PS2KEY0, PS2KEY1<br>1 1: 3 bytes: PS2KEY0, PS2KEY1, PS2KEY2 |

## 6.0 System Wake-Up Control (SWC) (Continued)

### 6.3.7 PS2 Protocol Control Register (PS2CTL)

This register configures the keyboard and mouse events detected by the Keyboard/Mouse Wake-Up Detector. It is reset to 10h.

Power Well: $V_{SB3}$

Location: Offset 05h

Type: R/W or RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **DISPAR** | **MSEVCFG** | | | **KBEVCFG** | | | |
| Reset | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7 | **DISPAR (Disable Parity Check).** This controls the parity checking of the keyboard and mouse data by the Keyboard/Mouse Wake-Up Detector.<br>0: Enable parity check (default)<br>1: Disable parity check |
| 6-4 | **MSEVCFG (Mouse Event Configuration).** These bits configure the mouse data sequence for the Mouse event. Before setting them to a new value, these bits must be cleared by writing a value of '000'.<br>**Bits 6 5 4 — Event Configuration**<br>0 0 0: Disable mouse wake-up detection<br>0 0 1: Wake-up on any mouse movement or button click (default)<br>0 1 0: Wake-up on left button click<br>0 1 1: Wake-up on left button double-click<br>1 0 0: Wake-up on right button click<br>1 0 1: Wake-up on right button double-click<br>1 1 0: Wake-up on any button single-click (left, right or middle)<br>1 1 1: Wake-up on any button double-click (left, right or middle) |
| 3-0 | **KBEVCFG (Keyboard Event Configuration).** These bits configure the keyboard data sequence for the Keyboard event indicating that any key or key sequence was pressed on the keyboard. The setting of the KBEVCFG field is relevant only if the Keyboard/Mouse Wake-Up Detector is in either Special Key Sequence or Password mode (KBDMODE = 00). The keyboard data sequence used to detect a Keyboard Event is stored in registers PS2KEY0-7, starting with PS2KEY0. Before setting them to a new value, the KBEVCFG field must be cleared by writing a value of '0000'.<br>**Bits 3 2 1 0 — Event Configuration**<br>0 0 0 0: Disable keyboard wake-up detection (default)<br>0 0 0 1 to 0 1 1 1: Special Key Sequence mode consisting of from two to eight PS/2 data bytes, "Make" and "Break" codes (including Shift and Alt keys)<br>1 0 0 0 to 1 1 1 1: Password Enabled mode with consisting of from one to eight keys "Make" code (excluding Shift and Alt keys) |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.3.8 Keyboard Data Shift Register (KDSR)

When keyboard wake-up detection is enabled, this register stores the keyboard data shifted in from the keyboard during data transmission. It is reset to 00h.

Power Well: $V_{SB3}$

Location: Offset 06h

Type: RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Keyboard Data** | | | | | | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-0 | **Keyboard Data.** |

## 6.3.9 Mouse Data Shift Register (MDSR)

When mouse wake-up detection is enabled, this register stores the mouse data shifted in from the mouse during data transmission. It is reset to 00h.

Power Well: $V_{SB3}$

Location: Offset 07h (offset in PC8741x = 17h)

Type: RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | | **Mouse Data** | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-3 | **Reserved.** |
| 2-0 | **Mouse Data.** |

## 6.3.10 PS2 Keyboard Key Data 0 to 7 Registers (PS2KEY0-7)

These eight registers (PS2KEY0-7) store the data bytes for Special Key Sequence or Password mode (KBDMODE = 00) or for Power Management Keys mode (KBDMODE = 10) of the Keyboard/Mouse Wake-Up Detector.

In Special Key Sequence or in Password modes, the keyboard data is stored as follows:

- PS2KEY0 register stores the data byte for the first key in the sequence.
- PS2KEY1 register stores the data byte for the second key in the sequence.
- PS2KEY2-7 registers store data bytes for the third to eighth key in the sequence.

For keyboard data storage in Power Management Keys mode, see Section 6.3.6 on page 82.

When one of these registers is set to 00h, it indicates that the value of the corresponding data byte is ignored (i.e., it is not compared with the keyboard data). These registers are reset to 00h.

Power Well: $V_{SB3}$

Location: Offset 08h to 0Fh

Type: R/W, RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Data Byte of Key** | | | | | | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-0 | **Data Byte of Key.** |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.4 ACPI REGISTERS

The ACPI registers are organized in two groups, which are both powered by $V_{SB3}$. The offsets of the two groups of ACPI registers are related to the base address determined by the Base Address registers at indexes 62h-63h in the SWC device configuration.

The PC87372 device supports the General-Purpose Event 1, ACPI generic register group. This group contains the GPE1_STS and GPE1_EN registers, each with a length of one byte. In addition, the device supports the “child” events of the General-Purpose Event 1 register group in the GPE1_STS_0-GPE1_STS_3 and the GPE1_EN_0-GPE1_EN_3 registers.

The following abbreviations are used to indicate the Register Type:

- R/W = Read/Write.
- R = Read from register (data written to this address is sent to a different register).
- W = Write (see above).
- RO = Read Only.
- WO = Write Only. Reading from the bit returns 0.
- R/W1C = Read/Write 1 to Clear. Writing 1 to a bit clears it to 0. Writing 0 has no effect.
- R/W1S = Read/Write 1 to Set. Writing 1 to a bit sets its value to 1. Writing 0 has no effect.

### 6.4.1 ACPI Register Map

The following table lists the ACPI registers. All of these registers are $V_{SB3}$ powered.

**Table 33. ACPI Register Map**

| Base Registers | Offset | Mnemonic | Register Name | Type | Power Well | Section |
|---|---|---|---|---|---|---|
| At index 62h, 63h | 00h | GPE1_STS | General-Purpose Status 1 Register | R/W1C | $V_{SB3}$ | 6.4.2 |
| | 01h-03h | Reserved | | | | |
| | 04h | GPE1_EN | General-Purpose Enable 1 Register | R/W | $V_{SB3}$ | 6.4.3 |
| | 05h-07h | Reserved | | | | |
| | 08h | GPE1_STS_0 | General-Purpose Status 1 Register 0 | R/W1C | $V_{SB3}$ | 6.4.4 |
| | 09h | GPE1_STS_1 | General-Purpose Status 1 Register 1 | R/W1C | $V_{SB3}$ | 6.4.5 |
| | 0Ah | GPE1_STS_2 | General-Purpose Status 1 Register 2 | R/W1C | $V_{SB3}$ | 6.4.6 |
| | 0Bh | GPE1_STS_3 | General-Purpose Status 1 Register 3 | R/W1C | $V_{SB3}$ | 6.4.7 |
| | 0Ch | GPE1_EN_0 | General-Purpose Enable 1 Register 0 | R/W | $V_{SB3}$ | 6.4.8 |
| | 0Dh | GPE1_EN_1 | General-Purpose Enable 1 Register 1 | R/W | $V_{SB3}$ | 6.4.9 |
| | 0Eh | GPE1_EN_2 | General-Purpose Enable 1 Register 2 | R/W | $V_{SB3}$ | 6.4.10 |
| | 0Fh | GPE1_EN_3 | General-Purpose Enable 1 Register 3 | R/W | $V_{SB3}$ | 6.4.11 |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.4.2 General-Purpose Status 1 Register (GPE1_STS)

This register contains the global Power Management Event status bit. This register belongs to the General-Purpose Event 1 register group of the ACPI generic-feature space registers.

The status bit behaves according to the Sticky Status Bit definition in the ACPI Specification (i.e., the bit is set when the level of the hardware signal is high and is only cleared by the software writing 1 to it).

Power Well: $V_{SB3}$

Location: Offset 00h

Type: R/W1C

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | | | | **PME_STS** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-1 | **Reserved.** |
| 0 | **PME_STS (Power Management Event Status).** Indicates that an enabled Power Management event has occurred. This bit is set if at least one enabled event (in GPE1_EN_0 to GPE1_EN_3 registers) is active (in GPE1_STS_0 to GPE1_STS_3 registers). This bit can be reset by writing 1 only if all the enabled events are inactive.<br>0: Inactive (default)<br>1: At least one enabled “child” event was active since this bit was last cleared |

## 6.4.3 General-Purpose Enable 1 Register (GPE1_EN)

This register contains the global Power Management Event enable bit. This register belongs to the General-Purpose Event 1 register group of the ACPI generic-feature space registers. It is reset to 00h.

The enable bit behaves according to the Enable Bit definition in the ACPI Specification (i.e., the bit can be read or written by software).

Power Well: $V_{SB3}$

Location: Offset 04h

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | | | | **PME_EN** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-1 | **Reserved.** |
| 0 | **PME_EN (Power Management Event Enable).** Controls SCI ($\overline{\text{SIOPME}}$) generation by a set PME_STS bit. If this bit is set, a set PME_STS bit in GPE1_STS register generates an SCI interrupt.<br>0: Disable SCI (default)<br>1: Enable SCI generation by a set PME_STS bit |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.4.4 General-Purpose Status 1 Register 0 (GPE1_STS_0)

This register contains “child” events 0-7 of the GPE1_STS register.

The status bits behave according to the Sticky Status Bit definition in the ACPI Specification (i.e., the bit is set when the hardware signal is high and is only cleared by the software writing 1 to it).

Power Well: $V_{SB3}$

Location: Offset 08h

Type: R/W1C

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **GPIOE07_STS** | **GPIOE06_STS** | **GPIOE05_STS** | **GPIOE04_STS** | **GPIOE03_STS** | **GPIOE02_STS** | **GPIOE01_STS** | **GPIOE00_STS** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7 | **GPIOE07_STS (GPIOE07 Event Status).** Indicates that an active event has been detected at pin 7 of GPIOE Port 0. The event has programmable polarity and the debounce option (see Section 5.3 on page 65). The bit is set by an active level at the GPIOE07 pin. Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: An active event has occurred |
| 6-0 | **GPIOE06_STS to GPIOE00_STS (GPIOE06 to GPIOE00 Event Status).** Same as above for pins 6-0 of GPIOE Port 0. |

## 6.4.5 General-Purpose Status 1 Register 1 (GPE1_STS_1)

This register contains “child” events 8-15 of the GPE1_STS register.

The status bits behave according to the Sticky Status Bit definition in the ACPI Specification (i.e., the bit is set when the hardware signal is high and is only cleared by the software writing 1 to it).

Power Well: $V_{SB3}$

Location: Offset 09h

Type: R/W1C

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | **GPIOE13_STS** | **GPIOE12_STS** | **GPIOE11_STS** | **GPIOE10_STS** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-4 | **Reserved.** |
| 3 | **GPIOE13_STS (GPIO13 Event Status).** Indicates that an active event has been detected at pin 3 of GPIOE Port 1. The event has programmable polarity and the debounce option (see Section 5.3 on page 65). The bit is set by an active level at the GPIOE13 pin. Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: An active event has occurred |
| 2-0 | **GPIOE12_STS to GPIOE10_STS (GPIOE12 to GPIOE10 Event Status).** Same as above for pins 2-0 of GPIOE Port 1. |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.4.6 General-Purpose Status 1 Register 2 (GPE1_STS_2)

This register contains “child” events 16-23 of the GPE1_STS register.

The status bits behave according to the Sticky status bit definition in the ACPI Specification (i.e., the bit is set when the level of the hardware signal is high and is only cleared by the software writing 1 to it).

Power Well: $V_{SB3}$

Location: Offset 0Ah

Type: R/W1C

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **KBD_EVT3_STS** | **KBD_EVT2_STS** | **KBD_EVT1_STS** | **MS_EVT_STS** | **KBD_ANYK_STS** | **RI_EVT_STS** | **Reserved** | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7 | **KBD_EVT3_STS (Keyboard Event 3 Status).** Indicates that “PM Key 3” was pressed and that the event was identified by the Keyboard/Mouse Wake-Up Detector. This bit is set only if the Keyboard/Mouse Wake-Up Detector is in Power Management Keys mode (see Section 6.3.6 on page 82). Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: The “PM Key 3” key was pressed on the keyboard |
| 6 | **KBD_EVT2_STS (Keyboard Event 2 Status).** Indicates that “PM Key 2” was pressed and that the event was identified by the Keyboard/Mouse Wake-Up Detector. This bit is set only if the Keyboard/Mouse Wake-Up Detector is in Power Management Keys mode (see Section 6.3.6 on page 82). Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: The “PM Key 2” key was pressed on the keyboard |
| 5 | **KBD_EVT1_STS (Keyboard Event 1 Status).** This bit indicates that a keyboard event occurred and was identified by the Keyboard/Mouse Wake-Up Detector. The event type depends on the selected operation mode for the Keyboard/Mouse Wake-Up Detector (see Sections 6.3.6 and 6.3.7 on page 82.):<br>• Pressing any key or a sequence of special keys in Special Key Sequence mode<br>• Pressing a sequence of keys in Password mode<br>• Pressing the “PM Key 1” in Power Management Keys mode<br>Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: A keyboard event occurred |
| 4 | **MS_EVT_STS (Mouse Event Status).** Indicates that a mouse event occurred and was identified by the Keyboard/Mouse Wake-Up Detector (see Section 6.3.7 on page 83). Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: A mouse event occurred |
| 3 | **KBD_ANYK_STS (Keyboard Any-Key Status).** This bit indicates that any key was pressed and that the event was identified by the Keyboard/Mouse Wake-Up Detector. This bit is set only if the Keyboard/Mouse Wake-Up Detector is in Fast Any-Key mode (see Section 6.3.6 on page 82). Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: A keyboard event occurred |
| 2 | **RI_EVT_STS ($\overline{\text{RI}}$ Event Status).** Indicates that a telephone ring signal was received at the Serial Port and the event was identified by the RI Wake-Up Detector. This bit is set by a high-to-low transition at the $\overline{\text{RI}}$ pin (see Section 6.2.1 on page 71). Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: A telephone ring signal was received at the Serial Port |
| 1-0 | **Reserved.** |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.4.7 General-Purpose Status 1 Register 3 (GPE1_STS_3)

This register contains “child” events 24-31 of the GPE1_STS register.

The status bits behave according to the Sticky Status Bit definition in the ACPI Specification (i.e., the bit is set when the level of the hardware signal is high and is only cleared by the software writing 1 to it).

Power Well: $V_{SB3}$

Location: Offset 0Bh

Type: R/W1C

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | **MOD_IRQ _STS** | **MS_IRQ _STS** | **KBD_IRQ _STS** | **Reserved** | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-5 | **Reserved.** |
| 4 | **MOD_IRQ_STS (Modules IRQ Event Status).** Indicates that an IRQ was generated by one of the Legacy modules (FDC, Parallel Port, Serial Port) or the Fan Speed Monitor. This bit is set only if the IRQ is enabled for wake-up (bit 4 of the Standard configuration register at index 70h) and the related module is active; see Section 3.2.3 on page 32. Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: An enabled IRQ from one of the Legacy modules or the Fan Speed Monitor is active |
| 3 | **MS_IRQ_STS (Mouse IRQ Event Status).** Indicates that an IRQ was generated by the mouse interface section of the KBC module. This bit is set only if the IRQ is enabled for wake-up (bit 4 of the Mouse Logical Device configuration register at index 70h) and the KBC module is active (see Section 3.2.3 on page 32). Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: An enabled IRQ from the mouse interface section of the KBC module is active |
| 2 | **KBD_IRQ_STS (Keyboard IRQ Event Status).** Indicates that an IRQ was generated by the keyboard interface section of the KBC module. This bit is set only if the IRQ is enabled for wake-up (bit 4 of the Keyboard Logical Device configuration register at index 70h) and the KBC module is active (see Section 3.2.3 on page 32). Writing 1 clears this bit; writing 0 is ignored.<br>0: Inactive since last cleared (default)<br>1: An enabled IRQ from the keyboard interface section of the KBC module is active |
| 1-0 | **Reserved.** |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.4.8 General-Purpose Enable 1 Register 0 (GPE1_EN_0)

This register contains “child” events 0-7 of the GPE1_EN register.

The enable bits behave according to the Enable Bit definition in the ACPI Specification (i.e., the bit can be read or written by software).

Power Well: $V_{SB3}$

Location: Offset 0Ch

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **GPIOE07_EN** | **GPIOE06_EN** | **GPIOE05_EN** | **GPIOE04_EN** | **GPIOE03_EN** | **GPIOE02_EN** | **GPIOE01_EN** | **GPIOE00_EN** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7 | **GPIOE07_EN (GPIOE07 Event Enable).** Enables an active event at pin 7 of GPIOE Port 0 to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event to set PME_STS |
| 6-0 | **GPIOE06_EN to GPIOE00_EN (GPIOE06 to GPIOE00 Event Enable).** Same as above for pins 6-0 of GPIOE Port 0. |

## 6.4.9 General-Purpose Enable 1 Register 1 (GPE1_EN_1)

This register contains “child” events 8-15 of the GPE1_EN register.

The enable bits behave according to the Enable Bit definition in the ACPI Specification (i.e., the bit can be read or written by software).

Power Well: $V_{SB3}$

Location: Offset 0Dh

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | | **GPIOE13_EN** | **GPIOE12_EN** | **GPIOE11_EN** | **GPIOE10_EN** |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-4 | **Reserved.** |
| 3 | **GPIOE13_EN (GPIOE13 Event Enable).** Enables an active event at pin 3 of GPIOE Port 1 to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event to set PME_STS |
| 2-0 | **GPIOE12_EN to GPIOE10_EN (GPIOE12 to GPIOE10 Event Enable).** Same as above for pins 2-0 of GPIOE Port 1. |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.4.10 General-Purpose Enable 1 Register 2 (GPE1_EN_2)

This register contains “child” events 16-23 of the GPE1_EN register.

The enable bits behave according to the Enable Bit definition in the ACPI Specification (i.e., the bit can be read or written by software).

Power Well: $V_{SB3}$

Location: Offset 0Eh

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **KBD_EVT3_EN** | **KBD_EVT2_EN** | **KBD_EVT1_EN** | **MS_EVT_EN** | **KBD_ANYK_EN** | **RI_EVT_EN** | **Reserved** | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7 | **KBD_EVT3_EN (Keyboard Event 3 Enable).** Enables the event of pressing “PM Key 3” (on the keyboard) to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event of pressing the “PM Key 3” on the keyboard to set PME_STS |
| 6 | **KBD_EVT2_EN (Keyboard Event 2 Enable).** Enables the event of pressing “PM Key 2” (on the keyboard) to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event of pressing the “PM Key 2” on the keyboard to set PME_STS |
| 5 | **KBD_EVT1_EN (Keyboard Event 1 Enable).** Enables the event of pressing any key, key sequence or “PM Key 1” (on the keyboard) to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event of pressing a sequence of keys or the “PM Key 1” on the keyboard to set PME_STS |
| 4 | **MS_EVT_EN (Mouse Event Enable).** Enables a mouse event identified by the Keyboard/Mouse Wake-Up Detector to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event of mouse event identified by the Keyboard/Mouse Wake-Up Detector to set PME_STS |
| 3 | **KBD_ANYK_EN (Keyboard Any-Key Enable).** Enables the event of pressing any key (on the keyboard) to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event of pressing any key on the keyboard to set PME_STS |
| 2 | **RI_EVT_EN ($\overline{\text{RI}}$ Event Enable).** Enables a telephone ring, received at Serial Port and identified by the RI Wake-Up Detector, to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event of telephone ring event received at the Serial Port to set PME_STS |
| 1-0 | **Reserved.** |

# 6.0 System Wake-Up Control (SWC) (Continued)

## 6.4.11 General-Purpose Enable 1 Register 3 (GPE1_EN_3)

This register contains “child” events 24-31 of the GPE1_EN register.

The enable bits behave according to the Enable Bit definition in the ACPI Specification (i.e., the bit can be read or written by software).

Power Well: $V_{SB3}$

Location: Offset 0Fh

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **Reserved** | | | **MOD_IRQ_EN** | **MS_IRQ_EN** | **KBD_IRQ_EN** | **Reserved** | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-5 | **Reserved.** |
| 4 | **MOD_IRQ_EN (Modules IRQ Event Enable).** Enables an active IRQ from one of the Legacy modules or the Fan Speed Monitor to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event of an active IRQ from one of the Legacy modules or the Fan Speed Monitor to set PME_STS |
| 3 | **MS_IRQ_EN (Mouse IRQ Event Enable).** Enables an IRQ generated by the mouse interface section of the KBC module to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event of an IRQ generated by the mouse interface section of the KBC module to set PME_STS |
| 2 | **KBD_IRQ_EN (Keyboard IRQ Event Enable).** Enables an IRQ generated by the keyboard interface section of the KBC module to set PME_STS bit in GPE1_STS register.<br>0: Disable event (default)<br>1: Enable event of an IRQ generated by the keyboard interface section of the KBC module to set PME_STS |
| 1-0 | **Reserved.** |

## 6.0 System Wake-Up Control (SWC) (Continued)

### 6.5 SYSTEM WAKE-UP CONTROL REGISTER BITMAP

**Table 34. SWC Register Map with Base Address at Index 60h, 61h**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Offset** | **Mnemonic** | **7** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| 00h | SLEDCTL LED_OPT=1 | Reserved | | | | | | BLINK | GRN_YLW |
| | Reserved LED_OPT=0 | Reserved | | | | | | | |
| 01h | SWC_CTL | LOCKSCF | Reserved | | | | | | LED_OPT |
| 02h | ALEDCTL LED_OPT=0 | Reserved | | LEDCFG | LEDPOL | Reserved | | LEDMOD | |
| | Reserved LED_OPT=1 | Reserved | | | | | | | |
| 03h | LEDBLNK LED_OPT=0 | Reserved | GRNBLNK | | | Reserved | YLWBLNK | | |
| | Reserved LED_OPT=1 | Reserved | | | | | | | |
| 04h | KBDWKCTL | KBDMODE | | EVT3CFG | | EVT2CFG | | EVT1CFG | |
| 05h | PS2CTL | DISPAR | MSEVCFG | | | KBEVCFG | | | |
| 06h | KDSR | Keyboard Data | | | | | | | |
| 07h | MDSR | Reserved | | | | | Mouse Data | | |
| 08h | PS2KEY0 | Data Byte of Key | | | | | | | |
| 09h | PS2KEY1 | Data Byte of Key | | | | | | | |
| 0Ah | PS2KEY2 | Data Byte of Key | | | | | | | |
| 0Bh | PS2KEY3 | Data Byte of Key | | | | | | | |
| 0Ch | PS2KEY4 | Data Byte of Key | | | | | | | |
| 0Dh | PS2KEY5 | Data Byte of Key | | | | | | | |
| 0Eh | PS2KEY6 | Data Byte of Key | | | | | | | |
| 0Fh | PS2KEY7 | Data Byte of Key | | | | | | | |

## 6.0 System Wake-Up Control (SWC) (Continued)

**Table 35. ACPI Register Map with Base Address at Index 62h, 63h**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Offset** | **Mnemonic** | **7** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| 00h | GPE1_STS | Reserved | | | | | | | PME_STS |
| 01h-03h | Reserved | Reserved | | | | | | | |
| 04h | GPE1_EN | Reserved | | | | | | | PME_EN |
| 05h-07h | Reserved | Reserved | | | | | | | |
| 08h | GPE1_STS_0 | GPIOE07_STS | GPIOE06_STS | GPIOE05_STS | GPIOE04_STS | GPIOE03_STS | GPIOE02_STS | GPIOE01_STS | GPIOE00_STS |
| 09h | GPE1_STS_1 | Reserved | | | | GPIOE13_STS | GPIOE12_STS | GPIOE11_STS | GPIOE10_STS |
| 0Ah | GPE1_STS_2 | KBD_EVT3_STS | KBD_EVT2_STS | KBD_EVT1_STS | MS_EVT_STS | KBD_ANYK_STS | RI_EVT_STS | Reserved | |
| 0Bh | GPE1_STS_3 | Reserved | | | MOD_IRQ_STS | MS_IRQ_STS | KBD_IRQ_STS | Reserved | |
| 0Ch | GPE1_EN_0 | GPIOE07_EN | GPIOE06_EN | GPIOE05_EN | GPIOE04_EN | GPIOE03_EN | GPIOE02_EN | GPIOE01_EN | GPIOE00_EN |
| 0Dh | GPE1_EN_1 | Reserved | | | | GPIOE13_EN | GPIOE12_EN | GPIOE11_EN | GPIOE10_EN |
| 0Eh | GPE1_EN_2 | KBD_EVT3_EN | KBD_EVT2_EN | KBD_EVT1_EN | MS_EVT_EN | KBD_ANYK_EN | RI_EVT_EN | Reserved | |
| 0Fh | GPE1_EN_3 | Reserved | | | MOD_IRQ_EN | MS_IRQ_EN | KBD_IRQ_EN | Reserved | |

# 7.0 Fan Speed Monitor

This chapter describes a generic Fan Speed Monitor unit. One or more Fan Speed Monitor units are included in the Fan Speed Monitor (FSM) module. For the implementation used in this device, see Section 3.14.1 on page 60.

## 7.1 OVERVIEW

The Fan Speed Monitor measures the fan speed by measuring the time between consecutive “active” tachometer pulses (obtained from the tachometer pulses generated by the fan). The FSM provides to the system a current speed reading; it can also alert the system by interrupt whenever the speed drops below a programmable threshold. The FSM indicates whether the speed is just below the threshold or low enough to consider the fan stopped (i.e., inefficient fan operation).

Figure 17 shows the basic system configuration of the Fan Speed Monitor.

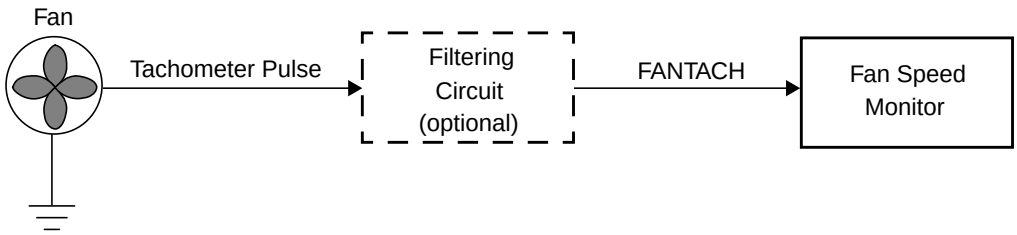



**Figure 17. Fan Speed Monitor - System Configuration**

## 7.2 FUNCTIONAL DESCRIPTION

The fan generates a tachometer pulse every half or full revolution (depending on the fan type). These pulses are fed into the Fan Speed Monitor through the FANTACH input pin.

The FANTACH pin has a Schmitt Trigger input buffer. In addition, the FANTACH signal passes through a digital filter, which ignores any tachometer pulses shorter than 750 µs. This filter can be enabled by setting FILTER_DIS bit in FMCSR register to 0.

Speed monitoring is based on measuring the time between tachometer pulses generated by the fan. The Fan Speed Monitor measures the time for a full fan revolution. Since fans generate one or two tachometer pulses per revolution (depending on the fan type), the incoming pulses at the FANTACH pin are either used directly or are divided by 2 to produce the active tachometer pulses. These active pulses eventually control the fan speed counter. Incoming tachometer pulse decimation is controlled by TPPR bit in FMCSR register.

The fan speed measured by the counter during a full fan revolution is stored as a 16-bit FAN_SPD value, where FAN_SPD_HIGH is the high byte and FAN_SPD_LOW is the low byte. The rotational speed of the fan is calculated according to the following relationship:

$$\text{Rotational Speed of Fan (in RPM)} = 60 * \frac{32000}{\text{FAN_SPD}}$$

The Fan Speed Monitor consists of a 16-bit counter, which measures the fan speed, and two 16-bit registers, FAN_SPD, which holds the current fan speed value, and THRSH, which holds the threshold value. The 16-bit THRSH value is composed of THRSH_HIGH (the high byte) and THRSH_LOW (the low byte). Figure 18 is a simplified diagram of the Fan Speed Monitor.

The Up Counter and the FAN_SPD data are cleared to 0 when the Fan Speed Monitor is disabled.

When the Fan Speed Monitor is enabled (by FANMON_EN bit in FSMCF register; see Section 3.14.3 on page 61) and there is no counter overflow, the Up Counter, which is clocked by a 32.000 KHz internal clock, increments by 1. Starting from the second active FANTACH pulse (after activation) and on every subsequent active FANTACH pulse, the FAN_SPD data is updated with the contents of the counter, the counter is cleared to 0 and SPD_RDY bit in FMCSR register is set to 1.

The above operation continually repeats itself, updating the current speed value as long as the FAN_SPD value is less than or equal to the THRSH value.

When the FAN_SPD value exceeds the THRSH value, OVR_THR bit in FMCSR register is set to 1. An interrupt is also asserted if IRQ_EN bit in FMCSR register is set to 1 (i.e., interrupt is enabled). After OVR_THR bit is set, the FAN_SPD data is no longer updated with new values from the Up Counter. A new value is loaded into FAN_SPD data only after OVR_THR bit is cleared by writing 1. This guarantees that the FAN_SPD value that generated the interrupt remains available for the interrupt handler.

If the Up Counter exceeds FFFFh, OVFLOW bit in FMCSR register is set to 1, the FAN_SPD data is set to FFFFh, and the interrupt is asserted (if enabled). The FAN_SPD data continues to be updated with new values from the Up Counter. OVFLOW bit is cleared to 0 when 1 is written to it.

## 7.0 Fan Speed Monitor (Continued)

To read the FAN_SPD data:

- Read the FMSPRL register: This reads the low byte of the FAN_SPD data and saves the high byte in a latch. In addition, the SPD_RDY bit in the FMCSR register is cleared to 0.
- Read the FMSPRH register: This reads the high byte of the FAN_SPD data from the latch.

.

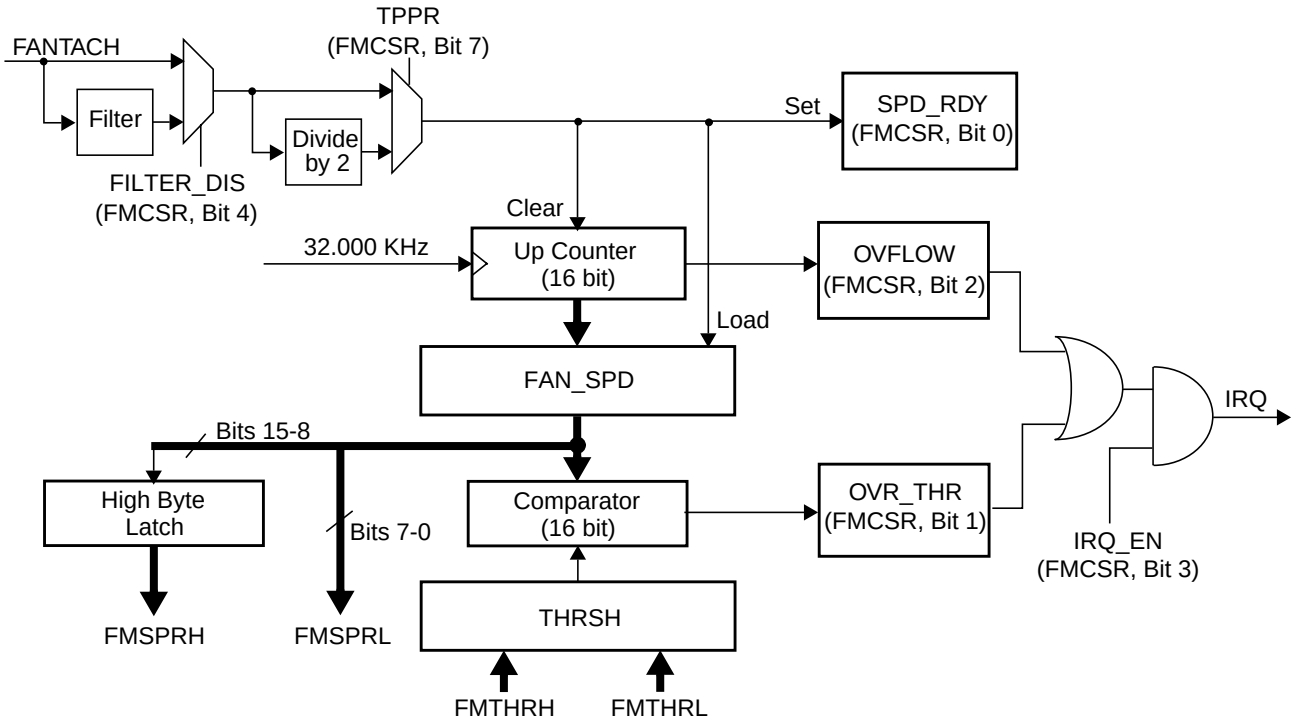



**Figure 18. Fan Speed Monitor (Simplified Diagram)**

# 7.0 Fan Speed Monitor (Continued)

## 7.3 FAN SPEED MONITOR REGISTERS

The following abbreviations are used to indicate the Register Type:

- R/W = Read/Write.
- R = Read from register (write to the same address is to a different register).
- W = Write (see above).
- RO = Read Only.
- WO = Write Only. Reading from the bit returns 0.
- R/W1C = Read/Write 1 to Clear. Writing 1 to a bit clears it to 0. Writing 0 has no effect.
- R/W1S = Read/Write 1 to Set. Writing 1 to a bit sets its value to 1. Writing 0 has no effect.

### 7.3.1 Fan Speed Monitor Register Map

**Table 36. Fan Speed Monitor Register Map**

| Offset | Mnemonic | Register Name | Type | Power Well | Section |
|---|---|---|---|---|---|
| Device specific[1] | FMTHRL | Fan Speed Monitor Threshold Low | R/W | $V_{DD3}$ | 7.3.2 |
| Device specific[1] | FMTHRH | Fan Speed Monitor Threshold High | R/W | $V_{DD3}$ | 7.3.3 |
| Device specific[1] | FMSPRL | Fan Speed Monitor Speed Low | RO | $V_{DD3}$ | 7.3.4 |
| Device specific[1] | FMSPRH | Fan Speed Monitor Speed High | RO | $V_{DD3}$ | 7.3.5 |
| Device specific[1] | FMCSR | Fan Speed Monitor Control and Status | Varies per bit | $V_{DD3}$ | 7.3.6 |

1. The location of this register is defined in Section 3.14.1 on page 60.

### 7.3.2 Fan Speed Monitor Threshold Low Register (FMTHRL)

This register holds the low byte (bits 7-0) of the lowest permitted fan speed value. It is reset to FFh.

Power Well: $V_{DD3}$

Location: Device specific

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **THRSH_LOW** | | | | | | | |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit | Description |
|---|---|
| 7-0 | **THRSH_LOW (Fan Speed Threshold Value - Low).** This field contains the low byte of the threshold setting, indicating the lowest permitted fan speed value. If the number of clock cycles counted in one fan revolution is higher than the THRSH value, OVR_THR bit is set in FMCSR register and the FAN_SPD data is “frozen” at its last value. In addition, an interrupt (if enabled) is issued.<br>To prevent unpredictable results, the contents of this register can only be changed when the corresponding FANMON_EN bit in FSMCF register is reset to 0 (see Section 3.14.3 on page 61). |

# 7.0 Fan Speed Monitor (Continued)

### 7.3.3 Fan Speed Monitor Threshold High Register (FMTHRH)

This register holds the high byte (bits 15-8) of the lowest permitted fan speed value. It is reset to FFh.

Power Well: $V_{DD3}$

Location: Device specific

Type: R/W

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **THRSH_HIGH** | | | | | | | |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit | Description |
|---|---|
| 7-0 | **THRSH_HIGH (Fan Speed Threshold Value - High).** This field contains the high byte of the threshold for the lowest permitted fan speed value; see Section 7.3.2 on page 97 for the description of this field. |

### 7.3.4 Fan Speed Monitor Speed Low Register (FMSPRL)

This register contains the low byte (bits 7-0) of the current fan speed value, which is updated once per fan revolution. It is reset to 00h. Whenever the FMSPRL register is read, the high byte of the FAN_SPD data is latched to save the current fan speed value until FMSPRH register is read. Therefore, the FMSPRL register must be read first. When FMSPRL register is read, SPD_RDY bit in FMCSR register is reset.

The FAN_SPD data is reset when one of the following conditions occurs:

- System reset (see Section 2.2 on page 26).
- The corresponding FANMON_EN bit in FSMCF register is reset to 0 (see Section 3.14.3 on page 61).

Power Well: $V_{DD3}$

Location: Device specific

Type: RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **FAN_SPD_LOW** | | | | | | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-0 | **FAN_SPD_LOW (Fan Speed Value - Low).** This field contains the low byte of the current fan speed value. The 16-bit FAN_SPD data represents the number of clock cycles counted during one full revolution of the fan, according to the setting of TPPR bit in FMCSR register. When SPD_RDY bit is set in FMCSR register, FAN_SPD contains new speed data that has not yet been read. |

## 7.0 Fan Speed Monitor (Continued)

### 7.3.5 Fan Speed Monitor Speed High Register (FMSPRH)

This register contains the high byte (bits 15-8) of the current fan speed value, which is updated once per fan revolution. It is reset to 00h. FMSPRH register must be read last; see Section 7.3.4 on page 98.

Power Well: $V_{DD3}$

Location: Device specific

Type: RO

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **FAN_SPD_HIGH** | | | | | | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | Description |
|---|---|
| 7-0 | **FAN_SPD_HIGH (Fan Speed Value - High).** This field contains the high byte of the current fan speed value. See Section 7.3.4 on page 98 for the description of this field. |

### 7.3.6 Fan Speed Monitor Control and Status Register (FMCSR)

This register contains control and status bits of the Fan Speed Monitor unit. FMCSR is reset to 10h.

Power Well: $V_{DD3}$

Location: Device specific

Type: Varies per bit

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Name | **TPPR** | **Reserved** | | **FILTER_DIS** | **IRQ_EN** | **OVFLOW** | **OVR_THR** | **SPD_RDY** |
| Reset | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

| Bit | Type | Description |
|---|---|---|
| 7 | R/W | **TPPR (Tachometer Pulses Per Revolution).** This bit selects the number of pulses per fan revolution generated by the tachometer and thus the division factor of the incoming pulses at the FANTACH pin.<br>0: Two pulses per revolution: division by 2 (default)<br>1: One pulse per revolution: no division<br>To prevent unpredictable results, the value of this bit can only be changed when the corresponding FANMON_EN bit in FSMCF register is reset to 0 (see Section 3.14.3 on page 61). |
| 6-5 | – | **Reserved.** |
| 4 | R/W | **FILTER_DIS (Filter Disable).** When this bit is set to 1, the digital Low Pass Filter on the FANTACH input is disabled.<br>0: Digital Low Pass Filter enabled<br>1: Digital Low Pass Filter disabled (default)<br>To prevent unpredictable results, the value of this bit can only be changed when the corresponding FANMON_EN bit in FSMCF register is reset to 0 (see Section 3.14.3 on page 61). |
| 3 | R/W | **IRQ_EN (Fan Interrupt Enable).** This bit controls the routing of Overflow and Over Threshold events to the FSM module interrupt.<br>0: Interrupt disabled (default)<br>1: Interrupt enabled. An interrupt is asserted when either OVR_THR bit or OVFLOW bit is set to 1. |
| 2 | R/W1C | **OVFLOW (Overflow).** This bit indicates that the number of clock cycles counted during one full revolution of the fan exceeds 65536 (FFFFh) clocks. This is equivalent to a fan speed slower than 29.3 RPM. At this speed, fan cooling is inefficient; therefore, the fan is considered stopped and an interrupt (if enabled) is issued. Writing 1 to this bit clears it to 0.<br>0: No overflow occurred since the last time this bit was cleared by writing 1 (default)<br>1: Counter overflow (FFFFh) occurred |

## 7.0 Fan Speed Monitor (Continued)

| Bit | Type | Description |
|---|---|---|
| 1 | R/W1C | **OVR_THR (Over Threshold).** This bit indicates that the FAN_SPD value (current speed) is higher than the THRSH value. This is equivalent to a fan speed slower than [60 * 32000 / THRSH] RPM. At this speed, the fan cooling is less efficient; therefore, an interrupt (if enabled) is issued. Writing 1 to this bit clears it to 0.<br>0: No Over Threshold occurred since the last time this bit was cleared by writing 1 (default)<br>1: FAN_SPD value is higher than THRSH value |
| 0 | RO | **SPD_RDY (Speed Data Ready).** This bit indicates that the FAN_SPD data contains a new current speed value that has not yet been read. SPD_RDY is set to 1 on each “active” tachometer pulse (after the division selected by TPPR bit) received at the FANTACH input, starting from the third “active” pulse, if OVR_THR bit is 0. SPD_RDY is cleared to 0 whenever FMSPRL register is read or when OVFLOW bit is set.<br>0: The FAN_SPD data is either invalid or has already been read (default)<br>1: FAN_SPD data contains a new value |

## 7.4 FAN SPEED MONITOR REGISTER BITMAP

**Table 37. Fan Speed Monitor Register Bitmap**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Offset[1]** | **Mnemonic** | **7** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| Device Specific | FMTHRL | THRSH_LOW | | | | | | | |
| Device Specific | FMTHRH | THRSH_HIGH | | | | | | | |
| Device Specific | FMSPRL | FAN_SPD_LOW | | | | | | | |
| Device Specific | FMSPRH | FAN_SPD_HIGH | | | | | | | |
| Device Specific | FMCSR | TPPR | Reserved | | FILTER_DIS | IRQ_EN | OVFLOW | OVR_THR | SPD_RDY |

1. The location of these registers is defined in Section 3.14.1 on page 60.

# 8.0 Glue Functions

This chapter describes the glue functions integrated in the PC87372 device.

## 8.1 OVERVIEW

This module contains 11 glue functions. Most of them operate independently of the other functions and of the other modules in the PC87372 device.

The 11 glue functions are divided into three groups:

- Power-related functions:
  - Highest active Main supply reference (REF5V)
  - Highest active Standby supply reference (REF5V_STBY)
  - Resume reset ($\overline{\text{RSMRST}}$)
  - Main power good (PWRGD_3V)
  - Rambus SCK clock gate control (SCK_BJT_GATE)
  - Power distribution control ($\overline{\text{BKFD_CUT}}$, LATCHED_BF_CUT)
  - Main power supply control ($\overline{\text{PS_ON}}$)
- Miscellaneous functions:
  - CNR downstream codec dynamic control ($\overline{\text{CDC_DWN_RST}}$)
  - Hard-disk LED indicator control ($\overline{\text{HD_LED}}$)
- SMBus support functions:
  - SMBus voltage translation (3V_DDCSCL, 3V_DDCSDA, 5V_DDCSCL, 5V_DDCSDA)
  - SMBus isolation (SMB1_SCL, SMB1_SDA, SMB2_SCL, SMB2_SDA)

Each function is described in the following sections.

## 8.2 FUNCTIONAL DESCRIPTION

### 8.2.1 Highest Active Main Supply Reference

This function generates the REF5V analog output signal (see specification in Section 10.2.9 on page 125). When the Main power supply is turned on or off, the REF5V signal tracks either the $V_{DD3}$ or $V_{DD5}$ power supplies, whichever has a higher voltage.

The circuit that generates the REF5V output is composed of two parts:

- One part tracks the $V_{DD3}$ supply voltage and is implemented in the PC87372 device.
- One part tracks the $V_{DD5}$ supply voltage and is implemented by an external resistor connected to the $V_{DD5}$ power supply.

Figure 19 shows a simplified diagram of the circuit that generates the REF5V analog output signal

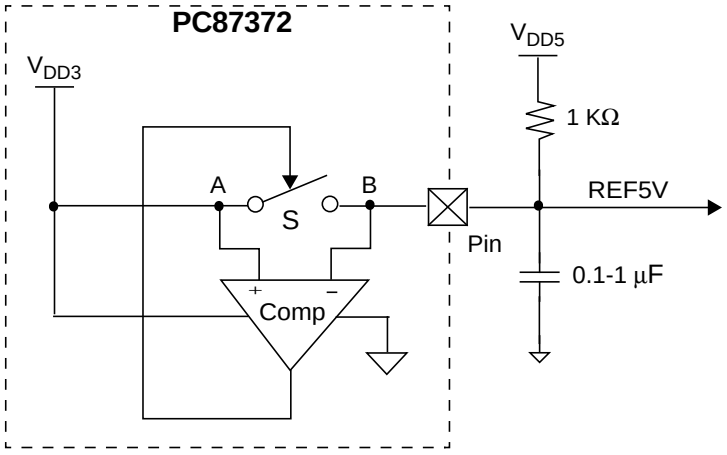



**Figure 19. REF5 Generation (Simplified Diagram)**

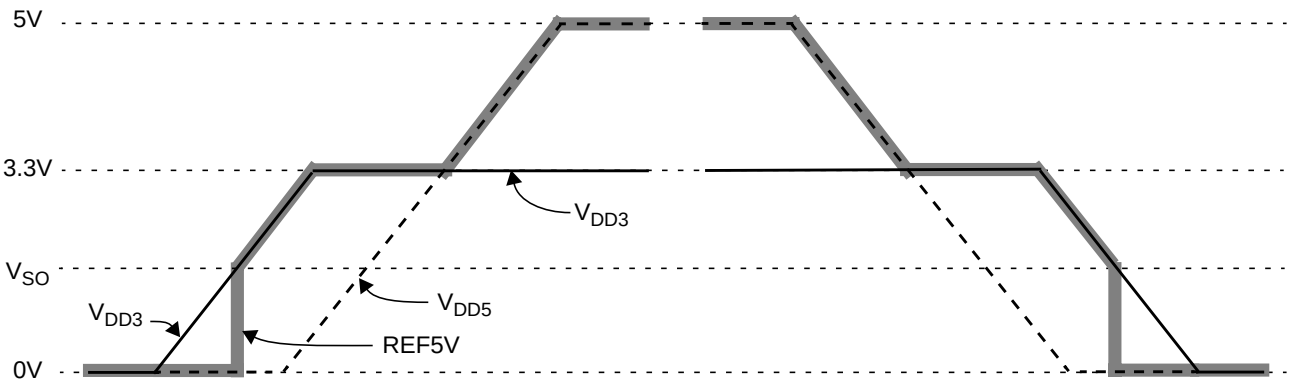
## 8.0 Glue Functions (Continued)

The voltage levels at both sides of switch “S” are measured by the comparator (“Comp”), which controls the state of the switch as follows:

- If $V_A > V_B$, then $V_{DD3} > V_{DD5}$; the switch is **closed**, and the output voltage $V_{REF5V} = V_{DD3}$.
- If $V_A < V_B$, then $V_{DD3} < V_{DD5}$; the switch is **open**, and the output voltage $V_{REF5V} = V_{DD5}$, through the external 1 KΩ resistor, is connected to the $V_{DD5}$ power supply.

The internal circuit is powered from the $V_{DD3}$ supply. For $V_{DD3} < V_{SO}$, switch “S” is **open**; therefore, the $V_{REF5V}$ output tracks only the $V_{DD5}$ supply. Figure 20 shows REF5 output in four cases of $V_{DD3}$ and $V_{DD5}$ ramp up and ramp down.

**a. $V_{DD3}$ Ramps Up Before and Ramps Down After $V_{DD5}$**




**b. $V_{DD3}$ Ramps Up After and Ramps Down Before $V_{DD5}$**

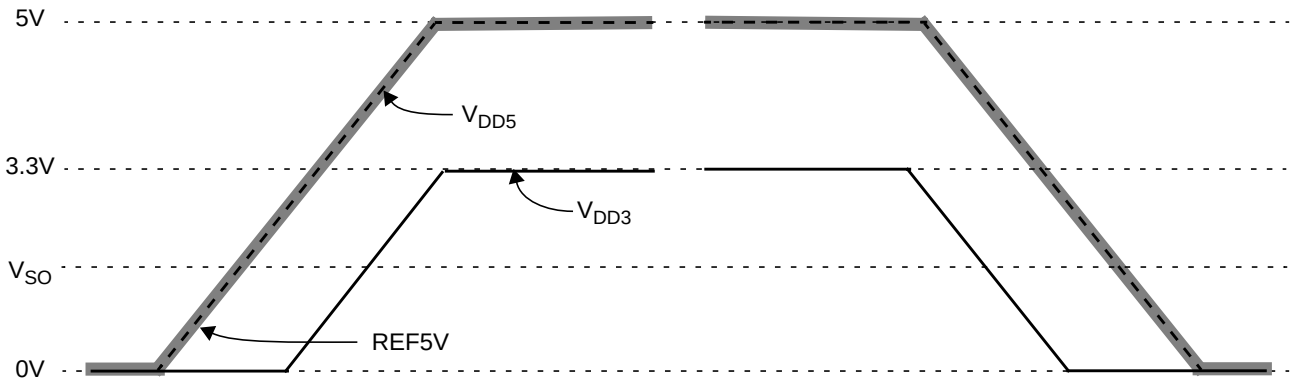


**Figure 20. REF5 as a Function of $V_{DD3}$ and $V_{DD5}$**

Table 38 defines the DC characteristics of the REF5 output, relative to the $V_{DD3}$ supply. For the AC characteristics, see *Highest Active Main and Standby Supply Reference* on page 140.

**Table 38. REF5V DC Characteristics**

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{SO}$ | Switch Open, $V_{DD3}$ Voltage Range | $0 < V_{DD5} < 5.5V$ | 0 | 1.5[1] | V |
| $V_{TRK}$ | Output Voltage Tracking of $V_{DD3}$ Voltage[1,] | $1.5V < V_{DD3}$, $V_{DD5} < V_{DD3} + 150$ mV | − 150 | + 150 | mV |

1. Not tested. Guaranteed by characterization.

## 8.0 Glue Functions (Continued)

### 8.2.2 Highest Active Standby Supply Reference

This function generates the REF5V_STBY analog output signal (see specification in Section 10.2.9 on page 125). When the Standby power supply is turned on or off, the REF5V_STBY signal tracks either the $V_{SB3}$ or $V_{SB5}$ power supplies, whichever has a higher voltage.

The circuit that generates the REF5V_STBY output is composed of two parts:

- One part tracks the $V_{SB3}$ supply voltage and is implemented in the PC87372 device.
- One part tracks the $V_{SB5}$ supply voltage and is implemented by an external resistor connected to the $V_{SB5}$ power supply.

Figure 21 shows a simplified diagram of the circuit that generates the REF5V_STBY analog output signal

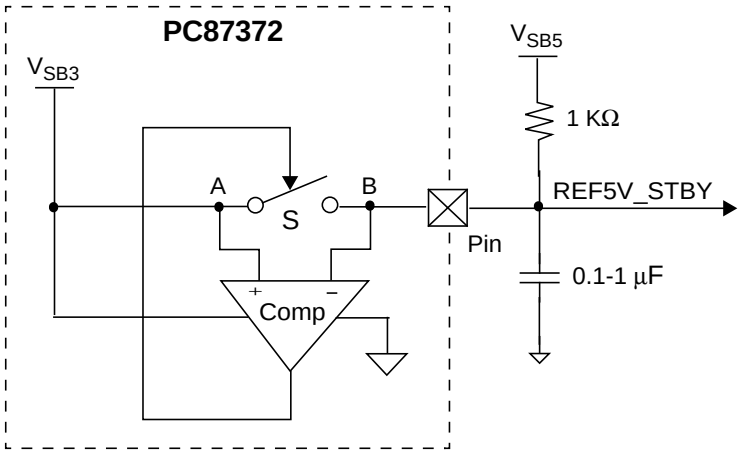



**Figure 21. REF5_STBY Generation (Simplified Diagram)**

The voltage levels at both sides of switch “S” are measured by the comparator (“Comp”), which controls the state of the switch as follows:

- If $V_A > V_B$, then $V_{SB3} > V_{SB5}$; the switch is **closed** and the output voltage $V_{REF5V_STBY} = V_{SB3}$
- If $V_A < V_B$, then $V_{SB3} < V_{SB5}$; the switch is **open** and the output voltage $V_{REF5V_STBY} = V_{SB5}$, through the external 1 KΩ resistor, is connected to the $V_{SB5}$ power supply

The internal circuit is powered from the $V_{SB3}$ supply. For $V_{SB3} < V_{SO}$, switch “S” is **open**; therefore, the $V_{REF5V_STBY}$ output tracks only the $V_{SB5}$ supply. Figure 22 shows the behavior of the REF5V_STBY output in four cases of $V_{SB3}$ and $V_{SB5}$ ramp up and ramp down.

## 8.0 Glue Functions (Continued)

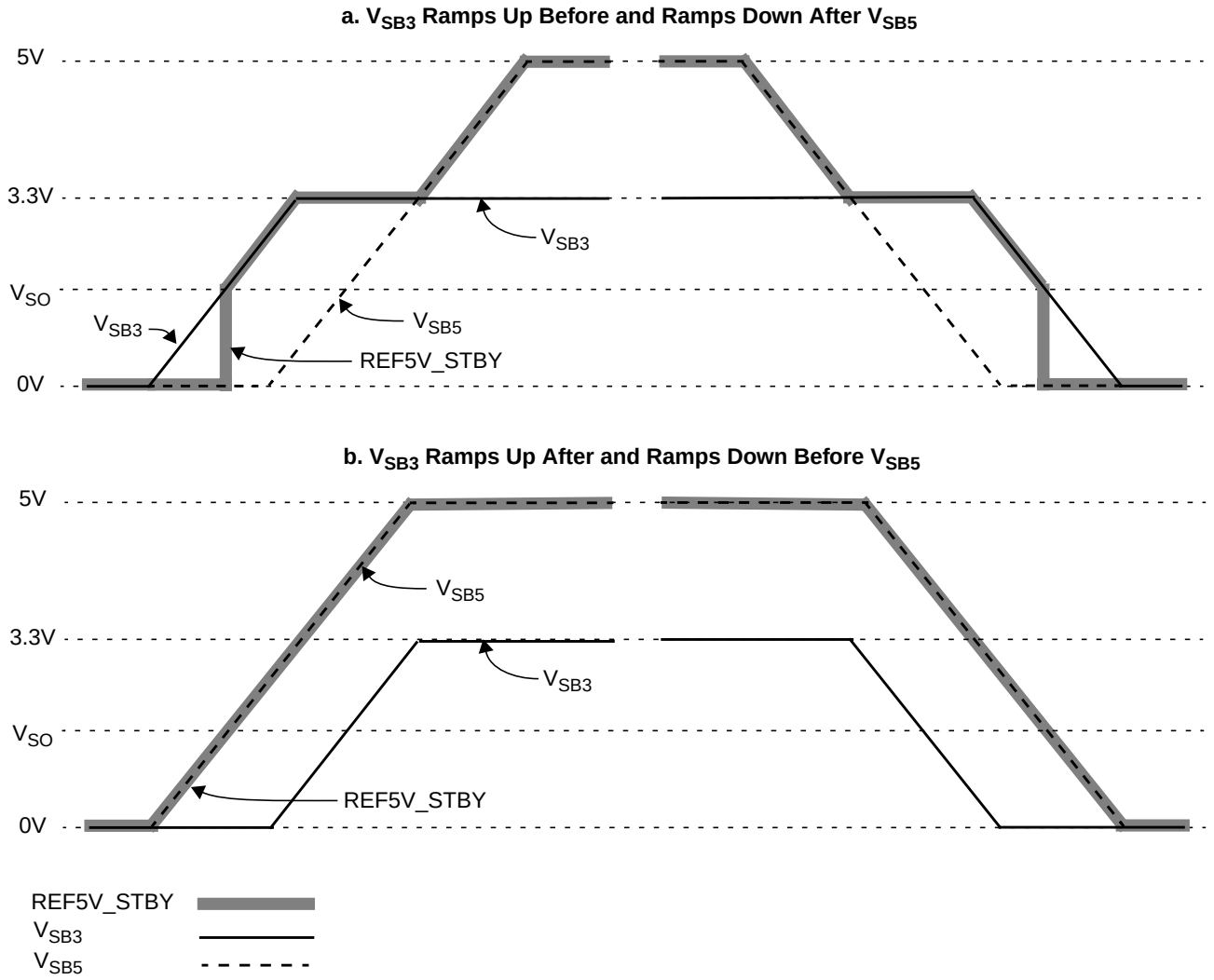



**Figure 22. REF5_STBY as a Function of $V_{SB3}$ and $V_{SB5}$**

Table 38 defines the DC characteristics of the REF5_STBY output relative to the $V_{SB3}$ supply. For the AC characteristics, see *Highest Active Main and Standby Supply Reference* on page 140.

**Table 39. REF5V_STBY DC Characteristics**

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{SO}$ | Switch Open, $V_{SB3}$ Voltage Range | $0 < V_{SB5} < 5.5V$ | 0 | 1.5[1] | V |
| $V_{TRK}$ | Output Voltage Tracking of $V_{SB3}$ Voltage[1,] | $1.5V < V_{SB3}$, $V_{SB5} < V_{SB3} + 150$ mV | − 150 | + 150 | mV |

1. Not tested. Guaranteed by characterization.

## 8.0 Glue Functions (Continued)

### 8.2.3 Resume Reset

This function generates the $\overline{\text{RSMRST}}$ signal by sensing the voltage level at the $V_{SB5}$ analog input (see specification in Section 10.2.5 on page 124). The $\overline{\text{RSMRST}}$ signal serves both as a Power-Up reset and as a "Brown-Out" reset for the system resume power well (powered by the $V_{SB3}$ or $V_{SB5}$ supplies).

The Resume Reset circuit compares the voltage at the $V_{SB5}$ input with a threshold value ($V_{TRIP}$). When the $V_{SB3}$ supply voltage is active, the circuit generates the $\overline{\text{RSMRST}}$ active low output signal, as follows:

- When $V_{SB5}$ rises above $V_{TRIP}$, the $\overline{\text{RSMRST}}$ signal switches from low to high after a $t_{RD}$ delay.
- When $V_{SB5}$ falls below $V_{TRIP}$, the $\overline{\text{RSMRST}}$ signal switches from high to low after a $t_{FD5}$ delay.
- When a glitch shorter than $t_{GA}$ (the time $V_{SB5}$ is below $V_{TRIP}$) occurs at the $V_{SB5}$ input, the $\overline{\text{RSMRST}}$ signal is not guaranteed to react (remains high).

The Resume Reset circuit is powered by the $V_{SB3}$ supply. When the $V_{SB5}$ supply voltage is active, the circuit compares the $V_{SB3}$ power supply voltage with the threshold value ($V_{SB3ON}$ or $V_{SB3OFF}$); see Section 10.1.5 on page 122. As a result, the $\overline{\text{RSMRST}}$ active low output signal is generated, as follows:

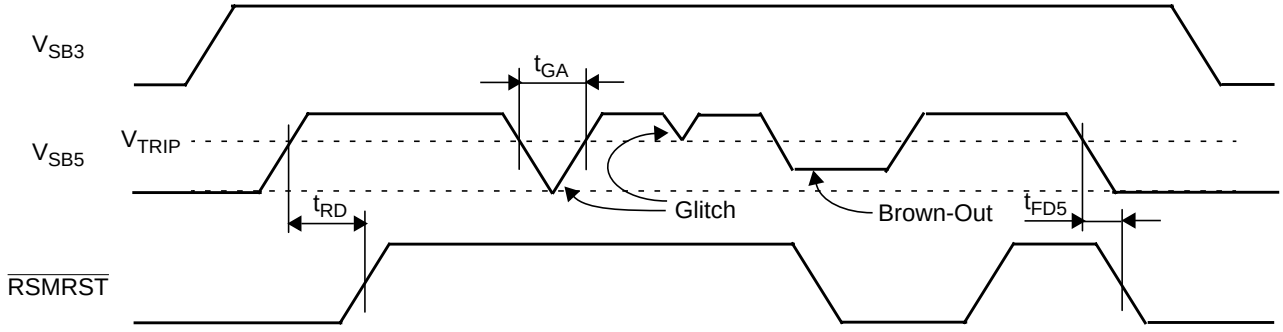
- When $V_{SB3}$ rises above $V_{SB3ON}$, the $\overline{\text{RSMRST}}$ signal switches from low to high after a $t_{RD}$ delay.
- When $V_{SB3}$ falls below $V_{SB3OFF}$, the $\overline{\text{RSMRST}}$ signal switches from high to low after a $t_{FD3}$ delay.
- When a glitch shorter than $t_{GA}$ (the time $V_{SB3}$ is below $V_{SB3OFF}$) occurs at the $V_{SB3}$ input, the $\overline{\text{RSMRST}}$ signal is not guaranteed to react (remains high).

When the $V_{SB3}$ power supply is off, the $\overline{\text{RSMRST}}$ output is at low level (active) having an internal impedance of $Z_{OFF}$.

The delays in $\overline{\text{RSMRST}}$ switching, generated by the Resume Reset circuit, are independent of the toggling of any of the clock domains of the PC87372 device (32 KHz, 48 MHz or LPC).

Figure 23 shows the behavior of the $\overline{\text{RSMRST}}$ output at $V_{SB3}$ and $V_{SB5}$ switching.

**a. $V_{SB5}$ Switching, $V_{SB3}$ Steady**




**b. $V_{SB3}$ Switching, $V_{SB5}$ Steady**

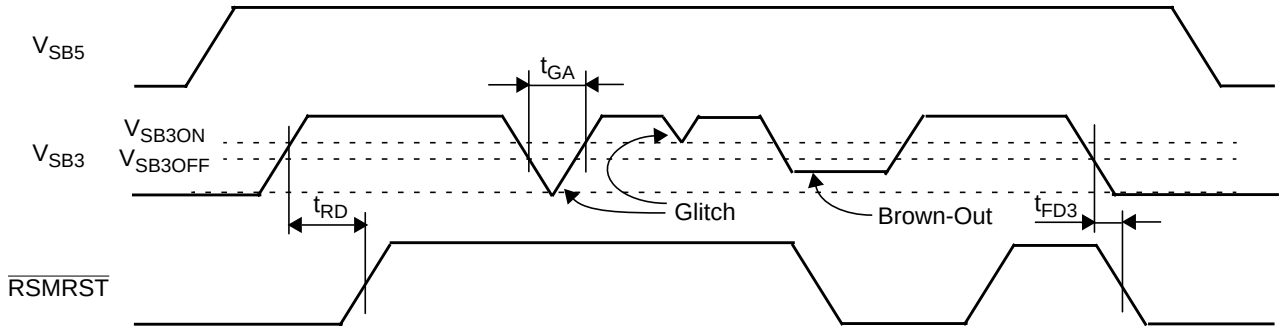



**Figure 23. $\overline{\text{RSMRST}}$ at $V_{SB5}$ and $V_{SB3}$ Switching**

## 8.0 Glue Functions (Continued)

Table 40 defines the DC characteristics of the Resume Reset circuit. For the AC characteristics, see *Resume Reset* on page 140.

**Table 40. Resume Reset Circuit DC Characteristics**

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{TRIP}$ | $V_{SB5}$ Threshold Level | $V_{SB3}$ = 3.3V ±10% | 4.2 | 4.5 | V |
| $Z_{OFF}$ | Output Impedance at $V_{SB3}$ Off[1] | $V_{SB3}$ = 0V, $V_{SB5}$ = 5V ±10% | 7 | 10 | KΩ |

1. Not tested. Guaranteed by characterization.

### 8.2.4 Main Power Good

This function generates the PWRGD_3V signal, indicating that the Main power supply voltage is valid and the reset button on the front panel is not pressed. The PWRGD_3V signal indicates to system components that their input power supplies are valid.

The $\overline{\text{FPRST}}$ input is debounced for at least $t_{DB}$ before entering the Main Power Good circuit, to ensure that the signal is stable. The debouncer adds a $t_{DB}$ delay to the PWRGD_3V output change in output caused by the $\overline{\text{FPRST}}$ input. The debouncer timing is based on the 32 KHz clock domain, which therefore must be valid to enable the correct operation of the Power Good function.

The PWRGD_3V is the AND function of the PWRGD_PS and $\overline{\text{FPRST}}$ inputs. Figure 24 shows a simplified diagram of the circuit that generates the PWRGD_3V signal.

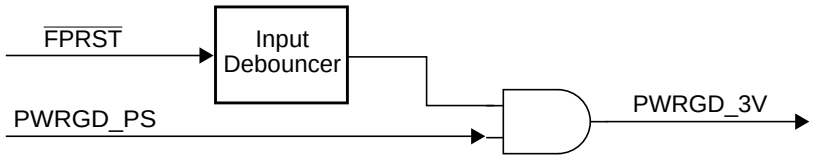



**Figure 24. PWRGD_3V Generation (Simplified Diagram)**

For the AC characteristics, see *Main Power Good* on page 141.

### 8.2.5 Rambus SCK Clock Gate Control

This function generates the SCK_BJT_GATE signal, which controls an external circuit that gates the SCK clock to the Rambus socket.

The SCK clock to the Rambus socket is disabled by an active high SCK_BJT_GATE signal, generated when either the Main power supply voltage is not valid **or** the reset button on the front panel is pressed (PWRGD_3V = low).

Figure 25 shows a simplified diagram of the circuit that generates the SCK_BJT_GATE signal.

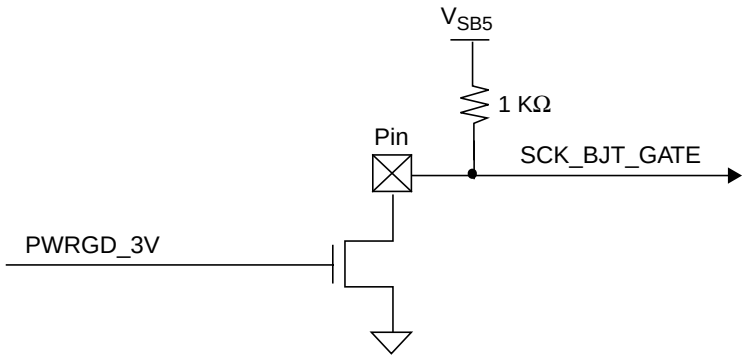



**Figure 25. SCK_BJT_GATE Generation (Simplified Diagram)**

For the AC characteristics, see *CNR Downstream Codec Dynamic Control* on page 142.

## 8.0 Glue Functions (Continued)

### 8.2.6 Power Distribution Control

This function generates the $\overline{\text{BKFD_CUT}}$ and the LATCHED_BF_CUT power distribution control signals.

An active low $\overline{\text{BKFD_CUT}}$ signal is generated when the Main power supply voltage is valid (PWRGD_PS = high) **and** the system is **not** in one of the S3 to S5 sleep states ($\overline{\text{SLP_S3}}$ = high).

The LATCHED_BF_CUT signal is generated from $\overline{\text{BKFD_CUT}}$ and $\overline{\text{SLP_S5}}$ as follows:

- Rising edge of $\overline{\text{BKFD_CUT}}$ while the system is **not** in S5 sleep state ($\overline{\text{SLP_S5}}$ = high) sets LATCHED_BF_CUT to high.
- Falling edge of $\overline{\text{BKFD_CUT}}$ while the system is **not** in S5 sleep state ($\overline{\text{SLP_S5}}$ = high) resets LATCHED_BF_CUT to low.
- When the system is in S5 sleep state ($\overline{\text{SLP_S5}}$ = low), LATCHED_BF_CUT is reset to low.

Figure 26 shows a simplified diagram of the circuit that generates the $\overline{\text{BKFD_CUT}}$ and the LATCHED_BF_CUT signals.

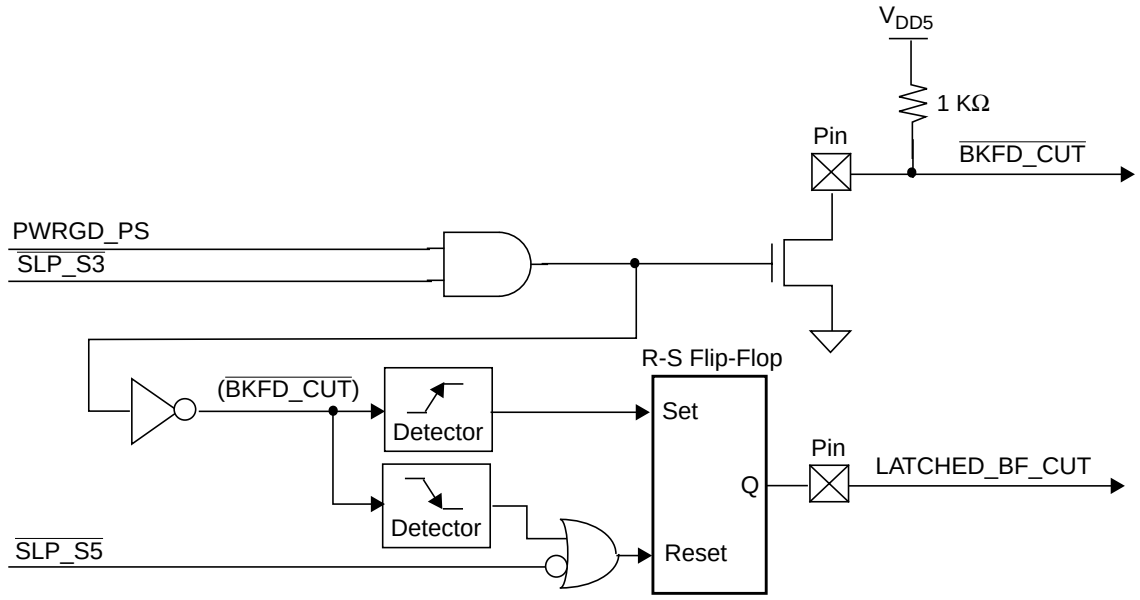



**Figure 26. $\overline{\text{BKFD_CUT}}$ and LATCHED_BF_CUT Generation (Simplified Diagram)**

For the AC characteristics, see *Power Distribution Control* on page 141.

### 8.2.7 Main Power Supply Control

This function generates the $\overline{\text{PS_ON}}$ signal, which turns the Main power supply on and off.

The Main power supply is turned on by an active low $\overline{\text{PS_ON}}$ signal, generated when the processor is currently inserted in its socket ($\overline{\text{CPU_PRESENT}}$ = low) **and** the system is **not** in one of the S3 to S5 sleep states ($\overline{\text{SLP_S3}}$ = high).

Figure 27 shows a simplified diagram of the circuit that generates the $\overline{\text{PS_ON}}$ signal.

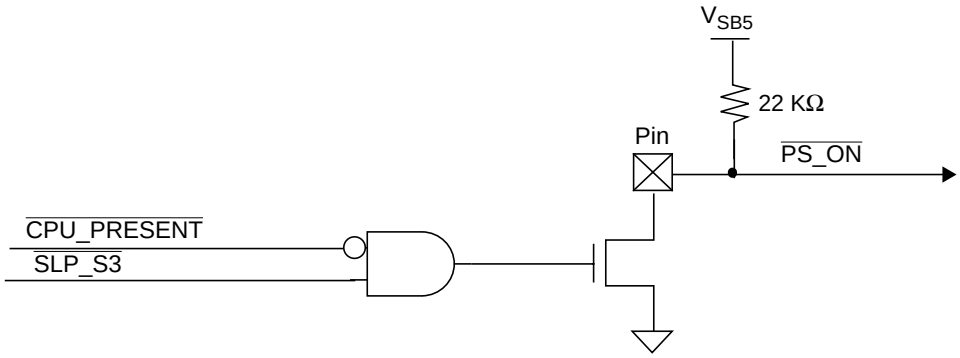



**Figure 27. $\overline{\text{PS_ON}}$ Generation (Simplified Diagram)**

For the AC characteristics, see *Main Power Supply Control* on page 142.

## 8.0 Glue Functions (Continued)

### 8.2.8 CNR Downstream Codec Dynamic Control

This function generates the CDC_DWN_RST signal, which enables the audio CNR board.

An active low codec reset signal (CDC_DWN_RST) is generated either when an active (low) AUD_LINK_RST is received **or** when CNR Downstream Codec is disabled (CDC_DWN_ENAB = high).

The level of the CDC_DWN_ENAB system configuration signal is controlled as follows:

- Externally, by connecting a pull-down resistor between the CDC_DWN_ENAB pin and GND (in this case, the output buffer of GPIO14 must be disabled; see Section 3.13.4 on page 57)
- Internally, by enabling the output buffer of GPIO14 and by writing the required level for CDC_DWN_ENAB to bit 4 of GPDO1 (or GPDIO1) register; see Section 5.4.3 on page 68 (in this case, it is not necessary to remove the pull-down resistor if it is connected between the CDC_DWN_ENAB pin and GND).

Figure 28 shows a simplified diagram of the circuit that generates the CDC_DWN_RST signal.

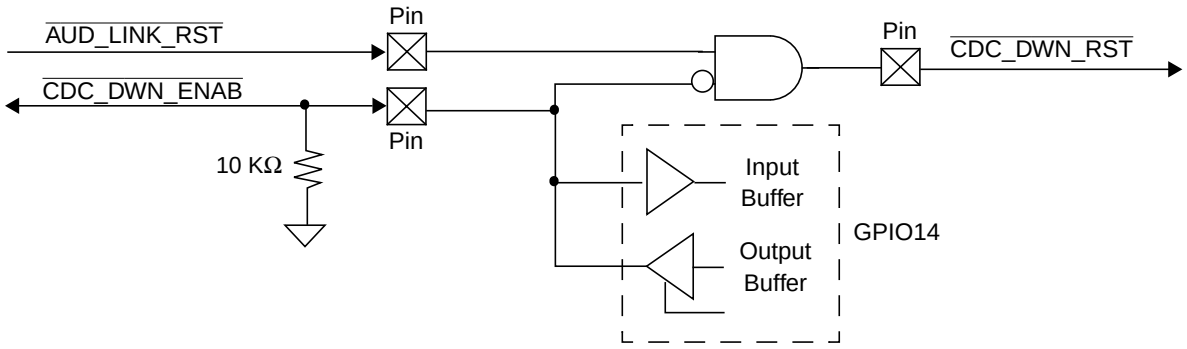



**Figure 28. CDC_DWN_RST Generation (Simplified Diagram)**

For the AC characteristics, see *CNR Downstream Codec Dynamic Control* on page 142.

### 8.2.9 Hard-Disk LED Indicator Control

This function generates the HD_LED signal, which controls the Hard Drive, red LED indicator.

The Hard Drive LED is turned on by an active low HD_LED signal, generated when at least one of the PRIMARY_HD **or** SECONDARY_HD **or** SCSI pins is active (low).

Figure 29 shows a simplified diagram of the circuit that generates the HD_LED signal.

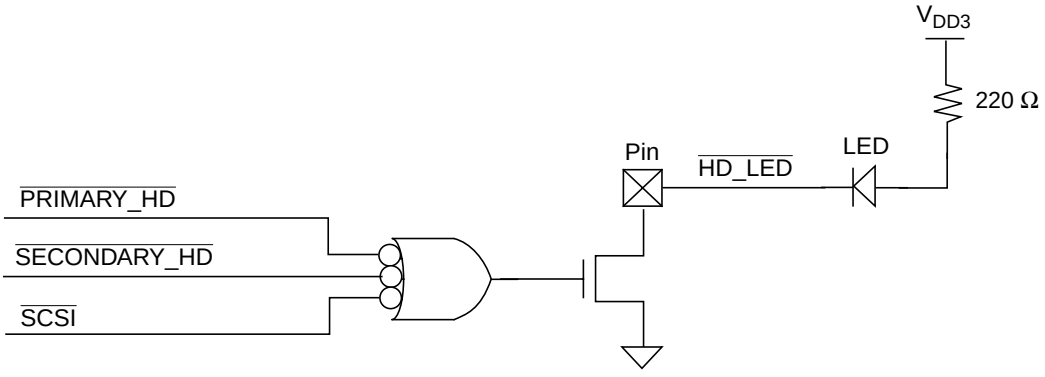



**Figure 29. HD_LED Generation (Simplified Diagram)**

### 8.2.10 SMBus Voltage Translation

This function performs "passive" level translation between the $V_{DD3}$-powered 3V_DDCSCL and 3V_DDCSDA signals and the $V_{DD5}$-powered 5V_DDCSCL and 5V_DDCSDA signals, respectively, for interfacing the Data Display Channel.

The signals connected to the 3V_DDCSCL, 3V_DDCSDA, 5V_DDCSCL and 5V_DDCSDA pins are compatible with Intel's SMBus (*Specification Rev 1.1, Dec. 11, 1998*) two-wire synchronous serial interface specifications.

## 8.0 Glue Functions (Continued)

The 3V_DDCSCL and 5V_DDCSCL pins are connected through a switch. This switch is controlled by a Level Translation Control circuit, according to the voltage levels at the 3V_DDCSCL and 5V_DDCSCL pins (for the DC characteristics, see Section 10.2.10 on page 125):

- For $V_{IN} < V_{ISC}$ at **either** pin, the switch is closed; therefore, both pins (3V_DDCSCL, and 5V_DDCSCL) are held at low level.
- For $V_{IN} > V_{ISO}$ at **both** pins, the switch is open; therefore, each pin is pulled up to high level by the external resistor connected to $V_{DD3}$ (for the 3V_DDCSCL pin) and to $V_{DD5}$ (for the 5V_DDCSCL pin).

In addition, when the $V_{DD3}$ power is off, the switch is open, regardless of the voltage levels at the 3V_DDCSCL and 5V_DDCSCL pins.

The 3V_DDCSDA and 5V_DDCSDA pins are connected through a similar level translation circuit and behave like 3V_DDCSCL and 5V_DDCSCL.

Figure 30 shows a simplified diagram of the circuit that performs SMBus voltage translation.

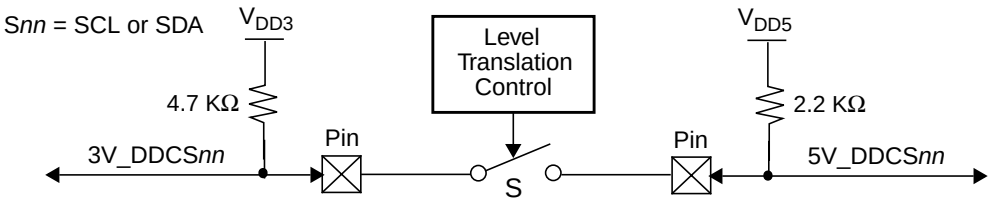



**Figure 30. SMBus Voltage Translation (Simplified Diagram)**

For the AC characteristics, see *SMBus Voltage Translation and Isolation Timing* on page 142.

### 8.2.11 SMBus Isolation

When the Main power is off, this function performs “passive” bus isolation between the SMB1_SCL, SMB1_SDA signals and the SMB2_SCL, SMB2_SDA signals respectively. The bus isolation enables the operation of the serial bus section connected to Standby power, if the other serial bus is connected to the Main power and the Main power is off.

The signals connected to the SMB1_SCL, SMB1_SDA, SMB2_SCL and SMB2_SDA pins are compatible Intel's SMBus (*Specification Rev 1.1, Dec. 11, 1998*) two-wire synchronous serial interface specifications.

The SMB1_SCL and SMB2_SCL pins are connected through a switch. This switch is controlled by the voltage levels at the SMB1_SCL and SMB2_SCL pins (for the DC characteristics, see Section 10.2.10 on page 125):

- For $V_{IN} < V_{ISC}$ at **either** pin, the switch is closed; therefore, both pins (SMB1_SCL, and SMB2_SCL) are held at low level.
- For $V_{IN} > V_{ISO}$ at **both** pins, the switch is open; therefore, each pin is pulled up to high level by the external resistor connected to $V_{SUP1}$ (for the SMB1_SCL pin) and to $V_{SUP2}$ (for the SMB2_SCL pin).

In addition, when the Main power supply voltage is not valid (PWRGD_PS = low), the switch is forced open and the unpowered SMB*x*_SCL signal is disconnected from the powered SMB*x*_SCL signal (*x* is either 1 or 2). This isolation between the two signals prevents the loading of the powered SMB*x*_SCL signal by the unpowered SMB*x*_SCL signal.

The SMB1_SDA and SMB2_SDA pins are connected through a similar level isolation circuit and behave like SMB1_SCL and SMB2_SCL.

Figure 31 shows a simplified diagram of the circuit that performs SMBus isolation.

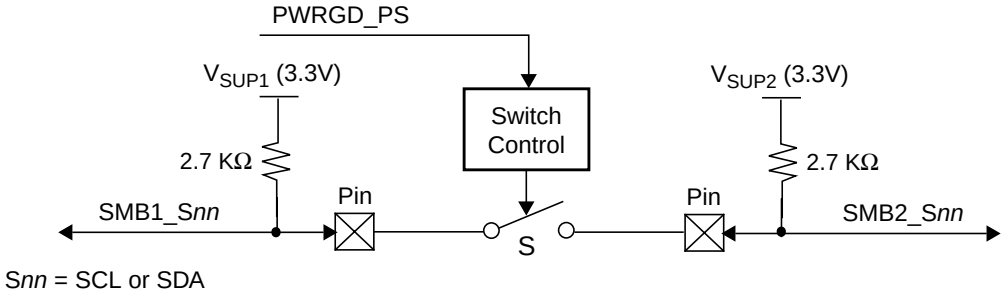



**Figure 31. SMBus Isolation (Simplified Diagram)**

For the AC characteristics, see *SMBus Voltage Translation and Isolation Timing* on page 142.

# 9.0 Legacy Functional Blocks

This chapter briefly describes the following blocks, which provide legacy device functions:

- Floppy Disk Controller (FDC)
- Parallel Port (PP)
- Serial Port (SP)
- Keyboard and Mouse Controller (KBC)

For details on the general implementation of each legacy block, see the *SuperI/O Legacy Functional Blocks* datasheet.

The register maps in this chapter use the following abbreviations for Type:

- R/W = Read/Write.
- R = Read from register (write to the same address is to a different register).
- W = Write (see above).
- RO = Read Only.
- WO = Write Only. Reading from the bit returns 0.
- R/W1C = Read/Write 1 to Clear. Writing 1 to a bit clears it to 0. Writing 0 has no effect.
- R/W1S = Read/Write 1 to Set. Writing 1 to a bit sets its value to 1. Writing 0 has no effect.

## 9.1 FLOPPY DISK CONTROLLER (FDC)

### 9.1.1 General Description

The generic FDC is a standard FDC with a digital data separator; it is software compatible with the µDP8473 and N82077. The PC87372 FDC supports 14 of the 17 standard FDC signals described in the generic Floppy Disk Controller (FDC) chapter, including:

- FDC supportS FM and MFM modes. To select either mode, set bit 6 of the first command byte when writing to/reading from a diskette, where:
  - — 0 = FM mode
  - — 1 = MFM mode
- A logic 1 is returned during LPC I/O read cycles by all register bits, reflecting the state of floating (TRI-STATE) FDC pins.

Exceptions to standard FDC are:

- Automatic media sense using MSEN0 and MSEN1 signals is not supported.
- DRATE1 is not supported.
- $\overline{DR1}$ is not supported.
- $\overline{MTR1}$ is not supported.

Table 41 lists the FDC functional block registers. All registers are $V_{DD3}$ powered.

**Table 41. FDC Register Map**

| Offset[1] | Mnemonic | Register Name | Type |
|---|---|---|---|
| 00h | SRA | Status A | RO |
| 01h | SRB | Status B | RO |
| 02h | DOR | Digital Output | R/W |
| 03h | TDR | Tape Drive | R/W |
| 04h | MSR | Main Status | R |
| | DSR | Data Rate Select | W |
| 05h | FIFO | Data (FIFO) | R/W |

## 9.0 Legacy Functional Blocks (Continued)

**Table 41. FDC Register Map**

| Offset[1] | Mnemonic | Register Name | Type |
|---|---|---|---|
| 06h | | N/A | X |
| 07h | DIR | Digital Input | R |
| | CCR | Configuration Control | W |

1. From the 8-byte aligned FDC base address.

### 9.1.2 FDC Bitmap Summary

The FDC supports two system operation modes: PC-AT mode and PS/2 mode. Unless specifically indicated otherwise, all fields in all registers are valid in both operation modes.

**Table 42. FDC Bitmap Summary**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Offset | Mnemonic | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 00h | SRA[1] | IRQ Pending | Reserved | Step | $\overline{\text{TRK0}}$ | Head Select | $\overline{\text{INDEX}}$ | $\overline{\text{WP}}$ | Head Direction |
| 01h | SRB[1] | Reserved | | Drive Select 0 Status | $\overline{\text{WDATA}}$ | $\overline{\text{RDATA}}$ | $\overline{\text{WGATE}}$ | $\overline{\text{MTR1}}$ | $\overline{\text{MTR0}}$ |
| 02h | DOR | Reserved | | Motor Enable 1 | Motor Enable 0 | DMAEN | Reset Controller | Drive Select | |
| 03h | TDR | Reserved | | | | | | Tape Drive Select 1,0 | |
| | TDR[2] | Reserved (must be 1111) | | | | Logical Drive Exchange | | Tape Drive Select 1,0 | |
| 04h | MSR | RQM | Data I/O Direction | Non-DMA Execution | Command in Progress | Reserved | | Drive 1 Busy | Drive 0 Busy |
| | DSR | Software Reset | Low Power | Reserved | Precompensation Delay Select | | | Data Transfer Rate Select | |
| 05h | FIFO | Data Bits | | | | | | | |
| 07h | DIR[3] | $\overline{\text{DSKCHG}}$ | Reserved | | | | | | |
| | DIR[1] | $\overline{\text{DSKCHG}}$ | Reserved | | | | DRATE 1,0 Status | | High Density |
| 07h | CCR | Reserved | | | | | | DRATE1,0 | |

1. Applicable only in PS/2 Mode.
2. Applicable only in Enhanced TDR Mode.
3. Applicable only in PC-AT Compatible Mode.

# 9.0 Legacy Functional Blocks (Continued)

## 9.2 PARALLEL PORT

### 9.2.1 General Description

The Parallel Port supports all IEEE1284 standard communication modes:

- Compatibility (known also as Standard or SPP)
- Bi-directional (known also as PS/2)
- FIFO
- EPP (known also as Mode 4)
- ECP (with an optional Extended ECP mode)

### 9.2.2 Parallel Port Register Map

The Parallel Port includes two groups of runtime registers, as follows:

- A group of 21 registers at first level offset, sharing 14 entries. Three of these registers (at offsets 403h, 404h and 405h) are used only in Extended ECP mode.
- A group of four registers, used only in Extended ECP mode, accessed by a second level offset.

EPP and second level offset registers are available only when the base address is 8-byte aligned.

The desired mode is selected by the ECR runtime register (offset 402h). The selected mode determines which runtime registers and which address bits are used for the base address. See Tables 43 and 44 for a listing of all registers, their offset addresses and the associated modes. All registers are $V_{DD3}$ powered.

**Table 43. Parallel Port Registers at First Level Offset**

| Offset | Mnemonic | Mode(s) | Register Name | Type |
|---|---|---|---|---|
| 00h | DATAR | 0,1 | Data | R/W |
| | AFIFO | 3 | ECP FIFO (Address) | W |
| | DTR | 4 | Data (for EPP) | R/W |
| 01h | DSR | All, except 4 | Status | RO |
| | STR | 4 | Status (for EPP) | RO |
| 02h | DCR | All, except 4 | Control | R/W |
| | CTR | 4 | Control (for EPP) | R/W |
| 03h | ADDR | 4 | EPP Address | R/W |
| 04h | DATA0 | 4 | EPP Data Port 0 | R/W |
| 05h | DATA1 | 4 | EPP Data Port 1 | R/W |
| 06h | DATA2 | 4 | EPP Data Port 2 | R/W |
| 07h | DATA3 | 4 | EPP Data Port 3 | R/W |
| 400h | CFIFO<br>DFIFO<br>TFIFO<br>CNFGA | 2<br>3<br>6<br>7 | PP Data FIFO<br>ECP Data FIFO<br>Test FIFO<br>Configuration A | W<br>R/W<br>R/W<br>RO |
| 401h | CNFGB | 7 | Configuration B | RO |
| 402h | ECR | All | Extended Control | R/W |
| 403h | EIR[1] | 0,1,2,3 | Extended Index | R/W |
| 404h | EDR[1] | 0,1,2,3 | Extended Data | R/W |
| 405h | EAR[1] | 0,1,2,3 | Extended Auxiliary Status | R/W |

1. These registers are extended to the standard IEEE1284 registers. They are only accessible when enabled by bit 4 of the Parallel Port Configuration register (see Section 3.9.3 on page 48).

## 9.0 Legacy Functional Blocks (Continued)

**Table 44. Parallel Port Registers at Second Level Offset**

| Offset | Mnemonic | Register Name | Type |
|---|---|---|---|
| 00h | Control0 | Extended Control 0 | R/W |
| 02h | Control2 | Extended Control 1 | R/W |
| 04h | Control4 | Extended Control 4 | R/W |
| 05h | PP Confg0 | Configuration 0 | R/W |

### 9.2.3 Parallel Port Bitmap Summary

The Parallel Port functional block bitmaps are grouped according to first and second level offsets.

**Table 45. Parallel Port Bitmap Summary for First Level Offset**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Offset** | **Mnemonic** | **7** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| 000h | DATAR | Data Bits | | | | | | | |
| | AFIFO | Address Bits | | | | | | | |
| 001h | DSR | Printer Status | $\overline{\text{ACK}}$ Status | PE Status | SLCT Status | $\overline{\text{ERR}}$ Status | Reserved | | EPP Time-Out Status |
| 002h | DCR | Reserved | | Direction Control | Interrupt Enable | PP Input Control | Printer Initialization Control | Automatic Line Feed Control | Data Strobe Control |
| 003h | ADDR | EPP Device or Register Selection Address Bits | | | | | | | |
| 004h | DATA0 | EPP Device or R/W Data | | | | | | | |
| 005h | DATA1 | EPP Device or R/W Data | | | | | | | |
| 006h | DATA2 | EPP Device or R/W Data | | | | | | | |
| 007h | DATA3 | EPP Device or R/W Data | | | | | | | |
| 400h | CFIFO | Data Bits | | | | | | | |
| 400h | DFIFO | Data Bits | | | | | | | |
| 400h | TFIFO | Data Bits | | | | | | | |
| 400h | CNFGA | Reserved | | | | Bit 7 of PP Confg0 | Reserved | | |
| 401h | CNFGB | Reserved | Interrupt Request Value | Interrupt Select | | | Reserved | DMA Channel Select | |
| 402h | ECR | ECP Mode Control | | | ECP Interrupt Mask | ECP DMA Enable | ECP Interrupt Service | FIFO Full | FIFO Empty |
| 403h | EIR | Reserved | | | | | Second Level Offset | | |
| 404h | EDR | Data Bits | | | | | | | |
| 405h | EAR | FIFO Tag | Reserved | | | | | | |

## 9.0 Legacy Functional Blocks (Continued)

**Table 46. Parallel Port Bitmap Summary for Second Level Offset**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Second Level Offset** | **Mnemonic** | **7** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| 00h | Control0 | Reserved | | DCR Register Live | Freeze Bit | Reserved | | | EPP Time-Out Interrupt Mask |
| 02h | Control2 | SPP Compatibility | Channel Address Enable | Reserved | Revision 1.7 or 1.9 Select | Reserved | | | |
| 04h | Control4 | Reserved | PP DMA Request Inactive Time | | | Reserved | PP DMA Request Active Time | | |
| 05h | PP Confg0 | Bit 3 of CNFGA | Demand DMA Enable | ECP IRQ Channel Number | | | PE Internal Pull-Up or Pull-Down | ECP DMA Channel Number | |

# 9.0 Legacy Functional Blocks (Continued)

## 9.3 UART FUNCTIONALITY (SERIAL PORT)

### 9.3.1 General Description

The Serial Port (SP) provides UART functionality. The generic SP supports serial data communication with a remote peripheral device or modem, using a wired interface. The functional block can function as a standard NS16450 or NS16550A or as an Extended UART.

### 9.3.2 UART Register Bank Overview

Four register banks, each containing eight registers, control UART operation. All registers use the same 8-byte address space to indicate offsets 00h through 07h. The Bank Select Register (BSR) selects the active bank and is common to all banks (see Figure 32).

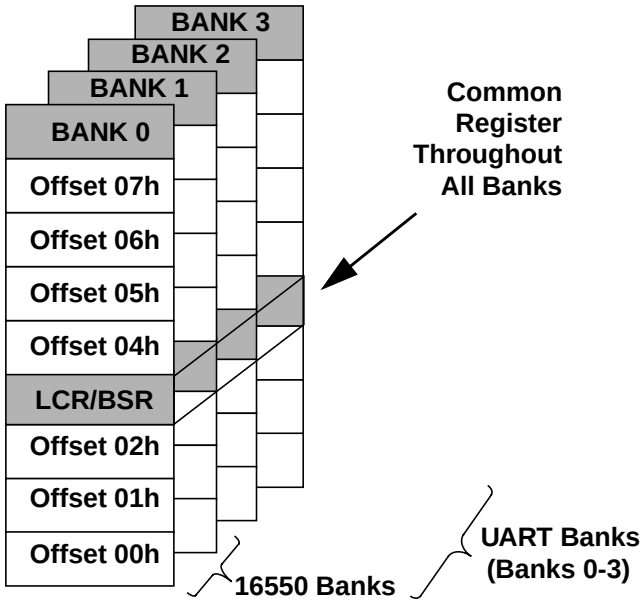



**Figure 32. UART Register Bank Architecture**

### 9.3.3 SP Register Maps

All registers are $V_{DD3}$ powered.

**Table 47. Bank 0 Register Map**

| Offset | Mnemonic | Register Name | Type |
|---|---|---|---|
| 00h | RXD | Receiver Data Port | RO |
| 00h | TXD | Transmitter Data Port | W |
| 01h | IER | Interrupt Enable | R/W |
| 02h | EIR | Event Identification (Read Cycles) | RO |
| | FCR | FIFO Control (Write Cycles) | W |
| 03h | LCR[1] | Line Control | R/W |
| | BSR[1] | Bank Select | |
| 04h | MCR | Modem/Mode Control | R/W |
| 05h | LSR | Link Status | RO |
| 06h | MSR | Modem Status | RO |
| 07h | SPR/ASCR | Scratchpad/Auxiliary Status and Control | R/W |

1. When bit 7 of this register is set to 1, bits 6–0 of BSR select the bank.

## 9.0 Legacy Functional Blocks (Continued)

**Table 48. Bank Selection Encoding**

| BSR Bits | | | | | | | | Bank Selected | Functionality |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | |
| 0 | x | x | x | x | x | x | x | 0 | UART (Serial Port) |
| 1 | 0 | x | x | x | x | x | x | 1 | |
| 1 | 1 | x | x | x | x | 1 | x | 1 | |
| 1 | 1 | x | x | x | x | x | 1 | 1 | |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 3 | |

**Table 49. Bank 1 Register Map**

| Offset | Mnemonic | Register Name | Type |
|---|---|---|---|
| 00h | LBGD(L) | Legacy Baud Generator Divisor Port (Low Byte) | R/W |
| 01h | LBGD(H) | Legacy Baud Generator Divisor Port (High Byte) | R/W |
| 02h | Reserved | | |
| 03h | LCR/BSR | Line Control/Bank Select | R/W |
| 04h-07h | Reserved | | |

**Table 50. Bank 2 Register Map**

| Offset | Mnemonic | Register Name | Type |
|---|---|---|---|
| 00h | BGD(L) | Baud Generator Divisor Port (Low Byte) | R/W |
| 01h | BGD(H) | Baud Generator Divisor Port (High Byte) | R/W |
| 02h | EXCR1 | Extended Control1 | R/W |
| 03h | LCR/BSR | Line Control/Bank Select | R/W |
| 04h | EXCR2 | Extended Control2 | R/W |
| 05h | Reserved | | |
| 06h | TXFLV | TX_FIFO Level | R/W |
| 07h | RXFLV | RX_FIFO Level | R/W |

**Table 51. Bank 3 Register Map**

| Offset | Mnemonic | Register Name | Type |
|---|---|---|---|
| 00h | MRID | Module Revision ID | RO |
| 01h | SH_LCR | Shadow of LCR (Read Only) | RO |
| 02h | SH_FCR | Shadow of FIFO Control (Read Only) | RO |
| 03h | LCR/BSR | Line Control/Bank Select | R/W |
| 04h-07h | Reserved | | |

# 9.0 Legacy Functional Blocks (Continued)

## 9.3.4 SP Bitmap Summary

**Table 52. Bank 0 Bitmap**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Offset | Mnemonic | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 00h | RXD | Receiver Data Bits | | | | | | | |
| | TXD | Transmitter Data Bits | | | | | | | |
| 01h | IER[1] | Reserved | | | | MS_IE | LS_IE | TXLDL_IE | RXHDL_IE |
| | IER[2] | Reserved | | TXEMP_IE | Reserved | MS_IE | LS_IE | TXLDL_IE | RXHDL_IE |
| 02h | EIR[1] | FEN1 | FEN0 | Reserved | | RXFT | IPR1 | IPR0 | IPF |
| | EIR[2] | Reserved | | TXEMP_EV | Reserved | MS_EV | LS_EV or TXHLT_EV | TXLDL_EV | RXHDL_EV |
| | FCR | RXFTH1 | RXFTH0 | TXFTH1 | TXFTH0 | Reserved | TXSR | RXSR | FIFO_EN |
| 03h | LCR[3] | BKSE | SBRK | STKP | EPS | PEN | $\overline{STB}$ | WLS1 | WLS0 |
| | BSR[3] | BKSE | Bank Select | | | | | | |
| 04h | MCR[1] | Reserved | | | LOOP | ISEN or DCDLP | RILP | RTS | $\overline{DTR}$ |
| | MCR[2] | Reserved | | | | TX_DFR | Reserved | RTS | $\overline{DTR}$ |
| 05h | LSR | ER_INF | TXEMP | TXRDY | BRK | FE | PE | OE | RXDA |
| 06h | MSR | DCD | RI | DSR | CTS | DDCD | TERI | DDSR | DCTS |
| 07h | SPR[1] | Scratch Data | | | | | | | |
| | ASCR[2] | Reserved | | | | | | | RXF_TOUT |

1. Non-Extended Mode.
2. Extended Mode.
3. When bit 7 of this register is set to 1, bits 6-0 of BSR select the bank, as shown in Table 48 on page 116.

## 9.0 Legacy Functional Blocks (Continued)

**Table 53. Bank 1 Bitmap**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Offset | Mnemonic | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 00h | LBGD(L) | Legacy Baud Generator Divisor (Least Significant Bits) | | | | | | | |
| 01h | LBGD(H) | Legacy Baud Generator Divisor (Most Significant Bits) | | | | | | | |
| 02h | Reserved | | | | | | | | |
| 03h | LCR/BSR | Same as Bank 0 | | | | | | | |
| 04h-07h | Reserved | | | | | | | | |

**Table 54. Bank 2 Bitmap**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Offset | Mnemonic | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 00h | BGD(L) | Baud Generator Divisor Low (Least Significant Bits) | | | | | | | |
| 01h | BGD(H) | Baud Generator Divisor High (Most Significant Bits) | | | | | | | |
| 02h | EXCR1 | BTEST | Reserved | ETDLBK | LOOP | Reserved | | | EXT_SL |
| 03h | LCR/BSR | Same as Bank 0 | | | | | | | |
| 04h | EXCR2 | LOCK | Reserved | PRESL1 | PRESL0 | Reserved | | | |
| 05h | Reserved | | | | | | | | |
| 06h | TXFLV | Reserved | | | TFL4 | TFL3 | TFL2 | TFL1 | TFL0 |
| 07h | RXFLV | Reserved | | | RFL4 | RFL3 | RFL2 | RFL1 | RFL0 |

**Table 55. Bank 3 Bitmap**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Offset | Mnemonic | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 00h | MRID | Module ID (MID 7-4) | | | | Revision ID (RID 3-0) | | | |
| 01h | SH_LCR | BKSE | SBRK | STKP | EPS | PEN | $\overline{\text{STB}}$ | WLS1 | WLS0 |
| 02h | SH_FCR | RXFTH1 | RXFTH0 | TXFHT1 | TXFTH0 | Reserved | TXSR | RXSR | FIFO_EN |
| 03h | LCR/BSR | Same as Bank 0 | | | | | | | |
| 04h-07h | Reserved | | | | | | | | |

# 9.0 Legacy Functional Blocks (Continued)

## 9.4 KEYBOARD AND MOUSE CONTROLLER (KBC)

### 9.4.1 General Description

The KBC is implemented physically as a single hardware module and houses two separate logical devices: a mouse controller (Logical Device 5) and a keyboard controller (Logical Device 6). The KBC is functionally equivalent to the industry standard 8042AH keyboard controller. The 8042AH datasheet can be used as a detailed technical reference for the KBC.

The hardware KBC module is integrated to provide the following pin functions: $\overline{\text{KBRST}}$ (P20), GA20 (P21), KBDAT, KBCLK, MDAT and MCLK. $\overline{\text{KBRST}}$ and GA20 are implemented as bi-directional open-drain pins with internal active pull-up. The keyboard and mouse interfaces are implemented as bi-directional open-drain pins. Their internal connections are shown in Figure 33.

Ports P10-P17 and P22-P27 of the KBC core are not available on dedicated pins; neither are T0 and T1. P10, P11, P22, P23, P26, P27, T0 and T1 are used to implement the keyboard and mouse interface.

The KBC executes a program fetched from an on-chip 2 Kbyte ROM. The code programed in this ROM is user-customizable. The KBC has two interrupt request signals: one for the keyboard and one for the mouse. The interrupt requests are implemented using ports P24 and P25 of the KBC core. The interrupt requests are controlled exclusively by the KBC firmware, except for the IRQ type and number, which are set by configuration registers (see Section 3.2.3 on page 32).

The interrupt requests are implemented as bi-directional signals. When an I/O port is read, all unused bits return the value latched in the output registers of the ports.

For KBC firmware that implements interrupt-on-OBF schemes, the following is the recommended implementation:

1. Put the data in DBBOUT.
2. Set the appropriate port bit to issue an interrupt request.

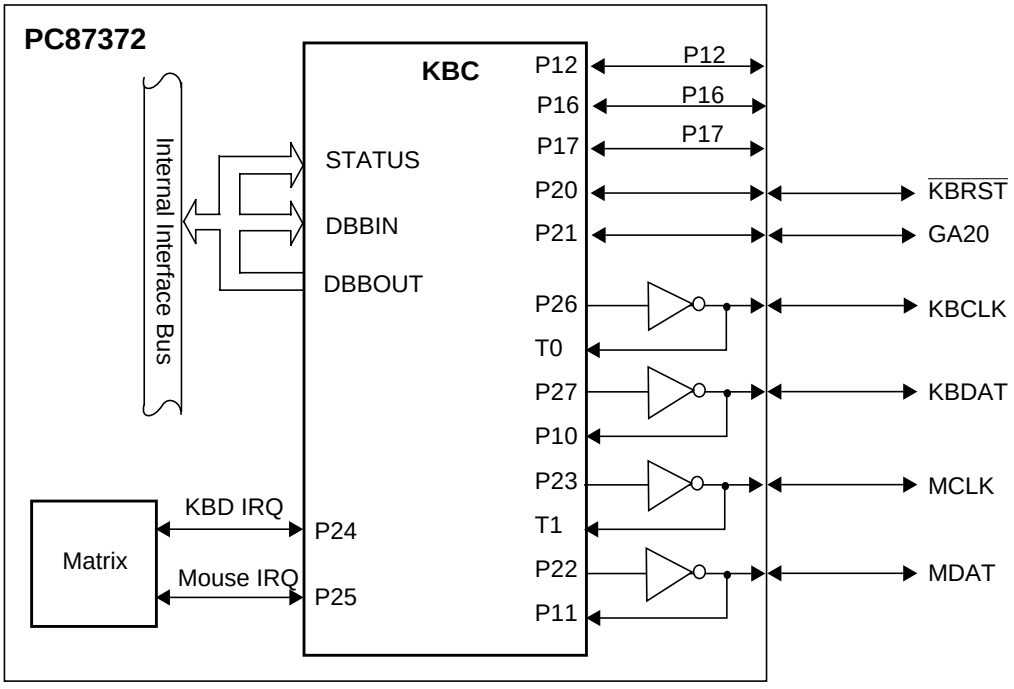



**Figure 33. Keyboard and Mouse Interfaces**

# 9.0 Legacy Functional Blocks (Continued)

## 9.4.2 KBC Register Map

All registers are $V_{DD3}$ powered.

**Table 56. KBC Register Map**

| Offset | Mnemonic | Register Name | Type |
|---|---|---|---|
| 00h | DBBOUT | Read KBC Data | R |
| | DBBIN | Write KBC Data | W |
| 04h | STATUS | Read Status | R |
| | DBBIN | Write KBC Command | W |

## 9.4.3 KBC Bitmap Summary

**Table 57. KBC Bitmap Summary**

| Register | | Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Offset | Mnemonic | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 00h | DBBOUT | KBC Data Bits (For Read cycles) | | | | | | | |
| | DBBIN | KBC Data Bits (For Write cycles) | | | | | | | |
| 04h | STATUS | General-Purpose Flags | | | | F1 | F0 | IBF | OBF |
| | DBBIN | KBC Command Bits (For Write cycles) | | | | | | | |

# 10.0 Device Characteristics

## 10.1 GENERAL DC ELECTRICAL CHARACTERISTICS

### 10.1.1 Recommended Operating Conditions

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $V_{DD3}$ | Main 3V Supply Voltage | 3.0 | 3.3 | 3.6 | V |
| $V_{SB3}$ | Standby 3V Supply Voltage | 3.0 | 3.3 | 3.6 | V |
| $T_A$ | Operating Temperature | 0 | | +70 | °C |

### 10.1.2 Absolute Maximum Ratings

Absolute maximum ratings are values beyond which damage to the device may occur. Unless otherwise specified, all voltages are relative to ground ($V_{SS}$).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{SUP}$ | Supply Voltage[1] | | –0.5 | +4.1 | V |
| $V_I$ | Input Voltage | All other pins | –0.5 | 5.5 | V |
| | | PCI_CLK, LAD3-0, $\overline{\text{LFRAME}}$, $\overline{\text{PCI_RESET}}$, SERIRQ, $\overline{\text{LPCPD}}$ | –0.5 | $V_{DD3}$ + 0.5 | V |
| $V_O$ | Output Voltage | All other pins | –0.5 | 5.5 | V |
| | | LAD3-0, $\overline{\text{LDRQ}}$, SERIRQ | –0.5 | $V_{DD3}$ + 0.5 | V |
| $T_{STG}$ | Storage Temperature | | –65 | +165 | °C |
| $P_D$ | Power Dissipation | | | 1 | W |
| $T_L$ | Lead Temperature Soldering (10 s) | | | +260 | °C |
| | ESD Tolerance | $C_{ZAP}$ = 100 pF<br>$R_{ZAP}$ = 1.5 KΩ[2] | 2000 | | V |

1. $V_{SUP}$ is $V_{DD3}$, $V_{SB3}$.
2. Value based on test complying with RAI-5-048-RA human body model ESD testing.

### 10.1.3 Capacitance

| Symbol | Parameter | Conditions | Min[2] | Typ[1] | Max[2] | Unit |
|---|---|---|---|---|---|---|
| $C_{IN}$ | Input Pin Capacitance | | | 4 | 5 | pF |
| $C_{INC}$ | LPC Clock Input Capacitance | PCI_CLK | 5 | 8 | 12 | pF |
| $C_{PCI}$ | LPC Pin Capacitance | LAD3-0, $\overline{\text{LFRAME}}$, $\overline{\text{PCI_RESET}}$, SERIRQ, $\overline{\text{LPCPD}}$, $\overline{\text{LDRQ}}$ | | 8 | 10 | pF |
| $C_{IO}$ | I/O Pin Capacitance | | | 8 | 10 | pF |
| $C_O$ | Output Pin Capacitance | | | 6 | 8 | pF |

1. $T_A$ = 25°C; f = 1 MHz.
2. Not tested. Guaranteed by characterization.

# 10.0 Device Characteristics (Continued)

## 10.1.4 Power Consumption under Recommended Operating Conditions

| Symbol | Parameter | Conditions[1] | Typ | Max[2] | Unit |
|---|---|---|---|---|---|
| $I_{DD3}$ | $V_{DD3}$ Average Supply Current | $V_{IL}$ = 0.5V, $V_{IH}$ = 2.4V, No Load | 12 | 25 | mA |
| $I_{DD3LP}$ | $V_{DD3}$ Quiescent Supply Current in Low Power Mode[3] | $V_{IL}$ = $V_{SS}$, $V_{IH}$ = $V_{DD3}$, No Load | 0.5 | 0.8 | mA |
| $I_{SB3}$ | $V_{SB3}$ Average Supply Current | $V_{IL}$ = 0.5V, $V_{IH}$ = 2.4V, No Load | 11 | 20 | mA |
| $I_{SB3LP}$ | $V_{SB3}$ Quiescent Supply Current in Low Power Mode[3] | $V_{IL}$ = $V_{SS}$, $V_{IH}$ = $V_{SB3}$, No Load | 5 | 12 | mA |

1. All parameters specified for 0°C ≤ $T_A$ ≤ 70°C; $V_{DD3}$ and $V_{SB3}$ = 3.3V ±10% unless otherwise specified.
2. Not tested. Guaranteed by characterization.
3. All the modules disabled; no LPC bus activity.

## 10.1.5 Voltage Thresholds

| Symbol | Parameter[1] | Min[2] | Typ | Max[2] | Unit |
|---|---|---|---|---|---|
| $V_{DD3ON}$ | $V_{DD3}$ Detected as Power-on | 2.3 | 2.6 | 2.9 | V |
| $V_{DD3OFF}$ | $V_{DD3}$ Detected as Power-off | 2.2 | 2.5 | 2.8 | V |
| $V_{DD3HY}$ | $V_{DD3}$ Hysteresis ($V_{DD3ON}$ − $V_{DD3OFF}$) | 0.1 | | | V |
| $V_{SB3ON}$ | $V_{SB3}$ Detected as Power-on | 2.3 | 2.6 | 2.9 | V |
| $V_{SB3OFF}$ | $V_{SB3}$ Detected as Power-off | 2.2 | 2.5 | 2.8 | V |
| $V_{SB3HY}$ | $V_{SB3}$ Hysteresis ($V_{SB3ON}$ − $V_{SB3OFF}$) | 0.1 | | | V |

1. All parameters specified for 0°C ≤ $T_A$ ≤ 70°C.
2. Not tested. Guaranteed by characterization.

# 10.0 Device Characteristics (Continued)

## 10.2 DC CHARACTERISTICS OF PINS, BY I/O BUFFER TYPES

The following tables summarize the DC characteristics of all device pins described in Section 1.2 on page 12. The characteristics describe the general I/O buffer types defined in Table 1 on page 12. For exceptions, refer to Section 10.2.11 on page 125. The DC characteristics of the LPC interface meet the *PCI Local Bus Specification (Rev 2.2 December 18, 1998)* for 3.3V DC signaling.

### 10.2.1 Input, TTL Compatible

**Symbol:** $IN_T$

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{IH}$ | Input High Voltage | | 2.0 | 5.5[1] | V |
| $V_{IL}$ | Input Low Voltage | | –0.5[1] | 0.8 | V |
| $I_{IL}$[2] | Input Leakage Current | $0 < V_{IN} < V_{SUP}$[3] | | ±1[4] | µA |

1. Not tested. Guaranteed by design.
2. Input leakage current includes the output leakage of the bi-directional buffers with TRI-STATE outputs.
3. $V_{SUP}$ is $V_{DD3}$ or $V_{SB3}$ according to the input power well.
4. Maximum 20 µA for all pins together (for exceptions, refer to Section 10.2.11 on page 125). Not tested. Guaranteed by characterization.

### 10.2.2 Input, TTL Compatible, with Schmitt Trigger

**Symbol:** $IN_{TS}$

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{IH}$ | Input High Voltage | | 2.0 | 5.5[1] | V |
| $V_{IL}$ | Input Low Voltage | | –0.5[1] | 0.8 | V |
| $V_{HY}$ | Input Hysteresis | | 250[2] | | mV |
| $I_{IL}$[3] | Input Leakage Current | $0 < V_{IN} < V_{SUP}$[4] | | ±1[5] | µA |

1. Not tested. Guaranteed by design.
2. Not tested. Guaranteed by characterization.
3. Input leakage current includes the output leakage of the bi-directional buffers with TRI-STATE outputs.
4. $V_{SUP}$ is $V_{DD3}$ or $V_{SB3}$ according to the input power well.
5. Maximum 20 µA for all pins together (for exceptions, refer to Section 10.2.11 on page 125.). Not tested. Guaranteed by characterization.

### 10.2.3 Input, TTL Compatible, with 400 mV Schmitt Trigger

**Symbol:** $IN_{TS4}$

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{IH}$ | Input High Voltage | | 2.0 | 5.5[1] | V |
| $V_{IL}$ | Input Low Voltage | | –0.5[1] | 0.8 | V |
| $V_{HY}$ | Input Hysteresis | | 400[2] | | mV |
| $I_{IL}$[3] | Input Leakage Current | $0 < V_{IN} < V_{SUP}$[4] | | ±1[5] | µA |

1. Not tested. Guaranteed by design.
2. Not tested. Guaranteed by characterization.
3. Input leakage current includes the output leakage of the bi-directional buffers with TRI-STATE outputs.
4. $V_{SUP}$ is $V_{DD3}$ or $V_{SB3}$ according to the input power well.
5. Maximum 20 µA for all pins together (for exceptions, refer to Section 10.2.11 on page 125.). Not tested. Guaranteed by characterization.

# 10.0 Device Characteristics (Continued)

## 10.2.4 Input, PCI 3.3V Compatible

**Symbol:** $IN_{PCI}$

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{IH}$ | Input High Voltage | | 0.5 $V_{DD}$ | $V_{DD}$ + 0.5[1] | V |
| $V_{IL}$ | Input Low Voltage | | –0.5[1] | 0.3 $V_{DD}$ | V |
| $I_{IL}$[2] | Input Leakage Current | $0 < V_{IN} < V_{DD3}$ | | ±1[3] | µA |

1. Not tested. Guaranteed by design.
2. Input leakage current includes the output leakage of the bi-directional buffers with TRI-STATE outputs.
3. Maximum 20 µA for all pins together (for exceptions, refer to Section 10.2.11 on page 125.). Not tested. Guaranteed by characterization.

## 10.2.5 Analog Input

**Symbol:** AI

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{IR}$ | Input Voltage Range | | 0 | 5.5[1] | V |
| $I_{IL}$ | Input Leakage Current | $V_{IN} = V_{IR}$ | | 300[2] | µA |

1. Not tested. Guaranteed by characterization.
2. This buffer type is excluded from the pins for which the total pins leakage of the device is maximum 20 µA. Not tested. Guaranteed by characterization.

## 10.2.6 Output, TTL/CMOS Compatible, Push-Pull Buffer

**Symbol:** $O_{p/n}$

Output, TTL/CMOS Compatible, rail-to-rail push-pull buffer that is capable of sourcing *p* mA and sinking *n* mA

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{OH}$ | Output High Voltage | $I_{OH} = -p$ mA | 2.4 | | V |
| | | $I_{OH}$ = –50 µA | $V_{SUP}$ – 0.2[1] | | V |
| $V_{OL}$ | Output Low Voltage | $I_{OL} = n$ mA | | 0.4 | V |
| | | $I_{OL}$ = 50 µA | | 0.2 | V |

1. $V_{SUP}$ is $V_{DD3}$ or $V_{SB3}$ according to the output power well.

## 10.2.7 Output, TTL/CMOS Compatible, Open-Drain Buffer

**Symbol:** $OD_n$

Output, TTL/CMOS-compatible open-drain output buffer capable of sinking *n* mA. Output from these signals is open-drain and is never forced high.

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{OL}$ | Output Low Voltage | $I_{OL} = n$ mA | | 0.4 | V |
| | | $I_{OL}$ = 50 µA | | 0.2 | V |

## 10.0 Device Characteristics (Continued)

### 10.2.8 Output, PCI 3.3V Compatible

**Symbol:** $O_{PCI}$

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{OH}$ | Output High Voltage | $I_{out}$ = –500 µA | 0.9 $V_{DD3}$ | | V |
| $V_{OL}$ | Output Low Voltage | $I_{out}$ = 1500 µA | | 0.1 $V_{DD3}$ | V |

### 10.2.9 Analog Output

**Symbol:** AO

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{OR}$ | Output Voltage Range | | 0 | 5.5[1] | V |
| $V_{OD}$ | Output Drive Voltage | $I_{out}$ = –3.6 mA | $V_{SUP}$[2] – 150 mV | | |
| $I_{OL}$ | Output Leakage Current | $V_{OUT} = V_{OR}$, $V_{SUP} < V_{OUT}$ | | 20[3] | µA |

1. Not tested. Guaranteed by characterization.
2. $V_{SUP}$ is $V_{DD3}$ or $V_{SB3}$ according to the pin power well.
3. This buffer type is excluded from the pins for which the total pins leakage of the device is maximum 10 µA. Not tested. Guaranteed by characterization.

### 10.2.10 Input/Output Switch, SMBus Compatible

**Symbol:** $SW_{SM}$

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{DRP}$ | Pin-to-Pin Voltage Drop | $I_{SW}$ = ±3 mA, Switch Closed | | 150[1] | mV |
| $V_{ISC}$ | Input Voltage for Switch Closed | $I_{SW}$ = ±3 mA | 1.5[1] | | V |
| $V_{ISO}$ | Input Voltage for Switch Open | $I_{SW}$ = ±20 µA | | $V_{SUP}$[2,3] | V |
| $I_{IL}$ | Input Leakage Current | $V_{ISO} < V_{IN} < 5.5V$ | | ±20[1] | µA |

1. Not tested. Guaranteed by characterization.
2. $V_{SUP}$ is $V_{DD3}$ or $V_{SB3}$ according to the pin power well.
3. Not tested. Guaranteed by design.

### 10.2.11 Exceptions

1. All pins are 5V tolerant except for the pins with PCI ($IN_{PCI}$, $O_{PCI}$) buffer types.
2. All pins are back-drive protected except for the output pins with PCI ($O_{PCI}$) buffer types.
3. The following pins are excluded from the requirement of total pins leakage maximum 10 µA: $V_{SB5}$, REF5V, REF5V_STBY, 3V_DDCSCL, 5V_DDCSCL, 3V_DDCSDA, 5V_DDCSDA, SMB1_SCL, SMB1_SDA, SMB2_SCL, SMB2_SDA.
4. The following pins have an internal static pull-up resistor (when enabled) and therefore may have leakage current from $V_{SUP}$ (when $V_{IN}$ = 0): $\overline{\text{LPCPD}}$, $\overline{\text{ACK}}$, $\overline{\text{AFD_DSTRB}}$, $\overline{\text{ERR}}$, $\overline{\text{INIT}}$, PE, $\overline{\text{SLIN_ASTRB}}$, $\overline{\text{STB_WRITE}}$, $\overline{\text{KBRST}}$, GA20, $\overline{\text{SIOPME}}$, GPIOE00-07, GPIOE10-13, PWRGD_PS, $\overline{\text{CPU_PRESENT}}$, $\overline{\text{FPRST}}$, $\overline{\text{PRIMARY_HD}}$, $\overline{\text{SECONDARY_HD}}$, $\overline{\text{SCSI}}$.
5. The following pins have an internal static pull-down resistor (when enabled) and therefore may have leakage current to $V_{SS}$ (when $V_{IN} = V_{SUP}$): BUSY_$\overline{\text{WAIT}}$, PE and SLCT.
6. The following strap pins have an internal static pull-up resistor enabled during Power-Up reset and therefore may have leakage current to $V_{SUP}$ (when $V_{IN}$ = 0): $\overline{\text{BADDR}}$, $\overline{\text{TRIS}}$, $\overline{\text{TEST}}$.
7. When $V_{DD3}$ = 0V, the following pins present a DC load to $V_{SS}$ of 30 KΩ minimum (not tested, guaranteed by design) for a pin voltage of 0V to 3.6V: $\overline{\text{CTS}}$, $\overline{\text{DCD}}$, $\overline{\text{DSR}}$, $\overline{\text{DTR_BOUT}}$, $\overline{\text{RI}}$, $\overline{\text{RTS}}$, SIN, SOUT.

## 10.0 Device Characteristics (Continued)

8. Output from SLCT, BUSY_$\overline{WAIT}$ (and PE if bit 2 of PP Confg0 register is 0) is open-drain in all SPP modes except in SPP-Compatible mode when the setup mode is ECP-based FIFO and bit 4 of the Control2 parallel port register is 1. Otherwise, output from these signals is level 2. External 4.7 KΩ pull-up resistors should be used.
9. Output from $\overline{ACK}$, $\overline{ERR}$ (and PE if bit 2 of PP Confg0 register is set to 1) is open-drain in all SPP modes except in SPP-Compatible mode when the setup mode is ECP-based FIFO and bit 4 of the Control2 parallel port register is set to 1. Otherwise, output from these signals is level 2. External 4.7 KΩ pull-up resistors should be used.
10. Output from $\overline{STB}$, $\overline{AFD}$, $\overline{INIT}$ and $\overline{SLIN}$ is open-drain in all SPP modes, except in SPP-Compatible mode when the setup mode is ECP-based (FIFO). Otherwise, output from these signals is level 2. External 4.7 KΩ pull-up resistors should be used.
11. $I_{OH}$ is valid for a GPIO pin only when it is not configured as open-drain.
12. In XOR Tree mode, the buffer type of the input pins participating in the XOR Tree (see Section 2.4.2 on page 29) is $IN_T$ (Input, TTL compatible), regardless of the buffer type of these pins in normal device operation mode (see Section 1.4 on page 14)

### 10.2.12 Terminology

**Back-Drive Protection.** A pin that is back-drive protected does not sink current into the supply when an input voltage higher than the supply, but below the pin's maximum input voltage, is applied to the pin. This is true even when the supply is inactive. Note that active pull-up resistors and active output buffers are typically not back-drive protected.

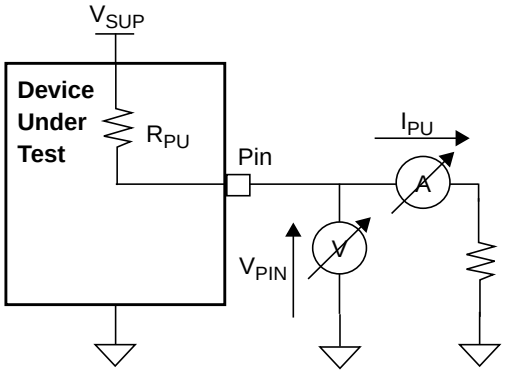
**5-Volt Tolerance.** An input signal that is 5V tolerant can operate with input voltage of up to 5V even though the supply to the device is only 3.3V. The actual maximum input voltage allowed to be supplied to the pin is indicated by the maximum high voltage allowed for the input buffer. Note that some pins have multiple buffers, not all of which are 5V tolerant. In such cases, there is a note that indicates at what conditions a 5V input may be applied to the pin; if there is no note, the low maximum voltage among the buffers is the maximum voltage allowed for the pin.

# 10.0 Device Characteristics (Continued)

## 10.3 INTERNAL RESISTORS

### DC Test Conditions

**Pull-Up Resistor Test Circuit**




**Pull-Down Resistor Test Circuit**

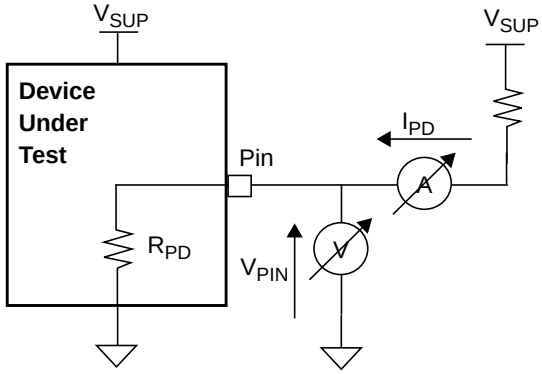



**Figure 34. Internal Resistor Test Conditions, $T_A$ = 0°C to 70°C, $V_{SUP}$ = 3.3V**

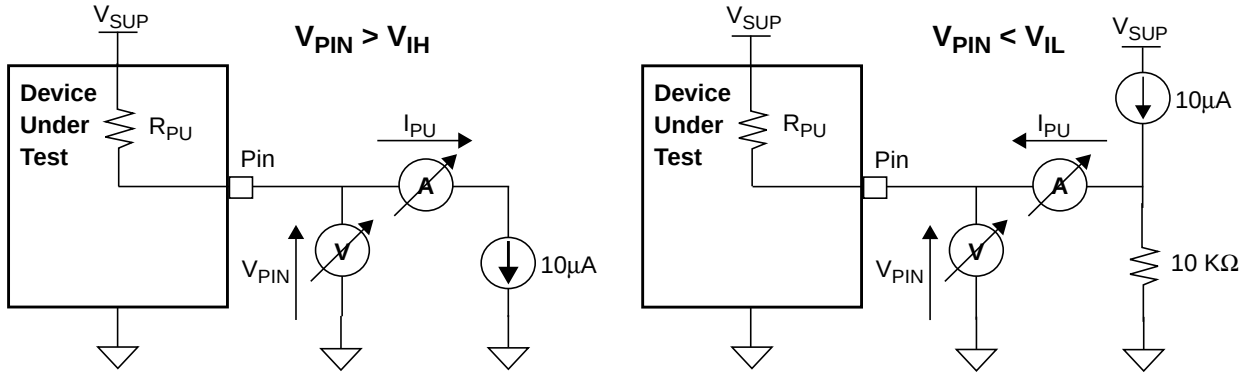



**Figure 35. Internal Pull-Down Resistor for Straps, $T_A$ = 0°C to 70°C, $V_{SUP}$ = 3.3V**

Notes for Figures 34 and 35:

1. $V_{SUP}$ is $V_{DD3}$ or $V_{SB3}$ according to the pin power well.
1. The equivalent resistance of the pull-up resistor is calculated by $R_{PU} = (V_{SUP} - V_{PIN}) / I_{PU}$.
2. The equivalent resistance of the pull-down resistor is calculated by $R_{PD} = V_{PIN} / I_{PD}$.

### 10.3.1 Pull-Up Resistor

**Symbol:** $PU_{nn}$

| Symbol | Parameter | Conditions[1] | Min[2] | Typical | Max[2] | Unit |
|---|---|---|---|---|---|---|
| $R_{PU}$ | Pull-up equivalent resistance | $V_{PIN}$ = 0V | *nn* – 30% | *nn* | *nn* + 30% | KΩ |
| | | $V_{PIN}$ = 0.8 $V_{SUP}$[3] | | | *nn* – 38% | KΩ |
| | | $V_{PIN}$ = 0.17 $V_{SUP}$[3] | *nn* – 35% | | | KΩ |

1. TA = 0°C to 70°C, $V_{SUP}$ = 3.3V.
2. Not tested. Guaranteed by characterization.
3. For strap pins only.

### 10.3.2 Pull-Down Resistor

**Symbol:** $PD_{nn}$

| Symbol | Parameter | Conditions[1] | Min[2] | Typical | Max[2] | Unit |
|---|---|---|---|---|---|---|
| $R_{PD}$ | Pull-down equivalent resistance | $V_{PIN}$ = $V_{SUP}$ | *nn* – 30% | *nn* | *nn* + 30% | KΩ |

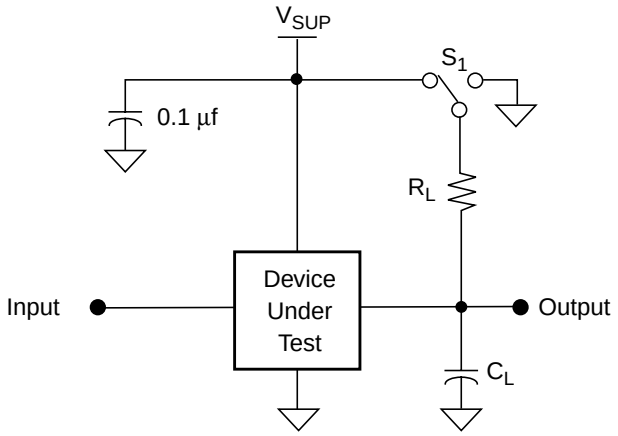
1. TA = 0°C to 70°C, $V_{SUP}$ = 3.3V.
2. Not tested. Guaranteed by characterization.

# 10.0 Device Characteristics (Continued)

## 10.4 AC ELECTRICAL CHARACTERISTICS

### 10.4.1 AC Test Conditions

**Load Circuit**




**AC Testing Input, Output Waveform**

(unless otherwise specified)

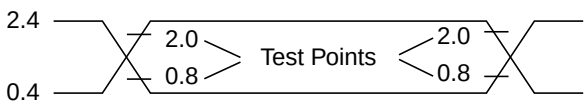



**Figure 36. AC Test Conditions, $T_A$ = 0°C to 70°C, $V_{SUP}$ = 3.3V ±10%**

Notes:

1. $V_{SUP}$ is either $V_{DD3}$ or $V_{SB3}$, according to the pin power well.
2. $C_L$ = 50 pF for all output pins except the following pin groups:
   – $C_L$ = 100 pF for Serial Port pins (see Section 1.4.2 on page 15), Parallel Port pins (see Section 1.4.3) and Floppy Disk Controller pins (see Section 1.4.4)
   – $C_L$ = 40 pF for $\overline{\text{IDE_RSTDRV}}$ pin
   – $C_L$ = 400 pF for SMBus pins (see *SMBus Voltage Translation and Isolation Timing* on page 142)
   These values include both jig and oscilloscope capacitance.
3. $S_1$ = Open – for push-pull output pins.
   $S_1 = V_{SUP}$ – for high-impedance to active low and active low to high impedance transition measurements
   $S_1$ = GND – for high-impedance to active high and active high to high impedance transition measurements
   $R_L$ = 1.0 KΩ– for all the pins
4. For the FDC open-drain interface pins, $S_1 = V_{DD3}$ and $R_L$ = 150Ω.

## 10.0 Device Characteristics (Continued)

### 10.4.2 Reset Timing

#### $V_{SB}$ Power-Up Reset

| Symbol | Figure | Description | Reference Conditions | | Min[1] | Max[1] |
|---|---|---|---|---|---|---|
| $t_{IRST}$ | 37 | Internal Power-Up Reset Time | $V_{SB3}$ power-up to end of internal reset | Ended by 32 KHz Clock Domain | | $t_{32KW} + t_{32KVAL}$[2] + 17 * $t_{CP}$ |
| | 38 | | | Ended by $\overline{\text{PCI_RESET}}$ | | $t_{LRST}$ |
| $t_{LRST}$ | 38 | $\overline{\text{PCI_RESET}}$ active time | $V_{SB3}$ power-up to end of $\overline{\text{PCI_RESET}}$ | | 10 ms | |

1. Not tested. Guaranteed by design.
2. $t_{32KW} + t_{32KVAL}$ from $V_{SB3}$ power-up to 32 KHz domain toggling; see *Low-Frequency Clock Timing on page 132*.

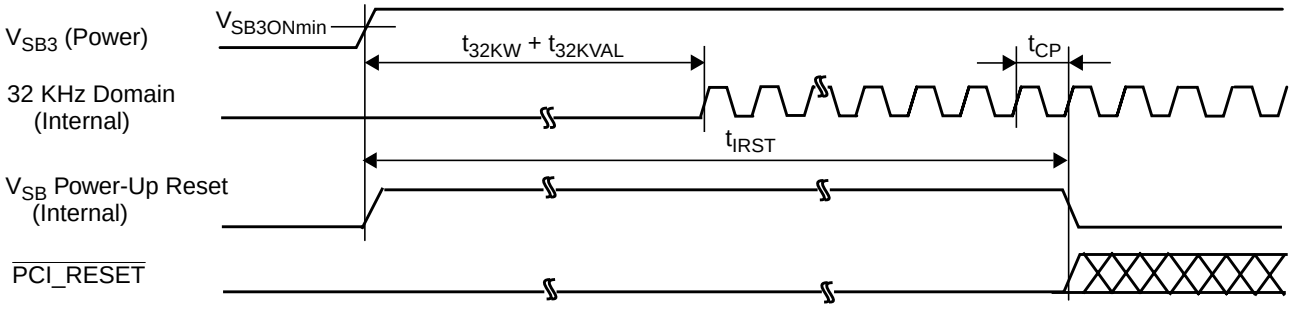



**Figure 37. Internal $V_{SB}$ Power-Up Reset - Ended by 32 KHz Clock**

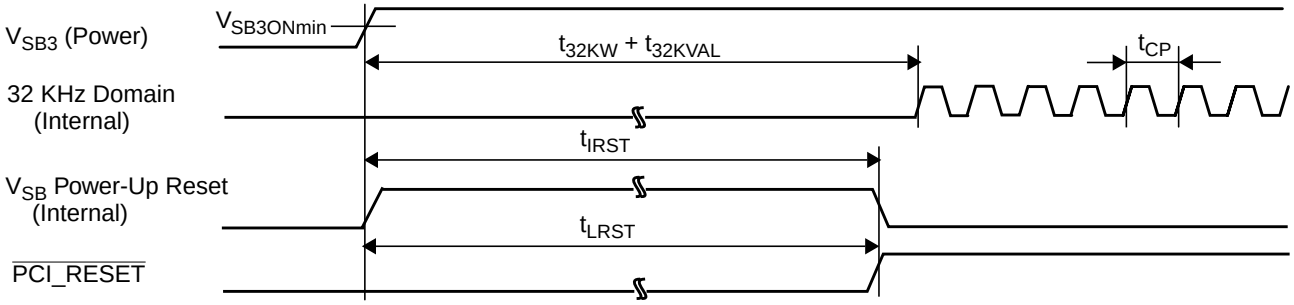



**Figure 38. Internal $V_{SB}$ Power-Up Reset - Ended by $\overline{\text{PCI_RESET}}$**

## 10.0 Device Characteristics (Continued)

### $V_{DD}$ Power-Up Reset

| Symbol | Figure | Description | Reference Conditions | Min[1] | Max[1] |
|---|---|---|---|---|---|
| $t_{IRST}$ | 39 | Internal Power-Up reset time | $V_{DD3}$ power-up to end of internal reset | | $t_{LRST}$ |
| $t_{LRST}$ | 39 | $\overline{PCI_RESET}$ active time | $V_{DD3}$ power-up to end of $\overline{PCI_RESET}$ | 10 ms | |
| $t_{IPLV}$ | 39 | Internal strap pull-up resistor, valid time[2] | Before end of internal reset | $t_{IRST}$ | |
| $t_{EPLV}$ | 39 | External strap pull-down resistor, valid time | Before end of internal reset | $t_{IRST}$ | |

1. Not tested. Guaranteed by design.
2. Active only during $V_{DD3}$ Power-Up reset.

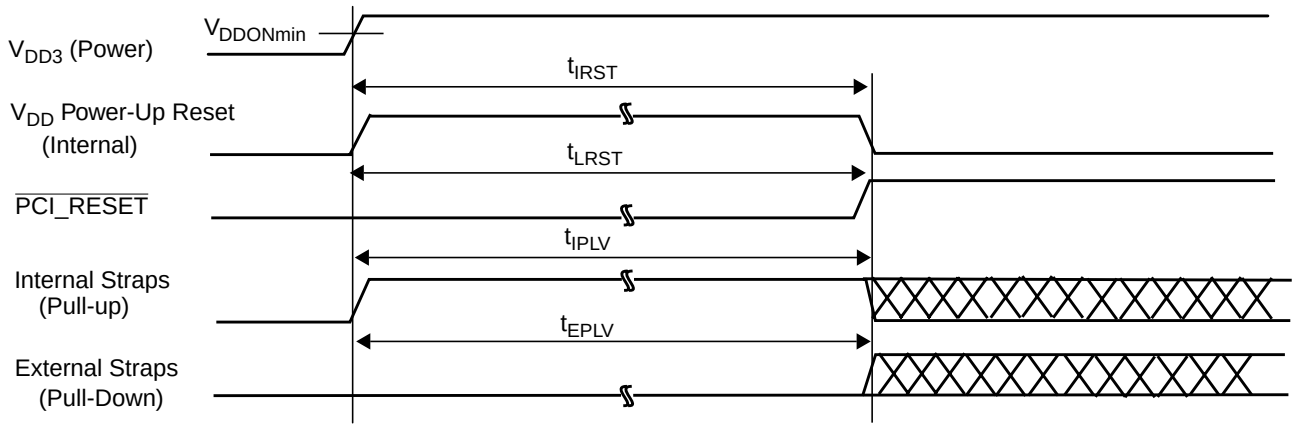



**Figure 39. Internal $V_{DD}$ Power-Up Reset**

### Hardware Reset

| Symbol | Figure | Description | Reference Conditions | Min | Max |
|---|---|---|---|---|---|
| $t_{WRST}$ | 40 | $\overline{PCI_RESET}$ pulse width | | 100 ns | |

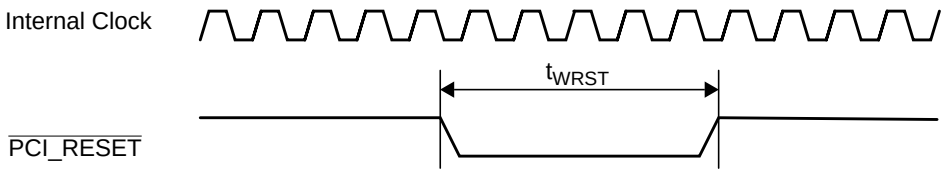



**Figure 40. Hardware Reset**

## 10.0 Device Characteristics (Continued)

### 10.4.3 Clock Timing

#### High-Frequency Clock Timing

| Symbol | Figure | Clock Input Parameters | Reference Conditions | CLOCKI14 | | | Units |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $t_{CH}$ | 41 | Clock High Pulse Width[1] | | 29.5 | | | ns |
| $t_{CL}$ | 41 | Clock Low Pulse Width[1] | | 29.5 | | | ns |
| $t_{CP}$ | 41 | Clock Period[1] (50%-50%) | | 69.14 | 69.84 | 70.54 | ns |
| $F_{CK}$ | – | Clock Frequency | | $F_{CKTYP}$ – 1% | 14.31818 | $F_{CKTYP}$ + 1% | MHz |
| $t_{CR}$ | 41 | Clock Rise Time[1] (20%-80%) | | | | 5[2] | ns |
| $t_{CF}$ | 41 | Clock Fall Time[1] (80%-20%) | | | | 5[2] | ns |
| $t_{14MW}$ | 42 | Clock Wake-Up Time | $V_{DD3}$ stable to clock start toggling | System dependent | | | |
| $t_{14MVAL}$ | 42 | Clock Valid Time[1] | Clock start toggling to clock valid | System dependent | | | |

1. Not tested. Guaranteed by design.
2. Recommended value

| Sym. | Fig. | Internal Clock Parameter | Reference Conditions | INT48M | | | Units |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $t_{CP}$ | 41 | Clock Period[1] (50%-50%) | | | 20.83 | | ns |
| $F_{CK}$ | – | Clock Frequency | | | 48 | | MHz |
| $t_{48MD}$ | 42 | Clock Wake-Up Time[1] | After Clock Generator enabled | | | 500 | µs |

1. Not tested. Guaranteed by characterization.

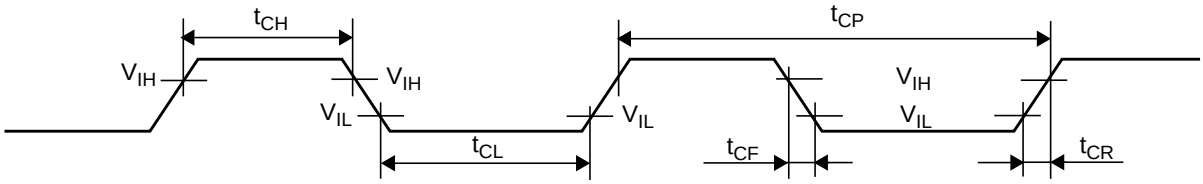



**Figure 41. High-Frequency Clock Waveform Timing**

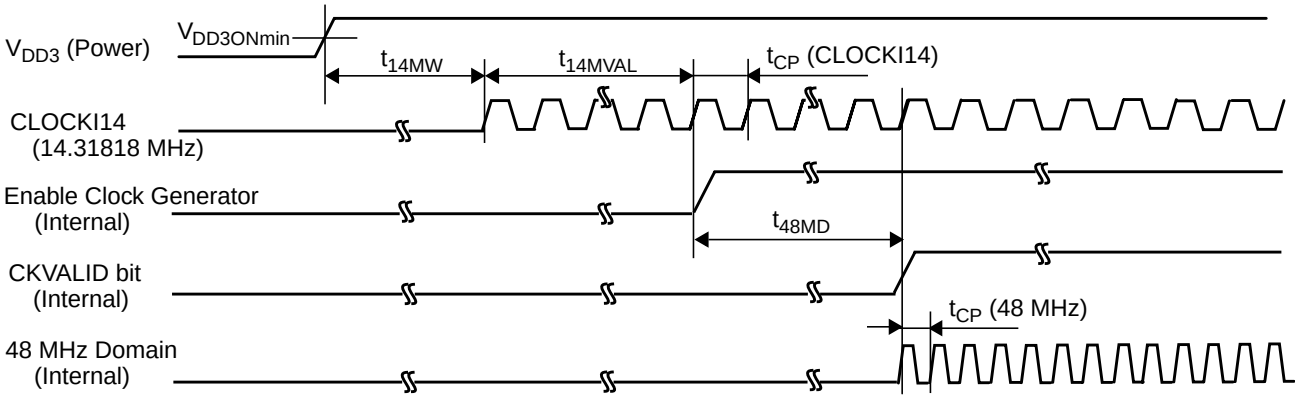



**Figure 42. CLOCKI14 and Internal 48 MHz Domain Timing**

## 10.0 Device Characteristics (Continued)

### Low-Frequency Clock Timing

| Symbol | Figure | Clock Input Parameters | Reference Conditions | CLOCKI32 | | | Units |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $t_{CP}$ | 43 | Clock Period[1] (50%-50%) | | 30.4871 | 30.517578 | 30.5481 | µs |
| $F_{CK}$ | – | Clock Frequency | | $F_{32TYP}$ – 0.1% | 32.768 ($F_{32TYP}$) | $F_{32TYP}$ + 0.1% | KHz |
| $t_{32KW}$ | 43 | Clock wake-up time | $V_{SB3}$ stable to clock start toggling | System dependent[2] | | | |
| $t_{32KVAL}$ | 43 | Clock valid time[1] | Clock start toggling to clock valid | | | 256 * $t_{CP}$ | |

1. Not tested. Guaranteed by design.
2. If $t_{32KW}$ of the CLOCKI32 input is lower than 0.5 ms, use the 0.5 ms value in calculations involving the total wake-up time of the low-frequency clock ($t_{32KW}$ + $t_{32KVAL}$).

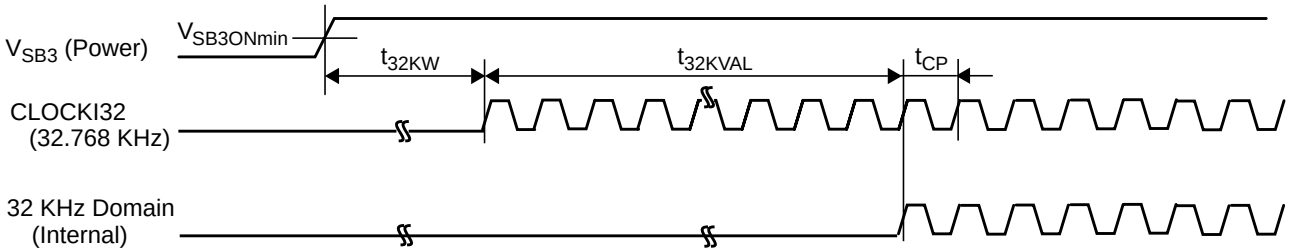



**Figure 43. CLOCKI32 Timing**

## 10.0 Device Characteristics (Continued)

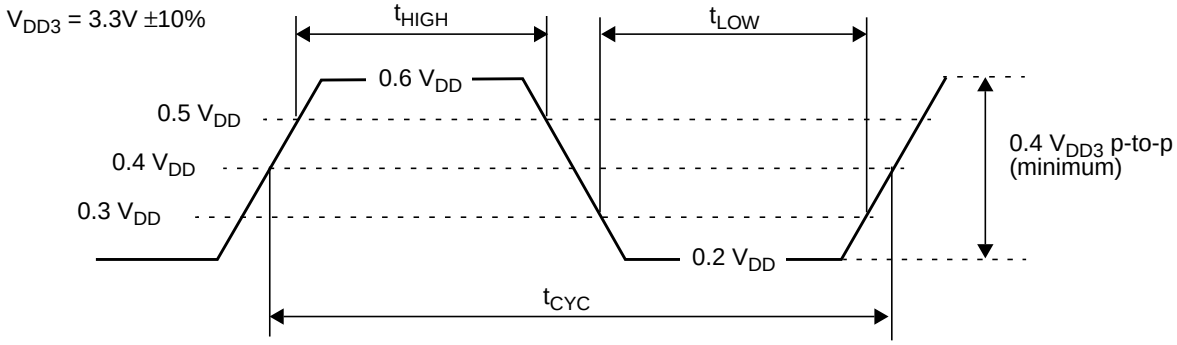
### 10.4.4 LPC Interface Timing

The AC characteristics of the LPC interface meet the PCI Local Bus Specification *(Rev 2.2 December 18, 1998)* for 3.3V DC signaling.

**PCI_CLK and $\overline{\text{PCI_RESET}}$**

| Symbol | Parameter | Min | Max | Units |
|---|---|---|---|---|
| $t_{CYC}$[1] | PCI_CLK Cycle Time | 30 | | ns |
| $t_{HIGH}$ | PCI_CLK High Time[2] | 11 | | ns |
| $t_{LOW}$ | PCI_CLK Low Time[2] | 11 | | ns |
| – | PCI_CLK Slew Rate[2,3] | 1 | 4 | V/ns |
| – | $\overline{\text{PCI_RESET}}$ Slew Rate[2,4] | 50 | | mV/ns |

1. The PCI may have any clock frequency between nominal DC and 33 MHz. Device operational parameters at frequencies under 16 MHz are guaranteed by design rather than by testing. The clock frequency may be changed at any time during the operation of the system as long as the clock edges remain “clean” (monotonic) and the minimum cycle high and low times are not violated. The clock may only be stopped in a low state.
2. Not tested. Guaranteed by characterization.
3. Rise and fall times are specified in terms of the edge rate measured in V/ns. This slew rate must be met across the minimum peak-to-peak portion of the clock wavering (0.2 * $V_{DD3}$ to 0.6 * $V_{DD3}$) as shown below.
4. The minimum $\overline{\text{PCI_RESET}}$ slew rate applies only to the rising (de-assertion) edge of the reset signal and ensures that system noise cannot make an otherwise monotonic signal appear to bounce in the switching range.



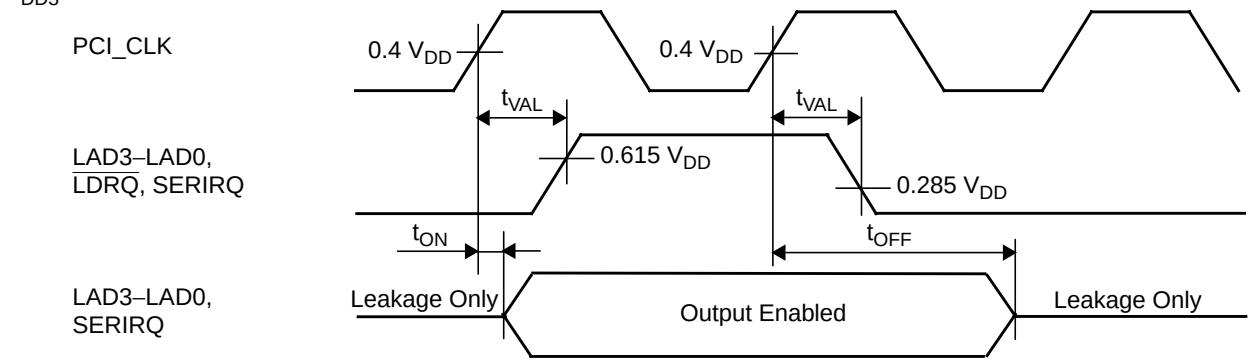
## 10.0 Device Characteristics (Continued)

### LPC Signals

| Symbol | Figure | Description | Reference Conditions | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{VAL}$ | Outputs | Output Valid Delay | After RE of CLK | | 11 | ns |
| $t_{ON}$ | Outputs | Float to Active Delay | After RE of CLK | 2 | | ns |
| $t_{OFF}$ | Outputs | Active to Float Delay | After RE of CLK | | 28 | ns |
| $t_{SU}$ | Inputs | Input Setup Time | Before RE of CLK | 7 | | ns |
| $t_{HL}$ | Inputs | Input Hold Time | After RE of CLK | 0 | | ns |
| $t_{PDR}$ | Reset Outputs | Rise Propagation Delay | From RE of $\overline{\text{PCI_RESET}}$ to RE of $\overline{\text{PCIRST_OUT}}$, $\overline{\text{PCIRST_OUT2}}$ | | 30 | ns |
| $t_R$ | Reset Outputs | Rise Time | $\overline{\text{PCIRST_OUT}}$, $\overline{\text{PCIRST_OUT2}}$ | | 50 | ns |
| $t_{PDF}$ | Reset Outputs | Fall Propagation Delay | From FE of $\overline{\text{PCI_RESET}}$ to FE of $\overline{\text{IDE_RSTDRV}}$ | | 20 | ns |
| $t_F$ | Reset Outputs | Fall Time | $\overline{\text{IDE_RSTDRV}}$ | | 15 | ns |

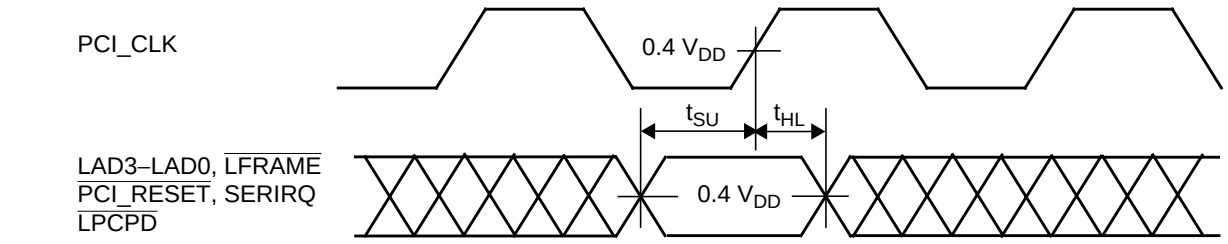
**Outputs**

$V_{DD3}$ = 3.3V ±10%

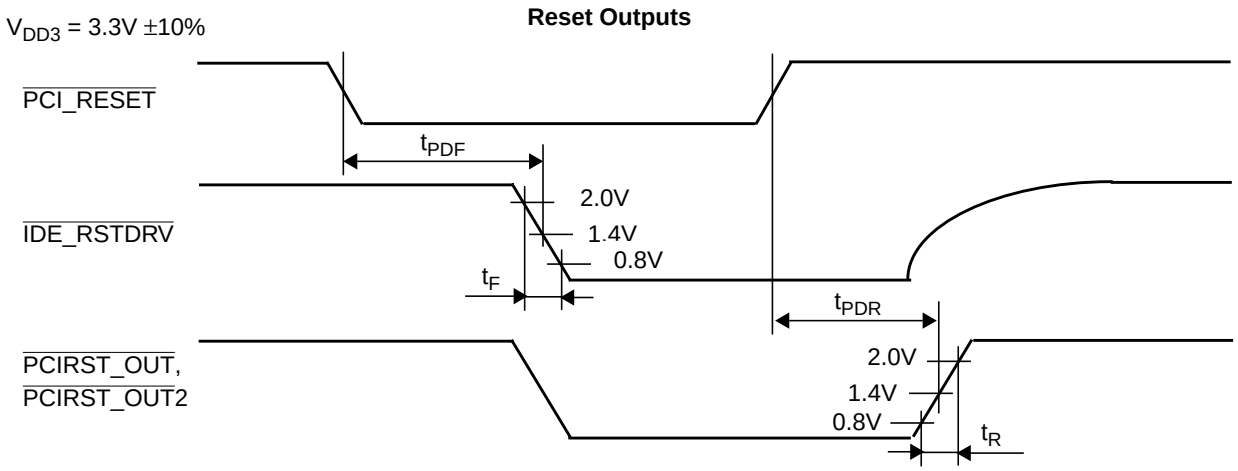



**Inputs**

$V_{DD3}$ = 3.3V ±10%



## 10.0 Device Characteristics (Continued)

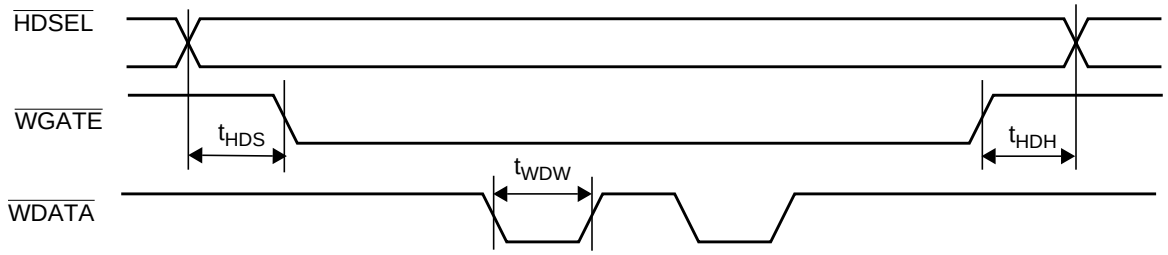



### 10.4.5 FDC Timing

#### FDC Write Data Timing

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $t_{HDH}$ | HDSEL Hold from WGATE Inactive[1] | 100 | | µs |
| $t_{HDS}$ | HDSEL Setup to WGATE Active[1] | 100 | | µs |
| $t_{WDW}$ | Write Data Pulse Width[1] | See $t_{DRP}$, $t_{ICP}$ and $t_{WDW}$ values in table below | | |

1. Not tested. Guaranteed by design.




**$t_{DRP}$ $t_{ICP}$ $t_{WDW}$ Values**

| Data Rate | $t_{DRP}$ | $t_{ICP}$ | $t_{ICP}$ Nominal | $t_{WDW}$ | $t_{WDW}$ Minimum | Unit |
|---|---|---|---|---|---|---|
| 1 Mbps | 1000 | 6 x $t_{CP}$[1] | 125 | 2 x $t_{ICP}$ | 250 | ns |
| 500 Kbps | 2000 | 6 x $t_{CP}$[1] | 125 | 2 x $t_{ICP}$ | 250 | ns |
| 300 Kbps | 3333 | 10 x $t_{CP}$[1] | 208 | 2 x $t_{ICP}$ | 375 | ns |
| 250 Kbps | 4000 | 12 x $t_{CP}$[1] | 250 | 2 x $t_{ICP}$ | 500 | ns |

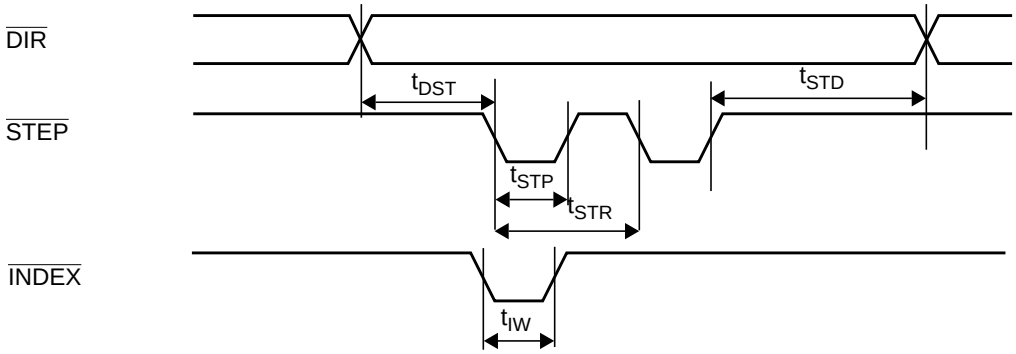
1. $t_{CP}$ is the clock period defined for CLOCKI in *Clock Timing on page 131*.

## 10.0 Device Characteristics (Continued)

### FDC Drive Control Timing

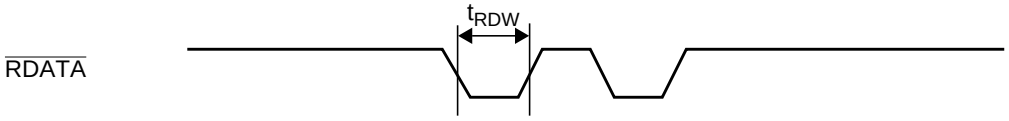
| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $t_{DST}$ | $\overline{DIR}$ Setup to $\overline{STEP}$ Active[1] | 6 | | µs |
| $t_{IW}$ | Index Pulse Width | 100 | | ns |
| $t_{STD}$ | $\overline{DIR}$ Hold from $\overline{STEP}$ Inactive | $t_{STR}$ | | ms |
| $t_{STP}$ | $\overline{STEP}$ Active High Pulse Width[1] | 8 | | µs |
| $t_{STR}$ | $\overline{STEP}$ Rate Time[1] | 0.5 | | ms |

1. Not tested. Guaranteed by design.




### FDC Read Data Timing

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $t_{RDW}$ | Read Data Pulse Width | 50 | | ns |

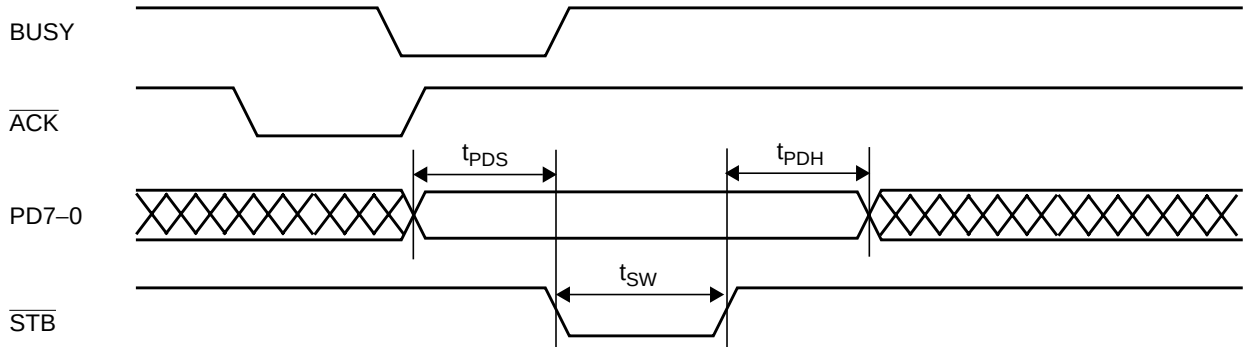


## 10.0 Device Characteristics (Continued)

### 10.4.6 Parallel Port Timing

#### Standard Parallel Port Timing

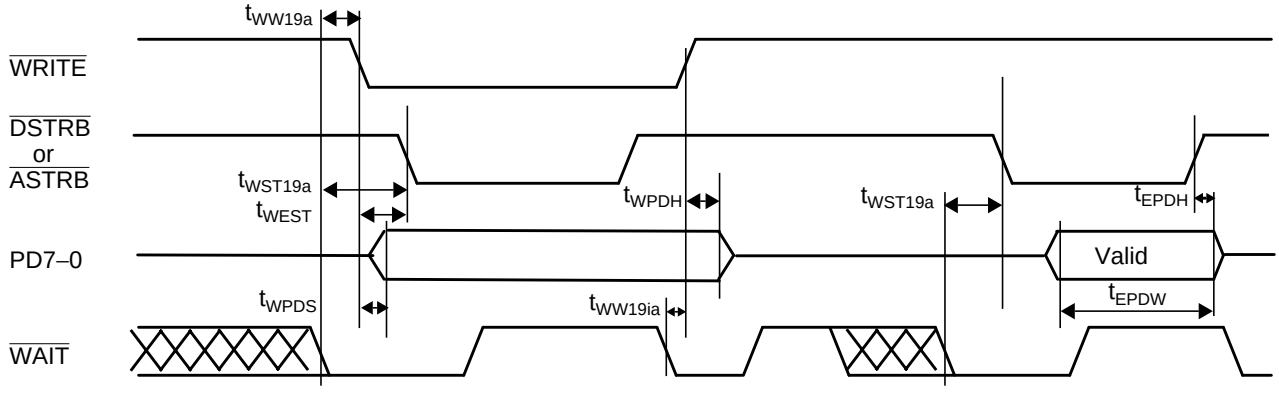
| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $t_{PDH}$ | Port Data Hold | SPP Mode 0 and Mode 1, ECP Mode 0 and Mode1: system dependent; ECP Mode 2: device dependent. | 750 | | ns |
| $t_{PDS}$ | Port Data Setup | SPP Mode 0 and Mode 1, ECP Mode 0 and Mode1: system dependent; ECP Mode 2: device dependent. | 750 | | ns |
| $t_{SW}$ | Strobe Width | SPP Mode 0 and Mode 1, ECP Mode 0 and Mode1: system dependent; ECP Mode 2: device dependent. | 750 | | ns |




#### Enhanced Parallel Port Timing

| Symbol | Parameter | Min | Max | EPP 1.7[1] | EPP 1.9[1] | Unit |
|---|---|---|---|---|---|---|
| $t_{WW19a}$ | $\overline{WRITE}$ Active from $\overline{WAIT}$ Low | | 45 | | ✔ | ns |
| $t_{WW19ia}$ | $\overline{WRITE}$ Inactive from $\overline{WAIT}$ Low | | 45 | | ✔ | ns |
| $t_{WST19a}$ | $\overline{DSTRB}$ or $\overline{ASTRB}$ Active from $\overline{WAIT}$ Low | | 65 | | ✔ | ns |
| $t_{WEST}$ | $\overline{DSTRB}$ or $\overline{ASTRB}$ Active after $\overline{WRITE}$ Active | 10 | | ✔ | ✔ | ns |
| $t_{WPDH}$ | PD7–0 Hold after $\overline{WRITE}$ Inactive | 0 | | ✔ | ✔ | ns |
| $t_{WPDS}$ | PD7–0 Valid after $\overline{WRITE}$ Active | | 15 | ✔ | ✔ | ns |
| $t_{EPDW}$ | PD7–0 Valid Width | 80 | | ✔ | ✔ | ns |
| $t_{EPDH}$ | PD7–0 Hold after $\overline{DSTRB}$ or $\overline{ASTRB}$ Inactive | 0 | | ✔ | ✔ | ns |

1. Also in ECP Mode 4



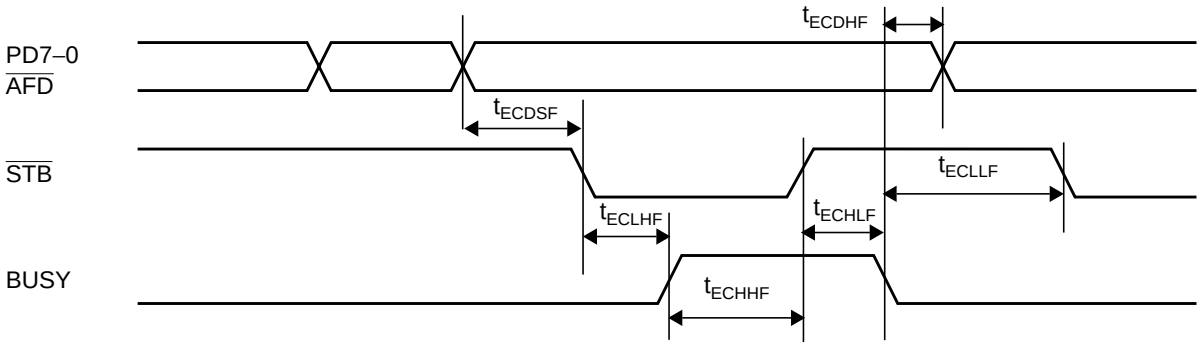
## 10.0 Device Characteristics (Continued)

### Extended Capabilities Port (ECP) Timing

**Forward Mode**

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $t_{ECDSF}$ | Data Setup before $\overline{STB}$ Active | 0 | | ns |
| $t_{ECDHF}$ | Data Hold after BUSY Inactive | 0 | | ns |
| $t_{ECLHF}$ | BUSY Active after $\overline{STB}$ Active | 75 | | ns |
| $t_{ECHHF}$ | $\overline{STB}$ Inactive after BUSY Active[1] | 0 | 1 | s |
| $t_{ECHLF}$ | BUSY Inactive after $\overline{STB}$ Active[1] | 0 | 35 | ms |
| $t_{ECLLF}$ | $\overline{STB}$ Active after BUSY Inactive | 0 | | ns |

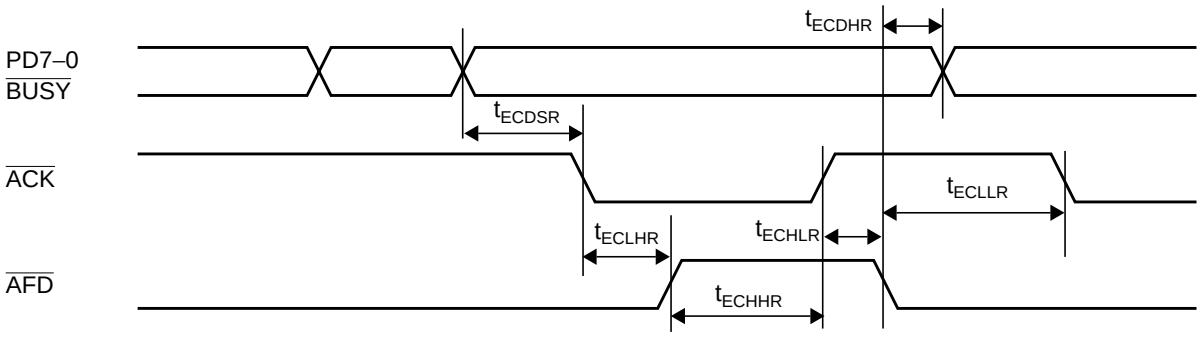
1. Not tested. Guaranteed by design.




**Reverse Mode**

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $t_{ECDSR}$ | Data Setup before $\overline{ACK}$ Active | 0 | | ns |
| $t_{ECDHR}$ | Data Hold after $\overline{AFD}$ Active | 0 | | ns |
| $t_{ECLHR}$ | $\overline{AFD}$ Inactive after $\overline{ACK}$ Active | 75 | | ns |
| $t_{ECHHR}$ | $\overline{ACK}$ Inactive after $\overline{AFD}$ Inactive[1] | 0 | 35 | ms |
| $t_{ECHLR}$ | $\overline{AFD}$ Active after $\overline{ACK}$ Inactive[1] | 0 | 1 | s |
| $t_{ECLLR}$ | $\overline{ACK}$ Active after $\overline{AFD}$ Active | 0 | | ns |

1. Not tested. Guaranteed by design.



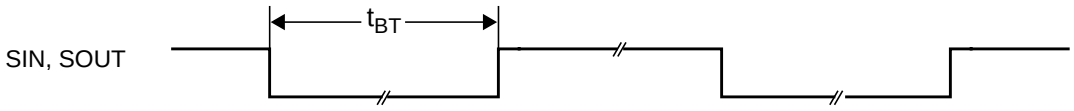
# 10.0 Device Characteristics (Continued)

## 10.4.7 Serial Port Timing

### Serial Port Data Timing

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $t_{BT}$ | Single Bit Time in Serial Port[1] | Transmitter | $t_{BTN} - 25$[2] | $t_{BTN} + 25$[2] | ns |
| | | Receiver | $t_{BTN} - 2\%$[2] | $t_{BTN} + 2\%$[2] | ns |

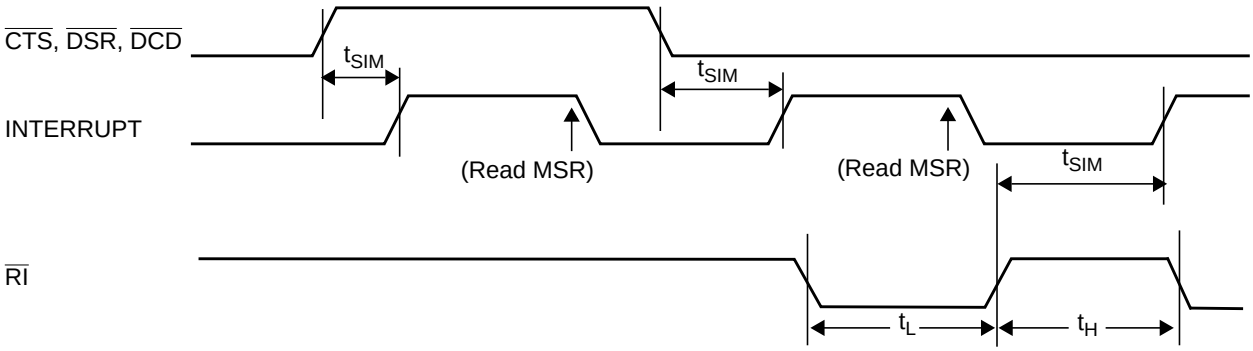
1. Not tested. Guaranteed by design.
2. $t_{BTN}$ is the nominal bit time in the Serial Port; it is determined by the setting of the Baud Generator Divisor registers.




### Modem Control Timing

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $t_L$ | $\overline{RI}$ Low Time[1,2] | 10 | | ns |
| $t_H$ | $\overline{RI}$ High Time[1,2] | 10 | | ns |
| $t_{SIM}$ | Delay to Set IRQ from Modem Input | | 40 | ns |

1. Not tested. Guaranteed by characterization.
2. The value also applies to $\overline{RI}$ wake-up detection in the SWC module



# 10.0 Device Characteristics (Continued)

## 10.4.8 Glue Function Timing

### Highest Active Main and Standby Supply Reference

| Symbol | Figure | Description | Reference Conditions | Min | Max |
|---|---|---|---|---|---|
| **Main** | | | | | |
| $t_{PD}$ | 44 | $V_{DD3}$ to REF5V Propagation Delay[1] | $V_{DD5}$ = 0; $V_{DD3}$ slew rate > 10 V/ms | | 1 ms |
| **Standby** | | | | | |
| $t_{PD}$ | 44 | $V_{SB3}$ to REF5V_STBY Propagation Delay[1] | $V_{SB5}$ = 0; $V_{SB3}$ slew rate > 10 V/ms | | 1 ms |

1. Not tested. Guaranteed by design.

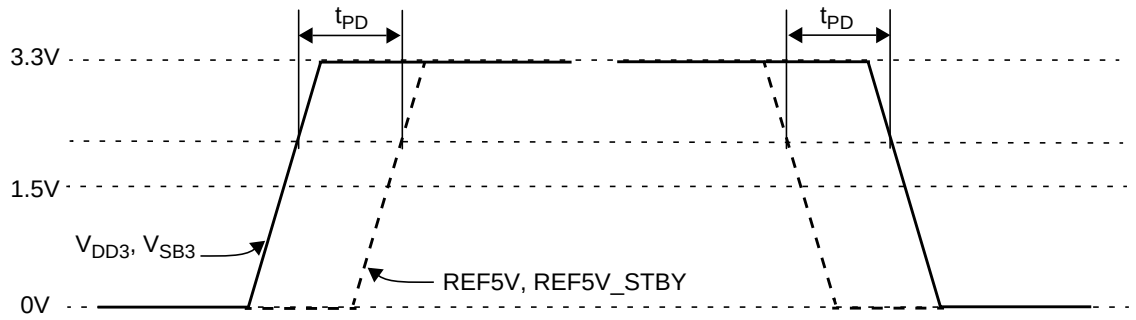



**Figure 44. REF5V and REF5V_STBY (AC Characteristics)**

### Resume Reset

| Symbol | Figure | Description | Reference Conditions | Min | Max | Units |
|---|---|---|---|---|---|---|
| $t_{RD}$ | 45 | Rising Supply Delay[1] (typ. 32 ms) | $V_{SB5} > V_{TRIP}$ or $V_{SB3} > V_{SB3ON}$ | 10 | 100 | ms |
| $t_{FD5}$ | 45 | Falling $V_{SB5}$ Supply Delay[1] | $V_{SB5} < V_{TRIP}$ and $V_{SB3} > V_{SB3ON}$ | | 100 | ns |
| $t_{GA}$ | 45 | $V_{SB5}$ and $V_{SB3}$ Glitch Allowance[1] | $V_{SB5} < V_{TRIP}$ or $V_{SB3} < V_{SB3ON}$ | | 100 | ns |
| $t_{FD3}$ | 45 | Falling $V_{SB3}$ Supply Delay[1] | $V_{SB3} < V_{SB3ON}$ and $V_{SB5} > V_{TRIP}$ | | 100 | ns |
| $t_R$ | 45 | Rise Time[2] | $V_{SB3} > V_{SB3ON}$ | | 100 | ns |
| $t_F$ | 45 | Fall Time[2] | $V_{SB3} > V_{SB3ON}$ | | 100 | ns |

1. Not tested. Guaranteed by characterization.
2. Not tested. Guaranteed by design.

## 10.0 Device Characteristics (Continued)

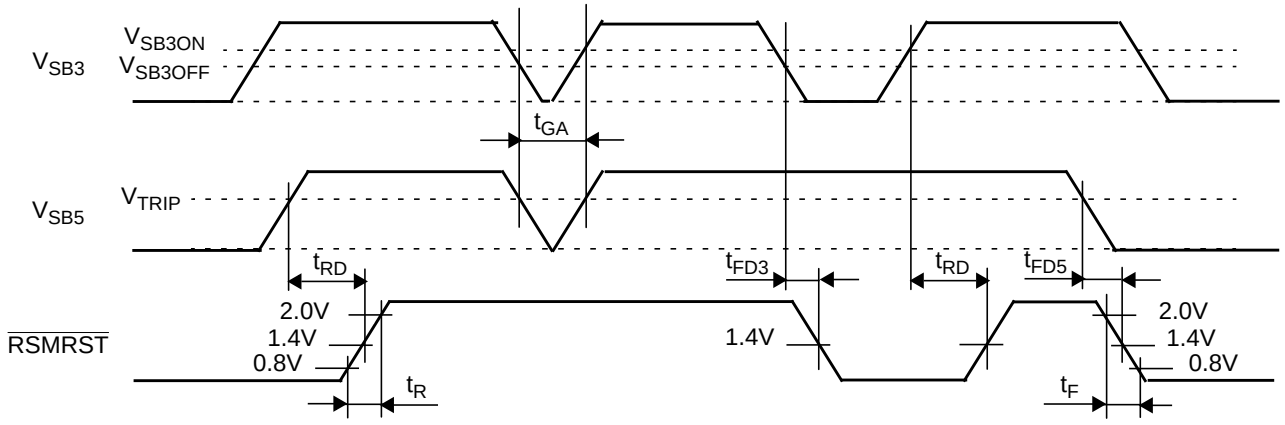



**Figure 45. $\overline{RSMRST}$ (AC Characteristics)**

### Main Power Good

| Symbol | Figure | Description | Reference Conditions | Min | Max | Units |
|---|---|---|---|---|---|---|
| $t_{DB}$ | – | Debouncing time[1] | After RE or FE of $\overline{FPRST}$ | 768 * $t_{CP}$[2] | 832 * $t_{CP}$ | |
| $t_{PDF}$ | – | $\overline{FPRST}$ Propagation Delay[1] | After RE or FE of $\overline{FPRST}$ | 768 * $t_{CP}$ | 832 * $t_{CP}$ | |
| $t_{PDP}$ | – | PWRGD_PS Propagation Delay[1] | After RE or FE of PWRGD_PS | | 1 | µs |
| $t_R$ | – | Rise Time[1] | 0.8V to 2.0V | | 50 | ns |
| $t_F$ | – | Fall Time[1] | 2.0V to 0.8V | | 50 | ns |

1. Not tested. Guaranteed by design.
2. $t_{CP}$ is the cycle time of the 32 KHz clock domain (see *Low-Frequency Clock Timing on page 132*)

### Rambus SCK Clock Gate Control

| Symbol | Figure | Description | Reference Conditions | Min | Max | Units |
|---|---|---|---|---|---|---|
| $t_{PF}$ | – | Fall Propagation Delay[1] | PWRGD_3V to FE of SCK_BJT_GATE | | 50 | ns |
| $t_F$ | – | Fall Time | 0.8V to 2.0V | | 15 | ns |

1. Not tested. Guaranteed by characterization.

### Power Distribution Control

| Symbol | Figure | Description | Reference Conditions | Min | Max | Units |
|---|---|---|---|---|---|---|
| $t_{PB}$ | – | $\overline{BKFD_CUT}$ Propagation Delay[1] | PWRGD_PS or $\overline{SLP_S3}$ to $\overline{BKFD_CUT}$ | | 1 | µs |
| $t_{TB}$ | – | $\overline{BKFD_CUT}$ Transition Time[1] | 0.8V to 2.0V | | 50 | ns |
| $t_{PL}$ | 46 | LATCHED_BF_CUT Propagation Delay[1] | $\overline{BKFD_CUT}$ or $\overline{SLP_S5}$ to LATCHED_BF_CUT | | 1 | µs |
| $t_{TL}$ | 46 | LATCHED_BF_CUT Transition Time[1] | 0.8V to 2.0V | | 50 | ns |

1. Not tested. Guaranteed by design.

## 10.0 Device Characteristics (Continued)

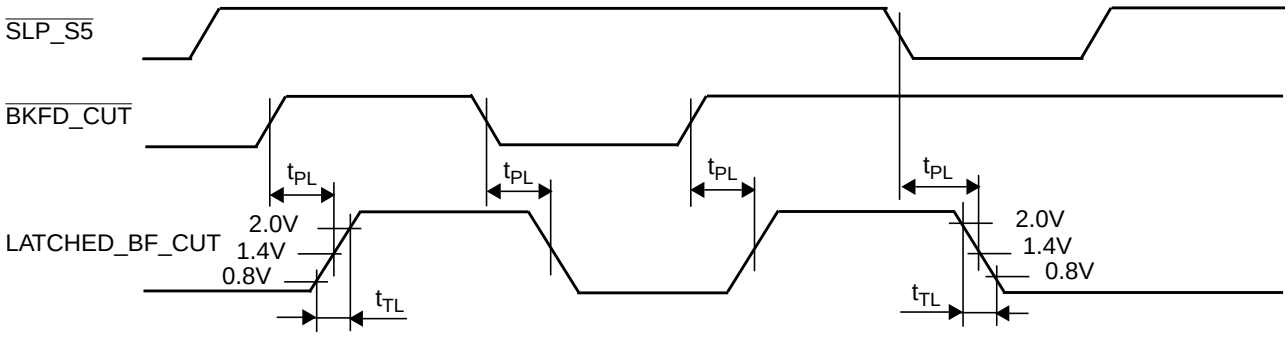



**Figure 46. BKFD_CUT and LATCHED_BF_CUT (AC Characteristics)**

### Main Power Supply Control

| Symbol | Figure | Description | Reference Conditions | Min | Max | Units |
|---|---|---|---|---|---|---|
| $t_{PR}$ | – | Rise Propagation Delay[1] | CPU_PRESENT or SLP_S3 to RE of PS_ON | | 1 | µs |
| $t_{PF}$ | – | Fall Propagation Delay[1] | CPU_PRESENT or SLP_S3 to FE of PS_ON | | 1 | µs |
| $t_R$ | – | Rise Time[1] | 0.8V to 2.0V | | 50 | ns |
| $t_F$ | – | Fall Time[1] | 0.8V to 2.0V | | 50 | ns |

1. Not tested. Guaranteed by design.

### CNR Downstream Codec Dynamic Control

| Symbol | Figure | Description | Reference Conditions | Min | Max | Units |
|---|---|---|---|---|---|---|
| $t_{PD}$ | – | Propagation Delay[1] | AUD_LINK_RST to CDC_DWN_RST | | 30 | ns |
| $t_{TR}$ | – | Transition Time[1] | 0.8V to 2.0V | | 15 | ns |

1. Not tested. Guaranteed by characterization.

### SMBus Voltage Translation and Isolation Timing

| Symbol | Figure | Description | Type of Requirement[1] | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{SMBR}$ | – | Rise Time (all signals) | Input | | 1000[2,3] | ns |
| $t_{SMBF}$ | – | Fall Time (all signals) | Input | | 250[3] | ns |
| | | | Output | | 300[2,4] | ns |
| $t_{SMBD}$ | – | Propagation Delay (each signal pair, in both directions) | Output | | 500[2,4] | ns |

1. An “Input” type is a value the PC87372 device expects from the system; an “Output” type is a value the PC87372 device provides to the system.
2. Test conditions: $R_L$ = 1 KΩ to $V_{DD3}$ = 3.3V, or $R_L$ = 1.5 KΩ to $V_{DD5}$ = 5V and $C_L$ = 400 pF to GND.
3. Not tested. Guaranteed by design.
4. Not tested. Guaranteed by characterization.

## 10.0 Device Characteristics (Continued)

### 10.4.9 SWC Timing

**Wake-Up Inputs at $V_{SB3}$ Power Switching**

| Symbol | Figure | Description | Reference Conditions | Min | Max |
|---|---|---|---|---|---|
| $t_{EWIV}$ | 47 | External Wake-Up Inputs Valid[1] | At $V_{SB3}$ power on, after the 32 KHz Domain is toggling | 24576 * $t_{CP}$[2] | 32768 * $t_{CP}$ |

1. Not tested. Guaranteed by characterization.
2. $t_{CP}$ is the cycle time of the 32 KHz clock domain (see *Low-Frequency Clock Timing on page 132*)

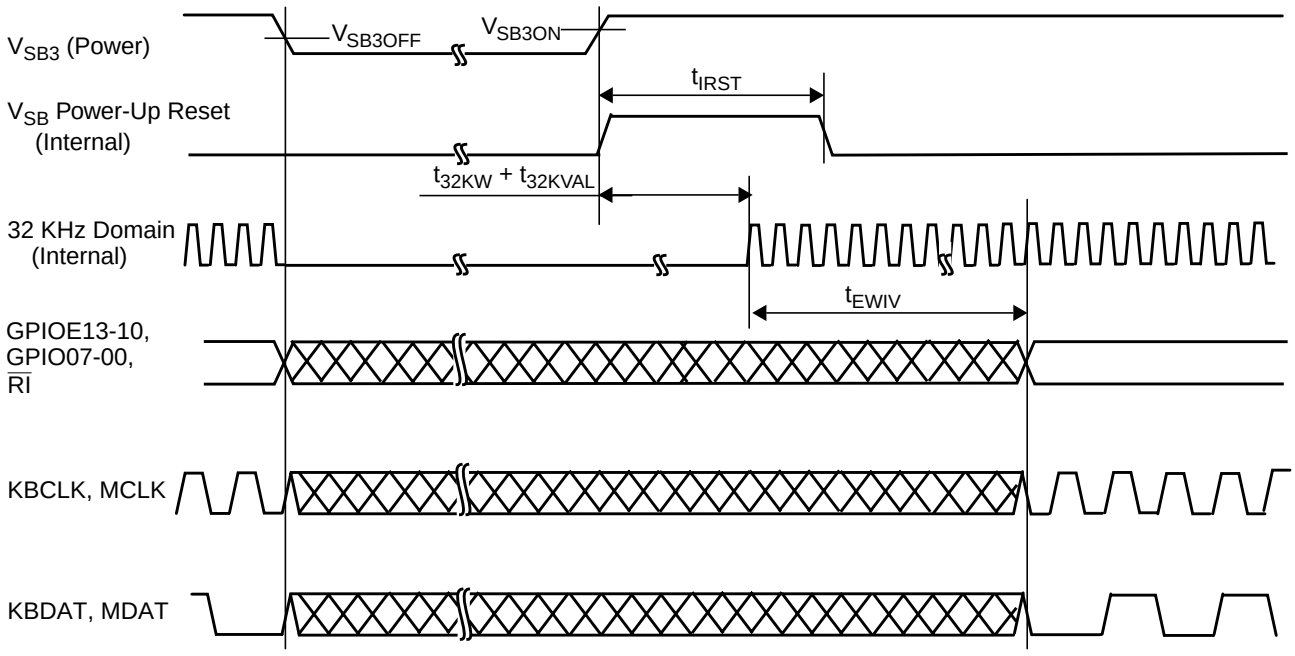



**Figure 47. Inputs at $V_{SB3}$ Power Switching**

**Wake-Up Inputs at $V_{DD3}$ Power Switching**

| Symbol | Figure | Description | Reference Conditions | Min | Max |
|---|---|---|---|---|---|
| $t_{EWIV}$ | 48 | External Wake-Up Inputs Valid[1] | After $V_{DD3}$ power on[2] | 24576 * $t_{CP}$[3] | 32768 * $t_{CP}$ |

1. Not tested. Guaranteed by characterization.
2. The 32 KHz clock domain is assumed to be toggling at $V_{DD3}$ power stable.
3. $t_{CP}$ is the cycle time of the 32 KHz clock domain (see *Low-Frequency Clock Timing on page 132*)

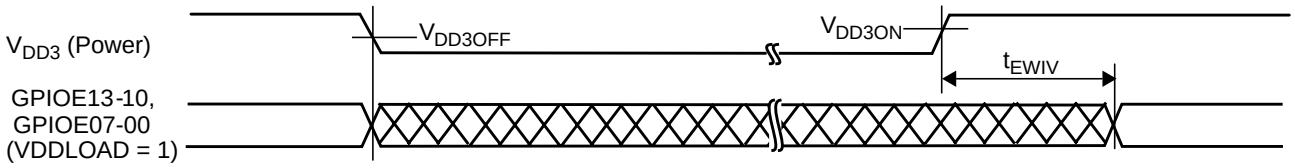
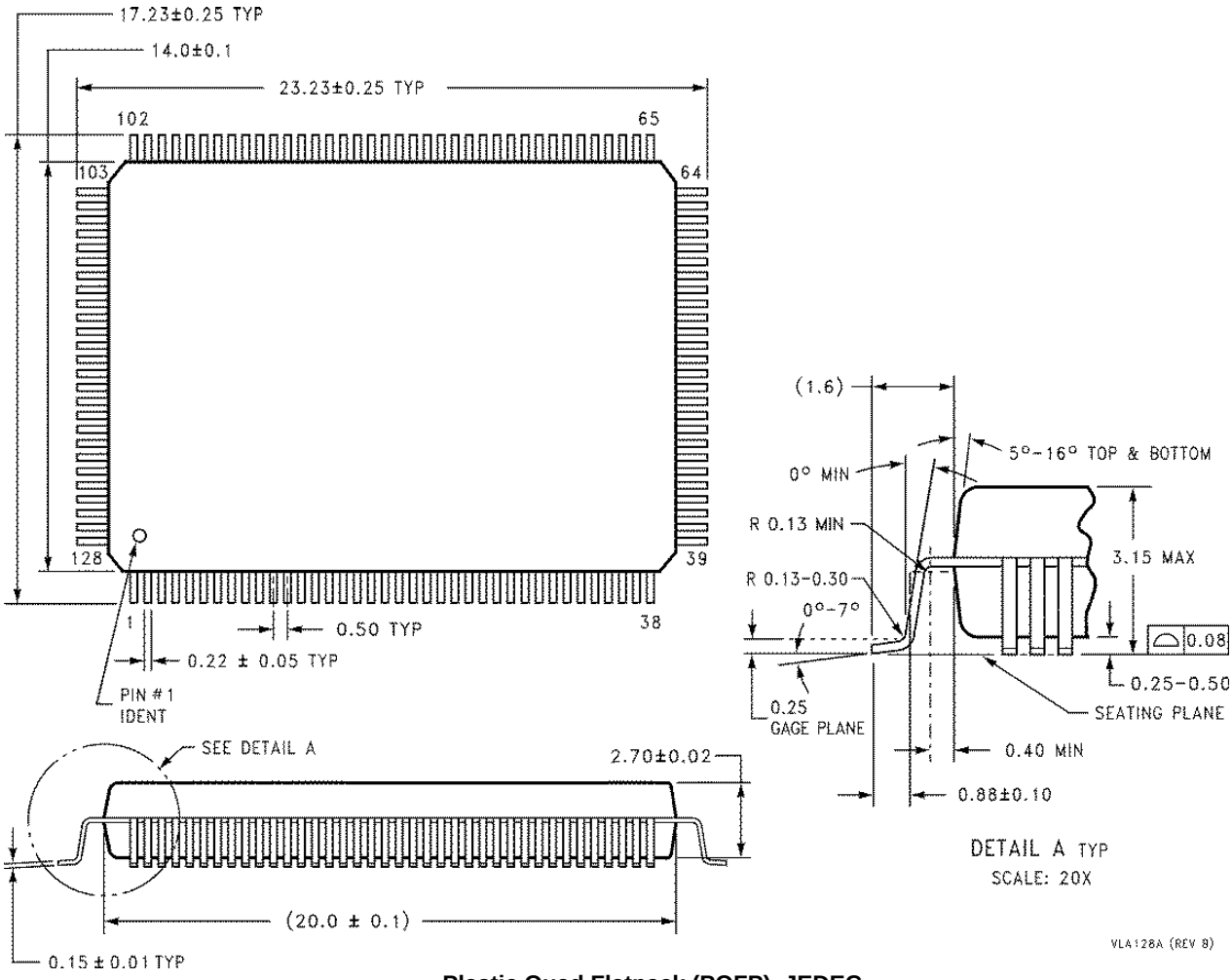



**Figure 48. Wake-Up Inputs at $V_{DD3}$ Power Switching**

## Physical Dimensions

All dimensions are in millimeters




**Plastic Quad Flatpack (PQFP), JEDEC**
**Order Number PC87372-xxx/VLA**
**NS Package Number VLA128A**

### LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

**National Semiconductor Corporation**
**Americas**
Email:
new.feedback@nsc.com

**National Semiconductor**
**Europe**
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 87 90

**National Semiconductor**
**Asia Pacific Customer**
**Response Group**
Tel: 65-2544466
Fax: 65-2504466
Email: ap.support@nsc.com

**National Semiconductor**
**Japan Ltd.**
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507
Email: nsj.crc@jksmtp.nsc.com

www.national.com

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.