RTL8308

8-Port 10/100 Ethernet Switch Controller with Embedded Memory

The RTL8308 chip is a **128-pin low cost and ultra low power consumption** 8-port 10/100M Ethernet switch controller integrated both with a **2M bits embedded DRAM** as packet buffer and a 8K entries of address table. The RTL8308 supports reduced MII (RMII) interface. **Only single 50MHz oscillator is needed** in a switch system to save your Bill Of Material. In addition, the RTL8308 provides a LED display specially to indicate a network loop existence.

1. Features

- Supports eight 10/100Mbps Ethernet ports with RMII interface
- Provides non-blocking and non-head-of-line-blocking forwarding
- **50MHz 2M bits DRAM is built in** as packet storage buffer. Page based buffer management to efficiently utilize the internal packet buffer
- **Ultra low power consumption with less than 180mA** at 3.3V operating voltage
- **Embedded 8K entries of look-up table** and 128 entries of CAM
- Supports address hashing or direct mapping for look-up table. 128-entry CAM is used to eliminate the hash collision problem
- Supports full and half duplex operations
- Link, speed and duplex status are auto-detected via MDIO
- 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 a LED display especially to indicate a network loop existence
- Broadcast storm control
- **Reversible PHYAD order** for diverse PHY
- 3.3V 24LC02 interface
- 128-pin PQFP, 0.35 um, 3.3V CMOS technology

2. General Description

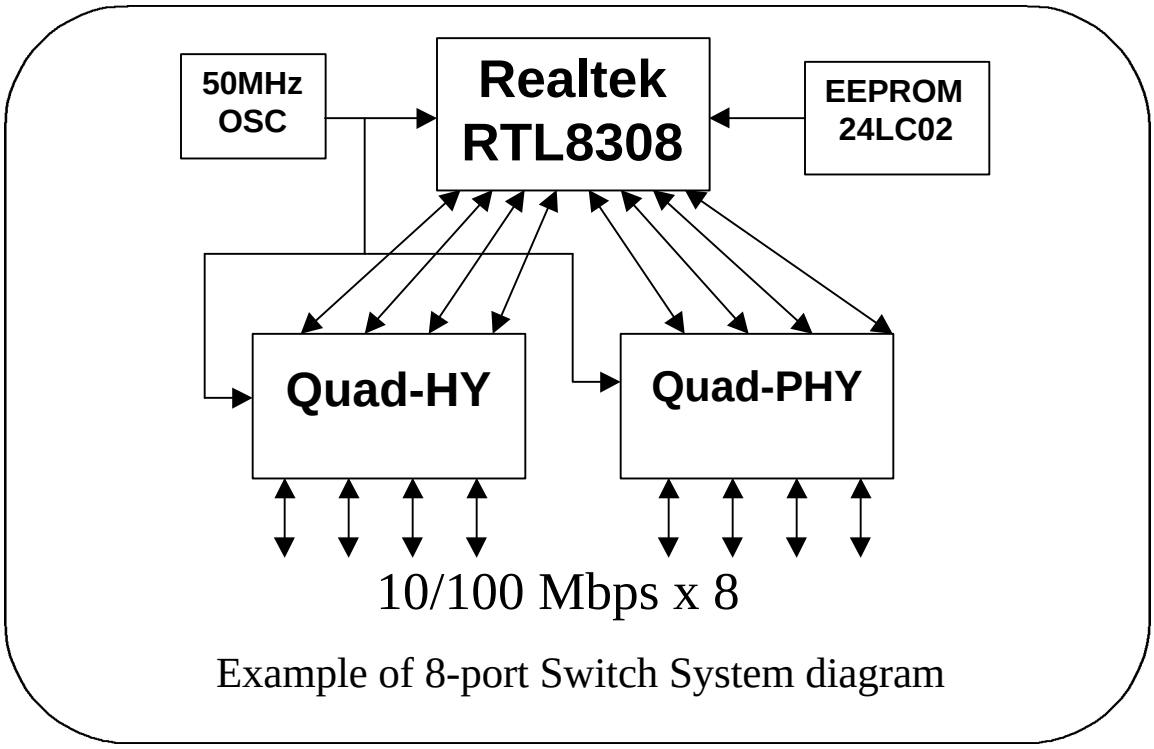
The RTL8308 provides eight 10/100 Mbps RMII Ethernet ports. Each port can operate in 10 Mbps or 100 Mbps data rate, and in full or half duplex mode. Speed, duplex, link status and flow control can be acquired by periodically polling the status of the PHY devices via MDIO.

Address look-up table consists of 8K entries of hash table and a 128 entries of CAM. The RTL8308 uses address hashing algorithm or direct mapping method to search destination MAC address and record source MAC address from and to the hash table.

The RTL8308 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 RTL8308 provides loop detect LED for visual diagnostic when detecting the network loop. And the Broadcast storm filtering function is provided for unusual broadcast storm.

The RTL8308 supports non-blocking 148800 packets/second wire speed forwarding rate and special design to resolve the head-of-line-blocking problem. The RTL8308 uses 2-wire 24LC02 interface to access external serial EEPROM and only one 50MHz OSC is needed.



Example of 8-port Switch System diagram

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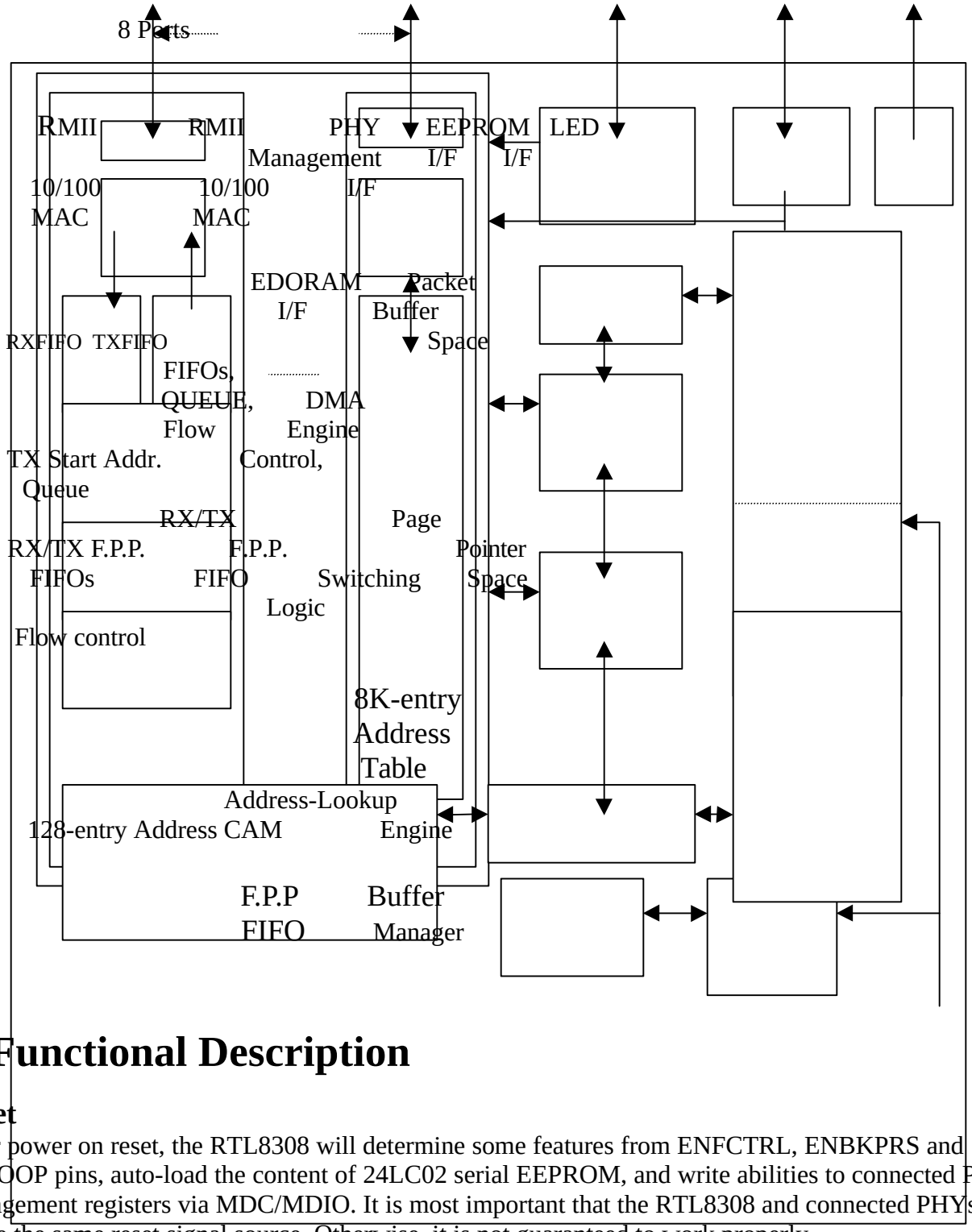
3. Block Diagram



4. Functional Description

Reset

After power on reset, the RTL8308 will determine some features from ENFCTRL, ENBKPRS and ENLOOP pins, auto-load the content of 24LC02 serial EEPROM, and write abilities to connected PHY management registers via MDC/MDIO. It is most important that the RTL8308 and connected PHYs have to use the same reset signal source. Otherwise, it is not guaranteed to work properly.

RMII interface

The RTL8308 provides 10/100 Mbps low pin count RMII interface for use between PHY and RTL8308. 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 receive and transmit. 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 RTL8308 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.

RMII Specification Signals are as 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 Date
TXEN	Input	Output	Transmit Enable
TXD[1:0]	Input	Output	Transmit Data

Serial Management Interface MDC/MDIO

The RTL8308 supports PHY management through the serial MDIO and MDC signal lines. After power on reset, the RTL8308 write abilities to the advertisement register 4 of connected PHY and restart the auto-negotiation process through MDIO using PHY address increasingly from 01000b to 01111b. After restarting auto-negotiation, the RTL8308 will continuously poll the link status and link partner's ability which including speed, duplex and flow control of the PHY devices via MDIO. The following is the management frame format

	Management frame fields							
	PRE	ST	OP	PHYAD	REGAD	TA	DATA	IDLE
READ	1…1	01	10	AAAAA	RRRRR	Z0	DDDDDDDDDDDDDDDD	Z
WRITE	1…1	01	01	AAAAA	RRRRR	10	DDDDDDDDDDDDDDDD	Z

Reversible PHYAD Order

The RTL8308 provides the reversible PHYAD order feature to connect diverse external PHY devices. The addresses of port [A] till [H] are corresponding to PHYAD 01000b till 01111b or to PHYAD 01111b till 01000b depending on the value of PHYAD_RV in EEPROM.

Address Search and Learning

Address look-up table consists of 8K entries of hash table and 128 entries of CAM. The RTL8308 uses address hashing algorithm or direct mapping method to search destination MAC address and record source MAC address from and to the table. If hashed or mapped location is not empty, the RTL8308 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 172~258 seconds. The

address hashing or direct mapping algorithm can be selected via 24LC02.

Address Hashing Mode

When a packet is receiving, firstly the RTL8308 hashes the ***destination*** MAC address to get a location index to the 8K-entry hash table and at the same time compares the destination MAC address with the contents of the 128-entry CAM. If the hash indexed location is valid or the CAM comparison is match, this receiving packet will be forwarded to the corresponding destination port. Otherwise, the RTL8308 broadcasts the packet. Next the RTL8308 hashes the ***source*** MAC address to get a location index to the hash table, if the hash indexed location has been occupied, i.e., hash collision occurs, the new source MAC address will be relocated into the 128-entry CAM accordingly. Using this eliminates the hash collision problem.

Address Direct Mapping Mode

In this mode, the RTL8308 uses the last 13 bits of MAC address to index to the 8K-entry look-up table.

Illegal Frame

The illegal frame such as CRC packet, runt packet(less than 64 bytes) and oversize packet(greater than 1724) will be discarded.

Back off Algorithm

The RTL8308 implements the truncated exponential back off algorithm compliant to 802.3 standard. The collision counter will be restarted after 16 consecutive collision.

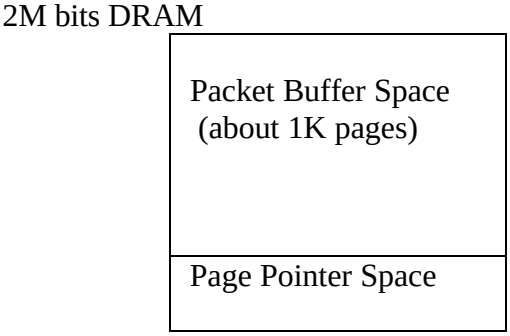
Inter-Frame Gap

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

Buffer Management

2M (32K x 64) bits, or 256K bytes DRAM operating in 50MHz clock is built-in as packet storage buffer. To efficiently utilize the packet buffer, the RTL8308 divides the 2Mbits(256Kbytes) DRAM into 1K pages of storage spaces, i.e., per page contains 256 bytes. For Ethernet packets, the maximum of seven pages are used and the minimum is one.

The embedded DRAM is divided into two parts. One is Packet Buffer Space for storing received packet data and the other is Page Pointer Space managed by buffer manager. The Packet Buffer Space consists of about 1k storage units in page. Each page is comprised of an 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.



Buffer Manager

The Buffer Manager of the RTL8308 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 *Descriptor Read* command to get some available free page pointers from Page Pointer Space. When the content of the FIFO is almost empty due to continuous data receptions, the Descriptor Read command will be reinitiated to get more available free page pointers. In the other hand, when the FIFO contents is almost full due to continuous successfully data transmissions, the RTL8308 initiates the *Descriptor Write* command to write the additional available free page pointers back to Page Pointers Space.

Data Reception

Each port contains a Receive Data FIFO and a Receive Free Page Pointer FIFO. Initially the Free Page Pointer FIFO is filled up with free page pointers getting from Buffer Manager. Once a packet is coming, the receive data flows into Receive Data FIFO first and then is moved into Packet Buffer by Receive DMA Engine using the free page pointers in Receive Free Page Pointer FIFO via *Get Free Page* command. The RTL8308 always attempts to fill the Free Page Pointer FIFO up with free page pointers.

Data Forwarding

Each port also contains a Transmit Data FIFO, a Transmit Free Page Pointer FIFO and a Transmit Start Address Queue. Once a forwarding condition is met, for cut through mode 512 bytes data are received OK or for store-and-forward mode a packet is received completely, the receiving port will pass the beginning page pointer using Send TX Descriptor command to transmit port and start the Transmit DMA. The transmission port stores the beginning page pointer in Transmit Head Point Queue. The Transmit DMA moves data from Packet Buffer through Transmit Data FIFO and to RMII interface using the free page pointer in the Transmit Free Page Pointer FIFO. Once the packet has been forwarded successfully, the RTL8308 uses Put Free Page command to put related free page pointers back to buffer manager's Free Page Pointer FIFO.

Flow Control

The RTL8308 supports IEEE 802.3x full duplex flow control and half duplex back pressure congestion control. The IEEE 802.3x flow control's ability is auto-negotiated between remote device and the RTL8308 by writing the flow control ability via MDIO to external connected PHY. The RTL8308 adopts a special back pressure design, forwarding one packet successfully after 28 force collisions, to avoid the connected repeater being partitioned. The full duplex flow control ability can be enable or disable via ENFCTRL pin. And the half duplex back pressure function can be enabled or disabled via the ENBKPRS pin.

Cut Through

The RTL8308 can operate in cut-through or store-and-forward mode. When in cut through mode (by pulled high the ENCUTHR pin), if receiving packet length is greater than 512 bytes, the RTL8308 starts to forward it after 512 bytes are received. If less than 512 bytes, the RTL8308 operates as same as store-and-forward mode.

Broadcast Storm Control

The RTL8308 can enable broadcast storm control by setting ENBRDCTRL in EEPROM. Each port will drop broadcast packet (DID is ff ff ff ff ff ff) after receiving continuous 64 broadcast packets. The counter will be reset as 0 every 800ms or when receiving any non-broadcast packet(DID is not ff ff ff ff ff ff) .

Loop Detection

When loop detection function is enabled, the RTL8308 will transmit a loop-detected frame out when link is established and then sends the loop-detected frame when 172 seconds time tick is arrived to detect whether if there is a network loop (or bridge loop) existence. The loop LED asserted low to indicate there is a loop exits. The LED goes out by unplugging all of RTL8308's looped ports.

The Loop-detected frame is a 64 bytes broadcast packet and its format is below.

FFFFFF	SID	0040	0000000…0000	CRC

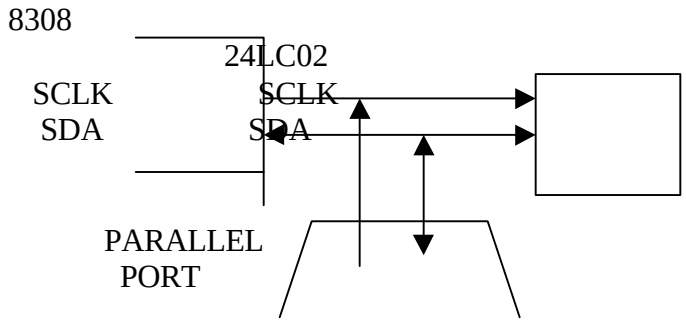
In order to achieve the loop detection. Each switch device needs different SID for detection. So that, the different EtherID is needed for each device when programming the EEPROM if the loop detection function is enabled.

Head-Of-Line Blocking

The RTL8308 incorporate a simple mechanism to prevent Head-Of -Line blocking problem when flow control is disabled. When flow control function is disabled, the RTL8308 will first check the destination address of incoming packet. If the destined port is congested, then the RTL8308 will discard this packet to avoid the blocking of next packet which is going to loose traffic port.

24LC02 Interface

The 24LC02 interface is a 2-wire serial EEPROM interface providing 2K bits storage space. After power on reset, the RTL8308 uses Random Read and Sequential Read commands to auto-load configuration settings, switch Ethernet ID and so on. After auto-loaded, the 24LC02 interface pins SCL and SDA are tri-stated for on-line updating 24LC02 contents through a parallel port.



24LC02 Device Operation

Clock and Data transitions: The SDA pin is normally pulled high with an external register. 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.

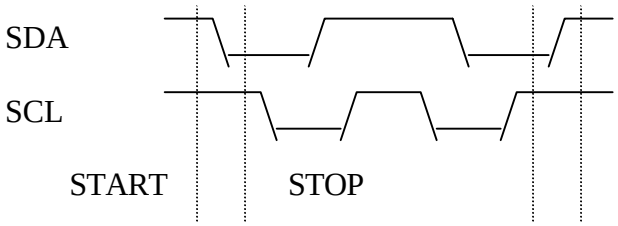
Stop condition: A low-to-high transition of SDA with SCL high is a stop condition.

Acknowledge: All addresses and data words are serially transmitted 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.

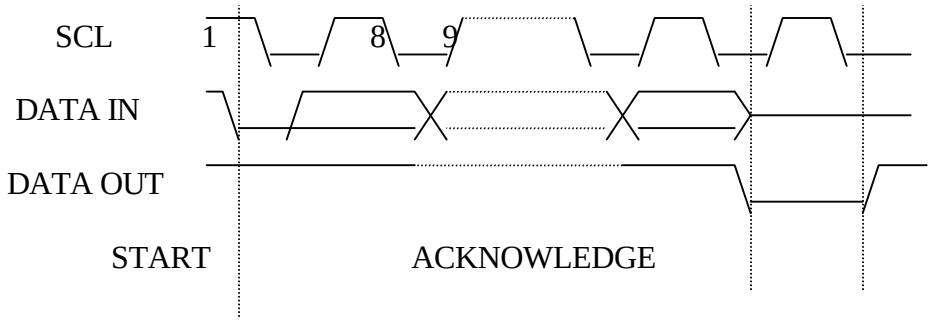
Random Read: A random read requires a "dummy" byte write sequence to load in the data word address.

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

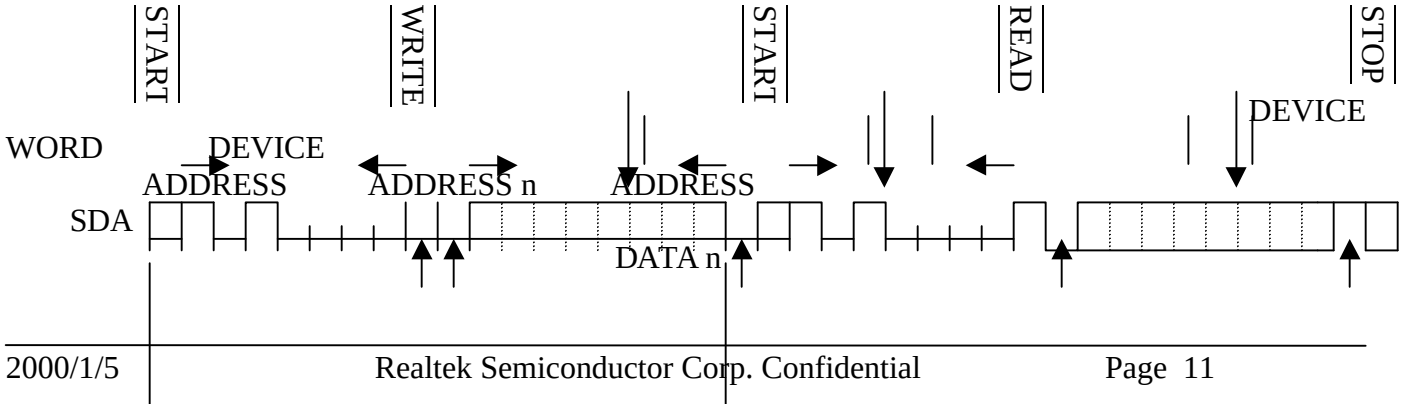
**Start and Stop Definition*



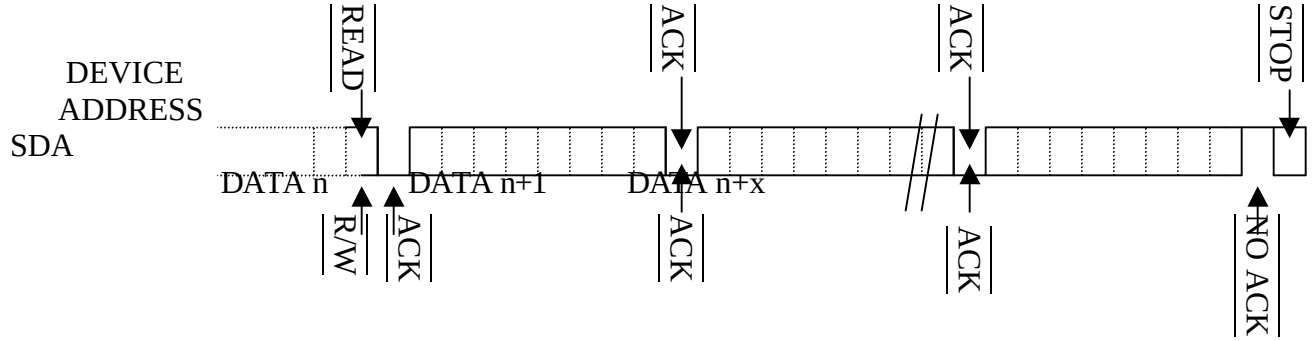
**Output Acknowledge*



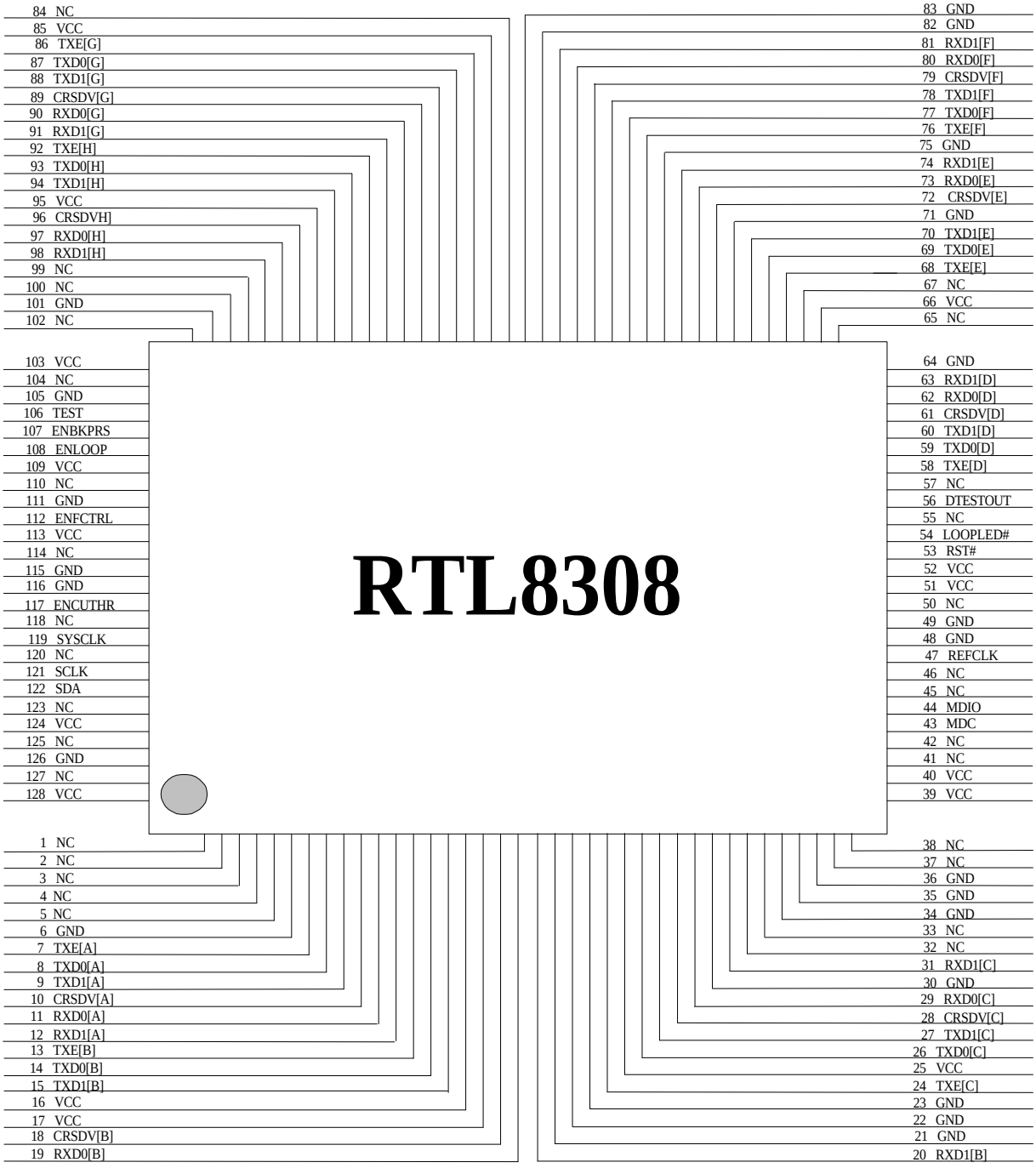
**Random Read*



**Sequential Read*



5. Pin Assignment



6. Pin Descriptions

RMII Interface			
Symbol	*Type*	*Pin No*	*Description*
TXE[A:H]	O	7,13,24,58, 68,76,86,92	Transmit Enable. The RTL8308 asserts high to indicate that valid data for transmission is presented on the TXD[1:0]
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].
CRSDV[A:H]	I	10,18,28,61, 72,79,89,96	CRSDV signals. CRSDV from PHY device is asserted high when media is non-idle.
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 RTL8308 captures the receive data on the rising edge of REFCLK when CRSDV is high.
REFCLK	I	47	Reference Clock input. A 50 MHz signal is used for RMII clock reference.
MDC	O	43	Management Data Clock
MDIO	I/O	44	Management Data Input/Output
Serial EEPROM 24LC02 Interface			
Symbol	*Type*	*Pin No*	*Description*
SCLK	O	121	Serial Clock: Internally pulled high
SDA	I/O	122	Serial Data Input/Output: Internally pulled high
System Pins			
Symbol	*Type*	*Pin No*	*Description*
RST#	I	53	Reset: Active low to a known reset state. After power-on reset (low to high), the configuration modes from Mode Pins are determined, the content of serial EEPROM is auto-loaded into and the RTL8308 begins to access the management data of PHY devices.
SYSCLK	I	119	System clock input 50 MHz system clock is used.
Mode Pins (Reset-read)			
Symbol	*Type*	*Pin No*	*Description*
ENLOOP	I	108	Enable loop detection: When pulled high upon reset, the auto loop detection is enabled. When pulled low upon reset, it is disabled.
ENCUTHR	I	117	Enable Cut-through: Pulled high upon reset will select the Cut-through mode. Pulled low upon reset selects the store-and-forward mode.
ENBKPRS	I	107	Enable Half duplex back pressure function Pulled high upon reset will enable the back pressure function. Pulled low upon reset will disable the back pressure function.

ENFCTRL	I	112	Enable Full Duplex Flow Control: Pulled high upon reset will enable the full duplex IEEE802.3x flow control function. The flow control ability will be write to the management register 4 of PHY device one and only one time after power-on reset, for advertising. Pulled low upon reset will disable the flow control function.
LED Pin			
Symbol	*Type*	*Pin No*	*Description*
LOOPLED#	O	54	Loop Detected LED: Low active Asserted low indicates that a network loop is detected.
DTESTOUT	O	56	DRAM Test Output : for internal test.
Test Pin			
Symbol	*Type*	*Pin No*	*Description*
TEST	I	106	Test pin : for internal use. Must be tied to ground for normal use.
Power Ground Pin			
GND		6,21,22,23,30,34, 35,36,48,49,64,71, 75,82,83,101,105, 111,115,116,126	
VCC		16,17,25,39,40,51, 52,66,85,95,103, 109,113,124,128	

7. Serial EEPROM 24LC02 Format

Below is the content of serial EEPROM 24LC02. The content includes configuration, Switch Ethernet ID, CRCs for flow control and loop detection.

Bit / Byte	7	6	5	4	3	2	1	0
0	BRDCTRL	0	0	0	AcceptErr	0	0	0
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.

BRDCTRL: When 0, the broadcast storm control function is disabled.
When 1, the broadcast storm control 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.

8. Electrical Characteristics

8.1 Temperature Limit Ratings:

Parameter	Minimum	Maximum	Units

Storage temperature	-55	+125	
Operating temperature	0	70	

8.2 DC Characteristics

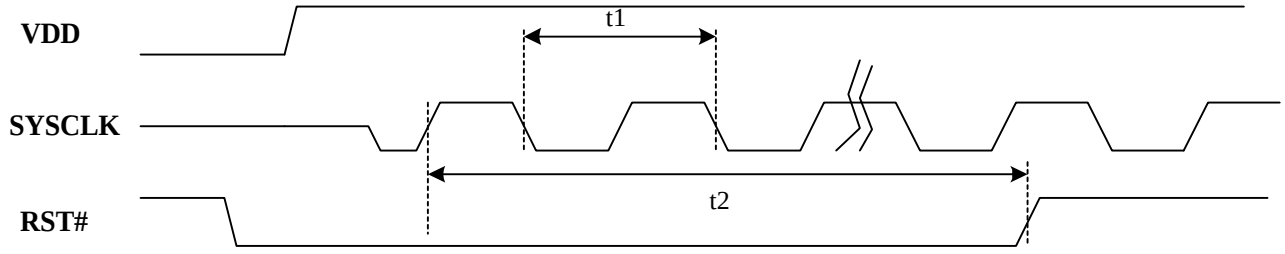
Supply voltage Vcc = 3.3V ± 5%

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
V_{OH}	Minimum High Level Output Voltage	I_{OH}= -8mA	0.9 * Vcc		Vcc	V
V_{OL}	Maximum Low Level Output Voltage	I_{OL}= 8mA			0.1 * Vcc	V
V_{IH}	Minimum High Level Input Voltage		0.5 * Vcc		Vcc+0.5	V
V_{IL}	Maximum Low Level Input Voltage		-0.5		0.3 * Vcc	V
I_{IN}	Input Current	V_{IN}=V_{CC} or GND	-1.0		1.0	A
I_{OZ}	Tri-State Output Leakage Current	V_{OUT}=V_{CC} or GND	-10		10	A
I_{CC}	Average Operating Supply Current	I_{OUT}=0mA,		**160**	**180**	mA

8.3 AC Characteristics

8.3.1 Reset and Clock Timing

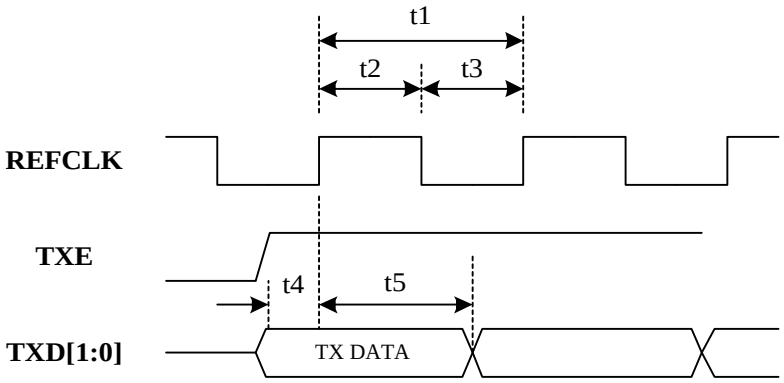
Symbol	Description	Minimum	Typical	Maximum	Units
$f_{clock\ (SYSCK)}$	SYSCLK clock frequency	40	50	66	MHZ
t1	SYSCLK clock period	15	20	25	ns
t2	RST# low pulse duration	1000	-	-	ns



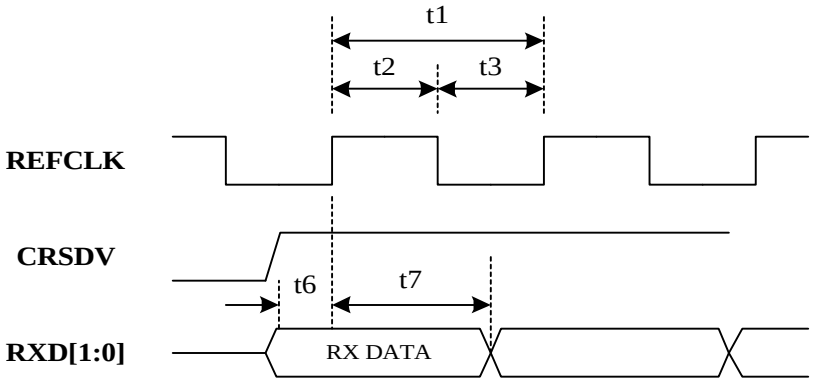
Reset and Clock Timing

8.3.2 RMII Timing

Symbol	Description	Minimum	Typical	Maximum	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	CSRDV ,RXD to REFCLK rising setup time	4	-	-	ns
t7	CRSDV ,RXD to REFCLK rising hold time	2	-	-	ns



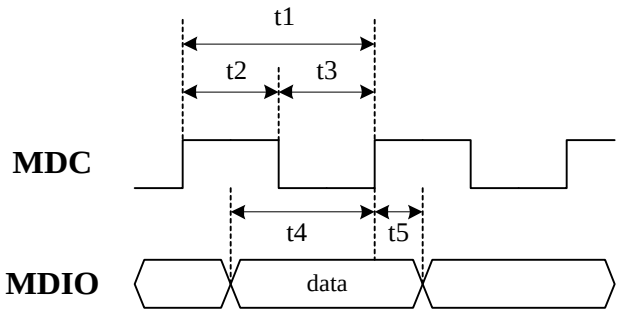
RMII Transmit Timing



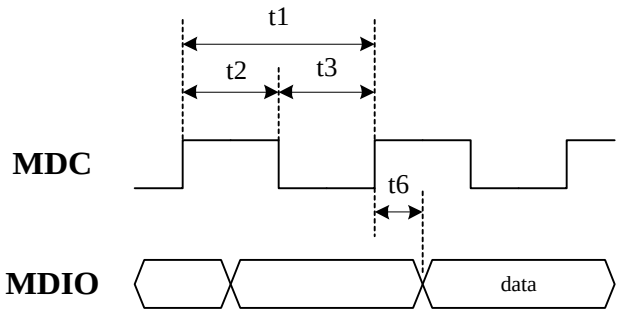
RMII Receive Timing

8.3.3 PHY Management Timing

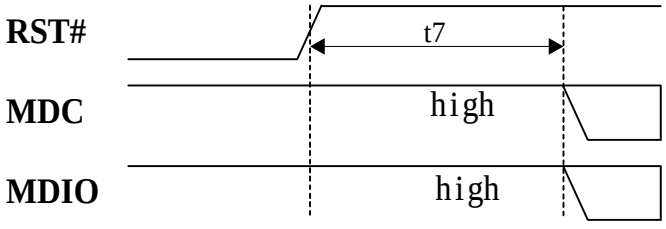
Symbol	Description	Minimum	Typical	Maximum	Units
t1	MDC clock period	-	SYSCK * 32	-	ns
t2	MDC high level width	-	SYSCK * 16	-	ns
t3	MDC low level width	-	SYSCK * 16	-	ns
t4	MDIO to MDC rising setup time (Write Bits)	10	-	-	ns
t5	MDIO to MDC rising hold time (Write Bits)	10	-	-	ns
t6	MDC to MDIO delay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



MDIO Write Timing



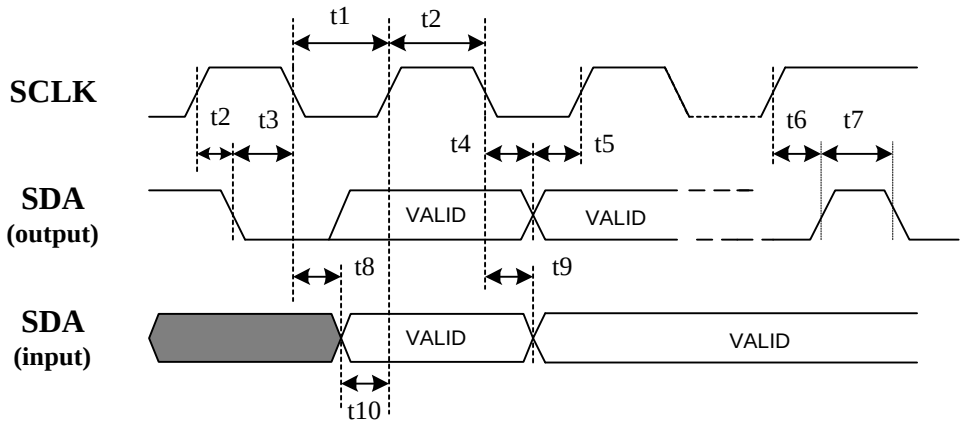
MDIO Read Timing



MDC/MDIO Reset Timing

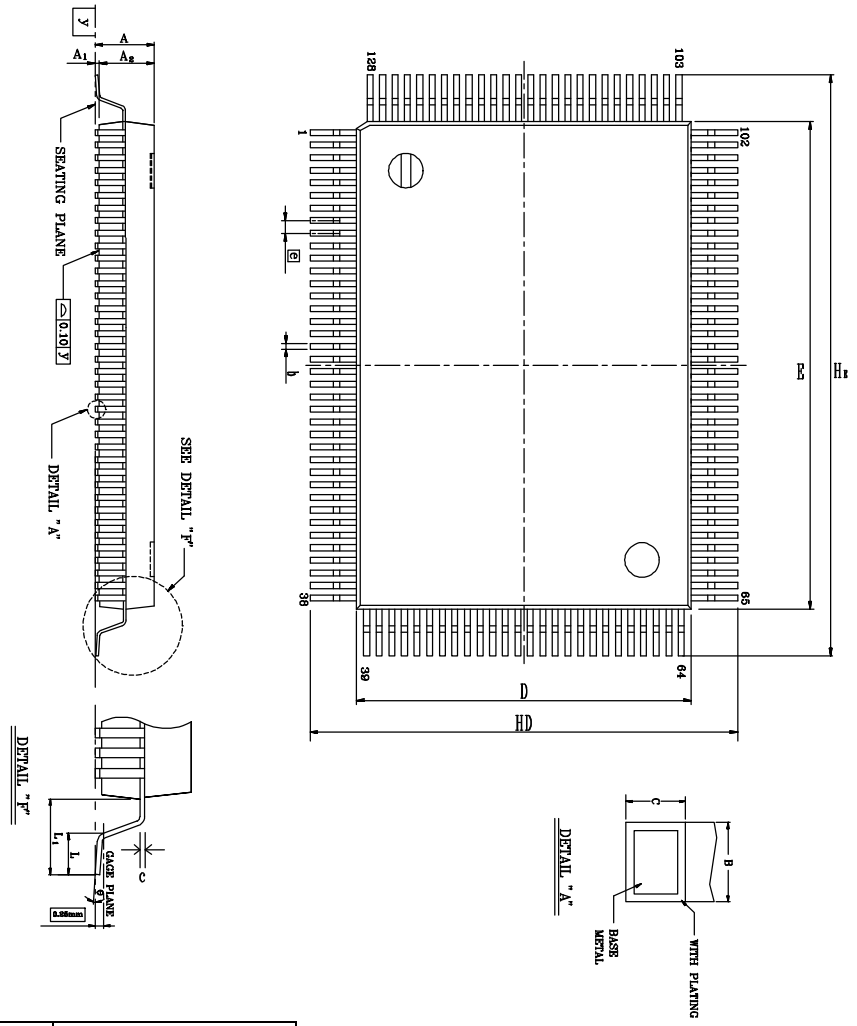
8.3.4 Serial EEPROM 24LC02 Timing

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



EEPROM Interface Timing

9. Mechanical Information



Symbol	Dimension in inch			Dimension in mm		
	Min	Type	Max	Min	Type	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
	0 °		12 °	0 °		12 °

1. Dimension D & E do not include interlead flash.
2. Dimension b does not include dambar rotrusion/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 :			
APPROVE		DOC. NO.	530-ASS-P004
		VERSION	1
		PAGE	OF
CHECK		DWG NO.	Q128 - 1
		DATE	Oct. 08 1998
REALTEK SEMI-CONDUCTOR CO., LTD			