

### Zarlink Features

April 2006

- Integrated Single-Chip 10/100/1000 Mbps Ethernet Switch
  - Eight 10/100 Mbps auto-negotiating Fast Ethernet (FE) ports with RMII, MII, GPSI, Reverse MII & Reverse GPSI interface options
  - One 10/100/1000 Mbps auto-negotiating port with GMII & MII interface options, that can be used as a WAN uplink or as a 9th port
- Embedded 2.0 Mbits (256 KBytes) internal memory for control databases and frame data buffer
  - Supports jumbo frames up to 4 KBytes
- CPU access supports the following interface options:
  - Serial interface in lightly managed mode, or in unmanaged mode with optional I<sup>2</sup>C EEPROM interface
- Operates stand-alone or can be cascaded with a second ZL50407 to reach 16 ports
- Ethernet IEEE 802.3x flow control for full duplex ports, back pressure flow control for half duplex ports
- Built-in reset logic triggered by system malfunction
- Built-In Self Test for internal SRAM

### Ordering Information

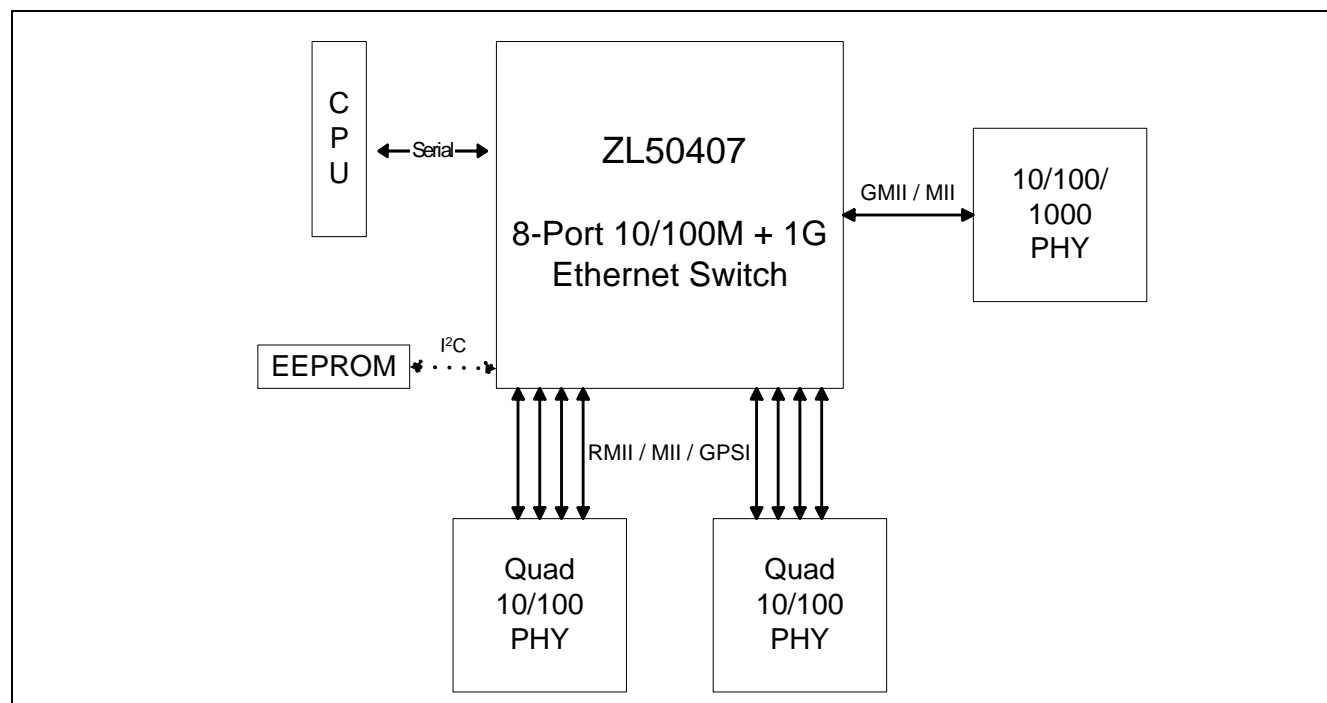
ZL50407GDC    208-Ball LBGA  
 ZL50407GDG2    208-Ball LBGA\*\*

\*\*Pb Free Tin/Silver/Copper  
**-40°C to +85°C**

- IEEE-1149.1 (JTAG) test port

### L2 Switching

- L2 switching
  - MAC address self learning, up to 4 K MAC addresses
  - MAC address table supports unicast MAC address learning
- Supports the following spanning standards
  - IEEE 802.1D spanning tree
  - IEEE 802.1w rapid spanning tree
- Supports Ethernet multicasting and broadcasting and flooding control



**Figure 1 - System Block Diagram**

## VLAN Support Features

- Supports the following VLAN standards
  - port-based VLAN

## Classification and Security

- Search engine classification
  - Classifies packets based on single field
    - Source and destination L4 logical ports, or
    - TOS/DS, or
    - VLAN (IEEE 802.1p), or
    - Physical port
  - Assigns a transmission priority and drop precedence
- Packet filtering and security
  - Static address filtering for source and/or destination MAC addresses
  - Static MAC address not subject to aging
  - Secure mode freezes MAC address learning (each port may independently use this mode)
  - IEEE 802.1x access control
  - Port-based priority: VLAN priority in a tagged frame can be overwritten by the priority of port VLAN ID

## Traffic Management

- Two (2) transmission classes for FE ports and four (4) transmission classes for uplink port
- Scheduling using weighted fair queuing (WFQ) or strict priority (SP) discipline
- At egress, per-queue weighted random early discard (WRED) with 2 drop precedence levels
  - Configurable WRED thresholds
- For FE ports, supports ingress and egress rate control
  - Bandwidth rationing, Bandwidth on demand, SLA (Service Level Agreement)
  - Granularity of rate regulation to 16 Kbps
  - Ingress rate regulated using WRED, with 2 drop precedence levels, or flow control
- Output traffic regulation per class available on uplink port
- Fully supports Differentiated Services' Expedited and Assured Forwarding (EF and AF) per-hop behaviours
- Intelligent buffer management
  - Achieves high buffer utilization while ensuring fairness among traffic classes and ports
  - Buffer reservations per class and per source port
- Failover Features
  - Rapid link failure detection using hardware-generated heartbeat packets
  - link failover in less than 50 ms
- Supports concentration mode
- Supports IEEE 802.3ad link aggregation
  - Eight (8) groups of up to 8 ports per group
  - Allows trunking of ports located on cascaded chip
  - Supports load sharing among trunk ports based on:
    - Source port
    - Source and/or destination MAC address
- Traffic Mirroring
  - Physical port based (RMII enabled ports only)
  - Source or destination MAC address based
  - MAC address pair based
- Supports module hot swap on all ports

## **Network Management Support**

- Built-in RMON MIB counters

## **Description**

The ZL50407 is a low density, low cost, high performance, non-blocking Ethernet switch chip. A single chip provides 8 ports at 10/100 Mbps, 1 uplink port at 10/100/1000 Mbps, and a CPU interface for lightly managed and unmanaged switch applications. The chip supports up to 4 K MAC addresses and port-based Virtual LANs (VLANs).

With strict priority and/or WFQ transmission scheduling and WRED dropping schemes, the ZL50407 provides powerful QoS functions for various multimedia and mission-critical applications. The chip provides 2 transmission priorities (4 priorities for uplink port) and 2 levels of dropping precedence. Each packet is assigned a transmission priority and dropping precedence based on the VLAN priority field in a VLAN tagged frame, or the DS/TOS field, or the UDP/TCP logical port fields in IP packets. The ZL50407 recognizes a total of 16 UDP/TCP logical ports, 8 hard-wired and 8 programmable (including one programmable range).

The ZL50407 provides the ability to monitor a link, detect a simple link failure, and provide notification of the failure to the CPU. The CPU can then failover that link to an alternate link.

The ZL50407 supports up to 8 groups of port trunking/load sharing. Each group can contain up to 8 ports. Port trunking/load sharing can be used to group ports between interlinked switches to increase the effective network bandwidth.

In half-duplex mode, all ports support backpressure flow control, to minimize the risk of losing data during long activity bursts. In full-duplex mode, IEEE 802.3x flow control is provided. The ZL50407 also supports a per-system option to enable flow control for best effort frames, even on QoS-enabled ports.

Statistical information for SNMP and the Remote Monitoring Management Information Base (RMON MIB) are collected independently for all ports. Access to these statistical counters/registers is provided via the CPU interface. SNMP Management frames can be received and transmitted via the CPU interface, creating a complete network management solution.

The ZL50407 is fabricated using 0.18 micron technology. The ZL50407 is packaged in a 208-pin Ball Grid Array package.

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## Changes Summary

### July 2003

- Initial Release

### November 2003

- Updated Ball Signal Description Table (1.3, "Ball Signal Descriptions" on page 14):
  - clarified the ball signal I/O description for Mn\_TXCLK & Mn\_RXCLK showing these signals are either inputs OR outputs
  - clarified that M9\_MTXCLK is an input only
- Updated 1.4, "Signal Mapping and Internal pull-up/Down Configuration" on page 19 to indicate operation of the internal pull-up/down resistors in different modes
- Clarified 10.1.3, "GMAC Reference Clock (GREF\_CLK) Speed Requirement" on page 46 on usage of GREF\_CLK
- Clarified PVMODE register bit description for bits [2] & [5]
- Updated ECR4Pn register description as port 9 (uplink) operates differently than the RMAC ports for MII bi-directional clocking (bits [1:0])
- I<sup>2</sup>C address mapping was corrected for QOSCN registers
- Added Maximum Junction Temperature to 13.1, "Absolute Maximum Ratings" on page 118
- Updated I/O voltage levels to use TTL spec values rather than % of Vcc (13.2, "DC Electrical Characteristics" on page 118)

### February 2004

- Added the following to the Feature List:
  - 4 K jumbo frames
  - IEEE 802.3ad support
  - Reverse MII/GPSI
- Added section on PHY addresses (2.2.4, "PHY Addresses" on page 25)
  - Clarified that they are hard-coded
- Fixed error in DS on sending Ethernet Frames via serial interface.
  - The Status Bytes is sent before the frame, for both Tx and Rx
- Added more cross-references to available AppNotes
- Added more clock descriptions to 10.0, "Clocks" on page 46
- INT\_MASK and INTP\_MASK registers should state that the default register value is 0x00

### August 2004

- Added section Changes Summary to document
- Added section on SCL clock generation (10.2.2, "SCL" on page 46)
- Interrupt Register was incorrectly identified as read only, should be read/write
  - Clarified that only bit [7] is not self-clearing

### November 2004

- Added section 1.6, "Default Switch Configuration and Initialization Sequence" on page 22

### January 2005

- Updated GMII timing (13.4.9, "Gigabit Media Independent Interface (GMII)" on page 128)
  - reduce min. hold time from 1ns to 0.5ns
  - reduced max. output delay by 1ns
- Removed reference to direct register INDEX\_REG1 (address 0x1) from SSI diagrams, as not applicable

**June 2005**

- Clarified that port mirroring is only available if the source & destination ports are in RMII mode
- Updated PVMODE bit [5] to reflect the proper MAC address range: 01-80-C2-00-00-00~F
- Clarified DATAOUT output can be open-drain or totem-pole based on debounce selection via bootstrap TSTOUT[0]
- Added power sequencing recommendation (1.7, "Power Sequencing" on page 23)
- Added Reverse MII/GPSI timing characteristics (13.4.8, "Reverse General Purpose Serial Interface (RvGPSI)" on page 127 and 13.4.10, "MII Management Data Interface (MDIO/MDC)" on page 130)
- Clarified that counter "DelayExceededDiscards" is not applicable for the ZL50407 (11.0, "Hardware Statistics Counters" on page 47)

**December 2005**

- Clarified that TRST signal should be externally tied to GND via weak resistor, as per JTAG standard (1.3, "Ball Signal Descriptions" on page 14)
- Added more text to section 2.8, "JTAG" on page 26
- Clarified counter definitions (11.0, "Hardware Statistics Counters" on page 47)
- Removed definition for SE\_OPMODE bit[5] (ARP report control), as this feature was not implemented and this bit was mistakenly left in the register definition.

**April 2006**

- Added Pb-free order code (ZL50407GDG2)
- Removed mention of multicast MAC address learning support, as feature is not available on the unmanaged/lightly managed chipsets
- Clarified registers UCC, MCC & MCCTH
- Renamed register UCC (now PCC), as name was misleading

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## 1.0 BGA and Ball Signal Descriptions

### 1.1 BGA Views (Top-View)

|   | 1             | 2           | 3           | 4           | 5           | 6           | 7           | 8            | 9            | 10           | 11           | 12          | 13          | 14           | 15            | 16          |             |             |             |             |   |
|---|---------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|-------------|-------------|--------------|---------------|-------------|-------------|-------------|-------------|-------------|---|
| A | SCLK          | DATAI<br>N  | DATAO<br>UT | STRO<br>BE  | RSVD        | RSVD        | RSVD        | RSVD         | RSVD         | RSVD         | RSVD         | RSVD        | REF_<br>CLK | M9_TX<br>CLK | M9_M<br>TXCLK | M9_TX<br>EN | A           |             |             |             |   |
| B | P_INT         | SDA         | SCL         | RSVD        | RSVD        | RSVD        | RSVD        | RSVD         | RSVD         | RSVD         | RSVD         | RSVD        | TCK         | TMS          | M9_TX<br>ER   | M9_RX<br>CK | B           |             |             |             |   |
| C | RESET<br>OUT# | TSTO<br>UT1 | TSTO<br>UT3 | TSTO<br>UT5 | TSTO<br>UT6 | TSTO<br>UT7 | TSTO<br>UT9 | TSTO<br>UT11 | TSTO<br>UT12 | TSTO<br>UT14 | TSTO<br>UT15 | TRST#       | TDI         | M9_RX<br>D7  | M9_C<br>RS    | M9_C<br>OL  | C           |             |             |             |   |
| D | RESIN<br>#    | TSTO<br>UT0 | TSTO<br>UT2 | TSTO<br>UT4 | 3.3V        | IC_GN<br>D  | TSTO<br>UT8 | TSTO<br>UT10 | 1.8V         | TSTO<br>UT13 | TDO          | 3.3V        | M9_RX<br>D5 | M9_RX<br>D6  | M9_RX<br>DV   | M9_RX<br>ER | D           |             |             |             |   |
| E | M2_C<br>OL    | M0_C<br>OL  | M1_C<br>OL  | 3.3V        |             |             |             |              |              |              |              |             | 3.3V        | M9_RX<br>D4  | M9_TX<br>D6   | M9_TX<br>D7 | E           |             |             |             |   |
| F | M_MD<br>C     | M_MDI<br>O  | M0_RX<br>D2 | M0_RX<br>D3 |             |             |             |              |              |              |              |             | M9_RX<br>D2 | M9_RX<br>D3  | M9_TX<br>D4   | M9_TX<br>D5 | F           |             |             |             |   |
| G | M0_RX<br>D0   | M0_RX<br>D1 | M0_RX<br>CK | M0_TX<br>D3 |             |             |             |              |              |              |              |             | GND         | GND          | GND           | GND         | M9_RX<br>D0 | M9_RX<br>D1 | M9_TX<br>D2 | M9_TX<br>D3 | G |
| H | M0_C<br>RS    | M0_TX<br>EN | M0_TX<br>D2 | 1.8V        |             |             |             |              |              |              |              |             | GND         | GND          | GND           | GND         | 1.8V        | M7_C<br>OL  | M9_TX<br>D0 | M9_TX<br>D1 | H |
| J | M0_TX<br>D0   | M0_TX<br>D1 | M0_TX<br>CK | M1_RX<br>D3 |             |             |             |              |              |              |              |             | GND         | GND          | GND           | GND         | M7_TX<br>D3 | M7_TX<br>CK | M7_TX<br>D1 | M7_TX<br>D0 | J |
| K | M1_RX<br>D0   | M1_RX<br>D1 | M1_RX<br>D2 | M1_RX<br>CK | GND         | GND         | GND         | GND          | M7_TX<br>D2  | M7_RX<br>D2  | M7_TX<br>EN  | M7_C<br>RS  | K           |              |               |             |             |             |             |             |   |
| L | M1_C<br>RS    | M1_TX<br>EN | M1_TX<br>D2 | M1_TX<br>D3 |             |             |             |              |              |              |              |             | M7_RX<br>D3 | M7_RX<br>CK  | M7_RX<br>D1   | M7_RX<br>D0 | L           |             |             |             |   |
| M | M1_TX<br>D0   | M1_TX<br>D1 | M1_TX<br>CK | 3.3V        |             |             |             |              |              |              |              |             | 3.3V        | M6_C<br>OL   | M5_C<br>OL    | M4_C<br>OL  | M           |             |             |             |   |
| N | M2_RX<br>D3   | M2_TX<br>CK | M2_TX<br>D3 | M3_RX<br>D3 | 3.3V        | M3_TX<br>D3 | 1.8V        | M4_RX<br>D3  | M4_TX<br>CK  | M4_TX<br>D3  | M5_RX<br>D3  | M5_TX<br>CK | M5_TX<br>D3 | M6_RX<br>D3  | M6_TX<br>CK   | M6_TX<br>D3 | N           |             |             |             |   |
| P | M2_RX<br>D2   | M2_RX<br>CK | M2_TX<br>D2 | M3_RX<br>D2 | M3_RX<br>CK | M3_TX<br>D2 | M3_C<br>OL  | M4_RX<br>D2  | M4_RX<br>CK  | M4_TX<br>D2  | M5_RX<br>D2  | M5_RX<br>CK | M5_TX<br>D2 | M6_RX<br>D2  | M6_RX<br>CK   | M6_TX<br>D2 | P           |             |             |             |   |
| R | M2_RX<br>D1   | M2_TX<br>EN | M2_TX<br>D1 | M3_RX<br>D1 | M3_TX<br>EN | M3_TX<br>D1 | M_CLK       | M4_RX<br>D1  | M4_TX<br>EN  | M4_TX<br>D1  | M5_RX<br>D1  | M5_TX<br>EN | M5_TX<br>D1 | M6_RX<br>D1  | M6_TX<br>EN   | M6_TX<br>D1 | R           |             |             |             |   |
| T | M2_RX<br>D0   | M2_C<br>RS  | M2_TX<br>D0 | M3_RX<br>D0 | M3_C<br>RS  | M3_TX<br>D0 | M3_TX<br>CK | M4_RX<br>D0  | M4_C<br>RS   | M4_TX<br>D0  | M5_RX<br>D0  | M5_C<br>RS  | M5_TX<br>D0 | M6_RX<br>D0  | M6_C<br>RS    | M6_TX<br>D0 | T           |             |             |             |   |
|   | 1             | 2           | 3           | 4           | 5           | 6           | 7           | 8            | 9            | 10           | 11           | 12          | 13          | 14           | 15            | 16          |             |             |             |             |   |

### 1.2 Power and Ground Distribution

|                               |      |                 |            |
|-------------------------------|------|-----------------|------------|
| G7-10, H7-10, J7-10, K7-10    | GND  | V <sub>SS</sub> | Ground     |
| D5, D12, E4, E13, M4, M13, N5 | 3.3V | V <sub>CC</sub> | I/O Power  |
| D9, H4, H13, N7               | 1.8V | V <sub>DD</sub> | Core Power |

### 1.3 Ball Signal Descriptions

All pins are CMOS type; all Input Pins are 5 Volt tolerance; and all Output Pins are 3.3 CMOS drive.

#### Notes

|             |   |
|-------------|---|
| # =         | Active low signal   |
| Input =     | Input signal  |
| Input-ST =  | Input signal with Schmitt-Trigger   |
| Output =    | Output signal (Tri-State driver)  |
| I/O-TS =    | Input & Output signal with Tri-State driver   |
| pull-up =   | Weak internal pull-up (nominal 100K $\Omega$ )<br><br>(refer to Section 1.4 on page 19 as some internal pull-ups are not enabled in certain configurations)     |
| pull-down = | Weak internal pull-down (nominal 100K $\Omega$ )<br><br>(refer to Section 1.4 on page 19 as some internal pull-downs are not enabled in certain configurations) |

**Ball Signal Description Table**

| Ball No(s)   | Symbol          | I/O                   | Description   |
|--|-----------------|-----------------------|---|
| <b>I<sup>2</sup>C Interface - Unmanaged Mode Only (TSTOUT[3] bootstrap must be '1')</b>  |                 |                       |   |
| B3   | SCL             | Output<br>w/ pull up  | I <sup>2</sup> C - Serial Clock Line<br>Unmanaged Mode Only                           |
| B2   | SDA             | I/O-TS<br>w/ pull up  | I <sup>2</sup> C - Serial Data Line<br>Unmanaged Mode Only                            |
| <b>Serial CPU Bus Interface</b>  |                 |                       |   |
| A4   | STROBE          | Input<br>w/ pull up   | SSI - Clock Signal  |
| A3   | DATAOUT         | Output                | SSI - Data Out  |
| A2   | DATAIN          | Input<br>w/ pull up   | SSI - Data In   |
| B1   | P_INT           | Output                | CPU Interrupt<br><br>Active high, but can be changed via register<br>DEVICE, bit [1]. |
| <b>Fast Ethernet Access Ports [7:0] MII</b>  |                 |                       |   |
|  |                 |                       |   |
| L13, K14, L15, L16,<br>N14, P14, R14, T14,<br>N11, P11, R11, T11,<br>N8, P8, R8, T8, N4,<br>P4, R4, T4, N1, P1,<br>R1, T1, J4, K3, K2,<br>K1, F4, F3, G2, G1 | M[7:0]_RXD[3:0] | Input<br>with pull-up | Ports [7:0] – Receive Data Bit [3:0]  |

Ball Signal Description Table (continued)

| Ball No(s)   | Symbol          | I/O                          | Description   |
|--|-----------------|------------------------------|---|
| K16, T15, T12, T9, T5, T2, L1, H1  | M[7:0]_CRS_DV   | Input with pull-up           | Ports [7:0] – Carrier Sense and Receive Data Valid                        |
| K15, R15, R12, R9, R5, R2, L2, H2  | M[7:0]_TXEN     | Output, slew                 | Ports [7:0] – Transmit Enable<br>This pin also serves as a bootstrap pin. |
| J13, K13, J15, J16, N16, P16, R16, T16, N13, P13, R13, T13, N10, P10, R10, T10, N6, P6, R6, T6, N3, P3, R3, T3, L4, L3, M2, M1, G4, H3, J2, J1 | M[7:0]_TXD[3:0] | Output, slew                 | Ports [7:0] – Transmit Data Bit [3:0]                                     |
| H14, M14, M15, M16, P7, E1, E3, E2   | M[7:0]_COL      | Input with pull-down         | Ports[7:0] – Collision  |
| J14, N15, N12, N9, T7, N2, M3, J3  | M[7:0]_TXCLK    | Input or Output with pull-up | Ports[7:0] – Transmit Clock<br>This pin in an output if ECR4Pn[1:0]='11'  |
| L14, P15, P12, P9, P5, P2, K4, G3  | M[7:0]_RXCLK    | Input or Output with pull-up | Ports[7:0] – Receive Clock<br>This pin in an output if ECR4Pn[1:0]='11'   |
| <b>Gigabit Ethernet Uplink Port GMII</b>   |                 |                              |   |
| E16, E15, F16, F15, G16, G15, H16, H15   | M9_TXD[7:0]     | Output                       | Transmit Data Bit [7:0]   |
| D15  | M9_RXDV         | Input with pull-up           | Receive Data Valid  |
| D16  | M9_RXER         | Input with pull-up           | Receive Error   |
| C15  | M9_CRS          | Input with pull-down         | Carrier Sense   |
| C16  | M9_COL          | Input with pull-down         | Collision Detected  |
| B16  | M9_RXCLK        | Input or Output with pull-up | Receive Clock<br>In MII mode, this pin in an output if ECR4P9[1:0]='11'   |
| C14, D14, D13, E14, F14, F13, G14, G13   | M9_RXD[7:0]     | Input with pull-up           | Receive Data Bit [7:0]  |
| A16  | M9_TXEN         | Output with pull-up          | Transmit Data Enable<br>This pin also serves as a bootstrap pin.          |

Ball Signal Description Table (continued)

| Ball No(s)  | Symbol          | I/O                 | Description  |
|---|-----------------|---------------------|--|
| B15   | M9_TXER         | Output with pull-up | Transmit Error<br>This pin also serves as a bootstrap pin.   |
| A15   | M9_MTXCLK       | Input with pull-up  | Transmit Clock   |
| A14   | M9_TXCLK        | Output              | Gigabit Transmit Clock   |
| <b>Test Interface</b>   |                 |                     |  |
| C11, C10, D10, C9, C8, D8, C7, D7, C6, C5, C4, D4, C3, D3, C2, D2 | TSTOUT[15:0]    | Output              | [15:4] Reserved<br>[3] EEPROM checksum is good<br>[2] Initialization Completed<br>[1] Memory Self Test in progress<br>[0] Initialization started<br><br>These pins also serve as bootstrap pins. |
| <b>Test Facility</b>  |                 |                     |  |
| C13   | TDI             | Input with pull-up  | JTAG - Test Data In  |
| C12   | TRST#           | Input with pull-up  | JTAG - Test Reset<br><br>In normal operation, this pin should be pulled low. Recommend weak external pull-down resistor (470 $\Omega$ to 1 k $\Omega$ ).   |
| B13   | TCK             | Input with pull-up  | JTAG - Test Clock  |
| B14   | TMS             | Input with pull-up  | JTAG - Test Mode State   |
| D11   | TDO             | Output              | JTAG - Test Data Out   |
| <b>System Clock, Power, and Ground Pins</b>                       |                 |                     |  |
| A1  | SCLK            | Input               | System Clock. Based on system requirement, SCLK needs to operate at difference frequency.<br>SCLK requires 40/60% duty cycle clock.  |
| D9, H4, H13, N7,  | V <sub>DD</sub> | Power               | +1.8 Volt DC Supply  |
| D5, D12, E4, E13, M4, M13, N5,                                    | V <sub>CC</sub> | Power               | +3.3 Volt DC Supply  |
| G7-10, H7-10, J7-10, K7-10  | V <sub>SS</sub> | Power Ground        | Ground   |
| <b>Misc.</b>  |                 |                     |  |
| D1  | RESIN#          | Input               | Reset Input  |



Ball Signal Description Table (continued)

| Ball No(s)  | Symbol      | I/O  | Description   |
|---|-------------|--|---|
| C1  | RESETOUT#   | Output   | Reset PHY   |
| F1  | M_MDC       | Output   | MII Management Data Clock   |
| F2  | M_MDIO      | I/O-TS<br>with pull-up                                 | MII Management Data I/O   |
| R7  | M_CLK       | Input  | RMAC Reference Clock  |
| A13   | GREF_CLK    | Input<br>with pull-up                                  | GMAC Reference Clock  |
| A12, B12, A11, B11,<br>A10, B10, A9, B9, A8,<br>B8, A7, B7, A6, B6,<br>A5, B5, B4   | RSVD        | N/A  | Reserved. Leave unconnected.  |
| D6  | IC_GND      | IC_GND   | Internal Connect. Tie to ground ( $V_{SS}$ ) via 1 K resistor.  |
| <b>Bootstrap Pins<sup>1</sup></b>   |             |  |   |
| External pull-up/down resistors are required on all bootstrap pins for proper operation. See “Bootstrap Options” on page 21 for more information. |             |  |   |
| D2  | TSTOUT[0]   | Input (Reset Only)                                     | <p>Enable Debounce on SSI interface<br/>Pullup – Enabled<br/>Pulldown - Disabled</p> <p>When enabled, DATAOUT is an open-drain output; when disabled, DATAOUT is a totem-pole output.</p> <p>See “Synchronous Serial Interface (SSI)” on page 121 for more details on debounce timing.</p>  |
| D3, C2  | TSTOUT[2:1] | Input (Reset Only)<br><br>Must be externally pulled-up | Reserved. Must be pulled up.  |
| C3  | TSTOUT[3]   | Input (Reset Only)                                     | <p>Management interface operation mode:<br/>Pulldown – Lightly Managed Serial. CPU can transmit/receive frames with the serial interface.<br/>Pullup – Unmanaged Serial. No CPU packet can be transmit or received with the serial interface. EEPROM can be used to configure the device at bootup.</p> <p>A one (1) indicates pullup. A zero (0) indicates pulldown.</p> |

Ball Signal Description Table (continued)

| Ball No(s)                        | Symbol           | I/O  | Description  |
|-----------------------------------|------------------|--|--|
| C5, C4, D4                        | TSTOUT[6:4]      | Input (Reset Only)                                       | Device ID. Default address of the device for serial interface. Up to 8 device can be sharing the serial management bus with different device ID.<br><br>A one (1) indicates pullup. A zero (0) indicates pulldown. TSTOUT[4] is the Least Significant Bit (LSB). |
| C6                                | TSTOUT[7]        | Input (Reset Only)                                       | EEPROM not installed.<br>Pullup: Not installed<br>Pulldown: Installed  |
| D7                                | TSTOUT[8]        | Input (Reset Only)<br><br>Must be externally pulled-up   | Manufacturing Option. Must be pulled up.   |
| C7                                | TSTOUT[9]        | Input (Reset Only)                                       | Module Detect<br>Pullup: Enable. In this mode, the device will detect the existence of a PHY (for hot swap purpose).<br>Pulldown: Disable  |
| D8                                | TSTOUT[10]       | Input (Reset Only)<br><br>Must be externally pulled-down | Manufacturing Option. Must be pulled down.   |
| C8                                | TSTOUT[11]       | Input (Reset Only)                                       | Power Saving<br>Pullup: Enable MAC power saving mode<br>Pulldown: Disable MAC power saving mode  |
| C9                                | TSTOUT[12]       | Input (Reset Only)                                       | Timeout Reset Enable<br>Pullup: Enable<br>Pulldown: Disable  |
| C11, C10, D10                     | TSTOUT[15:13]    | Input (Reset Only)<br><br>Must be externally pulled-up   | Manufacturing Options. Must be pulled-up.  |
| K15, R15, R12, R9, R5, R2, L2, H2 | M[7:0]_TXEN      | Input (Reset Only)                                       | User Defined Bootstrap:<br>Usually used in conjunction with Module Detect to determine what interface to use for the inserted module. Can be read from BOOTSTRAP2 register   |
| A16, B15                          | M9_TXEN, M9_TXER | Input with pull-up (Reset Only)                          | User Defined Bootstrap:<br>Usually used in conjunction with Module Detect to determine what interface to use for the inserted module. Can be read from BOOTSTRAP3 register   |

1. Note: 1=pull-up; 0=pull-down

#### 1.4 Signal Mapping and Internal pull-up/Down Configuration

The ZL50407 Fast Ethernet access ports (0-7) support 3 interface options: RMII, MII & GPSSI. The table below summarizes the interface signals required for each interface and how they relate back to the Pin Symbol name shown in the “Ball Signal Description Table” on page 14. It also specifies whether the internal pull-up/down resistor is present for each pin in the specific operating mode.

**Notes:**

I – Input  
O – Output  
U – Pullup  
D - Pulldown

| <b>Fast Ethernet<br/>Access Ports<br/>Pin Symbol</b> | <b>No<br/>Module<br/>(Bootstrap<br/>TSTOUT9='1')</b> | <b>RMII Mode<br/>(ECR4Pn[4:3]='11')</b> | <b>MI Mode<br/>(ECR4Pn[4:3]='01')</b> | <b>GPSSI Mode<br/>(ECR4Pn[4:3]='00')</b> |
|--|--|---|---------------------------------------|--|
| M[7:0]_RXD0  | (U)  | M[7:0]_RXD0 (I)                         | M[7:0]_RXD0 (I)                       | M[7:0]_RXD (I)                           |
| M[7:0]_RXD1  | (U)  | M[7:0]_RXD1 (I)                         | M[7:0]_RXD1 (I)                       | NC (U)                                   |
| M[7:0]_RXD2  | (U)  | NC (U)                                  | M[7:0]_RXD2 (I)                       | NC (U)                                   |
| M[7:0]_RXD3  | (U)  | NC (U)                                  | M[7:0]_RXD3 (I)                       | NC (U)                                   |
| M[7:0]_TXEN  | (O)  | M[7:0]_TXEN (O)                         | M[7:0]_TXEN (O)                       | M[7:0]_TXEN (O)                          |
| M[7:0]_CRS_DV  | (U)  | M[7:0]_CRS_DV (I)                       | M[7:0]_DV (I)                         | M[7:0]_CRS (I)                           |
| M[7:0]_TXD0  | (O)  | M[7:0]_TXD0 (O)                         | M[7:0]_TXD0 (O)                       | M[7:0]_TXD (O)                           |
| M[7:0]_TXD1  | (O)  | M[7:0]_TXD1 (O)                         | M[7:0]_TXD1 (O)                       | NC (O)                                   |
| M[7:0]_TXD2  | (O)  | NC (O)                                  | M[7:0]_TXD2 (O)                       | NC (O)                                   |
| M[7:0]_TXD3  | (O)  | NC (O)                                  | M[7:0]_TXD3 (O)                       | NC (O)                                   |
| M[7:0]_COL   | (D)  | NC (D)                                  | M[7:0]_COL (I)                        | M[7:0]_COL (I)                           |
| M[7:0]_TXCLK   | (U)  | NC (U)                                  | M[7:0]_TXCLK (IO)                     | M[7:0]_TXCLK (IO)                        |
| M[7:0]_RXCLK   | (U)  | NC (U)                                  | M[7:0]_RXCLK (IO)                     | M[7:0]_RXCLK (IO)                        |

**Table 1 - Signal Mapping In Different Operation Mode**

The ZL50407 Gigabit Ethernet uplink port (port 9) supports 2 interface options: GMII & MII. The table below summarizes the interface signals required for each interface, and how they relate back to the Pin Symbol name shown in “Ball Signal Description Table” on page 14.

| <b>Gigabit Ethernet<br/>Uplink Port<br/>Pin Symbol</b> | <b>No<br/>Module<br/>(Bootstrap<br/>TSTOUT9='1')</b> | <b>GMII Mode<br/>(ECR4P9[4:3]='11')</b> | <b>MI Mode<br/>(ECR4P9[4:3]='00')</b> |
|--|--|---|---------------------------------------|
| M9_RXD0  | (U)  | M9_RXD0 (I)                             | M9_RXD0 (I)                           |
| M9_RXD1  | (U)  | M9_RXD1 (I)                             | M9_RXD1 (I)                           |
| M9_RXD2  | (U)  | M9_RXD2 (I)                             | M9_RXD2 (I)                           |
| M9_RXD3  | (U)  | M9_RXD3 (I)                             | M9_RXD3 (I)                           |
| M9_RXD4  | (U)  | M9_RXD4 (I)                             | NC (U)                                |
| M9_RXD5  | (U)  | M9_RXD5 (I)                             | NC (U)                                |
| M9_RXD6  | (U)  | M9_RXD6 (I)                             | NC (U)                                |
| M9_RXD7  | (U)  | M9_RXD7 (I)                             | NC (U)                                |
| M9_RXDV  | (U)  | M9_RXDV (I)                             | M9_RXDV (I)                           |
| M9_RXER  | (U)  | M9_RXER (I)                             | M9_RXER (U)                           |
| M9_CRS   | (D)  | M9_CRS (I)                              | M9_CRS (I)                            |
| M9_COL   | (D)  | M9_COL (I)                              | M9_COL (I)                            |
| M9_RXCLK   | (U)  | M9_RXCLK (I)                            | M9_RXCLK (IO)                         |
| M9_TXD0  | (O)  | M9_TXD0 (O)                             | M9_TXD0 (O)                           |
| M9_TXD1  | (O)  | M9_TXD1 (O)                             | M9_TXD1 (O)                           |
| M9_TXD2  | (O)  | M9_TXD2 (O)                             | M9_TXD2 (O)                           |
| M9_TXD3  | (O)  | M9_TXD3 (O)                             | M9_TXD3 (O)                           |
| M9_TXD4  | (O)  | M9_TXD4 (O)                             | NC (O)                                |
| M9_TXD5  | (O)  | M9_TXD5 (O)                             | NC (O)                                |
| M9_TXD6  | (O)  | M9_TXD6 (O)                             | NC (O)                                |
| M9_TXD7  | (O)  | M9_TXD7 (O)                             | NC (O)                                |
| M9_TXEN  | (U)  | M9_TXEN (O)                             | M9_TXEN (O)                           |
| M9_TXER  | (U)  | M9_TXER (O)                             | M9_TXER (O)                           |
| M9_TXCLK   | (O)  | M9_TXCLK (O)                            | NC (O)                                |
| GREF_CLK   | (U)  | GREF_CLK (I)                            | REF_CLK (I)                           |
| M9_MTXCLK  | (U)  | M9_MTXCLK (I)                           | M9_MTXCLK (I)                         |

**Table 2 - Signal Mapping In Different Operation Mode**

## 1.5 Bootstrap Options

TSTOUT[15:0], M[7:0]\_TXEN, M9\_TXEN and M9\_TXER pins serve as bootstrap pins during device power-up or reset. Please refer to “Typical Reset & Bootstrap Timing Diagram” on page 120 for more information on when the bootstrap pins are sampled. The bootstrap pins require external pull-up/down resistors for proper operation. Recommend 10 K for pull-ups and 1 K for pull-downs.

The table below summarizes the bootstrap options.

| Feature            | Description  |
|--------------------|--|
| CPU Interface      | <p>The ZL50407 allows the selection of 2 different management interfaces: serial only and unmanaged serial with I<sup>2</sup>C EEPROM.</p> <p>TSTOUT[3] is used to select the interface options mentioned above. If the serial interface is selected, addition bootstrap options are required:</p> <ul style="list-style-type: none"> <li>• TSTOUT[0] enables or disables the DEBOUNCE feature (refer to “Synchronous Serial Interface” on page 31)</li> <li>• TSTOUT[6:4] selects the device ID</li> </ul> <p>Also, in unmanaged mode, an optional I<sup>2</sup>C EEPROM can be used to configure the device at power-up or reset. TSTOUT[7] selects the EEPROM option.</p> |
| Ethernet Interface | <p>The ZL50407 supports module hotswap on all it's ports. This is enabled via TSTOUT[9]. When enabled, bootstrap pins M[7:0]_TXEN (ports 0-7) and M9_TXEN &amp; M9_TXER (port 9) are used to specify the module type to support multiple ethernet interfaces during module hotswap.</p> <p>Another feature is the MAC power savings mode. When enabled via TSTOUT[11], each port's MAC will detect inactivity on the port and go into a power savings state. When activity is detected once again on the port, the MAC will come out of this state.</p>  |
| Misc. Features     | <p>One other feature selected via bootstrap is Timeout Reset Enable (TSTOUT[12]). This enables a monitoring block with the device which will detect if any hardware state machine is in a non-idle state for more than 5 seconds.</p> <p>Refer to section 2.7 for more details on this feature.</p>  |

**Table 3 - Bootstrap Features**

### 1.5.1 Recommended Default Bootstrap Settings

The following are the recommended default settings for the bootstrap options:

- Unmanaged/Lightly Managed
  - Reserved/Manufacturing bootstraps
    - TSTOUT[15:13,8,2,1] must be pulled-up
    - TSTOUT[10] must be pulled-down
  - CPU Interface:
    - Strobe debounce bootstrap, TSTOUT[0], should be normally pulled-up, unless you wish to disable the debounce logic
    - CPU Interface bootstrap, TSTOUT[3], should be pulled-up to indicate unmanaged SSI CPU interface. To enable lightly managed mode, pulled-down
    - SSI Device ID bootstrap, TSTOUT[6:4], should be pulled-down to indicate device ID 0x0 for the SSI interface. Can be changed to whatever device ID required if more than one device on the SSI bus.

- EEPROM bootstrap, TSTOUT[7], should be pulled-up to disable until the system is debugged. You can pull-down this bootstrap if using the optional EEPROM in unmanaged mode (NOTE: this bootstrap is not valid in any other CPU mode)
- Module Detect bootstrap, TSTOUT[9], should be pulled-down
  - In lightly managed mode, you can enable the optional Module Detect feature
  - If enabled, need to use Mn\_TXEN to indicate module type
- Power Saving bootstrap, TSTOUT[11], should be normally pulled-up
- Timeout Reset bootstrap, TSTOUT[12], should be pull-down
  - Once system is debugged, you can enable the optional feature with pull-up (Refer to section 2.7 for more details on this feature)

## 1.6 Default Switch Configuration and Initialization Sequence

The ZL50407 will come out of reset in a default configuration, which will allow for basic L2 switching and automatic MAC address learning.

In unmanaged mode, the default configuration will take effect immediately after reset. The default settings can be changed using the optional EEPROM.

- System Defaults
  - Port-based VLAN
  - MAC address 00-00-00-00-00-00 not learned
  - Drop MAC addresses 01-80-C2-00-00-01~F
  - Trunking and mirroring disabled
  - MAC address agetime is 300 seconds
  - VLAN 802.1p prioritization
    - All priority bits mapped to priority 0 (lowest)
  - 96 queued unicast/multicast frames will trigger flow control
  - All WRED drop percentages equal to 0%
  - Unicast/multicast/broadcast flood control disabled
  - No shared or per-class buffer pools
- Per-port Defaults
  - Disable per-port fixed priority and drop precedence
  - Disable asynchronous flow control
  - Spanning Tree per-port state equal to forwarding
  - Don't filter tagged/untagged VLAN frames
  - Automatic learning enabled
  - Per-port security disabled
  - Support frame size  $64 \leq n \leq 1522$
  - Pad transmit frames < 64B
  - Standard preamble
  - Strict Priority scheduling
  - FE Ports
    - RMII mode
    - Auto-negotiate 10/100 M, Full Duplex, Flow Control
    - Rate control disabled
    - per-source port buffer pool of 96 buffers, with flow control threshold of 48 buffers
  - Uplink Port
    - GMII mode
    - Auto-negotiate 10/100/1000 M, Full Duplex, Flow Control
    - per-source port buffer pool of 384 buffers, with flow control threshold of 192 buffers

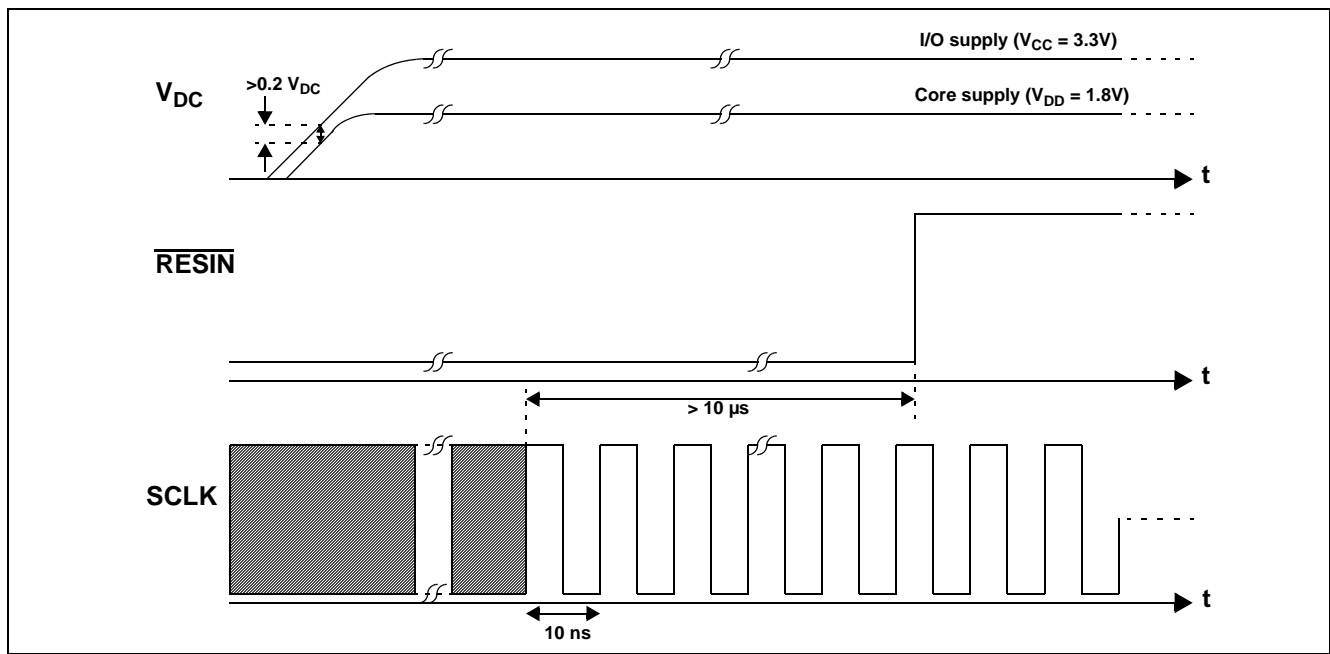
In lightly managed mode, the default configuration can be used as well, however, the device needs to be told when to start switching. This is done via the “Init Complete” bit, set in GCR[4]. The default settings can be overridden using the CPU interface, but should be done before setting of GCR[4]. One thing to note is after reset, the device will start to initialize the control tables. Therefore, a short delay (100  $\mu$ s~1 ms) is necessary before changing the register settings and/or control tables, and before setting GCR[4].

- System Defaults
  - CPU MAC address is 00-00-00-00-00-00
  - Forward MAC addresses 01-80-C2-00-00-00~F to CPU port
    - Except 01-80-C2-00-00-01~F, which are dropped
  - All interrupts enabled
  - MAC address learn report to CPU disabled
  - Statistics counters disabled
  - DiffServ EF code support disabled
  - No VLAN ID hashing
- Per-port Defaults
  - FE Ports
    - Link heart beat disabled
  - CPU Port
    - 100 M, Full Duplex, Flow Control
    - 8-byte header padding
    - per-source port buffer pool of 96 buffers, with flow control threshold of 48 buffers

## 1.7 Power Sequencing

The ZL50407 has two separate power supplies:  $V_{DD}$  (1.8 V) and  $V_{CC}$  (3.3 V). The recommended power-up sequence is for  $V_{CC}$  to be applied first, followed by the  $V_{DD}$  supply.  $V_{CC}$  should lead  $V_{DD}$  supply by at least 0.2 V, but by no more than 2 V.

Both supplies may be powered-down simultaneously.



**Figure 2 - Power-up Sequence**

See “Typical Reset & Bootstrap Timing Diagram” on page 120 for more details on reset and bootstrap sampling.

## 2.0 Block Functionality

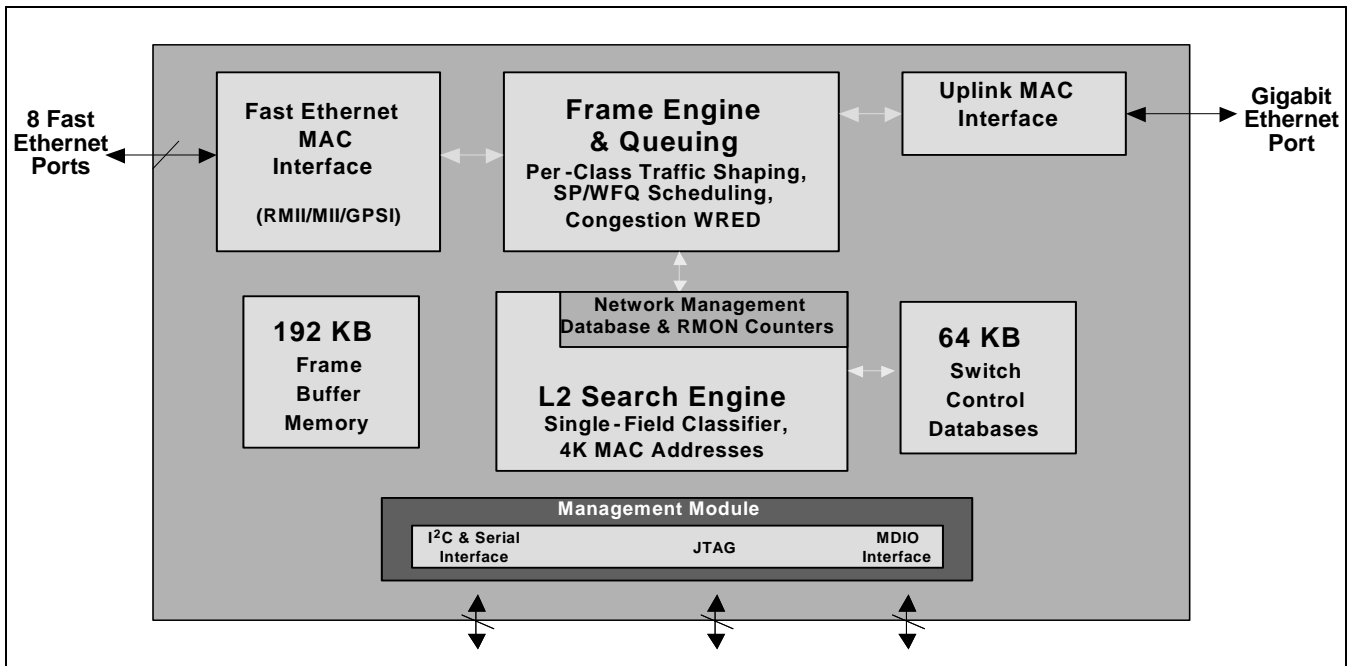


Figure 3 - Functional Block Diagram

### 2.1 Internal Memory

Two Megabit of internal memory is provided for ethernet Frame Data Buffering (FDB), storing of MAC Control Table database (MCT), and the Network Management (NM) Database statistics counters and MIB.

The MCT is used for storing MAC addresses and their physical port number. The FDB is used for storing the received frame data contents. The contents are stored in this memory until it is ready to be transmitted to the egress port.

A memory arbiter is used to arbitrary the memory access requests from various sources. A Built In Self Test (BIST) is used to detect any error in the memory array when the device is powered up. The BIST can also be requested by the writing to the GCR register.

### 2.2 MAC Modules

#### 2.2.1 RMII MAC Module (RMAC)

The RMII Media Access Control (RMAC) module provides the necessary buffers and control interface between the Frame Engine (FE) and the external physical device (PHY). It has five interfaces: MII, RMII, GPSI (only for 10M), Reverse MII, or Reverse GPSI (only for 10M).

The RMAC of the ZL50407 device meets the IEEE 802.3 specification. It is able to operate in either Half or Full Duplex mode with a back pressure/flow control mechanism. In addition, it will automatically retransmit upon collision for up to 16 total transmissions.

These eight ports are denoted as ports 0 to 7. The PHY addresses for the PHY devices connected to the 8 RMAC ports has to be from 08h (port 0) to 0Fh (port 7).



### 2.2.1.1 GPSI (7WS) Interface

The RMAC ethernet port can function in GPSI (7WS) mode. In this mode, the TXD[0], RXD[0] serve as TX data, RX data and respectively. The link and duplex of the port can be controlled by programming the ECR1Pn register. Only port-based VLAN is supported with GPSI interface.

### 2.2.2 CPU MAC Module (CMAC)

The CPU Media Access Control (CMAC) module provides the necessary buffers and control interface between the Frame Engine (FE) and the external CPU device. It support a register access mechanism via the serial interface.

This port is denoted as port 8.

### 2.2.3 GMII MAC Module (GMAC)

The GMII Media Access Control (GMAC) module provides the necessary buffers and control interface between the Frame Engine (FE) and the external physical device (PHY). The GMAC implements both GMII and MII interface, which offers a simple migration from 10/100 to 1G.

The GMAC of the ZL50407 device meets the IEEE 802.3Z specification. It is able to operate in 10 M/100 M either Half or Full Duplex mode with a back pressure/flow control mechanism or in 1G Full duplex mode with flow control mechanism. Furthermore, it will automatically retransmit upon collision for up to 16 total transmissions.

This port is denoted as port 9. The PHY address for the PHY device connected to the GMAC port has to be 10h.

### 2.2.4 PHY Addresses

The table below provides an overview of the PHY addresses required for each port in order for the MDIO auto-negotiation to work between the ZL50407 MAC and the PHY device. If a different PHY address is used, then the port must be manually brought up and the PHY will need to be polled for link status via the MIIC/D registers.

| MAC Port    | PHY Address |
|-------------|-------------|
| RMAC Port 0 | 0x08        |
| RMAC Port 1 | 0x09        |
| ...         | ...         |
| RMAC Port 7 | 0x0F        |
| CMAC Port 8 | NA          |
| GMAC Port 9 | 0x10        |

**Table 4 - PHY Addresses**

## 2.3 Management Module

The CPU can send a control frame to access or configure the internal network management database. The Management Module decodes the control frame and executes the functions requested by the CPU.

This module is only active in managed mode. In unmanaged mode, no control frame is accepted by the device.

## 2.4 Frame Engine

The main function of the frame engine is to forward a frame to its proper destination port or ports. When a frame arrives, the frame engine parses the frame header (64 bytes) and formulates a switching request, sent to the search engine, to resolve the destination port. The arriving frame is moved to the internal memory. After receiving a switch response from the search engine, the frame engine performs transmission scheduling based on the frame's priority. The frame engine forwards the frame to the MAC module when the frame is ready to be sent.

## 2.5 Search Engine

The Search Engine resolves the frame's destination port or ports according to the destination MAC address (L2) by searching the database. It also performs unicast MAC learning, trunking functions, and priority assignment.

## 2.6 Heartbeat Packet Generation and Response

The ZL50407 provides the ability to monitor a link and detect a simple link failure. The Link Heart Beat (LHB) packet generation module allows simultaneous tracking of all the RMAC ports.

Periodically, a LHB message will be sent for each link when inactivity is detected within a programmable time period. If a reply is not received in a specified amount of time, the failover detection module will identify a point-to-point failure for that link. The failover detection module will then interrupt the CPU.

The LHB packet response module can also reply to LHB messages initiated by other ZL50407 devices in the system, or by non-ZL50407 devices which use a conventional and recognizable LHB message format.

## 2.7 Timeout Reset Monitor

The ZL50407 supports a state machine monitoring block which can trigger a reset or interrupt if any state machine is determined to be stuck in a non-idle state for more than 5 seconds. This feature is enabled via a bootstrap pin (TSTOUT12). It also requires some register configuration via the CPU interface.

See Programming Timeout Reset application note, ZLAN-41, for more information.

## 2.8 JTAG

An IEEE1149.1 compliant test interface is provided for boundary scan. The JTAG interface, collectively known as a Test Access Port, or TAP, uses the following signals to support the operation of boundary scan:

- TCK – the TCK or 'test clock' synchronizes the internal state machine operations
- TMS – the TMS or 'test mode state' is sampled at the rising edge of TCK to determine the next state
- TDI – the TDI or 'test data in' represents the data shifted into the device's test or programming logic. It is sampled at the rising edge of TCK when the internal state machine is in the correct state
- TDO – the TDO or 'test data out' represents the data shifted out of the device's test or programming logic and is valid on the falling edge of TCK when the internal state machine is in the correct state
- TRST – the TRST or 'test reset' is an optional pin which, when available, can reset the TAP controller's state machine

### 2.8.1 Registers

There are two types of registers associated with boundary scan. Each compliant device has one instruction register and two or more data registers.

- Instruction Register – the instruction register holds the current instruction. Its content is used by the TAP controller to decide what to do with signals that are received. Most commonly, the content of the instruction register will define to which of the data registers signals should be passed.
- Data Registers – there are three primary data registers, the Boundary Scan Register (BSR), the BYPASS register and the IDCODES register. Other data registers may be present, but they are not required as part of the JTAG standard.
  - BSR – this is the main testing data register. It is used to move data to and from the 'pins' on a device.
  - BYPASS – this is a single-bit register that passes information from TDI to TDO. It allows other devices in a circuit to be tested with minimal overhead.
  - IDCODES – this register contains the ID code and revision number for the device. This information allows the device to be linked to its Boundary Scan Description Language (BSDL) file. The file contains details of the Boundary Scan configuration for the device.

### 2.8.2 Test Access Port (TAP) Controller

The TAP controller, a state machine whose transitions are controlled by the TMS signal, controls the behaviour of the JTAG system. For more detail on each state, refer to the IEEE 1149.1 Standard JTAG document.

### 2.8.3 Boundary Scan Instructions

The IEEE 1149.1 standard defines a set of instructions that must be available for a device to be considered compliant. These instructions are:

- **BYPASS** – the BYPASS instruction causes the TDI and TDO lines to be connected via a single-bit pass-through register (the BYPASS register). This instruction allows the testing of other devices in the JTAG chain without any unnecessary overhead.
- **EXTEST** – the EXTEST instruction causes the TDI and TDO to be connected to the Boundary Scan Register (BSR). The device's pin states are sampled with the 'capture dr' JTAG state and new values are shifted into the BSR with the 'shift dr' state; these values are then applied to the pins of the device using the 'update dr' state.
- **SAMPLE/PRELOAD** – the SAMPLE/PRELOAD instruction causes the TDI and TDO to be connected to the BSR. However, the device is left in its normal functional mode. During this instruction, the BSR can be accessed by a data scan operation to take a sample of the functional data entering and leaving the device. The instruction is also used to preload test data into the BSR prior to loading an EXTEST instruction.

Other available instructions for the ZL50407 include:

- **IDCODE** – the IDCODE instruction causes the TDI and TDO to be connected to the IDCODE register.
- **HIGHZ** – the HIGHZ instruction causes all of the logic outputs to be placed in an inactive drive state (e.g., high impedance).

## 3.0 Management and Configuration

One extra port is dedicated to the CPU via the CPU interface module. Two modes this port can operate: lightly managed or unmanaged mode. The different between these modes is tx/rx Ethernet frame, tx/rx control frame and receiving interrupt due to the lack of constant attention or processing power from the CPU.

Supported CPU interface modes are

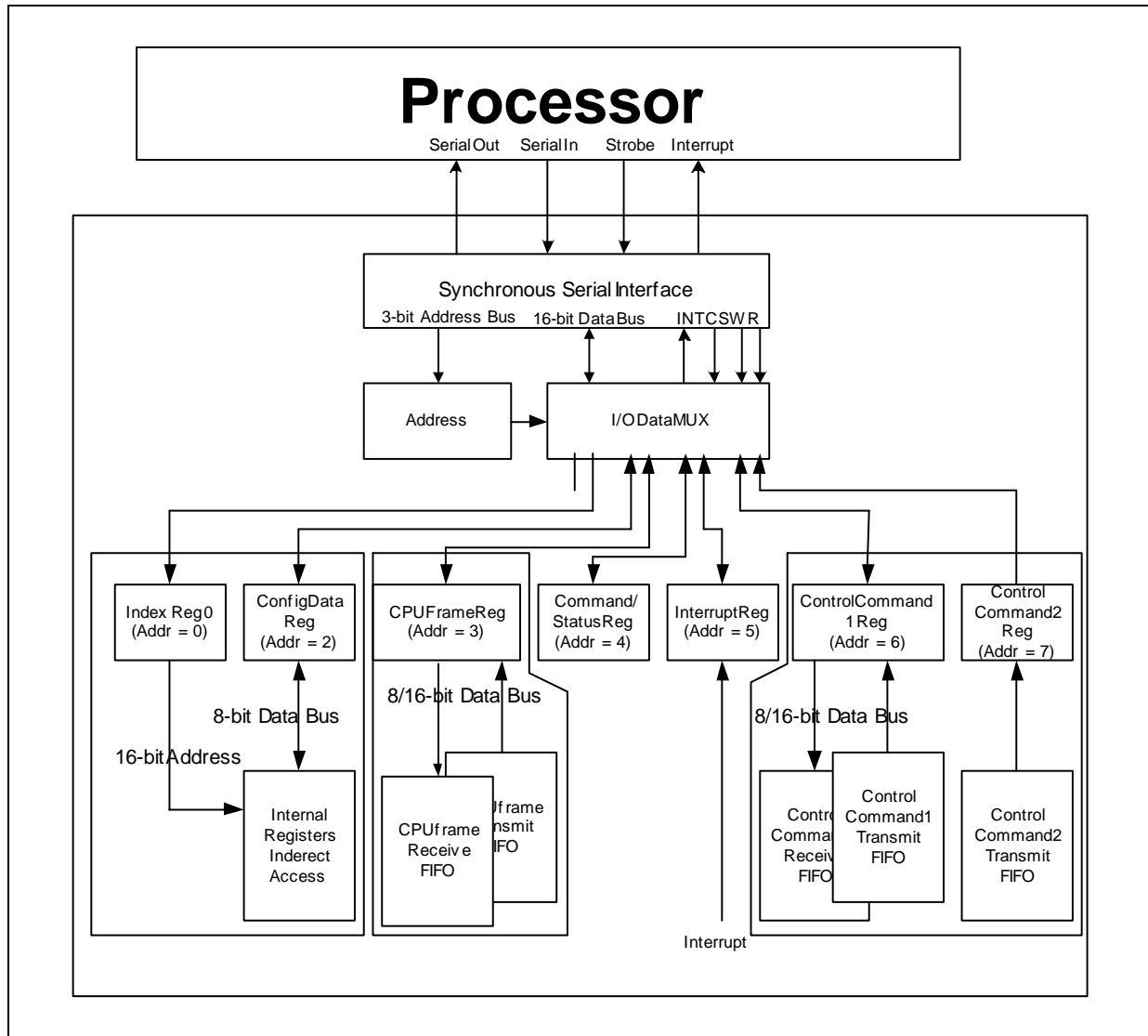
| Operation Mode         | ISA Interface | Serial | MII | I <sup>2</sup> C |
|------------------------|---------------|--------|-----|------------------|
| Lightly Managed Serial | NA            | Yes    | No  | No               |
| Unmanaged Serial       | NA            | Yes    | No  | Yes              |

**Table 5 - Supported CPU interface modes**

1. Lightly Managed Serial. Configuration registers access, Control frame and CPU transmit/receive packets are sent through a synchronous serial interface (SSI) bus.
2. Unmanaged Serial. The device can be configured by EEPROM using an I<sup>2</sup>C interface at bootup, or via a synchronous serial interface (SSI) otherwise. All configuration registers and internal control blocks are accessible by the interface. However, the CPU cannot receive or transmit frames nor will it receive any interrupt information.

The CPU interface provides for easy and effective management of the switching system.

Figure 4 on page 28 provides an overview of the SSI interface.



**Figure 4 - Overview of the SSI Interface**

### 3.1 Register Configuration, Frame Transmission and Frame Reception

#### 3.1.1 Register Configuration

The ZL50407 has many programmable parameters, covering such functions as QoS weights, VLAN control, and port mirroring setup. In managed mode, the CPU interface provides an easy way of configuring these parameters. The parameters are contained in 8-bit configuration registers. The device allows indirect access to these registers, as follows:

- In serial mode, the address, command and data are shifted in serially. To access the configuration registers, an “index” register (addresses 000b) needs to be written with the configuration register address. The desired data can be written into or read from the “data” register (address 010b).
- For example, if “XX” is required to be written to register “YY”, a write of “YY” is required to write to address “000b” (Index register). Then, a write of “XX” is required to write to address “010b” (Data Register). This completes the register write and register “YY” will contain the value of “XX”.

- To indirectly configure the register addressed by the index register, a “data” register (address 010b) must be written with the desired 8-bit data.
  - The ZL50407 supports special register-write in serial mode. This allows CPU to write to two consecutive configuration registers in a single write operation. By writing to bit[14] of configuration register address, CPU can write 16-bit data to address 010b. Lower 8 bit of data is for the address specified in index register and upper 8 bit of data is for the address + 1.

|            |         |          |                         |    |   |
|------------|---------|----------|-------------------------|----|---|
| 15         | 14      | 13       | 12                      | 11 | 0 |
| INC<br>R/W | SP<br>W | Reserved | 12 Bit Register Address |    |   |

- Similarly, to read the value in the register addressed by the index register, the “data” register can now simply be read.
- The ZL50407 supports an incremental read/write. If CPU requires to read or write to the configuration registers incrementally, CPU only has to write to index register once with the MSB of configuration register address set and then CPU can continuously reading or writing to “data” register (010b).

In summary, access to the many internal registers is carried out simply by directly accessing only two registers – one register to indicate the index of the desired parameter, and one register to read or write a value. Of course, because there is only one bus master, there can never be any conflict between reading and writing the configuration registers.

### 3.1.2 Rx/Tx of Standard Ethernet Frames

In serial only mode, the Ethernet frame is transmitted and received through the CPU interface. There is no ability to send/receive Ethernet frames in unmanaged mode.

To transmit a frame from the CPU in serial only mode:

- The CPU writes to the “data frame” register (address 011) with the frame size, destination port number, and frame status. After writing all the transmitting status bytes, it then writes the data it wants to transmit (minimum 64 bytes).
- The ZL50407 forwards the Ethernet frame to the desired destination port, no longer distinguishing the fact that the frame originated from the CPU.

To receive a frame into the CPU in serial only mode:

- The CPU receives an interrupt when an Ethernet frame is available to be received.
- Frame information arrives first in the data frame register. This includes source port number, frame size, and VLAN tag.
- The actual data follows the frame information. The CPU uses the frame size information to read the frame out.

In summary, in serial only mode, receiving and transmitting frames to and from the CPU is a simple process that uses one direct access register only. The details of sending an Ethernet Frame via the CPU interface is described in the Processor Interface Application Note, ZLAN-26.

Although there is the ability to Tx/Rx Ethernet Frames via the serial interface in lightly managed mode, the ZL50407 is not meant to be used in a fully managed system. The speed of the serial interface limits management capability. For example, if the system is trying to implement port security, it would require a faster interface between the CPU and the ZL50407, such as the 8/16-bit interface or the serial + MII interface found on the managed device.

### 3.1.3 Control Frames

In addition to standard Ethernet frames described in the preceding section, the CPU is also called upon to handle special “Control frames,” generated by the ZL50407 and sent to the CPU. These proprietary frames are related to such tasks as statistics collection, MAC address learning, and aging, etc. All Control frames are up to 40 bytes long. Transmitting and receiving these frames is similar to transmitting and receiving Ethernet frames, except that the register accessed is the “Control frame data” register (address 111).

Specifically, there are the following types of control frames generated by the CPU and sent to the ZL50407:

- Memory read request
- Memory write request
- Learn Unicast MAC address
- Delete Unicast MAC address
- Search Unicast MAC address

**Note:** Memory read and write requests by the CPU may include all internal memories which include statistic counters, MAC address control link table and the 2 Mbit (256 KB) memory block.

In addition, the following types of Control frames are generated by the ZL50407 and sent to the CPU:

- Interrupt CPU when statistics counter rolls over
- Response to memory read request from CPU
- Learn Unicast MAC address
- Delete Unicast MAC address
- Response to search Unicast MAC address request from CPU

The format of the Control Frame is described in the Processor Interface application note, ZLAN-26.

Although there is the ability to Tx/Rx Control Frames via the serial interface in lightly managed mode, the ZL50407 is not meant to be used in a fully managed system. The speed of the serial interface limits management capability. For example, if the system is trying to manage the MAC learning/deletion, it would require a faster interface between the CPU and the ZL50407, such as the 8/16-bit interface found on the managed device.

## 3.2 I<sup>2</sup>C Interface

The I<sup>2</sup>C interface serves the function of configuring the ZL50407 at boot time. The master is the ZL50407, and the slave is the EEPROM memory.

The I<sup>2</sup>C interface uses two bus lines, a serial data line (SDA) and a serial clock line (SCL). The SCL line carries the control signals that facilitate the transfer of information from EEPROM to the switch. Data transfer is 8-bit serial and bidirectional, at 50 Kbps. Data transfer is performed between master and slave IC using a request / acknowledgment style of protocol. The master IC generates the timing signals and terminates data transfer. Figure 5 depicts the data transfer format. The slave address is the memory address of the EEPROM. Refer to “ZL50407 Register Description” on page 56 for I<sup>2</sup>C address for each register.

|       |               |     |     |                |     |        |     |        |     |      |
|-------|---------------|-----|-----|----------------|-----|--------|-----|--------|-----|------|
| START | SLAVE ADDRESS | R/W | ACK | DATA 1 (8bits) | ACK | DATA 2 | ACK | DATA M | ACK | STOP |
|-------|---------------|-----|-----|----------------|-----|--------|-----|--------|-----|------|

**Figure 5 - Data Transfer Format for I<sup>2</sup>C Interface**

### 3.2.1 Start Condition

Generated by the master (in our case, the ZL50407). The bus is considered to be busy after the Start condition is generated. The Start condition occurs if while the SCL line is High, there is a High-to-Low transition of the SDA line.

Other than in the Start condition (and Stop condition), the data on the SDA line must be stable during the High period of SCL. The High or Low state of SDA can only change when SCL is Low. In addition, when the I<sup>2</sup>C bus is free, both lines are High.

### 3.2.2 Address

The first byte after the Start condition determines which slave the master will select. The slave in our case is the EEPROM. The first seven bits of the first data byte make up the slave address.

### 3.2.3 Data Direction

The eighth bit in the first byte after the Start condition determines the direction (R/W) of the message. A master transmitter sets this bit to W; a master receiver sets this bit to R.

### 3.2.4 Acknowledgment

Like all clock pulses, the acknowledgment-related clock pulse is generated by the master. However, the transmitter releases the SDA line (High) during the acknowledgment clock pulse. Furthermore, the receiver must pull-down the SDA line during the acknowledge pulse so that it remains stable Low during the High period of this clock pulse. An acknowledgment pulse follows every byte transfer.

If a slave receiver does not acknowledge after any byte, then the master generates a Stop condition and aborts the transfer.

If a master receiver does not acknowledge after any byte, then the slave transmitter must release the SDA line to let the master generate the Stop condition.

### 3.2.5 Data

After the first byte containing the address, all bytes that follow are data bytes. Each byte must be followed by an acknowledge bit. Data is transferred MSB first.

### 3.2.6 Stop Condition

Generated by the master. The bus is considered to be free after the Stop condition is generated. The Stop condition occurs if while the SCL line is High, there is a Low-to-High transition of the SDA line.

## 3.3 Synchronous Serial Interface

The synchronous serial interface (SSI) serves the function of configuring the ZL50407 not at boot time but via a PC. The PC serves as master and the ZL50407 serves as slave. The protocol for the synchronous serial interface is nearly identical to the I<sup>2</sup>C protocol. The main difference is that there is no acknowledgment bit after each byte of data transferred. Debounce logic on the clock signal (STROBE) can be turned off to speedup command time.

3 ID bits are used to allow up to eight ZL50407 devices to share the same synchronous serial interface. The ID of each device can be setup by bootstrap.

To reduce the number of signals required, the register address, command and data are shifted in serially through the DATAIN pin. STROBE- pin is used as the shift clock. DATAOUT pin is used as data return path.

Each command consists of four parts.

- START pulse
- Register Address
- Read or Write command
- Data to be written or read back

Write operation can be aborted in the middle by sending an ABORT pulse to the ZL50407. Read operation can only be aborted before issuing the read command to the ZL50407.

A START command is detected when DATAIN is sampled high when STROBE- rise and DATAIN is sampled low when STROBE- fall.

An ABORT command is detected when DATAIN is sampled low when STROBE- rise and DATAIN is sampled high when STROBE- fall.

### 3.3.1 Write Command

All registers in ZL50407 can be modified through this synchronous serial interface. Once the data has been sent, two extra STROBE clocks must be generated to indicate the end of the write command. The DATAIN line is ignored for these two pulses.

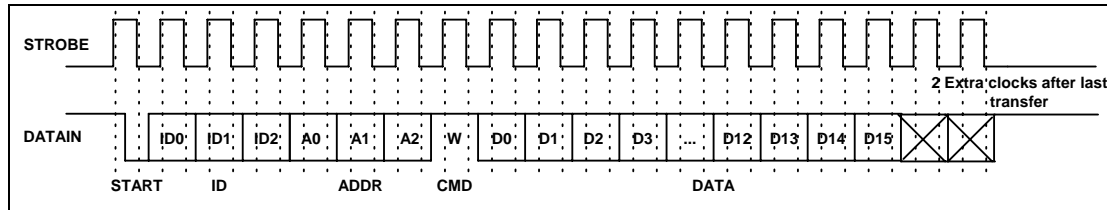


Figure 6 - Serial Interface Write Command Functional Timing

### 3.3.2 Read Command

All registers in ZL50407 can be read through this synchronous serial interface.

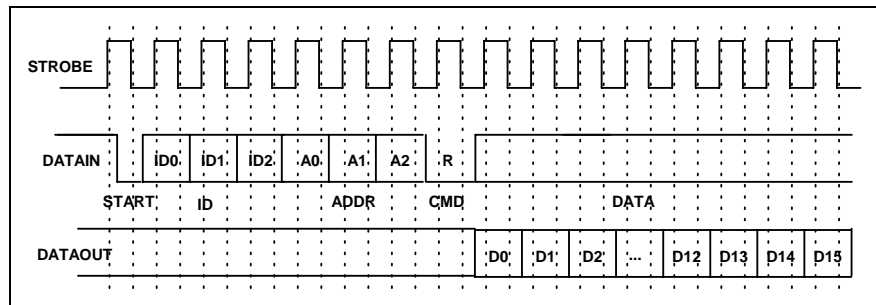


Figure 7 - Serial Interface Read Command Functional Timing

## 4.0 Data Forwarding Protocol

### 4.1 Unicast Data Frame Forwarding

When a frame arrives, it is assigned a handle in memory by the Frame Control Buffer Manager (FCB Manager). An FCB handle will always be available, because of advance buffer reservations.

The memory (SRAM) interface is a 64-bit bus, connected to internal memory block. The Receive DMA (RxDMA) is responsible for multiplexing the data and the address. On a port's "turn", the RxDMA will move 8 bytes (or up to the end-of-frame) from the port's associated Rx FIFO into memory (Frame Data Buffer, or FDB).

Once an entire frame has been moved to the FDB, and a good end-of-frame (EOF) has been received, the Rx interface makes a switch request. The RxDMA arbitrates among multiple switch requests.

The switch request consists of the first 64 bytes of a frame, containing among other things, the source and destination MAC addresses of the frame. The search engine places a switch response in the switch response queue of the frame engine when done. Among other information, the search engine will have resolved the destination port of the frame and will have determined that the frame is unicast.

After processing the switch response, the Transmission Queue Manager (TxQ manager) of the frame engine is responsible for notifying the destination port that it has a frame to forward. But first, the TxQ manager has to decide whether or not to drop the frame, based on global FDB reservations and usage, as well as TxQ occupancy at the destination. If the frame is not dropped, then the TxQ manager links the frame's FCB to the correct per-port-per-class TxQ. The switch response will come with 8 classified results. The TxQ manager will map this result into the per-port-per-class queue. Unicast TxQ's are linked lists of transmission jobs, represented by their associated frames' FCB's. There is one linked list for each transmission class for each port. There are 2



transmission classes for each of the 8 RMAC ports, and 4 classes for the GMAC and CPU ports – a total of 24 unicast queues.

The TxQ manager is responsible for scheduling transmission among the queues representing different classes for a port. When the port control module determines that there is room in the MAC Transmission FIFO (TxFIFO) for another frame, it requests the handle of a new frame from the TxQ manager. The TxQ manager chooses among the head-of-line (HOL) frames from the per-class queues for that port, using a Zarlink Semiconductor scheduling algorithm.

The Transmission DMA (TxDMA) is responsible for multiplexing the data and the address. On a port's turn, the TxDMA will move 8 bytes (or up to the EOF) from memory into the port's associated TxFIFO. After reading the EOF, the port control requests a FCB release for that frame. The TxDMA arbitrates among multiple buffer release requests.

The frame is transmitted from the TxFIFO to the line.

## 4.2 Multicast Data Frame Forwarding

After receiving the switch response, the TxQ manager has to make the dropping decision. A global decision to drop can be made, based on global FDB utilization and reservations. If so, then the FCB is released and the frame is dropped.

In addition, a selective decision to drop can be made, based on the TxQ occupancy at some subset of the multicast packet's destinations. If so, then the frame is dropped at some destinations but not others, and the FCB is not released.

If the frame is not dropped at a particular destination port, then the TxQ manager formats an entry in the multicast queue for that port and class. Multicast queues are physical queues (unlike the linked lists for unicast frames). There are 2 multicast queues for each of the 8 RMAC ports. There are 4 multicast queues for the GMAC and CPU ports. The mapping from the classified result to the priority queue is the same as the unicast traffic. By default, for the RMAC ports to map the 8 transmit priorities into 2 multicast queues, the 2 LSB are discarded. For the GMAC and CPU ports, to map the 8 transmit priorities into 4 multicast queues, the LSB is discarded. The priority mapping can be modified through memory configuration command. The multicast queue that is in FIFO format shares the space in the internal memory block. The size and starting address can also be programmed through memory configuration command.

During scheduling, the TxQ manager treats the unicast queue and the multicast queue of the same class as one logical queue. The older head of line of the two queues is forwarded first. The port control requests a FCB release only after the EOF for the multicast frame has been read by all ports to which the frame is destined.

## 4.3 Frame Forwarding To and From CPU

Frame forwarding from the CPU port to a regular transmission port is nearly the same as forwarding between transmission ports. The only difference is that the physical destination port must be indicated in addition to the destination MAC address.

Frame forwarding to the CPU port is nearly the same as forwarding to a regular transmission port. The only difference is in frame scheduling. Instead of using the patent-pending Zarlink Semiconductor scheduling algorithms, scheduling for the CPU port is simply based on strict priority. That is, a frame in a high priority queue will always be transmitted before a frame in a lower priority queue. There are four output queues to the CPU and one receive queue.

## 5.0 Search Engine

### 5.1 Search Engine Overview

The ZL50407 search engine is optimized for high throughput searching, with enhanced features to support:

- Up to 4 K of Unicast MAC addresses
- Up to 8 groups of port trunking
- Traffic classification into 2 (or 4 for GMAC) transmission priorities, and 2 drop precedence levels
- Packet filtering based on MAC address, Protocol or Logical Port number
- Security
- Individual Flooding, Broadcast, Multicast Storm Control
- MAC address learning and aging

### 5.2 Basic Flow

Shortly after a frame enters the ZL50407 and is written to the Frame Data Buffer (FDB), the frame engine generates a Switch Request, which is sent to the search engine. The switch request consists of the first 64 bytes of the frame, which contain all the necessary information for the search engine to perform its task. When the search engine is done, it writes to the Switch Response Queue, and the frame engine uses the information provided in that queue for scheduling and forwarding.

In performing its task, the search engine extracts and compresses the useful information from the 64-byte switch request. Among the information extracted are the source and destination MAC addresses, the packet's VLAN ID, and whether the frame is unicast or multicast or broadcast. Requests are sent to the SRAM to locate the associated entries in the MCT table.

When all the information has been collected from the SRAM, the search engine has to compare the MAC address on the current entry with the MAC address for which it is searching. If it is not a match, the process is repeated on the internal MCT Table. All MCT entries other than the first of each linked list are maintained internal to the chip. If the desired MAC address is still not found, then the result is either learning (source MAC address unknown) or flooding (destination MAC address unknown).

If the destination MAC address belongs to a port trunk, then the trunk number is retrieved instead of the port number. The selection of the port within the trunk that will transmit the frame is computed using a hash of the source and/or destination MAC addresses.

When all the information is compiled, the switch response is generated, as stated earlier. The search engine also interacts with the CPU with regard to learning and aging.

### 5.3 Search, Learning and Aging

#### 5.3.1 MAC Search

The search block performs source MAC address and destination MAC address searching. As we indicated earlier, if a match is not found, then the next entry in the linked list must be examined, and so on until a match is found or the end of the list is reached.

In port based VLAN mode, a bit map is used to determine whether the frame should be forwarded to the outgoing port. The main difference in this mode is that the bit map is not dynamic. Ports cannot enter and exit groups because of real-time learning made by a CPU.

The MAC search block is also responsible for updating the source MAC address timestamp used for aging. Moreover, if port trunking is enabled, this block selects the destination port (among those in the trunk group).

### 5.3.2 Learning

The learning module learns new MAC addresses and performs port change operations on the MCT database. The goal of learning is to update this database as the networking environment changes over time.

When CPU reporting is enabled, learning and port change will be performed when the CPU request queue has room, and a “Learn MAC Address” message is sent to the CPU.

### 5.3.3 Aging

Aging time is controlled by register 400h and 401h.

The aging module scans and ages MCT entries based on a programmable “age out” time interval. As we indicated earlier, the search module updates the source MAC address timestamps for each frame it processes. When an entry is ready to be aged, the entry is removed from the table, and a “Delete MAC Address” message is sent to inform the CPU.

Supported MAC entry types are: dynamic, static, source filter, destination filter, source and destination filter, and secure MAC addresses. Only dynamic entries can be aged; all others are static. The entry type is stored in the “status” field of the MCT data structure.

## 5.4 MAC Address Filtering

The ZL50407's implementation of intelligent traffic switching provides filters for source and destination MAC addresses. This feature filters unnecessary traffic, thereby providing intelligent control over traffic flows and broadcast traffic.

MAC address filtering allows the ZL50407 to block an incoming packet to an interface when it sees a specified MAC address in either the source address or destination address of the incoming packet. For example, if your network is congested because of high utilization from a MAC address, you can filter all traffic transmitted from that address and restore network flow, while you troubleshoot the problem.

## 5.5 Protocol Filtering

Packet filtering can be performed based on protocol type field in the packets. Up to eight protocols can be programmed to filter or allow packet to pass through the switch.

## 5.6 Logical Port Filtering

Similar to protocol filtering, if the packet's logical ports match the programmable registers, the packet can be filtered or passed through the switch. Up to eight programmable ports and one ranges can be assigned.

## 5.7 Quality of Service

Quality of Service (QoS) refers to the ability of a network to provide better service to selected network traffic over various technologies. Primary goals of QoS include dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics.

Traditional Ethernet networks have had no prioritization of traffic. Without a protocol to prioritize or differentiate traffic, a service level known as “best effort” attempts to get all the packets to their intended destinations with minimum delay; however, there are no guarantees. In a congested network or when a low-performance switch/router is overloaded, “best effort” becomes unsuitable for delay-sensitive traffic and mission-critical data transmission.

The advent of QoS for packet-based systems accommodates the integration of delay-sensitive video and multimedia traffic onto any existing Ethernet network. It also alleviates the congestion issues that have previously plagued such “best effort” networking systems. QoS provides Ethernet networks with the breakthrough technology to prioritize traffic and ensure that a certain transmission will have a guaranteed minimum amount of bandwidth.

Extensive core QoS mechanisms are built into the ZL50407 architecture to ensure policy enforcement and buffering of the ingress port, as well as weighted fair-queue (WFQ) scheduling at the egress port.

In the ZL50407, QoS-based policies sort traffic into a small number of classes and mark the packets accordingly. The QoS identifier provides specific treatment to traffic in different classes, so that different quality of service is provided to each class. Frame and packet scheduling and discarding policies are determined by the class to which the frames and packets belong. For example, the overall service given to frames and packets in the premium class will be better than that given to the standard class; the premium class is expected to experience lower loss rate or delay.

The ZL50407 supports the following QoS techniques:

- In a port-based setup, any station connected to the same physical port of the switch will have the same transmit priority.
- In a tag-based setup, a 3-bit field in the VLAN tag provides the priority of the packet. This priority can be mapped to different queues in the switch to provide QoS.
- In a TOS/DS-based set up, TOS stands for “Type of Service” that may include “minimize delay,” “maximize throughput,” or “maximize reliability.” Network nodes may select routing paths or forwarding behaviours that are suitably engineered to satisfy the service request.
- In a logical port-based set up, a logical port provides the application information of the packet. Certain applications are more sensitive to delays than others; using logical ports to classify packets can help speed up delay sensitive applications, such as VoIP.

## 5.8 Priority Classification Rule

Figure 8 shows the ZL50407 priority classification rule.

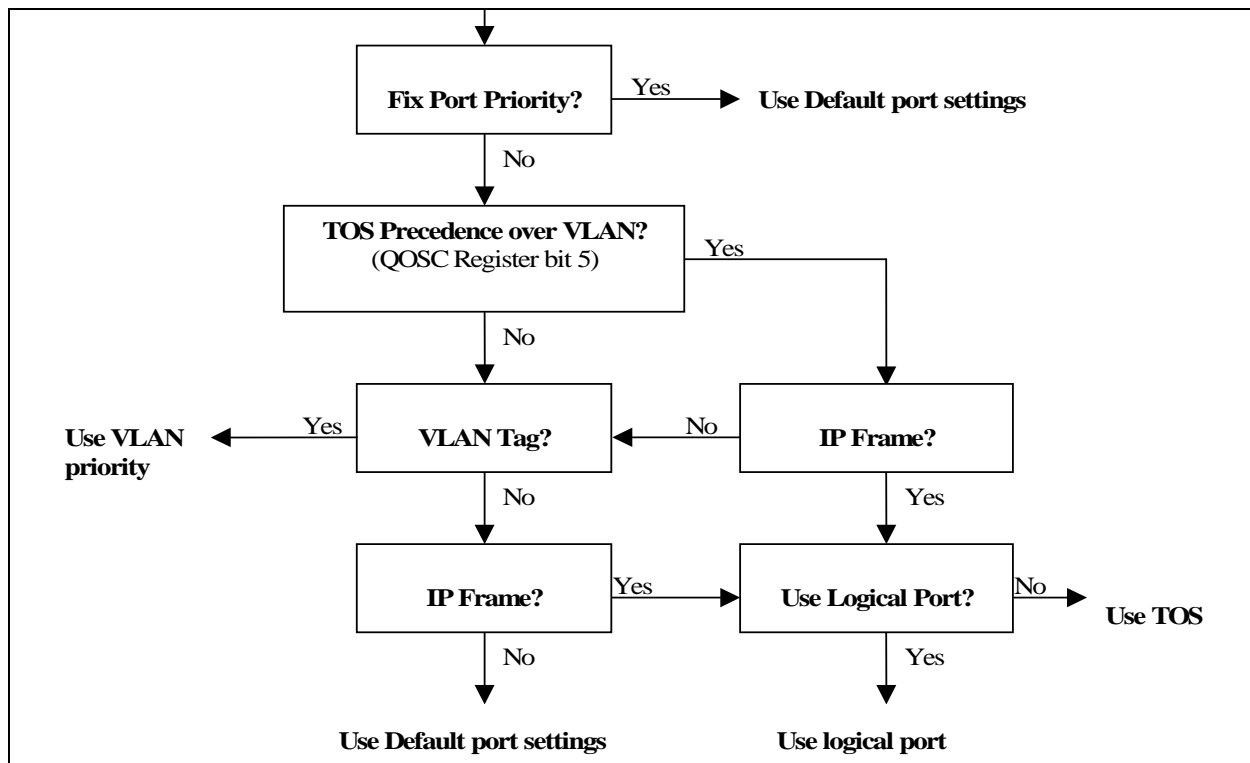


Figure 8 - Priority Classification Rule

## 5.9 Port Based VLAN

An administrator can use the PVMAP Registers to configure the ZL50407 for port-based VLAN (see “Register Definition” on page 56). For example, ports 1-3 might be assigned to the Marketing VLAN, ports 4-6 to the Engineering VLAN, and ports 7-9 to the Administrative VLAN. The ZL50407 determines the VLAN membership of each packet by noting the port on which it arrives. From there, the ZL50407 determines which outgoing port(s) is/are eligible to transmit each packet, or whether the packet should be discarded.

|  | Destination Port Numbers Bit Map |     |   |   |   |
|--|----------------------------------|-----|---|---|---|
| Port Registers   | 9                                | ... | 2 | 1 | 0 |
| Register for Port #0<br>PVMAP00_0[7:0] to PVMAP00_1[1:0] | 0                                |     | 1 | 1 | 0 |
| Register for Port #1<br>PVMAP01_0[7:0] to PVMAP01_1[1:0] | 0                                |     | 1 | 0 | 1 |
| Register for Port #2<br>PVMAP02_0[7:0] to PVMAP02_1[1:0] | 0                                |     | 0 | 0 | 0 |
| ...  |                                  |     |   |   |   |
| Register for Port #9<br>PVMAP09_0[7:0] to PVMAP09_1[1:0] | 0                                |     | 0 | 0 | 0 |

**Table 6 - Port-Based VLAN Mapping**

For example, in the above table a 1 denotes that an outgoing port is eligible to receive a packet from an incoming port. A 0 (zero) denotes that an outgoing port is not eligible to receive a packet from an incoming port.

In this example:

- Data packets received at port #0 are eligible to be sent to outgoing ports 1 and 2.
- Data packets received at port #1 are eligible to be sent to outgoing ports 0 and 2.
- Data packets received at port #2 are **NOT** eligible to be sent to ports 0 and 1.

## 6.0 Frame Engine

### 6.1 Data Forwarding Summary

When a frame enters the device at the RxMAC, the RxDMA will move the data from the MAC Rx FIFO to the FDB. Data is moved in 8-byte granules in conjunction with the scheme for the SRAM interface.

A switch request is sent to the Search Engine. The Search Engine processes the switch request.

A switch response is sent back to the Frame Engine and indicates whether the frame is unicast or multicast, and its destination port or ports. On receiving the response, the Frame Engine will check all the QoS related information and decide if this frame can be forwarded.

A Transmission Scheduling Request is sent in the form of a signal notifying the TxQ manager. Upon receiving a Transmission Scheduling Request, the device will format an entry in the appropriate Transmission Scheduling Queue (TxSch Q) or Queues. There are 2 TxSch Q for each RMAC port (and 4 per GMAC and CPU ports), one for each priority. Creation of a queue entry either involves linking a new job to the appropriate linked list if unicast, or adding an entry to a physical queue if multicast.

When the port is ready to accept the next frame, the TxQ manager will get the head-of-line (HOL) entry of one of the TxSch Qs, according to the transmission scheduling algorithm (so as to ensure per-class quality of service). (The unicast linked list and the multicast queue for the same port-class pair are treated as one logical queue. The older HOL between the two queues goes first.

The TxDMA will pull frame data from the memory and forward it granule-by-granule to the MAC TxFIFO of the destination port.

## 6.2 Frame Engine Details

This section briefly describes the functions of each of the modules of the ZL50407 frame engine.

### 6.2.1 FCB Manager

The FCB manager allocates FCB handles to incoming frames, and releases FCB handles upon frame departure. The FCB manager is also responsible for enforcing buffer reservations and limits that will be used for QoS control and source port flow control. The default values can be determined by referring to Section 7.6 on page 41. The frame buffer is managed in a 128bytes block unit. During initialization, this block will link all the available blocks in a free buffer list. When each port is ready to receive, this module hands the buffer handle to each requesting port. The FCB manager will also link the released buffer back into the free buffer list.

The maximum buffer size can be increased from the standard 1518 bytes (1522 with VLAN tag) to up to 4 K bytes. This is done using BUF\_LIMIT, and is enabled on a per port basis via bit [1] in ECR3Pn. See Buffer Allocation application note, ZLAN-47, for more information.

### 6.2.2 Rx Interface

The Rx interface is mainly responsible for communicating with the RxMAC. It keeps track of the start and end of frame and frame status (good or bad). Upon receiving an end of frame that is good, the Rx interface makes a switch request.

### 6.2.3 RxDMA

The RxDMA arbitrates among switch requests from each Rx interface. It also buffers the first 64 bytes of each frame for use by the search engine when the switch request has been made.

### 6.2.4 TxQ Manager

First, the TxQ manager checks the per-class queue status and global reserved resource situation, and using this information, makes the frame dropping decision after receiving a switch response. The dropping decision includes the head-of-link blocking avoidance if the source port is not flow control enabled. If the decision is not to drop, the TxQ manager links the unicast frame's FCB to the correct per-port-per-class TxQ and updates the FCB information. If multicast, the TxQ manager writes to the multicast queue for that port and class and also update the FCB information including the duplicate count for this multicast frame. The TxQ manager can also trigger source port flow control for the incoming frame's source if that port is flow control enabled. Second, the TxQ manager handles transmission scheduling; it schedules transmission among the queues representing different classes for a port. Once a frame has been scheduled, the TxQ manager reads the FCB information and writes to the correct port control module. The detail of the QoS decision guideline is described in chapter 5.

### 6.2.5 Port Control

The port control module calculates the SRAM read address for the frame currently being transmitted. It also writes start of frame information and an end of frame flag to the MAC TxFIFO. When transmission is done, the port control module requests that the buffer be released.

### 6.2.6 TxDMA

The TxDMA multiplexes data and address from port control, and arbitrates among buffer release requests from the port control modules.

## 7.0 Quality of Service and Flow Control

### 7.1 Model

Quality of service is an all-encompassing term for which different people have different interpretations. In general, the approach to quality of service described here assumes that we do not know the offered traffic pattern. We also assume that the incoming traffic is not policed or shaped. Furthermore, we assume that the network manager knows his applications, such as voice, file transfer, or web browsing, and their relative importance. The manager can then subdivide the applications into classes and set up a service contract with each. The contract may consist of bandwidth or latency assurances per class. Sometimes it may even reflect an estimate of the traffic mix offered to the switch. As an added bonus, although we do not assume anything about the arrival pattern, if the incoming traffic is policed or shaped, we may be able to provide additional assurances about our switch's performance.

A class is capable of offering traffic that exceeds the contracted bandwidth. A well-behaved class offers traffic at a rate no greater than the agreed-upon rate. By contrast, a misbehaving class offers traffic that exceeds the agreed-upon rate. A misbehaving class is formed from an aggregation of misbehaving microflows. To achieve high link utilization, a misbehaving class is allowed to use any idle bandwidth. However, such leniency must not degrade the quality of service (QoS) received by well-behaved classes.

Each traffic type may each have their own distinct properties and applications. Classes may receive bandwidth assurances or latency bounds. For example, the highest transmission class may require that all frames receive 50% of the 100 Mbps of bandwidth at that port.

Best-effort (P0) traffic forms a class that only receives bandwidth when none of the other classes have any traffic to offer. It is also possible to add a class that has strict priority over all others; if this class has even one frame to transmit, then it goes first. In the ZL50407, each RMAC port will support two total classes, and the GMAC port will support four classes. We will discuss the various modes of scheduling these classes in the next section.

In addition, each transmission class has two subclasses, high-drop and low-drop. Well-behaved users should rarely lose packets. But poorly behaved users—users who send frames at too high a rate – will encounter frame loss, and the first to be discarded will be high-drop. Of course, if this is insufficient to resolve the congestion, eventually some low-drop frames are dropped, and then all frames in the worst case. For example, casual web browsing fits into the category of high-loss, high-latency-tolerant traffic, whereas VoIP fits into the category of low-loss, low-latency traffic.

### 7.2 Two QoS Configurations

There are two basic pieces to QoS scheduling in the GMAC port of ZL50407: strict priority (SP) or weighted fair queuing (WFQ). The only configuration for a RMAC and CPU port is strict priority between the queues.

#### 7.2.1 Strict Priority

When strict priority is part of the scheduling algorithm, if a queue has any frame to transmit, it goes first. For RMAC ports, this is an easy way to provide the different service. For all recognizable traffic, the bandwidth is guaranteed to 100% of the line rate. This scheme works as long as the overall high priority bandwidth is not over the line rate and the latency on all the low priority traffic is don't care. The lowest priority queue is treated as "best effort" queue.

The strict priority queue in the GMAC and CPU ports is similar to RMAC ports other than having 4 queues instead of 2 queues. The priority queue P0 can be scheduled only if the priority queue P1 is empty, so as to priority queues P2 and P3.

Because we do not provide any assurances for "best effort" traffic, we do not enforce latency by dropping best effort traffic. Furthermore, because we assume that strict priority traffic is carefully controlled before entering the ZL50407, we do not enforce a fair bandwidth partition by dropping strict priority traffic. To summarize, dropping to enforce bandwidth or delay does not apply to strict priority or best effort queues. We only drop frames from best effort and strict priority queues when queue size is too long or global / class buffer resources become scarce.

### 7.2.2 Weighted Fair Queuing

In some environments – for example, in an environment in which delay assurances are not required, but precise bandwidth partitioning on small time scales is essential, WFQ may be preferable to a strict assurance scheduling discipline. The ZL50407 provides this kind of scheduling algorithm on GMAC port only. The user sets four WFQ “weights” such that all weights are whole numbers and sum to 64. This provides per-class bandwidth partitioning with granular within 2%.

In WFQ mode, though we do not assure frame latency, the ZL50407 still retains a set of dropping rules that helps to prevent congestion and trigger higher level protocol end-to-end flow control.

### 7.3 WRED Drop Threshold Management Support

To avoid congestion, the Weighted Random Early Detection (WRED) logic drops packets according to specified parameters. The following table summarizes the behavior of the WRED logic.

|           | <b>Px &gt; WRED_L1</b> | <b>Px &gt; WRED_L2</b> | <b>BM Reject</b> |
|-----------|------------------------|------------------------|------------------|
| High Drop | X%                     | 100%                   | 100%             |
| Low Drop  | Y%                     | Z%                     | 100%             |

**Table 7 - WRED Logic Behaviour**

Px is the total byte count, in the priority queue x, can be the strict priority queue of RMAC ports and higher 3 priority queues for GMAC port. The WRED logic has two drop levels, depending on the value of Px. Each drop level has defined high-drop and low-drop percentages, which indicate the minimum and maximum percentages of the data that can be discarded. The X, Y Z percent can be programmed by the register RDRC0, RDRC1. All packets will be dropped only if the system runs out of the specific buffer resource, per class buffer or per source port buffer. The WRED thresholds of each queue can be programmed by the QoS control registers (refer to the register group 8). See Programming QoS Registers application note, ZLAN-42, for more information.

### 7.4 Shaper

Although traffic shaping is not a primary function of the ZL50407, the chip does implement a shaper for every queue in the GMAC port. Our goal in shaping is to control the average rate of traffic exiting the ZL50407. If shaper is enabled, strict priority will be applied to that queue. The priority between two shaped queue is the same as in strict priority scheduling.

Traffic rate is set using a programmable whole number, no greater than 64. For example, if the setting is 32, then the traffic rate transmit out of the shaped queue is  $32/64 * 1000 \text{ Mbps} = 500 \text{ Mbps}$ . See Programming QoS Register application note, ZLAN-42, for more information.

Also, when shaping is enabled, it is possible for a queue to explode in length if fed by a greedy source. The reason is that a shaper is by definition not work-conserving; that is, it may hold back from sending a packet even if the line is idle. Though we do have global resource management, we do nothing other than per port WRED to prevent this situation locally. We assume the traffic is policed at a prior stage to the ZL50407 or WRED dropping is fine and shall restrain this situation.

### 7.5 Rate Control

The ZL50407 provides a rate control function on its RMAC ports. The concept is much the same as shaping, except that it applies to both ingress and egress directions and the control is per port rather than per queue. It provides a way of reducing the total bandwidth of all frames received from or transmitted to a port, to a rate below wire speed. As with shaping, the maximum burst size can also be configured.

Rate control may be a valuable feature on RMAC ports in access applications where the service provider would like to limit the traffic received and transmitted by each port independently of each other, and independently of the



physical line rate. The service provider can then provide differential pricing, based on the negotiated bandwidth requirements for each user. In such applications of the ZL50407, the GMAC port is viewed as an uplink port, where rate control is not desired.

See Rate Control application note, ZLAN-33, for more information.

## 7.6 Buffer Management

Because the number of FDB slots is a scarce resource, and because we want to ensure that one misbehaving source port or class cannot harm the performance of a well-behaved source port or class, we introduce the concept of buffer management into the ZL50407. Our buffer management scheme is designed to divide the total buffer space into numerous reserved regions and one shared pool, as shown in Figure 9 on page 41.

As shown in the figure, the FDB pool is divided into several parts. A reserved region for temporary frames stores frames prior to receiving a switch response. Such a temporary region is necessary, because when the frame first enters the ZL50407, its destination port and class are as yet unknown, and so the decision to drop or not needs to be temporarily postponed. This ensures that every frame can be received first before subjecting them to the frame drop discipline after classifying.

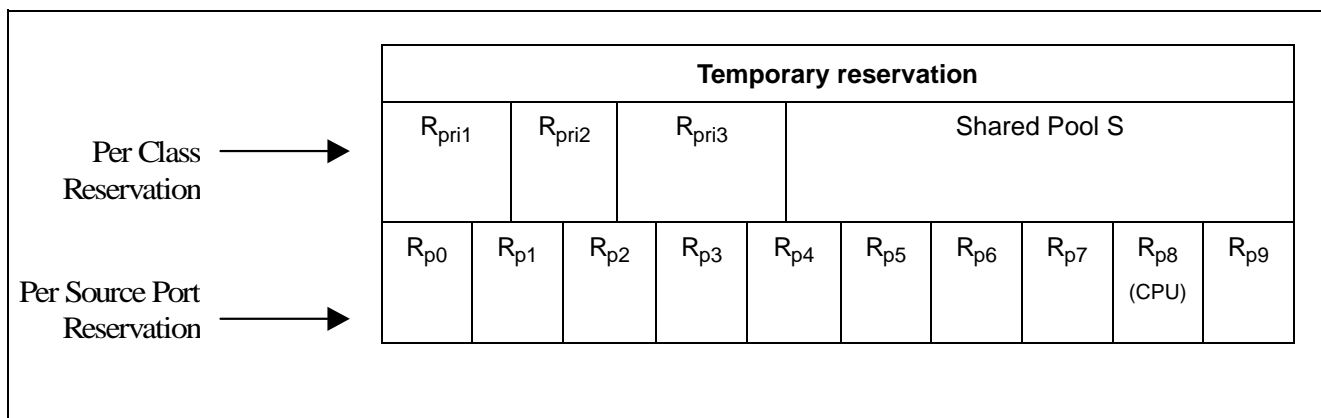
Three priority sections, one for each pair of the first six priority classes, ensure a programmable number of FDB slots per class. The lowest two classes do not receive any buffer reservation. Furthermore, a frame is stored in the region of the FDB corresponding to its class. As we have indicated, the eight classes use only two transmission scheduling queues for RMAC ports (four queues for the GMAC & CPU ports), but as far as buffer usage is concerned, there are still eight distinguishable classes.

Another segment of the FDB reserves space for each of the 10 ports — 9 ports for Ethernet and one CPU port (port number 8). Each port has its own programmable source port reservation. These 10 reserved regions make sure that no well-behaved source port can be blocked by another misbehaving source port.

In addition, there is a shared pool, which can store any type of frame. The frame engine allocates the frames first in the three priority sections. When the priority section is full or the packet has priority 1 or 0, the frame is allocated in the shared pool. Once the shared pool is full the frames are allocated in the section reserved for the source port.

The following registers define the size of each section of the Frame data Buffer:

- PR100\_N - Port Reservation for RMAC Ports
- PR100\_CPU - Port Reservation for CPU Port
- PRG - Port Reservation for GMAC Port
- SFCB - Share FCB Size
- C1RS - Class 1 Reserve Size (priority 2 & 3)
- C2RS - Class 2 Reserve Size (priority 4 & 5)
- C3RS - Class 3 Reserve Size (priority 6 & 7)



**Figure 9 - Buffer Partition Scheme**

See Buffer Allocation application note, ZLAN-47, for more information.

### 7.6.1 Dropping When Buffers Are Scarce

As already discussed, the WRED mechanism may drop frames on output queue status. In addition to these reasons for dropping, we also drop frames when global buffer space becomes scarce. The function of buffer management is to make sure that such dropping causes as little blocking as possible.

If a received frame is dispatched to the P0 (“best effort”) queue, the buffer management will check on the overall buffer situation plus the output queue status to decide the frame drop condition. If the source port has not enough buffer for it, the frame will be dropped. If the output queue reaches PCC (packet congest control) and the shared buffer has run out, the frame may be dropped by RED (at B%). If the output queue reaches PCC and the source port reservation is lower than the buffer low threshold, the frame will be dropped.

For multicast frames, global thresholds are used to manage scarce resources. When a multicast frame is received, the buffer management will check on the overall buffer situation. If total multicast resources reaches MCCTH (multicast congest control threshold), the frame may be dropped by RED (at B%). If total multicast resources reaches MCC, the frame will be dropped.

All the 100% dropping functions are disabled if the source port is flow control capable, however, RED (at B%) will still be applied.

## 7.7 Flow Control Basics

Because frame loss is unacceptable for some applications, the ZL50407 provides a flow control option. When flow control is enabled, scarcity of source port buffer space may trigger a flow control signal; this signal tells a source port sending a packet to this switch, to temporarily hold off.

While flow control offers the clear benefit of no packet loss, it also introduces a problem for quality of service. When a source port receives an Ethernet flow control signal, all microflows originating at that port, well-behaved or not, are halted. A single packet destined for a congested output can block other packets destined for un-congested outputs. The resulting head-of-line blocking phenomenon means that quality of service cannot be assured with high confidence when flow control is enabled.

On the other hand, the ZL50407 will still prioritize the received frame disregarding the outgoing port flow control capability. If a frame is classified as high priority, it is still subjected to the WRED, which means the no-loss on the high priority queue is not guaranteed. To resolve this situation, the user may set the output port WRED threshold so high that may never be reached, or program the priority mapping table in the queue manager to map all the traffic to “best effort” (P0) queue on the flow control capable port. The first method has side impact on the global resource management since the port may hold too much per class resource that is scarce in the system. The second method, by nature, lost the benefit of prioritization.

See Programming Flow Control Registers application note, ZLAN-44, for more information.

### 7.7.1 Unicast Flow Control

For unicast frames, flow control is triggered by source port resource availability. Recall that the ZL50407’s buffer management scheme allocates a reserved number of FDB slots for each source port. If a programmed number of a source port’s reserved FDB slots have been used, then flow control Xoff is triggered.

Xon is triggered when a port is currently being flow controlled, and all of that port’s reserved FDB slots have been released.

Note that the ZL50407’s per-source-port FDB reservations assure that a source port that sends a single frame to a congested destination will not be flow controlled.

### 7.7.2 Multicast Flow Control

Flow control for multicast frames is triggered by a global buffer counter. When the system exceeds a programmable threshold of multicast packets, Xoff is triggered. Xon is triggered when the system returns below this threshold.

**Note:** If per-port flow control is on, QoS performance will be affected.

### 7.8 Mapping to IETF Diffserv Classes

The mapping between priority classes discussed in this chapter and elsewhere is shown below.

|         |       |     |     |    |
|---------|-------|-----|-----|----|
| ZL50407 | P3    | P2  | P1  | P0 |
| IETF    | NM+EF | AF0 | AF1 | BE |

**Table 8 - Mapping to IETF Diffserv Classes for GMAC & CPU Ports**

As the table illustrates, the classes of Table 8 are merged in pairs— P3 is used for network management (NM) and expedited forwarding service (EF) frames. Classes P2 and P1 correspond to an assured forwarding (AF) group of size 2. Finally, P0 is for best effort (BE) class.

Features of the ZL50407 that correspond to the requirements of their associated IETF classes are summarized in the table below.

|   |  |
|---|--|
| Network management (NM) and Expedited forwarding (EF) | Global buffer reservation for NM and EF<br>Shaper for traffic on uplink port<br>No dropping if admission controlled  |
| Assured forwarding (AF)                               | Global buffer reservation for two AF classes<br>Shaper for traffic on uplink port<br>Random early discard, with programmable levels  |
| Best effort (BE)                                      | Service only when other queues are idle means that QoS not adversely affected<br>Shaper for traffic on uplink port<br>Random early discard, with programmable levels<br>Traffic from flow control enabled ports automatically classified as BE |

**Table 9 - ZL50407 Features Enabling IETF Diffserv Standards**

### 7.9 Failover Backplane Feature

The ZL50407 implements a hardware assisted link failure detection mechanism utilizing a Link Heart Beat (LHB) packet. The LHB packet format is defined as a 64-byte MAC control frame with a user defined opcode. The packet format is illustrated below:

|                   |                   |       |       |           |     |
|-------------------|-------------------|-------|-------|-----------|-----|
| 01-80-C2-00-00-01 | xx-xx-xx-xx-xx-xx | 88-08 | yy-yy | 00-00-... | CRC |
|-------------------|-------------------|-------|-------|-----------|-----|

Where “xx-xx-xx-xx-xx-xx” is the source port MAC address and “yy-yy” is the special opcode defined by register setup (LHBReg0,1). The opcode “00-01” is reserved for the flow control packet. We recommend opcode “00-12” for the LHB packet.

The LHB is done between two compatible MACs providing this function. A timer parameter will be set for both the receiver and transmitter (LHBTimer).

On the transmission side, the MAC will monitor the transmission activities. If there is no activity for more than the set period, a LHB packet will be sent to its link partner. Therefore, there should always be at least one packet transmitted from the MAC for every period specified.

On the receiving side, the MAC will also monitor the activity. If there is no good packet received for more than 2X the set period, an alarm will be raised to the CPU. The LHB packet is only used by the ZL50407 to reset the timeout counter, it is ignored otherwise (i.e. not passed on within the system).

See the Failover Protection Application Note, ZLAN-43, for more information.

## 8.0 Port Trunking

See Port Trunking application note, ZLAN-48, for more information.

### 8.1 Features and Restrictions

A port group (i.e., trunk) can include up to 8 physical ports, all of the ports in a group can be in the same ZL50407 or in multiple ZL50407 to form a fault tolerant link. There are eight trunk groups total.

Load distribution among the ports in a trunk for unicast is performed using hashing based on source MAC address and destination MAC address. Three other options include source MAC address only, destination MAC address only, and source port (in bidirectional ring mode only). Load distribution for multicast is performed similarly.

If a VLAN includes any of the ports in a trunk group, all the ports in that trunk group should be in the same VLAN member map.

The ZL50407 also provides a safe fail-over mode for port trunking automatically. If one of the ports in the trunking group goes down, the ZL50407 can redistribute the traffic over to the remaining ports in the trunk with software assistance.

### 8.2 Unicast Packet Forwarding

The search engine finds the destination MCT entry, and if the status field says that the destination port found belongs to a trunk, then the trunk group number is retrieved.

The source port of the packet is checked against the destination trunk group. If the source port belongs to the destination trunk group, the packet is discarded.

A hash key, based on some combination of the source and destination MAC addresses for the current packet, selects the appropriate forwarding port, as specified in the Trunk\_Hash registers. Each trunk has eight trunk\_hash registers which selects one of the potential eight outgoing ports. The hash key provides a pseudo flow identifier which force the same flow to the same destination flow. As a result, the packet will always arrive in order.

### 8.3 Multicast Packet Forwarding

Multicast frame forwarding is only slightly more complex than unicast frame forwarding in a port trunking environment:

1. Determine the VLAN to which the multicast frame belongs.
2. Is the frame's source port a member of the VLAN? If so, exclude that port. Is the frame's source port a member of a trunk group? If so, exclude all other ports in that group as well.
3. Finally, among the still-eligible members of the VLAN that belong to trunk groups, exclude all but one port from each trunk group. This selection is based on hashing or round robin, as in unicast frame forwarding.

Example: Ports 0, 1, and 2 belong to trunk group A. Ports 3 and 4 belong to trunk group B. A multicast frame is received from source port 3. Suppose that the VLAN of the frame has member ports 0, 1, 2, 3, 4, 5, and 6.

- Ports 0, 1, 2, 3, 4, 5, and 6 are potential destination ports for the frame.
- Port 3 is excluded as a destination because it is the frame's source port.

- Port 4 is excluded as a destination because it belongs to the same trunk group as port 3.
- Two of the three ports in trunk group A must now be excluded. The ZL330ENG hashing algorithm is applied, and in this example, assume that ports 0 and 1 are excluded.
- Therefore, ports 2, 5 and 6 comprise the final set of destination ports for the multicast frame.

## 9.0 Traffic Mirroring

See Traffic Mirroring application note, ZLAN-50, for more information.

### 9.1 Mirroring Features

Packets can be mirrored (duplicated) for network monitor purpose and/or network debug purpose. Three types of mirroring is available in ZL50407.

1. Source or Destination MAC address based
2. Flow based
3. Port based (RMII mode only)

In source or destination mac address based mirroring, the “M” bit of the mirroring MAC address in the MCT is set. Also, the user need to specify the mirroring MAC address is source or destination of the packet. If source is selected, any packet received with the mirroring MAC address as source MAC address will be copied to the mirrored port. In the same way, if destination is selected, any packet received with mirroring MAC address as destination MAC address will be copied to the mirrored port.

In flow based mirroring, a flow is established based on the source and destination mac address pair. When enabled, a packet with source and destination address match the pre-programmed source and destination mac address pair will be copied to the mirrored port. In reverse direction (source and destination match pre programmed destination and source), the flow can also be enabled and the frame will be copied to the mirrored port.

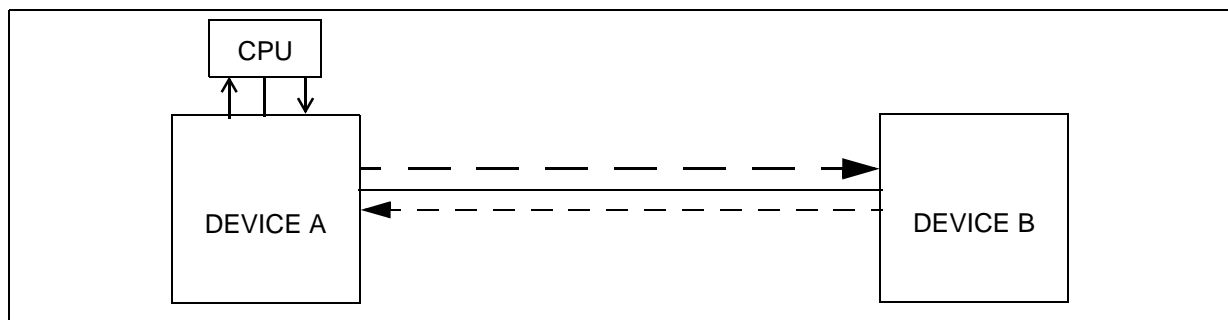
In port based mirroring, traffic from any RMII port can be mirrored to any other RMII port. The traffic from the source port can be either ingress or egress traffic. Up to two ports can be setup as mirrored ports. As a result, the traffic (both ingress and egress) of a specific port can be monitored by setting up both mirrored ports. Once a port is setup as mirrored port, it cannot be used for regular traffic.

The mirrored port can be any port in the ZL50407.

### 9.2 Using port mirroring for loop back

To perform remote loop back test, port mirroring can be used to bounce back the packet to the source port to check the data path.

The CPU needs to setup the remote device through the command channel to enable port mirroring in the remote device. A CPU packet is send to the port in test in Device A. The packet will be forwarded to the test port, external cable, the destination port in Device B, and loop back to itself, back to the cable and go back to Device A and the CPU. This way, the whole channel can be tested.



**Figure 10 - Remote Loopback Test**

## 10.0 Clocks

### 10.1 Clock Requirements

#### 10.1.1 System Clock (SCLK) Speed Requirement

SCLK is the primary clock for the ZL50407 device. The speed requirement is based on the system configuration. Below is a table for a few configuration.

| Configuration                 | Minimum SCLK speed required |
|-------------------------------|-----------------------------|
| 8 Port 10/100M + 1 port 1000M | 100 MHz                     |
| 6-9 ports 10/100 M            | 50 MHz                      |
| 1-5 ports 10/100 M            | 25 Mhz                      |

**Table 10 - SCLK Speed Requirements**

#### 10.1.2 RMAC Reference Clock (M\_CLK) Speed Requirement

M\_CLK is a 50 MHz clock used for the RMAC ports (ports 0-7).

If none of the RMAC ports are configured in RMII mode or Reverse MII mode, a different clock frequency can be applied to M\_CLK, as long as it's less than 50 MHz. In this case, register USD must be set to provide an internal 1usec timing.

#### 10.1.3 GMAC Reference Clock (GREF\_CLK) Speed Requirement

GREF\_CLK is a 125 MHz reference clock required for the GMAC port (port 9).

If the device is in a 9 port 10/100 configuration only, GREF\_CLK can be a lower frequency clock and can be connected to M\_CLK to reduce the number of clock sources.

If port 9 is not being used, GREF\_CLK can be left unconnected.

#### 10.1.4 JTAG Test Clock (TCK) Speed Requirements

TCK is a clock used for the JTAG port. The frequency on this clock can vary. Refer to "JTAG (IEEE 1149.1-2001)" on page 131 for the frequency range.

## 10.2 Clock Generation

### 10.2.1 MDC

MDC is used for the MII Management Interface and clocks data on MDIO. It is generated by the device from M\_CLK and is equal to 500 kHz ( $M\_CLK/100$ ). If a different speed clock other than 50 MHz is used on M\_CLK, the USD register must be programmed to reset MDC.

### 10.2.2 SCL

SCL is used for the I2C interface and clocks data on SDA. It is generated by the device from M\_CLK and is equal to 50kHz ( $M\_CLK/1000$ ). If a different speed clock other than 50 MHz is used on M\_CLK, the USD register must be programmed to reset SCL.

### 10.2.3 Ethernet Interface Clocks

If the RMAC ports are configured in Reverse MII mode, TXCLK and RXCLK are generated from M\_CLK and are equal to M\_CLK/2 for 100 M mode or M\_CLK/20 for 10M mode. M\_CLK needs to be a 50 MHz clock in this mode.

If the RMAC ports are configured in Reverse GPSI mode, TXCLK and RXCLK are generated from M\_CLK and are equal to M\_CLK/2 for 10 M mode. M\_CLK needs to be a 20 MHz clock in this mode and USD must be programmed accordingly.

The gigabit port generates an external TXCLK interface clock in GMII mode. It is equal to the 125 MHz GREF\_CLK. If the GMAC port is configured in Reverse MII mode, RXCLK is generated from GREF\_CLK and is equal to GREF\_CLK/2 for 100 M mode (no support for 10M Reverse MII mode). GREF\_CLK needs to be a 50 MHz clock in this mode.

## 11.0 Hardware Statistics Counters

### 11.1 Hardware Statistics Counters List

ZL50407 hardware provides a full set of statistics counters for each Ethernet port. The CPU accesses these counters through the CPU interface. All hardware counters are rollover counters. When a counter rolls over, the CPU is interrupted, so that long-term statistics may be kept. The MAC detects all statistics, except for the filtering counter (detected by queue manager). The following is the wrapped signal sent to the CPU through the command block.

See Processor Interface application note, ZLAN-26, for more information.

### 11.2 IEEE 802.3 HUB Management (RFC 1516)

#### 11.2.1 Event Counters

##### 11.2.1.1 PortReadableFrames

Counts the number of frames of valid frame length that have been received on this port.

|                              | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>                                       |
|------------------------------|------------------------|--|
| Frame size:                  | $\geq 64$ bytes,       | $\leq 1518$ bytes<br>( $\leq 1522$ bytes, if<br>VLAN tagged) |
| No FCS (i.e. checksum) error |                        |  |
| No collisions                |                        |  |

Use ZL50407 counter "Total Frames Received", C[8].

Note: max. frame size may be BUF\_LIMIT, if enabled on this port.

##### 11.2.1.2 PortReadableOctets

Counts the number of bytes (i.e. octets) contained in valid frames that have been received on this port.

|               | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>                                       |
|---------------|------------------------|--|
| Frame size:   | $\geq 64$ bytes,       | $\leq 1518$ bytes<br>( $\leq 1522$ bytes, if<br>VLAN tagged) |
| No FCS error  |                        |  |
| No collisions |                        |  |

Use ZL50407 counter "Total Bytes Received", C[7].

Note: max. frame size may be BUF\_LIMIT, if enabled on this port.

#### 11.2.1.3 PortFCSErrors

Counts number of valid frames received with bad FCS.

|                  | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>                                       |
|------------------|------------------------|--|
| Frame size:      | $\geq 64$ bytes,       | $\leq 1518$ bytes<br>( $\leq 1522$ bytes, if<br>VLAN tagged) |
| No framing error |                        |  |
| No collisions    |                        |  |

Use ZL50407 counter "CRC", C[23].

Note: if BUF\_LIMIT is enabled on this port, this counter still uses the above max. frame size definition. If a frame >1518B but  $\leq$ BUF\_LIMIT has a CRC error, it will be countered as an Oversized frame.

#### 11.2.1.4 PortAlignmentErrors

Counts number of valid frames received with bad alignment (not byte-aligned).

|               | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>                                       |
|---------------|------------------------|--|
| Frame size:   | $\geq 64$ bytes,       | $\leq 1518$ bytes<br>( $\leq 1522$ bytes, if<br>VLAN tagged) |
| Framing error |                        |  |
| FCS error     |                        |  |
| No collisions |                        |  |

Use ZL50407 counter "Alignment Error", C[21].

Note: when this counter is incremented, the ZL50407 also increments the "CRC" counter, C[23].



**11.2.1.5 PortFrameTooLongs**

Counts number of frames received with size exceeding the maximum allowable frame size.

|                           | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>                            |
|---------------------------|------------------------|---|
| Frame size:               | n/a                    | > 1518 bytes<br>(> 1522 bytes, if<br>VLAN tagged) |
| Framing error: don't care |                        |   |
| FCS error: don't care     |                        |   |
| No collisions             |                        |   |

Use ZL50407 counter "Oversize Frames", C[15].

Note: max. frame size may be BUF\_LIMIT, if enabled on this port. Also, if a frame >1518B but ≤BUF\_LIMIT has a CRC error, it will be countered as an Oversized frame.

**11.2.1.6 PortShortEvents**

Counts number of frames received with size less than the length of a short event.

|                           | <u>Min. Frame Size</u> | <u>Max. Frame Size</u> |
|---------------------------|------------------------|------------------------|
| Frame size:               | < 10 bytes             |                        |
| Framing error: don't care |                        |                        |
| FCS error: don't care     |                        |                        |
| No collisions             |                        |                        |

Use ZL50407 counter "Short Event", C[24].

**11.2.1.7 PortRunts**

Counts number of frames received with size under 64 bytes, but greater than the length of a short event.

|                           | <u>Min. Frame Size</u> | <u>Max. Frame Size</u> |
|---------------------------|------------------------|------------------------|
| Frame size:               | ≥ 10 bytes,            | < 64 bytes             |
| Framing error: don't care |                        |                        |
| FCS error: don't care     |                        |                        |
| No collisions             |                        |                        |

Use ZL50407 counter "Undersize Frames", C[22].

**11.2.1.8 PortCollisions**

Counts number of collision events.

|  | <u>Min. Frame Size</u> | <u>Max. Frame Size</u> |
|--|------------------------|------------------------|
|--|------------------------|------------------------|

|             |          |
|-------------|----------|
| Frame size: | any size |
|-------------|----------|

Use ZL50407 counter "Collision", C[25].

**11.2.1.9 PortLateEvents**

Counts number of collision events that occurred late (after LateEventThreshold = 64 bytes).

|  | <u>Min. Frame Size</u> | <u>Max. Frame Size</u> |
|--|------------------------|------------------------|
|--|------------------------|------------------------|

|             |          |
|-------------|----------|
| Frame size: | any size |
|-------------|----------|

Use ZL50407 counter "Port Late Collision", C[29].

Note: when this counter is incremented, the ZL50407 also increments the "Collision" counter, C[25].

**11.2.1.10 PortVeryLongEvents**

Counts number of frames received with size larger than Jabber Lockup Protection Timer (TW3 = 5 ms or 50 000 bit times – 20% + 50%).

|  | <u>Min. Frame Size</u> | <u>Max. Frame Size</u> |
|--|------------------------|------------------------|
|--|------------------------|------------------------|

|             |       |
|-------------|-------|
| Frame size: | > TW3 |
|-------------|-------|

No ZL50407 counter.

Note: the ZL50407 defines a jabber frame as any frame that exceeds 6400 bytes, however, the maximum buffer size supported by the device is 4 KBytes. Thus, any frame > 4KB would be counted as an Oversized Frame, C[15].

**11.2.1.11 PortDataRateMisatches**

For repeaters or HUB application only. No ZL50407 counter.

**11.2.1.12 PortAutoPartitions**

For repeaters or HUB application only. No ZL50407 counter.

**11.2.1.13 PortTotalErrors**

Sum of the following errors:

- PortFCSErrors
- PortAlignmentErrors
- PortFrameTooLong
- PortShortEvents
- PortLateEvents
- PortVeryLongEvents
- PortDataRateMisatches

### 11.3 IEEE 802.1 Bridge Management (RFC 1286)

#### 11.3.1 Event Counters

##### 11.3.1.1 PortDelayExceededDiscards

Counts number of frames discarded due to excessive transmit delay through the bridge.

Note: Not applicable for the ZL50407.

##### 11.3.1.2 PortMtuExceededDiscards

Counts number of frames discarded due to excessive size.

##### 11.3.1.3 PortInFrames

Counts number of frames received by this port or segment.

**Note:** A frame received by this port is only counted by this counter if and only if it is for a protocol being processed by the local bridge function.

##### 11.3.1.4 PortOutFrames

Counts number of frames transmitted by this port.

**Note:** A frame transmitted by this port is only counted by this counter if and only if it is for a protocol being processed by the local bridge function.

##### 11.3.1.5 PortInDiscards

Counts number of valid frames received which were discarded (i.e. filtered) by the forwarding process.

### 11.4 RMON – Ethernet Statistic Group (RFC 1757)

#### 11.4.1 Event Counters

##### 11.4.1.1 DropEvents

Counts number of times a packet is dropped, because of lack of available resources. DOES NOT include all packet dropping -- for example, random early drop for quality of service support.

Use ZL50407 counter "Drop", C[26].

##### 11.4.1.2 Octets

Counts the total number of octets (i.e. bytes) in any frames received.

|                       | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>   |
|-----------------------|------------------------|--|
| Frame size:           | $\geq 64$ bytes,       | $\leq 1518$ bytes<br><br>( $\leq 1522$ bytes, if<br>VLAN tagged) |
| No framing error      |                        |  |
| FCS error: don't care |                        |  |
| No collisions         |                        |  |

Use ZL50407 counter “Bytes Received”, C[5].

Note: max. frame size may be BUF\_LIMIT, if enabled on this port.

#### 11.4.1.3 Pkts

Counts the number of frames received, good or bad.

|                       | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>                                       |
|-----------------------|------------------------|--|
| Frame size:           | $\geq 64$ bytes,       | $\leq 1518$ bytes<br>( $\leq 1522$ bytes, if<br>VLAN tagged) |
| No framing error      |                        |  |
| FCS error: don't care |                        |  |
| No collisions         |                        |  |

Use ZL50407 counter “Frames Received”, C[6].

Note: max. frame size may be BUF\_LIMIT, if enabled on this port.

#### 11.4.1.4 BroadcastPkts

Counts the number of good frames received and forwarded with broadcast address. Does not include non-broadcast multicast frames.

Use ZL50407 counter “Broadcast Frames Received”, C[11].

#### 11.4.1.5 MulticastPkts

Counts the number of good frames received and forwarded with multicast address. Does not include broadcast frames.

Use ZL50407 counter “Multicast Frames Received”, C[10].

Note: this counter includes broadcast frames received.

#### 11.4.1.6 CRCAlignErrors

Counts number of frames received with FCS or alignment errors.

|                                | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>                                       |
|--------------------------------|------------------------|--|
| Frame size:                    | $\geq 64$ bytes,       | $\leq 1518$ bytes<br>( $\leq 1522$ bytes, if<br>VLAN tagged) |
| Framing error and/or FCS error |                        |  |
| No collisions                  |                        |  |

Use ZL50407 counters “CRC”, C[23], and “Alignment Error”, C[21].

Note: when the “Alignment Error” counter, C[21], is incremented, the ZL50407 also increments the “CRC” counter, C[23], thus, the CRC counter can be used for this statistic.

**11.4.1.7 UndersizePkts**

Counts number of frames received with size less than 64 bytes.

|             | <u>Min. Frame Size</u> | <u>Max. Frame Size</u> |
|-------------|------------------------|------------------------|
| Frame size: | n/a                    | < 64 bytes             |

Framing error: don't care

FCS error: don't care

No collisions

Use ZL50407 counter "Undersize Frames", C[22].

**11.4.1.8 OversizePkts**

Counts number of frames received with size exceeding the maximum allowable frame size.

|             | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>                            |
|-------------|------------------------|---|
| Frame size: | n/a                    | > 1518 bytes<br>(> 1522 bytes, if<br>VLAN tagged) |

Framing error: don't care

FCS error: don't care

No collisions

Use ZL50407 counter "Oversize Frames", C[15].

Note: max. frame size may be BUF\_LIMIT, if enabled on this port.

**11.4.1.9 Fragments**

Counts number of frames received with size less than 64 bytes and with bad FCS.

|             | <u>Min. Frame Size</u> | <u>Max. Frame Size</u> |
|-------------|------------------------|------------------------|
| Frame size: | n/a                    | < 64 bytes             |

Framing error and/or FCS error

No collisions

Use ZL50407 counter "Fragments", C[20].

**11.4.1.10 Jabbers**

Counts number of frames received with size exceeding maximum frame size and with bad FCS.

Note that this definition of jabber is different than the definition in IEEE 802.3 (this standard defines jabber as the condition where any packet exceeds Jabber Lockup Protection Timer (TW3)).

|                           | <u>Min. Frame Size</u> | <u>Max. Frame Size</u>                                |
|---------------------------|------------------------|---|
| Frame size:               | n/a                    | > 1518 bytes<br><br>(> 1522 bytes, if<br>VLAN tagged) |
| Framing error: don't care |                        |   |
| FCS error                 |                        |   |
| No collisions             |                        |   |

No ZL50407 counter.

Note: the ZL50407 defines a jabber frame as any frame that exceeds 6400 bytes, however, the maximum buffer size supported by the device is 4 KBytes. Thus, any frame > 4 KB would be counted as an Oversized Frame, C[15].

**11.4.1.11 Collisions**

Counts number of collision events detected.

Only a best estimate since collisions can only be detected while in transmit mode, but not while in receive mode.

|             | <u>Min. Frame Size</u> | <u>Max. Frame Size</u> |
|-------------|------------------------|------------------------|
| Frame size: |                        | any size               |

Use ZL50407 counter "Collision", C[25].

### 11.4.1.12 Packet Count for Different Size Groups

Six different size groups – one counter for each. Counts both good and bad packets.

|                      |  |
|----------------------|--|
| Pkts64Octets         | for any packet with size = 64 bytes.<br>Use ZL50407 counter “Frames with Length of 64 Bytes”, C[12].   |
| Pkts65to127Octets    | for any packet with size from 65 bytes to 127 bytes<br>Use ZL50407 counter “Frames with Length Between 65-127 Bytes”, C[14].   |
| Pkts128to255Octets   | or any packet with size from 128 bytes to 255 bytes<br>Use ZL50407 counter “Frames with Length Between 128-255 Bytes”, C[16].  |
| Pkts256to511Octets   | for any packet with size from 256 bytes to 511 bytes<br>Use ZL50407 counter “Frames with Length Between 256-511 Bytes”, C[17].   |
| Pkts512to1023Octets  | for any packet with size from 512 bytes to 1023 bytes<br>Use ZL50407 counter “Frames with Length Between 512-1023 Bytes”, C[18].   |
| Pkts1024to1518Octets | for any packet with size from 1024 bytes to 1518 bytes<br>Use ZL50407 counter “Frames with Length Between 1024-1518 Bytes”, C[19].<br>Note: the ZL50407 will include frames up to max. frame size. |

Note: the ZL50407 doesn't include bad frames in the above counters.

## 11.5 Miscellaneous Counters

In addition to the statistics groups defined in previous sections, the ZL50407 has other statistics counters for its own purposes.

1. Flow control – one counting the number of flow control frames received, C[9], and another counting the number of flow control frames sent, C[3].
2. Frames sent – one for unicast frames sent, C[1], and one for non-unicast frames sent, C[4]. A broadcast or multicast frame qualifies as non-unicast.
3. A counter called “frame send fail”, C[2]. This keeps track of FIFO under-runs, late collisions, and collisions that have occurred 16 times.
4. A counter called “filtering”, C[27]. This keeps track of all frames dropped due to queue congestion (i.e. egress WRED).

## 12.0 Register Definition

### 12.1 ZL50407 Register Description

| Register   | Description                            | CPU Addr (Hex) | R/W | I <sup>2</sup> C Addr (Hex) | Default (Hex) | Notes |
|--|--|----------------|-----|-----------------------------|---------------|-------|
| <b>0. ETHERNET Port Control Registers (Substitute [n] with Port number (0..9))</b> |  |                |     |                             |               |       |
| ECR1Pn   | Port Control Register 1 for Port n     | 0000+2n        | R/W | 000+n                       | C0            |       |
| ECR2Pn   | Port Control Register 2 for Port n     | 0001+2n        | R/W | 00A+n                       | 00            |       |
| ECR3Pn   | Port Control Register 3 for Port n     | 0080+2n        | R/W | 014+n                       | 00            |       |
| ECR4Pn   | Port Control Register 4 for Port n     | 0081+2n        | R/W | 01E+n                       | 18            |       |
| BUF_LIMIT  | Frame Buffer Limit                     | 0036           | R/W | NA                          | 40            |       |
| FCC  | Flow Control Grant Period              | 0037           | R/W | NA                          | 03            |       |
| <b>1. VLAN Control Registers (Substitute [n] with Port number (0..9))</b>          |  |                |     |                             |               |       |
| AVTCL  | VLAN Type Code Register Low            | 0100           | R/W | 028                         | 00            |       |
| AVTCH  | VLAN Type Code Register High           | 0101           | R/W | 029                         | 81            |       |
| PVMAPn_0   | Port n Configuration Register 0        | 0102+4n        | R/W | 02A+n                       | FF            |       |
| PVMAPn_1   | Port n Configuration Register 1        | 0103+4n        | R/W | 034+n                       | FF            |       |
| PVMAPn_3   | Port n Configuration Register 3        | 0105+4n        | R/W | 03E+n                       | 00            |       |
| PVMODE   | VLAN Operating Mode                    | 0170           | R/W | 048                         | 00            |       |
| <b>2. TRUNK Control Registers (Substitute [n] with Trunk Group number (0..7))</b>  |  |                |     |                             |               |       |
| TRUNKn   | Trunk Group n                          | 0200+n         | R/W | NA                          | 00            |       |
| TRUNKn_HASH10  | Trunk Group n Hash 10 Destination Port | 0208+4n        | R/W | NA                          | 00            |       |
| TRUNKn_HASH32  | Trunk Group n Hash 32 Destination Port | 0209+4n        | R/W | NA                          | 00            |       |
| TRUNKn_HASH54  | Trunk Group n Hash 54 Destination Port | 020A+4n        | R/W | NA                          | 00            |       |
| TRUNKn_HASH76  | Trunk Group n Hash 76 Destination Port | 020B+4n        | R/W | NA                          | 00            |       |
| MULTICAST_HASHn-0  | Multicast hash result n mask byte 0    | 0228+2n        | R/W | NA                          | FF            |       |

**Table 11 - Register Description**



| Register                               | Description                          | CPU Addr (Hex) | R/W | I <sup>2</sup> C Addr (Hex) | Default (Hex) | Notes    |
|--|--------------------------------------|----------------|-----|-----------------------------|---------------|----------|
| MULTICAST_HASHn-1                      | Multicast hash result n mask byte 1  | 0229+2n        | R/W | NA                          | FF            |          |
| <b>3. CPU Port Configuration</b>       |                                      |                |     |                             |               |          |
| MAC0                                   | CPU MAC Address byte 0               | 0300           | R/W | NA                          | 00            |          |
| MAC1                                   | CPU MAC Address byte 1               | 0301           | R/W | NA                          | 00            |          |
| MAC2                                   | CPU MAC Address byte 2               | 0302           | R/W | NA                          | 00            |          |
| MAC3                                   | CPU MAC Address byte 3               | 0303           | R/W | NA                          | 00            |          |
| MAC4                                   | CPU MAC Address byte 4               | 0304           | R/W | NA                          | 00            |          |
| MAC5                                   | CPU MAC Address byte 5               | 0305           | R/W | NA                          | 00            |          |
| INT_MASK0                              | Interrupt Mask 0                     | 0306           | R/W | NA                          | 00            |          |
| INTP_MASKn                             | Interrupt Mask for MAC Port 2n, 2n+1 | 0310+n         | R/W | NA                          | 00            | (n=0..4) |
| RQS                                    | Receive Queue Select                 | 0323           | R/W | NA                          | 00            |          |
| RQSS                                   | Receive Queue Status                 | 0324           | RO  | NA                          | NA            |          |
| MAC01                                  | Increment MAC port 0,1 address       | 0325           | R/W | NA                          | 00            |          |
| MAC23                                  | Increment MAC port 2,3 address       | 0326           | R/W | NA                          | 00            |          |
| MAC45                                  | Increment MAC port 4,5 address       | 0327           | R/W | NA                          | 00            |          |
| MAC67                                  | Increment MAC port 6,7 address       | 0328           | R/W | NA                          | 00            |          |
| MAC9                                   | Port 9 MAC address byte 5            | 0329           | R/W | NA                          | 00            |          |
| CPUQINS[6:0]                           |                                      | 0330-0336      | R/W | NA                          | 00            |          |
| CPUQINSRPT                             |                                      | 0337           | RO  | NA                          | NA            |          |
| CPUGRNHDL[1:0]                         |                                      | 0338-0339      | RO  | NA                          | NA            |          |
| CPURLSINFO[4:0]                        |                                      | 033A-033E      | R/W | NA                          | 00            |          |
| CPUGRNCTR                              |                                      | 033F           | R/W | NA                          | 00            |          |
| <b>4. Search Engine Configurations</b> |                                      |                |     |                             |               |          |
| AGETIME_LOW                            | MAC Address Aging Time Low           | 0400           | R/W | 049                         | 5C            |          |
| AGETIME_HIGH                           | MAC Address Aging Time High          | 0401           | R/W | 04A                         | 00            |          |
| SE_OPMODE                              | Search Engine Operating Mode         | 0403           | R/W | NA                          | 00            |          |
| <b>5. Global QOS Control</b>           |                                      |                |     |                             |               |          |
| QOSC                                   | QOS Control                          | 0500           | R/W | 04B                         | 00            |          |

Table 11 - Register Description (continued)

| Register                    | Description                                       | CPU Addr (Hex) | R/W | I <sup>2</sup> C Addr (Hex) | Default (Hex) | Notes    |
|-----------------------------|---|----------------|-----|-----------------------------|---------------|----------|
| PCC                         | Packet Congestion Control                         | 0510           | R/W | 068                         | 006           |          |
| MCC                         | Multicast Congestion Control                      | 0511           | R/W | 069                         | 06            |          |
| MCCTH                       | Multicast Congestion Threshold                    | 0512           | R/W | NA                          | 03            |          |
| RDRC0                       | WRED Drop Rate Control 0                          | 0513           | R/W | 090                         | 00            |          |
| RDRC1                       | WRED Drop Rate Control 1                          | 0514           | R/W | 091                         | 00            |          |
| RDRC2                       | WRED Drop Rate Control 2                          | 0515           | R/W | NA                          | 00            |          |
| SFCB                        | Share FCB Size                                    | 0518           | R/W | 074                         | 00            |          |
| C1RS                        | Class 1 Reserve Size                              | 0519           | R/W | 075                         | 00            |          |
| C2RS                        | Class 2 Reserve Size                              | 051A           | R/W | 076                         | 00            |          |
| C3RS                        | Class 3 Reserve Size                              | 051B           | R/W | 077                         | 00            |          |
| AVPML                       | VLAN Priority Map Low                             | 0530           | R/W | 056                         | 00            |          |
| AVPMM                       | VLAN Priority Map Middle                          | 0531           | R/W | 057                         | 00            |          |
| AVPMH                       | VLAN Priority Map High                            | 0532           | R/W | 058                         | 00            |          |
| AVDM                        | VLAN Discard Map                                  | 0533           | R/W | 05C                         | 00            |          |
| TOSPML                      | TOS Priority Map Low                              | 0540           | R/W | 059                         | 00            |          |
| TOSPMH                      | TOS Priority Map Middle                           | 0541           | R/W | 05A                         | 00            |          |
| TOSPMH                      | TOS Priority Map High                             | 0542           | R/W | 05B                         | 00            |          |
| TOSDML                      | TOS Discard Map                                   | 0543           | R/W | 05D                         | 00            |          |
| USER_PROTOCOL_n             | User Define Protocol n                            | 0550+n         | R/W | 0B3+n                       | 00            | (n=0..7) |
| USER_PROTOCOL_FORCE_DISCARD | User Define Protocol 0 To 7 Force Discard Enable  | 0558           | R/W | 0BB                         | 00            |          |
| WLPP10                      | Well Known Logic Port 0 and 1 Priority            | 0560           | R/W | 0A8                         | 00            |          |
| WLPP32                      | Well Known Logic Port 2 and 3 Priority            | 0561           | R/W | 0A9                         | 00            |          |
| WLPP54                      | Well Known Logic Port 4 and 5 Priority            | 0562           | R/W | 0AA                         | 00            |          |
| WLPP76                      | Well Known Logic Port 6 and 7 Priority            | 0563           | R/W | 0AB                         | 00            |          |
| WLPE                        | Well Known Logic Port 0 To 7 Enable               | 0564           | R/W | 0AC                         | 00            |          |
| WLPPFD                      | Well Known Logic Port 0 To 7 Force Discard Enable | 0565           | R/W | 0AD                         | 00            |          |

Table 11 - Register Description (continued)

| Register                              | Description  | CPU Addr (Hex) | R/W | I <sup>2</sup> C Addr (Hex) | Default (Hex) | Notes    |
|---------------------------------------|--|----------------|-----|-----------------------------|---------------|----------|
| USER_PORTn_LOW                        | User Define Logical Port n Low                     | 0570+2n        | R/W | 092+n                       | 00            | (n=0..7) |
| USER_PORTn_HIGH                       | User Define Logical Port n High                    | 0571+2n        | R/W | 09A+n                       | 00            |          |
| USER_PORT1:0_PRIORITY                 | User Define Logic Port 0 and 1 Priority            | 0590           | R/W | 0A2                         | 00            |          |
| USER_PORT3:2_PRIORITY                 | User Define Logic Port 2 and 3 Priority            | 0591           | R/W | 0A3                         | 00            |          |
| USER_PORT5:4_PRIORITY                 | User Define Logic Port 4 and 5 Priority            | 0592           | R/W | 0A4                         | 00            |          |
| USER_PORT7:6_PRIORITY                 | User Define Logic Port 6 and 7 Priority            | 0593           | R/W | 0A5                         | 00            |          |
| USER_PORT_ENABLE[7:0]                 | User Define Logic Port 0 To 7 Enable               | 0594           | R/W | 0A6                         | 00            |          |
| USER_PORT_FORCE_DISCARD[7:0]          | User Define Logic Port 0 To 7 Force Discard Enable | 0595           | R/W | 0A7                         | 00            |          |
| RLOWL                                 | User Define Range Low Bit [7:0]                    | 05A0           | R/W | 0AE                         | 00            |          |
| RLOWH                                 | User Define Range Low Bit [15:8]                   | 05A1           | R/W | 0AF                         | 00            |          |
| RHIGHL                                | User Define Range High Bit [7:0]                   | 05A2           | R/W | 0B0                         | 00            |          |
| RHIGHH                                | User Define Range High Bit [15:8]                  | 05A3           | R/W | 0B1                         | 00            |          |
| RRIORITY                              | User Define Range Priority                         | 05A4           | R/W | 0B2                         | 00            |          |
| <b>6. MISC Configuration Register</b> |  |                |     |                             |               |          |
| MII_OP0                               | MII Register Option 0                              | 0600           | R/W | 0BC                         | 00            |          |
| MII_OP1                               | MII Register Option 1                              | 0601           | R/W | 0BD                         | 00            |          |
| FEN                                   | Feature Registers                                  | 0602           | R/W | 0BE                         | 10            |          |
| MIIC0                                 | MII Command Register 0                             | 0603           | R/W | NA                          | 00            |          |
| MIIC1                                 | MII Command Register 1                             | 0604           | R/W | NA                          | 00            |          |
| MIIC2                                 | MII Command Register 2                             | 0605           | R/W | NA                          | 00            |          |
| MIIC3                                 | MII Command Register 3                             | 0606           | R/W | NA                          | 00            |          |
| MIID0                                 | MII Data Register 0                                | 0607           | RO  | NA                          | NA            |          |
| MIID1                                 | MII Data Register 1                                | 0608           | RO  | NA                          | NA            |          |
| USD                                   | One micro second divider                           | 0609           | R/W | NA                          | 00            |          |
| DEVICE                                | Device id and test                                 | 060A           | R/W | NA                          | 02            |          |

Table 11 - Register Description (continued)

| Register                          | Description                           | CPU Addr (Hex) | R/W | I <sup>2</sup> C Addr (Hex) | Default (Hex) | Notes |
|-----------------------------------|---------------------------------------|----------------|-----|-----------------------------|---------------|-------|
| SUM                               | EEPROM Checksum Register              | 060B           | R/W | 0FF                         | 00            |       |
| LHBTimer                          | Link heart beat time out timer        | 0610           | R/W | NA                          | 00            |       |
| LHBReg0                           | LHB control field value[7:0]          | 0611           | R/W | NA                          | 00            |       |
| LHBReg1                           | LHB control field value [15:8]        | 0612           | R/W | NA                          | 00            |       |
| fMACCReg0                         | Forced MAC control field value [7:0]  | 0613           | R/W | NA                          | 00            |       |
| fMACCReg1                         | Forced MAC control field value [15:8] | 0614           | R/W | NA                          | 00            |       |
| FCB_BASE_ADDR0                    | FCB Base Address Register 0           | 0620           | R/W | 0BF                         | 00            |       |
| FCB_BASE_ADDR1                    | FCB Base Address Register 1           | 0621           | R/W | 0C0                         | 60            |       |
| FCB_BASE_ADDR2                    | FCB Base Address Register 2           | 0622           | R/W | 0C1                         | 00            |       |
| <b>7. Port Mirroring Controls</b> |                                       |                |     |                             |               |       |
| MIRROR_DEST_MAC0                  | Mirror Destination MAC Address 0      | 0700           | R/W | NA                          | 00            |       |
| MIRROR_DEST_MAC1                  | Mirror Destination MAC Address 1      | 0701           | R/W | NA                          | 00            |       |
| MIRROR_DEST_MAC2                  | Mirror Destination MAC Address 2      | 0702           | R/W | NA                          | 00            |       |
| MIRROR_DEST_MAC3                  | Mirror Destination MAC Address 3      | 0703           | R/W | NA                          | 00            |       |
| MIRROR_DEST_MAC4                  | Mirror Destination MAC Address 4      | 0704           | R/W | NA                          | 00            |       |
| MIRROR_DEST_MAC5                  | Mirror Destination MAC Address 5      | 0705           | R/W | NA                          | 00            |       |
| MIRROR_SRC_MAC0                   | Mirror Source MAC Address 0           | 0706           | R/W | NA                          | 00            |       |
| MIRROR_SRC_MAC1                   | Mirror Source MAC Address 1           | 0707           | R/W | NA                          | 00            |       |
| MIRROR_SRC_MAC2                   | Mirror Source MAC Address 2           | 0708           | R/W | NA                          | 00            |       |
| MIRROR_SRC_MAC3                   | Mirror Source MAC Address 3           | 0709           | R/W | NA                          | 00            |       |
| MIRROR_SRC_MAC4                   | Mirror Source MAC Address 4           | 070A           | R/W | NA                          | 00            |       |

Table 11 - Register Description (continued)

| Register                | Description                              | CPU Addr (Hex) | R/W | I <sup>2</sup> C Addr (Hex) | Default (Hex) | Notes                       |
|-------------------------|--|----------------|-----|-----------------------------|---------------|-----------------------------|
| MIRROR_SRC_MAC5         | Mirror Source MAC Address 5              | 070B           | R/W | NA                          | 00            |                             |
| MIRROR_CONTROL          | Port Mirror Control Register             | 070C           | R/W | NA                          | 00            |                             |
| RMII_MIRROR0            | RMII Mirror 0                            | 0710           | R/W | NA                          | 00            |                             |
| RMII_MIRROR1            | RMII Mirror 1                            | 0711           | R/W | NA                          | 00            |                             |
| 8. Per Port QOS Control |  |                |     |                             |               |                             |
| FCRn                    | Flooding Control Register n              | 0800+n         | R/W | 04C+n                       | 00            | (n=0..9)                    |
| BMRCn                   | Broadcast/Multicast Rate Control n       | 0820+n         | R/W | 05E+n                       | 00            |                             |
| PR100_n                 | Port Reservation for RMAC Ports (n=0..7) | 0840+n         | R/W | 06A+n                       | 06            | 'd1536/16='d96, 'd96>>4='h6 |
| PR100_CPU               | Port Reservation for CPU Port            | 0848           | R/W | 073                         | 06            | 'd96                        |
| PRG                     | Port Reservation for GMAC Port           | 0849           | R/W | 072                         | 24            | 'd96x6='d576, 'd576>>4='h24 |
| PTH100_n                | Port Threshold for RMAC Ports (n=0..7)   | 0860+n         | R/W | 0C2+n                       | 03            | ½                           |
| PTH100_CPU              | Port Threshold for CPU Port              | 0868           | R/W | 0CB                         | 03            | ½                           |
| PTHG                    | Port Threshold for GMAC Port             | 0869           | R/W | 0CA                         | 12            | ½                           |
| QOSCn                   | QOS Control n                            | 0880+n         | R/W | 078-08F                     | 00            | (n=0..39)                   |
|                         |  |                |     | NA                          |               |                             |
| E. System Diagnostic    |  |                |     |                             |               |                             |
| DTSRL                   | Test Register Low                        | 0E00           | R/W | NA                          | 00            |                             |
| DTSRM                   | Test Register Medium                     | 0E01           | R/W | NA                          | 01            |                             |
| TESTOUT0                | Testmux Output [7:0]                     | 0E02           | R/O | NA                          | NA            |                             |
| TESTOUT1                | Testmux Output [15:8]                    | 0E03           | R/O | NA                          | NA            |                             |
| MASK0                   | MASK Timeout 0                           | 0E10           | R/W | 0F6                         | 00            |                             |
| MASK1                   | MASK Timeout 1                           | 0E11           | R/W | 0F7                         | 00            |                             |
| MASK2                   | MASK Timeout 2                           | 0E12           | R/W | 0F8                         | 00            |                             |
| MASK3                   | MASK Timeout 3                           | 0E13           | R/W | 0F9                         | 00            |                             |
| MASK4                   | MASK Timeout 4                           | 0E14           | R/W | 0FA                         | 00            |                             |

Table 11 - Register Description (continued)

| Register       | Description                          | CPU Addr (Hex) | R/W | I <sup>2</sup> C Addr (Hex) | Default (Hex) | Notes    |
|----------------|--------------------------------------|----------------|-----|-----------------------------|---------------|----------|
| BOOTSTRAP[2:0] | BOOTSTRAP Read Back                  | 0E80-0E82      | RO  | NA                          | NA            |          |
| PRTFSMSTn      | Ethernet Port n Status Read Back     | 0E90+n         | RO  | NA                          | NA            | (n=0..9) |
| PRTQOSSTn      | RMAC Port n QOS and Queue Status     | 0EA0+n         | RO  | NA                          | NA            | (n=0..7) |
| PRTQOSST8A     | CPU Port QOS and Queue Status A      | 0EA8           | RO  | NA                          | NA            |          |
| PRTQOSST8B     | CPU Port QOS and Queue Status B      | 0EA9           | RO  | NA                          | NA            |          |
| PRTQOSST9A     | GMAC Port QOS and Queue Status A     | 0EAA           | RO  | NA                          | NA            |          |
| PRTQUSST9B     | GMAC Port QOS and Queue Status B     | 0EAB           | RO  | NA                          | NA            |          |
| CLASSQOSST     | Class Buffer Status                  | 0EAC           | RO  | NA                          | NA            |          |
| PRTINTCTR      | Buffer Interrupt Status              | 0EAD           | R/W | NA                          | 00            |          |
| QMCTRLn        | Ports Queue Control Status           | 0EB0+n         | R/W | NA                          | 00            | (n=0..9) |
| QCTRL          | Ports Queue Control                  | 0EBA           | R/W | NA                          | 00            |          |
| BMBISTR0       | Memory bist result                   | 0EBB           | R/O | NA                          | NA            |          |
| BMBISTR1       | Memory bist result                   | 0EBC           | R/O | NA                          | NA            |          |
| BMControl      | Memory control                       | 0EBD           | R/W | NA                          | 0F            |          |
| BUFF_RST       | Buffer Reset Pool                    | 0EC0           | R/W | NA                          | 00            |          |
| FCBHEADPTR0    | FCB Head Pointer [7:0]               | 0EC1           | R/W | NA                          | 00            |          |
| FCB_HEAD_PTR1  | FCB Head Pointer [15:8]              | 0EC2           | R/W | NA                          | 00            |          |
| FCB_TAIL_PTR0  | FCB Tail Pointer [7:0]               | 0EC3           | R/W | NA                          | 00            |          |
| FCB_TAIL_PTR1  | FCB Tail Pointer [15:8]              | 0EC4           | R/W | NA                          | 00            |          |
| FCB_NUM0       | FCB Number [7:0]                     | 0EC5           | R/W | NA                          | 00            |          |
| FCB_NUM1       | FCB Init Start and FCB Number [14:8] | 0EC6           | R/W | NA                          | 06            |          |
| BM_RLSFF_CTRL  | Read control register                | 0EC7           | R/W | NA                          | 00            |          |
| BM_RLSFF_INFO0 | Bm_rlsfifo_info[7:0]                 | 0EC8           | RO  | NA                          | NA            |          |
| BM_RLSFF_INFO1 | Bm_rlsfifo_info[15:8]                | 0EC9           | RO  | NA                          | NA            |          |
| BM_RLSFF_INFO2 | Bm_rlsfifo_info[23:16]               | 0ECA           | RO  | NA                          | NA            |          |
| BM_RLSFF_INFO3 | Bm_rlsfifo_info[31:24]               | 0ECB           | RO  | NA                          | NA            |          |
| BM_RLSFF_INFO4 | Bm_rlsfifo_info[39:32]               | 0ECC           | RO  | NA                          | NA            |          |
| BM_RLSFF_INFO5 | Fifo_cnt[2:0],Bm_rlsfifo_info[44:40] | 0ECD           | RO  | NA                          | NA            |          |

Table 11 - Register Description (continued)

| Register                 | Description                 | CPU Addr (Hex) | R/W | I <sup>2</sup> C Addr (Hex) | Default (Hex) | Notes |
|--------------------------|-----------------------------|----------------|-----|-----------------------------|---------------|-------|
| <b>F. System Control</b> |                             |                |     |                             |               |       |
| GCR                      | Global Control Register     | 0F00           | R/W | NA                          | 00            |       |
| DCR                      | Device Control Register     | 0F01           | RO  | NA                          | NA            |       |
| DCR1                     | Device Control Register 1   | 0F02           | RO  | NA                          | NA            |       |
| DPST                     | Device Port Status Register | 0F03           | R/W | NA                          | 00            |       |
| DTST                     | Data read back register     | 0F04           | RO  | NA                          | NA            |       |
| DA                       | DA Register                 | 0FFF           | RO  | NA                          | DA            |       |

Table 11 - Register Description (continued)

## 12.2 Directly Accessed Registers

| INDEX_REG  | Width  | Access | Address |
|--|--------|--------|---------|
| Used to write the address of the indirect register to be accessed. | 16-bit | W      | 0       |
| Default: 00  |        |        |         |

| Bit #  | Name  | Type | Description                             |
|--------|-------|------|---|
| [15:0] | INDEX | W    | 16-bit address of the indirect register |

Register Table 1 - 0, INDEX\_REG

| DATA_REG  | Width | Access | Address |
|---|-------|--------|---------|
| Reflects the value of the indirect access register set by INDEX_REG | 8-bit | R/W    | 2       |
| Default: 00   |       |        |         |

| Bit # | Name | Type | Description                  |
|-------|------|------|------------------------------|
| [7:0] | DATA | R/W  | 8-bit indirect register data |

Register Table 2 - 2, DATA\_REG

| CPU_FRAME_REG  | Width       | Access | Address |
|--|-------------|--------|---------|
| Used to transmit/receive Ethernet frames via an 8-byte FIFO to/from the CPU MAC. | 16-bit      | R/W    | 3       |
| <i>This register (FIFO) is disabled in SSI+MII CPU interface mode.</i>           | Default: 00 |        |         |

| Bit #  | Name      | Type | Description  |
|--------|-----------|------|--|
| [15:0] | CPU_FRAME | W    | Send Ethernet frame to CPU MAC. Bits [7:0] is even byte, [15:8] is odd byte.<br><br>Data sequence specified in Processor Interface application note, ZLAN-26.      |
|        |           | R    | Receive Ethernet frame from CPU MAC. Bits [7:0] is even byte, [15:8] is odd byte.<br><br>Data sequence specified in Processor Interface application note, ZLAN-26. |

Register Table 3 - 3, CPU\_FRAME\_REG

| CMD_STATUS_REG   | Width       | Access | Address |
|--|-------------|--------|---------|
| CPU interface command status   | 8-bit       | R/W    | 4       |
| <i>This register is not applicable in SSI+MII, MII-only and Remote/No CPU interface modes.</i> | Default: 00 |        |         |

| Bit # | Name        | Type | Description  |
|-------|-------------|------|--|
| [0]   | RXBUF_DONE  | W    | Set Control Frame Receive buffer ready, after CPU writes a complete frame into the buffer. This bit is self-cleared.   |
|       | RXBUF_RDY   | R    | Control Frame receive buffer ready, CPU can write a new frame<br>1 – CPU can write a new control command<br>0 – CPU has to wait until this bit is 1 to write a new control command |
| [1]   | TXBUF1_DONE | W    | Set Control Frame Transmit buffer1 ready, after CPU reads out a complete frame from the buffer. This bit is self-cleared.  |
|       | TXBUF1_RDY  | R    | Control Frame transmit buffer1 ready for CPU to read<br>1 – CPU can read a new control command<br>0 – CPU has to wait until this bit is 1 to read a new control command            |
| [2]   | TXBUF2_DONE | W    | Set Control Frame Transmit buffer2 ready, after CPU reads out a complete frame from the buffer. This bit is self-cleared.  |
|       | TXBUF2_RDY  | R    | Control Frame transmit buffer2 ready for CPU to read<br>1 – CPU can read a new control command<br>0 – CPU has to wait until this bit is 1 to read a new control command            |

Register Table 4 - 4, CMD\_STATUS\_REG



|       |                |     |   |
|-------|----------------|-----|---|
| [3]   | TXFIFO_RXDONE  | W   | Set this bit to indicate CPU received a whole frame (transmit FIFO frame receive done), and flushed the rest of frame fragment, If occurs. This bit will be self-cleared. |
|       | TXFIFO_RDY     | R   | Transmit FIFO has data for CPU to read  |
| [4]   | RXFIFO_EOF     | W   | Set this bit to indicate that the following Write to the Receive FIFO is the last one. This bit will be self-cleared.   |
|       | RXFIFO_SPOK    | R   | Receive FIFO has space for incoming CPU frame   |
| [5]   | RXFIFO_REALIGN | W   | Set this bit to re-start the data that is sent from the CPU to Receive FIFO (re-align). This feature can be used for software debug. For normal operation must be '0'.    |
|       | TXFIFO_EOF     | R   | Transmit FIFO End Of Frame  |
| [7:6] | RSVD           | R/W | Reserved  |

Register Table 4 - 4, CMD\_STATUS\_REG (continued)

| INT_REG           | Width | Access | Address |
|-------------------|-------|--------|---------|
| Interrupt sources | 8-bit | R      | 5       |
| Default: N/A      |       |        |         |

| Bit # | Name           | Type | Description   |
|-------|----------------|------|---|
| [0]   | INT_CPU_FRAME  | R    | Ethernet frame interrupt. Ethernet Frame receive buffer has data for processor to read  |
| [1]   | INT_CTL_BUF1   | R    | Control frame 1 interrupt. Control Frame receive buffer 1 has data for processor to read  |
| [2]   | INT_CTL_BUF2   | R    | Control frame 2 interrupt. Control Frame receive buffer 2 has data for processor to read  |
| [6:3] | RSVD           | R    | Reserved  |
| [7]   | INT_CHIP_RESET | R    | Device Timeout Detected interrupt<br><br>Note: This bit is not self-cleared. After reading, the CPU has to clear the bit writing 0 to it. |

Register Table 5 - 5, INT\_REG

| CTL_FRAME_BUF1                          | Width  | Access | Address |
|---|--------|--------|---------|
| Used to transmit/receive control frames | 16-bit | R/W    | 6       |
| Default: 00                             |        |        |         |

| Bit #  | Name     | Type | Description   |
|--------|----------|------|---|
| [15:0] | CTL_BUF1 | W    | Send control frame to command engine. Bits [7:0] is even byte, [15:8] is odd byte.<br><br>Control frame format specified in Processor Interface application note, ZLAN-26.      |
|        |          | R    | Receive control frame from command engine. Bits [7:0] is even byte, [15:8] is odd byte.<br><br>Control frame format specified in Processor Interface application note, ZLAN-26. |

Register Table 6 - 6, CTL\_FRAME\_BUF1

| CTL_FRAME_BUF2                 | Width  | Access | Address |
|--------------------------------|--------|--------|---------|
| Used to receive control frames | 16-bit | R      | 7       |
| Default: 00                    |        |        |         |

| Bit #  | Name     | Type | Description   |
|--------|----------|------|---|
| [15:0] | CTL_BUF2 | R    | Receive control frame from command engine. Bits [7:0] is even byte, [15:8] is odd byte.<br><br>Control frame format specified in Processor Interface application note, ZLAN-26. |

Register Table 7 - 7, CTL\_FRAME\_BUF2

## 12.3 Indirectly Accessed Registers

### 12.3.1 (Group 0 Address) MAC Ports Group

#### 12.3.1.1 ECR1Pn: Port n Control Register

I<sup>2</sup>C Address: h000+n; CPU Address: h0000+2n (n = port number)

Accessed by CPU and I<sup>2</sup>C (R/W)

Port 0 – 7 & 9: (RMAC & GMAC Ports)

|         |   |
|---------|---|
| Bit [0] | Flow Control<br>0 - Enable (Default)<br>1 - Disable |
|---------|---|

|            |  |
|------------|--|
| Bit [1]    | Duplex Mode<br>0 - Full Duplex (Default)<br>1 - Half Duplex - Only in 10/100 mode  |
| Bit [2]    | Speed<br>0 - 100 Mbps (Default)<br>1 - 10 Mbps   |
| Bits [4:3] | 00 - Enable Auto-Negotiation (Default)<br>This enables hardware state machine for auto-negotiation.<br>01 - Limited Disable Auto-Negotiation<br>This disables hardware state machine for speed auto-negotiation (use ECR1Pn[2:0] for configuration). Hardware will still poll PHY for link status.<br>10 - Force Link Down<br>Disable the port. Hardware does not talk to PHY.<br>11 - Force Link Up<br>The configuration in ECR1Pn[2:0] is used for (speed/duplex/flow control) setup. Hardware does not talk to PHY. |
| Bit [5]    | Asymmetric Flow Control Enable.<br>0 – Disable asymmetric flow control (Default)<br>1 – Enable Asymmetric flow control<br><br>When this bit is set and flow control is on (bit [0] = 0), the device does not send out flow control frames, but it's receiver interprets and processes flow control frames.   |
| Bits [7:6] | SS - Spanning tree state (IEEE 802.1D spanning tree protocol)<br>00 - Blocking: Frame is dropped<br>01 - Listening: Frame is dropped<br>10 - Learning: Frame is dropped. Source MAC address is learned.<br>11 - Forwarding: Frame is forwarded. Source MAC address is learned. (Default)   |

Port 8: (CPU Port)

|                               |  |
|-------------------------------|--|
| 8/16-bit or Serial Only Modes |  |
| Bit [5:0]                     | Reserved   |
| Bits [7:6]                    | SS - Spanning tree state (IEEE 802.1D spanning tree protocol)<br>00 - Blocking: Frame is dropped<br>01 - Listening: Frame is dropped<br>10 - Learning: Frame is dropped. Source MAC address is learned.<br>11 - Forwarding: Frame is forwarded. Source MAC address is learned. (Default) |
| Serial + MII Mode             |  |
| Bit [0]                       | Flow Control<br>0 - Enable (Default)<br>1 - Disable  |
| Bit [1]                       | Duplex Mode<br>Must be 0 - Full Duplex (Default)   |
| Bit [2]                       | Speed<br>0 - 100 Mbps (Default)<br>1 - 10 Mbps   |

|            |  |
|------------|--|
| Bit [3]    | 1 - MII Port Up<br>The configuration in ECR1Pn[2:0] is used for (speed/duplex/flow control) setup.<br>0 - MII Port Down<br><br>Note: Bit [4] must be '1'.  |
| Bit [4]    | Must be '1'.   |
| Bit [5]    | Asymmetric Flow Control Enable.<br>0 – Disable asymmetric flow control (Default)<br>1 – Enable Asymmetric flow control<br><br>When this bit is set and flow control is on (bit [0] = 0), the device does not send out flow control frames, but it's receiver interprets and processes flow control frames. |
| Bits [7:6] | SS - Spanning tree state (IEEE 802.1D spanning tree protocol)<br>00 - Blocking: Frame is dropped<br>01 - Listening: Frame is dropped<br>10 - Learning: Frame is dropped. Source MAC address is learned.<br>11 - Forwarding: Frame is forwarded. Source MAC address is learned. (Default)                   |

### 12.3.1.2 ECR2Pn: Port n Control Register

I<sup>2</sup>C Address: h00A+n; CPU Address: h0001+2n (n = port number)

Accessed by CPU and I<sup>2</sup>C (R/W)

|          |  |
|----------|--|
| Bit [0]: | Filter untagged frame<br>0: Disable (Default)<br>1: All untagged frames from this port are discarded or follow security option when security is enable |
| Bit [1]: | Filter Tag frame<br>0: Disable (Default)<br>1: All tagged frames from this port are discarded or follow security option when security is enable        |
| Bit [2]: | Learning Disable<br>0: Learning is enabled on this port (Default)<br>1: Learning is disabled on this port  |
| Bit [3]: | Rate control timer select (RMAC ports only)<br>0: 10 microsecond refreshing time (Default)<br>1: 1 millisecond refreshing time                         |
| Bit [4]  | 0  |
| Bit [5]  | Reserved. Must be 0.   |

|            |   |
|------------|---|
| Bits [7:6] | <p>Security Enable. The ZL50407 checks the incoming data for one of the following conditions:</p> <ul style="list-style-type: none"> <li>If the source MAC address of the incoming packet is in the MAC table and is defined as secure address but the ingress port is not the same as the port associated with the MAC address in the MAC table. <ul style="list-style-type: none"> <li>A MAC address is defined as secure when its entry at MAC table has static status and bit 0 is set to 1. MAC address bit 0 (the first bit transmitted) indicates whether the address is unicast or multicast. As source addresses are always unicast bit 0 is not used (always 0). ZL50407 uses this bit to define secure MAC addresses.</li> </ul> </li> <li>If the port is set as learning disable and the source MAC address of the incoming packet is not defined in the MAC address table or the MAC address is not associated to the ingress port.</li> </ul> <p>If any one of the conditions is met, the packet is forwarded based on these setting.</p> <p>00 – Disable port security, forward packets as usual. (Default)<br/> 01 – Discard violating packets<br/> 10 – Forward violating packets as usual and also to the CPU for inspection<br/> 11 – Forward violating packets to the CPU for inspection</p> <p>It also checks for one of the following additional conditions:</p> <ul style="list-style-type: none"> <li>If the port is configured to filter untagged frames and an untagged frame arrives, or</li> <li>If the port is configured to filter tagged frames and a tagged frame arrives, or</li> <li>If the packet has the source mac address on the source mac address filter list, or</li> <li>If the packet has the destination mac address on the destination mac address filter list</li> </ul> <p>If any one of the conditions is met, the packet will be handled according to:</p> <p>0X – Discard violating packets<br/> 1X – Forward violating packets to CPU for inspection</p> |
|------------|---|

### 12.3.1.3 ECR3Pn: Port n Control Register

I<sup>2</sup>C Address: h014+n; CPU Address: h0080+2n (n = port number)

Accessed by CPU and I<sup>2</sup>C (R/W)

|            |  |
|------------|--|
| Bit [0]:   | <p>Enable receiving short frame &lt; 64B</p> <p>0: Disable (Default)<br/> 1: Allow receiving short frame with correct CRC.</p>             |
| Bit [1]:   | <p>Enable receiving long frame &gt; 1522</p> <p>0: Disable (Default)<br/> 1: Allow receiving long frame that are &lt;= BUF_LIMIT value</p> |
| Bit [2]:   | <p>Enable pad frame to 64B when transmitted</p> <p>0: Allow padding to 64B (Default)<br/> 1: Disable</p>                                   |
| Bit [3]:   | <p>Enable compress preamble</p> <p>0: Send standard preamble (Default)<br/> 1: Only one byte preamble+SFD</p>                              |
| Bits [6:4] | <p>Number of bytes removed from the Inter-Frame Gap (IFG). (Default 0x0)</p>   |

|         |   |
|---------|---|
| Bit [7] | Link Heart Beat Transmit (RMAC ports only)<br>0: Disable (Default)<br>1: Enable |
|---------|---|

#### 12.3.1.4 ECR4Pn: Port n Control Register

I<sup>2</sup>C Address: h01E+n; CPU Address: h0081+2n (n = port number)

Accessed by CPU and I<sup>2</sup>C (R/W)

Port 0 – 7: (RMAC Ports)

|             |  |
|-------------|--|
| Bit [1:0]:  | Enable PHY Mode<br>00: MAC Mode (Default)<br>11: PHY Mode (Reverse MII/GPSI)<br><br>Only valid in MII and GPSI interface modes. In PHY mode, Mn_TXCLK & Mn_RXCLK pins becomes outputs.   |
| Bit [2]:    | Internal loopback.<br>0: Disable (Default)<br>1: Enable<br><br>In this mode, the packet is looped back in the MAC layer before going out of the chip. You must force linkup at full duplex as well.<br><br>External loopback is another level of system diagnostic which involves the PHY device to loopback the packet.   |
| Bits [4:3]: | Interface mode:<br>00 - GPSI mode<br>01 - MII mode<br>10 - Reserved<br>11 - RMII mode (Default)  |
| Bit [5]:    | Frame loopback.<br>0: Disable frame from sending back to its source port. (Default)<br>1: Allow frame to send back to its source port<br><br>In a regular ethernet switch, a packet should never be receive and forwarded to the same port. Setting the bit allows it to happen.<br><br>This is not the same as an ingress MAC loopback. The destination MAC address has to be stored (learned) in the MCT and associated with the originating source port. The frame loopback will only work for unicast packets. |
| Bit [6]:    | Link Heart Beat Receive<br>0: Disable (Default). Also clears all MAC LHB status.<br>1: Enable  |
| Bit [7]:    | Soft reset.<br>0: Normal operation (Default)<br>1: Reset. Not self clearing.   |

## Port 8: (CPU Port)

|             |  |
|-------------|--|
| Bits [1:0]: | Reserved   |
| Bit [2]:    | Enable special write to 2 registers in a single write operation.<br>0: Disable (Default)<br>1: Enable  |
| Bit[4:3]:   | Reserved   |
| Bit [5]:    | Frame loopback.<br>0: Disable frame from sending back to its source port. (Default)<br>1: Allow frame to send back to its source port<br><br>In a regular ethernet switch, a packet should never be receive and forwarded to the same port. Setting the bit allows it to happen.<br><br>This is not the same as an ingress MAC loopback. The destination MAC address has to be stored (learned) in the MCT and associated with the originating source port. The frame loopback will only work for unicast packets. |
| Bit [6]:    | Reserved   |
| Bit [7]:    | Soft reset.<br>0: Normal operation (Default)<br>1: Reset. Not self clearing.   |

## Port 9: (GMAC Port)

|             |  |
|-------------|--|
| Bits [1:0]: | Enable PHY Mode<br>00: MAC Mode (Default)<br>11: PHY Mode (Reverse MII)<br><br>Only valid in MII interface mode. In PHY mode, M9_RXCLK pin becomes an output and M9_MTXCLK must be tied to M9_RXCLK externally.  |
| Bit [2]:    | Internal loopback.<br>0: Disable (Default)<br>1: Enable<br><br>In this mode, the packet is looped back in the MAC layer before going out of the chip. You must force linkup at full duplex as well.<br><br>External loopback is another level of system diagnostic which involves the PHY device to loopback the packet.   |
| Bits [4:3]: | Interface mode:<br>00 - MII mode<br>11 - GMII mode (Default)   |
| Bit [5]:    | Frame loopback.<br>0: Disable frame from sending back to its source port. (Default)<br>1: Allow frame to send back to its source port<br><br>In a regular ethernet switch, a packet should never be receive and forwarded to the same port. Setting the bit allows it to happen.<br><br>This is not the same as an ingress MAC loopback. The destination MAC address has to be stored (learned) in the MCT and associated with the originating source port. The frame loopback will only work for unicast packets. |

|          |  |
|----------|--|
| Bit [6]: | Reserved   |
| Bit [7]: | Soft reset.<br>0: Normal operation (Default)<br>1: Reset. Not self clearing. |

### 12.3.1.5 BUF\_LIMIT – Frame Buffer Limit

CPU Address: h0036

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [6:0]: | Frame Buffer Limit (max 4 KB). Multiple of 64 bytes (Default 0x40) |
| Bit [7]:    | Reserved   |

### 12.3.1.6 FCC – Flow Control Grant Period

CPU Address: h0037

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [2:0]: | Flow Control Grant Period. (Default 0x3)<br><br>Units are (FCC[2:0]+1)*4us |
| Bits [7:3]: | Reserved   |

## 12.3.2 (Group 1 Address) VLAN Group

### 12.3.2.1 AVTCL – VLAN Type Code Register Low

I<sup>2</sup>C Address: h028; CPU Address: h0100

Accessed by CPU and I<sup>2</sup>C (R/W)

|             |   |
|-------------|---|
| Bits [7:0]: | VLANType_LOW: Lower 8 bits of the VLAN type code (Default 0x00) |
|-------------|---|

### 12.3.2.2 AVTCH – VLAN Type Code Register High

I<sup>2</sup>C Address: h029; CPU Address: h0101

Accessed by CPU and I<sup>2</sup>C (R/W)

|             |   |
|-------------|---|
| Bits [7:0]: | VLANType_HIGH: Upper 8 bits of the VLAN type code (Default is 0x81) |
|-------------|---|



**12.3.2.3 PVMAP00\_0 – Port 0 Configuration Register 0**I<sup>2</sup>C Address: h02A, CPU Address: h0102Accessed by CPU and I<sup>2</sup>C (R/W)

|             |                                     |
|-------------|-------------------------------------|
| Bits [7:0]: | VLAN Mask for port 0 (Default 0xFF) |
|-------------|-------------------------------------|

This register indicates the legal egress ports. A “1” on bit 3 means that the packet can be sent to port 3. A “0” on bit 3 means that any packet destined to port 3 will be discarded. This register works with registers 1 to form a 10 bit mask to all egress ports.

**12.3.2.4 PVMAP00\_1 – Port 0 Configuration Register 1**I<sup>2</sup>C Address: h034, CPU Address: h0103Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [1:0]: | VLAN Mask for ports 9 to 8 (Default 0x3) |
| Bits [7:2]: | Reserved (Default 0x3F)                  |

**12.3.2.5 PVMAP00\_3 – Port 0 Configuration Register 3**I<sup>2</sup>C Address: h3E, CPU Address: h0105Accessed by CPU and I<sup>2</sup>C (R/W)

|             |   |
|-------------|---|
| Bits [2:0]: | Reserved  |
| Bits [5:3]: | Default transmit priority. Used when Bit [7]=1 (Default 0)<br><br>Transmit Priority Level 0 (Lowest)<br>Transmit Priority Level 1<br>...<br>Transmit Priority Level 6<br>Transmit Priority Level 7 (Highest)  |
| Bit [6]:    | Default drop precedence. Used when Bit [7]=1<br>0 – Drop Precedence Level 0 (Lowest) (Default)<br>1 – Drop Precedence Level 1 (Highest)   |
| Bit [7]:    | Enable Fix Priority (Default 0)<br>0 - Disable. All frames are analysed. Transmit Priority and Drop Precedence are based on VLAN Tag, TOS or Logical Port.<br>1 - Enable. Transmit Priority and Drop Precedence are based on values programmed in bit [6:3] |

**12.3.2.6 PVMAPnn\_0,1,3 – Ports 1~9 Configuration Registers****PVMAP01\_0,1,3** - I<sup>2</sup>C Address h02B, 035, 03F; CPU Address:h0106, 0107, 0109 (Port 1)**PVMAP02\_0,1,3** - I<sup>2</sup>C Address h02C, 036, 040; CPU Address:h010A, 010B, 010D (Port 2)**PVMAP03\_0,1,3** - I<sup>2</sup>C Address h02D, 037, 041; CPU Address:h010E, 010F, 0111 (Port 3)**PVMAP04\_0,1,3** - I<sup>2</sup>C Address h02E, 038, 042; CPU Address:h0112, 0113, 0115 (Port 4)**PVMAP05\_0,1,3** - I<sup>2</sup>C Address h02F, 039, 043; CPU Address:h0116, 0117, 0119 (Port 5)**PVMAP06\_0,1,3** - I<sup>2</sup>C Address h030, 03A, 044; CPU Address:h011A, 011B, 011D (Port 6)**PVMAP07\_0,1,3** - I<sup>2</sup>C Address h031, 03B, 045; CPU Address:h011E, 011F, 0121 (Port 7)**PVMAP08\_0,1,3** - I<sup>2</sup>C Address h032, 03C, 046; CPU Address:h0122, 0123, 0125 (Port CPU)**PVMAP09\_0,1,3** - I<sup>2</sup>C Address h033, 03D, 047; CPU Address:h0126, 0127, 0129 (Port GMAC)**12.3.2.7 PVMODE**I<sup>2</sup>C Address: h048, CPU Address: h0170Accessed by CPU and I<sup>2</sup>C (R/W)

|          |   |
|----------|---|
| Bit [0]: | Reserved. Must be 0.  |
| Bit [1]: | Slow learning (Default = 0)<br><br>Same function as SE_OPMODE bit [7]. Either bit can enable the function; both need to be turned off to disable the feature.   |
| Bit [2]: | Disable dropping of frames with destination MAC addresses 01-80-C2-00-00-01 to 0x01-80-C2-00-00-0F.<br>0: Drop all frames in this range (Default)<br>1: Disable dropping of frames in this range  |
| Bit [3]: | Flooding control in secure mode<br>0: Enable - Learning disabled port will not receive any flooding packets (Default)<br>1: Disable   |
| Bit [4]: | Support MAC address 0<br>0: MAC address 0 is not learned. (Default)<br>This means packet with destination MAC address 0 is forwarded as unknown destination. It is subjected to unicast to multicast rate control.<br>1: MAC address 0 is learned.                                  |
| Bit [5]: | Disable IEEE multicast control frame (01-80-C2-00-00-00 to 01-80-C2-00-00-0F) to CPU in managed mode. In unmanaged mode, frame is forwarded as multicast (except PAUSE frame).<br>0: Frame is forwarded to CPU (Default)<br>1: Frame is forwarded as multicast (except PAUSE frame) |
| Bit [6]: | Reserved. Must be 0.  |
| Bit [7]: | Enable logical port match in secure mode<br>0: Disable (Default)<br>1: Enable - When Well Known or User Define logical port force discard enabled, force any IP packet with logical port number matching logical port numbers to CPU.   |

### 12.3.3 (Group 2 Address) Port Trunking Groups

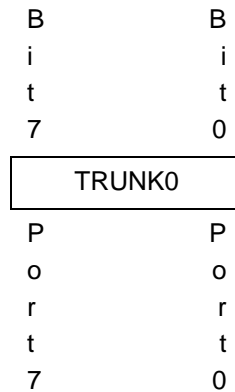
Trunk Group – Up to eight RMAC ports can be selected for each trunk group.

#### 12.3.3.1 TRUNKn– Trunk Group 0~7

CPU Address: h0200+n (n = trunk group)

Accessed by CPU (R/W)

Bit [7:0] Port 7-0 bit map of trunk n. (Default 0)



#### 12.3.3.2 TRUNKn\_HASH10 – Trunk group n hash result 1/0 destination port number

CPU Address: h0208+4n (n = trunk group)

Accessed by CPU (R/W)

|            |   |
|------------|---|
| Bits [3:0] | Hash result 0 destination port number (Default 0) |
| Bits [7:4] | Hash result 1 destination port number (Default 0) |

#### 12.3.3.3 TRUNKn\_HASH32 – Trunk group n hash result 3/2 destination port number

CPU Address: h0209+4n (n = trunk group)

Accessed by CPU (R/W)

|            |   |
|------------|---|
| Bits [3:0] | Hash result 2 destination port number (Default 0) |
| Bits [7:4] | Hash result 3 destination port number (Default 0) |

CPU Address: h020A+4n (n = trunk group)

Accessed by CPU (R/W)

|            |   |
|------------|---|
| Bits [3:0] | Hash result 4 destination port number (Default 0) |
| Bits [7:4] | Hash result 5 destination port number (Default 0) |

CPU Address: h020B+4n (n = trunk group)

Accessed by CPU (R/W)

|            |   |
|------------|---|
| Bits [3:0] | Hash result 6 destination port number (Default 0) |
| Bits [7:4] | Hash result 7 destination port number (Default 0) |

Multicast Hash registers are used to distribute multicast traffic. 16 registers are used to form a 8-entry array; each entry has 10 bits, with each bit representing one port. Any port not belonging to a trunk group should be programmed with 1. Ports belonging to the same trunk group should only have a single port set to “1” per entry. The port set to “1” is picked to transmit the multicast frame when the hash value is met.

|               |         |         |
|---------------|---------|---------|
| Hash Value =0 | HASH0-1 | HASH0-0 |
| Hash Value =1 | HASH1-1 | HASH1-0 |
| Hash Value =2 | HASH2-1 | HASH2-0 |
| Hash Value =3 | HASH3-1 | HASH3-0 |
| Hash Value =4 | HASH4-1 | HASH4-0 |
| Hash Value =5 | HASH5-1 | HASH5-0 |
| Hash Value =6 | HASH6-1 | HASH6-0 |
| Hash Value =7 | HASH7-1 | HASH7-0 |

**12.3.3.6 MULTICAST\_HASHn-0 – Multicast hash result 0~7 mask byte 0**

CPU Address: h0228+2n (n = hash value)

Accessed by CPU (R/W)

|             |   |
|-------------|---|
| Bits [7:0]: | Port 7-0 bit map for multicast hash. (Default 0xFF) |
|-------------|---|

**12.3.3.7 MULTICAST\_HASHn-1 – Multicast hash result 0~7 mask byte 1**

CPU Address: h0229+2n (n = hash value)

Accessed by CPU (R/W)

|             |   |
|-------------|---|
| Bits [1:0]: | Port 9-8 bit map for multicast hash. (Default 0x3)  |
| Bit [2]:    | Reserved (Default 0x1)  |
| Bits [5:3]: | Reserved (Default 0x7)  |
| Bits [7:6]: | <u>MULTICAST_HASH0-1</u><br>Hash Select. The hash algorithm selected is valid for all trunks<br>00 - Use Source and Destination MAC Address for hashing<br>01 - Use Source MAC Address for hashing<br>10 - Use Destination MAC Address for hashing<br>11 - Use Source Port Number for hashing (Default)<br><br><u>MULTICAST_HASH[7:1]-1</u><br>Reserved (Default 0x3) |

**12.3.4 (Group 3 Address) CPU Port Configuration Group**

47

0 (MC bit)

|      |      |      |      |      |      |
|------|------|------|------|------|------|
| MAC5 | MAC4 | MAC3 | MAC2 | MAC1 | MAC0 |
|------|------|------|------|------|------|

MAC5 to MAC0 registers form the CPU MAC address. When a packet with destination MAC address match MAC [5:0], the packet is forwarded to the CPU. The default MAC address is 00-00-00-00-00-00.

**12.3.4.1 MAC0 – CPU MAC address byte 0**

CPU Address: h0300

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [7:0]: | Byte 0 (bits [7:0]) of the CPU MAC address (Default 0) |
|-------------|--|

**12.3.4.2 MAC1 – CPU MAC address byte 1**

CPU Address: h0301

Accessed by CPU (R/W)

|             |   |
|-------------|---|
| Bits [7:0]: | Byte 1 (bits [15:8]) of the CPU MAC address (Default 0) |
|-------------|---|

**12.3.4.3 MAC2 – CPU MAC address byte 2**

CPU Address: h0302

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [7:0]: | Byte 2 (bits [23:16]) of the CPU MAC address (Default 0) |
|-------------|--|

**12.3.4.4 MAC3 – CPU MAC address byte 3**

CPU Address: h0303

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [7:0]: | Byte 3 (bits [31:24]) of the CPU MAC address (Default 0) |
|-------------|--|

**12.3.4.5 MAC4 – CPU MAC address byte 4**

CPU Address: h0304

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [7:0]: | Byte 4 (bits [39:32]) of the CPU MAC address (Default 0) |
|-------------|--|

**12.3.4.6 MAC5 – CPU MAC address byte 5**

CPU Address: h0305

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [7:0]: | Byte 5 (bits [47:40]) of the CPU MAC address (Default 0)<br><br>Note: Bits [42:40] are set on a per port basis using MAC01, MAC23, MAC45, MAC67 registers. For port 9, this register is ignored and MAC9 is used for bits [47:40]. |
|-------------|--|

**12.3.4.7 INT\_MASK0 – Interrupt Mask**

CPU Address: h0306

Accessed by CPU (R/W)

The CPU can dynamically mask the interrupt when it is busy and doesn't want to be interrupted. (Default 0x00)

- 1: Mask the interrupt
- 0: Unmask the interrupt (Enable interrupt) (Default)

|             |   |
|-------------|---|
| Bit [0]:    | CPU frame interrupt. CPU frame buffer has data for CPU to read                      |
| Bit [1]:    | Control Command 1 interrupt. Control Command Frame buffer1 has data for CPU to read |
| Bit [2]:    | Control Command 2 interrupt. Control command Frame buffer2 has data for CPU to read |
| Bits [6:3]: | Reserved  |
| Bit [7]:    | Device Timeout Detected interrupt   |

#### 12.3.4.8 INTP\_MASK0 – Interrupt Mask for MAC Port 0,1

CPU Address: h0310

Accessed by CPU (R/W)

The CPU can dynamically mask the interrupt when it is busy and doesn't want to be interrupted (Default 0x00)

- 1: Mask the interrupt
- 0: Unmask the interrupt (Default)

|          |  |
|----------|--|
| Bit [0]: | Port 0 statistic counter wrap around interrupt mask. An Interrupt is generated when a statistic counter wraps around. Refer to hardware statistic counter for interrupt sources  |
| Bit [1]: | Port 0 link change mask  |
| Bit [2]: | Port 0 module detect mask  |
| Bit [3]: | Reserved   |
| Bit [4]: | Port 1 statistic counter wrap around interrupt mask. An interrupt is generated when a statistic counter wraps around. Refer to hardware statistic counter for interrupt sources. |
| Bit [5]: | Port 1 link change mask  |
| Bit [6]: | Port 1 module detect mask  |
| Bit [7]: | Reserved   |

#### 12.3.4.9 INTP\_MASKn – Interrupt Mask for MAC Ports 2~9 Registers

**INTP\_MASK1** - CPU Address: h0311 (Ports 2,3)

**INTP\_MASK2** - CPU Address: h0312 (Ports 4,5)

**INTP\_MASK3** - CPU Address: h0313 (Ports 6,7)

**INTP\_MASK4** - CPU Address: h0314 (Port CPU,GMAC)

**12.3.4.10 RQS – Receive Queue Select**

CPU Address: h0323

Accessed by CPU (RW)

Select which receive queue is being used by the CPU port.

|          |  |
|----------|--|
| Bit [0]: | Select Queue 0<br>0: Not selected (Default)<br>1: Selected |
| Bit [1]: | Select Queue 1   |
| Bit [2]: | Select Queue 2   |
| Bit [3]: | Select Queue 3   |
| Bit [4]: | Select Multicast Queue 0                                   |
| Bit [5]: | Select Multicast Queue 1                                   |
| Bit [6]: | Select Multicast Queue 2                                   |
| Bit [7]: | Select Multicast Queue 3                                   |

**Note:** Strict priority applies between different selected queues (UQ3>UQ2>UQ1>UQ0>MQ3>MQ2>MQ1>MQ0).**12.3.4.11 RQSS – Receive Queue Status**

CPU Address: h0324

Accessed by CPU (RO)

CPU receive queue status

|             |  |
|-------------|--|
| Bits [3:0]: | Unicast Queue 3 to 0 not empty<br>0: Empty<br>1: Not Empty |
| Bits [7:4]: | Multicast Queue 3 to 0 not empty                           |

**12.3.4.12 MAC01 – Increment MAC port 0,1 address**

CPU Address: h0325

Accessed by CPU (RW)

|             |  |
|-------------|--|
| Bits [2:0]: | Bits [42:40] of Port 0 CPU MAC address |
| Bit [3]:    | Reserved                               |
| Bits [6:4]: | Bits [42:40] of Port 1 CPU MAC address |
| Bit [7]:    | Reserved                               |

MAC01, MAC23, MAC45, MAC67, and MAC9 registers are used with the MAC0~5 registers to form the CPU MAC address on a per port basis.



**12.3.4.13 MAC23 – Increment MAC port 2,3 address**

CPU Address: h0326

Accessed by CPU (RW)

|             |  |
|-------------|--|
| Bits [2:0]: | Bits [42:40] of Port 2 CPU MAC address |
| Bit [3]:    | Reserved                               |
| Bits [6:4]: | Bits [42:40] of Port 3 CPU MAC address |
| Bit [7]:    | Reserved                               |

**12.3.4.14 MAC45 – Increment MAC port 4,5 address**

CPU Address: h0327

Accessed by CPU (RW)

|             |  |
|-------------|--|
| Bits [2:0]: | Bits [42:40] of Port 4 CPU MAC address |
| Bit [3]:    | Reserved                               |
| Bits [6:4]: | Bits [42:40] of Port 5 CPU MAC address |
| Bit [7]:    | Reserved                               |

**12.3.4.15 MAC67 – Increment MAC port 6,7 address**

CPU Address: h0328

Accessed by CPU (RW)

|             |  |
|-------------|--|
| Bits [2:0]: | Bits [42:40] of Port 6 CPU MAC address |
| Bit [3]:    | Reserved                               |
| Bits [6:4]: | Bits [42:40] of Port 7 CPU MAC address |
| Bit [7]:    | Reserved                               |

**12.3.4.16 MAC9 – Increment MAC port 9 address**

CPU Address: h0329

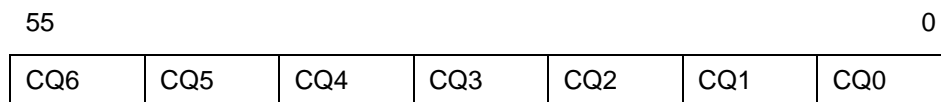
Accessed by CPU (RW)

|             |  |
|-------------|--|
| Bits [7:0]: | Bits [47:40] of Port 9 CPU MAC address |
|-------------|--|

**12.3.4.17 CPUQINS0 - CPUQINS6 – CPU Queue Insertion Command**

CPU Address: h0330-0336

Accessed by CPU, (R/W)



CPU Queue insertion command

|                 |  |
|-----------------|--|
| <b>CPUQINS0</b> |  |
| Bit[7:0]:       | Destination Map (port 7-0).  |
| <b>CPUQINS1</b> |  |
| Bit[9:8]:       | Destination Map (GMAC, CPU).                                       |
| Bits [13:10]    | Priority   |
| Bits [15:14]    | Number of granules for the frame                                   |
| <b>CPUQINS2</b> |  |
| Bits [20:16]    | Number of granules for the frame (con't)                           |
| Bits [23:21]    | Tail pointer   |
| <b>CPUQINS3</b> |  |
| Bits [31:24]    | Tail pointer (con't)   |
| <b>CPUQINS4</b> |  |
| Bits [35:32]    | Tail pointer (con't)   |
| Bits [39:36]    | Header Pointer   |
| <b>CPUQINS5</b> |  |
| Bits [47:40]    | Header Pointer (con't)   |
| <b>CPUQINS6</b> |  |
| Bits [50:48]    | Header Pointer (con't)   |
| Bit [51]        | Multicast frame (has to be one if more than one destination port)  |
| Bits [54:52]    | Reserved   |
| Bit [55]        | Command valid (will be processed on the rising edge of the signal) |

**12.3.4.18 CPUQINSRPT – CPU Queue Insertion Report**

CPU Address: h0337

Accessed by CPU, (RO)

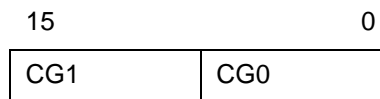
CPU command queue status

|          |  |
|----------|--|
| Bit [0]: | The command is under processing.                             |
| Bit [1]: | Insertion Fail (May be due to queue full, WRED or filtering) |

**12.3.4.19 CPUGRNHDL0 - CPUGRNHDL1 – CPU Allocated Granule Pointer**

CPU Address: h0338-339

Accessed by CPU, (RO)



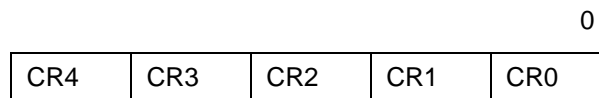
CPU Queue insertion command

|              |                  |
|--------------|------------------|
| Bits [14:0]: | Granule pointer. |
| Bit [15]:    | Pointer valid    |

**12.3.4.20 CPURLSINFO0 - CPURLSINFO4 – Receive Queue Status**

CPU Address: h033A-033E

Accessed by CPU, (R/W)



CPU Queue insertion command

|              |                                    |
|--------------|------------------------------------|
| Bits [14:0]: | Header pointer                     |
| Bits [30:15] | Tail pointer                       |
| Bits [38:32] | Number of granules for the release |

**12.3.4.21 CPUGRNCTR – CPU Granule Control**

CPU Address: h033f

Accessed by CPU, (R/W)

CPU receive queue status

|          |   |
|----------|---|
| Bit [0]: | Allocate granule to the CPU if set to one. Otherwise, do not allocate any resource. |
| Bit [1]: | Read allocated granule (at rising edge only)  |
| Bit [2]: | Release info valid (will be processed at rising edge only)                          |

**12.3.5 (Group 4 Address) Search Engine Group****12.3.5.1 AGETIME\_LOW – MAC address aging time Low**I<sup>2</sup>C Address: h049; CPU Address: h0400Accessed by CPU and I<sup>2</sup>C (R/W)

Used in conjunction with AGETIME\_HIGH. The ZL50407 removes the MAC address from the data base and sends a Delete MAC Address Control Command to the CPU.

|             |  |
|-------------|--|
| Bits [7:0]: | Low byte of the MAC address aging timer (Default 0x5C) |
|-------------|--|

**12.3.5.2 AGETIME\_HIGH –MAC address aging time High**I<sup>2</sup>C Address: h04A; CPU Address: h0401Accessed by CPU and I<sup>2</sup>C (R/W)

|             |   |
|-------------|---|
| Bits [7:0]: | High byte of the MAC address aging timer (Default 0x00) |
|-------------|---|

The default setting of AGETIME\_LOW/HIGH provides 300 seconds aging time. Aging time is based on the following equation:

{AGETIME\_HIGH,AGETIME\_LOW} X (# of MAC entries in the memory X 800 μsec). Number of MAC entries = 4 K.

**12.3.5.3 SE\_OPMODE – Search Engine Operation Mode**

CPU Address: h0403

Accessed by CPU (R/W)

**Note:** ECR2[2] enable/disable learning for each port.

|          |   |
|----------|---|
| Bit [0]: | Reserved. Must be 0.  |
| Bit [1]: | Protocol filtering mode<br>0 – Inclusive (Default)<br>1 – Exclusive |

|          |   |
|----------|---|
| Bit [2]: | Delete MAC report control<br>0 – Report MAC address deletion (MAC address is deleted from MCT after aging time) (Default)<br>1 – Disable report MAC address deletion  |
| Bit [3]: | Delete Control<br>0 – MAC address entry is removed when it is old enough to be aged (Default)<br>1 – Disable aging logic from removing MAC during aging<br><br>However, a report is still sent to the CPU in both cases, when bit [2] = 0 |
| Bit [4]: | Reserved. Must be 0.  |
| Bit [5]: | Reserved  |
| Bit [6]: | Disable MCT speed-up aging<br>0 – Enable speed-up aging when MCT resource is low. (Default)<br>1 – Disable speed-up aging when MCT resource is low.   |
| Bit [7]: | Slow Learning<br>0 – Learning is performed independent of search demand (Default)<br>1 – Enable slow learning. Learning is temporary disabled when search demand is high  |

### 12.3.6 (Group 5 Address) Buffer Control/QOS Group

#### 12.3.6.1 QOSC – QOS Control

I<sup>2</sup>C Address: h04B; CPU Address: h0500

Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bit [0]:    | Enable TX rate control (on RMAC ports only)<br>0 – Disable (Default)<br>1 – Enable   |
| Bit [1]:    | Enable RX rate control (on RMAC ports only)<br>0 – Disable (Default)<br>1 – Enable   |
| Bits [4:2]: | Reserved   |
| Bit [5]:    | Select VLAN tag or TOS (IP packets) to be preferentially picked to map transmit priority and drop precedence<br>0 – Select VLAN Tag priority field over TOS (Default)<br>1 – Select TOS over VLAN tag priority field |
| Bit [6]:    | Select TOS bits for transmission priority<br>0 – Use TOS [4:2] bits to map the transmit priority (Default)<br>1 – Use TOS [7:5] bits to map the transmit priority  |
| Bit [7]:    | Select TOS bits for drop precedence<br>0 – Use TOS [4:2] bits to map the drop precedence (Default)<br>1 – Use TOS [7:5] bits to map the drop precedence  |

**12.3.6.2 PCC – Packet Congestion Control**I<sup>2</sup>C Address: h068; CPU Address: h0510Accessed by CPU and I<sup>2</sup>C (R/W)

|   |   |
|---|---|
| Bits [7:0]:   | Packet congestion control on the granule count of P0 queue.<br><br>Used to trigger RED at B% when destination port's P0 queue granule count reaches PCC and shared pool is all in use. Granularity is 16 granule (Default 0x6). |
| See Programming QoS Registers application note, ZLAN-42, for more information |   |

**12.3.6.3 MCC – Multicast Congestion Control**I<sup>2</sup>C Address: h069; CPU Address: h0511Accessed by CPU and I<sup>2</sup>C (R/W)

|   |   |
|---|---|
| Bits [7:0]:   | Global congestion control on the multicast granule count.<br><br>Used to trigger 100% drop (or flow control, if FC enabled on source port) when total multicast granule count reaches MCC. Granularity is 16 granule (Default 0x6). |
| See Programming QoS Registers application note, ZLAN-42, for more information |   |

**12.3.6.4 MCCTH – Multicast Threshold Control**

CPU Address: h0512

Accessed by CPU (R/W)

|   |  |
|---|--|
| Bits [7:0]:   | Global congestion control threshold on the multicast granule count. Exceeding the MCCTH threshold is considered as an indication of multicast resources being low.<br><br>Used to trigger RED at B% when total multicast granule count reaches MCCTH. Granularity is 16 granule (Default 0x3). |
| See Programming QoS Registers application note, ZLAN-42, for more information |  |

**12.3.6.5 RDRC0 – WRED Rate Control 0**I<sup>2</sup>C Address: h090; CPU Address: h0513Accessed by CPU and I<sup>2</sup>C (R/W)

|   |  |
|---|--|
| Bits [3:0]:   | Corresponds to the frame drop percentage Y% for WRED. Granularity 6.25%. |
| Bits [7:4]:   | Corresponds to the frame drop percentage X% for WRED. Granularity 6.25%. |
| See Programming QoS Registers application note, ZLAN-42, for more information |  |

**12.3.6.6 RDRC1 – WRED Rate Control 1**I<sup>2</sup>C Address: h091; CPU Address: h0514Accessed by CPU and I<sup>2</sup>C (R/W)

|   |  |
|---|--|
| Bits [3:0]:   | Corresponds to the frame drop percentage B% for RED. Granularity 6.25%.  |
| Bits [7:4]:   | Corresponds to the frame drop percentage Z% for WRED. Granularity 6.25%. |
| See Programming QoS Registers application note, ZLAN-42, for more information |  |

**12.3.6.7 RDRC2 – WRED Rate Control 2**

CPU Address: h0515

Accessed by CPU (R/W)

|  |   |
|--|---|
| Bits [3:0]:  | Corresponds to the frame drop percentage RB% for ingress rate control. Granularity 6.25%. |
| Bits [7:4]:  | Corresponds to the frame drop percentage RA% for ingress rate control. Granularity 6.25%. |
| See Rate Control application note, ZLAN-33, for more information |   |

**12.3.6.8 SFCB – Share FCB Size**I<sup>2</sup>C Address: h074; CPU Address: h0518Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [7:0]: | Expressed in multiples of 16 granules. Buffer reservation for shared pool. |
|-------------|--|

**12.3.6.9 C1RS – Class 1 Reserve Size**I<sup>2</sup>C Address: h075; CPU Address: h0519Accessed by CPU and I<sup>2</sup>C (R/W)

|             |                         |
|-------------|-------------------------|
| Bits [7:0]: | Class 1 FCB Reservation |
|-------------|-------------------------|

Buffer reservation for class 1. Granularity 16 granules. **(Default 0)****12.3.6.10 C2RS – Class 2 Reserve Size**I<sup>2</sup>C Address: h076; CPU Address: h051AAccessed by CPU and I<sup>2</sup>C (R/W)

|             |                         |
|-------------|-------------------------|
| Bits [7:0]: | Class 2 FCB Reservation |
|-------------|-------------------------|

Buffer reservation for class 2. Granularity 16 granules. **(Default 0)**

**12.3.6.11 C3RS – Class 3 Reserve Size**I<sup>2</sup>C Address: h077; CPU Address: h051BAccessed by CPU and I<sup>2</sup>C (R/W)

|             |                         |
|-------------|-------------------------|
| Bits [7:0]: | Class 3 FCB Reservation |
|-------------|-------------------------|

Buffer reservation for class 3. Granularity 16 granules. **(Default 0)****12.3.6.12 AVPML – VLAN Tag Priority Map**I<sup>2</sup>C Address: h056; CPU Address: h0530Accessed by CPU and I<sup>2</sup>C (R/W)

Registers AVPML, AVPMM, and AVPMH allow the eight VLAN Tag priorities to map into eight Internal level transmit priorities. Under the Internal transmit priority, seven is the highest priority where as zero is the lowest. This feature allows the user the flexibility of redefining the VLAN priority field. For example, programming a value of 7 into bit 2:0 of the AVPML register would map packet VLAN priority 0 into Internal transmit priority 7. The new priority is used inside the ZL50407. When the packet goes out it carries the original priority.

|             |  |
|-------------|--|
| Bits [2:0]: | Priority when the VLAN tag priority field is 0 (Default 0)<br><br>Transmit Priority Level 0 (Lowest)<br>Transmit Priority Level 1<br>...<br>Transmit Priority Level 6<br>Transmit Priority Level 7 (Highest) |
| Bits [5:3]: | Priority when the VLAN tag priority field is 1 (Default 0)   |
| Bits [7:6]: | Priority when the VLAN tag priority field is 2 (Default 0)   |

**12.3.6.13 AVPMM – VLAN Priority Map**I<sup>2</sup>C Address: h057; CPU Address: h0531Accessed by CPU and I<sup>2</sup>C (R/W)

Map VLAN priority into eight level transmit priorities:

|             |  |
|-------------|--|
| Bit [0]:    | Priority when the VLAN tag priority field is 2 (Default 0) |
| Bits [3:1]: | Priority when the VLAN tag priority field is 3 (Default 0) |
| Bits [6:4]: | Priority when the VLAN tag priority field is 4 (Default 0) |
| Bit [7]:    | Priority when the VLAN tag priority field is 5 (Default 0) |



**12.3.6.14 AVPMH – VLAN Priority Map**I<sup>2</sup>C Address: h058; CPU Address: h0532Accessed by CPU and I<sup>2</sup>C (R/W)

Map VLAN priority into eight level transmit priorities:

|             |  |
|-------------|--|
| Bits [1:0]: | Priority when the VLAN tag priority field is 5 (Default 0) |
| Bits [4:2]: | Priority when the VLAN tag priority field is 6 (Default 0) |
| Bits [7:5]: | Priority when the VLAN tag priority field is 7 (Default 0) |

**12.3.6.15 AVDM – VLAN Discard Map**I<sup>2</sup>C Address: h05C; CPU Address: h0533Accessed by CPU and I<sup>2</sup>C (R/W)

Map VLAN priority into frame discard when low priority buffer usage is above threshold

|          |  |
|----------|--|
| Bit [0]: | Frame drop precedence when VLAN Tag priority field is 0 (Default 0)<br><br>0 – Drop Precedence Level 0 (Lowest) (Default)<br>1 – Drop Precedence Level 1 (Highest) |
| Bit [1]: | Frame drop precedence when VLAN Tag priority field is 1 (Default 0)  |
| Bit [2]: | Frame drop precedence when VLAN Tag priority field is 2 (Default 0)  |
| Bit [3]: | Frame drop precedence when VLAN Tag priority field is 3 (Default 0)  |
| Bit [4]: | Frame drop precedence when VLAN Tag priority field is 4 (Default 0)  |
| Bit [5]: | Frame drop precedence when VLAN Tag priority field is 5 (Default 0)  |
| Bit [6]: | Frame drop precedence when VLAN Tag priority field is 6 (Default 0)  |
| Bit [7]: | Frame drop precedence when VLAN Tag priority field is 7 (Default 0)  |

**12.3.6.16 TOSPML – TOS Priority Map**I<sup>2</sup>C Address: h059; CPU Address: h0540Accessed by CPU and I<sup>2</sup>C (R/W)

Map TOS field in IP packet into eight level transmit priorities

|             |  |
|-------------|--|
| Bits [2:0]: | Priority when the TOS field is 0 (Default 0)<br><br>Transmit Priority Level 0 (Lowest)<br>Transmit Priority Level 1<br>...<br>Transmit Priority Level 6<br>Transmit Priority Level 7 (Highest) |
|-------------|--|

|             |  |
|-------------|--|
| Bits [5:3]: | Priority when the TOS field is 1 (Default 0) |
| Bits [7:6]: | Priority when the TOS field is 2 (Default 0) |

### 12.3.6.17 TOSPM – TOS Priority Map

I<sup>2</sup>C Address: h05A; CPU Address: h0541

Accessed by CPU and I<sup>2</sup>C (R/W)

Map TOS field in IP packet into eight level transmit priorities

|             |  |
|-------------|--|
| Bit [0]:    | Priority when the TOS field is 2 (Default 0) |
| Bits [3:1]: | Priority when the TOS field is 3 (Default 0) |
| Bits [6:4]: | Priority when the TOS field is 4 (Default 0) |
| Bit [7]:    | Priority when the TOS field is 5 (Default 0) |

### 12.3.6.18 TOSPMH – TOS Priority Map

I<sup>2</sup>C Address: h05B; CPU Address: h0542

Accessed by CPU and I<sup>2</sup>C (R/W)

Map TOS field in IP packet into eight level transmit priorities:

|             |  |
|-------------|--|
| Bits [1:0]: | Priority when the TOS field is 5 (Default 0) |
| Bits [4:2]: | Priority when the TOS field is 6 (Default 0) |
| Bits [7:5]: | Priority when the TOS field is 7 (Default 0) |

### 12.3.6.19 TOSDML – TOS Discard Map

I<sup>2</sup>C Address: h05D; CPU Address: h0543

Accessed by CPU and I<sup>2</sup>C (R/W)

Map TOS into frame discard when low priority buffer usage is above threshold

|          |  |
|----------|--|
| Bit [0]: | Frame drop precedence when TOS field is 0 (Default 0)<br><br>0 – Drop Precedence Level 0 (Lowest) (Default)<br>1 – Drop Precedence Level 1 (Highest) |
| Bit [1]: | Frame drop precedence when TOS field is 1 (Default 0)  |
| Bit [2]: | Frame drop precedence when TOS field is 2 (Default 0)  |
| Bit [3]: | Frame drop precedence when TOS field is 3 (Default 0)  |
| Bit [4]: | Frame drop precedence when TOS field is 4 (Default 0)  |
| Bit [5]: | Frame drop precedence when TOS field is 5 (Default 0)  |

|          |   |
|----------|---|
| Bit [6]: | Frame drop precedence when TOS field is 6 (Default 0) |
| Bit [7]: | Frame drop precedence when TOS field is 7 (Default 0) |

### 12.3.6.20 USER\_PROTOCOL\_n – User Define Protocol 0~7

I<sup>2</sup>C Address: h0B3+n; CPU Address: h0550+n

Accessed by CPU and I<sup>2</sup>C (R/W)

(Default 00) This register is duplicated eight times from PROTOCOL 0~7 and allows the CPU to define eight separate protocols.

|             |                      |
|-------------|----------------------|
| Bits [7:0]: | User Define Protocol |
|-------------|----------------------|

### 12.3.6.21 USER\_PROTOCOL\_FORCE\_DISCARD – User Define Protocol 0~7 Force Discard

I<sup>2</sup>C Address: h0BB; CPU Address: h0558

Accessed by CPU and I<sup>2</sup>C (R/W)

|          |  |
|----------|--|
| Bit [0]: | Enable Protocol 0 Force Discard<br>1 – Enable<br>0 – Disable |
| Bit [1]: | Enable Protocol 1 Force Discard                              |
| Bit [2]: | Enable Protocol 2 Force Discard                              |
| Bit [3]: | Enable Protocol 3 Force Discard                              |
| Bit [4]: | Enable Protocol 4 Force Discard                              |
| Bit [5]: | Enable Protocol 5 Force Discard                              |
| Bit [6]: | Enable Protocol 6 Force Discard                              |
| Bit [7]: | Enable Protocol 7 Force Discard                              |

### User Defined Logical Ports and Well Known Ports

The ZL50407 supports classifying packet priority through layer 4 logical port information. It can be setup by 8 Well Known Ports, 8 User Defined Logical Ports, and 1 User Defined Range. The 8 Well Known Ports supported are:

- 23
- 512
- 6000
- 443
- 111
- 22555
- 22
- 554

Their respective priority can be programmed via WELL\_KNOWN\_PORT[7:0]\_PRIORITY register. WELL\_KNOWN\_PORT[\_ENABLE can individually turn on/off each Well Known Port if desired.

Similarly, the User Defined Logical Port provides the user programmability to the priority, plus the flexibility to select specific logical ports to fit the applications. The 8 User Logical Ports can be programmed via User\_Port 0-7 registers. Two registers are required to be programmed for the logical port number. The respective priority can be programmed to the User\_Port [7:0] priority register. The port priority can be individually enabled/disabled via User\_Port\_Enable register.

The User Defined Range provides a range of logical port numbers with the same priority level. Programming is similar to the User Defined Logical Port. Instead of programming a fixed port number, an upper and lower limit need to be programmed, they are: {RHIGHH, RHIGHL} and {RLOWH, RLOWL} respectively. If the value in the upper limit is smaller or equal to the lower limit, the function is disabled. Any IP packet with a logical port that is less than the upper limit and more than the lower limit will use the priority specified in RPRIORITY.

#### 12.3.6.22 WELL\_KNOWN\_PORT[1:0]\_PRIORITY- Well Known Logic Port 1 and 0 Priority

I<sup>2</sup>C Address: h0A8; CPU Address: h0560

Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [3:0]: | Priority setting, transmission + dropping, for Well known port 0 (23 for telnet)<br><br>Bit[0]     0 – Drop Precedence Level 0 (Lowest) (Default)<br>1 – Drop Precedence Level 1 (Highest)<br><br>Bits[3:1] Transmit Priority Level 0 (Lowest)<br>Transmit Priority Level 1<br>...<br>Transmit Priority Level 6<br>Transmit Priority Level 7 (Highest) |
| Bits [7:4]: | Priority setting, transmission + dropping, for Well known port 1 (512 for TCP/UDP)   |

#### 12.3.6.23 WELL\_KNOWN\_PORT[3:2]\_PRIORITY- Well Known Logic Port 3 and 2 Priority

I<sup>2</sup>C Address: h0A9; CPU Address: h0561

Accessed by CPU and I<sup>2</sup>C (R/W)

|             |   |
|-------------|---|
| Bits [3:0]: | Priority setting, transmission + dropping, for Well known port 2 (6000 for XWIN)    |
| Bits [7:4]: | Priority setting, transmission + dropping, for Well known port 3 (443 for HTTP sec) |

**12.3.6.24 WELL\_KNOWN\_PORT[5:4]\_PRIORITY- Well Known Logic Port 5 and 4 Priority**I<sup>2</sup>C Address h0AA, CPU Address 562Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [3:0]: | Priority setting, transmission + dropping, for Well known port 4 (111 for sun remote procedure call) |
| Bits [7:4]: | Priority setting, transmission + dropping, for Well known port 5 (22555 for IP Phone call setup)     |

**12.3.6.25 WELL\_KNOWN\_PORT[7:6]\_PRIORITY- Well Known Logic Port 7 and 6 Priority**I<sup>2</sup>C Address: h0AB; CPU Address: h0563Accessed by CPU and I<sup>2</sup>C (R/W)

|             |   |
|-------------|---|
| Bits [3:0]: | Priority setting, transmission + dropping, for Well known port 6 (22 for ssh)   |
| Bits [7:4]: | Priority setting, transmission + dropping, for Well known port 7 (554 for rtsp) |

**12.3.6.26 WELL\_KNOWN\_PORT\_ENABLE – Well Known Logic Port 0 to 7 Enables**I<sup>2</sup>C Address: h0AC; CPU Address: h0564Accessed by CPU and I<sup>2</sup>C (R/W)

|          |  |
|----------|--|
| Bit [0]: | Enable Well Known Port 0 Priority<br>1 – Enable<br>0 – Disable |
| Bit [1]: | Enable Well Known Port 1 Priority                              |
| Bit [2]: | Enable Well Known Port 2 Priority                              |
| Bit [3]: | Enable Well Known Port 3 Priority                              |
| Bit [4]: | Enable Well Known Port 4 Priority                              |
| Bit [5]: | Enable Well Known Port 5 Priority                              |
| Bit [6]: | Enable Well Known Port 6 Priority                              |
| Bit [7]: | Enable Well Known Port 7 Priority                              |

**12.3.6.27 WELL\_KNOWN\_PORT\_FORCE\_DISCARD – Well Known Logic Port 0~7 Force Discard**I<sup>2</sup>C Address: h0AD; CPU Address: h0565Accessed by CPU and I<sup>2</sup>C (R/W)

|          |   |
|----------|---|
| Bit [0]: | Enable Well Known Port 0 Force Discard<br>1 – Enable<br>0 – Disable |
|----------|---|

|          |  |
|----------|--|
| Bit [1]: | Enable Well Known Port 1 Force Discard |
| Bit [2]: | Enable Well Known Port 2 Force Discard |
| Bit [3]: | Enable Well Known Port 3 Force Discard |
| Bit [4]: | Enable Well Known Port 4 Force Discard |
| Bit [5]: | Enable Well Known Port 5 Force Discard |
| Bit [6]: | Enable Well Known Port 6 Force Discard |
| Bit [7]: | Enable Well Known Port 7 Force Discard |

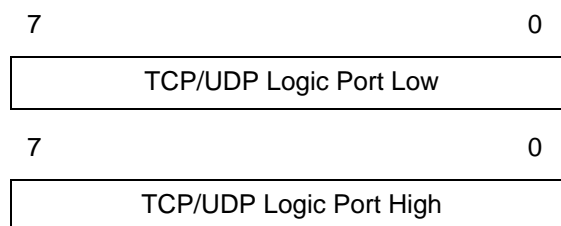
#### 12.3.6.28 USER\_PORT[7:0]\_ [LOW/HIGH] – User Define Logical Port 0~7

I<sup>2</sup>C Address: h092+n(Low); CPU Address: h0570+2n(Low) (n = logical port number)

I<sup>2</sup>C Address: h09A+n(High); CPU Address: h0571+2n(High)

Accessed by CPU and I<sup>2</sup>C (R/W)

(Default 00) This register is duplicated eight times from PORT 0 through PORT 7 and allows the CPU to define eight separate ports.



### 12.3.6.29 USER\_PORT\_[1:0]\_PRIORITY - User Define Logic Port 1 and 0 Priority

I<sup>2</sup>C Address: h0A2; CPU Address: h0590

Accessed by CPU and I<sup>2</sup>C (R/W)

The chip allows the CPU to define the priority

|             |  |
|-------------|--|
| Bits [3:0]: | <p>Priority setting, transmission + dropping, for logic port 0</p> <p>Bit[0]      0 – Drop Precedence Level 0 (Lowest) (Default)<br/>                          1 – Drop Precedence Level 1 (Highest)</p> <p>Bits[3:1]   Transmit Priority Level 0 (Lowest)<br/>                          Transmit Priority Level 1<br/>                          ...<br/>                          Transmit Priority Level 6<br/>                          Transmit Priority Level 7 (Highest)</p> |
| Bits [7:4]: | Priority setting, transmission + dropping, for logic port 1 (Default 00)   |

**12.3.6.30 USER\_PORT\_[3:2]\_PRIORITY - User Define Logic Port 3 and 2 Priority**I<sup>2</sup>C Address: h0A3; CPU Address: h0591Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [3:0]: | Priority setting, transmission + dropping, for logic port 2              |
| Bits [7:4]: | Priority setting, transmission + dropping, for logic port 3 (Default 00) |

**12.3.6.31 USER\_PORT\_[5:4]\_PRIORITY - User Define Logic Port 5 and 4 Priority**I<sup>2</sup>C Address: h0A4; CPU Address: h0592Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [3:0]: | Priority setting, transmission + dropping, for logic port 4              |
| Bits [7:4]: | Priority setting, transmission + dropping, for logic port 5 (Default 00) |

**12.3.6.32 USER\_PORT\_[7:6]\_PRIORITY - User Define Logic Port 7 and 6 Priority**I<sup>2</sup>C Address: h0A5; CPU Address: h0593Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [3:0]: | Priority setting, transmission + dropping, for logic port 6              |
| Bits [7:4]: | Priority setting, transmission + dropping, for logic port 7 (Default 00) |

**12.3.6.33 USER\_PORT\_ENABLE[7:0] – User Define Logic Port 0 to 7 Enables**I<sup>2</sup>C Address: h0A6; CPU Address: h0594Accessed by CPU and I<sup>2</sup>C (R/W)

|          |  |
|----------|--|
| Bit [0]: | Enable User Port 0 Priority<br>1 – Enable<br>0 – Disable |
| Bit [1]: | Enable User Port 1 Priority                              |
| Bit [2]: | Enable User Port 2 Priority                              |
| Bit [3]: | Enable User Port 3 Priority                              |
| Bit [4]: | Enable User Port 4 Priority                              |
| Bit [5]: | Enable User Port 5 Priority                              |
| Bit [6]: | Enable User Port 6 Priority                              |
| Bit [7]: | Enable User Port 7 Priority                              |

**12.3.6.34 USER\_PORT\_FORCE\_DISCARD[7:0] – User Define Logic Port 0~7 Force Discard**I<sup>2</sup>C Address: h0A7; CPU Address: h0595Accessed by CPU and I<sup>2</sup>C (R/W)

|          |   |
|----------|---|
| Bit [0]: | Enable User Port 0 Force Discard<br>1 – Enable<br>0 – Disable |
| Bit [1]: | Enable User Port 1 Force Discard                              |
| Bit [2]: | Enable User Port 2 Force Discard                              |
| Bit [3]: | Enable User Port 3 Force Discard                              |
| Bit [4]: | Enable User Port 4 Force Discard                              |
| Bit [5]: | Enable User Port 5 Force Discard                              |
| Bit [6]: | Enable User Port 6 Force Discard                              |
| Bit [7]: | Enable User Port 7 Force Discard                              |

**12.3.6.35 RLOWL – User Define Range Low Bit 7:0**I<sup>2</sup>C Address: h0AE; CPU Address: h05A0Accessed by CPU and I<sup>2</sup>C (R/W)

|             |   |
|-------------|---|
| Bits [7:0]: | Lower 8 bit of the User Define Logical Port Low Range |
|-------------|---|

**12.3.6.36 RLOWH – User Define Range Low Bit 15:8**I<sup>2</sup>C Address: h0AF; CPU Address: h05A1Accessed by CPU and I<sup>2</sup>C (R/W)

|             |   |
|-------------|---|
| Bits [7:0]: | Upper 8 bit of the User Define Logical Port Low Range |
|-------------|---|

**12.3.6.37 RHIGHL – User Define Range High Bit 7:0**I<sup>2</sup>C Address: h0B0; CPU Address: h05A2Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [7:0]: | Lower 8 bit of the User Define Logical Port High Range |
|-------------|--|



**12.3.6.38 RHIGHH – User Define Range High Bit 15:8**I<sup>2</sup>C Address: h0B1; CPU Address: h05A3Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [7:0]: | Upper 8 bit of the User Define Logical Port High Range |
|-------------|--|

**12.3.6.39 RRIORITY – User Define Range Priority**I<sup>2</sup>C Address: h0B2; CPU Address: h05A4Accessed by CPU and I<sup>2</sup>C (R/W)

RLOW and RHIGH form a range for logical ports to be classified with priority specified in RRIORITY.

|            |  |
|------------|--|
| Bit [0]:   | Drop Precedence (inclusive only)<br><br>0 – Drop Precedence Level 0 (Lowest) (Default)<br>1 – Drop Precedence Level 1 (Highest)  |
| Bits [3:1] | Transmit Priority (inclusive only)<br><br>Transmit Priority Level 0 (Lowest)<br>Transmit Priority Level 1<br>...<br>Transmit Priority Level 6<br>Transmit Priority Level 7 (Highest) |
| Bits [5:4] | Reserved   |
| Bits [7:6] | 00 - No Filtering<br>01 - Exclusive Filtering ( $x \leq RLOW$ or $x \geq RHIGH$ )<br>10 - Inclusive Filtering ( $RLOW < x < RHIGH$ )<br>11 - Invalid                                 |

**12.3.7 (Group 6 Address) MISC Group****12.3.7.1 MII\_OP0 – MII Register Option 0**I<sup>2</sup>C Address: h0BC; CPU Address: h0600Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [4:0]: | Vendor specified link status register address (null value means don't use it) (Default 00). This is used if the Linkup bit position in the PHY is non-standard |
| Bits [5]    | Disable jabber detection. This is for HomePNA applications or any serial operation slower than 10 Mbps.<br>0 = Enable<br>1 = Disable                           |
| Bits [6]    | Reserved   |

|          |   |
|----------|---|
| Bit [7]: | Half duplex flow control feature<br>0 = Half duplex flow control always enable<br>1 = Half duplex flow control by negotiation |
|----------|---|

### 12.3.7.2 MII\_OP1 – MII Register Option 1

I<sup>2</sup>C Address: h0BD; CPU Address: h0601

Accessed by CPU and I<sup>2</sup>C (R/W)

|             |   |
|-------------|---|
| Bits [3:0]: | Duplex bit location in vendor specified register                |
| Bits [7:4]: | Speed bit location in vendor specified register<br>(Default 00) |

### 12.3.7.3 FEN – Feature Enable Register

I<sup>2</sup>C Address: h0BE; CPU Address: h0602

Accessed by CPU and I<sup>2</sup>C (R/W)

|          |   |
|----------|---|
| Bit [0]: | Statistic Counter<br>0 – Disable (Default)<br>1 – Enable (all ports)<br><br>When statistic counter is enable, an interrupt control frame is generated to the CPU, every time a counter wraps around. This feature requires an external CPU. |
| Bit [1]: | 0   |
| Bit [2]: | Support DS EF Code.<br>0 – Disable (Default)<br>1 – Enable (all ports)<br><br>When 101110 is detected in DS field (TOS[7:2]), the frame priority is set for 110 and drop is set for 0.  |
| Bit [3]: | Reserved. Must be 0.  |
| Bit [4]: | Reserved. Must be 1.  |
| Bit [5]: | Report to CPU<br>0 – Disable (Default)<br>1 – Enable<br><br>When disable new MAC address report or aging reports are disable for all ports. When enable, register SE_OPMODE is used to enable/disable selectively each function.            |
| Bit [6]: | MII Management State Machine<br>0: Enable (Default)<br>1: Disable<br><br>This bit must be set so that there is no contention on the MDIO bus between MII Management state machine and MIIC & MIID PHY register accesses.                    |

|          |  |
|----------|--|
| Bit [7]: | MCT Link List structure<br>0 – Enable (Default)<br>1 – Disable |
|----------|--|

#### 12.3.7.4 MIIC0 – MII Command Register 0

CPU Address: h0603

Accessed by CPU (R/W)

|             |                        |
|-------------|------------------------|
| Bits [7:0]: | MII Command Data [7:0] |
|-------------|------------------------|

**Note:** Before programming MII command: set FEN[6]; check MIIC3, making sure RDY; then program MII command.

#### 12.3.7.5 MIIC1 – MII Command Register 1

CPU Address: h0604

Accessed by CPU (R/W)

|             |                         |
|-------------|-------------------------|
| Bits [7:0]: | MII Command Data [15:8] |
|-------------|-------------------------|

#### 12.3.7.6 MIIC2 – MII Command Register 2

CPU Address: h0605

Accessed by CPU (R/W)

|            |  |
|------------|--|
| Bits [4:0] | REG_AD – Register PHY Address  |
| Bits [6:5] | OP – Operation code<br>“10” for read command<br>“01” for write command |
| Bits [7]   | Reserved   |

#### 12.3.7.7 MIIC3 – MII Command Register 3

CPU Address: h0606

Accessed by CPU (R/W)

|            |  |
|------------|--|
| Bits [4:0] | PHY_AD – 5-bit PHY address                       |
| Bit [5]    | Reserved   |
| Bit [6]    | VALID – Data valid from PHY (Read Only)          |
| Bit [7]    | RDY – MII management interface ready (Read Only) |

**Note:** Writing to this register will initiate a serial management cycle to the MII management interface.

**12.3.7.8 MIID0 – MII Data Register 0**

CPU Address: h0607

Accessed by CPU (RO)

|             |                 |
|-------------|-----------------|
| Bits [7:0]: | MIID Data [7:0] |
|-------------|-----------------|

**12.3.7.9 MIID1 – MII Data Register 1**

CPU Address: h0608

Accessed by CPU (RO)

|             |                  |
|-------------|------------------|
| Bits [7:0]: | MIID Data [15:8] |
|-------------|------------------|

**12.3.7.10 USD – One Micro Second Divider**

CPU Address: h0609

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [5:0]: | <p>Divider to get one micro second from M_CLK (only used when not in standard RMII mode)</p> <p>In a MII or GPSI system, a 50 MHz M_CLK may not be available. The system designer can decide to use another frequency on the M_CLK signal. To compensate for this, this register is required to be programmed.</p> <p>For example. If 20 MHz is used on M_CLK, to compensate for the difference, this register is programmed with 20 to provide 1 usec for internal reference.</p> |
| Bits [7:6]: | Reserved   |

**12.3.7.11 DEVICE - Device Mode**

CPU Address: h060A

Accessed by CPU (R/W)

|             |   |
|-------------|---|
| Bit [0]:    | Reserved  |
| Bit [1]:    | <p>CPU Interrupt Polarity</p> <p>0: Negative Polarity</p> <p>1: Positive Polarity (Default)</p> |
| Bits [4:2]: | Reserved  |
| Bits [7:5]: | Device ID (Default 0x0). See application note ZLAN-26, Processor Interface, for usage.          |

**12.3.7.12 CHECKSUM - EEPROM Checksum**I<sup>2</sup>C Address: 0FF; CPU Address: h060BAccessed by CPU and I<sup>2</sup>C (R/W)

|             |                              |
|-------------|------------------------------|
| Bits [7:0]: | Checksum content (Default 0) |
|-------------|------------------------------|

This register is used in unmanaged mode only. Before requesting that the ZL50407 updates the EEPROM device, the correct checksum needs to be calculated and written into this checksum register.

The checksum formula is:

$$\sum_{i=0}^{FF} \text{I}^2\text{C register} = 0$$

When the ZL50407 boots from the EEPROM the checksum is calculated and the value must be zero. If the checksum is not zeroed the ZL50407 does not start and pin CHECKSUM\_OK is set to zero.

**12.3.7.13 LHBTimer – Link Heart Beat Timeout Timer**

CPU Address: h0610

Accessed by CPU (R/W)

In slot time (512 bit time). LHB packet will be sent out to the remote device if no other packet is transmitted in half this period. The receiver will trigger LHB timeout interrupt if not receiving any good packet in this period.

**12.3.7.14 LHBReg0, LHBReg1 - Link Heart Beat OpCode**

CPU Address: h0611, h0612

Accessed by CPU (R/W)

The LHB frame uses MAC control frame format (same as flow control frame.) The register here defines the operation code (we recommend h00-12).

**12.3.7.15 fMACCReg0, fMACCReg1 - MAC Control Frame OpCode**

CPU Address: h0613, h0614

Accessed by CPU (R/W)

The registers define the operation code if MAC control frame is forced out by processor.

**12.3.7.16 FCB Base Address Register 0**I<sup>2</sup>C Address: h0BF; CPU Address: h0620Accessed by CPU and I<sup>2</sup>C (R/W)

|            |                                      |
|------------|--------------------------------------|
| Bits [7:0] | FCB Base address bit 7:0 (Default 0) |
|------------|--------------------------------------|

**12.3.7.17 FCB Base Address Register 1**I<sup>2</sup>C Address: h0C0; CPU Address: h0621Accessed by CPU and I<sup>2</sup>C (R/W)

|            |  |
|------------|--|
| Bits [7:0] | FCB Base address bit 15:8 (Default 0x60) |
|------------|--|

**12.3.7.18 FCB Base Address Register 2**I<sup>2</sup>C Address: h0C1; CPU Address: h0622Accessed by CPU and I<sup>2</sup>C (R/W)

|            |  |
|------------|--|
| Bits [7:0] | FCB Base address bit 23:16 (Default 0) |
|------------|--|

**12.3.8 (Group 7 Address) Port Mirroring Group****12.3.8.1 MIRROR CONTROL – Port Mirror Control Register**

CPU Address: h070C

Accessed by CPU (R/W) (Default 00)

|             |  |
|-------------|--|
| Bits [3:0]: | Destination port to be mirrored to.                          |
| Bit [4]     | Mirror Flow from MIRROR_SRC_MAC[5:0] to MIRROR_DEST_MAC[5:0] |
| Bit [5]     | Mirror Flow from MIRROR_DEST_MAC[5:0] to MIRROR_SRC_MAC[5:0] |
| Bit [6]:    | Mirror when address is destination                           |
| Bit [7]:    | Mirror when address is source                                |

**12.3.8.2 MIRROR\_DEST\_MAC[5:0] – Mirror Destination MAC Address 0~5**

CPU Address: h0700-0705

Accessed by CPU (R/W)

| DEST_MAC5               | DEST_MAC4               | DEST_MAC3               | DEST_MAC2               | DEST_MAC1              | DEST_MAC0             |
|-------------------------|-------------------------|-------------------------|-------------------------|------------------------|-----------------------|
| [47:40]<br>(Default 00) | [39:32]<br>(Default 00) | [31:24]<br>(Default 00) | [23:16]<br>(Default 00) | [15:8]<br>(Default 00) | [7:0]<br>(Default 00) |

**12.3.8.3 MIRROR\_SRC\_MAC[5:0] – Mirror Source MAC Address 0~5**

CPU Address: h0706-070B

Accessed by CPU (R/W)

| SRC_MAC5                | SRC_MAC4                | SRC_MAC3                | SRC_MAC2                | SRC_MAC1               | SRC_MAC0              |
|-------------------------|-------------------------|-------------------------|-------------------------|------------------------|-----------------------|
| [47:40]<br>(Default 00) | [39:32]<br>(Default 00) | [31:24]<br>(Default 00) | [23:16]<br>(Default 00) | [15:8]<br>(Default 00) | [7:0]<br>(Default 00) |

**12.3.8.4 RMII\_MIRROR0 – RMII Mirror 0**

CPU Address: h0710

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [2:0]: | Source port to be mirrored               |
| Bit [3]:    | Mirror path<br>0: Receive<br>1: Transmit |
| Bits [6:4]: | Destination port for mirrored traffic    |
| Bit [7]:    | Mirror enable                            |

**12.3.8.5 RMII\_MIRROR1 – RMII Mirror 1**

CPU Address: h0711

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [2:0]: | Source port to be mirrored               |
| Bit [3]:    | Mirror path<br>0: Receive<br>1: Transmit |
| Bits [6:4]: | Destination port for mirrored traffic    |
| Bit [7]:    | Mirror enable                            |

**12.3.9 (Group 8 Address) Per Port QOS Control****12.3.9.1 FCRn – Port 0~9 Flooding Control Register**I<sup>2</sup>C Address: h04C+n; CPU Address: h0800+n (n = port number)Accessed by CPU and I<sup>2</sup>C (R/W)

|             |  |
|-------------|--|
| Bits [3:0]: | U2MR: Unicast to Multicast Rate. Units in terms of time base defined in bits [6:4]. This is used to limit the amount of flooding traffic from Port n. The value in U2MR specifies how many packets are allowed to flood within the time specified by bit [6:4]. To disable this function, program U2MR to 0. (Default = 0) |
| Bits [6:4]: | Time Base for Unicast to Multicast, Multicast and Broadcast rate control of Port n: (Default = 000)<br>000 = 100 us<br>001 = 200 us<br>010 = 400 us<br>011 = 800 us<br>100 = 1.6 ms<br>101 = 3.2 ms<br>110 = 6.4 ms<br>111 = 12.8 ms   |
| Bit [7]:    | Reserved   |

**12.3.9.2 BMRCn - Port 0~9 Broadcast/Multicast Rate Control**

I<sup>2</sup>C Address: h05E+n; CPU Address: h0820+n (n = port number)

Accessed by CPU and I<sup>2</sup>C (R/W)

This broadcast and multicast rate defines for Port n, the number of packets allowed to be forwarded within a specified time. Once the packet rate is reached, packets will be dropped. To turn off the rate limit, program the field to 0. Time base is based on register FCR0 [6:4]

|             |  |
|-------------|--|
| Bits [3:0]: | Multicast Rate Control. Number of multicast packets allowed within the time defined in bits 6 to 4 of the Flooding Control Register (FCRn). (Default 0). |
| Bits [7:4]: | Broadcast Rate Control. Number of broadcast packets allowed within the time defined in bits 6 to 4 of the Flooding Control Register (FCRn). (Default 0)  |

**12.3.9.3 PR100\_n – Port 0~7 Reservation**

I<sup>2</sup>C Address: h06A+n; CPU Address: h0840+n (n = port number)

Accessed by CPU and I<sup>2</sup>C (R/W)

Expressed in multiples of 16 granules. (Default 0x6)

**12.3.9.4 PR100\_CPU – Port CPU Reservation**

I<sup>2</sup>C Address: h073; CPU Address: h0848

Accessed by CPU and I<sup>2</sup>C (R/W)

Expressed in multiples of 16 granules. (Default 0x6)

**12.3.9.5 PRG – Port GMAC Reservation**

I<sup>2</sup>C Address: h072; CPU Address: h0849

Accessed by CPU and I<sup>2</sup>C (R/W)

Expressed in multiples of 16 granules. (Default 0x24)

**12.3.9.6 PTH100\_n – Port 0~7 Threshold**

I<sup>2</sup>C Address: h0C2+n; CPU Address: h0860+n (n = port number)

Accessed by CPU and I<sup>2</sup>C (R/W)

Expressed in multiples of 16 granules. More than this number used on a source port will trigger either random drop or flow control (Default 0x3)

**12.3.9.7 PTH100\_CPU – Port CPU Threshold**

I<sup>2</sup>C Address: h0CB; CPU Address: h0868

Accessed by CPU and I<sup>2</sup>C (R/W)

Expressed in multiples of 16 granules. More than this number used on a source port will trigger either random drop or flow control (Default 0x3)



**12.3.9.8 PTHG – Port GMAC Threshold**

I<sup>2</sup>C Address: h0CA; CPU Address: h0869

Accessed by CPU and I<sup>2</sup>C (R/W)

Expressed in multiples of 16 granules. More than this number used on a source port will trigger either random drop or flow control (Default 0x12)

**12.3.9.9 QOSC00, QOSC01 - Classes Byte Limit port 0**

I<sup>2</sup>C Address: h078-079; CPU Address: h0880-0881

Accessed by CPU and I<sup>2</sup>C (R/W)

- QOSC00 – Port 0 L1 threshold for queue 1
- QOSC01 – Port 0 L2 threshold for queue 1

Multiple of 16 granules. The two numbers set the two level for WRED on the high priority queue. When the queue size exceeds the L1 threshold, received frame will subject to X% (high drop) or Y% (low drop) WRED. When the queue size exceeds L2 threshold, received frame will either be filtered (high drop) or subject to Z% WRED.

**12.3.9.10 QOSC02, QOSC15 - Classes Byte Limit port 1-7**

I<sup>2</sup>C Address: h07A-087; CPU Address: h0882-088F

Accessed by CPU and I<sup>2</sup>C (R/W)

Same as QOSC00, QOSC01 for ports 1-7

**12.3.9.11 QOSC16 - QOSC21 - Classes Byte Limit CPU port**

I<sup>2</sup>C Address: h088-08D; CPU Address: h0890-0895

Accessed by CPU and I<sup>2</sup>C (R/W):

- QOSC16 – Port 8 (CPU) L1 threshold for queue 1
- QOSC17 – Port 8 (CPU) L2 threshold for queue 1
- QOSC18 – Port 8 (CPU) L1 threshold for queue 2
- QOSC19 – Port 8 (CPU) L2 threshold for queue 2
- QOSC20 – Port 8 (CPU) L1 threshold for queue 3
- QOSC21 – Port 8 (CPU) L2 threshold for queue 3

Multiple of 16 granules. The two numbers set the two level for WRED on the high priority queue. When the queue size exceeds the L1 threshold, received frame will subject to X% (high drop) or Y% (low drop) WRED. When the queue size exceeds L2 threshold, received frame will either be filtered (high drop) or subject to Z% WRED.

**12.3.9.12 QOSC22 - QOSC27 - Classes Byte Limit GMAC port**

I<sup>2</sup>C Address: h08E-08F; CPU Address: h0896-089B

Accessed by CPU and I<sup>2</sup>C (R/W)

- QOSC22 – Port 9 (uplink) L1 threshold for queue 1
- QOSC23 – Port 9 (uplink) L2 threshold for queue 1
- QOSC24 – Port 9 (uplink) L1 threshold for queue 2
- QOSC25 – Port 9 (uplink) L2 threshold for queue 2
- QOSC26 – Port 9 (uplink) L1 threshold for queue 3
- QOSC27 – Port 9 (uplink) L2 threshold for queue 3

Multiple of 16 granules. The two numbers set the two level for WRED on the high priority queue. When the queue size exceeds the L1 threshold, received frame will subject to X% (high drop) or Y% (low drop) WRED. When the queue size exceeds L2 threshold, received frame will either be filtered (high drop) or subject to Z% WRED.

### 12.3.9.13 QOSC28 - QOSC31 - Classes WFQ Credit For GMAC

CPU Address: h089C-089F

Accessed by CPU (R/W)

- QOSC28 – CREDIT\_C00
- QOSC29 – CREDIT\_C01
- QOSC30 – CREDIT\_C02
- QOSC31 – CREDIT\_C03

Bits [5:0] in QOSC28 through QOSC31 represents one set of WFQ parameters for GMAC port. The granularity of the numbers is 1, and their sum must be 64. QOSC31 corresponds to queue 3, that is the highest priority, and QOSC27 corresponds to queue 0.

Default scheduling method will be strict priority across all queues. Only when the bit [7] is set, the queue will be scheduled as WFQ. The credit number also works as shaper credit if bit [6] is set. A queue with shaper enabled will be scheduled by strict priority when the token is available. The shaper setting override the WFQ (bit [7]) setting.

|             |   |
|-------------|---|
| Bits [5:0]: | Class scheduling credit                               |
| Bit [6]:    | Traffic Shaper Enable<br>0: Disable<br>1: Enable      |
| Bit [7]:    | Enable WFQ Scheduling<br>0: Strict Priority<br>1: WFQ |

### 12.3.9.14 QOSC36 - QOSC39 - Shaper Control Port GMAC

CPU Address: h08A4-08A7

Accessed by CPU (R/W)

- QOSC36 – TOKEN\_LIMIT\_C00
- QOSC37 – TOKEN\_LIMIT\_C01
- QOSC38 – TOKEN\_LIMIT\_C02
- QOSC39 – TOKEN\_LIMIT\_C03

QOSC36 through QOSC39 represents one set of token limit on the shaper of GMAC port. The granularity of the numbers is 64 bytes. The shaper is implemented as leaky bucket and the limit here works as bucket size. Since the hardware implementation can keep negative number, the limit can be as small as one and still can transmit oversized frame, as long as one byte token is available.

### 12.3.10 (Group E Address) System Diagnostic

**NOTE: Device Manufacturing test registers.**

**12.3.10.1 DTSRL – Test Output Selection**

CPU Address: h0E00

Accessed by CPU (R/W)

Test group selection for testout[7:0].

**12.3.10.2 DTSRM – Test Output Selection**

CPU Address: h0E01

Accessed by CPU (R/W)

Test group selection for testout[15:8].

**12.3.10.3 TESTOUT0, TESTOUT1 – Testmux Output [7:0], [15:8]**

CPU Address: h0E02-0E03

Accessed by CPU (RO)

**12.3.10.4 MASK0-MASK4 – Timeout Reset Mask**

CPU Address: h0E10-E14

Accessed by CPU (R/W)

Disable timeout reset on selected state machine status.

See Programming Timeout Reset application note, ZLAN-41, for more information.

**12.3.10.5 BOOTSTRAP0 – BOOTSTRAP3**

CPU Address: h0E80-E83

Accessed by CPU (RO)

|               |  |     |     |     |
|---------------|--|-----|-----|-----|
|               | 31   | 23  | 15  | 0   |
|               | BT3  | BT2 | BT1 | BT0 |
| Bits [15:0]:  | Bootstrap value from TSTOUT[15:0]:<br>Bit [6:0]: TSTOUT[6:0]<br>Bit [8:7]: Invert of TSTOUT[8:7]<br>Bit [9]: TSTOUT[11]<br>Bit [10]: TSTOUT[9]<br>Bit [11]: TSTOUT[10]<br>Bit [14:12]: TSTOUT[14:12]<br>Bit [15]: Always 0 |     |     |     |
| Bits [23:16]: | Bootstrap value from M[7:0]_TXEN<br>Bit [16]: M0_TXEN<br>Bit [17]: M1_TXEN<br>...<br>Bit [23]: M7_TXEN   |     |     |     |
| Bits [25:24]: | Bootstrap value from M9_TXEN, M9_TXER  |     |     |     |

|               |          |
|---------------|----------|
| Bits [31:26]: | Reserved |
|---------------|----------|

### 12.3.10.6 PRTFSMST0~9

CPU Address: h0E90+n

Accessed by CPU (RO)

|          |                                     |
|----------|-------------------------------------|
| Bit [0]: | TX FSM NOT idle for 5 sec           |
| Bit [1]: | TX FIFO control NOT idle for 5 sec  |
| Bit [2]: | RX SFD detection NOT idle for 5 sec |
| Bit [3]: | RXINF NOT idle for 5 sec            |
| Bit [4]: | PTCTL NOT idle for 5 sec            |
| Bit [5]: | Reserved                            |
| Bit [6]: | LHB frame detected                  |
| Bit [7]: | LHB receiving timeout               |

### 12.3.10.7 PRTQOSST0-PRTQOSST7

CPU Address: h0EA0+n

Accessed by CPU (RO)

|          |   |
|----------|---|
| Bit [0]: | Source port reservation low                           |
| Bit [1]: | No source port buffer left                            |
| Bit [2]: | Unicast congestion detected on best effort (P0) queue |
| Bit [3]: | Reserved  |
| Bit [4]: | High priority queue reach L1 WRED level               |
| Bit [5]: | High priority queue reach L2 WRED level               |
| Bit [6]: | Low priority MC queue full                            |
| Bit [7]: | High priority MC queue full                           |

### 12.3.10.8 PRTQOSST8A, PRTQOSST8B (CPU port)

CPU Address: h0EA8 – 0EA9

Accessed by CPU (RO)

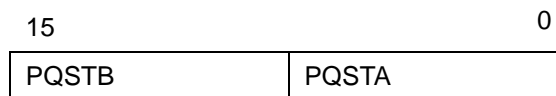
|       |       |
|-------|-------|
| 15    | 0     |
| PQSTB | PQSTA |

|               |   |
|---------------|---|
| Bit [0]:      | Source port reservation low                           |
| Bit [1]:      | No source port buffer left                            |
| Bit [2]:      | Unicast congestion detected on best effort (P0) queue |
| Bit [3]:      | Reserved  |
| Bit [4]:      | priority queue 1 reach L1 WRED level                  |
| Bit [5]:      | priority queue 1 reach L2 WRED level                  |
| Bit [6]:      | priority queue 2 reach L1 WRED level                  |
| Bit [7]:      | priority queue 2 reach L2 WRED level                  |
| Bit [8]:      | priority queue 3 reach L1 WRED level                  |
| Bit [9]:      | priority queue 3 reach L2 WRED level                  |
| Bit [10]:     | priority 0 MC queue full                              |
| Bit [11]:     | priority 1 MC queue full                              |
| Bit [12]:     | priority 2 MC queue full                              |
| Bit [13]:     | Priority 3 MC queue full                              |
| Bits [15:14]: | Reserved  |

### 12.3.10.9 PRTQOSST9A, PRTQOSST9B (GMAC port)

CPU Address: h0EAA – 0EAB

Accessed by CPU (RO)



|           |   |
|-----------|---|
| Bit [0]:  | Source port reservation low                           |
| Bit [1]:  | No source port buffer left                            |
| Bit [2]:  | Unicast congestion detected on best effort (P0) queue |
| Bit [3]:  | Reserved  |
| Bit [4]:  | Priority queue 1 reach L1 WRED level                  |
| Bit [5]:  | Priority queue 1 reach L2 WRED level                  |
| Bit [6]:  | Priority queue 2 reach L1 WRED level                  |
| Bit [7]:  | Priority queue 2 reach L2 WRED level                  |
| Bit [8]:  | Priority queue 3 reach L1 WRED level                  |
| Bit [9]:  | Priority queue 3 reach L2 WRED level                  |
| Bit [10]: | Priority 0 MC queue full                              |
| Bit [11]: | Priority 1 MC queue full                              |
| Bit [12]: | Priority 2 MC queue full                              |

|               |                          |
|---------------|--------------------------|
| Bit [13]:     | Priority 3 MC queue full |
| Bits [15:14]: | Reserved                 |

### 12.3.10.10 CLASSQOSST

CPU Address: h0EAC

Accessed by CPU (RO)

|             |                   |
|-------------|-------------------|
| Bit [0]:    | No share buffer   |
| Bit [1]:    | No class 1 buffer |
| Bit [2]:    | No class 2 buffer |
| Bit [3]:    | No class 3 buffer |
| Bits [7:4]: | Reserved          |

### 12.3.10.11 PRTINTCTR

CPU Address: h0EAD

Accessed by CPU (R/W)

|          |                                  |
|----------|----------------------------------|
| Bit [0]: | Interrupt when source buffer low |
| Bit [1]: | Interrupt when no source buffer  |
| Bit [2]: | Interrupt when UC congest        |
| Bit [3]: | Interrupt when L1 WRED level     |
| Bit [4]: | Interrupt when L2 WRED level     |
| Bit [5]: | Interrupt when MC queue full     |
| Bit [6]: | Interrupt when LHB timeout       |
| Bit [7]: | Interrupt when no class buffer   |

### 12.3.10.12 QMCTRL0~9

CPU Address: h0EB0+n

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bit [0]:    | Suspend port scheduling (no departure) |
| Bit [1]:    | Reset queue                            |
| Bits [4:2]: | Reserved                               |
| Bit [5]:    | Force out MAC control frame            |
| Bit [6]:    | Force out XOFF flow control frame      |
| Bit [7]:    | Force out XON flow control frame       |

**12.3.10.13 QCTRL**

CPU Address: h0EBA

Accessed by CPU (R/W)

|             |                                      |
|-------------|--------------------------------------|
| Bit [0]:    | Stop QM FSM at idle                  |
| Bit [1]:    | Stop MCQ FSM at idle                 |
| Bit [2]:    | Stop new granule grant to any source |
| Bit [3]:    | Stop release granule from any source |
| Bits [7:4]: | Reserved                             |

**12.3.10.14 BMBISTR0, BMBISTR1**

CPU Address: h0EBB - 0EBC

Accessed by CPU (RO)

**12.3.10.15 BMControl**

CPU Address: h0EBD

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [3:0]: | Block Memory redundancy control<br>0: Use hardware detected value<br>All others: Overwrite the hardware detected memory swap map |
| Bits [7:4]: | Reserved   |

**12.3.10.16 BUFF\_RST**

CPU Address: h0EC0

Accessed by CPU (R/W)

|            |   |
|------------|---|
| Bits [3:0] | Assign a value that the pool to be reset<br>0: port 0 pool<br>1: port 1 pool<br>2: port 2 pool<br>3: port 3 pool<br>4: port 4 pool<br>5: port 5 pool<br>6: port 6 pool<br>7: port 7 pool<br>8: port GMAC pool<br>9: shared pool<br>10: class 1 pool<br>11: class 2 pool<br>12: class 3 pool<br>13: multicast pool<br>14: cpu pool<br>15: reserved |
| Bit [4]    | If this bit is 1, then all the pools are assigned   |
| Bit [5]    | Set 1 to reset the pools that are assigned  |
| Bits [7:6] | Reserved  |

If CPU wants to reset pools again, CPU has to clear bit 5 and then set bit 5.

**Note:** Before CPU doing so, CPU should set QCTRL (CPU Address EBA) bit 2 and bit 3 to one. After reset the pools, CPU shall reprogram free granule link list (CPU address EC1, EC2, EC3, EC4, EC5, EC6). Then clear QCTRL (EBA).

**12.3.10.17 FCB\_HEAD\_PTR0, FCB\_HEAD\_PTR1**

CPU address: h0EC1

Accessed by CPU (R/W)

|            |  |
|------------|--|
| Bits [7:0] | Fcb_head_ptr[7:0]. The head pointer of free granule link that CPU assigns. |
|------------|--|

CPU address: h0EC2

Accessed by CPU (R/W)

|            |   |
|------------|---|
| Bits [6:0] | Fcb_head_ptr[14:8]. The head pointer of free granule link that CPU assigns. |
| Bit [7]    | Set 1 to write  |

If CPU wants to write again, CPU has to clear bit 15 and then set bit 15.



**12.3.10.18 FCB\_TAIL\_PTR0, FCB\_TAIL\_PTR1**

CPU address: h0EC3

Accessed by CPU (R/W)

|            |  |
|------------|--|
| Bits [7:0] | Fcb_tail_ptr[7:0]. The tail pointer of free granule link that CPU assigns. |
|------------|--|

CPU address: h0EC4

Accessed by CPU (R/W)

|            |   |
|------------|---|
| Bits [6:0] | Fcb_tail_ptr[14:8]. The tail pointer of free granule link that CPU assigns. |
| Bit [7]    | Set 1 to write  |

If CPU wants to write again, CPU has to clear bit 15 and then set bit 15.

**12.3.10.19 FCB\_NUM0, FCB\_NUM1**

CPU address: h0EC5

Accessed by CPU (R/W)

|            |   |
|------------|---|
| Bits [7:0] | Fcb_number[7:0]. The total number of granules that CPU assigns. |
|------------|---|

CPU address: h0EC6

Accessed by CPU (R/W)

|            |  |
|------------|--|
| Bits [6:0] | Fcb_number[14:8]. The total number of granules that CPU assigns. |
| Bit [7]    | Set 1 to write   |

If CPU wants to write again, CPU has to clear bit 15 and then set bit 15.

**Note:** There are two ways to reprogram the free granules.

1. CPU links all the granules: CPU writes memory directly, at last write head pointer (address EC1, EC2), tail pointer (address EC3, EC4) and granule number (address EC5, EC6).
2. CPU tells Buffer Manager to link: CPU clear head pointer (address EC1, EC2), clear tail pointer (address EC3, EC4), then write granule number that tells Buffer Manager to link (address EC5, EC6).

**12.3.10.20 BM\_RLSFF\_CTRL**

CPU address: h0EC7

Accessed by CPU (R/W)

|            |                       |
|------------|-----------------------|
| Bit [0]    | Read BM release FIFO. |
| Bits [7:1] | Reserved              |

The information of BM release FIFO is relocated to registers BM\_RLSFF\_INFO (address ECD, ECC, ECB, ECA, EC9 and EC8). If the FIFO is not empty, CPU can read out the next by setting the bit 0. Read only happens when bit 0 is changing from 0 to 1.

**12.3.10.21 BM\_RSLFF\_INFO[5:0]**

CPU address: h0EC8

Accessed by CPU (RO)

|            |                    |
|------------|--------------------|
| Bits [7:0] | Rls_head_ptr[7:0]. |
|------------|--------------------|

CPU address: h0EC9

Accessed by CPU (RO)

|            |                     |
|------------|---------------------|
| Bits [6:0] | Rls_head_ptr[14:8]. |
| Bit [7]    | Rls_tail_ptr[0]     |

CPU address: h0ECA

Accessed by CPU (RO)

|            |                   |
|------------|-------------------|
| Bits [7:0] | Rls_tail_ptr[8:1] |
|------------|-------------------|

CPU address: h0ECB

Accessed by CPU (RO)

|            |                    |
|------------|--------------------|
| Bits [5:0] | Rls_tail_ptr[14:9] |
| Bits [7:6] | Rls_count[1:0]     |

CPU address: h0ECC

Accessed by CPU (RO)

|            |                                    |
|------------|------------------------------------|
| Bits [4:0] | Rls_count[6:2]                     |
| Bit [5]    | If 1, then It is multicast packet. |
| Bits [7:6] | Rls_src_port[1:0]                  |

CPU address: h0ECD

Accessed by CPU (RO)

|            |  |
|------------|--|
| Bits [1:0] | Rls_src_port[3:2]                                    |
| Bits [3:2] | Class[1:0]   |
| Bit [4]    | This release request is from QM directly.            |
| Bits [7:5] | Entries count in release FIFO, 0 means FIFO is empty |

### 12.3.11 (Group F Address) CPU Access Group

#### 12.3.11.1 GCR - Global Control Register

CPU Address: h0F00

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bit [0]:    | Store configuration (Default = 0)<br>Write '1' followed by '0' to store configuration into external EEPROM   |
| Bit [1]:    | Store configuration and reset (Default = 0)<br>Write '1' to store configuration into external EEPROM and reset chip  |
| Bit [2]:    | Start BIST (Default = 0)<br>Write '1' followed by '0' to start the device's built-in self-test. The result is found in the DCR register.   |
| Bit [3]:    | Soft Reset (Default = 0)<br>Write '1' to reset chip  |
| Bit [4]:    | Initialization Completed (Default = 0)<br>This bit is reserved in unmanaged mode.<br>In managed mode, the CPU writes this bit with '1' to indicate initialization is completed and ready to forward packets. The '0' to '1' transition will toggle TSTOUT[2] from low to high. |
| Bits [7:5]: | Reserved   |

**12.3.11.2 DCR - Device Status and Signature Register**

CPU Address: h0F01

Accessed by CPU (RO)

|             |  |
|-------------|--|
| Bit [0]:    | 1: Busy writing configuration to I <sup>2</sup> C<br>0: Not busy (not writing configuration to I <sup>2</sup> C)     |
| Bit [1]:    | 1: Busy reading configuration from I <sup>2</sup> C<br>0: Not busy (not reading configuration from I <sup>2</sup> C) |
| Bit [2]:    | 1: BIST in progress<br>0: BIST not running   |
| Bit [3]:    | 1: RAM Error<br>0: RAM OK  |
| Bits [5:4]: | Device Signature<br>11: ZL50407 device   |
| Bits [7:6]: | Revision<br>00: Initial Silicon<br>01: Second Silicon  |

**12.3.11.3 DCR1 - Device Status Register 1**

CPU Address: h0F02

Accessed by CPU (RO)

|            |                               |
|------------|-------------------------------|
| Bits [6:0] | Reserved                      |
| Bit [7]    | Chip initialization completed |

**12.3.11.4 DPST – Device Port Status Register**

CPU Address: h0F03

Accessed by CPU (R/W)

|             |  |
|-------------|--|
| Bits [4:0]: | Read back index register. This is used for selecting what to read back from DTST. (Default 00) <ul style="list-style-type: none"> <li>- 5'b00000 - Port 0 Operating mode and Negotiation status</li> <li>- 5'b00001 - Port 1 Operating mode and Negotiation status</li> <li>- 5'b00010 - Port 2 Operating mode and Negotiation status</li> <li>- 5'b00011 - Port 3 Operating mode and Negotiation status</li> <li>- 5'b00100 - Port 4 Operating mode and Negotiation status</li> <li>- 5'b00101 - Port 5 Operating mode and Negotiation status</li> <li>- 5'b00110 - Port 6 Operating mode and Negotiation status</li> <li>- 5'b00111 - Port 7 Operating mode and Negotiation status</li> <li>- 5'b01000 - Port CPU Operating mode and Negotiation status</li> <li>- 5'b01001 - Port GMAC Operating mode and Negotiation status</li> </ul> |
| Bits [7:5]: | Reserved   |

**12.3.11.5 DTST – Data read back register**

CPU Address: h0F04

Accessed by CPU (RO)

This register provides various internal information as selected in DPST bit [4:0]. Refer to the PHY Port Control Application Note, ZLAN-37.

|         |  |
|---------|--|
| Bit [0] | Flow control enable<br>1: Flow control<br>0: No flow control   |
| Bit [1] | Full duplex port<br>1: Full duplex<br>0: Half duplex   |
| Bit [2] | Fast Ethernet port (if bit [5] not set)<br>1: FE Port  |
| Bit [3] | Link is down<br>1: Link down<br>0: Link up   |
| Bit [4] | Auto negotiation disabled<br>1: Disable<br>0: Enable   |
| Bit [5] | Gigabit Ethernet port<br>1: GE Port  |
| Bit [6] | Reserved   |
| Bit [7] | Module detected (for hot swap purpose)<br>0: No module<br>1: Module detected<br><br>Note: If Module Detect feature is disabled (bootstrap TSTOUT[9]='0'), this bit will always be '1'. |

**12.3.11.6 DA – Dead or Alive Register**

CPU Address: h0FFF

Accessed by CPU (RO)

Always return 8'h **DA**. Indicate the CPU interface or serial port connection is good.

|            |                  |
|------------|------------------|
| Bits [7:0] | Always return DA |
|------------|------------------|

## 13.0 Characteristics and Timing

### 13.1 Absolute Maximum Ratings

|  |                               |
|--|-------------------------------|
| Storage Temperature                              | -65°C to +150°C               |
| Operating Temperature                            | -40°C to +85°C                |
| Maximum Junction Temperature                     | +125°C                        |
| Supply Voltage $V_{CC}$ with Respect to $V_{SS}$ | +2.95 V to +3.65 V            |
| Supply Voltage $V_{DD}$ with Respect to $V_{SS}$ | +1.60 V to +2.00 V            |
| Voltage on 5 V Tolerant Input Pins               | -0.5 V to ( $V_{CC} + 2.5$ V) |
| Voltage on Other Pins                            | -0.5 V to ( $V_{DD} + 0.3$ V) |

**Caution:** Stress above those listed may damage the device. Exposure to the Absolute Maximum Ratings for extended periods may affect device reliability. Functionality at or above these limits is not implied.

### 13.2 DC Electrical Characteristics

$V_{CC} = 3.3$  V +/- 10%

$T_{AMBIENT} = -40$  C to +85 C

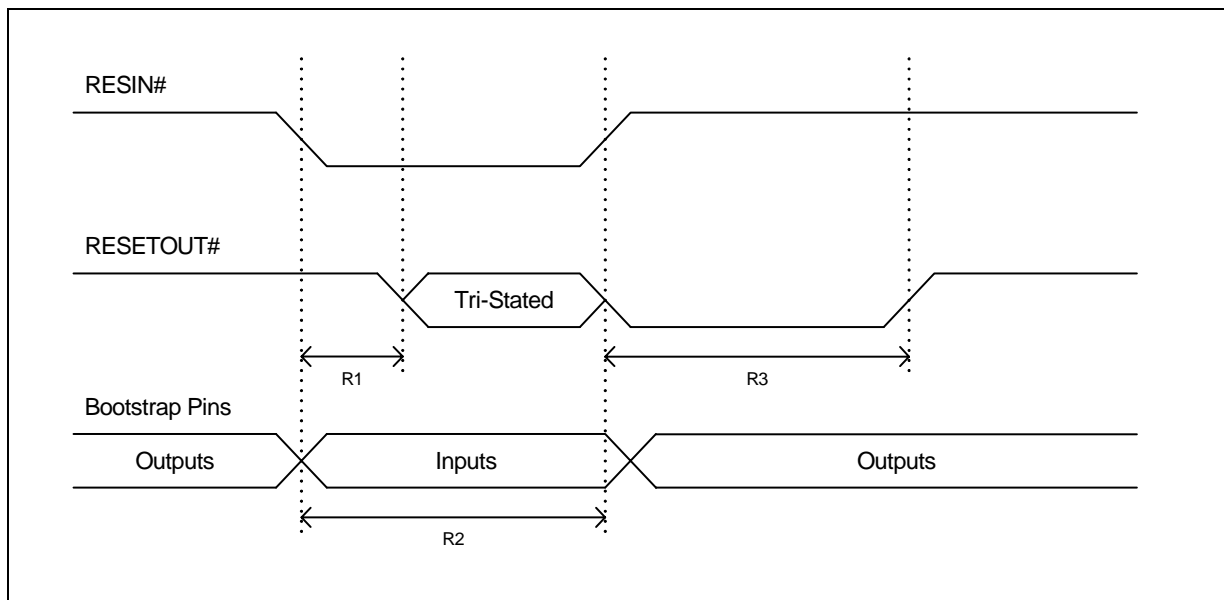
$V_{DD} = 1.8$  V +/- 5%

### 13.3 Recommended Operating Conditions

| Symbol        | Parameter Description   |      |      |                | Unit    |
|---------------|---|------|------|----------------|---------|
|               |   | Min. | Typ. | Max.           |         |
| $f_{osc}$     | Frequency of Operation (SCLK)   |      | 100  | 100            | MHz     |
| $I_{CC}$      | $V_{CC}$ (3.3V) Supply Current @ 100 MHz  |      |      | 105            | mA      |
| $I_{DD}$      | $V_{DD}$ (1.8V) Supply Current @ 100 MHz  |      |      | 350            | mA      |
| Pwr           | Power @ SCLK = 100MHz   |      |      | 0.98           | W       |
| $V_{OH}$      | Output High Voltage (CMOS)  | 2.4  |      |                | V       |
| $V_{OL}$      | Output Low Voltage (CMOS)   |      |      | 0.4            | V       |
| $V_{IH}$      | Input High Voltage (TTL 5 V tolerant)   | 2.0  |      | $V_{CC} + 2.0$ | V       |
| $V_{IL}$      | Input Low Voltage (TTL 5 V tolerant)  |      |      | 0.8            | V       |
| $I_{IL}$      | Input Leakage Current (0.1 V < $V_{IN}$ < $V_{CC}$ )<br>(all pins except those with internal pull-up/pull-down resistors) |      |      | 10             | $\mu$ A |
| $I_{OL}$      | Output Leakage Current (0.1 V < $V_{OUT}$ < $V_{CC}$ )  |      |      | 10             | $\mu$ A |
| $C_{IN}$      | Input Capacitance   |      |      | 5              | pF      |
| $C_{OUT}$     | Output Capacitance  |      |      | 5              | pF      |
| $C_{I/O}$     | I/O Capacitance   |      |      | 7              | pF      |
| $\theta_{ja}$ | Thermal resistance with 0 air flow  |      |      | 24.3           | C/W     |
| $\theta_{ja}$ | Thermal resistance with 1 m/s air flow  |      |      | 20.0           | C/W     |
| $\theta_{ja}$ | Thermal resistance with 2 m/s air flow  |      |      | 18.1           | C/W     |
| $\theta_{jc}$ | Thermal resistance between junction and case  |      |      | 4.6            | C/W     |

## 13.4 AC Characteristics and Timing

### 13.4.1 Typical Reset & Bootstrap Timing Diagram



**Figure 11 - Typical Reset & Bootstrap Timing Diagram**

| Symbol | Parameter                           | Min.      | Typ.       | Refer to Figure 11   |
|--------|-------------------------------------|-----------|------------|--|
| R1     | Delay until RESETOUT# is tri-stated |           | 10 ns      | RESETOUT# state is then determined by the external pull-up/down resistor |
| R2     | Bootstrap stabilization             | 1 $\mu$ s | 10 $\mu$ s | Bootstrap pins sampled on rising edge of RESIN#                          |
| R3     | RESETOUT# assertion                 |           | 2 ms       |  |

**Table 12 - Reset Timing**



### 13.4.2 Synchronous Serial Interface (SSI)

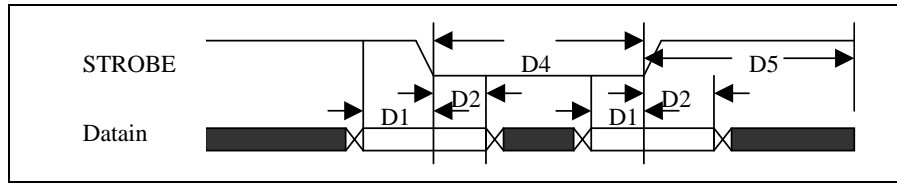


Figure 12 - SSI Setup & Hold Timing

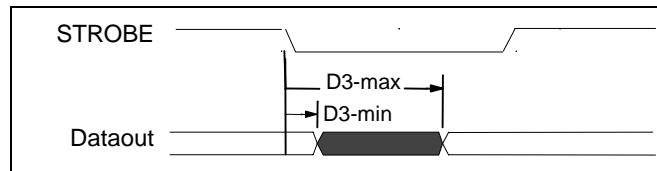


Figure 13 - SSI Output Delay Timing

| Symbol   | Parameter                     | Min. (ns) | Max. (ns) | Notes                                   |
|--|-------------------------------|-----------|-----------|---|
| D1   | DATAIN setup time             | 20        |           |   |
| D2   | DATAIN hold time              | 3 $\mu$ s |           | Debounce on                             |
|  |                               | 20        |           | Debounce off                            |
| D3*  | DATAOUT output delay time     | 1         | 50        | Debounce on<br>C <sub>L</sub> = 100 pf  |
| D3**   |                               |           |           | Debounce off<br>C <sub>L</sub> = 100 pf |
| D4   | STROBE low time               | 5 $\mu$ s |           | Debounce on                             |
|  |                               | 50        |           | Debounce off                            |
| D5   | STROBE high time              | 5 $\mu$ s |           | Debounce on                             |
|  |                               | 50        |           | Debounce off                            |
|  | STROBE frequency of operation |           | 100 kHz   | Debounce on                             |
|  |                               |           | 10 MHz    | Debounce off                            |
| * Open Drain Output. Low to High transition is controlled by external pullup resistor. |                               |           |           |   |
| ** Totem Pole Output.  |                               |           |           |   |

### 13.4.3 EEPROM Inter-Integrated Circuit (I<sup>2</sup>C)

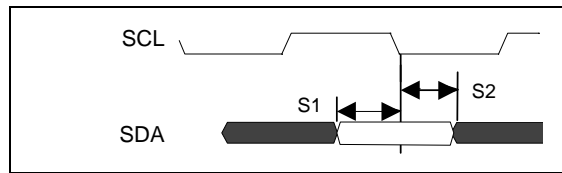


Figure 14 - I<sup>2</sup>C Setup & Hold Timing

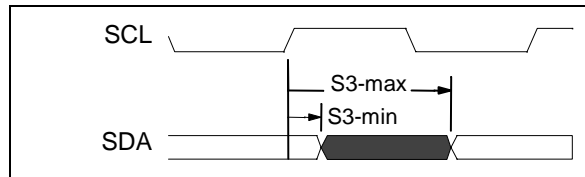
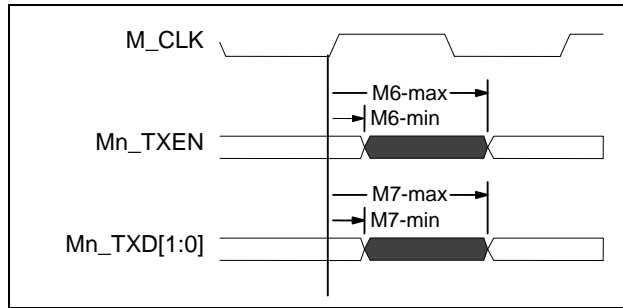


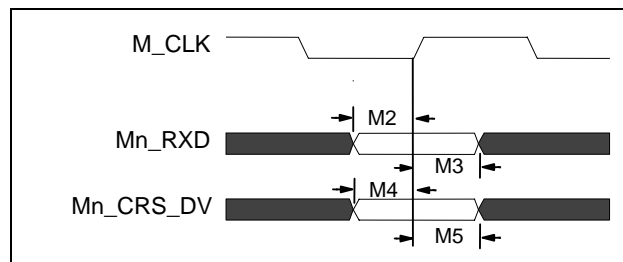
Figure 15 - I<sup>2</sup>C Output Delay Timing

| Symbol   | Parameter             | SCL=50 KHz |           | Notes         |
|--|-----------------------|------------|-----------|---------------|
|  |                       | Min. (ns)  | Max. (ns) |               |
| S1   | SDA input setup time  | 20         |           |               |
| S2   | SDA input hold time   | 1          |           |               |
| S3*  | SDA output delay time | 4 $\mu$ s  | 6 $\mu$ s | $C_L = 30$ pf |
| * Open Drain Output. Low to High transition is controlled by external pullup resistor. |                       |            |           |               |

### 13.4.4 Reduced Media Independent Interface (RMII)



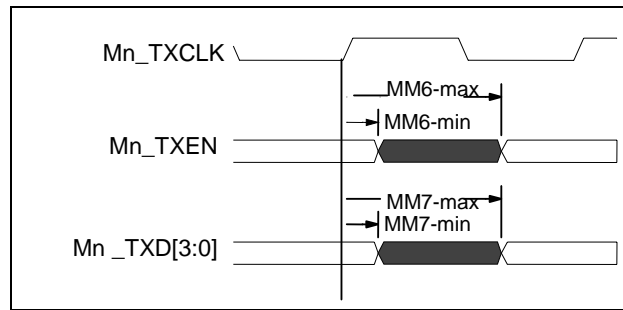
**Figure 16 - RMII Transmit Timing**



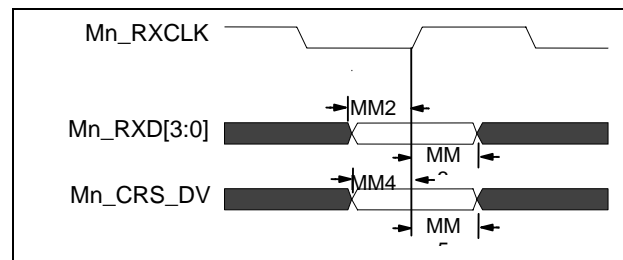
**Figure 17 - RMII Receive Timing**

| Symbol | Parameter                         | M_CLK=50 MHz |           | Notes                  |
|--------|-----------------------------------|--------------|-----------|------------------------|
|        |                                   | Min. (ns)    | Max. (ns) |                        |
| M2     | M[7:0]_RXD[1:0] Input Setup Time  | 4            |           |                        |
| M3     | M[7:0]_RXD[1:0] Input Hold Time   | 2            |           |                        |
| M4     | M[7:0]_CRS_DV Input Setup Time    | 4            |           |                        |
| M5     | M[7:0]_CRS_DV Input Hold Time     | 3            |           |                        |
| M6     | M[7:0]_TXEN Output Delay Time     | 2            | 11        | C <sub>L</sub> = 20 pF |
| M7     | M[7:0]_TXD[1:0] Output Delay Time | 2            | 11        | C <sub>L</sub> = 20 pF |

### 13.4.5 Media Independent Interface (MII)



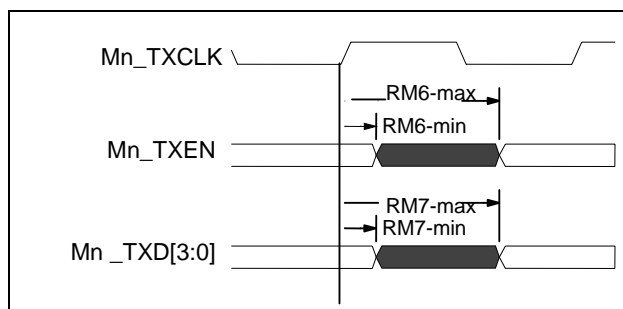
**Figure 18 - MII Transmit Timing**



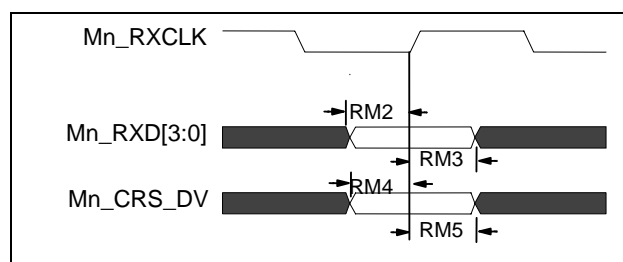
**Figure 19 - MII Receive Timing**

| Symbol | Parameter                     | 25 MHz    |           | Notes                 |
|--------|-------------------------------|-----------|-----------|-----------------------|
|        |                               | Min. (ns) | Max. (ns) |                       |
| MM2    | Mn_RXD[3:0] Input Setup Time  | 4         |           |                       |
| MM3    | Mn_RXD[3:0] Input Hold Time   | 2         |           |                       |
| MM4    | Mn_CRS_DV Input Setup Time    | 4         |           |                       |
| MM5    | Mn_CRS_DV Input Hold Time     | 2         |           |                       |
| MM6    | Mn_TXEN Output Delay Time     | 2         | 14        | $C_L = 20 \text{ pF}$ |
| MM7    | Mn_TXD[3:0] Output Delay Time | 2         | 14        | $C_L = 20 \text{ pF}$ |

### 13.4.6 Reverse Media Independent Interface (RvMII)



**Figure 20 - RvMII Transmit Timing**



**Figure 21 - RvMII Receive Timing**

| Symbol   | Parameter                     | 25 MHz    |           | Notes                 |
|--|-------------------------------|-----------|-----------|-----------------------|
|  |                               | Min. (ns) | Max. (ns) |                       |
| RM2  | Mn_RXD[3:0] Input Setup Time  | 4         |           |                       |
| RM3  | Mn_RXD[3:0] Input Hold Time   | 2         |           |                       |
| RM4  | Mn_CRS_DV Input Setup Time    | 4         |           |                       |
| RM5  | Mn_CRS_DV Input Hold Time     | 2         |           |                       |
| RM6*   | Mn_TXEN Output Delay Time     | 2         | 14        | $C_L = 20 \text{ pF}$ |
| RM7*   | Mn_TXD[3:0] Output Delay Time | 2         | 14        | $C_L = 20 \text{ pF}$ |
| * May need to add external delay depending on other MAC device's min. hold time. |                               |           |           |                       |

### 13.4.7 General Purpose Serial Interface (GPSI)

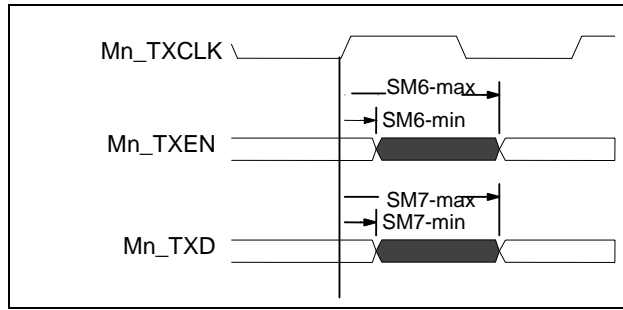


Figure 22 - GPSI Transmit Timing

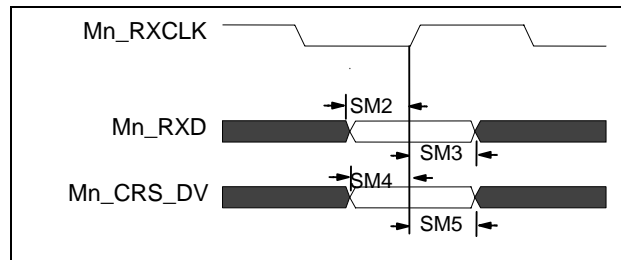
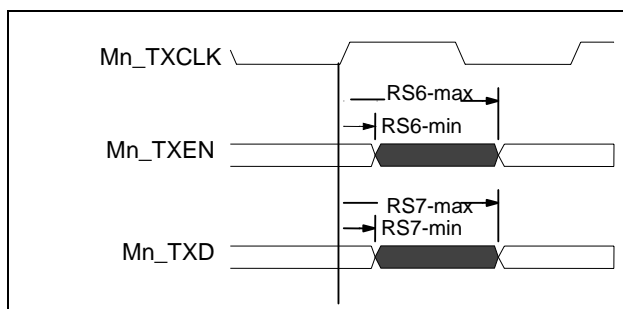


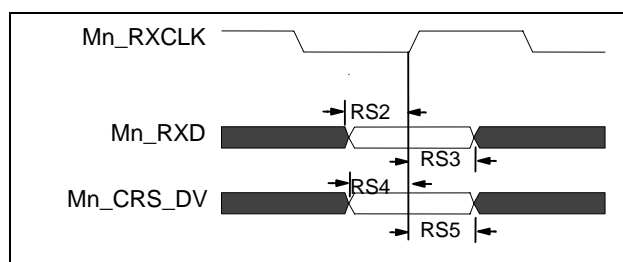
Figure 23 - GPSI Receive Timing

| Symbol | Parameter                      | 10 MHz    |           | Notes                 |
|--------|--------------------------------|-----------|-----------|-----------------------|
|        |                                | Min. (ns) | Max. (ns) |                       |
| SM2    | M[7:0]_RXD Input Setup Time    | 4         |           |                       |
| SM3    | M[7:0]_RXD Input Hold Time     | 2         |           |                       |
| SM4    | M[7:0]_CRS_DV Input Setup Time | 4         |           |                       |
| SM5    | M[7:0]_CRS_DV Input Hold Time  | 2         |           |                       |
| SM6    | M[7:0]_TXEN Output Delay Time  | 2         | 14        | $C_L = 20 \text{ pF}$ |
| SM7    | M[7:0]_TXD Output Delay Time   | 2         | 14        | $C_L = 20 \text{ pF}$ |

### 13.4.8 Reverse General Purpose Serial Interface (RvGPSI)



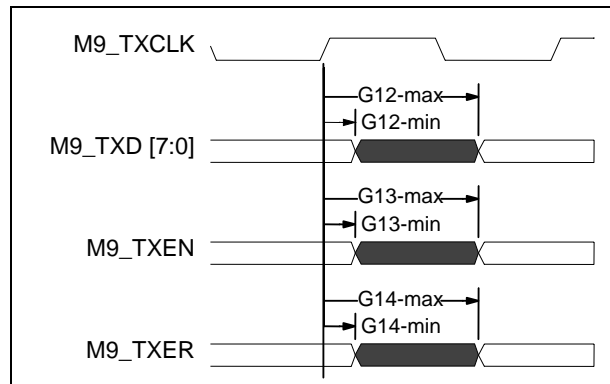
**Figure 24 - RvGPSI Transmit Timing**



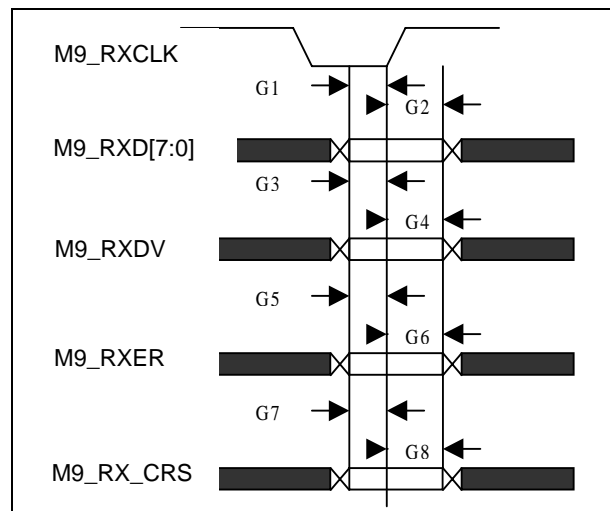
**Figure 25 - RvGPSI Receive Timing**

| Symbol   | Parameter                      | 10 MHz    |           | Notes                  |
|--|--------------------------------|-----------|-----------|------------------------|
|  |                                | Min. (ns) | Max. (ns) |                        |
| RS2  | M[7:0]_RXD Input Setup Time    | 4         |           |                        |
| RS3  | M[7:0]_RXD Input Hold Time     | 2         |           |                        |
| RS4  | M[7:0]_CRS_DV Input Setup Time | 4         |           |                        |
| RS5  | M[7:0]_CRS_DV Input Hold Time  | 2         |           |                        |
| RS6*   | M[7:0]_TXEN Output Delay Time  | 2         | 14        | C <sub>L</sub> = 20 pF |
| RS7*   | M[7:0]_TXD Output Delay Time   | 2         | 14        | C <sub>L</sub> = 20 pF |
| * May need to add external delay depending on other MAC device's min. hold time. |                                |           |           |                        |

### 13.4.9 Gigabit Media Independent Interface (GMII)



**Figure 26 - GMII Transmit Timing**



**Figure 27 - GMII Receive Timing**



| Symbol | Parameter                      | 125 Mhz   |           | Notes                 |
|--------|--------------------------------|-----------|-----------|-----------------------|
|        |                                | Min. (ns) | Max. (ns) |                       |
| G1     | M9_RXD[7:0] Input Setup Times  | 2         |           |                       |
| G2     | M9_RXD[7:0] Input Hold Times   | 0.5       |           |                       |
| G3     | M9_RXDV Input Setup Times      | 2         |           |                       |
| G4     | M9_RXDV Input Hold Times       | 0.5       |           |                       |
| G5     | M9_RXER Input Setup Times      | 2         |           |                       |
| G6     | M9_RXER Input Hold Times       | 0.5       |           |                       |
| G7     | M9_CRS Input Setup Times       | 2         |           |                       |
| G8     | M9_CRS Input Hold Times        | 0.5       |           |                       |
| G12    | M9_TXD[7:0] Output Delay Times | 1         | 5         | $C_L = 20 \text{ pf}$ |
| G13    | M9_TXEN Output Delay Times     | 1         | 5.5       | $C_L = 20 \text{ pf}$ |
| G14    | M9_TXER Output Delay Times     | 1         | 5         | $C_L = 20 \text{ pf}$ |

### 13.4.10 MII Management Data Interface (MDIO/MDC)

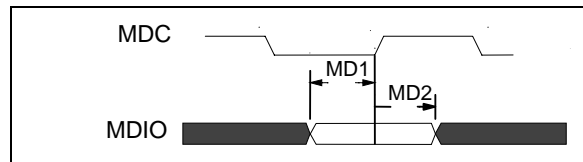


Figure 28 - MDIO Setup & Hold Timing

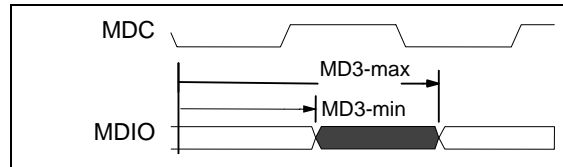


Figure 29 - MDIO Output Delay Timing

| Symbol | Parameter              | MDC=500 KHz |           | Notes                 |
|--------|------------------------|-------------|-----------|-----------------------|
|        |                        | Min. (ns)   | Max. (ns) |                       |
| MD1    | MDIO input setup time  | 10          |           |                       |
| MD2    | MDIO input hold time   | 2           |           |                       |
| MD3    | MDIO output delay time | 1           | 20        | $C_L = 50 \text{ pf}$ |

## 13.4.11 JTAG (IEEE 1149.1-2001)

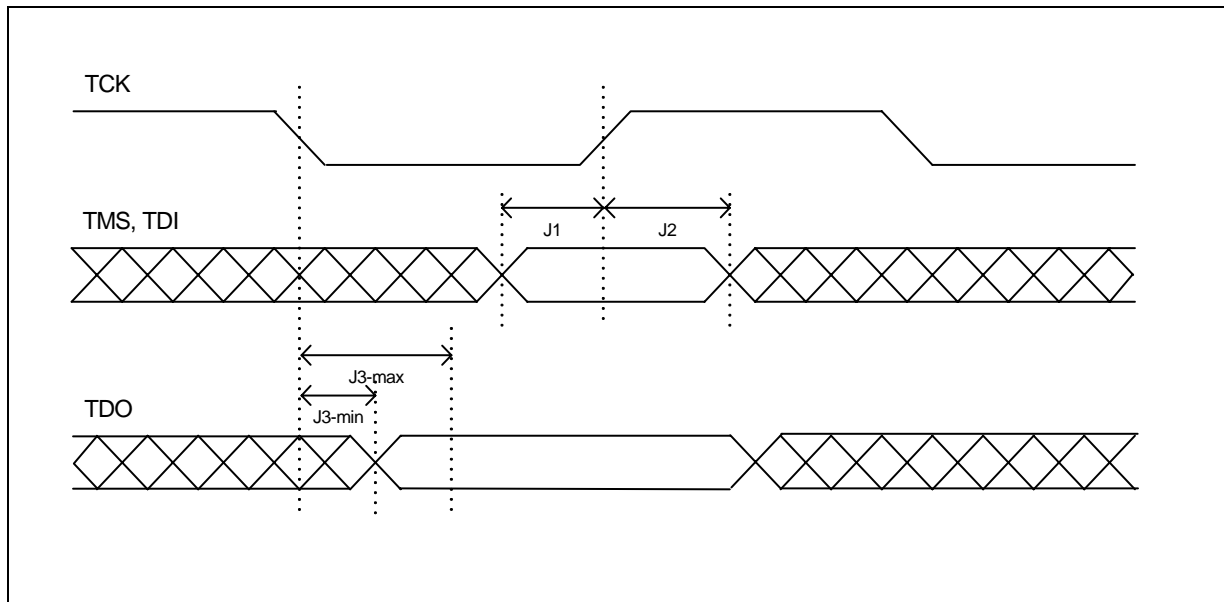
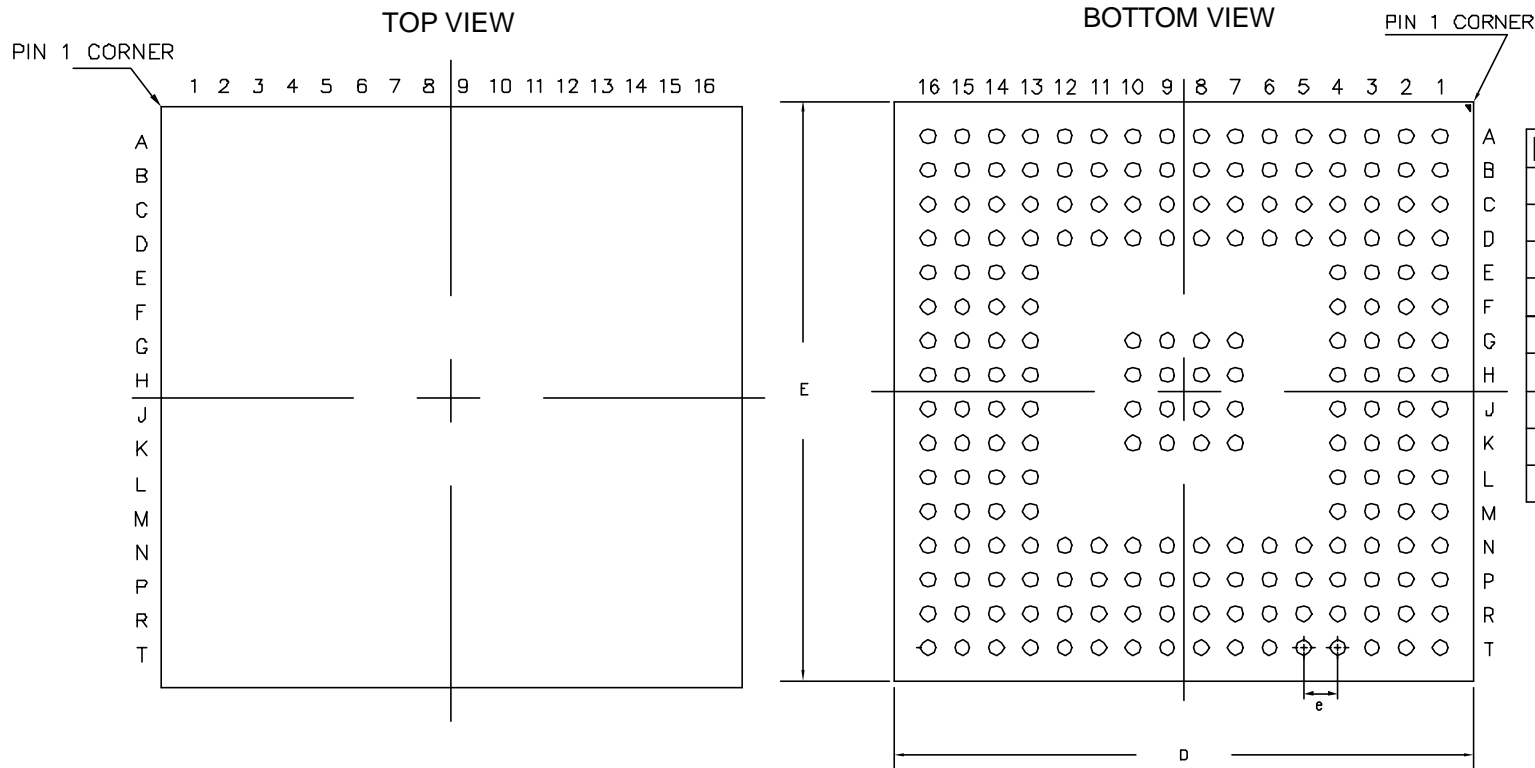
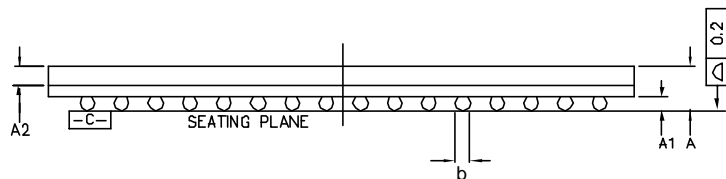


Figure 30 - JTAG Timing Diagram

| Symbol | Parameter                  | Min. | Typ. | Max. | Units | Refer to Figure 30             |
|--------|----------------------------|------|------|------|-------|--------------------------------|
|        | TCK frequency of operation | 0    | 10   | 50   | MHz   |                                |
|        | TCK cycle time             | 20   |      |      | ns    |                                |
|        | TCK clock pulse width      | 10   |      |      | ns    |                                |
|        | TRST# assert time          | 20   |      | -    | ns    | TRST is an asynchronous signal |
| J1     | TMS, TDI data setup time   | 3    |      |      | ns    |                                |
| J2     | TMS, TDI data hold time    | 7    |      |      | ns    |                                |
| J3     | TCK to TDO data valid      | 0    |      | 15   | ns    |                                |



| Dimension                | MIN      | MAX   |
|--------------------------|----------|-------|
| A                        | -        | 1.40  |
| A1                       | 0.30     | 0.50  |
| A2                       | 0.53 REF |       |
| D                        | 16.90    | 17.10 |
| E                        | 16.90    | 17.10 |
| b                        | 0.40     | 0.60  |
| e                        | 1.00     |       |
| N                        | 208      |       |
| Conforms to JEDEC MO-192 |          |       |



SIDE VIEW

NOTES: -

1. Controlling dimensions are in MM.
2. Seating plane is defined by the spherical crown of the solder balls.
3. Not to scale.
4. N is the number of solder balls
5. Substrate thickness is 0.36 MM.

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|        |         |  |  |  |
|--------|---------|--|--|--|
| ISSUE  | 1       |  |  |  |
| ACN    | 213730  |  |  |  |
| DATE   | 14Nov02 |  |  |  |
| APPRD. |         |  |  |  |



Previous package codes

Package Code GD

Package Outline for  
208ball LBGA  
17x17x1.4mm Max

GPD00802



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