
REALTEK SINGLE CHIP 8-PORT 10/100 ETHERNET SWITCH CONTROLLER WITH EMBEDDED MEMORY RTL8308B

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1. Features

- Supports eight 10/100Mbps Ethernet ports with RMI interface
- Provides forwarding of non-blocking and non-head-of-line-blocking
- 2M bit DRAM built in as a packet storage buffer
- Page based buffer management to efficiently utilize the internal packet buffer
- Ultra low power consumption with less than 160mA at 3.3V operating voltage
- Embedded 8K entry look-up table and 128 entry CAM
- Supports address hashing or direct mapping for look-up table
- 128-entry CAM is used to eliminate the hash collision issues
- Supports full and half duplex operation
- Link, speed and duplex status are auto-detected via MDIO
- Broadcast storm control
- Flow control fully supported:
 - Half-duplex: back pressure
 - Full-duplex: IEEE 802.3X
- Auto-negotiated Full-duplex flow control by writing the ability via MDIO to external PHY
- Supports Store-and-forward and cut-through operation
- Provides an LED display to indicate network loop existence
- Reversible PHYAD order for diverse PHY usage
- 3.3V 24LC02 interface
- Optional EEPROM 24LC02 for Loop detect configuration
- 128-pin PQFP, 0.35 um, 3.3V CMOS technology

2. General Description

The RTL8308B is a 128-pin, low cost and ultra low power consumption 8-port 10/100M Ethernet switch controller. It is integrated both with a 2M bit embedded DRAM, as a packet buffer, and an 8K entry address table. The RTL8308B supports the reduced MII (RMII) interface. Only a single 50MHz oscillator is needed and the EEPROM is optional, which can save BOM costs. In addition, the RTL8308B provides an LED display to indicate a network loop existence.

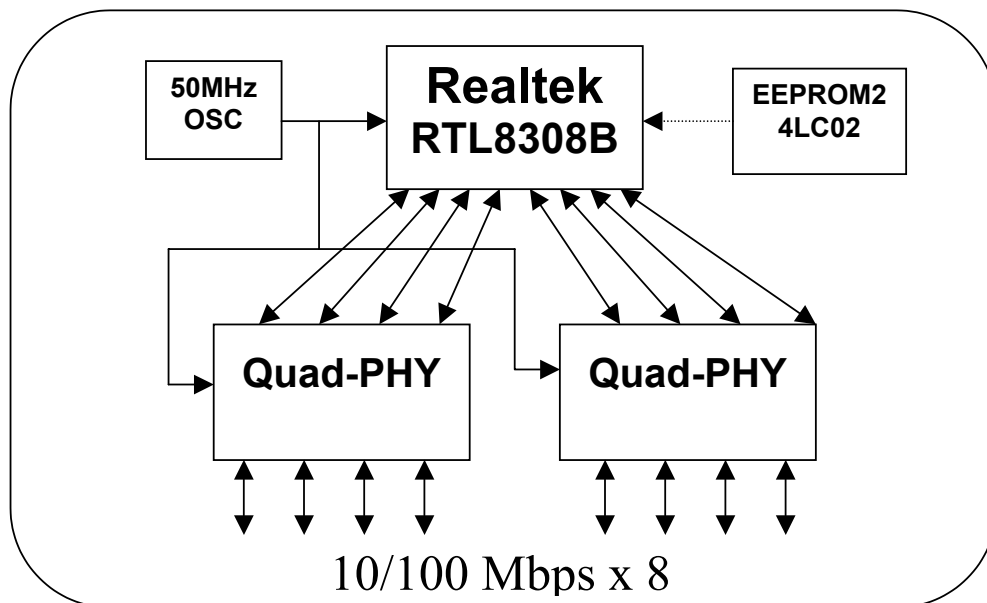
The RTL8308B provides eight 10/100 Mbps RMII Ethernet ports. Each port can operate in 10 Mbps or 100 Mbps data rate, and in full or half duplex mode. Speed, duplex, link status and flow control can be acquired by periodically polling the status of the PHY devices via MDIO.

The address look-up table consists of an 8K entry hash table and a 128 entry CAM. The RTL8308B uses the address hashing algorithm or direct mapping method to search destination MAC addresses from and record source MAC addresses to the hash table. Data received from the MAC interface is stored in the external memory buffer.

The RTL8308B supports IEEE 802.3x full duplex flow control and half duplex back pressure control. The ability of IEEE 802.3x flow control is auto-negotiated by writing the flow control ability via MDIO. The reversible PHYAD order feature is provided to connect diverse external PHY devices for PCB layout.

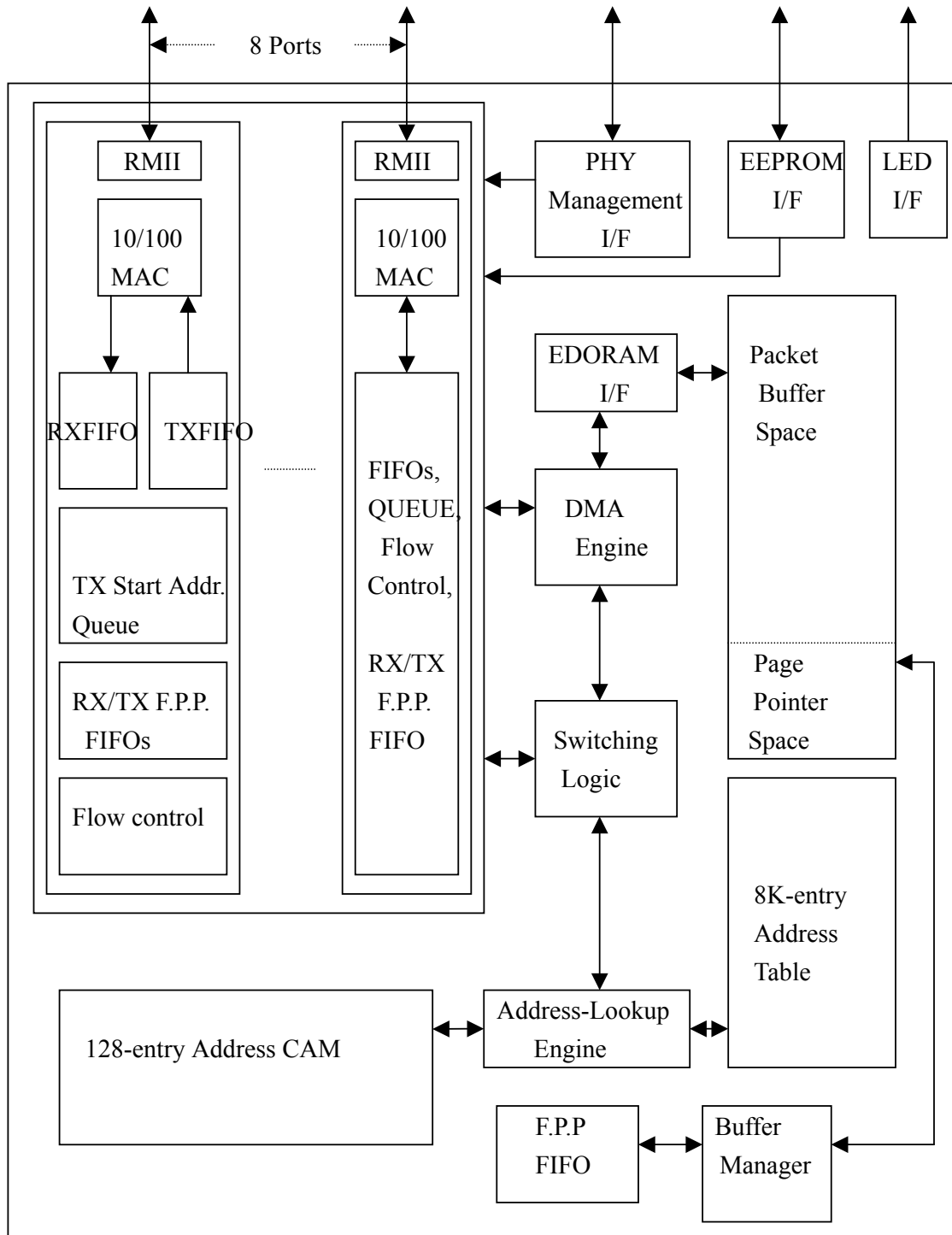
The RTL8308B provides a loop detect LED for visual diagnostics when detecting the network loop. The Broadcast storm filtering function is provided for unusual broadcast storm traffic.

The RTL8308B supports non-blocking 148800 packets/second wire speed forwarding rate and a special design to resolve the head-of-line-blocking problem. The RTL8308B uses a 2-wire 24LC02 interface to access the external serial EEPROM, which is not required. Only one 50MHz OSC is needed.

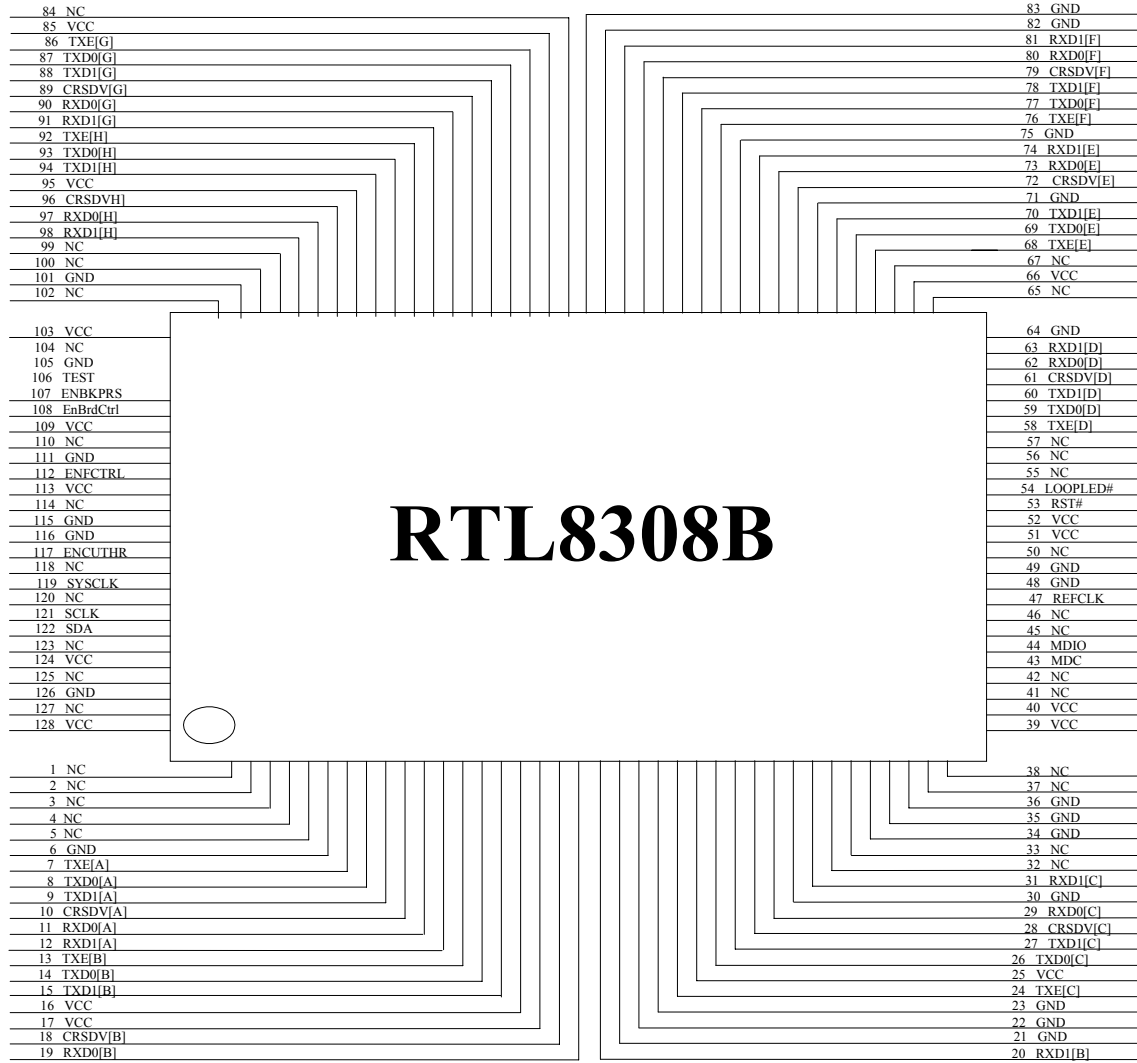


Example of 8-port Switch System diagram

3. Block Diagram



4. Pin Assignments



5. Pin Description

5.1 RMII Interface

| Symbol | Type | Pin No | Description |
|---|------|---|--|
| TXEN[A:H] | O | 7,13,24,58, 68,76,86,92 | Transmit Enable: The RTL8308B asserts high to indicate that valid di-bit data for transmission is presented on TXD[1:0], and transitions synchronously with respect to REFCLK. TXEN will be asserted synchronously with the first nibble of the preamble and will remain asserted while all di-bits that are to be transmitted are presented. TXEN will be negated prior to the first REFCLK rising edge following the final di-bit of a frame. |
| TXD[0:1][A], TXD[0:1][B], TXD[0:1][C], TXD[0:1][D], TXD[0:1][E], TXD[0:1][F], TXD[0:1][G], TXD[0:1][H] | O | 8,9,14,15,26, 27,59,60,69, 70,77,78,87,88, 93,94 | Transmit Data [1:0]: TXD[1:0] will transition synchronously with respect to REFCLK. When TXEN is asserted, TXD[1:0] is accepted for transmission by the PHY. TXD[1:0] will be '00' to indicate idle when TXEN is deasserted. |
| CRSDV[A:H] | I | 10,18,28,61, 72,79,89,96 | CRSDV Signals: This signal will be asserted high by the PHY when the medium is active. It is asserted asynchronously on detection of carrier due to criteria defined in the IEEE 802.3 specifications. Loss of carrier will result in the deassertion of this pin, synchronous to the cycle of the reference clock, REFCLK. |
| RXD[0:1][A], RXD[0:1][B], RXD[0:1][C], RXD[0:1][D], RXD[0:1][E], RXD[0:1][F], RXD[0:1][G], RXD[0:1][H] | I | 11,12,19,20, 29,31,62,63, 73,74,80,81, 90,91,97,98 | Receive Data [1:0]: The RTL8308B captures the receive data on the rising edge of REFCLK when CRSDV is asserted high. When CRSDV is asserted high, RXD[1:0] will transition synchronously to REFCLK. For each clock period in which CRSDV is asserted, RXD[1:0] transfers two bits of recovered data from the PHY. Values other than '00' on RXD[1:0] while RXDV as recovered from CRSDV is deasserted will be ignored by the controller. Upon assertion of CRSDV, the PHY will ensure that RXD[1:0] = '00' until proper receive decoding takes place. |
| REFCLK | I | 47 | RMII Reference Clock Input: A continuous clock which provides the timing reference for CRS_DV, RXD[1:0], TX_EN, and TXD[1:0]. It is a 50 MHz OSC, 3.3V, +/-50ppm, 0° C ~70° C, symmetry 45%~55%, Rise/Fall time 5ns, supply 40mA. It is assumed that the PHY uses REFCLK as the network clock so no buffering is required on the transmit data path. |
| MDC | O | 43 | Management Data Clock: A clock source common to all ports, generated by the controller with a frequency of 312.5 kHz, it is used to synchronize the MII data stream (MDIO) for transferring MII management data between the controller and transceivers. This pin is Tri-state at reset. |

| | | | |
|------|-----|----|---|
| MDIO | I/O | 44 | <p>Management Data Input/Output: This pin is used during the MII setup process. The whole setup sequence will set Register 4h, address 16-20 of the PHY to 05E1h, REGISTER 0h to value 1200h. It also advertises 100/10 full duplex with pause capability & enables auto-negotiation. Sending after reset signal release about 1.6ms.</p> <p>This pin is Tri-state at reset.</p> |
|------|-----|----|---|

5.2 Serial EEPROM 24LC02 Interface

| Symbol | Type | Pin No | Description |
|--------|------|--------|--|
| SCLK | O | 121 | <p>Serial Clock: Internally pulled high, this pin is used to enable data transfers from the EEPROM to the controller.</p> <p>This output is used to clock the serial EEPROM inputs and outputs. It operates at 1.6us or 625KHz.</p> |
| SDA | I/O | 122 | <p>Serial Data Input/Output: Internally pulled high, this pin is used to obtain configuration data from the external serial EEPROM after reset. The data is synchronized by MDC.</p> |

5.3 System Pins

| Symbol | Type | Pin No | Description |
|--------|------|--------|---|
| RST# | I | 53 | <p>Reset: Active low to a known reset state. After power-on reset (low to high), the configuration modes from Mode Pins are determined. Then, the contents of the serial EEPROM is auto-loaded into and the RTL8308B, which begins to access the management data of PHY devices.</p> |
| SYSCLK | I | 119 | <p>System clock input: The same 50 MHz clock as REFCLK is used.</p> |

5.4 Mode Pins (Reset-Read)

| Symbol | Type | Pin No | Description |
|-----------|------|--------|---|
| ENBrdCtrl | I | 108 | <p>Enable Broadcast Storm Control detection: Pulled low internally by default, Broadcast Storm Control is disabled. When pulled high upon reset, Broadcast Storm Control is enabled.</p> |
| ENCUTHR | I | 117 | <p>Enable Cut-through: Pulled low internally by default, cut-through is disabled. When pulled high upon reset, Cut-through is enabled.</p> |
| ENBKPRS | I | 107 | <p>Enable Half duplex back pressure function: Pulled low internally by default, back pressure is enabled. When pulled low upon reset, back pressure is disabled.</p> |
| ENFCTRL | I | 112 | <p>Enable Full Duplex Flow Control: Pulled low internally by default, Flow Control is enabled. The flow control ability will write to management register 4 of PHY device one and only one time after power-on reset, for advertising. When pulled low upon reset, the flow control function will be disabled.</p> |

5.5 LED Pin

| Symbol | Type | Pin No | Description |
|----------|------|--------|---|
| LOOPLED# | O | 54 | Loop Detected LED: Low active. This pin, asserted low indicates that a network loop is detected. |
| DTESTOUT | O | 56 | DRAM Test Output: For internal test use. |

5.6 Test Pin

| Symbol | Type | Pin No | Description |
|--------|------|--------|---|
| CTEST | I | 106 | Test pin: For internal use. Must be tied to ground for normal operation. |

5.7 Power & Ground Pins

| Symbol | Type | Pin No | Description |
|--------|------|---|-------------|
| GND | P | 6,21,22,23,30, 34,35,36,48, 49,64,71,75,82, 83,101,105,111, 115,116,126 | |
| VCC | P | 16,17,25,39,40, 51,52,66,85,95, 103,109,113, 124,128 | |

Please specify Analog/Digital Power & GND.

6. Functional Description

6.1 Reset

The minimum required reset duration is 1 μ s. After power on reset, the RTL8308B will determine some features from the ENFCTRL, ENBKPRS and ENBrdCtrl pins, auto-load the content of 24LC02 serial EEPROM, and write abilities to connected PHY management registers via MDC/MDIO. It is recommended that the RTL8308B and connected PHYs use the same reset signal source. The PHY reset must be completed before the RTL8308B.

6.2 Network Interface

The RTL8308B has 8 10/100 Mbps Ethernet ports (port 0 to port 7) with Reduced MII (R-MII) interfaces. It has 1 MII port in addition to the 4 R-MII ports for 10/100Mbps Ethernet transceivers. Note that an MII interface operates at 25MHz in 100Mbps transmission and 2.5MHz for 10Mbps transmission. Reduced MII interfaces use the same 50MHz clock rate for both 10Mbps and 100Mbps operation. All MII interfaces support auto-negotiation for transmission speeds, duplex modes and flow control options.

6.2.1 Medium Access Control

The RTL8308B implements the IEEE Std 802.3 binary exponential back-off algorithm and conforms to IEEE 802.3 specifications.

Data received from the PHY is interpreted and assembled into the external buffer memory by the RTL8308B flow controller. Interpretation involves detection and removal of the preamble, extraction of the address and FCS verification. Also included is a jabber-detection timer to detect frames of greater than maximum length being received on the network. In 10Mbps mode, the raw data received from the PHY as input is converted to 8-bit width before further processing. Similarly, in 100Mbps mode, the data received from the external PHY is converted to 8-bit data width in the shifter. The data is then synchronized to the internal clock of the RTL8308B. Once the 100Mbps data has been deserialized it is handled no differently than the 10Mbps data. By default, the RTL8308B detects collision signals by itself, which makes normal and reverse MII connection easy. Because signals from the PHY are not synchronized with internal clocks of the RTL8308B, the Rx FIFO adjusts timing differences between external & internal clocks. Data transmission requires more processing and data handling than data reception. This is due to the overhead of implementing collision detection and recovery logic. Data entering from the FIFO is serialized for transmission at the transmit clock rate (this also requires the data to be synchronized to the transmit clock rate from the internal clock). Because the transmit clock is asynchronous with the internal clock of the RTL8308B, the Tx FIFO is needed for timing adjustment. The Tx FIFO will also transmit JAM pattern and PAUSE frames to work with the flow control mechanism in the Flow Control Unit.

The Tx FIFO handles the output of data to the PHY devices, and several error states are handled. If a collision is detected in half duplex mode, the state machine jams the output. If the collision was late (after the first 64-bytes have been transmitted), the frame is lost. If it is an early collision, the controller backs off before retrying. While operating in full duplex mode, both carrier-sense (CRS) mode and collision-sensing modes are disabled. Internally, frame data only is removed from buffer memory once it has been successfully transmitted without collision (for the half-duplex ports). Transmission recovery also is handled in this state machine. If a collision is detected, frame recovery and retransmission are initiated.

6.2.2 Auto Negotiation

Each individual port can operate at 10Mbps or 100Mbps in half or full duplex mode, and can indicate support of IEEE 802.3x flow control. The operating modes for each port can be negotiated between the MAC and PHY devices after power up if auto-negotiation is enabled for that port. Auto-negotiation may be enabled for each port by setting the corresponding auto-negotiation parameter through a configuration pin, EEPROM or serial configuration interface. This provides for unmanaged operation, when using PHY devices that support this signaling scheme.

6.2.3 MII Interface

Through the MII interface, the 10/100Mbps ports support a number of options, such as full/half duplex and 10M/100M bit rate. The architecture for the 100Mbps interface is similar to that for 10Mbps. This permits the interface to support both 10 and 100Mbps operation. When operated at 10Mbps, the ports support nibble mode at 2.5 MHz clock rate.

6.2.4 RMII interface

The RTL8308B provides a 10/100 Mbps low pin count RMII interface for use between PHY and RTL8308. The MAC of each port of RTL8308B is connected to the PHY through the standard RMII interface. The RMII is capable of supporting 10Mbps and 100Mbps data rates. A single clock reference, 50MHz, sourced from an external clock input is used for receiving and transmitting.

It also provides independent 2 bit wide (di-bit) transmit and receive data paths. As the REFCLK is 10 times the data rate in 10Mbps mode, each data di-bit must be output on TXD[1:0] and input on RXD[1:0] for ten consecutive REFCLK cycles. The RTL8308B can regenerate the COL signal of the MII internally by ANDing TXEN and CRS as recovered from CRSDV. Note that TXEN cannot be ANDed directly with CRSDV since CRSDV may toggle at the end of the frame to provide separation of RXDV and CRS.

Prior to any data transaction, RTL8308B will output di-bits of '01' as preamble signal. After the preamble, a '11' signal is used to indicate the start of the frame. For reception, the received data (RXD) is sampled by the rising edge of the REFCLK. Assertion of the CRSDV signal indicates that the receive channel is active. The di-bit RXD[1:0] is nominally '00' until the PHY detects a valid SFD and sends a '01' preamble. Valid data will follow SFD. For transmission, TXEN is asserted when the first preamble nibble is sent on the transmit data (TXD) lines. The transmit data is clocked out by the rising edge of the reference clock.

RMII Specification Signals are listed below:

| Signal Name | Direction (with respect to the PHY) | Direction (with respect to the RTL8308) | Use |
|-------------|---|---|--|
| REFCLK | Input | Input | Synchronous clock reference for receive, transmit and control interface. |
| CRSDV | Output | Input | Carrier Sense/Receive Data Valid |
| RXD[1:0] | Output | Input | Receive Data |
| TXEN | Input | Output | Transmit Enable |
| TXD[1:0] | Input | Output | Transmit Data |

6.2.5 Illegal Frames

During the receiving process, the MAC will monitor the length of the received frame. Illegal frames such as a bad CRC packet, runt packet (less than 64 bytes) or oversized packet (greater than 1536) will be discarded.

If the carrier sense (CRS) signal in the RMII interface is asserted and RXD[1:0] at the beginning of the packet is '10', the port is considered to have a false carrier event. Normal carrier has a preamble value of '01'. The false carrier event is recorded for the MIB counter.

The RTL8308B can handle frames up to 1536 bytes. All frames longer than 1536 byte will be discarded. If the port continues to receive data after the 1536th byte, the port's data will be filtered. If the port is in half duplex mode, the port will no longer be able to transmit or receive data during the long packet reception.

6.3 EEPROM Interface

The serial EEPROM interface is designed to load information required by various optional functions. The interface implements the SDA signal and it is directly compatible with the 93C46 device. The controller reads, in serial format, in the first 272 bits (seventeen 16-bit words) out of the EEPROM and stores them in registers. Because the information stored in EEPROM is static, this read occurs only on power-up. The serial EEPROM shifts out the most significant bit of the word first.

6.4 Serial Management Interface MDC/MDIO

The RTL8308B supports PHY management through the serial MDIO and MDC signal lines. After power on reset, the RTL8308B writes abilities to the advertisement register 4 of the connected PHY and restarts the auto-negotiation process through MDIO using PHY addresses incrementally from 01000b to 01111b. After restarting auto-negotiation, the RTL8308B will continuously poll the link status and link partner's ability which includes speed, duplex and flow control of the PHY devices via MDIO.

The MDIO operation for the RMII is the same as that for the MII. The device will send a '01' to signal a write operation. The 5 bit ID address of the PHY device and the 5 bit register address is next, and a '10' turn-around signal is then used to avoid contention during a read transaction. After the turn around, the 16 bits of data will be written into the register. After the completion of the write transaction, the line will be put into a high impedance state.

For a read operation, the RTL8308B will output a '10' to indicate read operation after the start of frame indicator. The 5-bit ID address of the PHY device and the 5-bit register address is next. Then, the RTL8308B will stop driving the MDIO line, and wait for one bit time. During this time, the MDIO should be in a high impedance state. The device will then synchronize with the next bit of '0' driven by the PHY device, and continue to read the 16 bits of data from the register. The detailed timing requirements on PHY management signals are described in the timing part of Section 8.

The MDIO port can be disabled through the use of the port configuration register. This allows usage of a 100Base-TX transceiver without auto-negotiation capability or an RMII to RMII interconnect. In this mode of operation, the PHY has no communication with the RTL8308. Therefore, the RTL8308B will assert the link status as soon as initialization is completed and assumes the connected PHY is operating at the specified operating mode and speed.

The Management frame format is listed below:

| | Management frame fields | | | | | | | |
|--------------|-------------------------|----|----|-------|-------|----|--------------------|------|
| | PRE | ST | OP | PHYAD | REGAD | TA | DATA | IDLE |
| READ | 1...1 | 01 | 10 | AAAAA | RRRRR | Z0 | DDDDDDDDDDDDDDDDDD | Z |
| WRITE | 1...1 | 01 | 01 | AAAAA | RRRRR | 10 | DDDDDDDDDDDDDDDDDD | Z |

6.5 Reversible PHYAD Order

In order to maintain maximum flexibility, the RTL8308B provides a reversible PHYAD order feature. This allows reverse ordering of the PHY addresses, which allows connection of the RTL8308B to diverse external PHY devices. The addresses of ports [A] to [H] correspond to PHYAD 01000b to 01111b, or to PHYAD 01111b to 01000b, depending on the value of PHYAD_RV in the EEPROM.

6.6 Address Search and Learning

The address look-up table consists of an 8K entry hash table and a 128 entry CAM. The RTL8308B uses the hashing algorithm or direct mapping method to search destination MAC addresses from and record source MAC address to the table. If a hashed or mapped location is not empty, the RTL8308B will compare the destination MAC address with the contents of the CAM for address searching and store source MAC address to CAM for learning.

The aging time of the MAC address is 300 seconds. The address hashing or direct mapping algorithm can be selected via the 24LC02. A port's MAC address register is cleared on power-up, or hardware reset. If the SA aging option is enabled, the dynamically learned SA will be cleared if it is not refreshed in less than programmed time.

The table lookup engine provides the switching information required for routing the data packets. The address look up table is set up through auto address learning (dynamic) or manual entry (static). The static addresses are assigned to the address table by the EEPROM or management device. All static address entries will not be aged or updated by the RTL8308B.

After a frame is received by RTL8308B, the embedded source address (SA) and destination addresses (DA) are retrieved. The source address retrieved from the received frame is automatically stored in a SA buffer. The RTL8308B will then check for error and security violation, and perform a SA search. If there is no error or security violation, the chip will store the source address in the address lookup table. If the SA has been previously stored in another port's SA table, the RTL8308B will delete the SA from the previously stored location.

The Individual MAC Address is a 48-bit unique MAC address to be programmed or learned. Bit 0 of a SA will be masked, i.e. no multicast SA.

The RTL8308B provides an on-chip MACAddress-To-PortID/TrunkID table with up to 1K entries for packet destination look-up operation.

The RTL8308B address table contains both the static addresses input by the CPU or the EEPROM and dynamically learned address. It learns the individual MAC addresses from 3 different sources.

1. Packet received with no errors from the local ports.
2. Packets forwarded from other devices through the ring to the device
3. The Table Convergence message received from the ring, which is not issued by the device itself.

If a received packet contains a source address that has already been learned in another port's address table but not aged out, it will perform the following operation based on the switch's configuration.

If the security option is selected for the port, RTL8308B will consider this as a security violation. If port is a nonprotected port, RTL8308B will delete the SA from the previous port's address table and update it to the current port's address table. However, if the SA is an static address entry, the address will not be updated.

6.7 Address Hashing Mode

On reception of a packet, the RTL8308B first hashes the destination MAC address to get a location index to the 8K-entry hash table. At the same time, it compares the destination MAC address with the contents of the 128 entry CAM. If the hash indexed location is valid or the CAM comparison matches, this received packet will be forwarded to the corresponding destination port. Otherwise, the RTL8308B broadcasts the packet. Next, the RTL8308B hashes the source MAC address to get a location index to the hash table. If the hash indexed location is occupied, i.e., a hash collision has occurred, the new source MAC address will be relocated into the 128 entry CAM accordingly. Using this eliminates the hash collision problem.

6.8 Address Direct Mapping Mode

In this mode, the RTL8308B uses the last 13 bits of the MAC address to index to the 8K-entry look-up table.

6.9 Frame Filtering

The RTL8308B will make filtering and forwarding decisions for each packet received based on its packet routing table, VLAN Mapping, port state, and the system configuration.

Received frames will be filtered under the following conditions:

1. The RTL8308B will check all received frames for errors such as symbol error, FCS error, short event, runt, long event, etc. Frames with any kind of error will not be forwarded to their destination port.
2. Any frame heading to its own source port will be filtered.
3. Packets heading to a disabled receiving port will be filtered.
4. If the input buffer of the port is full, the incoming frame will be discarded. It is recommended to use flow control to prevent any loss of data. If the flow control option is enabled, this event will not occur. The remote station will transmit a frame when the input buffer becomes available.
5. If the packet has any security violation and security option is enabled at the receiving port

If the Spanning Tree Protocol is enabled, the RTL8308B will forward the packet as follows:

1. If the port is in the Block-N-Listen state or the Learning state, forward the packet to the CPU when it is a BPDU packet, discard the packet otherwise;
2. If the port is in the Forwarding State, forward the packet to the CPU when it is a BPDU packet.

6.10 Back off Algorithm

The RTL8308B implements the truncated exponential back off algorithm compliant to the IEEE 802.3 standard. The collision counter will be restarted after 16 consecutive collisions.

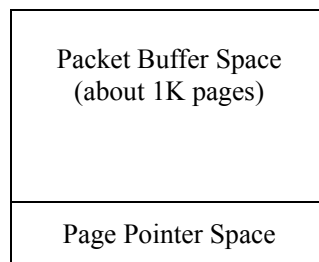
6.11 Inter-Frame Gap

The Inter-Frame Gap is 9.6us for 10Mbps Ethernet and is 960ns for 100Mbps fast Ethernet.

6.12 Buffer Management

An embedded 2M bit (32K x 64) or 256K byte DRAM operating at the 50MHz clock rate is built-in as a packet storage buffer. To efficiently utilize the packet buffer, the RTL8308B divides the 2Mbit (256Kbytes) DRAM into 1K pages of storage space, i.e., each page contains 256 bytes. For Ethernet packets, a maximum of seven pages can be used and the minimum is one.

The embedded DRAM is divided into two parts. The first is the Packet Buffer Space, used for storing received packet data. The second is Page Pointer Space for buffer management. The Packet Buffer Space consists of about 1k storage units in a page. Each page consists of 8-byte Header information, including next page pointer and received byte count, and 248 bytes of data. The page pointers are contained in Page Pointer Space.



2M bit DRAM

6.13 Buffer Manager

The Buffer Manager of the RTL8308B contains a Free Page Pointer FIFO pool to store and provide available free page pointers to all ports. After power up reset, the Buffer Manager will initiate the *Descriptor Read* command to get some available free page pointers from Page Pointer Space. When the contents of the Free Page Pointer FIFO is almost empty due to continuous data receptions, the Descriptor Read command will be reinitiated to get more available free page pointers. However, when the FIFO contents are almost full due to continuous successful data transmissions, the RTL8308B initiates the *Descriptor Write* command to write the additional available free page pointers back to Page Pointers Space.

6.14 Data Reception

Each port contains a Receive Data FIFO and a Receive Free Page Pointer FIFO. Initially the Free Page Pointer FIFO is filled with free page pointers received from the Buffer Manager. On reception of a packet, the received data flows into the Receive Data FIFO first and then is moved into the Packet Buffer by the Receive DMA Engine, using the free page pointers in the Receive Free Page Pointer FIFO via the *Get Free Page* command. The RTL8308B always attempts to fill the Receive Free Page Pointer FIFO with free page pointers.

6.15 Data Forwarding

Each port also contains a Transmit Data FIFO, a Transmit Free Page Pointer FIFO and a Transmit Start Address Queue.

After a packet is received, its source address (SA) and destination address (DA) are retrieved. The SA is used to update the port's address table and the DA is used to determine the packet's destination port. Once a forwarding condition is met (for store-and-forward mode, a packet is completely received) the receiving port will pass the beginning page pointer using the Send TX Descriptor command to the transmit port and start the Transmit DMA. The transmission port stores the beginning page pointer in the Transmit Start address Queue. The Transmit DMA moves data from the Packet Buffer through the Transmit Data FIFO and to the RMII interface using the free page pointer in the Transmit Free Page Pointer FIFO. Once the packet has been forwarded successfully, the RTL8308B uses the Put Free Page command to put related free page pointers back to buffer manager's Free Page Pointer FIFO.

The Address Lookup Engine will attempt to match the destination address with the addresses stored in the address table. If there is a match found, a link between the source port and the destination port is then established.

If the first bit of the destination address is 0, the frame is regarded as an unicast frame. The destination address is passed to the Address Lookup Engine; which returns a matched destination port number to identify which port should the frame be forwarded to. If the destination port is within the same VLAN of the receiving port, the frame will be forwarded.

If the destination port does not belong to the VLANs specified at the receiving ports, the frame will be discarded. The event will be recorded as a VLAN boundary violation.

There are two ways that RTL8308B handles packet with unknown destination. The forwarding decision is controlled by the Flood Control option (System Configuration register 00). If Flood Control is disabled, the packet will be forwarded to all ports (except the receiving port) within the same VLANs of the receiving port. If the FloodControl option is enabled, the RTL8308B will forward the packet only to the uplink port specified at the receiving port.

RTL8308B defines a port as either a single port or a trunk.

If the port monitoring function is enabled, the packet forwarding decision is also subject to the port monitoring configurations.

If the first bit of the destination address is a 1, the frame will be handled as a multicast or broadcast frame. The RTL8308B does not differentiate multicast packet from broadcast packet except the reserved bridge management group address, as specified in table 3.5 of IEEE 802.1d standard. The destination ports of the broadcast frame is all ports within the same VLAN except the source port itself.

If Multicast/Broadcast packet trapping (MCtrap) is enabled, the multicast/broadcast packets will be forwarded to the CPU only.

6.16 Flow Control

The RTL8308B supports IEEE 802.3x full duplex flow control and half duplex back pressure congestion control. The IEEE 802.3x flow control ability is auto-negotiated between a remote device and the RTL8308B by writing the flow control ability via MDIO to the external, connected PHY. The RTL8308B adopts a special half duplex back pressure design, forwarding one packet successfully after 28 force collisions to prevent the connected repeater from being partitioned due to excessive collisions. The full duplex flow control ability can be enabled or disabled via the ENFCTRL pin, and the half duplex back pressure function can be enabled or disabled via the ENBKPRS pin, both during hardware reset.

If ENFCTRL is set and the 802.3x pause ability from the auto-negotiation result is enabled, the full duplex 802.3x flow control function is enabled. Otherwise, the full duplex 802.3x flow control function is disabled. When 802.3x flow control is enabled, the RTL8308B will only recognize the 802.3x flow control PAUSE ON/OFF frames with DA="0180C2000001", type="8808", OP-code="01", PAUSE Time = maximum or zero, and with good CRC.

If a PAUSE frame is received from any PAUSE flow control enabled port with DA=0180C2000001, the corresponding port of the RTL8308B will stop its packet transmission until a PAUSE timer timeout or another PAUSE frame with zero PAUSE time is received. No 802.3x PAUSE frames received from any port will be forwarded by the RTL8308B.

6.17 Cut Through

The RTL8308B can operate in cut-through or store-and-forward mode. When in cut through mode (by pulling the ENCUTHR pin high), if receiving packet length is greater than 512 bytes, the RTL8308B starts to forward it after 512 bytes are received. If less than 512 bytes, the RTL8308B operates as same as store-and-forward mode.

6.18 Broadcast Storm Filtering Control

The RTL8308B can enable broadcast storm filtering control by pulling high EnBrdCtrl (pin108). This allows limitation of the number of broadcast packets into the switch, and can be implemented on a per port basis. The threshold of number of broadcast packets is set to 64. When enabled, each port will drop broadcast packets (Destination MAC ID is ff ff ff ff ff) after receiving 64 continuous broadcast packets. The counter will be reset to 0 every 800ms or when receiving any non-broadcast packets (Destination MAC ID is not ff ff ff ff ff).

When disabled, or the number of non-unicast packets received at the port is not over the programmed threshold, the RTL8308B will forward the packet to all the ports (except the receiving port) within the VLANs specified at the receiving port. If the CPU port is within the specified VLAN, the packet will also be forwarded to the CPU.

If Broadcast-Storm-drop (BOnly_SC) is enabled, the RTL8308B will only drop broadcast packets but not the multicast packets.

6.19 Loop Detection

When the loop detection function is enabled, by setting Enloop in EEPROM, the RTL8308B periodically sends out a broadcast 64-byte packet every 3~5 minutes and automatically detects the existence of a network loop (or bridge loop). The loop LED asserted low indicates that a loop exists. The LED will go out by unplugging both of the RTL8308B ports of the loop. The Loop frame length is 64 bytes and its format is below.

| | | | | |
|-----------|-----|------|----------------|-----|
| FFFFFF80F | SID | 0040 | 0000000...0000 | CRC |
|-----------|-----|------|----------------|-----|

In order to achieve loop detection, each switch device needs a different SID for detection. In addition, a different EtherID is needed for each device when the loop detection function is enabled. If no EEPROM is used, the RTL8308B uses a default SID (0180c2000001) and FCS.

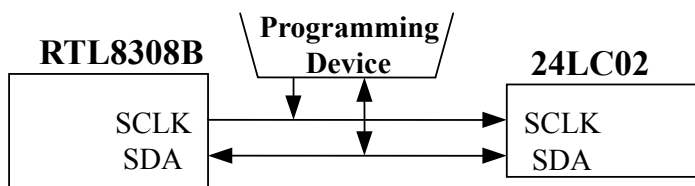
6.20 Head-Of-Line Blocking

The RTL8308B incorporate a simple mechanism to prevent Head-Of-Line blocking problems when flow control is disabled. When the flow control function is disabled, the RTL8308B will first check the destination address of the incoming packet. If the destined port is congested, then the RTL8308B will discard this packet to avoid blocking the next packet which is going to a non-congested port.

6.21 24LC02 Interface

The 24LC02 interface is a 2-wire serial EEPROM interface providing 2K bits of storage space. After a power on reset, the RTL8308B uses Random Read and Sequential Read commands to auto-load configuration settings, switch Ethernet ID, etc. After it is auto-loaded, the 24LC02 interface pins SCL and SDA are tri-stated for other devices (e.g. PC parallel port or 8051 controller) to program the 24LC02 contents.

If a 24LC02 is not used, byte 0 of the 24LC02 would be read as FF. When byte 0 is not FF, the RTL8308B will directly use the default value. The default values of byte 0 and byte 1 are 00. When the 24LC02 is not used, the RTL8308B will also use default SID, FCS of Pause-On and Pause-off.



6.22 24LC02 Device Operation

Clock and Data transitions: The SDA pin is normally pulled high by an external resistor. Data on the SDA pin may change only during SCL low time periods. Data changes during SCL high periods will indicate a start or stop condition as defined below.

Start condition: A high-to-low transition of SDA with SCL high is a start condition which must precede any other command.

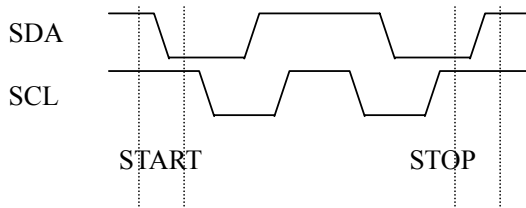
Stop condition: A low-to-high transition of SDA with SCL high is a stop condition.

Acknowledge: All addresses and data are transmitted serially to and from the EEPROM in 8-bit words. The 24LC02 sends a zero to acknowledge that it has received each word. This happens during the ninth clock cycle.

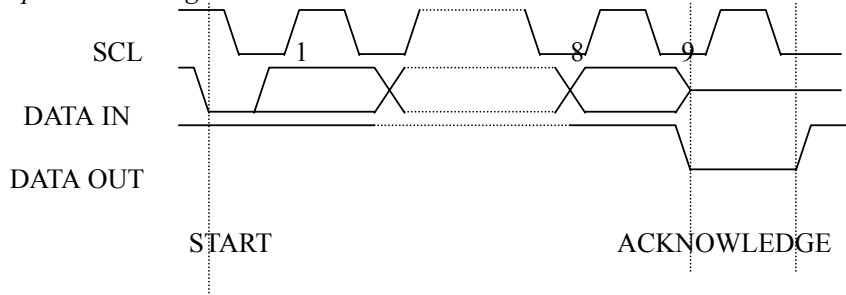
Random Read: A random read requires a "dummy" byte write sequence to load in the data word address.

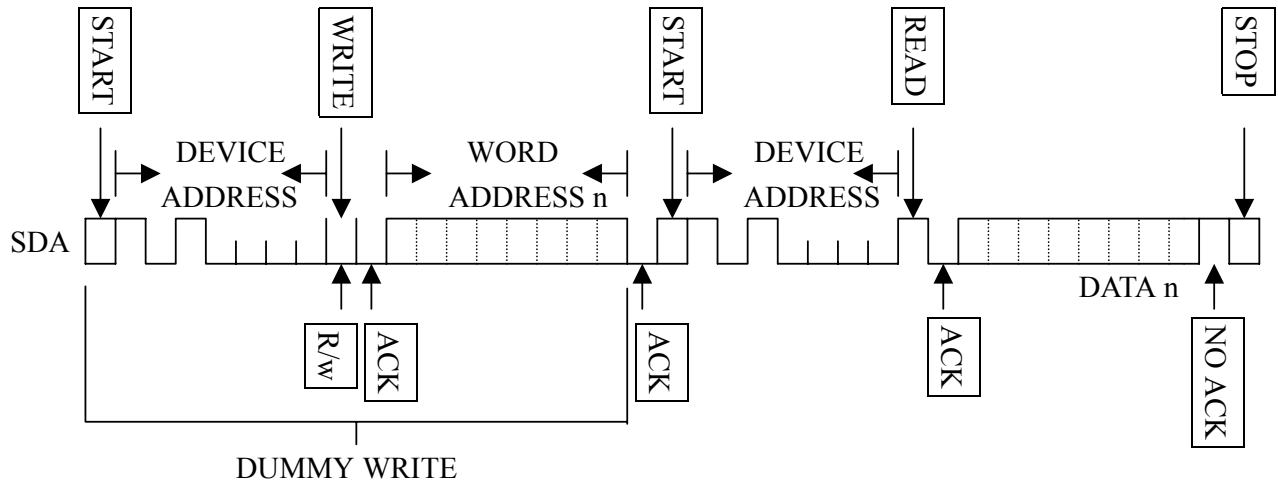
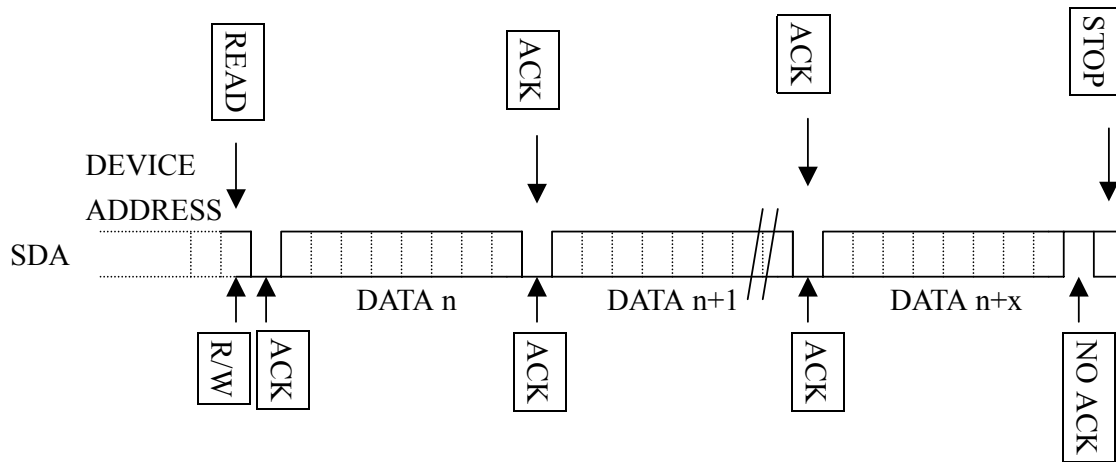
Sequential Read: For the RTL8308, the sequential reads are initiated by a random address read. After the 24LC02 receives a data word, it responds with an acknowledgement. As long as the 24LC02 receives an acknowledgement, it will continue to increment the data word address and serially clock out sequential data words.

*Start and Stop Definition



*Output Acknowledge



**Random Read*

**Sequential Read*


6.23 Testing

There are several testing and diagnostic options for the RTL8308B. This section will describe the External SRAM Test, Production Testing and the External Loopback Test.

6.23.1 External SRAM Test

After RESET signal goes high, the RTL8308B will perform external memory self-test. It performs a worse case test by changing Address & Data bus bits as much as possible between each access. The whole test takes about 14ms. The corresponding memory error indication bit accessible via serial LED interface will be turn on if any data read is different from written.

6.23.2 Production Testing

The RTL8308B supports a simple but effective testing function for final production test in the process of switch manufacturing. If board diagnostic function is enabled, the switch may act as a packet generator to be part of the production test fixture to test finished switch system on production line. In this mode, the switch generates 16 broadcast packets on each port, from port 0 to port 4/7 sequentially. All other ports except the transmitting port should received 16 valid packets. If any port failed to receive packets as expected, the switch will turn on the corresponding RX ERR LED. Otherwise, RXOK LEDs will be lit. During the process of testing, the switch turns on TXON LED of the transmitting port and RXON LED of all other ports. When the process completed successfully, the switch will turn on the TESTOK LED. The switch will re-start testing cycle when a trigger signal applied to the CFGIN pin or when a test cycle timer of 26 seconds expired. Note that all links must operate in full duplex mode and transmit/receive at 100Mbps. Note that this feature is supported only when the switch in test fixture and the switch in production are both designed based on the RTL8308B controllers.

6.23.3 Loopback

This feature is designed to simplify field support task for system manufacturers and distributors. In this mode, the switch should have switch ports connected in pairs using cross-over CAT-5 cables. When external loop-back test is enabled, the switch sends 16 packets on all active (connected) ports simultaneously. And each active port should receive exactly 16 valid packets. . If any port failed to receive packets as expected, the switch will turn on the corresponding RX ERR LED. Otherwise, RXOK LEDs will be lit. During the process of testing, the switch turns on TXON LEDs and RXON LEDs of all active ports. When the process completed successfully, the switch will turn on the TESTOK LED. The switch will re-start testing cycle when a trigger signal applied to the CFG_IN pin or when a test cycle timer of 26 seconds expired. Note that all links must operate in full duplex mode and transmit/receive at 100 Mbps.

7. 24LC02 Serial EEPROM Format

The contents of the 24LC02 serial EEPROM are listed below. The contents include configuration, Switch Ethernet ID, CRCs for flow control and loop detection.

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------|--|----------|---|---|-----------|---|---|----------|
| Byte 0 | EnLoop | 0 | 0 | 0 | AcceptErr | 0 | 0 | 0 |
| Byte 1 | 0 | HashMode | 0 | 0 | 0 | 0 | 0 | PHYAD_RV |
| 2-7 | Ethernet ID (Physical Address) PAR47~0 | | | | | | | |
| 8-11 | Pause ON CRC 31~0 | | | | | | | |
| 12-15 | Pause OFF CRC 31~0 | | | | | | | |
| 16-19 | Loop Detection CRC 31~0 | | | | | | | |

- AcceptErr: When 0, CRC error packet will be discarded for normal use.
When 1, CRC Error packet can be accepted and forwarded for test.
- EnLoop: When 0, the Loop detection function is disabled.
When 1, the Loop detection function is enabled.
- PHYAD_RV: When 0, port[A]~[H] uses PHYAD = 01000b ~ 01111b to access external PHY status.
When 1, port[H]~[A] uses PHYAD = 01000b ~ 01111b.
- HashMode: When 1, address hashing algorithm used for search and learning.
When 0, address direct mapping algorithm used.
- If no 24LC02 is used, the default values of byte 0 and byte 1 are 00, and the default SID is 0180c2000001.

8. Electrical Characteristics

8.1 Temperature Limit Ratings

| Parameter | Minimum | Maximum | Units |
|-----------------------|---------|---------|-------|
| Storage temperature | -55 | +125 | °C |
| Operating temperature | 0 | 70 | °C |

8.2 DC Characteristics

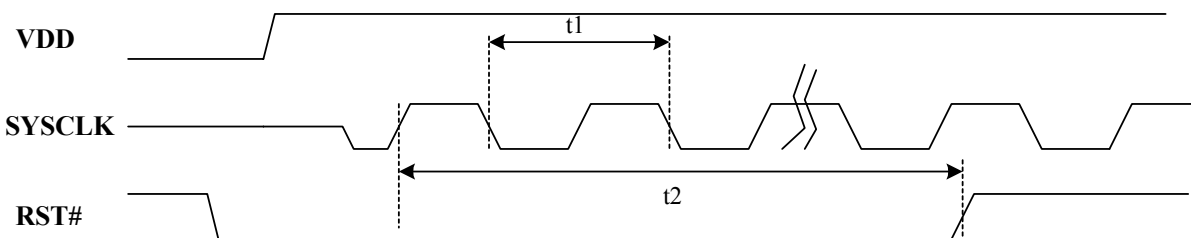
Supply voltage $V_{CC} = 3.3V \pm 5\%$

| Symbol | Parameter | Conditions | Min. | Typical | Max. | Units |
|----------|-----------------------------------|---------------------------|----------------|---------|----------------|---------|
| V_{OH} | Minimum High Level Output Voltage | $I_{OH} = -8mA$ | $0.9 * V_{CC}$ | | V_{CC} | V |
| V_{OL} | Maximum Low Level Output Voltage | $I_{OL} = 8mA$ | | | $0.1 * V_{CC}$ | V |
| V_{IH} | Minimum High Level Input Voltage | | $0.5 * V_{CC}$ | | $V_{CC} + 0.5$ | V |
| V_{IL} | Maximum Low Level Input Voltage | | -0.5 | | $0.3 * V_{CC}$ | V |
| I_{IN} | Input Current | $V_{IN} = V_{CC}$ or GND | -1.0 | | 1.0 | μA |
| I_{OZ} | Tri-State Output Leakage Current | $V_{OUT} = V_{CC}$ or GND | -10 | | 10 | μA |
| I_{CC} | Average Operating Supply Current | $I_{OUT} = 0mA$, | | 145 | 160 | mA |

8.3 AC Characteristics

8.3.1 Reset and Clock Timing

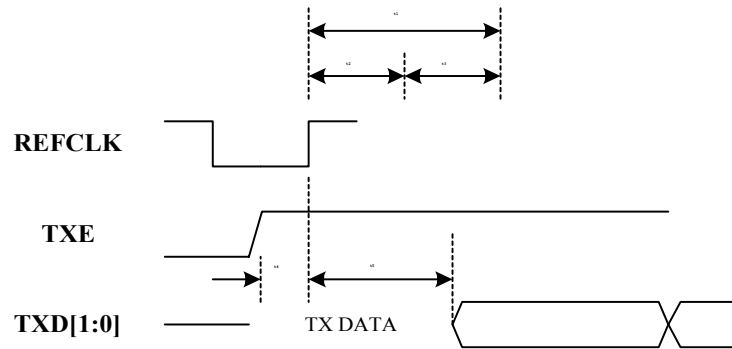
| Symbol | Description | Min. | Typical | Max. | Units |
|----------------------|-------------------------|------|---------|------|-------|
| $f_{clock} (SYSCLK)$ | SYSCLK clock frequency | 40 | 50 | 66 | MHZ |
| t_1 | SYSCLK clock period | 15 | 20 | 25 | ns |
| t_2 | RST# low pulse duration | 1000 | - | - | ns |



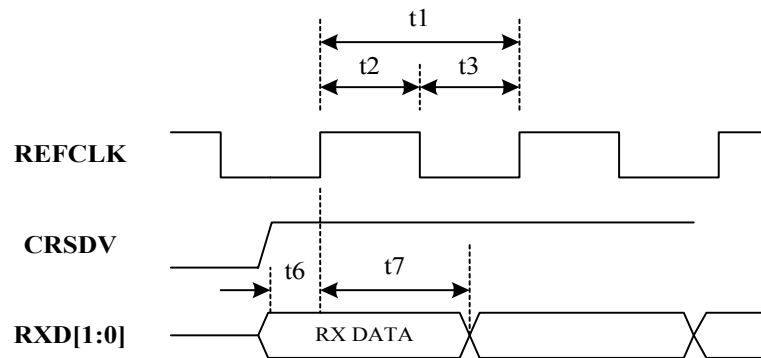
Reset and Clock Timing

8.3.2 RMII Timing

| Symbol | Description | Min. | Typical | Max. | Units |
|--------|--|------|---------|------|-------|
| t1 | REFCLK clock period | - | 20 | - | ns |
| t2 | REFCLK high level width | - | 10 | - | ns |
| t3 | REFCLK low level width | - | 10 | - | ns |
| t4 | TXE, TXD to REFCLK rising setup time | 4 | - | - | ns |
| t5 | TXE, TXD to REFCLK rising hold time | 2 | - | - | ns |
| t6 | CRSDV, RXD to REFCLK rising setup time | 4 | - | - | ns |
| t7 | CRSDV, RXD to REFCLK rising hold time | 2 | - | - | ns |



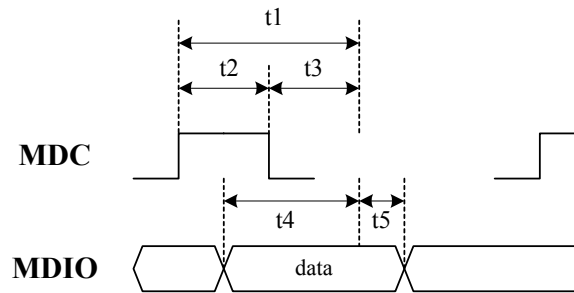
RMII Transmit Timing



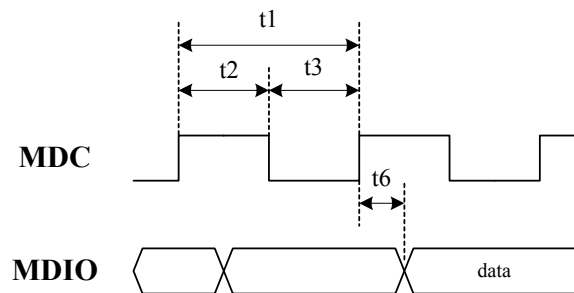
RMII Receive Timing

8.3.3 PHY Management Timing

| Symbol | Description | Min. | Typical | Max. | Units |
|--------|--|------|---------------|------|-------|
| t1 | MDC clock period | - | SYSCK * 32 | - | ns |
| t2 | MDC high level width | - | SYSCK * 16 | - | ns |
| t3 | MDC low level width | - | SYSCK * 16 | - | ns |
| t4 | MDIO to MDC rising setup time (Write Bits) | 10 | - | - | ns |
| t5 | MDIO to MDC rising hold time (Write Bits) | 10 | - | - | ns |
| t6 | MDC to MDIO delay (Read Bits) | - | - | 20 | ns |
| t7 | MDC/MDIO actives from RST# deasserted | - | 94.377 | - | ms |



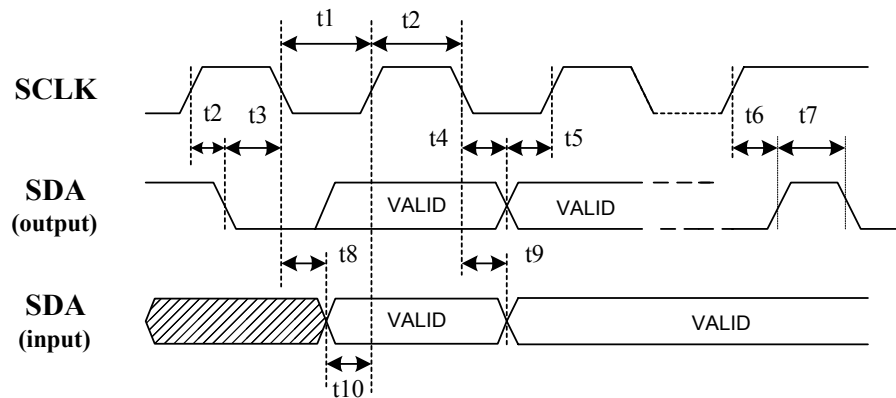
MDIO Write Timing



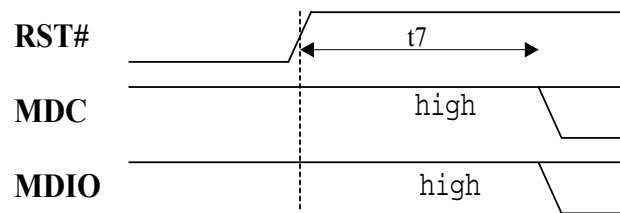
MDIO Read Timing

8.3.4 Serial EEPROM 24LC02 Timing

| Symbol | Description | Min. | Typical | Max. | Units |
|----------------------------|--|------|---------|------|-------|
| f_{clock} (EESCK) | Clock frequency, SCLK | - | - | 66 | kHZ |
| t1 | Clock pulse period | 23 | - | - | us |
| t2 | Delay time, from SCLK rising to SDA falling | 5 | - | - | us |
| t3 | Delay time, from SDA falling to SCLK falling | 5 | - | - | us |
| t4 | Delay time, from SCLK falling to SDA changing | 0 | - | - | us |
| t5 | Delay time, from SDA valid output to SCLK rising | 0 | - | - | us |
| t6 | Stop Set-up time | 5 | - | - | us |
| t7 | Time the bus must be free before a new transmission starts | 5 | - | - | us |
| t8 | Delay time, from SCLK falling to SDA valid | 0 | - | - | us |
| t9 | Delay time, from SCLK falling to SDA changing | 0 | - | - | us |
| t10 | Delay time, from SDA valid input to SCLK rising | 10 | - | - | us |

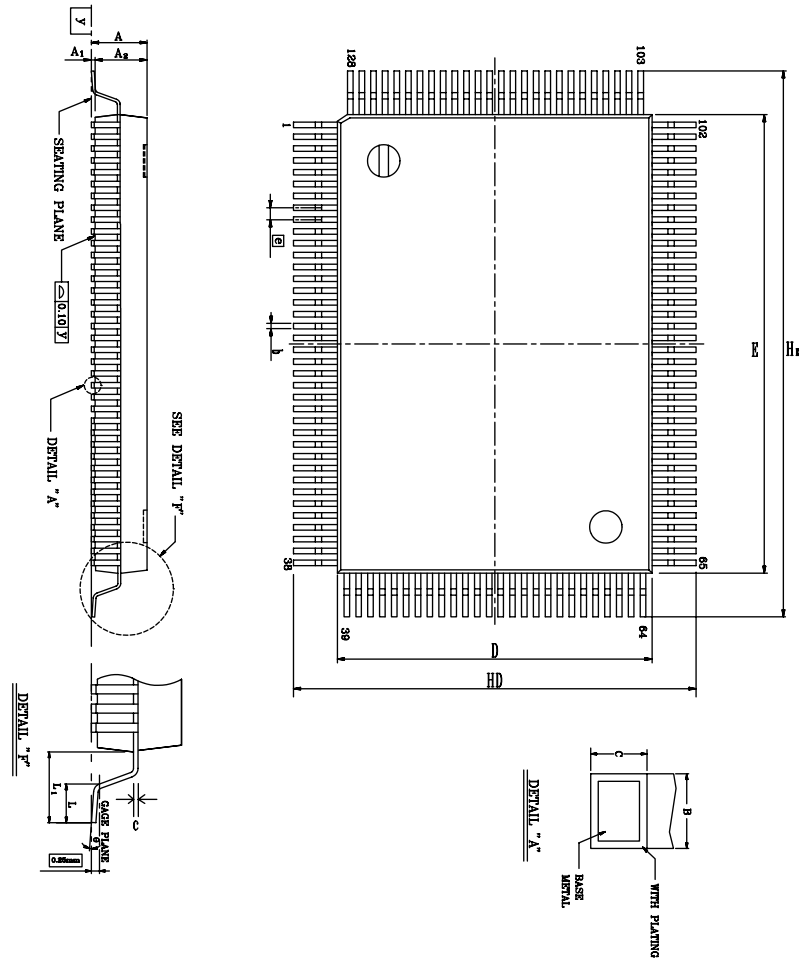


EEPROM Interface Timing



MDC/MDIO Reset Timing

9. Mechanical Information



| Symbol | Dimension in inch | | | Dimension in mm | | |
|-----------|-------------------|---------|-------|-----------------|---------|-------|
| | Min | Typical | Max | Min | Typical | Max |
| A | - | | 0.134 | - | - | 3.40 |
| A1 | 0.004 | 0.010 | 0.036 | 0.10 | 0.25 | 0.91 |
| A2 | 0.102 | 0.112 | 0.122 | 2.60 | 2.85 | 3.10 |
| b | 0.005 | 0.009 | 0.013 | 0.12 | 0.22 | 0.32 |
| c | 0.002 | 0.006 | 0.010 | 0.05 | 0.15 | 0.25 |
| D | 0.541 | 0.551 | 0.561 | 13.75 | 14.00 | 14.25 |
| E | 0.778 | 0.787 | 0.797 | 19.75 | 20.00 | 20.25 |
| e | 0.010 | 0.020 | 0.030 | 0.25 | 0.5 | 0.75 |
| HD | 0.665 | 0.677 | 0.689 | 16.90 | 17.20 | 17.50 |
| HE | 0.902 | 0.913 | 0.925 | 22.90 | 23.20 | 23.50 |
| L | 0.027 | 0.035 | 0.043 | 0.68 | 0.88 | 1.08 |
| L1 | 0.053 | 0.063 | 0.073 | 1.35 | 1.60 | 1.85 |
| y | - | - | 0.004 | - | - | 0.10 |
| θ | 0° | - | 12° | 0° | - | 12° |

1. Dimensions D & E do not include interlead flash.
2. Dimension b does not include dambar protrusion/intrusion.
3. Controlling dimension: Millimeter
4. General appearance spec. should be based on final visual inspection spec.

| TITLE: 128 QFP (14x20 mm) PACKAGE OUTLINE -CU L/F, FOOTPRINT 3.2 mm | | | |
|--|----------|--------------|--|
| LEADFRAME MATERIAL: | | | |
| APPROVAL | DOC. NO. | 530-ASS-P004 | |
| | VERSION | 1 | |
| | PAGE | OF | |
| CHECK | DWG NO. | Q128 - 1 | |
| | DATE | Oct. 08 1998 | |
| REALTEK SEMICONDUCTOR, INC. | | | |

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