

USB 2.0 Hub and 10/100 Ethernet Controller

PRODUCT FEATURES

Datasheet

Highlights

- Three downstream ports, one upstream port
 - Three integrated downstream USB 2.0 PHYs
 - One integrated upstream USB 2.0 PHY
- Integrated 10/100 Ethernet MAC with full-duplex support
- Integrated 10/100 Ethernet PHY with HP Auto-MDIX
- Implements Reduced Power Operating Modes
- Minimized BOM Cost
 - Single 25 MHz crystal (Eliminates cost of separate crystals for USB and Ethernet)
 - Built-in Power-On-Reset (POR) circuit (Eliminates requirement for external passive or active reset)

Target Applications

- Desktop PCs
- Notebook PCs
- Printers
- Game Consoles
- Embedded Systems
- Docking Stations

Key Features

- USB Hub
 - Fully compliant with Universal Serial Bus Specification Revision 2.0
 - HS (480 Mbps), FS (12 Mbps), and LS (1.5 Mbps) compatible
 - Three downstream ports, one upstream port
 - Port mapping and disable support
 - Port Swap: Programmable USB diff-pair pin location
 - PHY Boost: Programmable USB signal drive strength
 - Select presence of a permanently hardwired USB peripheral device on a port by port basis
 - Advanced power saving features
 - Downstream PHY goes into low power mode when port power to the port is disabled
 - Full Power Management with individual or ganged power control of each downstream port.
 - Integrated USB termination Pull-up/Pull-down resistors
 - Internal short circuit protection of USB differential signal pins

- High-Performance 10/100 Ethernet Controller
 - Fully compliant with IEEE802.3/802.3u
 - Integrated Ethernet MAC and PHY
 - 10BASE-T and 100BASE-TX support
 - Full- and half-duplex support with flow control
 - Preamble generation and removal
 - Automatic 32-bit CRC generation and checking
 - Automatic payload padding and pad removal
 - Loop-back modes
 - TCP/UDP checksum offload support
 - Flexible address filtering modes
 - One 48-bit perfect address
 - 64 hash-filtered multicast addresses
 - Pass all multicast
 - Promiscuous mode
 - Inverse filtering
 - Pass all incoming with status report
 - Wakeup packet support
 - Integrated Ethernet PHY
 - Auto-negotiation, HP Auto-MDIX
 - Automatic polarity detection and correction
 - Energy Detect
- Power and I/Os
 - Three PHY LEDs
 - Eight GPIOs
 - Supports bus-powered and self-powered operation
 - Internal 1.8v core supply regulator
 - External 3.3v I/O supply
- Miscellaneous features
 - Optional EEPROM
 - Optional 24MHz reference clock output for partner hub
 - IEEE 1149.1 (JTAG) Boundary Scan
- Software
 - Windows 2000/XP/Vista Driver
 - Linux Driver
 - Win CE Driver
 - MAC OS Driver
 - EEPROM Utility
- Packaging
 - 64-pin QFN, lead-free RoHS compliant
- Environmental
 - Commercial Temperature Range (0°C to +70°C)
 - Industrial Temperature Range (-40°C to +85°C)
 - ±8kV HBM without External Protection Devices
 - ±8kV contact mode (IEC61000-4-2)
 - ±15kV air-gap discharge mode (IEC61000-4-2)

Order Numbers:**LAN9513-JZX for 64-pin, QFN lead-free RoHS compliant package (0 to +70°C temp range)****LAN9513i-JZX for 64-pin, QFN lead-free RoHS compliant package (-40 to +85°C temp range)****This product meets the halogen maximum concentration values per IEC61249-2-21****For RoHS compliance and environmental information, please visit www.smsc.com/rohs**

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Table of Contents

| | | |
|------------------|---|-----------|
| Chapter 1 | Introduction | 6 |
| 1.1 | Block Diagram | 6 |
| 1.1.1 | Overview | 6 |
| 1.1.2 | USB Hub | 7 |
| 1.1.3 | Ethernet Controller | 7 |
| 1.1.4 | EEPROM Controller | 7 |
| 1.1.5 | Peripherals | 7 |
| 1.1.6 | Power Management | 8 |
| <hr/> | | |
| Chapter 2 | Pin Description and Configuration | 9 |
| 2.1 | Power Connections | 16 |
| 2.2 | Port Power Control | 17 |
| 2.2.1 | Port Power Control Using a USB Power Switch | 17 |
| 2.2.2 | Port Power Control Using a Poly Fuse | 18 |
| 2.3 | Buffer Types | 20 |
| <hr/> | | |
| Chapter 3 | EEPROM Controller (EPC) | 21 |
| 3.1 | EEPROM Format | 21 |
| 3.1.1 | Hub Configuration | 24 |
| 3.2 | EEPROM Defaults | 34 |
| 3.3 | EEPROM Auto-Load | 34 |
| 3.4 | An Example of EEPROM Format Interpretation | 35 |
| <hr/> | | |
| Chapter 4 | Operational Characteristics | 40 |
| 4.1 | Absolute Maximum Ratings* | 40 |
| 4.2 | Operating Conditions** | 40 |
| 4.3 | Power Consumption | 41 |
| 4.3.1 | SUSPEND0 | 41 |
| 4.3.2 | SUSPEND1 | 41 |
| 4.3.3 | SUSPEND2 | 41 |
| 4.3.4 | Operational Current Consumption & Power Dissipation | 42 |
| 4.4 | DC Specifications | 43 |
| 4.5 | AC Specifications | 45 |
| 4.5.1 | Equivalent Test Load | 45 |
| 4.5.2 | Reset Timing | 45 |
| 4.5.3 | EEPROM Timing | 46 |
| 4.5.4 | JTAG Timing | 47 |
| 4.6 | Clock Circuit | 48 |
| <hr/> | | |
| Chapter 5 | Package Outline | 49 |
| 5.1 | 64-QFN Package | 49 |
| <hr/> | | |
| Chapter 6 | Datasheet Revision History | 51 |

List of Figures

| | | |
|------------|--|----|
| Figure 1.1 | Internal Block Diagram | 6 |
| Figure 2.1 | LAN9513/LAN9513i 64-QFN Pin Assignments (TOP VIEW) | 9 |
| Figure 2.2 | Power Connections | 16 |
| Figure 2.3 | Port Power Control with USB Power Switch | 17 |
| Figure 2.4 | Port Power Control with Poly Fuse | 18 |
| Figure 2.5 | Port Power with Ganged Control with Poly Fuse | 19 |
| Figure 4.1 | Output Equivalent Test Load | 45 |
| Figure 4.2 | EEPROM Timing | 46 |
| Figure 4.3 | JTAG Timing | 47 |
| Figure 5.1 | LAN9513/LAN9513i 64-QFN Package Definition | 49 |
| Figure 5.2 | LAN9513/LAN9513i Recommended PCB Land Pattern | 50 |

List of Tables

| | | |
|------------|---|----|
| Table 2.1 | EEPROM Pins | 10 |
| Table 2.2 | JTAG Pins | 10 |
| Table 2.3 | Miscellaneous Pins | 10 |
| Table 2.4 | USB Pins | 12 |
| Table 2.5 | Ethernet PHY Pins | 13 |
| Table 2.6 | I/O Power Pins, Core Power Pins, and Ground Pad | 14 |
| Table 2.7 | No-Connect Pins | 14 |
| Table 2.8 | 64-QFN Package Pin Assignments | 15 |
| Table 2.9 | Buffer Types | 20 |
| Table 3.1 | EEPROM Format | 21 |
| Table 3.2 | Configuration Flags Description | 23 |
| Table 3.3 | Hub Configuration | 24 |
| Table 3.4 | Config Data Byte 1 Register (CFG1) Format | 30 |
| Table 3.5 | Config Data Byte 2 Register (CFG2) Format | 31 |
| Table 3.6 | Config Data Byte 3 Register (CFG3) Format | 32 |
| Table 3.7 | Boost_Up Register (BOOSTUP) Format | 32 |
| Table 3.8 | Boost_4:2 Register (BOOST42) Format | 32 |
| Table 3.9 | Status/Command Register (STCD) Format | 33 |
| Table 3.10 | EEPROM Defaults | 34 |
| Table 3.11 | Dump of EEPROM Memory | 35 |
| Table 3.12 | EEPROM Example - 256 Byte EEPROM | 36 |
| Table 4.1 | SUSPEND0 Current Consumption and Power Dissipation (VDD33IO = VDD33A = 3.3V) | 41 |
| Table 4.2 | SUSPEND1 Current Consumption and Power Dissipation (VDD33IO = VDD33A = 3.3V) | 41 |
| Table 4.3 | SUSPEND2 Current Consumption and Power Dissipation (VDD33IO = VDD33A = 3.3V) | 41 |
| Table 4.4 | Operational Current Consumption & Power Dissipation (VDD33IO = VDD33A = 3.3V) | 42 |
| Table 4.5 | I/O Buffer Characteristics | 43 |
| Table 4.6 | 100BASE-TX Transceiver Characteristics | 44 |
| Table 4.7 | 10BASE-T Transceiver Characteristics | 44 |
| Table 4.8 | EEPROM Timing Values | 46 |
| Table 4.9 | JTAG Timing Values | 47 |
| Table 4.10 | LAN9513/LAN9513i Crystal Specifications | 48 |
| Table 5.1 | LAN9513/LAN9513i 64-QFN Dimensions | 49 |
| Table 6.1 | Customer Revision History | 51 |

Chapter 1 Introduction

1.1 Block Diagram

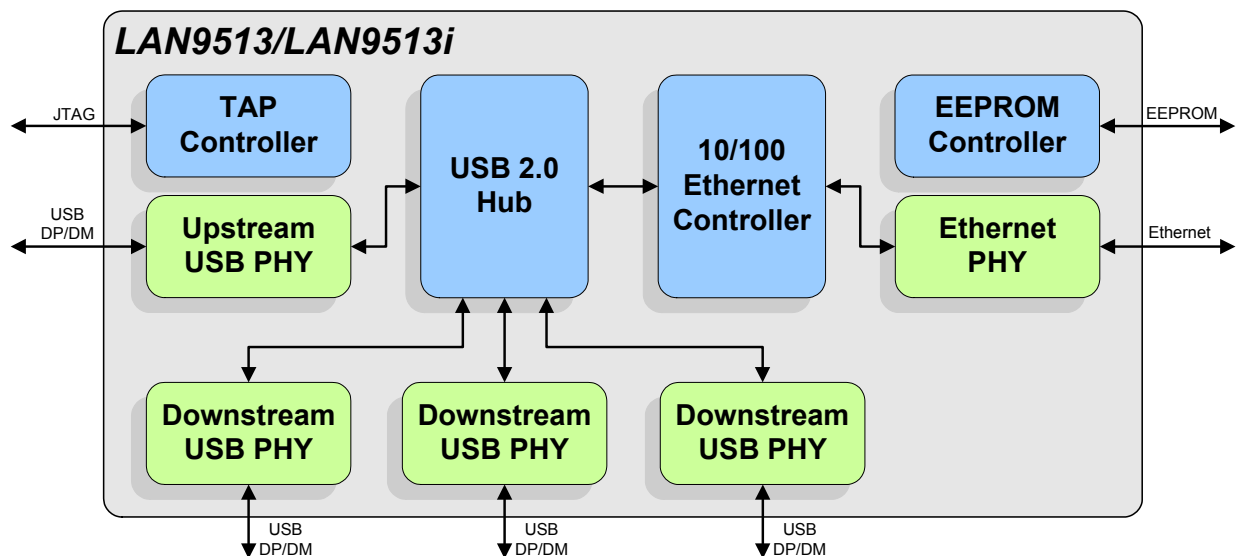


Figure 1.1 Internal Block Diagram

1.1.1 Overview

The LAN9513/LAN9513i is a high performance Hi-Speed USB 2.0 hub with a 10/100 Ethernet controller. With applications ranging from embedded systems, desktop PCs, notebook PCs, printers, game consoles, and docking stations, the LAN9513/LAN9513i is targeted as a high performance, low cost USB/Ethernet and USB/USB connectivity solution.

The LAN9513/LAN9513i contains an integrated USB 2.0 hub, three integrated downstream USB 2.0 PHYs, an integrated upstream USB 2.0 PHY, a 10/100 Ethernet PHY, a 10/100 Ethernet Controller, a TAP controller, and a EEPROM controller. A block diagram of the LAN9513/LAN9513i is provided in [Figure 1.1](#).

The LAN9513/LAN9513i hub provides over 30 programmable features, including:

PortMap (also referred to as port remap) which provides flexible port mapping and disabling sequences. The downstream ports of the LAN9513/LAN9513i hub can be reordered or disabled in any sequence to support multiple platform designs with minimum effort. For any port that is disabled, the LAN9513/LAN9513i automatically reorders the remaining ports to match the USB host controller's port numbering scheme.

PortSwap which adds per-port programmability to USB differential-pair pin locations. PortSwap allows direct alignment of USB signals (D+/D-) to connectors avoiding uneven trace length or crossing of the USB differential signals on the PCB.

PHYBoost which enables four programmable levels of USB signal drive strength in USB port transceivers. PHYBoost attempts to restore USB signal integrity that has been compromised by system level variables such as poor PCB layout, long cables, etc.

Datasheet**1.1.2 USB Hub**

The integrated USB hub is fully compliant with the USB 2.0 Specification and will attach to a USB host as a Full-Speed Hub or as a Full-/High-Speed Hub. The hub supports Low-Speed, Full-Speed, and High-Speed (if operating as a High-Speed hub) downstream devices on all of the enabled downstream ports.

A dedicated Transaction Translator (TT) is available for each downstream facing port. This architecture ensures maximum USB throughput for each connected device when operating with mixed-speed peripherals.

The hub works with an external USB power distributed switch device to control V_{BUS} switching to downstream ports, and to limit current and sense over-current conditions.

All required resistors on the USB ports are integrated into the hub. This includes all series termination resistors on D+ and D- pins and all required pull-down and pull-up resistors on D+ and D- pins. The over-current sense inputs for the downstream facing ports have internal pull-up resistors.

Three external ports are available for general USB device connectivity.

1.1.3 Ethernet Controller

The 10/100 Ethernet controller provides an integrated Ethernet MAC and PHY which are fully IEEE 802.3 10BASE-T and 802.3u 100BASE-TX compliant. The 10/100 Ethernet controller also supports numerous power management wakeup features, including “Magic Packet”, “Wake on LAN” and “Link Status Change”. These wakeup events can be programmed to initiate a USB remote wakeup.

The 10/100 Ethernet PHY integrates an IEEE 802.3 physical layer for twisted pair Ethernet applications. The PHY block includes support for auto-negotiation, full or half-duplex configuration, auto-polarity correction and Auto-MDIX. Minimal external components are required for the utilization of the integrated PHY.

The Ethernet controller implements four USB endpoints: Control, Interrupt, Bulk-in, and Bulk-out. The Bulk-in and Bulk-out Endpoints allow for Ethernet reception and transmission respectively. Implementation of vendor-specific commands allows for efficient statistics gathering and access to the Ethernet controller’s system control and status registers.

1.1.4 EEPROM Controller

The LAN9513/LAN9513i contains an EEPROM controller for connection to an external EEPROM. This allows for the automatic loading of static configuration data upon power-on reset, pin reset, or software reset. The EEPROM can be configured to load USB descriptors, USB device configuration, and the MAC address.

1.1.5 Peripherals

The LAN9513/LAN9513i also contains a TAP controller, and provides three PHY LED indicators, as well as eight general purpose I/O pins. All GPIOs can serve as remote wakeup events when LAN9513/LAN9513i is in a suspended state.

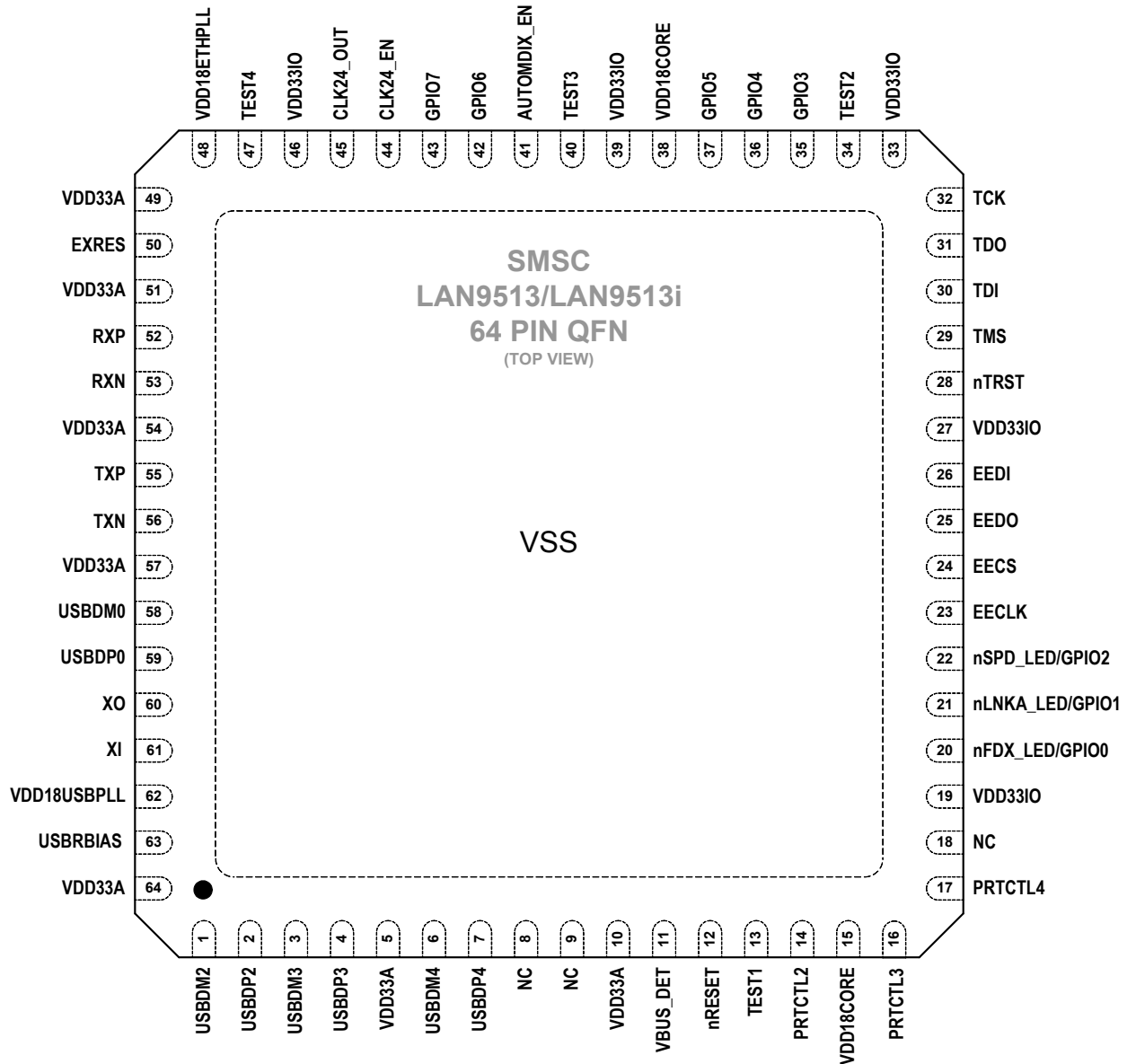
The integrated IEEE 1149.1 compliant TAP controller provides boundary scan via JTAG.

1.1.6 Power Management

The LAN9513/LAN9513i features three variations of USB suspend: SUSPEND0, SUSPEND1, and SUSPEND2. These modes allow the application to select the ideal balance of remote wakeup functionality and power consumption.

- **SUSPEND0:** Supports GPIO, “Wake On LAN”, and “Magic Packet” remote wakeup events. This suspend state reduces power by stopping the clocks of the MAC and other internal modules.
- **SUSPEND1:** Supports GPIO and “Link Status Change” for remote wakeup events. This suspend state consumes less power than SUSPEND0.
- **SUSPEND2:** Supports only GPIO assertion for a remote wakeup event. This is the default suspend mode for the LAN9513/LAN9513i.

Chapter 2 Pin Description and Configuration



NOTE: When HP Auto-MDIX is activated, the TXN/TXP pins can function as RXN/RXP and vice-versa

NOTE: Exposed pad (VSS) on bottom of package must be connected to ground

Figure 2.1 LAN9513/LAN9513i 64-QFN Pin Assignments (TOP VIEW)

Table 2.1 EEPROM Pins

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|--------------------|--------|-------------|--|
| 1 | EEPROM Data In | EEDI | IS (PD) | This pin is driven by the EEDO output of the external EEPROM. |
| 1 | EEPROM Data Out | EEDO | O8 | This pin drives the EEDI input of the external EEPROM. |
| 1 | EEPROM Chip Select | EECS | O8 | This pin drives the chip select output of the external EEPROM. |
| 1 | EEPROM Clock | EECLK | O8 | This pin drives the EEPROM clock of the external EEPROM. |

Table 2.2 JTAG Pins

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|-----------------------|--------|-------------|--|
| 1 | JTAG Test Port Reset | nTRST | IS | This active low pin functions as the JTAG test port reset input. Note: This pin should be tied high if it is not used. |
| 1 | JTAG Test Mode Select | TMS | IS | This pin functions as the JTAG test mode select. |
| 1 | JTAG Test Data Input | TDI | IS | This pin functions as the JTAG data input. |
| 1 | JTAG Test Data Out | TDO | O12 | This pin functions as the JTAG data output. |
| 1 | JTAG Test Clock | TCK | IS | This pin functions as the JTAG test clock. |

Table 2.3 Miscellaneous Pins

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|------------------------------------|----------|------------------|--|
| 1 | System Reset | nRESET | IS | This active low pin allows external hardware to reset the device. Note: This pin should be tied high if it is not used. |
| 1 | Ethernet Full-Duplex Indicator LED | nFDX_LED | OD12 (PU) | This pin is driven low (LED on) when the Ethernet link is operating in full-duplex mode. |
| | General Purpose I/O 0 | GPIO0 | IS/O12/OD12 (PU) | This General Purpose I/O pin is fully programmable as either a push-pull output, an open-drain output, or a Schmitt-triggered input. |

Table 2.3 Miscellaneous Pins (continued)

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|--------------------------------------|-------------|------------------|--|
| 1 | Ethernet Link Activity Indicator LED | nLNKA_LED | OD12 (PU) | This pin is driven low (LED on) when a valid link is detected. This pin is pulsed high (LED off) for 80mS whenever transmit or receive activity is detected. This pin is then driven low again for a minimum of 80mS, after which time it will repeat the process if TX or RX activity is detected. Effectively, LED2 is activated solid for a link. When transmit or receive activity is sensed, LED2 will function as an activity indicator. |
| | General Purpose I/O 1 | GPIO1 | IS/O12/OD12 (PU) | This General Purpose I/O pin is fully programmable as either a push-pull output, an open-drain output, or a Schmitt-triggered input. |
| 1 | Ethernet Speed Indicator LED | nSPD_LED | OD12 (PU) | This pin is driven low (LED on) when the Ethernet operating speed is 100Mbps, or during auto-negotiation. This pin is driven high during 10Mbps operation, or during line isolation. |
| | General Purpose I/O 2 | GPIO2 | IS/O12/OD12 (PU) | This General Purpose I/O pin is fully programmable as either a push-pull output, an open-drain output, or a Schmitt-triggered input. |
| 1 | General Purpose I/O 3 | GPIO3 | IS/O8/OD8 (PU) | This General Purpose I/O pin is fully programmable as either a push-pull output, an open-drain output, or a Schmitt-triggered input. |
| 1 | General Purpose I/O 4 | GPIO4 | IS/O8/OD8 (PU) | This General Purpose I/O pin is fully programmable as either a push-pull output, an open-drain output, or a Schmitt-triggered input. |
| 1 | General Purpose I/O 5 | GPIO5 | IS/O8/OD8 (PU) | This General Purpose I/O pin is fully programmable as either a push-pull output, an open-drain output, or a Schmitt-triggered input. |
| 1 | General Purpose I/O 6 | GPIO6 | IS/O8/OD8 (PU) | This General Purpose I/O pin is fully programmable as either a push-pull output, an open-drain output, or a Schmitt-triggered input. |
| 1 | General Purpose I/O 7 | GPIO7 | IS/O8/OD8 (PU) | This General Purpose I/O pin is fully programmable as either a push-pull output, an open-drain output, or a Schmitt-triggered input. |
| 1 | Detect Upstream VBUS Power | VBUS_DET | IS_5V | <p>This pin detects the state of the upstream bus power. The Hub monitors VBUS_DET to determine when to assert the USBDP0 pin's internal pull-up resistor (signaling a connect event).</p> <p>For bus powered hubs, this pin must be tied to VDD33IO.</p> <p>For self powered hubs where the device is permanently attached to a host, VBUS_DET should be pulled to VDD33IO. For other self powered applications, refer to the device reference schematic for additional connection information.</p> |
| 1 | Auto-MDIX Enable | AUTOMDIX_EN | IS | <p>Determines the default Auto-MDIX setting.</p> <p>0 = Auto-MDIX is disabled. 1 = Auto-MDIX is enabled.</p> |

Table 2.3 Miscellaneous Pins (continued)

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|---------------------|-----------|-------------|--|
| 1 | Test 1 | TEST1 | - | Used for factory testing, this pin must always be left unconnected. |
| 1 | Test 2 | TEST2 | - | Used for factory testing, this pin must always be connected to VSS for proper operation. |
| 1 | Test 3 | TEST3 | - | Used for factory testing, this pin must always be connected to VDD33IO for proper operation. |
| 1 | 24 MHz Clock Enable | CLK24_EN | IS | This pin enables the generation of the 24 MHz clock on the CLK_24_OUT pin. |
| 1 | 24 MHz Clock | CLK24_OUT | 08 | This pin outputs a 24 MHz clock that can be used a reference clock for a partner hub. |
| 1 | Test 4 | TEST4 | - | Used for factory testing, this pin must always be left unconnected. |

Table 2.4 USB Pins

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|-------------------------|--------|-------------|--|
| 1 | Upstream USB DMINUS 0 | USBDM0 | AIO | Upstream USB DMINUS signal. |
| 1 | Upstream USB DPLUS 0 | USBDP0 | AIO | Upstream USB DPLUS signal. |
| 1 | Downstream USB DMINUS 2 | USBDM2 | AIO | Downstream USB peripheral 2 DMINUS signal. |
| 1 | Downstream USB DPLUS 2 | USBDP2 | AIO | Downstream USB peripheral 2 DPLUS signal. |
| 1 | Downstream USB DMINUS 3 | USBDM3 | AIO | Downstream USB peripheral 3 DMINUS signal. |
| 1 | Downstream USB DPLUS 3 | USBDP3 | AIO | Downstream USB peripheral 3 DPLUS signal. |
| 1 | Downstream USB DMINUS 4 | USBDM4 | AIO | Downstream USB peripheral 4 DMINUS signal. |
| 1 | Downstream USB DPLUS 4 | USBDP4 | AIO | Downstream USB peripheral 4 DPLUS signal. |

Table 2.4 USB Pins (continued)

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|----------------------------|-------------|--------------|--|
| 1 | USB Port Power Control 2 | PRTCTL2 | IS/OD12 (PU) | <p>When used as an output, this pin enables power to downstream USB peripheral 2.</p> <p>When used as an input, this pin is used to sample the output signal from an external current monitor for downstream USB peripheral 2. An overcurrent condition is indicated when the signal is low.</p> <p>Refer to Section 2.2 for additional information.</p> |
| 1 | USB Port Power Control 3 | PRTCTL3 | IS/OD12 (PU) | <p>When used as an output, this pin enables power to downstream USB peripheral 3.</p> <p>When used as an input, this pin is used to sample the output signal from an external current monitor for downstream USB peripheral 3. An overcurrent condition is indicated when the signal is low.</p> <p>Refer to Section 2.2 for additional information.</p> |
| 1 | USB Port Power Control 4 | PRTCTL4 | IS/OD12 (PU) | <p>When used as an output, this pin enables power to downstream USB peripheral 4.</p> <p>When used as an input, this pin is used to sample the output signal from an external current monitor for downstream USB peripheral 4. An overcurrent condition is indicated when the signal is low.</p> <p>Refer to Section 2.2 for additional information.</p> |
| 1 | External USB Bias Resistor | USBRBIAS | AI | Used for setting HS transmit current level and on-chip termination impedance. Connect to an external 12K 1.0% resistor to ground. |
| 1 | USB PLL +1.8V Power Supply | VDD18USBPLL | P | Refer to the LAN9513/LAN9513i reference schematics for additional connection information. |
| 1 | Crystal Input | XI | ICLK | <p>External 25 MHz crystal input.</p> <p>Note: This pin can also be driven by a single-ended clock oscillator. When this method is used, XO should be left unconnected</p> |
| 1 | Crystal Output | XO | OCLK | External 25 MHz crystal output. |

Table 2.5 Ethernet PHY Pins

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|-------------------------------|--------|-------------|--|
| 1 | Ethernet TX Data Out Negative | TXN | AIO | Negative output of the Ethernet transmitter. The transmit data outputs may be swapped internally with receive data inputs when Auto-MDIX is enabled. |
| 1 | Ethernet TX Data Out Positive | TXP | AIO | Positive output of the Ethernet transmitter. The transmit data outputs may be swapped internally with receive data inputs when Auto-MDIX is enabled. |

Table 2.5 Ethernet PHY Pins (continued)

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|---------------------------------|-------------|-------------|--|
| 1 | Ethernet RX Data In Negative | RXN | AIO | Negative input of the Ethernet receiver. The receive data inputs may be swapped internally with transmit data outputs when Auto-MDIX is enabled. |
| 1 | Ethernet RX Data In Positive | RXP | AIO | Positive input of the Ethernet receiver. The receive data inputs may be swapped internally with transmit data outputs when Auto-MDIX is enabled. |
| 7 | +3.3V Analog Power Supply | VDD33A | P | Refer to the LAN9513/LAN9513i reference schematics for connection information. |
| 1 | External PHY Bias Resistor | EXRES | AI | Used for the internal bias circuits. Connect to an external 12.4K 1.0% resistor to ground. |
| 1 | Ethernet PLL +1.8V Power Supply | VDD18ETHPLL | P | Refer to the LAN9513/LAN9513i reference schematics for additional connection information. |

Table 2.6 I/O Power Pins, Core Power Pins, and Ground Pad

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|-------------------------------|--|-----------|-------------|---|
| 5 | +3.3V I/O Power | VDD33IO | P | +3.3V Power Supply for I/O Pins. Refer to the LAN9513/LAN9513i reference schematics for connection information. |
| 2 | Digital Core +1.8V Power Supply Output | VDD18CORE | P | +1.8 V power from the internal core voltage regulator. All VDD18CORE pins must be tied together for proper operation. Refer to the LAN9513/LAN9513i reference schematics for connection information. |
| 1 Note 2.1 | Ground | VSS | P | Ground |

Note 2.1 Exposed pad on package bottom ([Figure 2.1](#)).

Table 2.7 No-Connect Pins

| NUM PINS | NAME | SYMBOL | BUFFER TYPE | DESCRIPTION |
|----------|------------|--------|-------------|--|
| 3 | No Connect | NC | - | These pins must be left floating for normal device operation |

Table 2.8 64-QFN Package Pin Assignments

| PIN NUM | PIN NAME | PIN NUM | PIN NAME | PIN NUM | PIN NAME | PIN NUM | PIN NAME |
|---|-----------|---------|---------------------|---------|-------------|---------|-------------|
| 1 | USBDM2 | 17 | PRTCTL4 | 33 | VDD33IO | 49 | VDD33A |
| 2 | USBDP2 | 18 | NC | 34 | TEST2 | 50 | EXRES |
| 3 | USBDM3 | 19 | VDD33IO | 35 | GPIO3 | 51 | VDD33A |
| 4 | USBDP3 | 20 | nFDX_LED/ GPIO0 | 36 | GPIO4 | 52 | RXP |
| 5 | VDD33A | 21 | nLNKA_LED/ GPIO1 | 37 | GPIO5 | 53 | RXN |
| 6 | USBDM4 | 22 | nSPD_LED/ GPIO2 | 38 | VDD18CORE | 54 | VDD33A |
| 7 | USBDP4 | 23 | EECLK | 39 | VDD33IO | 55 | TXP |
| 8 | NC | 24 | EECS | 40 | TEST3 | 56 | TXN |
| 9 | NC | 25 | EEDO | 41 | AUTOMDIX_EN | 57 | VDD33A |
| 10 | VDD33A | 26 | EEDI | 42 | GPIO6 | 58 | USBDM0 |
| 11 | VBUS_DET | 27 | VDD33IO | 43 | GPIO7 | 59 | USBDP0 |
| 12 | nRESET | 28 | nTRST | 44 | CLK24_EN | 60 | XO |
| 13 | TEST1 | 29 | TMS | 45 | CLK24_OUT | 61 | XI |
| 14 | PRTCTL2 | 30 | TDI | 46 | VDD33IO | 62 | VDD18USBPLL |
| 15 | VDD18CORE | 31 | TDO | 47 | TEST4 | 63 | USBRBIAS |
| 16 | PRTCTL3 | 32 | TCK | 48 | VDD18ETHPLL | 64 | VDD33A |
| EXPOSED PAD MUST BE CONNECTED TO VSS | | | | | | | |

2.1 Power Connections

Figure 2.2 illustrates the power connections for LAN9513/LAN9513i..

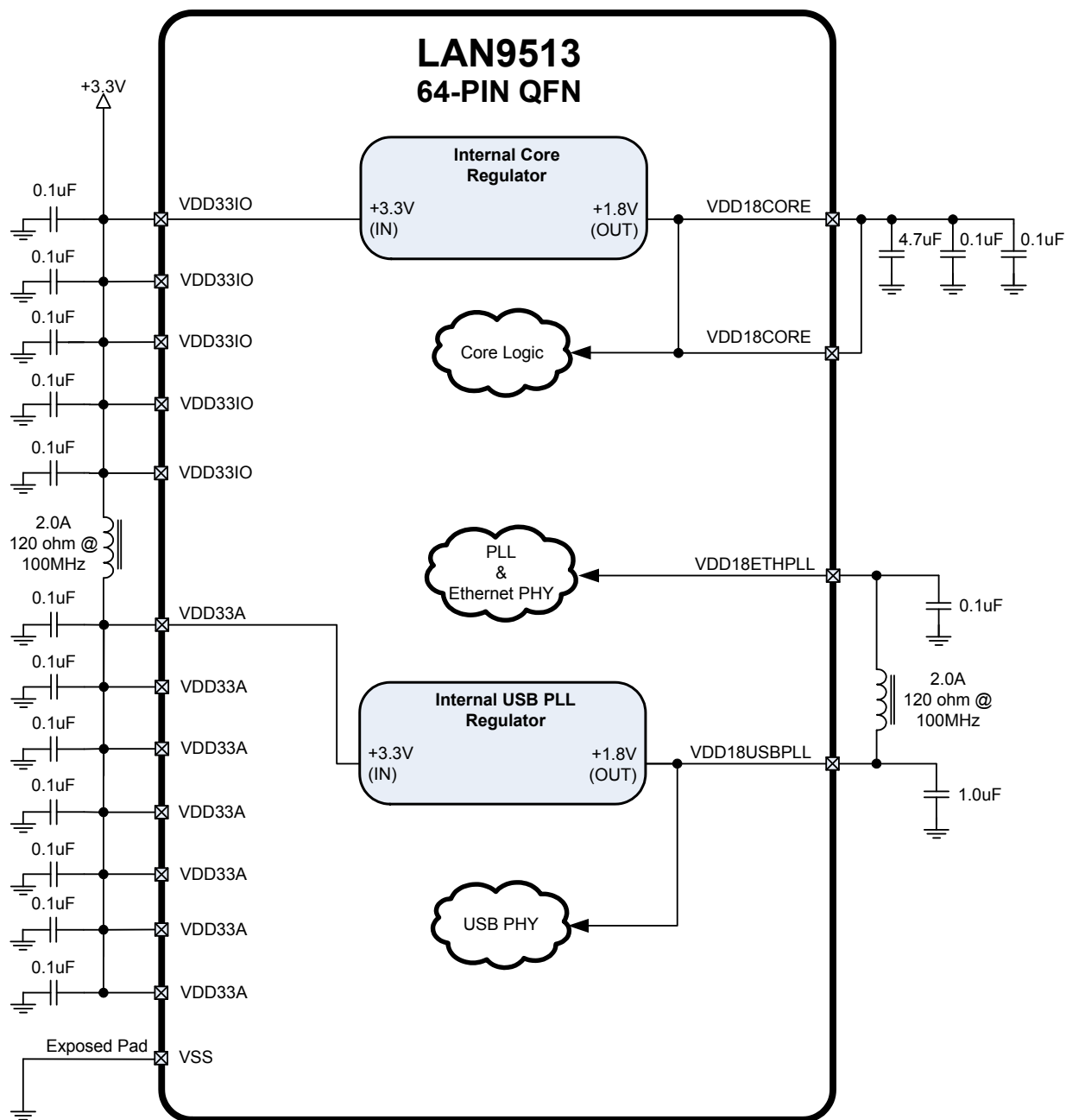


Figure 2.2 Power Connections

2.2 Port Power Control

This section details the usage of the port power control pins PRTCTL[4:2].

2.2.1 Port Power Control Using a USB Power Switch

The LAN9513/LAN9513i has a single port power control and over-current sense signal for each downstream port. When disabling port power the driver will actively drive a '0'. To avoid unnecessary power dissipation, the internal pull-up resistor will be disabled at that time. When port power is enabled, the output driver is disabled and the pull-up resistor is enabled, creating an open drain output. If there is an over-current situation, the USB Power Switch will assert the open drain OCS signal. The schmitt trigger input will recognize this situation as a low. The open drain output does not interfere. The overcurrent sense filter handles the transient conditions, such as low voltage, while the device is powering up.

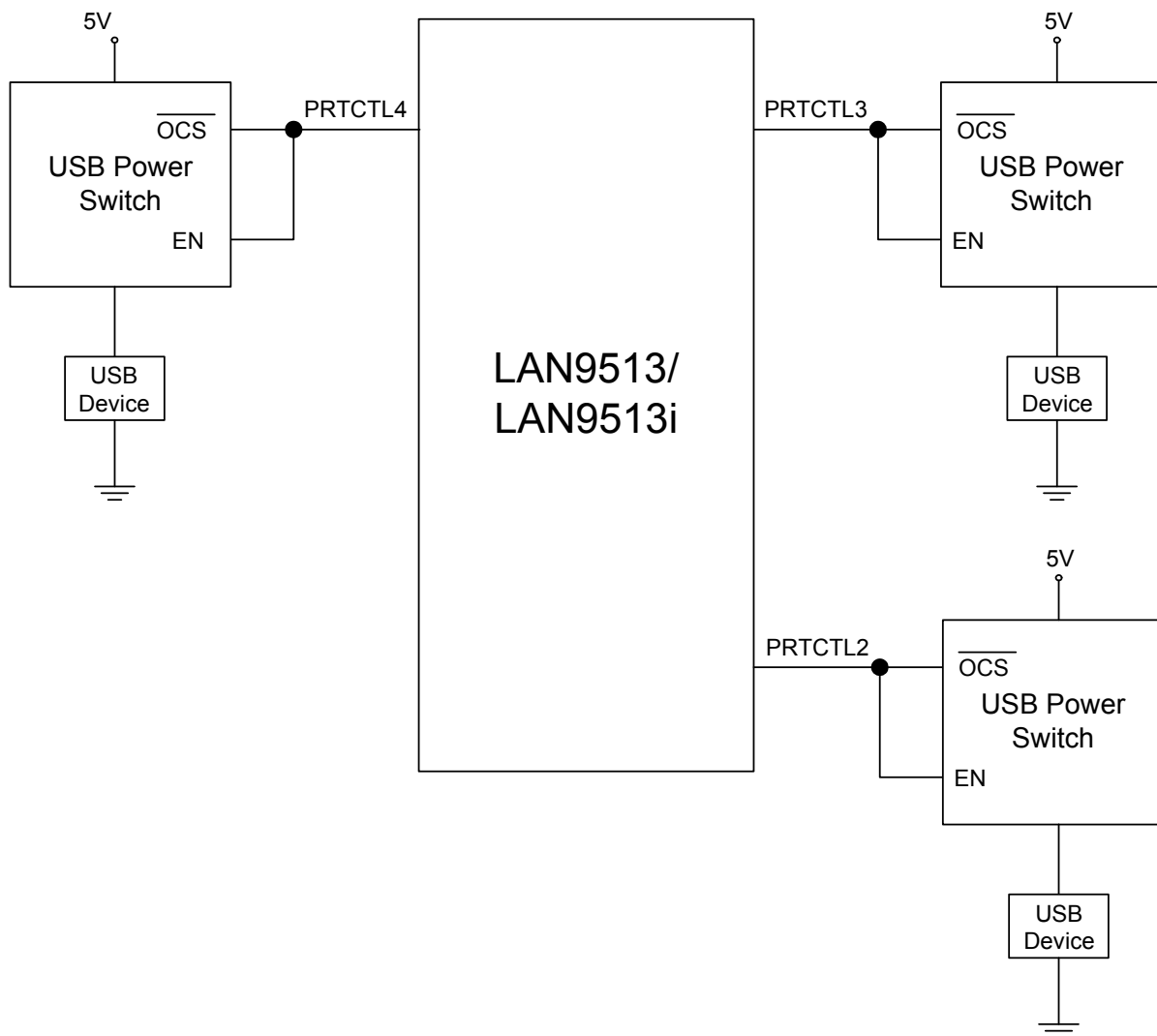


Figure 2.3 Port Power Control with USB Power Switch

2.2.2 Port Power Control Using a Poly Fuse

When using the LAN9513/LAN9513i with a poly fuse, an external diode must be used (See [Figure 2.4](#)). When disabling port power, the driver will drive a '0'. This procedure will have no effect since the external diode will isolate the pin from the load. When port power is enabled, the output driver is disabled and the pull-up resistor is enabled, which creates an open drain output. This means that the pull-up resistor is providing 3.3 volts to the anode of the diode. If there is an over-current situation, the poly fuse will open. This will cause the cathode of the diode to go to 0 volts. The anode of the diode will be at 0.7 volts, and the Schmidt trigger input will register this as a low, resulting in an overcurrent detection. The open drain output does not interfere.

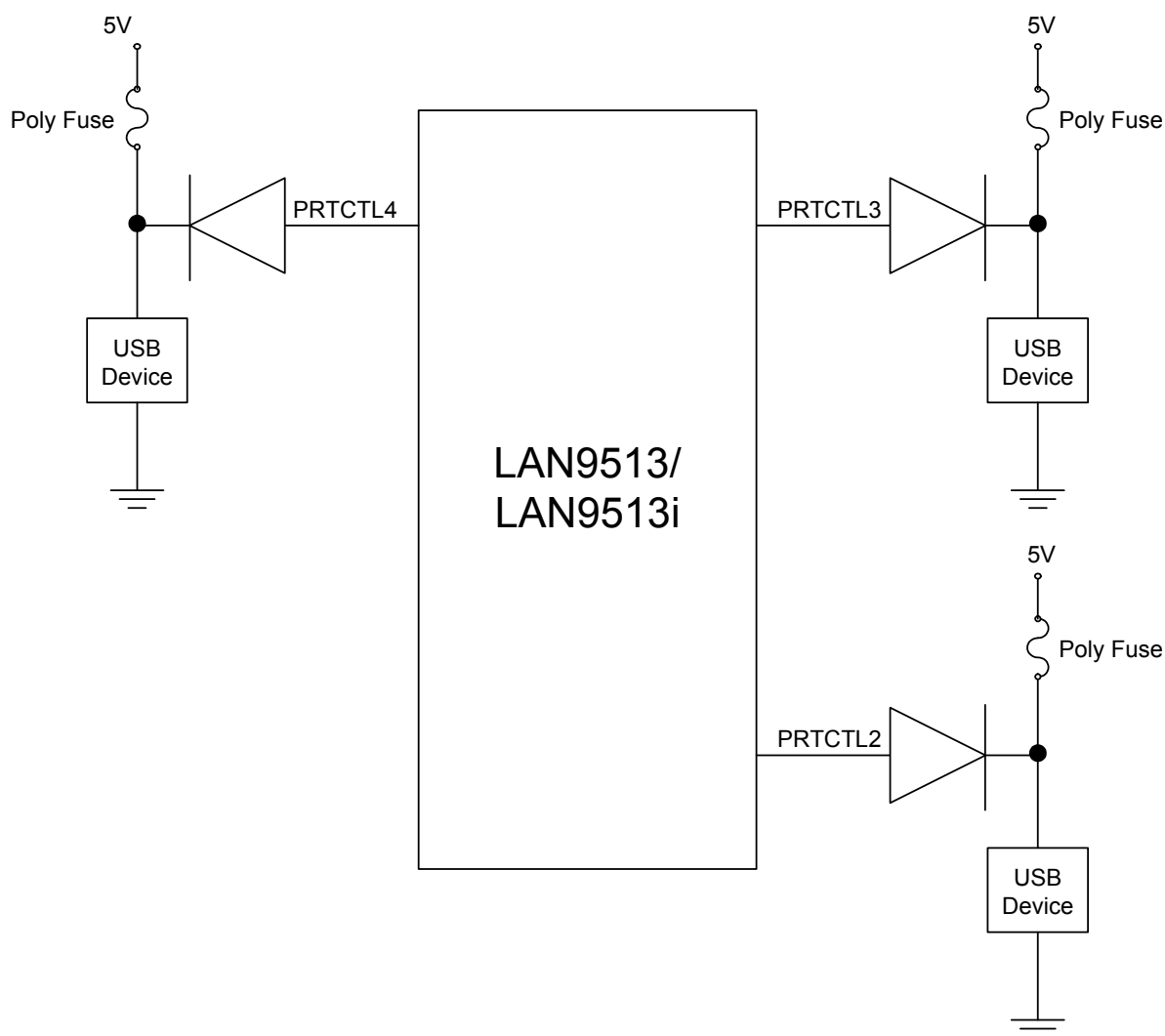


Figure 2.4 Port Power Control with Poly Fuse

Many customers use a single poly fuse to power all their devices. For the ganged situation, all power control pins must be tied together.

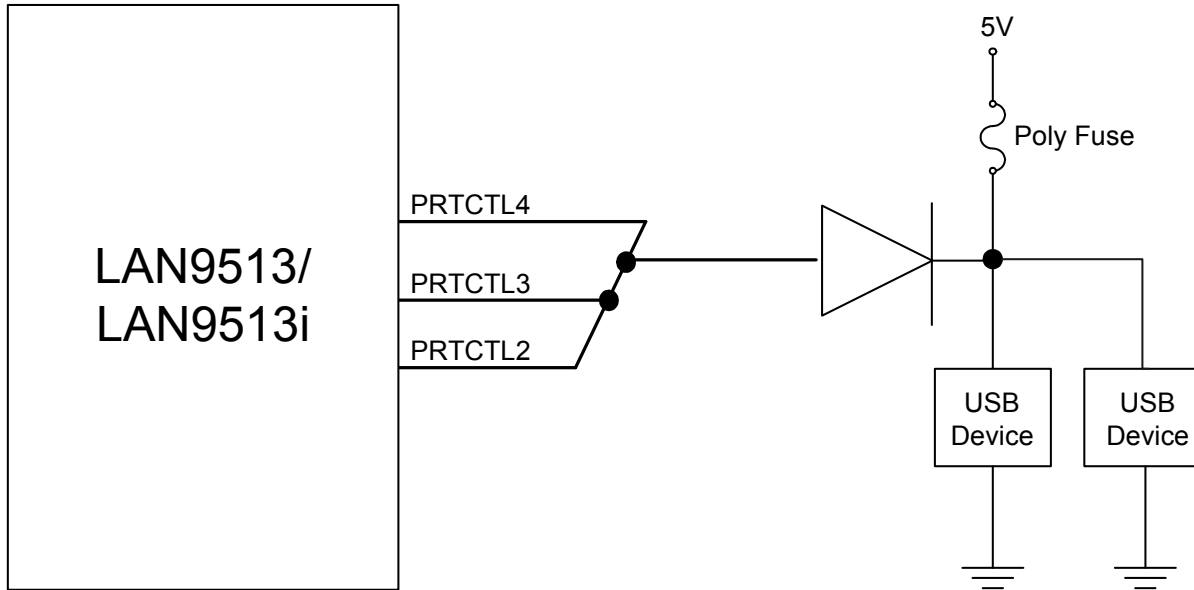


Figure 2.5 Port Power with Ganged Control with Poly Fuse

2.3 Buffer Types

Table 2.9 Buffer Types

| BUFFER TYPE | DESCRIPTION |
|-------------|---|
| IS | Schmitt-triggered Input |
| IS_5V | 5V Tolerant Schmitt-triggered Input |
| O8 | Output with 8mA sink and 8mA source |
| OD8 | Open-drain output with 8mA sink |
| O12 | Output with 12mA sink and 12mA source |
| OD12 | Open-drain output with 12mA sink |
| PU | 50uA (typical) internal pull-up. Unless otherwise noted in the pin description, internal pull-ups are always enabled. Note: Internal pull-up resistors prevent unconnected inputs from floating. Do not rely on internal resistors to drive signals external to LAN9513/LAN9513i. When connected to a load that must be pulled high, an external resistor must be added. |
| PD | 50uA (typical) internal pull-down. Unless otherwise noted in the pin description, internal pull-downs are always enabled. Note: Internal pull-down resistors prevent unconnected inputs from floating. Do not rely on internal resistors to drive signals external to LAN9513/LAN9513i. When connected to a load that must be pulled low, an external resistor must be added. |
| AI | Analog input |
| AIO | Analog bi-directional |
| ICLK | Crystal oscillator input pin |
| OCLK | Crystal oscillator output pin |
| P | Power pin |

Chapter 3 EEPROM Controller (EPC)

LAN9513/LAN9513i may use an external EEPROM to store the default values for the USB descriptors and the MAC address. The EEPROM controller supports most “93C46” type EEPROMs. A total of nine address bits are used to support 256/512 byte EEPROMs.

Note: A 3-wire style 2K/4K EEPROM that is organized for 256/512 x 8-bit operation must be used.

The MAC address is used as the default Ethernet MAC address and is loaded into the MAC’s ADDRH and ADDRL registers. If a properly configured EEPROM is not detected, it is the responsibility of the Host LAN Driver to set the IEEE addresses.

After a system-level reset occurs, the device will load the default values from a properly configured EEPROM. The device will not accept USB transactions from the Host until this process is completed.

The EEPROM controller also allows the Host system to read, write and erase the contents of the Serial EEPROM.

3.1 EEPROM Format

Table 3.1 illustrates the format in which data is stored inside of the EEPROM.

Note the EEPROM offsets are given in units of 16-bit word offsets. A length field with a value of zero indicates that the field does not exist in the EEPROM. The device will use the field’s HW default value in this case.

Note: For Device Descriptors, the only valid values for the length are 0 and 18.

Note: For Configuration and Interface Descriptors, the only valid values for the length are 0 and 18.

Note: The EEPROM programmer must ensure that if a String Descriptor does not exist in the EEPROM, the referencing descriptor must contain 00h for the respective string index field.

Note: If no Configuration Descriptor is present in the EEPROM, then the Configuration Flags affect the values of bmAttributes and bMaxPower in the Ethernet Controller Configuration Descriptor.

Note: If all String Descriptor lengths are zero, then a Language ID will not be supported.

Table 3.1 EEPROM Format

| EEPROM ADDRESS | EEPROM CONTENTS |
|----------------|--|
| 00h | 0xA5 |
| 01h | MAC Address [7:0] |
| 02h | MAC Address [15:8] |
| 03h | MAC Address [23:16] |
| 04h | MAC Address [31:24] |
| 05h | MAC Address [39:32] |
| 06h | MAC Address [47:40] |
| 07h | Full-Speed Polling Interval for Interrupt Endpoint |
| 08h | Hi-Speed Polling Interval for Interrupt Endpoint |

Table 3.1 EEPROM Format (continued)

| EEPROM ADDRESS | EEPROM CONTENTS |
|----------------|--|
| 09h | Configuration Flags |
| 0Ah | Language ID Descriptor [7:0] |
| 0Bh | Language ID Descriptor [15:8] |
| 0Ch | Manufacturer ID String Descriptor Length (bytes) |
| 0Dh | Manufacturer ID String Descriptor EEPROM Word Offset |
| 0Eh | Product Name String Descriptor Length (bytes) |
| 0Fh | Product Name String Descriptor EEPROM Word Offset |
| 10h | Serial Number String Descriptor Length (bytes) |
| 11h | Serial Number String Descriptor EEPROM Word Offset |
| 12h | Configuration String Descriptor Length (bytes) |
| 13h | Configuration String Descriptor Word Offset |
| 14h | Interface String Descriptor Length (bytes) |
| 15h | Interface String Descriptor Word Offset |
| 16h | Hi-Speed Device Descriptor Length (bytes) |
| 17h | Hi-Speed Device Descriptor Word Offset |
| 18h | Hi-Speed Configuration and Interface Descriptor Length (bytes) |
| 19h | Hi-Speed Configuration and Interface Descriptor Word Offset |
| 1Ah | Full-Speed Device Descriptor Length (bytes) |
| 1Bh | Full-Speed Device Descriptor Word Offset |
| 1Ch | Full-Speed Configuration and Interface Descriptor Length (bytes) |
| 1Dh | Full-Speed Configuration and Interface Descriptor Word Offset |
| 1Eh-1Fh | RESERVED |
| 20h | Vendor ID LSB Register (VIDL) |
| 21h | Vendor ID MSB Register (VIDM) |
| 22h | Product ID LSB Register (PIDL) |
| 23h | Product ID MSB Register (PIDM) |
| 24h | Device ID LSB Register (DIDL) |
| 25h | Device ID MSB Register (DIDM) |
| 26h | Config Data Byte 1 Register (CFG1) |
| 27h | Config Data Byte 2 Register (CFG2) |
| 28h | Config Data Byte 3 Register (CFG3) |
| 29h | Non-Removable Devices Register (NRD) |

Table 3.1 EEPROM Format (continued)

| EEPROM ADDRESS | EEPROM CONTENTS |
|----------------|--|
| 2Ah | Port Disable (Self) Register (PDS) |
| 2Bh | Port Disable (Bus) Register (PDB) |
| 2Ch | Max Power (Self) Register (MAXPS) |
| 2Dh | Max Power (Bus) Register (MAXPB) |
| 2Eh | Hub Controller Max Current (Self) Register (HCMCS) |
| 2Fh | Hub Controller Max Current (Bus) Register (HCMCB) |
| 30h | Power-on Time Register (PWRT) |
| 31h | Boost_Up Register (BOOSTUP) |
| 32h | RESERVED |
| 33h | Boost_4:2 Register (BOOST42) |
| 34h | RESERVED |
| 35h | Port Swap Register (PRTSP) |
| 36h | Port Remap 12 Register (PRTR12) |
| 37h | Port Remap 34 Register (PRTR34) |
| 38h | RESERVED |
| 39h | Status/Command Register (STCD) |

Note: EEPROM byte addresses past 39h can be used to store data for any purpose.

[Table 3.2](#) describes the Configuration Flags

Table 3.2 Configuration Flags Description

| BIT | NAME | DESCRIPTION |
|-----|-----------------------|--|
| 7:3 | RESERVED | 00000b |
| 2 | Remote Wakeup Support | 0 = The device does not support remote wakeup. 1 = The device supports remote wakeup. |
| 1 | RESERVED | 0b |
| 0 | Power Method | 0 = The device Controller is bus powered. 1 = The device Controller is self powered. |

3.1.1 Hub Configuration

EEPROM offsets 20h through 39h comprise the Hub Configuration parameters. [Table 3.3](#) describes these parameters and their default ROM values (Values assumed if no valid EEPROM present).

Table 3.3 Hub Configuration

| EEPROM OFFSET | DESCRIPTION | DEFAULT |
|---------------|--|--------------------------|
| 20h | Vendor ID LSB Register (VIDL) Least Significant Byte of the Vendor ID. This is a 16-bit value that uniquely identifies the Vendor of the user device (assigned by USB-Interface Forum). | 24h |
| 21h | Vendor ID MSB Register (VIDM) Most Significant Byte of the Vendor ID. This is a 16-bit value that uniquely identifies the Vendor of the user device (assigned by USB-Interface Forum). | 04h |
| 22h | Product ID LSB Register (PIDL) Least Significant Byte of the Product ID. This is a 16-bit value that the Vendor can assign that uniquely identifies this particular product (assigned by the OEM). | 14h |
| 23h | Product ID MSB Register (PIDM) Most Significant Byte of the Product ID. This is a 16-bit value that the Vendor can assign that uniquely identifies this particular product (assigned by the OEM). | 95h |
| 24h | Device ID LSB Register (DIDL) Least Significant Byte of the Device ID. This is a 16-bit device release number in BCD format (assigned by the OEM). | 00h |
| 25h | Device ID MSB Register (DIDM) Most Significant Byte of the Device ID. This is a 16-bit device release number in BCD format (assigned by the OEM). | Note 3.1 |
| 26h | Config Data Byte 1 Register (CFG1) Refer to Table 3.4, "Config Data Byte 1 Register (CFG1) Format," on page 30 for details. | 9Bh |
| 27h | Config Data Byte 2 Register (CFG2) Refer to Table 3.5, "Config Data Byte 2 Register (CFG2) Format," on page 31 for details. | 18h |
| 28h | Config Data Byte 3 Register (CFG3) Refer to Table 3.6, "Config Data Byte 3 Register (CFG3) Format," on page 32 for details. | 00h |

Table 3.3 Hub Configuration (continued)

| EEPROM OFFSET | DESCRIPTION | DEFAULT |
|------------------|--|---------|
| 29h | <p>Non-Removable Devices Register (NRD) Indicates which port(s) include non-removable devices.</p> <p>0 = Port is removable 1 = Port is non-removable</p> <p>Informs the host if one of the active ports has a permanent device that is not detachable from the Hub.</p> <p>Note: The device must provide its own descriptor data.</p> <p>Bit 7 = RESERVED Bit 6 = RESERVED Bit 5 = RESERVED Bit 4 = 1; Port 4 non-removable Bit 3 = 1; Port 3 non-removable Bit 2 = 1; Port 2 non-removable Bit 1 = 1; Port 1 non-removable Bit 0 is RESERVED, always = 0b</p> <p>Note: Bit 1 must be set to 1 by firmware for proper identification of the Ethernet Controller as a non-removable device.</p> | 02h |
| 2Ah | <p>Port Disable (Self) Register (PDS) Disables 1 or more ports.</p> <p>0 = Port is available 1 = Port is disabled</p> <p>During Self-Powered operation, this selects the ports which will be permanently disabled, and are not available to be enabled or enumerated by a host controller. The ports can be disabled in any order, the internal logic will automatically report the correct number of enabled ports to the USB host, and will reorder the active ports in order to ensure proper function.</p> <p>Bit 7 = RESERVED Bit 6 = RESERVED Bit 5 = RESERVED Bit 4 = 1; Port 4 disabled Bit 3 = 1; Port 3 disabled Bit 2 = 1; Port 2 disabled Bit 1 = 1; Port 1 disabled Bit 0 is RESERVED, always = 0b</p> | 00h |
| 2Bh | <p>Port Disable (Bus) Register (PDB) Disables 1 or more ports.</p> <p>0 = Port is available 1 = Port is disabled</p> <p>During Bus-Powered operation, this selects the ports which will be permanently disabled, and are not available to be enabled or enumerated by a host controller. The ports can be disabled in any order, the internal logic will automatically report the correct number of enabled ports to the USB host, and will reorder the active ports in order to ensure proper function.</p> <p>Bit 7 = RESERVED Bit 6 = RESERVED Bit 5 = RESERVED Bit 4 = 1; Port 4 disabled Bit 3 = 1; Port 3 disabled Bit 2 = 1; Port 2 disabled Bit 1 = 1; Port 1 disabled Bit 0 is RESERVED, always = 0b</p> | 00h |

Table 3.3 Hub Configuration (continued)

| EEPROM OFFSET | DESCRIPTION | DEFAULT |
|------------------|--|---------|
| 2Ch | Max Power (Self) Register (MAXPS) Value in 2mA increments that the Hub consumes from an upstream port (VBUS) when operating as a self-powered hub. This value includes the hub silicon along with the combined power consumption (from VBUS) of all associated circuitry on the board. This value also includes the power consumption of a permanently attached peripheral if the hub is configured as a compound device, and the embedded peripheral reports 0mA in its descriptors. Note: The USB2.0 Specification does not permit this value to exceed 100mA. | 01h |
| 2Dh | Max Power (Bus) Register (MAXPB) Value in 2mA increments that the Hub consumes from an upstream port (VBUS) when operating as a bus-powered hub. This value includes the hub silicon along with the combined power consumption (from VBUS) of all associated circuitry on the board. This value also includes the power consumption of a permanently attached peripheral if the hub is configured as a compound device, and the embedded peripheral reports 0mA in its descriptors. | 00h |
| 2Eh | Hub Controller Max Current (Self) Register (HCMCS) Value in 2mA increments that the Hub consumes from an upstream port (VBUS) when operating as a self-powered hub. This value includes the hub silicon along with the combined power consumption (from VBUS) of all associated circuitry on the board. This value does NOT include the power consumption of a permanently attached peripheral if the hub is configured as a compound device. Note: The USB2.0 Specification does not permit this value to exceed 100mA. | 01h |
| 2Fh | Hub Controller Max Current (Bus) Register (HCMCB) Value in 2mA increments that the Hub consumes from an upstream port (VBUS) when operating as a bus-powered hub. This value includes the hub silicon along with the combined power consumption (from VBUS) of all associated circuitry on the board. This value does NOT include the power consumption of a permanently attached peripheral if the hub is configured as a compound device. | 00h |
| 30h | Power-on Time Register (PWRT) The length of time that it takes (in 2mS intervals) from the time the host initiated power-on sequence begins on a port until power is good on that port. System software uses this value to determine how long to wait before accessing a powered-on port. | 32h |
| 31h | Boost_Up Register (BOOSTUP) Refer to Table 3.7, "Boost_Up Register (BOOSTUP) Format," on page 32 for details. | 00h |
| 32h | RESERVED | 00h |
| 33h | Boost_4:2 Register (BOOST42) Refer to Table 3.8, "Boost_4:2 Register (BOOST42) Format," on page 32 for details. | 00h |
| 34h | RESERVED | 00h |

Table 3.3 Hub Configuration (continued)

| EEPROM OFFSET | DESCRIPTION | DEFAULT |
|------------------|---|---------|
| 35h | <p>Port Swap Register (PRTSP) Swaps the Upstream and Downstream USB DP and DM pins for ease of board routing to devices and connectors.</p> <p>0 = USB D+ functionality is associated with the DP pin and D- functionality is associated with the DM pin.</p> <p>1 = USB D+ functionality is associated with the DM pin and D- functionality is associated with the DP pin.</p> <p>Bit 7 = RESERVED Bit 6 = RESERVED Bit 5 = RESERVED Bit 4 = 1; Port 4 DP/DM is swapped Bit 3 = 1; Port 3 DP/DM is swapped Bit 2 = 1; Port 2 DP/DM is swapped Bit 1 = RESERVED Bit 0 = 1; Upstream Port DP/DM is swapped</p> | 00h |

Table 3.3 Hub Configuration (continued)

| EEPROM OFFSET | DESCRIPTION | DEFAULT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------|--|---|------|-----------------------------|--|------|---|--|------|---|--|------|---|--|------|---|--|--|---------------------|-------------|------|-----------------------------|--|------|---|--|------|---|--|------|---|--|------|---|--|--|---------------------|-----|
| 36h | <p>Port Remap 12 Register (PRTR12) When a hub is enumerated by a USB Host Controller, the hub is only permitted to report how many ports it has. The hub is not permitted to select a numerical range or assignment. The Host Controller will number the downstream ports of the hub starting with the number 1, up to the number of ports that the hub reported having.</p> <p>The host's port number is referred to as "Logical Port Number" and the physical port on the hub is the "Physical Port Number". When remapping mode is enabled, (see Port Re-Mapping Enable (PRTMAP_EN) bit in Config Data Byte 3 Register (CFG3 Format)) the hub's downstream port numbers can be remapped to different logical port numbers (assigned by the host).</p> <p>Note: The OEM must ensure that Contiguous Logical Port Numbers are used, starting from #1 up to the maximum number of enabled ports. This ensures that the hub's ports are numbered in accordance with the way a Host will communicate with the ports.</p> <table border="1" data-bbox="342 804 1154 1409"> <tbody> <tr> <td data-bbox="342 804 526 852">Bit [7:4] =</td> <td data-bbox="526 804 634 852">0000</td> <td data-bbox="634 804 1154 852">Physical Port 2 is Disabled</td> </tr> <tr> <td></td> <td data-bbox="526 852 634 900">0001</td> <td data-bbox="634 852 1154 900">Physical Port 2 is mapped to Logical Port 1</td> </tr> <tr> <td></td> <td data-bbox="526 900 634 949">0010</td> <td data-bbox="634 900 1154 949">Physical Port 2 is mapped to Logical Port 2</td> </tr> <tr> <td></td> <td data-bbox="526 949 634 997">0011</td> <td data-bbox="634 949 1154 997">Physical Port 2 is mapped to Logical Port 3</td> </tr> <tr> <td></td> <td data-bbox="526 997 634 1045">0100</td> <td data-bbox="634 997 1154 1045">Physical Port 2 is mapped to Logical Port 4</td> </tr> <tr> <td></td> <td data-bbox="526 1045 634 1094"></td> <td data-bbox="634 1045 1154 1094">All others RESERVED</td> </tr> <tr> <td data-bbox="342 1094 526 1142">Bit [3:0] =</td> <td data-bbox="526 1094 634 1142">0000</td> <td data-bbox="634 1094 1154 1142">Physical Port 1 is Disabled</td> </tr> <tr> <td></td> <td data-bbox="526 1142 634 1190">0001</td> <td data-bbox="634 1142 1154 1190">Physical Port 1 is mapped to Logical Port 1</td> </tr> <tr> <td></td> <td data-bbox="526 1190 634 1239">0010</td> <td data-bbox="634 1190 1154 1239">Physical Port 1 is mapped to Logical Port 2</td> </tr> <tr> <td></td> <td data-bbox="526 1239 634 1287">0011</td> <td data-bbox="634 1239 1154 1287">Physical Port 1 is mapped to Logical Port 3</td> </tr> <tr> <td></td> <td data-bbox="526 1287 634 1335">0100</td> <td data-bbox="634 1287 1154 1335">Physical Port 1 is mapped to Logical Port 4</td> </tr> <tr> <td></td> <td data-bbox="526 1335 634 1383"></td> <td data-bbox="634 1335 1154 1383">All others RESERVED</td> </tr> </tbody> </table> | Bit [7:4] = | 0000 | Physical Port 2 is Disabled | | 0001 | Physical Port 2 is mapped to Logical Port 1 | | 0010 | Physical Port 2 is mapped to Logical Port 2 | | 0011 | Physical Port 2 is mapped to Logical Port 3 | | 0100 | Physical Port 2 is mapped to Logical Port 4 | | | All others RESERVED | Bit [3:0] = | 0000 | Physical Port 1 is Disabled | | 0001 | Physical Port 1 is mapped to Logical Port 1 | | 0010 | Physical Port 1 is mapped to Logical Port 2 | | 0011 | Physical Port 1 is mapped to Logical Port 3 | | 0100 | Physical Port 1 is mapped to Logical Port 4 | | | All others RESERVED | 21h |
| Bit [7:4] = | 0000 | Physical Port 2 is Disabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0001 | Physical Port 2 is mapped to Logical Port 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0010 | Physical Port 2 is mapped to Logical Port 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0011 | Physical Port 2 is mapped to Logical Port 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0100 | Physical Port 2 is mapped to Logical Port 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | All others RESERVED | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit [3:0] = | 0000 | Physical Port 1 is Disabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0001 | Physical Port 1 is mapped to Logical Port 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0010 | Physical Port 1 is mapped to Logical Port 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0011 | Physical Port 1 is mapped to Logical Port 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0100 | Physical Port 1 is mapped to Logical Port 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | All others RESERVED | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 3.3 Hub Configuration (continued)

| EEPROM OFFSET | DESCRIPTION | DEFAULT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------|--|---|------|-----------------------------|--|------|---|--|------|---|--|------|---|--|------|---|--|--|---------------------|-------------|------|-----------------------------|--|------|---|--|------|---|--|------|---|--|------|---|--|--|---------------------|-----|
| 37h | <p>Port Remap 34 Register (PRTR34) When a hub is enumerated by a USB Host Controller, the hub is only permitted to report how many ports it has. The hub is not permitted to select a numerical range or assignment. The Host Controller will number the downstream ports of the hub starting with the number 1, up to the number of ports that the hub reported having.</p> <p>The host's port number is referred to as "Logical Port Number" and the physical port on the hub is the "Physical Port Number". When remapping mode is enabled (see Port Re-Mapping Enable (PRTMAP_EN) bit in Config Data Byte 3 Register (CFG3) Format), the hub's downstream port numbers can be remapped to different logical port numbers (assigned by the host).</p> <p>Note: The OEM must ensure that Contiguous Logical Port Numbers are used, starting from #1 up to the maximum number of enabled ports, this ensures that the hub's ports are numbered in accordance with the way a Host will communicate with the ports.</p> <table border="1" data-bbox="342 800 1154 1404"> <tbody> <tr> <td>Bit [7:4] =</td> <td>0000</td> <td>Physical Port 4 is Disabled</td> </tr> <tr> <td></td> <td>0001</td> <td>Physical Port 4 is mapped to Logical Port 1</td> </tr> <tr> <td></td> <td>0010</td> <td>Physical Port 4 is mapped to Logical Port 2</td> </tr> <tr> <td></td> <td>0011</td> <td>Physical Port 4 is mapped to Logical Port 3</td> </tr> <tr> <td></td> <td>0100</td> <td>Physical Port 4 is mapped to Logical Port 4</td> </tr> <tr> <td></td> <td></td> <td>All others RESERVED</td> </tr> <tr> <td>Bit [3:0] =</td> <td>0000</td> <td>Physical Port 3 is Disabled</td> </tr> <tr> <td></td> <td>0001</td> <td>Physical Port 3 is mapped to Logical Port 1</td> </tr> <tr> <td></td> <td>0010</td> <td>Physical Port 3 is mapped to Logical Port 2</td> </tr> <tr> <td></td> <td>0011</td> <td>Physical Port 3 is mapped to Logical Port 3</td> </tr> <tr> <td></td> <td>0100</td> <td>Physical Port 3 is mapped to Logical Port 4</td> </tr> <tr> <td></td> <td></td> <td>All others RESERVED</td> </tr> </tbody> </table> | Bit [7:4] = | 0000 | Physical Port 4 is Disabled | | 0001 | Physical Port 4 is mapped to Logical Port 1 | | 0010 | Physical Port 4 is mapped to Logical Port 2 | | 0011 | Physical Port 4 is mapped to Logical Port 3 | | 0100 | Physical Port 4 is mapped to Logical Port 4 | | | All others RESERVED | Bit [3:0] = | 0000 | Physical Port 3 is Disabled | | 0001 | Physical Port 3 is mapped to Logical Port 1 | | 0010 | Physical Port 3 is mapped to Logical Port 2 | | 0011 | Physical Port 3 is mapped to Logical Port 3 | | 0100 | Physical Port 3 is mapped to Logical Port 4 | | | All others RESERVED | 43h |
| Bit [7:4] = | 0000 | Physical Port 4 is Disabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0001 | Physical Port 4 is mapped to Logical Port 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0010 | Physical Port 4 is mapped to Logical Port 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0011 | Physical Port 4 is mapped to Logical Port 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0100 | Physical Port 4 is mapped to Logical Port 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | All others RESERVED | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit [3:0] = | 0000 | Physical Port 3 is Disabled | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0001 | Physical Port 3 is mapped to Logical Port 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0010 | Physical Port 3 is mapped to Logical Port 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0011 | Physical Port 3 is mapped to Logical Port 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0100 | Physical Port 3 is mapped to Logical Port 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | All others RESERVED | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38h | RESERVED | 00h | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 39h | Status/Command Register (STCD) Refer to Table 3.9, "Status/Command Register (STCD) Format," on page 33 for details. | 01h | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Note 3.1 Default value is dependent on device revision.

Table 3.4 Config Data Byte 1 Register (CFG1) Format

| BITS | DESCRIPTION | DEFAULT |
|------|--|---------|
| 7 | <p>Self or Bus Power (SELF_BUS_PWR) Selects between Self or Bus-Powered operation.</p> <p>0 = Bus-Powered 1 = Self-Powered</p> <p>The Hub is either Self-Powered (draws less than 2mA of upstream bus power) or Bus-Powered (limited to a 100mA maximum of upstream power prior to being configured by the host controller).</p> <p>When configured as a Bus-Powered device, the SMSC Hub consumes less than 100mA of current prior to being configured. After configuration, the Bus-Powered SMSC Hub (along with all associated hub circuitry, any embedded devices if part of a compound device, and 100mA per externally available downstream port) must consume no more than 500mA of upstream VBUS current. The current consumption is system dependent, and the OEM must ensure that the USB2.0 specifications are not violated.</p> <p>When configured as a Self-Powered device, <1mA of upstream VBUS current is consumed and all ports are available, with each port being capable of sourcing 500mA of current.</p> | 1b |
| 6 | RESERVED | 0b |
| 5 | <p>High Speed Disable (HS_DISABLE) Disables the capability to attach as either a High/Full-Speed device, and forces attachment as Full-Speed only (no High-Speed support).</p> <p>0 = High-/Full-Speed 1 = Full-Speed-Only (High-Speed disabled)</p> | 0b |
| 4 | <p>Multiple TT Enable (MTT_ENABLE) Enables one transaction translator per port operation.</p> <p>Selects between a mode where only one transaction translator is available for all ports (Single-TT), or each port gets a dedicated transaction translator (Multi-TT) {Note: The host may force Single-TT mode only}.</p> <p>0 = Single TT for all ports. 1 = One TT per port (multiple TT's supported)</p> | 1b |
| 3 | <p>EOP Disable (EOP_DISABLE) Disables EOP generation of EOF1 when in Full-Speed mode. During FS operation only, this permits the Hub to send EOP if no downstream traffic is detected at EOF1. See Section 11.3.1 of the USB 2.0 Specification for additional details.</p> <p>Note: Generation of an EOP at the EOF1 point may prevent a Host controller (operating in FS mode) from placing the USB bus in suspend.</p> <p>0 = An EOP is generated at the EOF1 point if no traffic is detected. 1 = EOP generation at EOF1 is disabled (note: this is normal USB operation).</p> <p>Note: This is a rarely used feature in the PC environment, existing drivers may not have been thoroughly debugged with this feature enabled. It is included because it is a permitted feature in Chapter 11 of the USB specification.</p> | 1b |

Table 3.4 Config Data Byte 1 Register (CFG1) Format (continued)

| BITS | DESCRIPTION | DEFAULT |
|------|---|---------|
| 2:1 | <p>Over Current Sense (CURRENT_SNS) Selects current sensing on a port-by-port basis, all ports ganged, or none (only for bus-powered hubs) The ability to support current sensing on a port or ganged basis is hardware implementation dependent.</p> <p>00 = Ganged sensing (all ports together) 01 = Individual port-by-port 1x = Over current sensing not supported (must only be used with Bus- Powered configurations!)</p> | 01b |
| 0 | <p>Port Power Switching (PORT_PWR) Enables power switching on all ports simultaneously (ganged), or port power is individually switched on and off on a port by port basis (individual). The ability to support power enabling on a port or ganged basis is hardware implementation dependent.</p> <p>0 = Ganged switching (all ports together) 1 = Individual port by port switching</p> | 1b |

Table 3.5 Config Data Byte 2 Register (CFG2) Format

| BITS | DESCRIPTION | DEFAULT |
|------|---|---------|
| 7:6 | RESERVED | 00b |
| 5:4 | <p>Over Current Timer (OC_TIMER) Over Current Timer delay</p> <p>00 = 50ns 01 = 100ns (This is the recommended value) 10 = 200ns 11 = 400ns</p> | 01b |
| 3 | <p>Compound Device (COMPOUND) Allows the OEM to indicate that the Hub is part of a compound (see the USB Specification for definition) device. The applicable port(s) must also be defined as having a "Non-Removable Device".</p> <p>0 = No 1 = Yes, Hub is part of a compound device</p> | 1b |
| 2:0 | RESERVED | 000b |

Table 3.6 Config Data Byte 3 Register (CFG3) Format

| BITS | DESCRIPTION | DEFAULT |
|-------------|---|----------------|
| 7:4 | RESERVED | 0h |
| 3 | <p>Port Re-Mapping Enable (PRTMAP_EN) Selects the method used by the Hub to assign port numbers and disable ports.</p> <p>0 = Standard Mode. The following EEPROM addresses are used to define which ports are enabled. The ports mapped as Port'n' on the Hub are reported as Port'n' to the host, unless one of the ports is disabled, then the higher numbered ports are remapped in order to report contiguous port numbers to the host.</p> <p>EEPROM Address 2Ah: Port Disable for Self-Powered operation EEPROM Address 2Bh: Port Disable for Bus-Powered operation</p> <p>1 = Port Re-Map mode. The mode enables remapping via the following EEPROM addresses:</p> <p>EEPROM Address 36h: Port Remap 12 EEPROM Address 37h: Port Remap 34</p> | 0b |
| 2:0 | RESERVED | 000b |

Table 3.7 Boost_Up Register (BOOSTUP) Format

| BITS | DESCRIPTION | DEFAULT |
|-------------|--|----------------|
| 7:2 | RESERVED | 000000b |
| 1:0 | <p>Upstream USB Electrical Signaling Drive Strength Boost Bit for Upstream Port A (BOOST_IOUT_A)</p> <p>00 = Normal electrical drive strength 01 = Elevated electrical drive strength (+4% boost) 10 = Elevated electrical drive strength (+8% boost) 11 = Elevated electrical drive strength (+12% boost)</p> | 00b |

Table 3.8 Boost_4:2 Register (BOOST42) Format

| BITS | DESCRIPTION | DEFAULT |
|-------------|--|----------------|
| 7:6 | <p>Upstream USB Electrical Signaling Drive Strength Boost Bit for Downstream Port 4 (BOOST_IOUT_4)</p> <p>00 = Normal electrical drive strength 01 = Elevated electrical drive strength (+4% boost) 10 = Elevated electrical drive strength (+8% boost) 11 = Elevated electrical drive strength (+12% boost)</p> | 00b |

Table 3.8 Boost_4:2 Register (BOOST42) Format (continued)

| BITS | DESCRIPTION | DEFAULT |
|------|---|---------|
| 5:4 | Upstream USB Electrical Signaling Drive Strength Boost Bit for Downstream Port 3 (BOOST_IOUT_3) 00 = Normal electrical drive strength 01 = Elevated electrical drive strength (+4% boost) 10 = Elevated electrical drive strength (+8% boost) 11 = Elevated electrical drive strength (+12% boost) | 00b |
| 3:2 | Upstream USB Electrical Signaling Drive Strength Boost Bit for Downstream Port 2 (BOOST_IOUT_2) 00 = Normal electrical drive strength 01 = Elevated electrical drive strength (+4% boost) 10 = Elevated electrical drive strength (+8% boost) 11 = Elevated electrical drive strength (+12% boost) | 00b |
| 1:0 | RESERVED | 00b |

Table 3.9 Status/Command Register (STCD) Format

| BITS | DESCRIPTION | DEFAULT |
|------|---|---------|
| 7:2 | RESERVED | 000000b |
| 1 | Reset (RESET) Resets the internal memory back to nRESET assertion default settings. 0 = Normal Run/Idle State 1 = Force a reset of the registers to their default state Note: During this reset, this bit is automatically cleared to its default value of 0. | 0b |
| 0 | USB Attach and Write Protect (USB_ATTACH) 0 = Device is in configuration state 1 = Hub will signal a USB attach event to an upstream device, and the internal memory (address range 00h - FEh) is "write-protected" to prevent unintentional data corruption. Note: This bit is write once and is only cleared by assertion of the external nRESET or POR. | 1b |

3.2 EEPROM Defaults

The signature value of 0xA5 is stored at address 0. A different signature value indicates to the EEPROM controller that no EEPROM or an un-programmed EEPROM is attached to the device. In this case, the hardware default values are used, as shown in [Table 3.10](#).

Table 3.10 EEPROM Defaults

| FIELD | DEFAULT VALUE |
|--|---------------|
| Ethernet Controller MAC Address | FFFFFFFFFFFFh |
| Ethernet Controller Full-Speed Polling Interval (mS) | 01h |
| Ethernet Controller Hi-Speed Polling Interval (mS) | 04h |
| Ethernet Controller Configuration Flags | 05h |
| Ethernet Controller Maximum Power (mA) | 01h |
| Ethernet Controller Vendor ID | 0424h |
| Ethernet Controller Product ID | EC00h |

3.3 EEPROM Auto-Load

Certain system level resets (USB reset, POR, nRESET, and SRST) cause the EEPROM contents to be loaded into the device. After a reset, the EEPROM controller attempts to read the first byte of data from the EEPROM. If the value 0xA5 is read from the first address, then the EEPROM controller will assume that the external Serial EEPROM is configured for auto-loading. If a value other than 0xA5 is read from the first address, the EEPROM auto-load will not commence.

Note: The EEPROM contents are loaded for both the Hub and the Ethernet Controller as a result of a POR or nRESET. The USB reset results only in the loading of the MAC address from the EEPROM. A software reset (SRST) or a EEPROM Reload Command causes the EEPROM contents related solely to the Ethernet Controller to be loaded.

3.4 An Example of EEPROM Format Interpretation

Table 3.11 and Table 3.12 provide an example of how the contents of a EEPROM are formatted. Table 3.11 is a dump of the EEPROM memory (256-byte EEPROM), while Table 3.12 illustrates, byte by byte, how the EEPROM is formatted.

Table 3.11 Dump of EEPROM Memory

| OFFSET BYTE | VALUE |
|----------------|-------------------------|
| 0000h | A5 12 34 56 78 9A BC 01 |
| 0008h | 04 05 09 04 0A 1D 00 00 |
| 0010h | 00 00 00 00 00 00 12 22 |
| 0018h | 12 2B 12 34 12 3D 00 00 |
| 0020h | 24 04 13 95 00 01 9B 18 |
| 0028h | 00 02 20 20 01 00 01 00 |
| 0030h | 32 00 00 00 00 00 21 43 |
| 0038h | 00 01 0A 03 53 00 4D 00 |
| 0040h | 53 00 43 00 12 01 00 02 |
| 0048h | FF 00 01 40 24 04 00 EC |
| 0050h | 00 01 01 00 00 01 09 02 |
| 0058h | 27 00 01 01 00 E0 01 09 |
| 0060h | 04 00 00 03 FF 00 FF 00 |
| 0068h | 12 01 00 02 FF 00 FF 40 |
| 0070h | 24 04 00 EC 00 01 01 00 |
| 0078h | 00 01 09 02 27 00 01 01 |
| 0080h | 00 E0 01 09 04 00 00 03 |
| 0088h | FF 00 FF 00 |
| 0090h - 00FFh | |

Table 3.12 EEPROM Example - 256 Byte EEPROM

| EEPROM ADDRESS | EEPROM CONTENTS (HEX) | DESCRIPTION |
|-----------------------|------------------------------|--|
| 00h | A5 | EEPROM Programmed Indicator |
| 01h-06h | 12 34 56 78 9A BC | MAC Address 12 34 56 78 9A BC |
| 07h | 01 | Full-Speed Polling Interval for Interrupt Endpoint (1ms) |
| 08h | 04 | Hi-Speed Polling Interval for Interrupt Endpoint (4ms) |
| 09h | 05 | Configuration Flags - The device is self powered and supports remote wakeup. |
| 0Ah-0Bh | 09 04 | Language ID Descriptor 0409h, English |
| 0Ch | 0A | Manufacturer ID String Descriptor Length (10 bytes) |
| 0Dh | 1D | Manufacturer ID String Descriptor EEPROM Word Offset (1Dh) Corresponds to EEPROM Byte Offset 3Ah |
| 0Eh | 00 | Product Name String Descriptor Length (0 bytes - NA) |
| 0Fh | 00 | Product Name String Descriptor EEPROM Word Offset (Don't Care) |
| 10h | 00 | Serial Number String Descriptor Length (0 bytes - NA) |
| 11h | 00 | Serial Number String Descriptor EEPROM Word Offset (Don't Care) |
| 12h | 00 | Configuration String Descriptor Length (0 bytes - NA) |
| 13h | 00 | Configuration String Descriptor Word Offset (Don't Care) |
| 14h | 00 | Interface String Descriptor Length (0 bytes - NA) |
| 15h | 00 | Interface String Descriptor Word Offset (Don't Care) |
| 16h | 12 | Hi-Speed Device Descriptor Length (18 bytes) |
| 17h | 22h | Hi-Speed Device Descriptor Word Offset (22h) Corresponds to EEPROM Byte Offset 44h |
| 18h | 12 | Hi-Speed Configuration and Interface Descriptor Length (18 bytes) |
| 19h | 2B | Hi-Speed Configuration and Interface Descriptor Word Offset (2Bh) Corresponds to EEPROM Byte Offset 56h |
| 1Ah | 12 | Full-Speed Device Descriptor Length (18 bytes) |
| 1Bh | 34 | Full-Speed Device Descriptor Word Offset (34h) Corresponds to EEPROM Byte Offset 68h |
| 1Ch | 12 | Full-Speed Configuration and Interface Descriptor Length (18bytes) |
| 1Dh | 3D | Full-Speed Configuration and Interface Descriptor Word Offset (3Dh) Corresponds to EEPROM Byte Offset 7Ah |
| 1Eh | 00 | RESERVED |
| 1Fh | 00 | RESERVED |
| 20h | 24 | Vendor ID LSB Register (VIDL) |

Table 3.12 EEPROM Example - 256 Byte EEPROM (continued)

| EEPROM ADDRESS | EEPROM CONTENTS (HEX) | DESCRIPTION |
|----------------|-------------------------|--|
| 21h | 04 | Vendor ID MSB Register (VIDM) |
| 22h | 13 | Product ID LSB Register (PIDL) |
| 23h | 95 | Product ID MSB Register (PIDM) |
| 24h | 00 | Device ID LSB Register (DIDL) |
| 25h | 01 | Device ID MSB Register (DIDM) |
| 26h | 9B | Config Data Byte 1 Register (CFG1) |
| 27h | 18 | Config Data Byte 2 Register (CFG2) |
| 28h | 00 | Config Data Byte 3 Register (CFG3) |
| 29h | 02 | Non-Removable Devices Register (NRD) |
| 2Ah | 20 | Port Disable (Self) Register (PDS) |
| 2Bh | 20 | Port Disable (Bus) Register (PDB) |
| 2Ch | 01 | Max Power (Self) Register (MAXPS) |
| 2Dh | 00 | Max Power (Bus) Register (MAXPB) |
| 2Eh | 01 | Hub Controller Max Current (Self) Register (HCMCS) |
| 2Fh | 00 | Hub Controller Max Current (Bus) Register (HCMCB) |
| 30h | 32 | Power-on Time Register (PWRT) |
| 31h | 00 | Boost_Up Register (BOOSTUP) |
| 32h | 00 | RESERVED |
| 33h | 00 | Boost_2 Register (BOOST2) |
| 34h | 00 | RESERVED |
| 35h | 00 | Port Swap Register (PRTSP) |
| 36h | 21 | Port Remap 12 Register (PRTR12) |
| 37h | 43 | Port Remap 34 Register (PRTR34) |
| 38h | 00 | RESERVED |
| 39h | 01 | Status/Command Register (STCD) |
| 3A | 0A | Size of Manufacturer ID String Descriptor (10 bytes) |
| 3Bh | 03 | Descriptor Type (String Descriptor - 03h) |
| 3Ch-43h | 53 00 4D 00 53 00 43 00 | Manufacturer ID String ("SMSC" in UNICODE) |
| 44h | 12 | Size of Hi-Speed Device Descriptor in Bytes (18 bytes) |
| 45h | 01 | Descriptor Type (Device Descriptor - 01h) |
| 46h-47h | 00 02 | USB Specification Number that the device complies with (0200h) |

Table 3.12 EEPROM Example - 256 Byte EEPROM (continued)

| EEPROM ADDRESS | EEPROM CONTENTS (HEX) | DESCRIPTION |
|-----------------------|------------------------------|--|
| 48h | FF | Class Code |
| 49h | 00 | Subclass Code |
| 4Ah | FF | Protocol Code |
| 4Bh | 40 | Maximum Packet Size for Endpoint 0 |
| 4Ch-4Dh | 24 04 | Vendor ID (0424h) |
| 4Eh-4Fh | 00 EC | Product ID (EC00h) |
| 50h-51h | 00 01 | Device Release Number (0100h) |
| 52h | 01 | Index of Manufacturer String Descriptor |
| 53h | 00 | Index of Product String Descriptor |
| 54h | 00 | Index of Serial Number String Descriptor |
| 55h | 01 | Number of Possible Configurations |
| 56h | 09 | Size of Hi-Speed Configuration Descriptor in bytes (9 bytes) |
| 57h | 02 | Descriptor Type (Configuration Descriptor - 02h) |
| 58h-59h | 27 00 | Total length in bytes of data returned (0027h = 39 bytes) |
| 5Ah | 01 | Number of Interfaces |
| 5Bh | 01 | Value to use as an argument to select this configuration |
| 5Ch | 00 | Index of String Descriptor describing this configuration |
| 5Dh | E0 | Self powered and remote wakeup enabled |
| 5Eh | 01 | Maximum Power Consumption is 2 mA |
| 5Fh | 09 | Size of Descriptor in Bytes (9 Bytes) |
| 60h | 04 | Descriptor Type (Interface Descriptor - 04h) |
| 61h | 00 | Number identifying this Interface |
| 62h | 00 | Value used to select alternative setting |
| 63h | 03 | Number of Endpoints used for this interface (Less endpoint 0) |
| 64h | FF | Class Code |
| 65h | 00 | Subclass Code |
| 66h | FF | Protocol Code |
| 67h | 00 | Index of String Descriptor Describing this interface |
| 68h | 12 | Size of Full-Speed Device Descriptor in Bytes (18 Bytes) |
| 69h | 01 | Descriptor Type (Device Descriptor - 01h) |
| 6Ah-6Bh | 00 02 | USB Specification Number that the device complies with (0200h) |

Table 3.12 EEPROM Example - 256 Byte EEPROM (continued)

| EEPROM ADDRESS | EEPROM CONTENTS (HEX) | DESCRIPTION |
|----------------|-----------------------|--|
| 6Ch | FF | Class Code |
| 6Dh | 00 | Subclass Code |
| 6Eh | FF | Protocol Code |
| 6Fh | 40 | Maximum Packet Size for Endpoint 0 |
| 70h-71h | 24 04 | Vendor ID (0424h) |
| 72h-73h | 00 EC | Product ID (EC00h) |
| 74h-75h | 00 01 | Device Release Number (0100h) |
| 76 | 01 | Index of Manufacturer String Descriptor |
| 77h | 00 | Index of Product String Descriptor |
| 78h | 00 | Index of Serial Number String Descriptor |
| 79h | 01 | Number of Possible Configurations |
| 7Ah | 09 | Size of Full-Speed Configuration Descriptor in bytes (9 bytes) |
| 7Bh | 02 | Descriptor Type (Configuration Descriptor - 02h) |
| 7Ch-7Dh | 27 00 | Total length in bytes of data returned (0027h = 39 bytes) |
| 7Eh | 01 | Number of Interfaces |
| 7Fh | 01 | Value to use as an argument to select this configuration |
| 80h | 00 | Index of String Descriptor describing this configuration |
| 81h | E0 | Self powered and remote wakeup enabled |
| 82h | 01 | Maximum Power Consumption is 2 mA |
| 83h | 09 | Size of Full-Speed Interface Descriptor in Bytes (9 Bytes) |
| 84h | 04 | Descriptor Type (Interface Descriptor - 04h) |
| 85h | 00 | Number identifying this Interface |
| 86h | 00 | Value used to select alternative setting |
| 87h | 03 | Number of Endpoints used for this interface (Less endpoint 0) |
| 88h | FF | Class Code |
| 89h | 00 | Subclass Code |
| 8Ah | FF | Protocol Code |
| 8Bh | 00 | Index of String Descriptor describing this interface |
| 8Ch-FFh | - | Data storage for use by Host as desired |

Chapter 4 Operational Characteristics

4.1 Absolute Maximum Ratings*

| | |
|--|--------------------------------|
| Supply Voltage (VDD33IO, VDD33A) (Note 4.1) | 0V to +3.6V |
| Positive voltage on signal pins, with respect to ground (Note 4.2) | +6V |
| Negative voltage on signal pins, with respect to ground (Note 4.3) | -0.5V |
| Positive voltage on XI, with respect to ground | +4.6V |
| Positive voltage on XO, with respect to ground | +2.5V |
| Ambient Operating Temperature in Still Air (T_A) | Note 4.4 |
| Storage Temperature | -55°C to +150°C |
| Lead Temperature Range | Refer to JEDEC Spec. J-STD-020 |
| HBM ESD Performance per JESD 22-A114-E | +/- 8kV |
| Contact Discharge ESD Performance per IEC61000-4-2 (Note 4.5) | +/- 8kV |
| Air-Gap Discharge ESD Performance per IEC61000-4-2 (Note 4.5) | +/- 15kV |
| Latch-up Performance per EIA/JESD 78 | +/- 200mA |

Note 4.1 When powering this device from laboratory or system power supplies, it is important that the absolute maximum ratings not be exceeded or device failure can result. Some power supplies exhibit voltage spikes on their outputs when AC power is switched on or off. In addition, voltage transients on the AC power line may appear on the DC output. If this possibility exists, it is suggested that a clamp circuit be used.

Note 4.2 This rating does not apply to the following pins: XI, XO, EXRES, USBRBIAS.

Note 4.3 This rating does not apply to the following pins: EXRES, USBRBIAS.

Note 4.4 0°C to +70°C for commercial version, -40°C to +85°C for industrial version.

Note 4.5 Performed by independent 3rd party test facility.

*Stresses exceeding those listed in this section could cause permanent damage to the device. This is a stress rating only. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Functional operation of the device at any condition exceeding those indicated in Section 4.2, "Operating Conditions**", Section 4.4, "DC Specifications", or any other applicable section of this specification is not implied. Note, device signals are *NOT* 5 volt tolerant unless specified otherwise.

4.2 Operating Conditions**

| | |
|--|-----------------|
| Supply Voltage (VDD33A, VDD33BIAS, VDD33IO) | +3.3V +/- 300mV |
| Ambient Operating Temperature in Still Air (T_A) | Note 4.4 |

**Proper operation of LAN9513/LAN9513i is guaranteed only within the ranges specified in this section.

4.3 Power Consumption

This section details the power consumption of the device as measured during various modes of operation. Power dissipation is determined by temperature, supply voltage, and external source/sink requirements.

4.3.1 SUSPEND0

Table 4.1 SUSPEND0 Current Consumption and Power Dissipation (VDD33IO = VDD33A = 3.3V)

| PARAMETER | MIN | TYPICAL | MAX | UNIT |
|--|-----|---------|-----|------|
| Supply current (VDD33IO, VDD33A) | | 74 | | mA |
| Power Dissipation (Device Only) | | 245 | | mW |
| Power Dissipation (Device and Ethernet components) | | 379 | | mW |

4.3.2 SUSPEND1

Table 4.2 SUSPEND1 Current Consumption and Power Dissipation (VDD33IO = VDD33A = 3.3V)

| PARAMETER | MIN | TYPICAL | MAX | UNIT |
|--|-----|---------|-----|------|
| Supply current (VDD33IO, VDD33A) | | 68 | | mA |
| Power Dissipation (Device Only) | | 224 | | mW |
| Power Dissipation (Device and Ethernet components) | | 229 | | mW |

4.3.3 SUSPEND2

Table 4.3 SUSPEND2 Current Consumption and Power Dissipation (VDD33IO = VDD33A = 3.3V)

| PARAMETER | MIN | TYPICAL | MAX | UNIT |
|--|-----|---------|-----|------|
| Supply current (VDD33IO, VDD33A) | | 4.2 | | mA |
| Power Dissipation (Device Only) | | 14.0 | | mW |
| Power Dissipation (Device and Ethernet components) | | 14.1 | | mW |

4.3.4 Operational Current Consumption & Power Dissipation

Table 4.4 Operational Current Consumption & Power Dissipation (VDD33IO = VDD33A = 3.3V)

| PARAMETER | MIN | TYPICAL | MAX | UNIT |
|--|-----|---------|-----|------|
| 100BASE-TX Full Duplex (USB High-Speed) | | | | |
| Supply current (VDD33IO, VDD33A) | | 260 | | mA |
| Power Dissipation (Device Only) | | 857 | | mW |
| 10BASE-T Full Duplex (USB High-Speed) | | | | |
| Supply current (VDD33IO, VDD33A) | | 216 | | mA |
| Power Dissipation (Device Only) | | 712 | | mW |
| 10BASE-T Full Duplex (USB Full-Speed) | | | | |
| Supply current (VDD33IO, VDD33A) | | 166 | | mA |
| Power Dissipation (Device Only) | | 548 | | mW |

Note: All values measured with maximum simultaneous traffic on the Ethernet port and all USB ports.

Note: Magnetic power consumption:

- 100BASE-TX: ~42mA
- 10BASE-T: ~104mA

4.4 DC Specifications

Table 4.5 I/O Buffer Characteristics

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|--|-----------|-----------------|------|------|-------|--------------------|
| IS Type Input Buffer | | | | | | |
| Low Input Level | V_{ILI} | -0.3 | | | V | |
| High Input Level | V_{IHI} | | | 3.6 | V | |
| Negative-Going Threshold | V_{ILT} | 1.01 | 1.18 | 1.35 | V | Schmitt trigger |
| Positive-Going Threshold | V_{IHT} | 1.39 | 1.6 | 1.8 | V | Schmitt trigger |
| SchmittTrigger Hysteresis ($V_{IHT} - V_{ILT}$) | V_{HYS} | 345 | 420 | 485 | mV | |
| Input Leakage ($V_{IN} = VSS$ or $VDD33IO$) | I_{IH} | -10 | | 10 | uA | Note 4.6 |
| Input Capacitance | C_{IN} | | | 2.5 | pF | |
| IS_5V Type Input Buffer | | | | | | |
| Low Input Level | V_{ILI} | -0.3 | | | V | |
| High Input Level | V_{IHI} | | | 5.5 | V | |
| Negative-Going Threshold | V_{ILT} | 1.01 | 1.18 | 1.35 | V | Schmitt trigger |
| Positive-Going Threshold | V_{IHT} | 1.39 | 1.6 | 1.8 | V | Schmitt trigger |
| SchmittTrigger Hysteresis ($V_{IHT} - V_{ILT}$) | V_{HYS} | 345 | 420 | 485 | mV | |
| Input Leakage ($V_{IN} = VSS$ or $VDD33IO$) | I_{IH} | -10 | | 10 | uA | Note 4.6 |
| Input Leakage ($V_{IN} = 5.5V$) | I_{IH} | | | 120 | uA | Note 4.6, Note 4.7 |
| Input Capacitance | C_{IN} | | | 3.5 | pF | |
| O8 Type Buffers | | | | | | |
| Low Output Level | V_{OL} | | | 0.4 | V | $I_{OL} = 8mA$ |
| High Output Level | V_{OH} | $VDD33IO - 0.4$ | | | V | $I_{OH} = -8mA$ |
| OD8 Type Buffer | | | | | | |
| Low Output Level | V_{OL} | | | 0.4 | V | $I_{OL} = 8mA$ |
| O12 Type Buffers | | | | | | |
| Low Output Level | V_{OL} | | | 0.4 | V | $I_{OL} = 12mA$ |
| High Output Level | V_{OH} | $VDD33IO - 0.4$ | | | V | $I_{OH} = -12mA$ |
| OD12 Type Buffer | | | | | | |
| Low Output Level | V_{OL} | | | 0.4 | V | $I_{OL} = 12mA$ |
| ICLK Type Buffer (XI Input) | | | | | | |
| Low Input Level | V_{ILI} | -0.3 | | 0.5 | V | Note 4.8 |
| High Input Level | V_{IHI} | 1.4 | | 3.6 | V | |

Note 4.6 This specification applies to all inputs and tri-stated bi-directional pins. Internal pull-down and pull-up resistors add +/- 50uA per-pin (typical).

Note 4.7 This is the total 5.5V input leakage for the entire device.

Note 4.8 XI can optionally be driven from a 25MHz single-ended clock oscillator.

Table 4.6 100BASE-TX Transceiver Characteristics

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|---------------------------------------|-----------|------|-----|-------|-------|---------------------------|
| Peak Differential Output Voltage High | V_{PPH} | 950 | - | 1050 | mVpk | Note 4.9 |
| Peak Differential Output Voltage Low | V_{PPL} | -950 | - | -1050 | mVpk | Note 4.9 |
| Signal Amplitude Symmetry | V_{SS} | 98 | - | 102 | % | Note 4.9 |
| Signal Rise and Fall Time | T_{RF} | 3.0 | - | 5.0 | nS | Note 4.9 |
| Rise and Fall Symmetry | T_{RFS} | - | - | 0.5 | nS | Note 4.9 |
| Duty Cycle Distortion | D_{CD} | 35 | 50 | 65 | % | Note 4.10 |
| Overshoot and Undershoot | V_{OS} | - | - | 5 | % | |
| Jitter | | | | 1.4 | nS | Note 4.11 |

Note 4.9 Measured at line side of transformer, line replaced by 100Ω (+/- 1%) resistor.

Note 4.10 Offset from 16nS pulse width at 50% of pulse peak.

Note 4.11 Measured differentially.

Table 4.7 10BASE-T Transceiver Characteristics

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|--|-----------|-----|-----|-----|-------|---------------------------|
| Transmitter Peak Differential Output Voltage | V_{OUT} | 2.2 | 2.5 | 2.8 | V | Note 4.12 |
| Receiver Differential Squelch Threshold | V_{DS} | 300 | 420 | 585 | mV | |

Note 4.12 Min/max voltages guaranteed as measured with 100Ω resistive load.

4.5 AC Specifications

This section details the various AC timing specifications of the LAN9513/LAN9513i.

Note: The USBDP and USBDM pin timing adheres to the USB 2.0 specification. Refer to the Universal Serial Bus Revision 2.0 specification for detailed USB timing information.

4.5.1 Equivalent Test Load

Output timing specifications assume the 25pF equivalent test load illustrated in [Figure 4.1](#) below.

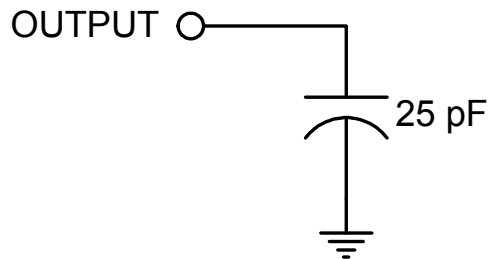


Figure 4.1 Output Equivalent Test Load

4.5.2 Reset Timing

The nRESET pin input assertion time must be a minimum of 1 μ S. Assertion of nRESET is not a requirement. However, if used, it must be asserted for the minimum period specified.

4.5.3 EEPROM Timing

The following specifies the EEPROM timing requirements for LAN9513/LAN9513i:

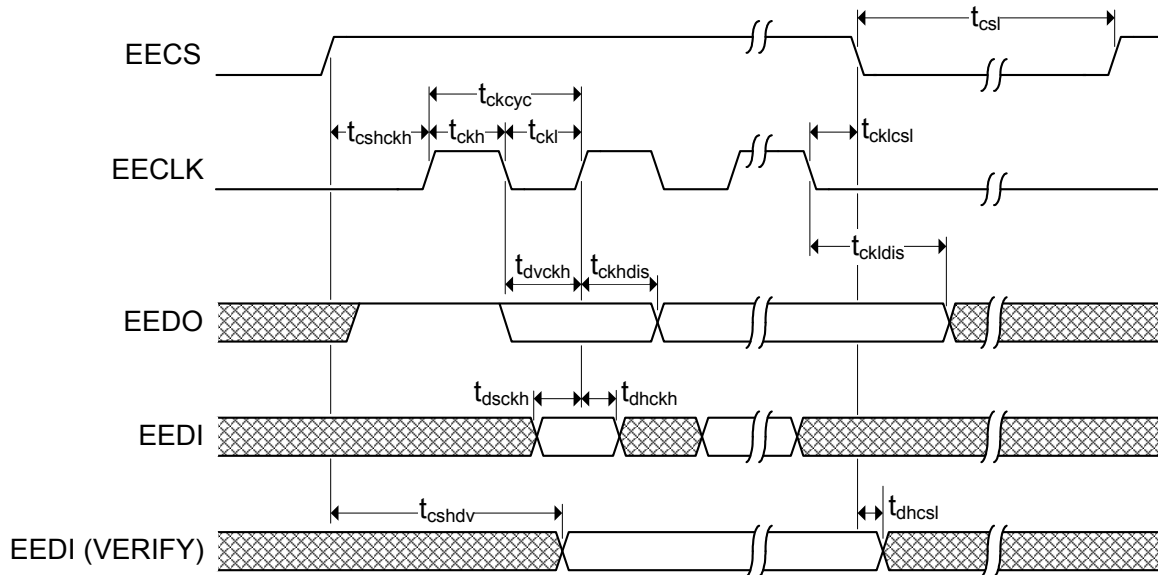


Figure 4.2 EEPROM Timing

Table 4.8 EEPROM Timing Values

| SYMBOL | DESCRIPTION | MIN | TYP | MAX | UNITS |
|--------------|--|------|-----|------|-------|
| t_{ckcyc} | EECLK Cycle time | 1110 | | 1130 | ns |
| t_{ckh} | EECLK High time | 550 | | 570 | ns |
| t_{ckl} | EECLK Low time | 550 | | 570 | ns |
| t_{cshckh} | EECS high before rising edge of EECLK | 1070 | | | ns |
| t_{cklcsl} | EECLK falling edge to EECS low | 30 | | | ns |
| t_{dvckh} | EEDO valid before rising edge of EECLK | 550 | | | ns |
| t_{ckhdis} | EEDO disable after rising edge EECLK | 550 | | | ns |
| t_{dsckh} | EEDI setup to rising edge of EECLK | 90 | | | ns |
| t_{dhckh} | EEDI hold after rising edge of EECLK | 0 | | | ns |
| t_{ckldis} | EECLK low to data disable (OUTPUT) | 580 | | | ns |
| t_{cshdv} | EEDIO valid after EECS high (VERIFY) | | | 600 | ns |
| t_{dhcsl} | EEDIO hold after EECS low (VERIFY) | 0 | | | ns |
| t_{csl} | EECS low | 1070 | | | ns |

4.5.4 JTAG Timing

This section specifies the JTAG timing of the device.

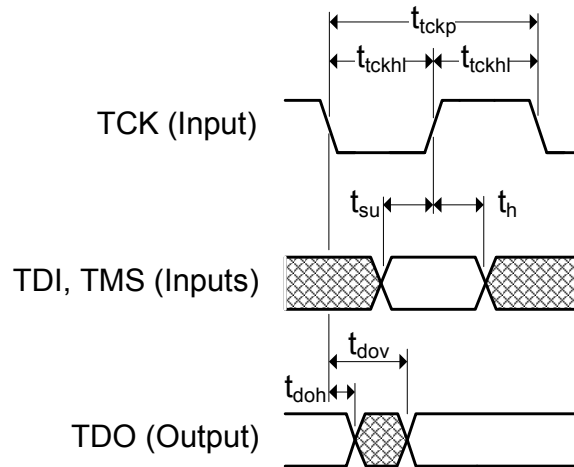


Figure 4.3 JTAG Timing

Table 4.9 JTAG Timing Values

| SYMBOL | DESCRIPTION | MIN | MAX | UNITS | NOTES |
|-------------|--|------------------|------------------|-------|-------|
| t_{tckp} | TCK clock period | 66.67 | | ns | |
| t_{tckhl} | TCK clock high/low time | $t_{tckp} * 0.4$ | $t_{tckp} * 0.6$ | ns | |
| t_{su} | TDI, TMS setup to TCK rising edge | 10 | | ns | |
| t_h | TDI, TMS hold from TCK rising edge | 10 | | ns | |
| t_{dov} | TDO output valid from TCK falling edge | | 16 | ns | |
| t_{doh} | TDO output hold from TCK falling edge | 0 | | ns | |

4.6 Clock Circuit

LAN9513/LAN9513i can accept either a 25MHz crystal (preferred) or a 25MHz single-ended clock oscillator (+/- 50ppm) input. If the single-ended clock oscillator method is implemented, XO should be left unconnected and XI should be driven with a nominal 0-3.3V clock signal. The input clock duty cycle is 40% minimum, 50% typical and 60% maximum.

It is recommended that a crystal utilizing matching parallel load capacitors be used for the crystal input/output signals (XI/XO). See [Table 4.10](#) for the recommended crystal specifications.

Table 4.10 LAN9513/LAN9513i Crystal Specifications

| PARAMETER | SYMBOL | MIN | NOM | MAX | UNITS | NOTES |
|-------------------------------------|------------------------|---------------------------|-----------|---------------------------|-------|---------------------------|
| Crystal Cut | AT, typ | | | | | |
| Crystal Oscillation Mode | Fundamental Mode | | | | | |
| Crystal Calibration Mode | Parallel Resonant Mode | | | | | |
| Frequency | F_{fund} | - | 25.000 | - | MHz | |
| Frequency Tolerance @ 25°C | F_{tol} | - | - | +/-50 | PPM | Note 4.13 |
| Frequency Stability Over Temp | F_{temp} | - | - | +/-50 | PPM | Note 4.13 |
| Frequency Deviation Over Time | F_{age} | - | +/-3 to 5 | - | PPM | Note 4.14 |
| Total Allowable PPM Budget | | - | - | +/-50 | PPM | Note 4.15 |
| Shunt Capacitance | C_O | - | 7 typ | - | pF | |
| Load Capacitance | C_L | - | 20 typ | - | pF | |
| Drive Level | P_W | 300 | - | - | uW | |
| Equivalent Series Resistance | R_1 | - | - | 50 | Ohm | |
| Operating Temperature Range | | Note 4.16 | - | Note 4.17 | °C | |
| LAN9513/LAN9513i XI Pin Capacitance | | - | 3 typ | - | pF | Note 4.18 |
| LAN9513/LAN9513i XO Pin Capacitance | | - | 3 typ | - | pF | Note 4.18 |

Note 4.13 The maximum allowable values for Frequency Tolerance and Frequency Stability are application dependant. Since any particular application must meet the IEEE +/-50 PPM Total PPM Budget, the combination of these two values must be approximately +/-45 PPM (allowing for aging).

Note 4.14 Frequency Deviation Over Time is also referred to as Aging.

Note 4.15 The total deviation for the Transmitter Clock Frequency is specified by IEEE 802.3u as +/- 50 PPM.

Note 4.16 0°C for commercial version, -40°C for industrial version.

Note 4.17 +70°C for commercial version, +85°C for industrial version.

Note 4.18 This number includes the pad, the bond wire and the lead frame. PCB capacitance is not included in this value. The XO/XI pin and PCB capacitance values are required to accurately calculate the value of the two external load capacitors. These two external load capacitors determine the accuracy of the 25.000 MHz frequency.

Chapter 5 Package Outline

5.1 64-QFN Package

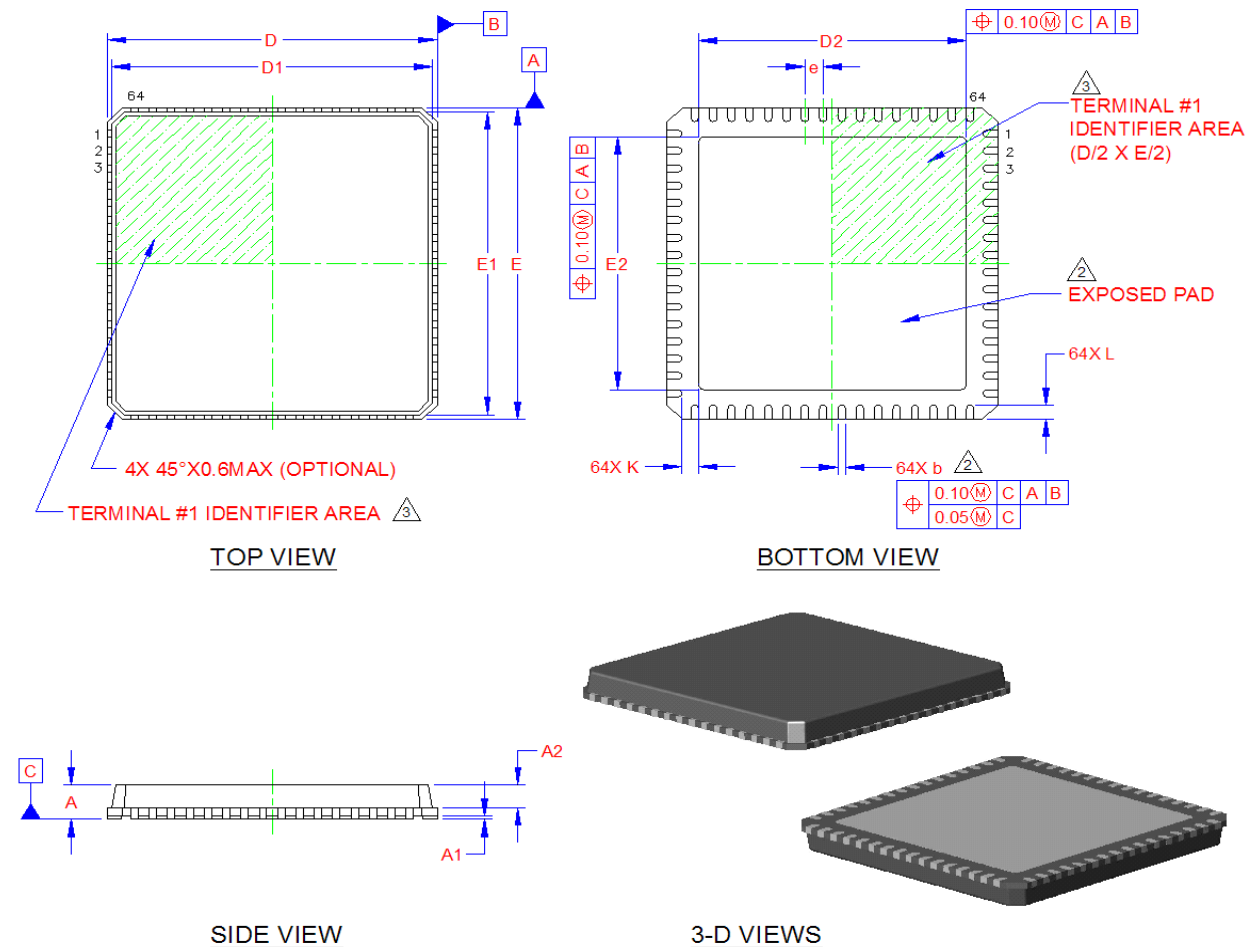


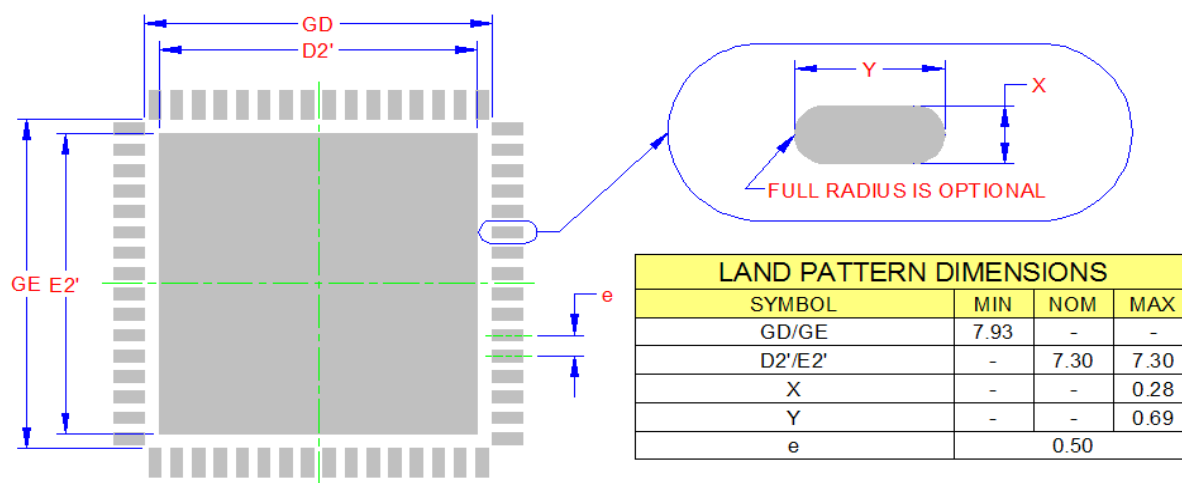
Figure 5.1 LAN9513/LAN9513i 64-QFN Package Definition

Table 5.1 LAN9513/LAN9513i 64-QFN Dimensions

| | MIN | NOMINAL | MAX | REMARKS |
|-------|----------|---------|------|-----------------------------|
| A | 0.80 | 0.85 | 1.00 | Overall Package Height |
| A1 | 0.00 | 0.02 | 0.05 | Standoff |
| A2 | - | 0.65 | 0.80 | Mold Cap Thickness |
| D/E | 8.90 | 9.00 | 9.10 | X/Y Body Size |
| D1/E1 | 8.65 | 8.75 | 8.85 | X/Y Mold Cap Size |
| D2/E2 | 7.20 | 7.30 | 7.40 | X/Y Exposed Pad Size |
| L | 0.30 | 0.40 | 0.50 | Terminal Length |
| b | 0.18 | 0.25 | 0.30 | Terminal Width |
| e | 0.50 BSC | | | Terminal Pitch |
| K | 0.35 | - | - | Pin to Center Pad Clearance |

Notes:

1. All dimensions are in millimeters unless otherwise noted.
2. Dimension "b" applies to plated terminals and is measured between 0.15 and 0.30 mm from the terminal tip.
3. Details of terminal #1 identifier are optional, but must be located within the area indicated. The terminal #1 identifier may be either a mold or marked feature.



THE USER MAY MODIFY THE PCB LAND PATTERN DIMENSIONS
BASED ON THEIR EXPERIENCE AND/OR PROCESS CAPABILITY

RECOMMENDED PCB LAND PATTERN
Figure 5.2 LAN9513/LAN9513i Recommended PCB Land Pattern

Chapter 6 Datasheet Revision History

Table 6.1 Customer Revision History

| REVISION LEVEL AND DATE | SECTION/FIGURE/ENTRY | CORRECTION |
|--------------------------------|--|---|
| Rev. 1.2 (02-29-12) | Section 4.3, "Power Consumption," on page 41 | Added suspend 0, suspend 1, and suspend 3 power consumption data. |
| Rev. 1.1 (09-19-11) | All | Fixed typos. |
| | Section 2.1, "Power Connections," on page 16 | Added power connections section with diagram. |
| Rev. 1.0 (11-24-09) | Initial release of LAN9513/LAN9513i | |

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