8 Port 10/100 Ethernet Integrated Switch

(85nm /Extreme Low Power, PWMT® and AFT®)

Features

- 8 port Embedded 10/100 PHY Switch Controller
- Support 8 100BaseTX or 6 100Base TX + 2 FX
- 100M PHY support IEEE802.3az at full duplex
- 10M PHY only support 10BaseTe
- Support Auto MDI-MDIX function
- Power Management Tool (PWMT®)
  - APS, auto-power saving while Link-off
  - IEEE 802.3az protocol based power saving
  - WOL+®, light traffic power saving
  - PWD, force-off power saving
- Support Auto Factory Test (AFT®)
- Single Power 3.3V supply
- Built in 1.1V core voltage LDO Regulator
- Two Priority queues per port
- Support 802.1p & DiffServ based QoS
- QoS
  - Port base
  - 802.1p
  - IP DiffServ IPV4/IPV6
  - TCP/UDP port number
  - Pins configure ports priority (VIP port)
- Support max forwarding packet length 1552/1536 bytes option
- Embedded 448K bits packet buffer
- Support port mirror function
- Support 1k MAC address
- Support broadcast storm protection
- Support port trunking (Link Aggregation)
- Support 16 VLAN (IEEE Std 802.1q)
  - Port-based/Tagged-based VLAN
  - Support Port-based insert, remove tag
- Built-in 50 ohm resistors for simplifying BOM
- 85nm Process
- Package and operation temperature
  - IP178G: 68 Pin QFN, 0~70℃

General Description

IP178G is fabricated with advanced CMOS (85nm) technology and only requires a 3.3V single power supply. This feature makes IP178G used very low power consume, such as the full load operation (100Mbps full duplex 8 ports), it only takes 0.95W.

IP178G also supports Power Management Tool (PWMT®) for IEEE 802.3az, APS, WOL+ and PWD for Green Power. While two link devices have no IEEE 802.3az capability, IP178G use WOL+ to change link from 100Mbps to 10Mbps for saving power.

The PWD, force-off power saving of IP178G is designed for power down switch immediately by pushing a button, user don't plug out the power adapter. Push the button again, it will power on immediately.

Except Low Power and Rich Power Saving method, IP178G supports AFT® for saving Customer Testing Cost. By using a push button and cables, IP178G will Auto test completely by itself.

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Application

- 8 port 10/100 Dumb switch
- 6TX+2FX Dumb Switch or 7TX + 1FX Dumb Switch

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Revision History

Revision #	Date	Change Description
IP178G-DS-R01	2012/07/06	Initial release
IP178G-DS-R01.1	2012/10/01	Add 1.1V power pin description – page 19
IP178G-DS-R01.2	2012/11/27	Delete default VLAN Information TPID description – page 68
IP178G-DS-R01.3	2012/12/19	Remove IP178GA / IP178GI description

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Features comparison between IP178D and IP178G

Table 1 IP178D and IP178G/GA Features comparison table

Function	IP178D	IP178G
Process	0.16 um	85 nm
Package	PQFP 128	**IP178G :** QFN 68
Switch structure	8 port Embedded 10/100 PHY Switch Controller	
Port based priority	Yes	
802.1p priority	Yes	
Support Fiber function	2 ports with FXSD	2 ports with FXSD
VLAN	No	Port base / insert, remove tag Tag base
IP DiffServ Priority	Yes	
Port mirroring	Yes	
Pins configure for port-priority	Yes	
Reduce IPG function	Yes	
TCP/UDP port number priority	Yes	
Port trunking	No	Yes
Auto Factory Test (AFT®)	No	Yes
IEEE 802.3az	No	Yes
WOL+®	No	Yes
PWD (Force off power key)	No	Yes
IC Power consumption (Max)	1.9W	0.95W

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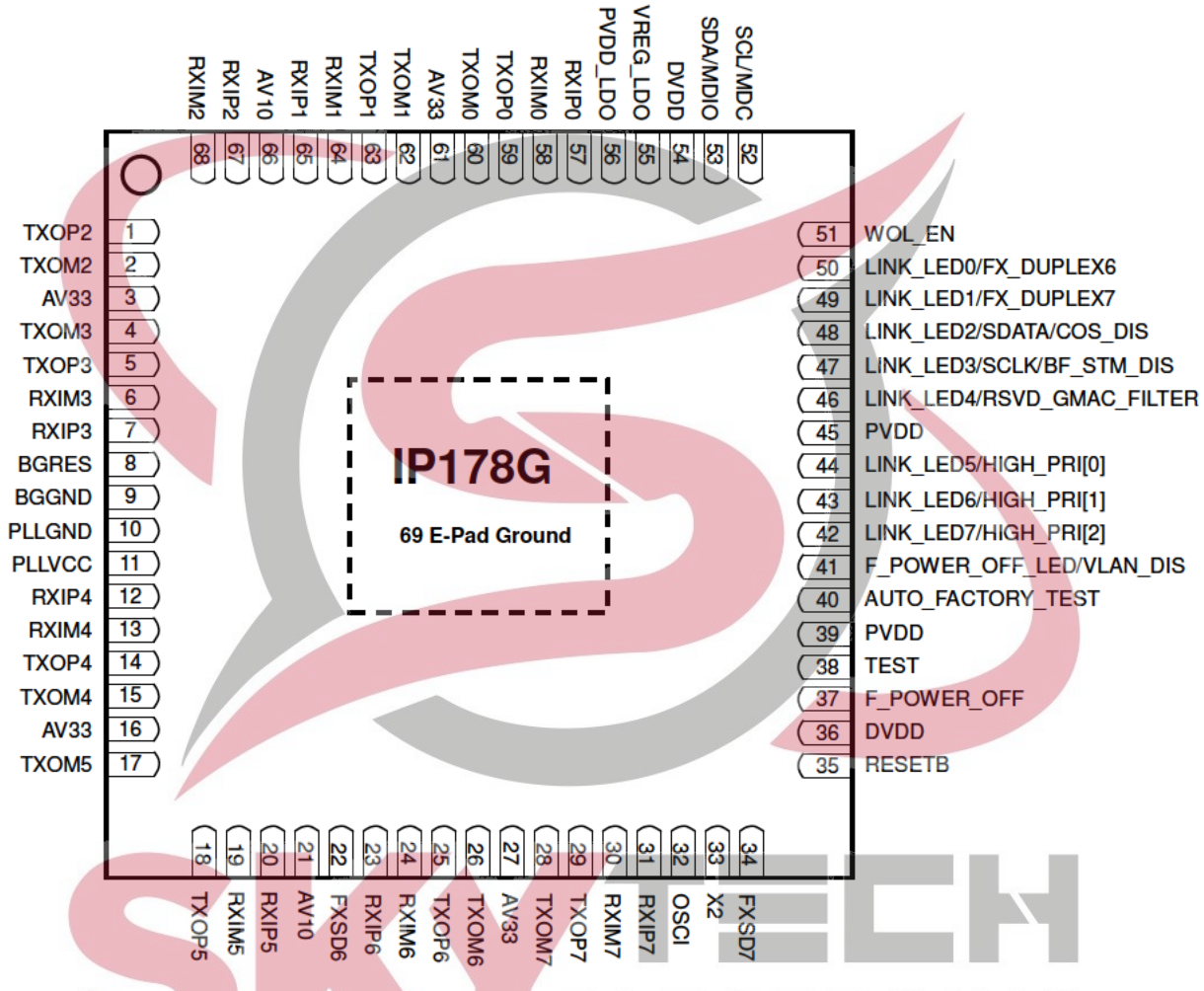
1 Pin diagram

1.1 IP178G Pin diagram (QFN68)

(8mm X 8mm Top view)



Exposed pad (pad 69) is system GND, must be soldered to PCB ground plane

Figure 1 Pin Diagram (IP178G)

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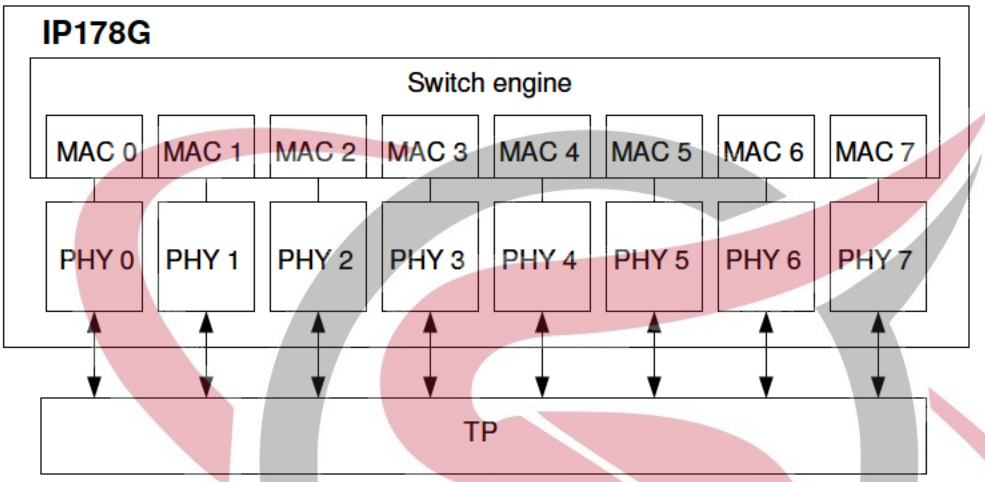
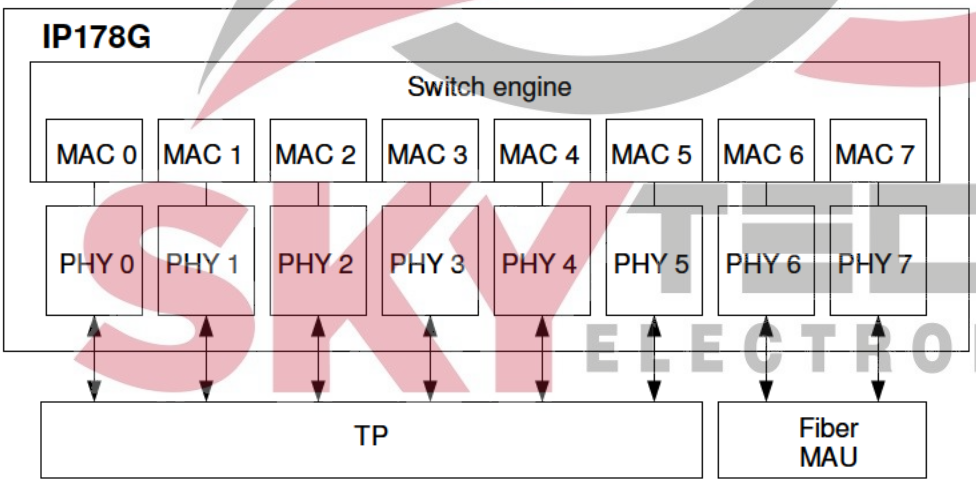
2 IP178G application diagram

2.1 An 8 TP port switch application

Here shows the application diagram of 8-port switch.



2.2 An 8-port switch mixed with two fiber ports



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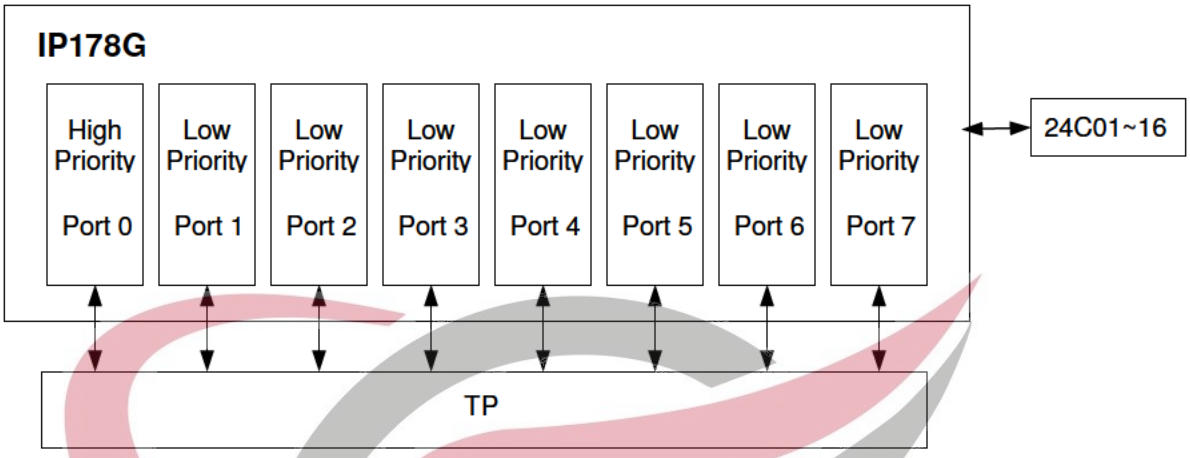
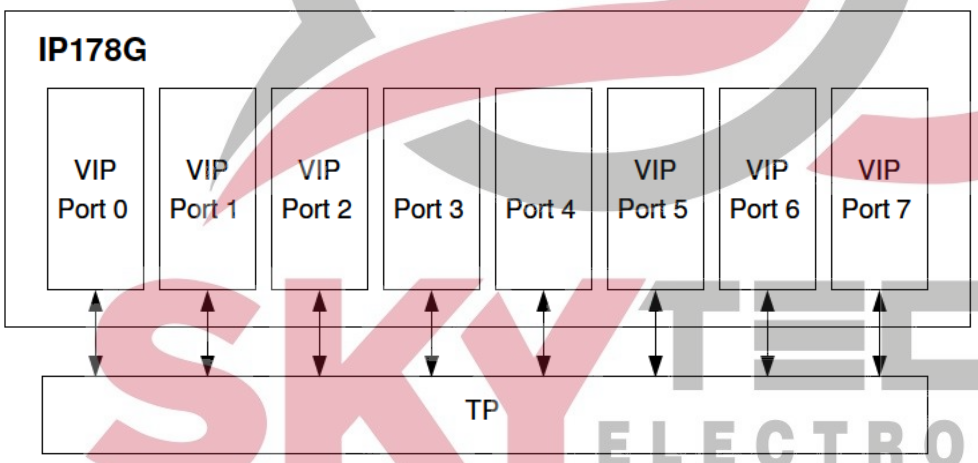
2.3 TCP/UDP QoS Switch for time-sensitive application from EEPROM setting



Port 0 received packet with reserved TCP/UDP port number, Port 0 will enable its ingress port as a high priority port for 300 seconds.

If the other ports received packets with the same reserved port number, it also has the same behavior as port 0.

2.4 Switch with VIP ports for specific users from Pin setting



VIP port setting as follow,

HIGH_PRI[2:0]

IP178G Pin 42,43,44 IP178GA Pin 89,90,91	high priority port number
001	6, 7
010	5, 6, 7
011	7
101	0, 1
110	0, 1, 2
000	0
111	disable (default)

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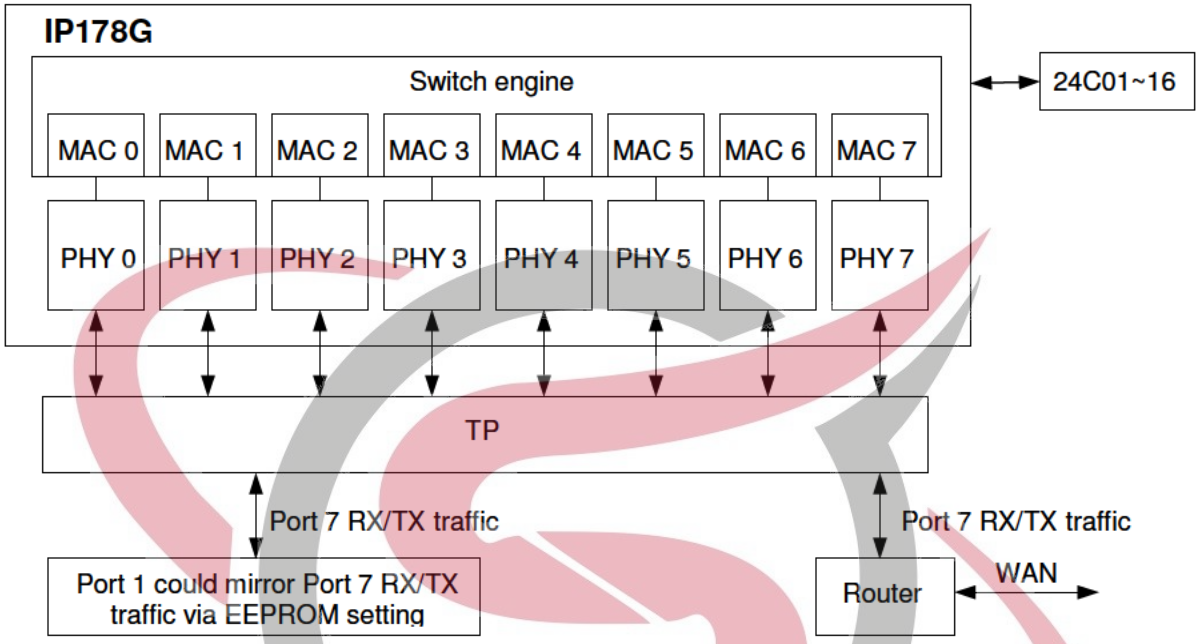
2.5 A 8-port Switch with Port mirror capability setting from EEPROM



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3 Pin description

Table 2 Pin description

Type	Description	Type	Description
I	Input pin	IPL	Input pin with internal pull low 100K ohm
O	Output pin	IPH	Input pin with internal pull high 200K ohm
P	Power or Ground		

3.1 Analog pins

Pin No.	Label	Type	Description
LDO Regulator			
55	VREG_LDO	P	LDO regulator output It is an output power pin for 1.1V power source.
56	PVDD_LDO	P	LDO regulator input It is an input power pin for reference voltage.

IP178G includes a LDO regulator to convert 3.3V to 1.1V.

3.2 MDI (Media Dependent Interface)

Pin No.	Label	Type	Description
Transceiver			
57, 58, 65, 64, 67, 68, 7, 6, 12, 13 20, 19 23, 24 31 30	RXIP0, RXIM0, RXIP1, RXIM1, RXIP2, RXIM2, RXIP3, RXIM3, RXIP4, RXIM4 RXIP5, RXIM5 RXIP6, RXIM6 RXIP7, RXIM7	I	TP receive
59, 60, 63, 62, 1, 2, 5, 4, 14, 15 18, 17 25, 26 29, 28	TXOP0, TXOM0, TXOP1, TXOM1, TXOP2, TXOM2, TXOP3, TXOM3, TXOP4, TXOM4 TXOP5, TXOM5, TXOP6, TXOM6, TXOP7, TXOM7,	O	TP transmit
22 34	FXSD6 FXSD7	I	Fiber signal detection of port 6,7 Port 6,7 can be configured to be either a TP port or a Fiber port with this pin. Connect this pin to GND for TP mode, and do not left this pin floating. Please refer to the paragraph “I/O Electrical Characteristics” for more detail information.
8	BGRES	O	Band gap resistor. It is connected GND through a precision resistor (R=6.19K, 1%) for band gap reference. Please refer to application circuit for more information.

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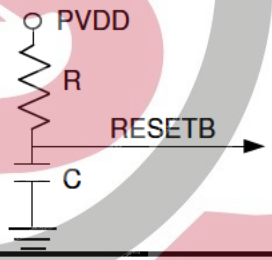
3.3 System clock & reset pins

Pin No.	Label	Type	Description
32	OSCI	I	25MHz system clock input It is recommended to connect OSCI and X2 to a 25MHz crystal. If the clock source is from another chip or oscillator, the clock should be active at least for 10ms before pin 35 RESETB de-asserted. Pin 33 X2 should be left open in this application.
33	X2	O	Crystal pin A 25Mhz crystal can be connected to OSCI and X2.
35	RESETB	IPH	Reset It is a low active input pad with Schmitt trigger. The reset time must be hold for more than 10 ms. If an R/C reset circuit is used; the capacitor should be connected to GND as shown in the figure. 

3.4 Boundry scan & test mode

Pin No.	Label	Type	Description
38	TEST	IPL	Test mode enable It should be connected to GND for normal operation
40	AUTO_FACTORY_TEST	IPH	Auto Factory Test (AFT®) enable pin

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3.5 EEPROM interface /SMI (Serial Management interface)

Pin No.	Label	Type	Description
EEPROM (only 24C01~16 supported)			
52	SCL/MDC	IPL/I	After reset, it is used as clock pin SCL of EEPROM. Its period is longer than 10us. IP178G stops reading EEPROM if it finds there is no 0x55AA pattern in address 0. After reading EEPROM, this pin will switch to SMI mode MDC input.
53	SDA/MDIO	IPH, I/O	After reset, it is used as data pin SDA of EEPROM. A bi-directional multi-drop bus for accessing the internal registers. It's recommended to add a 4.7K pull up resistor connecting to PVDD and a 30pf capacitor connecting to ground. After reading EEPROM, this pin will switch to SMI mode MDIO for read/write internal register.

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3.6 Frame priority setting pins

Pin No.	Label	Type	Description
44	HIGH_PRI[0]	IPH/O	Port based priority setting, bit 0 It is an input signal during reset and its value is latched at the end of reset. It acts as a link LED of port 5 after reset. VIP port setting as follow, HIGH_PRI [2:0] Pin 42, 43, 44 –IP178G high priority port number Pin 89, 90, 91 –IP178GA high priority port number 001 6, 7 010 5, 6, 7 011 7 101 0, 1 110 0, 1, 2 000 0 111 disable (default)
43	HIGH_PRI[1]	IPH/O	Port based priority setting, bit 1 For the port based priority setting, reference HIGH_PRI[0] setting as detail. It is an input signal during reset and its value is latched at the end of reset. This pin acts as a link LED of port 6 after reset.
42	HIGH_PRI[2]	IPH/O	Port based priority setting, bit 2 For the port based priority setting, reference HIGH_PRI[0] setting as detail. It is an input signal during reset and its value is latched at the end of reset. This pin acts as a link LED of port 7 after reset
48	COS_DIS	IPH/O	Class of service disable Packets with high priority tag are handled as high priority packets if the function is enabled. 1: COS disabled (default) 0: COS enable. It is an input signal during reset and its value is latched at the end of reset. It acts as a link LED of port 2 after reset.

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3.7 Miscellaneous setting pins

Pin No.	Label	Type	Description
Misc.			
37	F_POWER_OFF	IPH/I	Force Power Off function for power saving setting pin It should be connected to PVDD for normal operation; pull low 3 seconds to enable Force Power Off function.
41	VLAN_DIS	IPH/O	Home VLAN setting enable setting pin. Port 0~Port 6 are all individual VLAN and only send to port 7. 1: disable (default) 0: enable It is an input signal during reset and its value is latched at the end of reset. This pin acts as a F_POWER_OFF_LED after reset
46	RSVD_GMAC_FILTER	IPH/O	Reserved group address filtering It configures how to process the reserved group address, detail see 4.2.
47	BF_STM_DIS	IPH/O	Broadcast storm protection enable This function defined in MII register 20.1[6] 1: disable (default) 0: enable A port begins to drop incoming packets if it receives broadcast packets more than the threshold defined in MII register 20.9[15:14] It is an input signal during reset and its value is latched at the end of reset. This pin acts as a link LED of port 3 after reset
49	FX_DUPLEX6	IPH/O	Port 6 fiber port half duplex setting pin 1: port 6 is full duplex in fiber mode (default) 0: port 6 is half duplex in fiber mode
50	FX_DUPLEX7	IPH/O	Port 7 fiber port half duplex setting pin 1: port 7 is full duplex in fiber mode (default) 0: port 7 is half duplex in fiber mode
51	WOL_EN	IPL/O	Wake on LAN enable 1: enable 0: disable (default)

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3.8 LED interface

Pin No.	Label	Type	Description
LED			
50 49 48 47 46 44 43 42	LINK_LED0 LINK_LED1 LINK_LED2 LINK_LED3 LINK_LED4 LINK_LED5 LINK_LED6 LINK_LED7	IPH/O	LINK LED The detail functions are illustrated in 4.11~4.13. It should be connected to PVDD through a LED and resistor. Application circuit
41	F_POWER_OF F_LED		Force Power Off function LED When normal operation output low can used by power LED display.
Serial LED (Enable by MII page 3 register 16)			
48	SDATA	IPH/O	LED serial data
47	SCLK	PH/O	LED serial clock It is a 312.5KHz clock.

3.9 Power & ground pads

Pin No.	Label	Type	Description
9	BGGND	P	Ground of band gap circuit
10	PLLGND	P	Ground of PLL circuit
11	PLLVCC	P	Power of PLL circuit
36,54	DVDD	P	1.1V Core power These pins must be connect to pin 55/109 VREG_LDO via a resister or bead, do not connect to external power supply
21,66	AV10	P	1.1V Analog power These pins must be connect to pin 55/109 VREG_LDO via a resister or bead, do not connect to external power supply
3,16 27,61	AV33	P	3.3V Analog power
39,45,	PVDD	P	3.3V power
69	E-pad GND	P	Exposed pad for system ground, must be soldered to PCB ground plane

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4 Functional Description

4.1 Switch Engine and Queue Management

4.1.1 Switch Engine

IP178G integrates an 8-port switch controller, SSRAM, and 8 10/100 Ethernet transceivers. Each of the transceivers complies with the IEEE 802.3, IEEE 802.3u, and IEEE 802.3x specifications. IP178G offers all the rich features of a high-speed broadband wire Internet services including non-blocking switch fabric

4.1.2 Packet Forwarding

IP178G utilizes the "store & forward" method to handle packet transfer. IP178G begins to forward a packet to a destination port after the entire packet is received. A received packet will be forwarded to the destination port only if it is error free; otherwise, it will be discarded.

4.1.3 Flow control

IP178G jams or pauses a port, which causes output queue over the threshold. Its link partner will defer transmission after detecting the jam or pause frame. A port of IP178G defers transmission when it receives a jam or a pause frame. The source address (SA) of pause control frame will be [IP178G OUI (0090C3), port number]. For example, the SA of port 1 pause control frame will be " 00 90 C3 00 00 01".

When CoS is enabled, IP178G may disable the flow control function for a short term to guarantee the bandwidth of high priority packets. A port disables its flow control function for 2 ~ 3 seconds when it receives a high priority packet. It doesn't transmit pause frame or jam pattern during the period but it still responses to pause frame or jam pattern.

The flow control function can be enabled by programming registers 0.4[11:10] ~ 7.4[11:10] for 8 PHY.

4.1.4 Backpressure

In half duplex mode, the IP178G supports backpressure flow control. When set BK_EN of MII register 20.1[8] to "1", the packets in buffer reach the threshold, IP178G generates a jam pattern to back off the link partner. IP178G supports carrier-sense based backpressure. When the carrier-sense based backpressure is enabled, MII register 20.1[7] is set to "0", and IP178G transmits null packets continuously to prevent link partner's transmission when the buffer is not available.

4.1.5 Broadcast storm protection

A port of IP178G begins to drops broadcast packets if the received broadcast packets are more than the threshold defined in MII register 21.9[15:14] BF_STM_THR_SEL [1:0] in 10ms (100Mbps) or 100ms (10Mbps)

The function can be enabled by pulling low pin 47 BF_STM_DIS or programming MII register 20.1[6].

IP178G handles multicast frame as a broadcast frame in broadcast storm protection function if MII register 21.30[12] is set to "0"

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4.2 Rserved Group MAC Address

The table shows the reserved group address for standard use and how frames are processed.

Table 3 Rserved Group MAC Address table

MAC Address	Protocol	Action	
		RSVD_GMAC_FILTER=1 (default)	RSVD_GMAC_FILTER =0
01-80-c2-00-00-00	Bridge Group Address	Forward	Forward
01-80-c2-00-00-01	MAC Control of IEEE 802.3	Drop	Drop
01-80-c2-00-00-02	Slow protocol address: 802.3ad LACP, 802.3ah OAM	Forward	Forward
01-80-c2-00-00-03	802.1x	Forward	Forward
01-80-c2-00-00-04	Reserved for future media access method	Drop	Forward
01-80-c2-00-00-05	Reserved for future media access method	Drop	Forward
01-80-c2-00-00-06	Reserved for future bridge use	Drop	Forward
01-80-c2-00-00-07	Reserved for future bridge use	Drop	Forward
01-80-c2-00-00-08	Provider bridge group address	Drop	Forward
01-80-c2-00-00-09	Reserved for future bridge use	Drop	Forward
01-80-c2-00-00-0A	Reserved for future bridge use	Drop	Forward
01-80-c2-00-00-0B	Reserved for future bridge use	Drop	Forward
01-80-c2-00-00-0C	Reserved for future bridge use	Drop	Forward
01-80-c2-00-00-0D	Provider bridge GVRP address	Drop	Forward
01-80-c2-00-00-0E	802.1AB LLDP	Forward	Forward
01-80-c2-00-00-0F	Reserved for future bridge use	Drop	Forward
01-80-c2-00-00-10	All bridges address	Drop	Forward
01-80-c2-00-00-11to1F	Others	Forward	Forward
01-80-c2-00-00-20	GMRP	Drop	Forward
01-80-c2-00-00-21	GVRP	Drop	Forward
01-80-c2-00-00-22to2F	Reserved for future use	Drop	Forward
01-80-c2-00-00-30to3F	802.1ag	Forward	Forward
01-80-c2-00-00-40to4F	Others	Forward	Forward

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4.3 Green Power

IP178G provides various power management modes to save the power consumption. In addition to the power down mode defined on IEEE802.3, two extra power saving modes are used to further reduce the system power consumption.

4.3.1 Auto Power Saving Mode

IP178G will automatically enter this mode if no cable link is established. After entering this mode, IP178G will shutdown unnecessary function and issue the link pulse at a rate lower than the regular rate specified on IEEE 802.3.

4.3.2 IEEE802.3az EEE (Energy Efficient Ethernet)

In order to enter this mode, the PHY part should declare the EEE capability during the auto-negotiation phase.

It's the higher layer's responsibility to memorize the link partner's wakeup time and wakeup the link partner before sending data. The higher layer means a mechanism that can evaluate the packet buffer utilization and wake the link partner before sending the data. In general speaking, this mechanism probably consists of at least one of the following items: the packet buffer manager, the application program and OS.

The EEE module works well at LPI (Low Power Idle) mode when

1. Link at full-duplex and
2. Auto-negotiation is enabled in both local and remote PHYs and
3. 100Mbps full duplex and
4. EEE ability is supported in both local & remote PHYs and
5. EEE_EN (Reg 22.0[7:0]) is enabled for EEE function via default value and
6. SLEEP_TIMER (Reg 22.1[11:0]) is the default value for EEE sleep timer and
7. WAKE_TIME (Reg 22.2~9) is the default value for EEE wake time.

4.3.3 WOL+ (Wake On LAN Plus)

IP178G not only consumes low power, but also provides various energy-saving methods to save the power. These combined methods make IP178G a "green" PHY. The following pictures show the method.

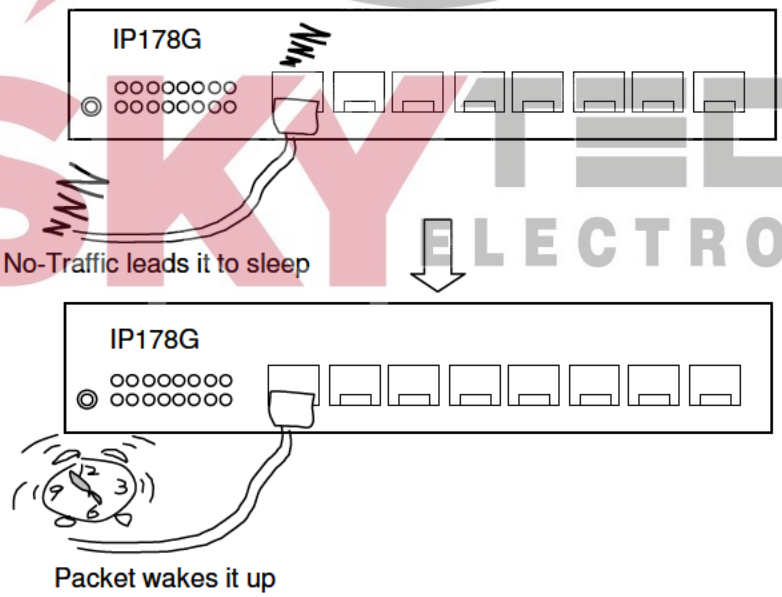

Figure 2 WOL+ Application Diagram

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The IP178G WOL+ function will be active if a port's RX is in idle state for a period time and this port WOL+ function is enabled (by pin 51 or Reg 20.10[15:8]). This period time can be configured by WOL+ timer register (Reg22.10).

This port will be wake up if

a) Sense magic packet;
b) Sense link change;
c) Sense any packet;

The packet format of Magic packet is showing as follows, source address=0x112233445566 for example, repeat this source address 16 times at least.

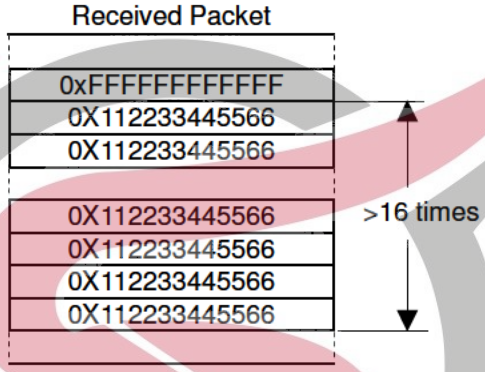

Figure 3 Magic Packet Format

.

4.3.4 Force Power Off

When "Force power off enable" (pin 37) is pull low for 3 seconds, IP178G will enter force power off mode. If "Force power off enable" pin pull low for 3 seconds again, IP178G will return normal mode. The expired timer (default value is 3 seconds) is configurable in "FORCE_POWER_OFF_TIME" (MII Register 21.10[7:6]).

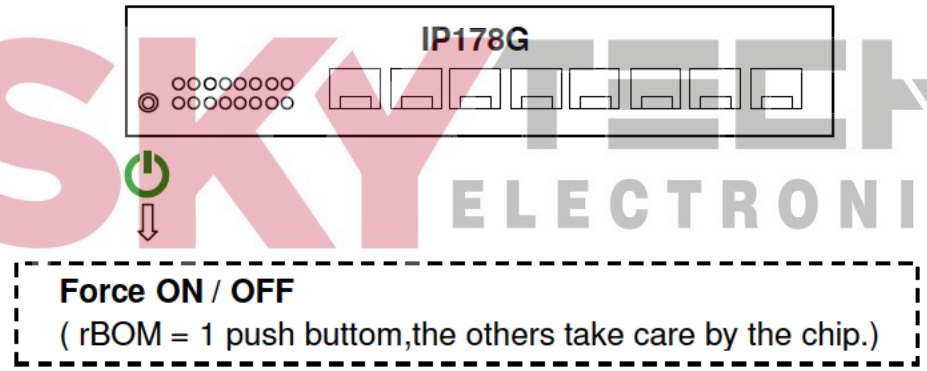

Figure 4 Force Power Off Application Diagram

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4.4 Auto Factory Test (AFT) Mode

IP178G implements an AFT mechanism, which is very useful for switch pre-test as **Figure 4 AFT system diagrams**. When this function is triggered by hardware pin AFT, IP178G physical ports are connected either port-pairs loopback or self-loopback and then IP178G will generate frames for TX of all ports and LED will flash.

For example, port1 and port2 are connected to each other (loopback). Check the LED of port1 and port2 is light-on, and then trigger this AFT function and wait a moment trigger again. If the test result is passed (no CRC or packet loss), show LED of port1 and port2 light-on. Otherwise, show LED light-off when CRC or packet loss is happened.

Procedure:
1. Power On
2. Wait for someone Push AFT button to start test
3. IP178G transmit packet and LED flash
4. If Push AFT button then goto step 5, else goto step 3
5. LED Show the test result, goto step 2

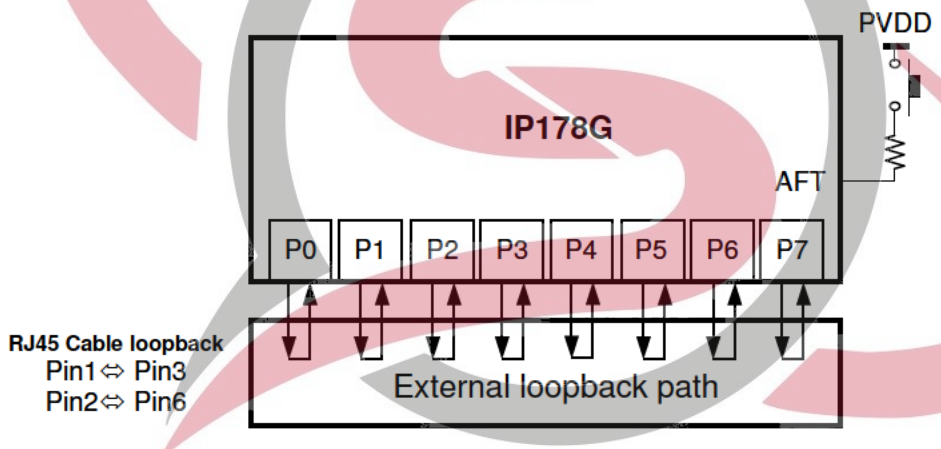

Figure 5 Auto Factory Test Application Diagram

4.5 Reset

Hardware Reset: Hardware pin RESETB should be asserted LOW at least for 10ms to reset IP178G, and gets initial values from pins, registers and EEPROM after reset.

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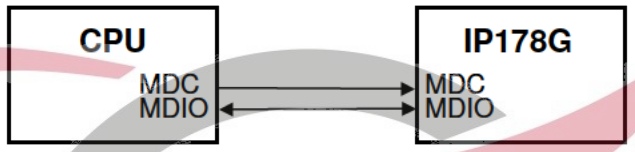
4.6 Serial management interface

User can access IP178G's MII registers through serial management interface with pin MDC and MDIO. Its format is shown in the following table. To access MII register in IP178G, MDC should be at least one more cycle than MDIO. That is, a complete command consists of 32 bits MDIO data and at least 33 MDC clocks. When the SMI is idle, MDIO is in high impedance.

System diagram



Frame format	<Idle><start><op code><PHY address><Registers address><turnaround><data><idle>
Read Operation	<Idle><01><10><$A_4A_3A_2A_1A_0$><$R_4R_3R_2R_1R_0$><Z0><b_{15} b_{14} b_{13} b_{12} b_{11} b_{10} b_9 b_8 b_7 b_6 b_5 b_4 b_3 b_2 $b_1$$b_0$><Idle>
Write Operation	<Idle><01><01><$A_4A_3A_2A_1A_0$><$R_4R_3R_2R_1R_0$><10><b_{15} b_{14} b_{13} b_{12} b_{11} b_{10} b_9 b_8 b_7 b_6 b_5 b_4 b_3 b_2 $b_1$$b_0$><Idle>

Figure 6 Serial management interface Read / Write Diagram

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4.7 CoS

IP178G supports two types of CoS. One is port base priority function and the other is frame base priority function. IP178G supports two levels of priority queues. A high priority packet will be queued to the high priority queue to share more bandwidth. The ratio of bandwidth of high priority and low priority queue is defined in MII register **20.1[15]**.

4.7.1 Port base priority

The packets received from high priority port will be handled as high priority frames if the port base priority is enabled. It is enabled by programming the corresponding bit in MII register **21.0[9]** ~ **21.7[9]**. Each port of IP178G can be configured as a high priority port individually.

4.7.2 VIP ports

This port based priority function can active either by register or pin setting. There are three pins dedicate for enabling the port based priority function. The follow illustration shows the pin setting part of the port based priority function.

Table 4 VIP port pin setting table

IP178G pin number	42	43	44
Pin name	HIGH_PRI[2]	HIGH_PRI[1]	HIGH_PRI[0]

HIGH[2:0]	High priority port
001	6, 7
010	5, 6, 7
011	7
101	0, 1
110	0, 1, 2
000	0
111	Disable (default)

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4.7.3 Frame base priority

4.7.3.1 VLAN tag and TCP/IP TOS

IP178G examines the specific bits of VLAN tag and TCP/IP TOS for priority frames if the frame base priority is enabled. The packets will be handled as high priority frames if the tag value meets the high priority requirement, that is, VLAN tag or TCP/IP TOS field bigger than 3. It is enabled by programming the corresponding bit in MII register 21.0[10]~21.7[10]. The frame base priority function of each port can be enabled individually.

IP178G supports an easy way to enable a sub set of CoS function without programming MII registers. Frame base priority function of all ports is enabled if pin 48 COS_DIS is pulled low. The setting in register takes precedence of the setting on pins.

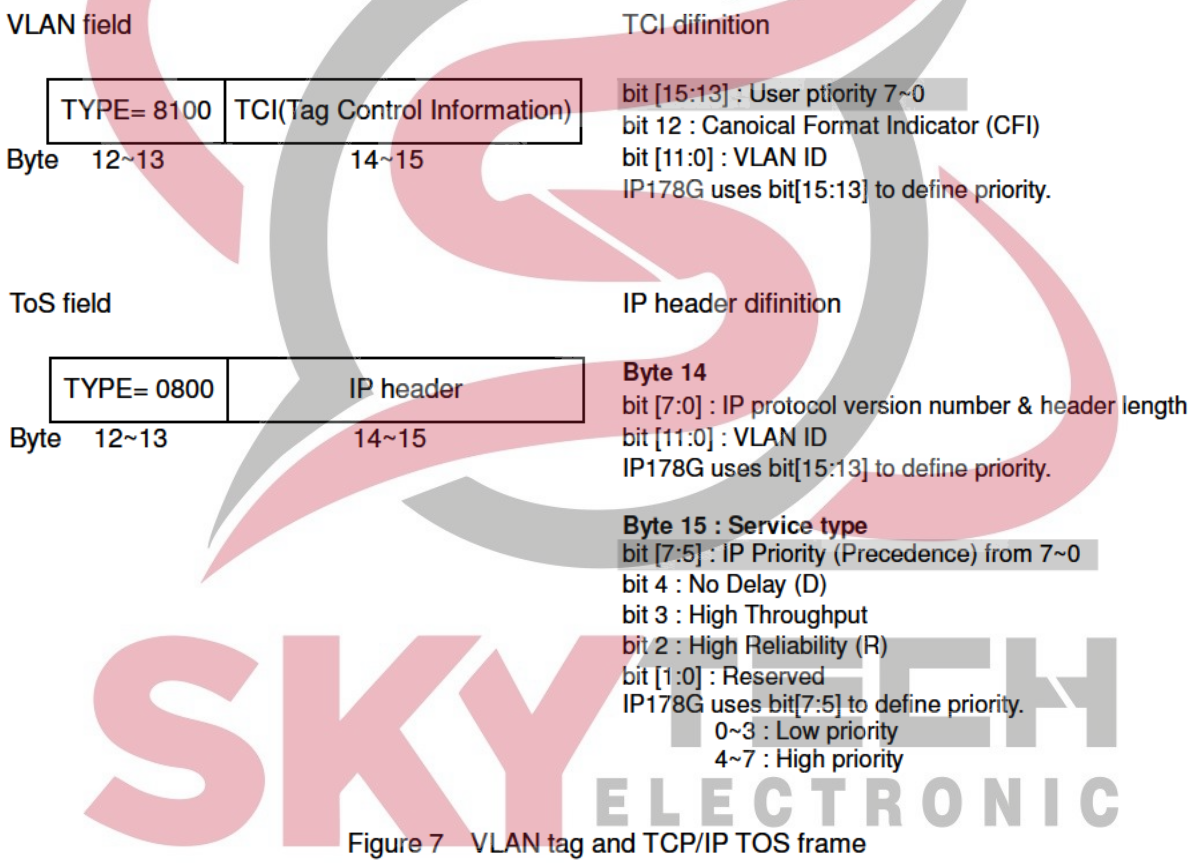

Figure 7 VLAN tag and TCP/IP TOS frame

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4.7.3.2 IPv4/IPv6 DiffServ

IP178G checks the DiffServ field of a IPv4 frame or Traffic class field [7:2] (TC[7:2]) of a IPv6 frame and uses them to decide the frame's priority if MII register 21.30.[13] DIFFSERV_EN is enabled. IP178G uses DiffServ or TC[7:2] as index to select one of 64 bits. If the bit is "1", the received frame is handled as a high priority frame. IP178G recognize the following DSCP (Differentiated Service Code Point) Octet as high priority frame.

6'b101110
6'b001010
6'b010010
6'b011010
6'b100010
6'b11x000

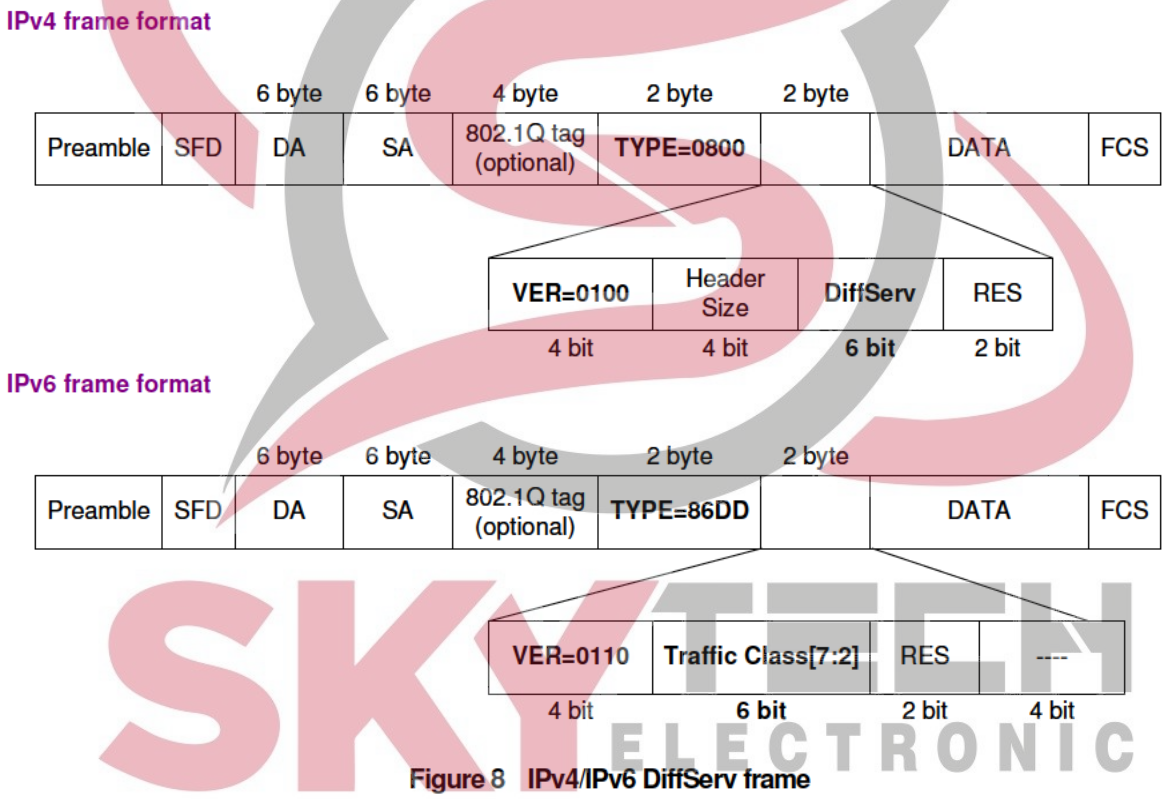

Figure 8 IPv4/IPv6 DiffServ frame

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4.7.3.3 TCP/UDP logical port priority

IP178G can configure the ingress port frame priority by using the TCP/UDP frame logical port number. When the incoming IP packet with TCP or UDP protocols, the 16 bits destination or source port field in the TCP/UDP header can be used for assign the frame priority. It means the source's logical port or the destination's logical port in the incoming packet match any of the pre-defined logical ports, the incoming frame will give a high priority mark and put it in the high priority queue.
TCP/UDP logical port priority function of all ports is enabled if pin 48 COS_DIS is pulled high. The logical port priority of each pre-defined port number or user defined range of logical port number can be enabled individually by programming the corresponding bit in the MII register 20.14[5:0].

Table 5 TCP/UDP logical port priority table

■ Pre-defined logical ports list

Service	TCP	Description
SSH	22	secure shell
HTTPs	443	secure HTTP (SSL)
RDP	3389	Windows Remote Desktop Protocol
XWIN	6000	X11 – used for X-Windows

When the "LPP_AGING_EN (MII register 20.14[15:8])" function enable, once receive a IP frame with TCP/UDP protocol and the logical port number is the pre-defined port number, the ingress port will treat as a port based high priority port for 300 seconds. After the internal timer expired, the ingress port will change back to previous behavior

These pre-defined logical ports can be enable individually by programming MII register 20.14[3:0] or EEPROM register 10[3:0].

■ User defined range logical ports list (defaulting setting)

Service	TCP	Description
telnet	23	Remote terminal protocol
VNC	5800	VNC remote desktop protocol

For the user defined range logical ports, it contains two set of range and can be changed by programming via MII register or EEPROM register. Each range consists of a high and low limit register to set the TCP or UDP logical port range. The high limit port number can not large than the low limit port number. The default logical port number of range 0 and 1 are default set to 23 and 5800, for this case the high and low limit port number is the same value. If an incoming IP frame with TCP/UDP port number is between the low and high limit, it will be treated as a high priority frame.

4.8 Port Mirroring

There are some circumstances that the network administrator requires to monitor the network status. The port mirroring function can help the network administrator diagnose the network.

A port mirroring function can be accomplished through assigning 1 to 7 monitored ports and a snooping port. The IP178G supports four kinds of monitoring methods: RX(ingress), TX(egress), RX-and-TX, and RX-or-TX. This function can be enabled by programming the corresponding bit in MII registers 20.3 ~ 20.4.

For example, if designer wants to monitor the output traffic of port5 and port4 as shown in the following figure. He has to write "2'b01" to register 20.3[14:13] to choose monitor method to be TX traffic, write 0x30 to registers 20.4[7:0] to select port5 and port4 to be monitored ports, write 1'b1 and 3'b000 to registers 20.3[15] and 20.4[15:13] to select port0 as a monitoring port. IP178G will copy tx traffic of port5 and port4 to port0.

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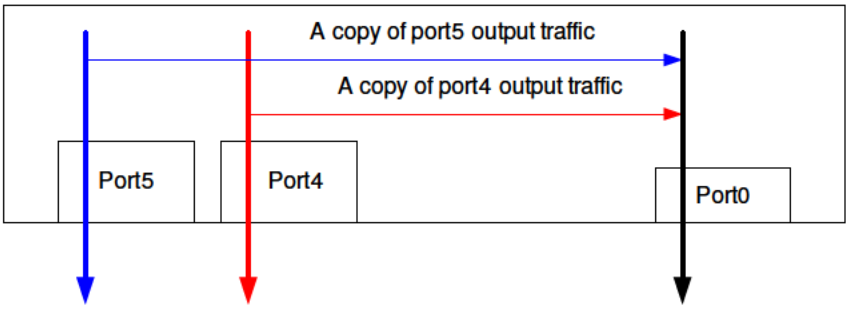

Figure 9 Port Mirroring Security Block Diagram

4.9 Link Aggergation

Link aggregation is used to provide a large throughput between two network nodes by using the method of grouping a set of ports. If some of ports are in a trunk group, all ports in that trunk group shall be in the same VLAN group.

Each trunk group may comprise 2 to 6 ports. Designer can configure the trunk group members individually by writing non-zero values to the corresponding bits of a port in the registers 22.12[7:0] and 22.13[7:0] for trunk group 0 and trunk group 1. A trunk channel works as if a "big" port with multiple times of bandwidth. If the destination port of a packet is un-link, IP178G forwards the packet to the other port of the trunk (auto recovery).

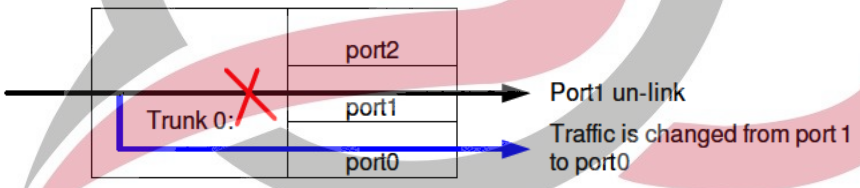

Figure 10 Trunk Channel Behavior Block Diagram

To fully utilize the bandwidth in a trunk channel, IP178G supports load balance function. A physical port of a trunk forwards a packet only if the trunk group of the packet matches the group setting of the port. That is, when a packet is forwarded to a port in a trunk, its destination port is according to trunk group.

The aggregation mode determines which index would be used to search aggregation mask table. Here provide four ways: the four LSB of the SMAC, the four LSB of the DMAC, the four LSB of the SMAC xor DMAC, and Source port ID.

Link aggregation function only uses a 3-bit index to search aggregation mask table. To achieve it, the aggregation index selection is used to extract a 3-bit index from the mentioned in AGGR_MODE.

If the destination port of a trunk is un-link, the packet will be forward the port shifted by 2. If the port is un-link, too, the packet will be forward the port shifted by 3. For example, if port 3 is un-link, its packet will be forwarded to port 5. If port 5 is un-link, too, the packet will be forwarded to port 4.

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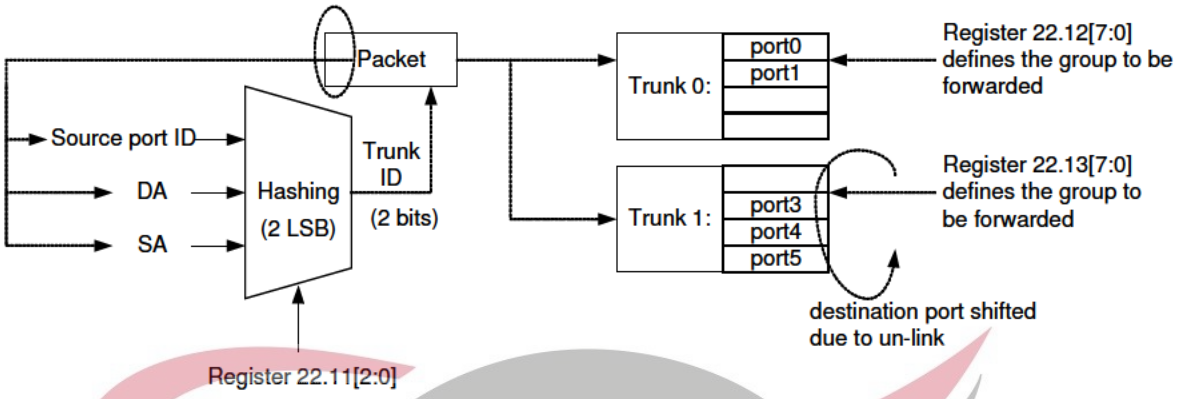

Figure 11 Load Balance Block Diagram

Link aggregation example:

Here have two trunk groups.
Trunk 0: port 0, 1
Trunk 1: port 5, 6, 7

The link aggregation parameters are set as:

AGGR_MODE: The aggregation mode determines which index would be used to search aggregation mask table. Here provide four ways:
The four LSB of the SMAC
The four LSB of the DMAC
The four LSB of the SMAC xor DMAC
Source port ID

PHY22 REG11[2:0] = 0x0 (AGGR_MODE = SMAC)

AGGR_IDX_SEL: Link aggregation function only uses a 3-bit index to search aggregation mask table. To achieve it, the aggregation index selection is used to extract 3-bit index from the mentioned in AGGR_MODE.

PHY22 REG11[4:3] = 0x0 (AGGR_IDX_SEL = index[2:0])

AGGR_GROUP: The port mask is logically grouping a set of ports.
PHY22 REG21[7:0] = 0x03 (AGGR_GROUP0: port 0 and port 1)
PHY22 REG22[7:0] = 0xe0 (AGGR_GROUP1: port 5, 6, 7)

Aggregation mask table:
PHY22 REG14[7:0] = 8'b0011_1101 (AGGR_MASK0)
PHY22 REG15[7:0] = 8'b0101_1110 (AGGR_MASK1)
PHY22 REG16[7:0] = 8'b1001_1101 (AGGR_MASK2)
PHY22 REG17[7:0] = 8'b0011_1110 (AGGR_MASK3)
PHY22 REG18[7:0] = 8'b0101_1101 (AGGR_MASK4)
PHY22 REG19[7:0] = 8'b1001_1110 (AGGR_MASK5)
PHY22 REG20[7:0] = 8'b0011_1101 (AGGR_MASK6)
PHY22 REG21[7:0] = 8'b0101_1110 (AGGR_MASK7)

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4.10 Buffer Aging

When buffer aging was enabled, a frame stayed in output port for transmission is discarded if buffer aging time has exceeded one second. The buffer aging time is the maximum delay time for transmission on output port. This function can be set from MII register 20.13[13].

4.11 LED display (normal operation)

Normal operation			
LED_O_SEL[1:0]	LINK_LED	SPEED_LED	FDX_LED
00	Off: 100 Mbps link fail On: 100 Mbps link ok Flash: TX/RX	Off: no collision Flash: collision	Off: 10 Mbps link fail On: 10 Mbps link ok Flash: TXRX
01	Off: link fail On: link ok	Off: 10 Mbps On: 100 Mbps	Off: half duplex On: full duplex Flash: collision
10	Off: 100 Mbps link fail On: 100 Mbps link ok Flash: TX/RX	Off: half duplex On: full duplex Flash: collision	Off: 10 Mbps link fail On: 10 Mbps link ok Flash: TXRX
11	Off: link fail On: link ok Flash: TX/RX	Off: 10 Mbps On: 100 Mbps	Off: half duplex On: full duplex Flash: collision
Flash behavior: Off 105ms → On 105ms → Off 105ms → ...			

4.12 Serial LED Mode

IP178G supports serial LED mode and can be setting MII register SERIAL_LED_EN to 1 by MII page3 register 16[12].
There are no enough pins for LED and IP178G sends out LED information through pin 47 (SCLK) and pin 48 (SDATA). It is necessary to use TTL chip to decode and drive LED. The application circuit is shown below.
IP178G supports two types of serial LED mode and can be setting by MII page3 register 16[11]. The default value is 0 (SERIAL_LED_MODE = 0) and can be setting to 1 by MII page3 register 16[11].

4.12.1 Supports link LED only

IP178G supports link LED only when setting SERIAL_LED_MODE to 1 and SERIAL_LED_EN to 1.

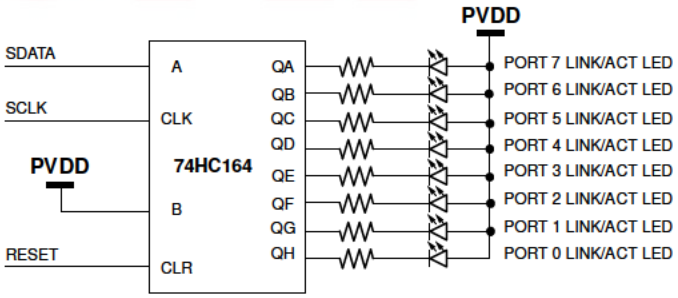

Figure 12 Serial LED Link/Activity Mode

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4.12.2 Supports link, speed, and duplex LED

IP178G supports link, speed, and duplex LED when setting SERIAL_LED_MODE to 0 and SERIAL_LED_EN to 1.

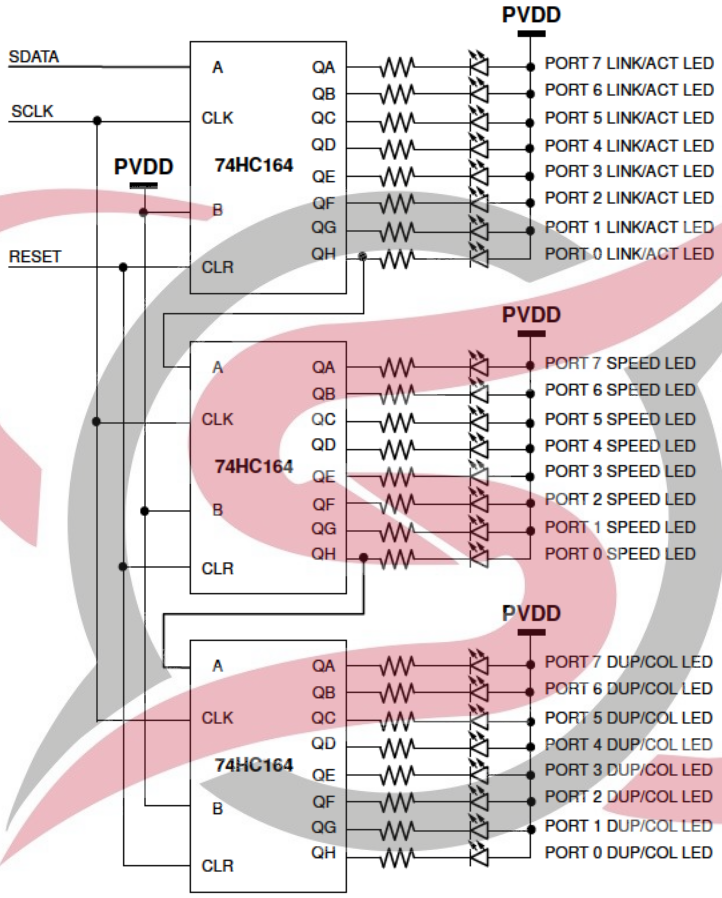

Figure 13 Serial LED Fully Mode

4.13 LED Blink Timing

Table 6 LED Blink Timing

LED mode	Blinking speed
Serial mode update period	10ms
Active LED blink	Off 105ms → On 105ms → Off 105ms → …
Collision LED blink	Off 105ms → On 105ms → Off 105ms → …

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4.14 PAD Driving Calibration

This function illustrates the interface between switch and high speed pad groups for pad driving calibration. In default the pad driving capability sets by switch MII register (PHY address 21 Reg10.[14:12). It also can automatically calibrate to determine pad driving and feedback it to the final pad driving current.

4.15 Fiber port configuration

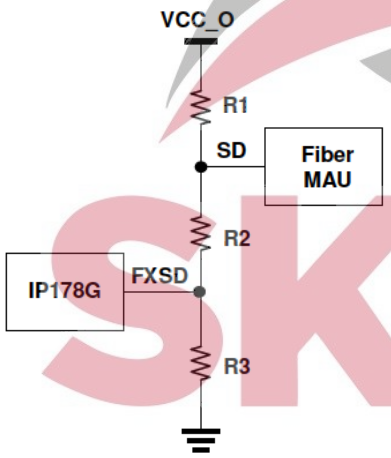
Port 6 and 7 of IP178G can be configured to be a fiber port or a TP port individually. A port becomes a fiber port if its FXSDx is connected to a fiber MAU or pulled to high. A port becomes a TP port if it's FXSDx is pulled low.

Table 7 Fiber port Parameter

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Fiber Rx common mode Voltage	V_{FRC}	-	AVDD*0.6	-	V
Fiber Rx differential mode Voltage	V_{FRD}	0.4	-	-	V

PVDD = 3.3V

Voltage on FXSDx	TP port	Fiber port	Fiber signal detect	Condition
< 0.4 V	Yes	--	--	
> 1.2 V < 1.7 V	--	Yes	Off	Fiber unplugged
> 1.95 V < 3.3 V	--	Yes	On	Fiber plugged



	3V	5V
R1	1K	470
R2	100	300
R3	910	330

Figure 14 Fiber FXSD application circuit

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5 Register descriptions

The IP178G can be configured via external EEPROM interface at boot time. During operation, IP178G registers are accessible via SMI interface.

5.1 Register map

5.1.1 MII register map

Table 8 MII register map table

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
20.0	Software Reset Register (55 AA)															
20.1	priority_rate			Reduce_ipg	drop16		modify_carrier_algorithm	bk_en	bp_kind	bf_stm_en			aging		modbck	learn_dis_pause
20.2	tmode_sel								input_filter	hash_mode						
20.3	port_mirror_en	port_mirror_mode							sel_rx_port_mirror							
20.4	sel_mirror_port								sel_tx_port_mirror							
20.5									CRC_counter							
20.6	pause_trigger								pause_flag							
20.7	thr_setting	read_thr	wait_backoff						unit_default_threshold							
20.8	share_high_threshold								share_low_threshold							
20.9	pkt_high_threshold								pkt_low_threshold							
20.10	unit_high_threshold								unit_low_threshold							
20.11	mon_en							unit_low_num								
20.12								share_high_num								
20.13	fiber_duplex[7:6]		buf_aging_en	src_blk_protect					port_backpressure_en[7:0]							
20.14	ipp_aging_en[7:0]										userdef_range_en[1:0]		predef_port_en[3:0]			
20.15	userdef_range0_high[15:0]															
20.16	userdef_range0_low[15:0]															
20.17	userdef_range1_high[15:0]															
20.18	userdef_range1_low[15:0]															
20.19	fast_mode			test_latin											test_sel	
21.0						port0_cos_en	port0_high_priority									
21.1						port1_cos_en	port1_high_priority									
21.2						port2_cos_en	port2_high_priority									
21.3						port3_cos_en	port3_high_priority									
21.4						port4_cos_en	port4_high_priority									
21.5						port5_cos_en	port5_high_priority									
21.6						port6_cos_en	port6_high_priority									
21.7						port7_cos_en	port7_high_priority									
21.8																
21.9	bf_stm_thr_sel		share_full_thr_sel		unit_default_thr_sel		unit_low_thr_sel		unit_high_thr_sel			Predrop en	pkt_low_thr_sel		pkt_high_thr_sel	
21.10		driver[2:0]			bf_stm_en_qm	hp_dis_flow_en	twopart	allpass	analog_off_time							
21.11~29																
21.30			diffserv_en	bf_ffff_only	special_add_forward				fwd_mac_ctl						Drop_extra_long_packet	

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6 PHY registers

Table 9 PHY Register Map

Page	Register	Description	Default	Note
0	0	Control Register		PHY 0~7
0	1	Status Register		PHY 0~7
0	2	PHY Identifier 1 Register		PHY 0~7
0	3	PHY Identifier 2 Register		PHY 0~7
0	4	Auto-Negotiation Advertisement Register		PHY 0~7
0	5	Auto-Negotiation Link Partner Ability Register		PHY 0~7
0	6	Auto-Negotiation Expansion Register		PHY 0~7
0	7	Auto-Negotiation Next Page Transmit Register		PHY 0~7
0	8	Auto-Negotiation Link Partner Next Page Register		PHY 0~7
0	13	MMD Access Control Register		PHY 0~7
0	14	MMD Access Address Data Register		PHY 0~7
0	3.0	PCS control 1 register		PHY 0~7
0	3.1	PCS status 1 register		PHY 0~7
0	3.20	EEE capability		PHY 0~7
0	3.22	EEE wake error count		PHY 0~7
0	7.60	EEE advertisement register		PHY 0~7
0	7.61	EEE link partner ability		PHY 0~7
0	16	Special Control Register (APS)		SHARE
0	18	Special Status Register		PHY 0~7
X	20	Page Control Register		SHARE
3	16	LED Control Register		SHARE
4	16	WOL+ Control Register		SHARE

Share: 8 ports share the register
X8: Each port has its individual register
X: indicate do not care.

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Register descriptions
R/W = Read/Write, SC = Self-Clearing, RO = Read Only, LL = Latching Low, LH = Latching High

6.1 MII Register

PHY	MII	R/W	Description	Default
Control Register				
0~7	0.15	RW/ SC	Reset The PHY is reset if user writes "1" to this bit. The reset period is around 2ms. User has to wait for at least 2ms to access IP178G. (according design should delete)	0
0~7	0.14	R/W	Loop back 1 = Loop back mode 0 = normal operation When this bit set, IP178G will be isolated from the network media, that is, the assertion of TXEN at the MII will not transmit data on the network. All MII transmission data will be returned to MII receive data path in response to the assertion of TXEN. Bit 0.12 is cleared automatically, if this bit is set. User has to program bit 0.12 again after loop back test. (according design should delete)	0
0~7	0.13	RW	Speed Selection 1 = 100Mbps 0 = 10Mbps It is valid only if bit 0.12 is set to be 0.	1
0~7	0.12	RW	Auto-Negotiation(AN) Enable 1 = Auto-Negotiation Enable 0 = Auto-Negotiation Disable	1
0~7	0.11	R/W	Power Down 1: power down mode 0: normal operation	0
0~7	0.10		Isolate IP178G doesn't support this function.	0
0~7	0.9	RW SC	Restart Auto-Negotiation 1 = re-starting Auto-Negotiation 0: normal operation	0
0~7	0.8	R/W	Duplex mode 1 = full duplex 0 = half duplex It is valid only if bit 0.12 is set to be 0.	1
0~7	0.7	R/W	Collision test	0
0~7	0[6:0]	RO	Reserved	0

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PHY	MII	R/W	Description	Default
Status Register				
0~7	1.15	RO	100Base-T4 capable 1 = 100Base-T4 capable 0 = not 100Base-T4 capable IP178G does not support 100Base-T4. This bit is fixed to be 0.	0
0~7	1.14	RO	100Base-X full duplex Capable 1 = 100Base-X full duplex capable 0 = not 100Base-X full duplex capable	1
0~7	1.13	RO	100Base-X half duplex Capable 1 = 100Base-X half duplex capable 0 = not 100Base-X half duplex capable	1
0~7	1.12	RO	10Base-T full duplex Capable 1 = 10Base-T full duplex capable 0 = not 10Base-T full duplex capable	1
0~7	1.11	RO	10Base-T half duplex Capable 1 = 10Base-T half duplex capable 0 = not 10Base-T half duplex capable	1
0~7	1.10	RO	100Base-T2 full duplex Capable 1 = 100Base-T2 full duplex capable 0 = not 100Base-T2 full duplex capable	0
0~7	1.9	RO	100Base-T2 half duplex Capable 1 = 100Base-T2 half duplex capable 0 = not 100Base-T2 half duplex capable	0
0~7	1.8	RO	Extended Status	0
0~7	1.7	RO	Reserved	0
0~7	1.6	RO	MF preamble Suppression 1 = preamble may be suppressed 0 = preamble always required	1
0~7	1.5	RO	Auto-Negotiation Complete 1 = Auto-Negotiation complete 0 = Auto-Negotiation in progress When read as logic 1, indicates that the Auto-Negotiation process has been completed, and the contents of register 4 and 5 are valid. When read as logic 0, indicates that the Auto-Negotiation process has not been completed, and the contents of register 4 and 5 are meaningless. If Auto-Negotiation is disabled (bit 0.12 set to logic 0), then this bit will always read as logic 0.	0
0~7	1.4	RO LH	Remote fault 1 = remote fault detected 0 = not remote fault detected When read as logic 1, indicates that IP178G has detected a remote fault condition. This bit is set until remote fault condition gone and before reading the contents of the register. This bit is cleared after IP178G reset.	0
0~7	1.3	RO	Auto-Negotiation Ability 1 = Auto-Negotiation capable 0 = not Auto-Negotiation capable When read as logic 1, indicates that IP178G has the ability to perform Auto-Negotiation.	1

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PHY	MII	R/W	Description	Default
Status Register				
0~7	1.2	RO LL	Link Status 1 = Link Pass 0 = Link Fail When read as logic 1, indicates that IP178G has determined a valid link has been established. When read as logic 0, indicates the link is not valid. This bit is cleared until a valid link has been established and before reading the contents of this registers.	0
0~7	1.1	RO LH	Jabber Detect 1 = jabber condition detected 0 = no jabber condition detected When read as logic 1, indicates that IP178G has detected a jabber condition. This bit is always 0 for 100Mbps operation and is cleared after IP178G reset. When the duration of TXEN exceeds the jabber timer (21ms), the transmission and loop back functions will be disabled and the COL is active. After TXEN goes low for more than 500 ms, the transmitter will be re-enabled.	0
0~7	1.0	RO	Extended capability 1 = Extended register capabilities 0 = No extended register capabilities IP178G has extended register capabilities.	1

PHY	MII	R/W	Description	Default
PHY Identifier 1 Register				
0~7	2	RO	IP178G OUI (Organizationally Unique Identifier) ID, the MSB is 3rd bit of IP178G OUI ID, and the LSB is 18th bit of IP178G OUI ID. IP178G OUI is 0090C3.	16'h0243

PHY	MII	R/W	Description	Default
PHY Identifier 2 Register				
0~7	3[15:10]	RO	PHY identifier IP178G OUI ID, the MSB is 19th bit of IP178G OUI ID, and LSB is 24th bit of IP178G OUI ID.	6'h03
0~7	3[9:4]	RO	Manufacture's Model Number IP178G model number	6'h18
0~7	3[3:0]	RO	Revision Number IP178G revision number	0

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MII register 4 of PHY0~7 (Each PHY has its own MII register 4 with different PHY address)

PHY	MII	R/W	Description	Default
Auto-Negotiation Advertisement Register				
0~7	4.15	R/W	1 = Next pages are supported 0 = Next pages are not supported	0
0~7	4.14	RO	Reserved by IEEE, write as 0, ignore on read	0
0~7	4.13	R/W	Remote Fault 1 = Advertises that this port has detected a remote fault. 0 = There is no remote fault.	0
0~7	4.12	RO	Reserved for future IEEE use, write as 0, ignore on read	0
0~7	4.11	RW	Asymmetric PAUSE 1 = Asymmetric flow control is supported 0 = Asymmetric flow control is not supported	1
0~7	4.10	RW	PAUSE 1 = Symmetric flow control is supported 0 = Symmetric flow control is not supported	1
0~7	4.9	RO	100BASE-T4 Not supported	0
0~7	4.8	R/W	100BASE-TX full duplex 1 = 100BASE-TX full duplex is supported 0 = 100BASE-TX full duplex is not supported	1
0~7	4.7	R/W	100BASE-TX 1 = 100BASE-TX is supported 0 = 100BASE-TX is not supported	1
0~7	4.6	R/W	10BASE-T full duplex 1 = 10BASE-T full duplex is supported 0 = 10BASE-T full duplex is not supported	1
0~7	4.5	R/W	10BASE-T 1 = 10BASE-T is supported 0 = 10BASE-T is not supported	1
0~7	4[4:0]	RO	Selector Field Use to identify the type of message being sent by Auto-Negotiation.	5'b00001

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MII register 5 of PHY0~7 (Each PHY has its own MII register 5 with different PHY address)

PHY	MII	R/W	Description	Default
Auto-Negotiation Link Partner Ability Register				
0~7	5.15	RO	Next Page 1 = Next Page ability is supported by link partner 0 = Next Page ability does not supported by link partner	0
0~7	5.14	RO	Acknowledge 1 = Link partner has received the ability data word 0 = Not acknowledge	0
0~7	5.13	RO	Remote Fault 1 = Link partner indicates a remote fault 0 = No remote fault indicate by link partner If this bit is set to logic 1, then bit 1.4 (Remote fault) will set to logic 1.	0
0~7	5.12	RO	Reserved by IEEE for future use, write as 0, and read as 0.	0
0~7	5.11	RO	Asymmetric PAUSE 1 = Link partner support Asymmetric PAUSE 0 = Link partner does not support Asymmetric PAUSE When local or link partner is Auto-negotiation disabled, this bit is read as 1. The pause resolution is determined by MII Reg4.[11:10].	0
0~7	5.10	RO	PAUSE 1 = Link partner support Symmetric PAUSE 0 = Link partner does not support Symmetric PAUSE When local or link partner is Auto-negotiation disabled, this bit is read as 1. The pause resolution is determined by MII Reg4.[11:10].	0
0~7	5.9	RO	100BASE-T4 1 = Link partner support 100BASE-T4 0 = Link partner does not support 100BASE-T4	0
0~7	5.8	RO	100BASE-TX full duplex 1 = Link partner support 100BASE-TX full duplex 0 = Link partner does not support 100BASE-TX full duplex	0
0~7	5.7	RO	100BASE-TX 1 = Link partner support 100BASE-TX 0 = Link partner does not support 100BASE-TX	0
0~7	5.6	RO	10BASE-T full duplex 1 = Link partner support 10BASE-T full duplex 0 = Link partner does not support 10BASE-T full duplex	0
0~7	5.5	RO	10BASE-T 1 = Link partner support 10BASE-T 0 = Link partner does not support 10BASE-T When AN is disabled, this bit is set if register 0.13=0	0
0~7	5[4:0]	RO	Selector Field Protocol selector of the link partner	5'b00000

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MII register 6 of PHY0~7 (Each PHY has its own MII register 6 with different PHY address)

PHY	MII	R/W	Description	Default
Auto-Negotiation Expansion Register				
0~7	6[15:5]	RO	Reserved	0
0~7	6.4	RO/ LH	Parallel Detection Fault 1 = a fault has been detected via parallel detection function. 0 = a fault has not been detected via parallel detection function.	0
0~7	6.3	RO	Link Partner Next Page Able 1 = Link partner is next page able. 0 = Link partner is not next page able.	0
0~7	6.2	RO	Next Page Able 1 = IP178G next page able. 0 = IP178G is not next page able.	1
0~7	6.1	RO/ LH	Page Recieved 1 = A new page has been received. 0 = A new page has not been received.	0
0~7	6.0	RO	If AN is enabled, this bit means: 1 = Link partner is Auto-Negotiation able. 0 = Link partner is not Auto-Negotiation able. In 100FX or AN disabled, then this bit is always equal to 0.	0 (AN) (100FX)

MII register 7 of PHY0~7 (Each PHY has its own MII register 7 with different PHY address)

PHY	MII	R/W	Description	Default
Auto-Negotiation Next Page Transmit Register				
0~7	7.15	RW	Next Page Transmit Code Word Bit 15	0
0~7	7.14	RO	Reserved Transmit Code Word Bit 14	0
0~7	7.13	RW	Message Page Transmit Code Word Bit 13	1
0~7	7.12	RW	Acknowledge 2 Transmit Code Word Bit 12	0
0~7	7.11	RO	Toggle Transmit Code Word Bit 11	0
0~7	7[10:0]	RW	Message/Unformatted Field Transmit Code Word Bit 10:0	1

MII register 8 of PHY0~7 (Each PHY has its own MII register 8 with different PHY address)

PHY	MII	R/W	Description	Default
Auto-Negotiation Link Partner Next Page Register				
0~7	8.15	RO	Next Page Received Code Word Bit 15	0
0~7	8.14	RO	Acknowledge Received Code Word Bit 14	0

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MII register 8 of PHY0~7 (Each PHY has its own MII register 8 with different PHY address)

PHY	MII	R/W	Description	Default
0~7	8.13	RO	Message Page Received Code Word Bit 13	0
0~7	8.12	RO	Acknowledge 2 Received Code Word Bit 12	0
0~7	8.11	RO	Toggle Received Code Word Bit 11	0
0~7	8[10:0]	RO	Message/Unformatted Field Received Code Word Bit 10:0	0

PHY	MII	R/W	Description	Default
Special Control Register				
0~7	16.7	RW	Advance power saving mode 1 = Enable APS mode (Default) 0 = Disable APS mode Please refer to the Power Saving application note for more detail description.	1
0~7	16.4	RW	Far end fault function 1 = Far end fault function disable 0 = Far end fault function enable (Default) This bit is only used for fiber mode.	0

PHY	MII	R/W	Description	Default
Special Status Register				
0~7	18.14	RO	Linkup 1 = linkup 0 = unlink	0
0~7	18.11	RO	Speed Mode 1 = 100 Mbps 0 = 10 Mbps	0
0~7	18.10	RO	Duplex Mode 1 = Full Duplex 0 = Half Duplex	0

The other Registers are reserved registers. User is inhibited to access to these registers. It may introduce abnormal function to write these registers.

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6.2 MMD Control Register

Table 10 MMD Control Register table

MII register 13 of PHY0~7 (Each PHY has its own MII register 13 with different PHY address)

PHY	MII	R/W	Description	Default
MMD Access Control Register				
0~7	13[15:14]	R/W	Function 00 = address 01 = data, no post increment 10 = data, post increment on reads and writes 11 = data, post increment on writes only	0
0~7	13[13:5]	RO	Reserved Write as 0, ignore on read	0
0~7	13[4:0]	R/W	DEVAD Device Address	0

MII register 14 of PHY0~7 (Each PHY has its own MII register 14 with different PHY address)

PHY	MII	R/W	Description	Default
MMD Access Address Data Register				
0~7	14[15:0]	R/W	Address Data If 13.15:14 = 00, MMD DEVAD's address register. Otherwise, MMD DEVAD's data register as indicated by the contents of its address register	0

Example 1, Read 0.3.20 (Read Data from MMD register 3.20 of PHY address 0):

1. Write 0.13 = 0x0003 //MMD DEVAD 3
2. Write 0.14 = 0x0014 //MMD Address 20
3. Write 0.13 = 0x4003 //MMD Data command for MMD DEVAD 3
4. Read 0.14 //Read MMD Data from 0.3.20

Example 2, Write 1.7.60 = 0x3210 (Write 0x3210 Data to MMD register 7.60 of PHY address 1):

1. Write 1.13 = 0x0007 //MMD DEVAD 7
2. Write 1.14 = 0x003C //MMD Address 60
3. Write 1.13 = 0x4007 //MMD Data command for MMD DEVAD 7
4. Write 1.14 = 0x3210 //Write MMD Data 0x3210 to 1.7.60

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6.3 MMD Data Register

Table 11 MMD Data Register table

MMD register 3.0 of PHY0~7 (Each PHY has its own MMD register 3.0 with different PHY address)

PHY	MII	R/W	Description	Default
PCS control 1 Register				
0~7	3.0[15:11]	RO	Reserved Ignore when read	0
0~7	3.0.10	R/W	Clock stop enable 1 = PHY may stop xMII Rx clock during LPI (IP178G doesn't support) 0 = Clock not stoppable	0
0~7	3.0[9:0]	RO	Reserved Ignore when read	0

MMD register 3.1 of PHY0~7 (Each PHY has its own MMD register 3.1 with different PHY address)

PHY	MII	R/W	Description	Default
PCS status 1 Register				
0~7	3.1[15:12]	RO	Reserved Ignore when read	0
0~7	3.1.11	RO/LH	Tx LPI received 1 = Tx PCS has received LPI 0 = LPI not received	0
0~7	3.1.10	RO/LH	Rx LPI received 1 = Rx PCS has received LPI 0 = LPI not received	0
0~7	3.1.9	RO	Tx LPI indication 1 = Tx PCS is currently receiving LPI 0 = PCS is not currently receiving LPI	0
0~7	3.1.8	RO	Rx LPI indication 1 = Rx PCS is currently receiving LPI 0 = PCS is not currently receiving LPI	0
0~7	3.1.7	RO	Reserved Ignore on read	0
0~7	3.1.6	RO	Clock stop capable 1 = The MAC may stop the xMII Tx clock during LPI 0 = Clock not stoppable	0
0~7	3.1[5:0]	RO	Reserved Ignore when read	0

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MMD register 3.20 of PHY0~7 (Each PHY has its own MMD register 3.20 with different PHY address)

PHY	MII	R/W	Description	Default
EEE capability Register				
0~7	3.20[15:7]	RO	Reserved Ignore when read	0
0~7	3.20.6	RO	10GBASE-KR EEE 1 = EEE is supported for 10GBASE-KR 0 = EEE is not supported for 10GBASE-KR	0
0~7	3.20.5	RO	10GBASE-KX4 EEE 1 = EEE is supported for 10GBASE-KX4 0 = EEE is not supported for 10GBASE-KX4	0
0~7	3.20.4	RO	1000BASE-KX EEE 1 = EEE is supported for 1000BASE-KX 0 = EEE is not supported for 1000BASE-KX	0
0~7	3.20.3	RO	10GBASE-T EEE 1 = EEE is supported for 10GBASE-T 0 = EEE is not supported for 10GBASE-T	0
0~7	3.20.2	RO	1000BASE-T EEE 1 = EEE is supported for 1000BASE-T 0 = EEE is not supported for 1000BASE-T	0
0~7	3.20.1	RO	100BASE-TX EEE 1 = EEE is supported for 100BASE-TX 0 = EEE is not supported for 100BASE-TX	1
0~7	3.20.0	RO	Reserved Ignore when read	0

MMD register 3.22 of PHY0~7 (Each PHY has its own MMD register 3.22 with different PHY address)

PHY	MII	R/W	Description	Default
EEE wake error count				
0~7	3.22[15:0]	RO	EEE wake error count Count wake time faults where IP178G fails to complete its normal wake sequence within the time required for the specific PHY type. This register keeps the value before reading the contents of the register.	0x0000

MMD register 7.60 of PHY0~7 (Each PHY has its own MMD register 7.60 with different PHY address)

PHY	MII	R/W	Description	Default
EEE advertisement Register				
0~7	7.60[15:7]	RO	Reserved Ignore when read	0
0~7	7.60.6	RO	10GBASE-KR EEE 1 = Advertise that the 10GBASE-KR has EEE capability 0 = Do not advertise that the 10GBASE-KR has EEE capability	0
0~7	7.60.5	RO	10GBASE-KX4 EEE 1 = Advertise that the 10GBASE-KX4 has EEE capability 0 = Do not advertise that the 10GBASE-KX4 has EEE capability	0

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MMD register 7.60 of PHY0~7 (Each PHY has its own MMD register 7.60 with different PHY address)

PHY	MII	R/W	Description	Default
0~7	7.60.4	RO	1000BASE-KX EEE 1 = Advertise that the 1000BASE-KX has EEE capability 0 = Do not advertise that the 1000BASE-KX has EEE capability	0
0~7	7.60.3	RO	10GBASE-T EEE 1 = Advertise that the 10GBASE-T has EEE capability 0 = Do not advertise that the 10GBASE-T has EEE capability	0
0~7	7.60.2	RO	1000BASE-T EEE 1 = Advertise that the 1000BASE-T has EEE capability 0 = Do not advertise that the 1000BASE-T has EEE capability	0
0~7	7.60.1	R/W	100BASE-TX EEE 1 = Advertise that the 100BASE-TX has EEE capability 0 = Do not advertise that the 100BASE-TX has EEE capability	1
0~7	7.60.0	RO	Reserved Ignore when read	0

MMD register 7.61 of PHY0~7 (Each PHY has its own MMD register 7.61 with different PHY address)

PHY	MII	R/W	Description	Default
EEE link partner ability				
0~7	7.61[15:7]	RO	Reserved Ignore when read	0
0~7	7.61.6	RO	10GBASE-KR EEE 1 = Link partner is advertising EEE capability for 10GBASE-KR 0 = Link partner is not advertising EEE capability for 10GBASE-KR	0
0~7	7.61.5	RO	10GBASE-KX4 EEE 1 = Link partner is advertising EEE capability for 10GBASE-KX4 0 = Link partner is not advertising EEE capability for 10GBASE-KX4	0
0~7	7.61.4	RO	1000BASE-KX EEE 1 = Link partner is advertising EEE capability for 1000BASE-KX 0 = Link partner is not advertising EEE capability for 1000BASE-KX	0
0~7	7.61.3	RO	10GBASE-T EEE 1 = Link partner is advertising EEE capability for 10GBASE-T 0 = Link partner is not advertising EEE capability for 10GBASE-T	0
0~7	7.61.2	RO	1000BASE-T EEE 1 = Link partner is advertising EEE capability for 1000BASE-T 0 = Link partner is not advertising EEE capability for 1000BASE-T	0
0~7	7.61.1	RO	100BASE-TX EEE 1 = Link partner is advertising EEE capability for 100BASE-TX 0 = Link partner is not advertising EEE capability for 100BASE-TX	0
0~7	7.61.0	RO	Reserved Ignore when read	0

The other Registers are reserved registers. User is inhibited to access to these registers. It may introduce abnormal function to write these registers.

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6.4 LED mode Control Register

Table 12 LED mode Control Register table

MII page3 register16 of PHY0~7 (8 PHYs share the MII register)

page	MII	R/W	Description	Default
LED Control Register				
3	16[15:14]	R/W	LED_SEL[1:0] LED output mode selection. LED_SEL[1:0]=2'b00: LED mode 0, LED_SEL[1:0]=2'b01: LED mode 1, LED_SEL[1:0]=2'b10: LED mode 2, LED_SEL[1:0]=2'b11: LED mode 3 (default)	11
	16.12	RW	SERIAL_LED_EN 1: supports LED serial mode 0: supports LED direct mode (default)	0
	16.11	RW	SERIAL_LED_MODE 1: supports link LED only 0: supports link, speed, and duplex LED (default)	0

The other Registers are reserved registers. User is inhibited to access to these registers. It may introduce abnormal function to write these registers.

LED mode behavior:

	LED mode 0	LED mode 1	LED mode 2	LED mode 3
LED_SEL[1:0]	00	01	10	11
LED_LINK[7:0]	100M Link + Activity (1: 100M Link fail, 0: 100M Link ok and no activity, flash: 100M Link ok and TX/RX activity)	Link (1: link fail, 0: link ok)	100M Link + Activity (same as mode 0)	Link + Activity (1: link fail, 0: link ok, flash: Link ok and TX/ RX activity)
LED_SPEED[7:0]	Collision (1: no collision, flash: collision)	Speed (same as mode 3)	Full/half (1: half, 0: full, flash: collision)	Speed (1: speed=10M, 0: speed=100M
LED_FULL[7:0]	10M Link + Activity (1: 10M Link fail, 0: 10M Link ok and no activity, flash: 10M Link ok and TX/RX activity)	Full/half (same as mode 3)	10M Link + Activity (same as mode 0)	Full/half (1: half, 0: full, flash: collision)

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6.5 WOL+ Control Register

Table 13 WOL+ Control Register table

MII page4 register16 of PHY0 (8 PHYs share the MII register)

page	MII	R/W	Description	Default
PHY WOL+ Control Register				
4	16.[15]	RW	WOL+ Interrupt Enable Set high to enable WOL+ interrupt 1=Enable 0=Disable Each PHY address can access the register of the corresponding port.	0
	16.[14]	RW	WOL+ Level Trigger This bit is used to select the output mode of WOL+ interrupt. 1=Level trigger (Low goes high or high goes low when WOL+ interrupt) 0=Edge trigger (Positive pulse or negative pulse when WOL+ interrupt)	1
	16.[13]	RW	WOL+ Positive Trigger This bit is used to select the polarity of WOL+ interrupt. 1=Low goes high or positive pulse 0=High goes low or negative pulse	0
	16.[12]	RW	Sense Link Change Set high to enable WOL+ interrupt when link change is sensing. 1=Enable 0=Disable	1
	16.[11]	RW	Sense Magic Packet Set high to enable WOL+ interrupt when magic packet is receiving. 1=Enable 0=Disable	1
	16.[10]	RW	Sense Any Packet Set high to enable WOL+ interrupt when any packet is receiving. 1=Enable 0=Disable	1
	16.[9]	RW	Sense DUT Set high to enable WOL+ interrupt when DUT is sensing WOL+ event. 1=Enable 0=Disable Each PHY address can access the register of the corresponding port.	1
	16.[8]	RW	WOL+ Down Speed Enable Set high to enable WOL+ down speed function 1=Enable 0=Disable	1
	16.[7:1]	RO	Reserved	0x00
	16.[0]	RO	PHY WOL+ Interrupt Status The status of PHY WOL+ interrupt is based on the setting of Reg16 Page4 Bit14 and Bit13. Each PHY address can access the register of the corresponding port.	1

MII page5 register16 of PHY0 (8 PHYs share the MII register)

page	MII	R/W	Description	Default
PHY WOL+ MAC Address Register 0				
5	16[15:0]	R/W	WOL+ MAC Address 0 (the most significant word) WOL+ MAC Address = {WOL+_MAC_Address_0, WOL+_MAC_Address_1, WOL+_MAC_Address_2}	0x0000

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MII page6 register16 of PHY0 (8 PHYs share the MII register)

page	MII	R/W	Description	Default
PHY WOL+ MAC Address Register 1				
6	16[15:0]	R/W	WOL+ MAC Address 1 WOL+ MAC Address = {WOL+_MAC_Address_0, WOL+_MAC_Address_1, WOL+_MAC_Address_2}	0x0000

MII page7 register16 of PHY0 (8 PHYs share the MII register)

page	MII	R/W	Description	Default
PHY WOL+ MAC Address Register 2				
7	16[15:0]	R/W	WOL+ MAC Address 2 (the least significant word) WOL+ MAC Address = {WOL+_MAC_Address_0, WOL+_MAC_Address_1, WOL+_MAC_Address_2}	0x0000

The other Registers are reserved registers. User is inhibited to access to these registers. It may introduce abnormal function to write these registers.

Example 1, Read page3 register16 (Read Data from page3 register16 of PHY address 0):

1. Write 0.20 = 0x0003 //page3
2. Read 0.16 //Read Data from page3 register16
3. Write 0.20 = 0x0000 //restore to page0

Example 2, Write page3 register16 = 0x3400 (Write Data 0x3400 to page3 register16 of PHY address 0):

1. Write 0.20 = 0x0003 //page3
2. Write 0.16 = 0x3400 //Write Data 0x3400 to page3 register16
3. Write 0.20 = 0x0000 //restore to page0

6.6 Register Page mode Control Register

Table 14 Page control registers table

MII register 20 of PHY0~7 (8 PHYs share the MII register)

PHY	MII	R/W	Description	Default
Page Control Register				
0~7	20[4:0]	RW	Reg16~31_Page_Sel[4:0]	00000

The other Registers are reserved registers. User is inhibited to access to these registers. It may introduce abnormal function to write these registers.

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6.7 Switch control registers (I)

Table 15 Switch control registers (I) table

PHY	MII	R/W	Description	Default
EEPROM enable register / Software reset register				
20	--		EEPROM enable register This register should be filled with 55AA in EERPOM register 0 and 1. IP178G will examine the specified pattern to confirm if there is a valid EEPROM. The initial setting is updated with the content of EEPROM only if the specified pattern 55 AA is found.	
20	0	R/W	Software reset register MII register 0 is software reset register. User can reset IP178G by writing 55AA to this register.	
20	0[15]	R	BFLL_FULL, free buffer is full 1: full, 0: not full This bit is for debug only.	
20	0[13]	R	Empty, all output queue is empty 1: empty 0: not empty This bit is for debug only.	
20	0[12:4]		Reserved	
20	0[3]	R	PAD_RESET	
20	0[2]	R	EE_RESET1	
20	0[1]	R	SOFT_RESET	
20	0[0]	R	EE_RESET	
20	1[15]	R/W	PRIORITY_RATE 1: 8 packets 0: 16 packets Output Queue Scheduling: high priority packet rate	1'b0
20	1[12]	R/W	REDUCE_IPG This function reduce the IPG by random from 0 ~ 20 PPM. 1: enable, 0:disable	1'b1
20	1[11]	R/W	Drop16 1: enable, 0:disable	1'b0
20	1[9]	R/W	MOD_CARRIER_ALGORITHM Modified carrier based collision algorithm 1: enable, 0:disable	1'b0
20	1[8]	R/W	BK_EN, Backpressure enable 1: enable, 0: disable	1'b1
20	1[7]	R/W	BP_KIND, Backpressure type selection It is valid only if BK_EN is set to 1'b1. 0: carrier base backpressure 1: reserved	1'b0

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<table>
<tr><th>PHY</th><th>MII</th><th>R/W</th><th>Description</th><th>Default</th></tr>
<tr><td>20</td><td>1[6]</td><td>R/W</td><td>BF_STM_EN, Broadcast storm enable
1: enable
IP178G drops the incoming packet if the number of broadcast packet in queue is over the threshold.
0: disable</td><td>P(0)</td></tr>
<tr><td>20</td><td>1[3:2]</td><td>R/W</td><td>AGING. Aging time of address table selection
An address tag in hashing table will be removed if this function is turned on and its aging timer expires.
<table>
<tr><th></th><th>Aging time</th><th>note</th></tr>
<tr><td>00</td><td>no aging</td><td></td></tr>
<tr><td>01</td><td>30s</td><td></td></tr>
<tr><td>10</td><td>300s</td><td>default</td></tr>
<tr><td>11</td><td>reserved</td><td></td></tr>
</table></td><td>2'b10</td></tr>
<tr><td>20</td><td>1[1]</td><td>R/W</td><td>MODBCK. Turn on modified back off algorithm
The maximum back off period is limited to 8-slot time if this function is turned on.
1: turn on, 0: turn off</td><td>1'b0</td></tr>
<tr><td>20</td><td>1[0]</td><td>R/W</td><td>LEARN_DIS_PAUSE
0: Enable to learn the SMAC of the received PAUSE frame.
1: Disable.</td><td>1'b0</td></tr>
</table>

6.8 Test mode control registers

Table 16 Test mode control registers table

PHY	MII	R/W	Description	Default
Test mode control registers				
20	2[15:10]	R/W	TMODE_SEL. Test mode selection This function is for testing only. The default value must be adopted for normal operation.	6'h00
20	2[8]		Reserved	
20	2[7]	R/W	INPUT_FILTER Packet is filtered in input port. 0: no operation (default) 1: perform input filtering when queue full	0
20	2[6:5]	R/W	HASH_MODE MAC address table hashing mode 00: direct + CRC mapping (default) 11: direct mapping	2'b00
20	2[4:1]		Reserved	

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6.9 Port mirroring control registers

PHY	MII	R/W	Description	Default
20	3[15]	R/W	PORT_MIRROR_EN Port Mirror Enable 1: Enable 0: Disable	1'b0
	3[14:13]	R/W	PORT_MIRROR_MODE Select a mirror mode to monitor 00: mirror RX (default) 01: mirror TX 10: mirror RX and TX, RX and TX path must be at the different port 11: mirror RX or TX, RX or TX path must be at the same port	2'b00
	3[12:8]		Reserved	
	3[7:0]	R/W	SEL_RX_PORT_MIRROR Select the source (receive) port to be mirrored Set 1 to select the RX path of port to be monitored. Bit0 is for Port0, bit7 for Port7, and so on.	8'h01
	4[15:13]	R/W	SEL_MIRROR_PORT Select a mirror port to monitor any other port 000: port 0 001: port 1 010: port 2 011: port 3 100: port 4 101: port 5 110: port 6 111: port 7 (default)	3'b111
	4[12:8]		Reserved	
	4[7:0]	R/W	SEL_TX_PORT_MIRROR Select the destination (transmit) port to be mirrored Set 1 to select the TX path of port to be monitored. Bit0 is for Port0, bit7 for Port7, and so on.	8'h01

6.10 Debug Regiister

PHY	MII	R/W	Description	Default
20	5[15:8]	R/W	RESERVED	16'h0
	5[7:0]	RO (SC)	CRC_COUNTER	8'h00
	6[15:8]	R/W (SC)	PAUSE_TRIGGER	8'h00
	6[7:0]	RO (SC)	PAUSE_FLAG	8'h0
	7[15]	R/W	THR_SETTING	1'b0
	7[14]	R/W (SC)	READ_THR	1'b0
	7[13]	R/W	WAIT_BACKOFF	1'b0
	7[12:8]		RESERVED	
	7[7:0]	R/W	UNIT_DEFAULT_THRESHOLD	8'd12

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PHY	MII	R/W	Description	Default
	8[15:8]	R/W	SHARE_HIGH_THRESHOLD	
	8[7:0]	R/W	SHARE_LOW_THRESHOLD	
	9[15:8]	R/W	PKT_HIGH_THRESHOLD	8'd96
	9[7:0]	R/W	PKT_LOW_THRESHOLD	8'd80
	10[15:8]	R/W	UNIT_HIGH_THRESHOLD	
	10[7:0]	R/W	UNIT_LOW_THRESHOLD	
	11[15]	R/W	MON_EN	1'b0
	11[14:9]		RESERVED	
	11[8:0]	RO (SC)	UNIT_LOW_NUM	9'd224
	12[15:9]		RESERVED	
	12[8:0]	RO (SC)	SHARE_HIGH_NUM	9'd224

6.11 Fiber duplex setting registers

PHY	MII	R/W	Description	Default
20	13[15:14]	R/W	FIBER_DUPLEX Fiber duplex setting for each port. 1: fiber port is full-duplex 0: fiber port is half_duplex bit[15]: port 7 duplex ability setting bit[14]: port 6 duplex ability setting	2'b11
	13.[13]	R/W	BUF_AGING_EN	1'b0
	13.[12]	R/W	SRC_BLK_PROTECT	1'b1
	13[11:8]		Reserved	

6.12 Backpressure setting registers

PHY	MII	R/W	Description	Default
20	13[7:0]	R/W	PORT_BACKPRESSURE_EN Backpressure ability setting at half-duplex mode for each port. To ensure this function works correctly, BK_EN (backpressure enable, reg 20.1[8]) should set to logic zero first. 1: enable backpressure ability 0: disable bit[7] : port 7 enable backpressure ability bit[6] : port 6 enable backpressure ability bit[5] : port 5 enable backpressure ability bit[4] : port 4 enable backpressure ability bit[3] : port 3 enable backpressure ability bit[2] : port 2 enable backpressure ability bit[1] : port 1 enable backpressure ability bit[0] : port 0 enable backpressure ability	8'h00

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6.13 TCP/UDP port priority registers

PHY	MII	R/W	Description	Default
20	14[15:8]	R/W	LPP_AGING_EN TCP/UDP logical port priority aging enable 0: disable TCP/UDP logical port priority aging function 1: enable TCP/UDP logical port priority aging function When this function active, once receive a IP frame with TCP/UDP protocol and the logical port number is the pre-defined port number, the ingress port will treat as a port based high priority port for 300 seconds. After the internal timer expired, the ingress port will change back to previous behavior. bit[15]: port 7 logical port priority aging enable bit[14]: port 6 logical port priority aging enable bit[13]: port 5 logical port priority aging enable bit[12]: port 4 logical port priority aging enable bit[11]: port 3 logical port priority aging enable bit[10]: port 2 logical port priority aging enable bit[9]: port 1 logical port priority aging enable bit[8]: port 0 logical port priority aging enable	8'h00
20	14[7:6]		Reserved	
20	14[5:4]	R/W	USERDEF_RANGE_EN User defined logic port range enable. bit[1]: user define range 1 register enable bit[0]: user define range 0 register enable	2'b11
20	14[3:0]	R/W	PREDEF_PORT_EN Pre-defined logic port number enable. bit[3]: logic port set 3 enable, port 6000 bit[2]: logic port set 2 enable, port 3389 bit[1]: logic port set 1 enable, port 443 bit[0]: logic port set 0 enable, port 22	4'hF
20	15	R/W	USERDEF_RANGE0_HIGH User defined logic port range 0 high limit	16'd23
20	16	R/W	USERDEF_RANGE0_LOW User defined logic port range 0 low limit	16'd23
20	17	R/W	USERDEF_RANGE1_HIGH User defined logic port range 1 high limit	16'd 5800
20	18	R/W	USERDEF_RANGE1_LOW User defined logic port range 1 low limit	16'd 5800

6.14 Test mode

PHY	MII	R/W	Description	Default
20	19[15]	R/W	FAST_MODE	1'b0
20	19[11:2]	R/W	TEST_LATIN (only for PHY test mode)	10'h000
20	19[1:0]	R/W	TEST_SEL 0x0: normal mode 0x1: switch test mode 0x2: phy test mode	2'b00

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6.15 CoS control registers – port 0

PHY	MII	R/W	Description	Default
21	0[10]	R/W	Port 0 Class of service enable 1: enable, 0: disabled (default) Packets with high priority tag from port 0 are handled as high priority packets.	1'b0
	0[9]	R/W	Port 0 set to be high priority port 1: enable, 0: disabled (default) Packets received from port 0 are handled as high priority packets.	1'b0

6.16 CoS control registers – port 1

PHY	MII	R/W	Description	Default
21	1[10]	R/W	Port 1 Class of service enable 1: enable, 0: disabled (default) Packets with high priority tag from port 1 are handled as high priority packets.	1'b0
	1[9]	R/W	Port 1 set to be high priority port 1: enable, 0: disabled (default) Packets received from port 1 are handled as high priority packets.	1'b0

6.17 CoS control registers – port 2

PHY	MII	R/W	Description	Default
21	2[10]	R/W	Port 2 Class of service enable 1: enable, 0: disabled (default) Packets with high priority tag from port 2 are handled as high priority packets.	1'b0
	2[9]	R/W	Port 2 set to be high priority port 1: enable, 0: disabled (default) Packets received from port 2 are handled as high priority packets.	1'b0

6.18 CoS control registers – port 3

PHY	MII	R/W	Description	Default
21	3[10]	R/W	Port 3 Class of service enable 1: enable, 0: disabled (default) Packets with high priority tag from port 3 are handled as high priority packets.	1'b0
	3[9]	R/W	Port 3 set to be high priority port 1: enable, 0: disabled (default) Packets received from port 3 are handled as high priority packets.	1'b0

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6.19 CoS control registers – port 4

PHY	MII	R/W	Description	Default
21	4[10]	R/W	Port 4 Class of service enable 1: enable, 0: disabled (default) Packets with high priority tag from port 4 are handled as high priority packets.	1'b0
	4[9]	R/W	Port 4 set to be high priority port 1: enable, 0: disabled (default) Packets received from port 4 are handled as high priority packets.	1'b0

6.20 CoS control registers – port 5

PHY	MII	R/W	Description	Default
21	5[10]	R/W	Port 5 Class of service enable 1: enable, 0: disabled (default) Packets with high priority tag from port 5 are handled as high priority packets.	1'b0
	5[9]	R/W	Port 5 set to be high priority port 1: enable, 0: disabled (default) Packets received from port 5 are handled as high priority packets.	1'b0

6.21 CoS control registers – port 6

PHY	MII	R/W	Description	Default
21	6[10]	R/W	Port 6 Class of service enable 1: enable, 0: disabled (default) Packets with high priority tag from port 6 are handled as high priority packets.	1'b0
	6[9]	R/W	Port 6 set to be high priority port 1: enable, 0: disabled (default) Packets received from port 6 are handled as high priority packets.	1'b0

6.22 CoS control registers – port 7

PHY	MII	R/W	Description	Default
21	7[10]	R/W	Port 7 Class of service enable 1: enable, 0: disabled (default) Packets with high priority tag from port 7 are handled as high priority packets.	1'b0
	7[9]	R/W	Port 7 set to be high priority port 1: enable, 0: disabled (default) Packets received from port 7 are handled as high priority packets.	1'b0

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6.23 Switch control registers (IV)

PHY	MII	R/W	Description	Default
21	9[15:14]	R/W	BF_STM_THR_SEL[1:0]. Broadcast storm threshold selection 00: 2 packets/10ms for 100Mbps port, or 2 packets/100ms for 10Mbps port, 01: 6 packets/10ms for 100Mbps port, or 6 packets/100ms for 10Mbps port, 10: 14 packets/10ms for 100Mbps port, or 14 packets/100ms for 10Mbps port, 11: 30 packets/10ms for 100Mbps port, or 30 packets/100ms for 10Mbps port	2'b00
	9[13:12]	R/W	SHARE_FULL_THR_SEL[1;0]. Share buffer threshold selection 00: 160 units 01: 180 units 10: 140 units 11: 120 units	2'b00
	9[11:10]	R/W	UNIT_DEFAULT_THR_SEL[1:0]. Output Queue minimum threshold selection 00: 40 units 01: 32 units 10: 48 units 11: 56 units	2'b00
	9[9:8]	R/W	UNIT_LOW_THR_SEL	2'b00
	9[7:6]	R/W	UNIT_HIGH_THR_SEL[1;0]. Output Queue Flow control ON threshold selection If share buffer is over share buffer full threshold, Output Queue Flow control ON threshold will be dynamic changed to 28. Others, 00: 50 units 01: 70 units 10: 90 units 11: 110 units	2'b00
	9[5]		Reserved	
	9[4]	R/W	PREDROP_EN 1: Drop an incoming broadcast packet if any port is congested. 0: forward an incoming broadcast packet to un-congested ports instead of congested ports.	1'b0
	9[3:2]	R/W	PKT_LOW_THR_SEL[1:0]. Packet low water mark threshold selection 00: 40 units 01: 30 units 10: 20 units 11: 10 units	2'b00
	9[1:0]	R/W	PKT_HIGH_THR_SEL[1:0]. Packet high water mark threshold selection 00: 50 units 01: 40 units 10: 30 units 11: 20 units	2'b00

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PHY	MII	R/W	Description	Default
	10[15]		RESERVED	
	10[14:12]	R/W	DRIVER[2:0] Pad Drive Current 000: 0 mA 001: 1.5 mA 010: 4.6 mA (default) 011: 9.9 mA 100: 9.9 mA 101: 9.9 mA 110: 15.1 mA 111: 18.4 mA	3'b 010
	10[11]	R/W	BF_STM_EN_QM	1'b0
	10[10]	R/W	HP_DIS_FLOW_EN Disable flow control when recived high priority packet	1'b0
	10[9]	R/W	TWOPART	1'b1
	10[8]	R/W	ALLPASS All packet forwarded include CRC packet.	1'b0
	10[7:6]	R/W	ANALOG_OFF_TIME The length of time of the push button input must be held low in order to turn off analog power 0x0: 1.5 sec 0x1: 3 sec (default) 0x2: 4.5 sec 0x3: reserved	2'b01
	10[5]		RESERVED	

6.24 Reserved Group MAC addresses

PHY	MII	R/W	Description	Default
21	11[15]	R/W	PAUSE_FILTER DA=01-80-c2-00-00-01 & EtherType=0x8808 & Opcode=1 1: forward, 0: discard (default).	1'b0
	11[14]	R/W	RSVD_GMAC_FILTER_4 Reserved Group Address 01-80-c2-00-00-40 to FF 1: forward (default), 0: discard.	1'b1
	11[13]	R/W	RSVD_GMAC_FILTER_3 Reserved Group Address 01-80-c2-00-00-30 to 3F 1: forward (default), 0: discard.	1'b1

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PHY	MII	R/W	Description	Default
	11[12]	R/W	RSVD_GMAC_FILTER_2 Reserved Group Address 01-80-c2-00-00-22 to 2F 1: forward, 0: discard (default).	1'b0
	11[11]	R/W	RSVD_GMAC_FILTER_2 GVRP GARP VLAN Registration Protocol 01-80-c2-00-00-21 1: forward, 0: discard (default).	1'b0
	11[10]	R/W	RSVD_GMAC_FILTER_2 GMRP GARP Multicast Registration Protocol 01-80-c2-00-00-20 1: forward, 0: discard (default).	1'b0
	11[9]	R/W	RSVD_GMAC_FILTER_1 Reserved Group Address 01-80-c2-00-00-10 to 1F 1: forward (default), 0: discard.	1'b1
	11[8]	R/W	RSVD_GMAC_FILTER_1 ABM All LANs Bridge Management Group address 1: forward, 0: discard (default).	1'b0
	11[7]	R/W	RSVD_GMAC_FILTER_0 Reserved Group Address 01-80-c2-00-00-04 to 0F 1: forward, 0: discard (default).	1'b0
	11[6]	R/W	RSVD_GMAC_FILTER_0 LLDP Std 802.1AB Link Layer Discovery Protocol address 01-80-C2-00-00-0E 1: forward (default), 0: discard.	1'b1

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PHY	MII	R/W	Description	Default
	11[5]	R/W	RSVD_GMAC_FILTER_0 MVRP Provider Bridge MVRP Address 01-80-C2-00-00-0D 1: forward, 0: discard (default).	1'b0
	11[4]	R/W	RSVD_GMAC_FILTER_0 PBGA Provider Bridge Group Address 01-80-C2-00-00-08 1: forward, 0: discard (default).	1'b0
	11[3]	R/W	RSVD_GMAC_FILTER_0 802.1x 802.1x PAE Address 01-80-C2-00-00-03 1: forward (default), 0: discard.	1'b1
	11[2]	R/W	RSVD_GMAC_FILTER_0 SP Slow Protocol (Link Aggregation and 802.3 OAM) 01-80-C2-00-00-02 1: forward (default), 0: discard.	1'b1
	11[1]	R/W	RSVD_GMAC_FILTER_0 MAC_CTRL MAC Control of Std IEEE 802.3 01-80-C2-00-00-01 (Not include PAUSE and 802.3ah) 1: forward, 0: discard (default).	1'b0
	11[0]	R/W	RSVD_GMAC_FILTER_0 BGA Bridge Group Address 01-80-C2-00-00-00 1: forward (default), 0: discard.	1'b1
	12[15:11]	R/W	RESERVED	

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PHY	MII	R/W	Description	Default
	12[10:2]		RSVD_FUTURE_0_FILTER Reserved for Future Standardization 0 01-80-c2-00-00-04 to 0F 1: forward. 0: discard (default),.	9'h 000
	12[1]	R/W	RSVD_MAC_CTRL_FILTER Reserved MAC Control Opcode DA=01-80-c2-00-00-01 & EtherType=0x8808 & Opcode=0x0007-0xffff 1: forward, 0: discard (default).	1'b0
	12[0]	R/W	MPCP_FILTER Multi-Poin Control Protocol Five message as follows: 1. GATE DA=01-80-c2-00-00-01 & EtherType=0x8808 & Opcode=2 2. REPORT DA=01-80-c2-00-00-01 & EtherType=0x8808 & Opcode=3 3. REGISTER_REQ DA=01-80-c2-00-00-01 & EtherType=0x8808 & Opcode=4 4. REGISTER DA=individual MAC EtherType=0x8808 & Opcode=5 5. REGISTER_ACK DA=01-80-c2-00-00-01 & EtherType=0x8808 & Opcode=6 1: forward, 0: discard (default).	1'b0
	13[13:0]	R/W	RSVD_FUTURE_1_FILTER Reserved for Future Standardization 1 01-80-c2-00-00-22 to 2F 1: forward, 0: discard (default).	14'h 0000
	14	R/W	IEEE802.1ag_FILTER IEEE 802.1ag Filter 01-80-c2-00-00-30 to 3F 1: forward (default), 0: discard.	16'h FFFF

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6.25 Switch control registers (V)

PHY	MII	R/W	Description	Default
21	30[15:8]	R/W	[15:14]: Reserved [13]: DIFFSERV_EN [12]: BF_FFFF_ONLY 1: broadcast DA=FFFFFFFF 0: broadcast DA=FFFFFFFF and multicast frame [11:8]: reserved	8'h0d
	30[7]	R/W	FWD_MAC_CTL Forward MAC control frame, the MAC control frame is identified by Ether/Type field (0x8808). 1: forward (default), 0: discard.	1'b1
	30[6:2]		Reserved	
	30[1:0]	R/W	Drop extra long packet Max forwarded packet length 2'b00: 1536 bytes (default) 2'b01: 1552 bytes 2'b10: 1518 bytes 2'b11: resreved	2'b00

6.26 EEE Timing Parameter

PHY	MII	R/W	Description	Default
22	0[15:8]		Reserved	
	0[7:0]	R/W	EEE_EN[7:0] Energy Efficient Ethernet Enable for each port bit[7]: Port 7 enable EEE function bit[6]: Port 6 enable EEE function bit[5]: Port 5 enable EEE function bit[4]: Port 4 enable EEE function bit[3]: Port 3 enable EEE function bit[2]: Port 2 enable EEE function bit[1]: Port 1 enable EEE function bit[0]: Port 0 enable EEE function	8'hFF
	1[15:14]	R/W	SLEEP_TIME_UNIT Sleep Time Unit 0x0: 1s 0x1: 1ms 0x2: 1us	2'd2
	1[11:0]	R/W	SLEEP_TIME The time to sleep = SLEEP_TIME_UNIT * SLEEP_TIME	12'd15
	2[15:14]	R/W	WAKE_TIME_UNIT_P0 Wake Up Time Unit for Port 0 0x0: 1s 0x1: 1ms 0x2: 1us	2'd2

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PHY	MII	R/W	Description	Default
	2[11:0]	R/W	WAKE_TIME_P0 Wake Up Time for Port 0 The time to wake = WAKE_TIME_UNIT_P0 * WAKE_TIME_P0 The time is between when switch de-assert LPI and when it can send data.	12'd35
	3[15:14]	R/W	WAKE_TIME_UNIT_P1 Wake Up Time Unit for Port 1	2'd2
	3[11:0]	R/W	WAKE_TIME_P1 Wake Up Time for Port 1	12'd35
	4[15:14]	R/W	WAKE_TIME_UNIT_P2 Wake Up Time Unit for Port 2	2'd2
	4[11:0]	R/W	WAKE_TIME_P2 Wake Up Time for Port 2	12'd35
	5[15:14]	R/W	WAKE_TIME_UNIT_P3 Wake Up Time Unit for Port 3	2'd2
	5[11:0]	R/W	WAKE_TIME_P3 Wake Up Time for Port 3	12'd35
	6[15:14]	R/W	WAKE_TIME_UNIT_P4 Wake Up Time Unit for Port 4	2'd2
	6[11:0]	R/W	WAKE_TIME_P4 Wake Up Time for Port 4	12'd35
	7[15:14]	R/W	WAKE_TIME_UNIT_P5 Wake Up Time Unit for Port 5	2'd2
	7[11:0]	R/W	WAKE_TIME_P5 Wake Up Time for Port 5	12'd35
	8[15:14]	R/W	WAKE_TIME_UNIT_P6 Wake Up Time Unit for Port 6	2'd2
	8[11:0]	R/W	WAKE_TIME_P6 Wake Up Time for Port 6	12'd35
	9[15:14]	R/W	WAKE_TIME_UNIT_P7 Wake Up Time Unit for Port 7	2'd2
	9[11:0]	R/W	WAKE_TIME_P7 Wake Up Time for Port 7	12'd35

6.27 WOL (Wake on LAN)

PHY	MII	R/W	Description	Default
22	10[15:8]	R/W	WOL_EN[7:0] Wake on lan enable for each port	P(8'hff)
	10[7:2]	R/W	RESERVED	
	10[1:0]	R/W	WOL_TIMER 0x0: disable 0x1: 3min 0x2: 5min 0x3: 10min	2'b0

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6.28 Link Aggregation

PHY	MII	R/W	Description	Default
22	11[15:5]		RESERVED	
	11[4:3]	R/W	AGGR_IDX_SEL Aggregation Index Selection 2'b00: index[2:0] 2'b01: {index[3], index[1:0]} 2'b10: {index[3:2], index[0]} 2'b11: index[3:1]	2'b00
	11[2:0]	R/W	AGGR_MODE Aggregation Mode 3'b000: SMAC 3'b001: DMAC 3'b010: SMAC xor DMAC 3'b011: Source port	3'b000
	12[7:0]	R/W	AGGR_GROUP0 Aggregation Group 0	8'h00
	13[7:0]	R/W	AGGR_GROUP1 Aggregation Group 1	8'h00
	14[7:0]	R/W	AGGR_MASK0 Aggregation Port Mask 0 Only one port can be selected in each aggregation group	8'hFF
	15[7:0]	R/W	AGGR_MASK1 Aggregation Port Mask 1	8'hFF
	16[7:0]	R/W	AGGR_MASK2 Aggregation Port Mask 2	8'hFF
	17[7:0]	R/W	AGGR_MASK3 Aggregation Port Mask 3	8'hFF
	18[7:0]	R/W	AGGR_MASK4 Aggregation Port Mask 4	8'hFF
	19[7:0]	R/W	AGGR_MASK5 Aggregation Port Mask 5	8'hFF
	20[7:0]	R/W	AGGR_MASK6 Aggregation Port Mask 6	8'hFF
	21[7:0]	R/W	AGGR_MASK7 Aggregation Port Mask 7	8'hFF

6.29 VLAN Group Control Register

6.29.1 VLAN Classification

PHY	MII	R/W	Description	Default
23	0[15]	R/W (SC)	VLAN_TABLE_CLR Clear the contents of VLAN TABLE register 1: clear register 0: do nothing (default) Self-clear after set and register cleared	1'b0
	0[14]		RESERVED	

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PHY	MII	R/W	Description	Default
	0[13]	R/W	UNVID_MODE Unknown-VID Mode 0: discard 1 : flood packet	1'b0
	0[12:0]		RESERVED	
	1[15:8]	R/W	VLAN_CLS[7:0] VLAN Classification associated with each port Only active at tagged-based VLAN 0 : use VID to classify VLAN -use VID to search VLAN table if tag packet -use PVID to search VLAN table if untag packet 1 : use PVID to classify VLAN -always use PVID to search VLAN table	8'h00
	1[7:0]		TAG_VLAN_EN Tag-based VLAN enable	8'h00

6.29.2 VLAN Ingress Rule

PHY	MII	R/W	Description		Default
23	2[15:14]		RESERVED		
	2[13]	R/W	VLAN_DROP_CFI Drop incoming frame, if the CFI field is not equal to zero.		1'b0
	2[12:10]	R/W	RSVD_VID[2:0] Reserved VID		3'b001
			Bit 0	The null VID. If set, frames with null VID (priority-tagged frame) treat as untagged frames. 0: disable 1: enable (default)	
			Bit 1	VID=1 (default VID) Replace default VID with PVID 0: disable (default) 1: enable	
			Bit 2	VID=FFF Discard frame if the VID is the value FFF 0: disable(default) 1: enable	
	2[9:8]	R/W	ACCEPTABLE_FRM_TYPE[1:0] Acceptable Frame Type 2'b00 Admit all frames (default) 2'b01 Admit VLAN-tagged frames 2'b10 Admit Untagged frames 2'b11 Reserved		2'b00
	2[7:0]	R/W	VLAN_INGRESS_FILTER[7:0] VLAN Ingress Filter associated with each port If ingress filter for a given port is set, frame shall discard on that port whose VLAN classification does not include that port in it member set.		8'hFF
	3		RESERVED		

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6.29.3 Default VLAN Information

PHY	MII	R/W	Description	Default
23	5[15:0]	R/W	VLAN_INFO_0. Port 0 default VLAN information value (PVID_0)	16'h0001
	6[15:0]	R/W	VLAN_INFO_1. Port 1 default VLAN information value (PVID_1)	16'h0001
	7[15:0]	R/W	VLAN_INFO_2. Port 2 default VLAN information value (PVID_2)	16'h0001
	8[15:0]	R/W	VLAN_INFO_3. Port 3 default VLAN information value (PVID_3)	16'h0001
	9[15:0]	R/W	VLAN_INFO_4. Port 4 default VLAN information value (PVID_4)	16'h0001
	10[15:0]	R/W	VLAN_INFO_5. Port 5 default VLAN information value (PVID_5)	16'h0001
	11[15:0]	R/W	VLAN_INFO_6. Port 6 default VLAN information value (PVID_6)	16'h0001
	12[15:0]	R/W	VLAN_INFO_7. Port 7 default VLAN information value (PVID_7)	16'h0001

6.29.4 VLAN TAG Control Register

PHY	MII	R/W	Description	Default
23	13[7:0]	R/W	ADD_TAG[7:0] Port x adds a VLAN tag of each outgoing packet Bit 0: Port0 Bit 1: Port1 … Bit7: Port7	8'h00
	14[7:0]	R/W	REMOVE_TAG[7:0] Port x removes the VLAN tag of each outgoing packet Bit 0: Port0 Bit 1: Port1 … Bit 7: Port7	8'h00

6.29.5 Port Based VLAN Member Register

PHY	MII	R/W	Description	Default
23	15[7:0]	R/W	PBV_MEMBER_P0[7:0] Port based VLAN member port VLAN member port associated with the Port0.	8'hFF
	15[15:8]	R/W	PBV_MEMBER_P1[7:0] Port based VLAN member port VLAN member port associated with the Port1.	8'hFF
	16[7:0]	R/W	PBV_MEMBER_P2[7:0] Port based VLAN member port VLAN member port associated with the Port2.	8'hFF
	16[15:8]	R/W	PBV_MEMBER_P3[7:0] Port based VLAN member port VLAN member port associated with the Port3.	8'hFF

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PHY	MII	R/W	Description	Default
	17[7:0]	R/W	PBV_MEMBER_P4[7:0] Port based VLAN member port VLAN member port associated with the Port4.	8'hFF
	17[15:8]	R/W	PBV_MEMBER_P5[7:0] Port based VLAN member port VLAN member port associated with the Port5.	8'hFF
	18[7:0]	R/W	PBV_MEMBER_P6[7:0] Port based VLAN member port VLAN member port associated with the Port6.	8'hFF
	18[15:8]	R/W	PBV_MEMBER_P7[7:0] Port based VLAN member port VLAN member port associated with the Port7.	8'hFF

6.29.6 Leaky VLAN Control Register

PHY	MII	R/W	Description	Default
23	19[15:3]		RESERVED	
	19[2:0]	R/W	LEAKY_VLAN[2:0] Bit0: ARP leaky VLAN Bit1: Unicast forwarding leaky VLAN, DA=individual MAC & DA match was found Bit2: Multicast leaky VLAN	3'b000

6.30 VLAN Table

6.30.1 VLAN Control Register

PHY	MII	R/W	Description	Default
24	0[15:0]	R/W	VLAN_VALID[15:0] VLAN filter is valid. The VLAN filter entry X is valid associated with the VID_X.	16'h 0000

6.30.2 VLAN Identifier Register

PHY	MII	R/W	Description	Default
24	1[11:0]	R/W	VID_0[11:0] VLAN identifier associated with VLAN 0.	12'h001
	2[11:0]	R/W	VID_1[11:0] VLAN identifier associated with VLAN 1.	12'h002
	3[11:0]	R/W	VID_2[11:0] VLAN identifier associated with VLAN 2.	12'h003
	4[11:0]	R/W	VID_3[11:0] VLAN identifier associated with VLAN 3.	12'h004
	5[11:0]	R/W	VID_4[11:0] VLAN identifier associated with VLAN 4.	12'h005
	6[11:0]	R/W	VID_5[11:0] VLAN identifier associated with VLAN 5.	12'h006
	7[11:0]	R/W	VID_6[11:0] VLAN identifier associated with VLAN 6.	12'h007

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PHY	MII	R/W	Description	Default
	8[11:0]	R/W	VID_7[11:0] VLAN identifier associated with VLAN 7.	12'h008
	9[11:0]	R/W	VID_8[11:0] VLAN identifier associated with VLAN 8.	12'h009
	1011:0]	R/W	VID_9[11:0] VLAN identifier associated with VLAN 9.	12'h00A
	11[11:0]	R/W	VID_A[11:0] VLAN identifier associated with VLAN A.	12'h00B
	12[11:0]	R/W	VID_B[11:0] VLAN identifier associated with VLAN B.	12'h00C
	13[11:0]	R/W	VID_C[11:0] VLAN identifier associated with VLAN C.	12'h00D
	14[11:0]	R/W	VID_D[11:0] VLAN identifier associated with VLAN D.	12'h00E
	15[11:0]	R/W	VID_E[11:0] VLAN identifier associated with VLAN E.	12'h00F
	16[11:0]	R/W	VID_F[11:0] VLAN identifier associated with VLAN F.	12'h010

6.30.3 VLAN Member Register

PHY	MII	R/W	Description	Default
24	17[7:0]	R/W	VLAN_MEMBER_0[7:0] VLAN member port VLAN member port associated with the VID_0.	8'hFF
	17[15:8]	R/W	VLAN_MEMBER_1[7:0] VLAN member port VLAN member port associated with the VID_1.	8'hFF
	18[7:0]	R/W	VLAN_MEMBER_2[7:0] VLAN member port VLAN member port associated with the VID_2.	8'hFF
	18[15:8]	R/W	VLAN_MEMBER_3[7:0] VLAN member port VLAN member port associated with the VID_3.	8'hFF
	19[7:0]	R/W	VLAN_MEMBER_4[7:0] VLAN member port VLAN member port associated with the VID_4.	8'hFF
	19[15:8]	R/W	VLAN_MEMBER_5[7:0] VLAN member port VLAN member port associated with the VID_5.	8'hFF
	20[7:0]	R/W	VLAN_MEMBER_6[7:0] VLAN member port VLAN member port associated with the VID_6.	8'hFF
	20[15:8]	R/W	VLAN_MEMBER_7[7:0] VLAN member port VLAN member port associated with the VID_7.	8'hFF

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PHY	MII	R/W	Description	Default
	21[7:0]	R/W	VLAN_MEMBER_8[7:0] VLAN member port VLAN member port associated with the VID_8.	8'hFF
	21[15:8]	R/W	VLAN_MEMBER_9[7:0] VLAN member port VLAN member port associated with the VID_9.	8'hFF
	22[7:0]	R/W	VLAN_MEMBER_A[7:0] VLAN member port VLAN member port associated with the VID_A.	8'hFF
	22[15:8]	R/W	VLAN_MEMBER_B[7:0] VLAN member port VLAN member port associated with the VID_B.	8'hFF
	23[7:0]	R/W	VLAN_MEMBER_C[7:0] VLAN member port VLAN member port associated with the VID_C.	8'hFF
	23[15:8]	R/W	VLAN_MEMBER_D[7:0] VLAN member port VLAN member port associated with the VID_D.	8'hFF
	24[7:0]	R/W	VLAN_MEMBER_E[7:0] VLAN member port VLAN member port associated with the VID_E.	8'hFF
	24[15:8]	R/W	VLAN_MEMBER_F[7:0] VLAN member port VLAN member port associated with the VID_F.	8'hFF

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7 Electrical Characteristics

7.1 Absolute Maximum Rating

Stresses exceed those values listed under Absolute Maximum Ratings may cause permanent damage to the device. Functional performance and device reliability are not guaranteed under these conditions. All voltages are specified with respect to GND.

Supply Voltage	– 0.3V to 3.63V
Input Voltage	– 0.3V to 3.63V
Output Voltage	– 0.3V to 3.63V
Storage Temperature	– 65°C to 150°C
Ambient Operating Temperature (Ta) (IP178G/GA)	0°C to 70°C
IC Junction Temperature (Tj) (IP178G/GA)	0°C to 125°C

7.2 Crystal Specifications

Item	Parameter	Range
1	Nominal Frequency	25.000 MHz
2	Oscillation Mode	Fundamental Mode
3	Frequency Tolerance at 25℃	+/- 50 ppm
4	Temperature Characteristics	+/- 50 ppm
5	Operating Temperature Range	-10℃ ~ +70℃
6	Equivalent Series Resistance	40 ohm Max.
7	Drive Level	100 μW
8	Load Capacitance	20 pF
9	Shunt Capacitance	7 pF Max
10	Insulation Resistance	Mega ohm Min./DC 100V
11	Aging Rate A Year	+/- 5 ppm/year

7.3 DC Characteristic

7.3.1 Operating Conditions

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Core Supply Voltage	DVDD	1.05	1.1	1.23	V	
Analog Low Supply Voltage	AV10					
Analog High Supply Voltage	AV33	3.15	3.3	3.45		
I/O pad Supply Voltage	PVDD					
Power Consumption	P_{100MF}		950		mW	All port link 100M Full activ
	P_{10MF}		880			All port link 10M Full activ
	P_{IDLE}		180			All port unlink

7.3.2 Input Clock

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Frequency	F		25		MHz	
Frequency Tolerance	F_T	-50		+50	ppm	

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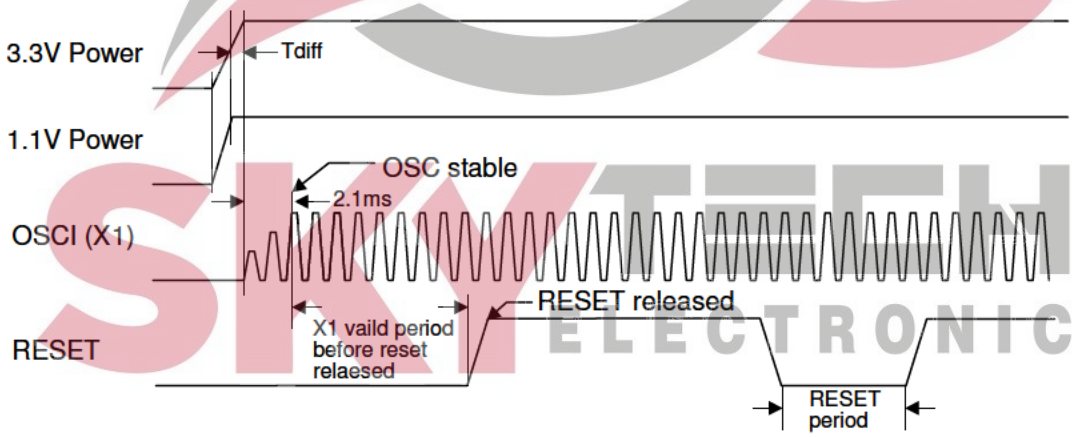
7.3.3 I/O Electrical Characteristics

Parameter	Sym	Min.	Max.	Unit	Conditions
Input Low Voltage -LED PAD direct mode -LED PAD bicolor mode -NOT LED PAD	V_{IL}		0.39*PVDD 0.36*PVDD 0.4*PVDD	V	
Input High Voltage -LED PAD direct mode -LED PAD bicolor mode -NOT LED PAD	V_{IH}	0.58*PVDD 0.58*PVDD 0.6*PVDD		V	
X1 Input Low Voltage	V_{ILosc}		0.6	V	
X1 Input High Voltage	V_{IHosc}	1.5		V	
Output Low Voltage	V_{OL}		0.1*PVDD	V	
Output High Voltage	V_{OH}	0.8*PVDD		V	
RESETB Threshold Voltage	V_{THRST}	0.4*PVDD	0.6*PVDD	V	

7.4 AC Timing

7.4.1 Power On Sequence and Reset Timing

Description	Min.	Typ.	Max.	Unit
X1 valid period before reset released	10	-	-	ms
Reset period	10	-	-	ms
All power source ready before reset released	10			ms
Time difference between VCC3.3 and VCC1.0 (Tdiff)	-2			ms



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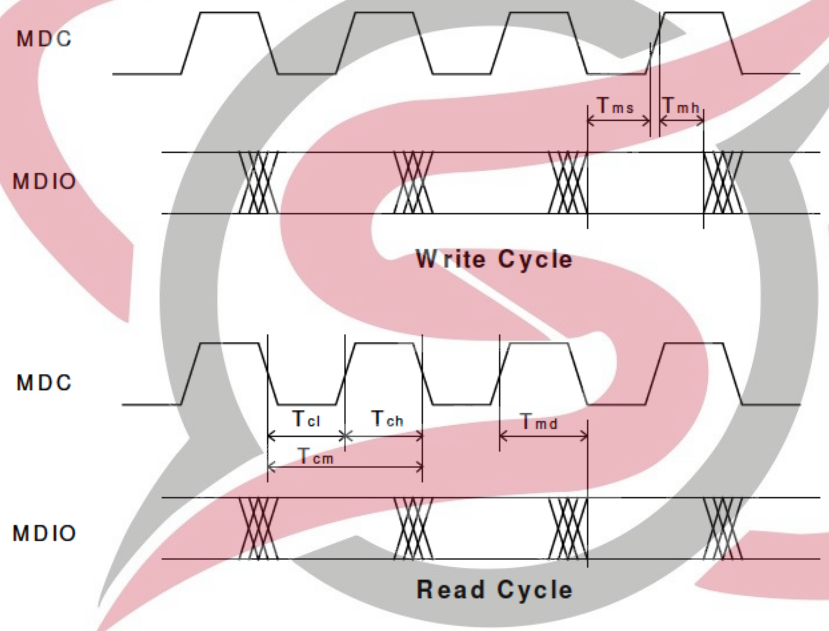
7.4.2 Serial Management Imierface Timing

Symbol	Description	Min.	Typ.	Max.	Unit
T_{ch}	MDC High Time	200	-	-	ns
T_{cl}	MDC Low Time	200	-	-	ns
T_{cm}	MDC period	400	-	-	ns
T_{md}	MDIO output delay	-	-	20	ns
T_{mh}	MDIO setup time	10	-	-	ns
T_{ms}	MDIO hold time	10	-	-	ns



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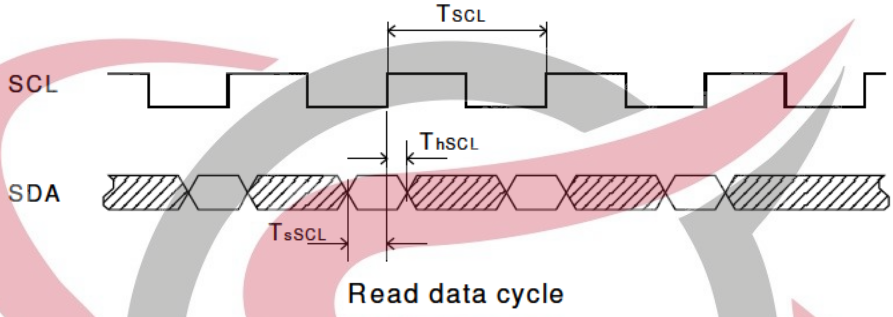
7.4.3 EEPROM Timing

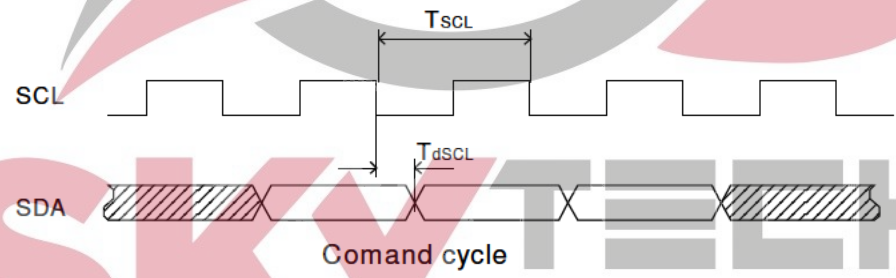
7.4.3.1 Data read cycle

Symbol	Description	Min.	Typ.	Max.	Unit
T_{SCL}	Receive clock period	-	20480	-	ns
T_{sSCL}	SDA to SCL setup time	2	-	-	ns
T_{hSCL}	SDA to SCL hold time	0.5	-	-	ns



7.4.3.2 Command cycle

Symbol	Description	Min.	Typ.	Max.	Unit
T_{SCL}	Transmit clock period	-	20480	-	ns
T_{dSCL}	SCL falling edge to SDA	-	-	5200	ns



7.5 Thermal Data

IP178G/IP178GI

Theta Ja	Theta Jc	Psi JT	Conditions	Units
29.9	14.1	4.3	2 Layer PCB	°C/W
25.4	12.7	4.1	4 Layer PCB	°C/W

IP178GA/IP178GAI

Theta Ja	Theta Jc	Psi JT	Conditions	Units
37.3	19.0	5.5	2 Layer PCB	°C/W
31.7	18.1	5.2	4 Layer PCB	°C/W

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8 Order Information

Part No.	Package	Operating Temperature	Notice
IP178G	68-Lead QFN	0°C to 70°C	

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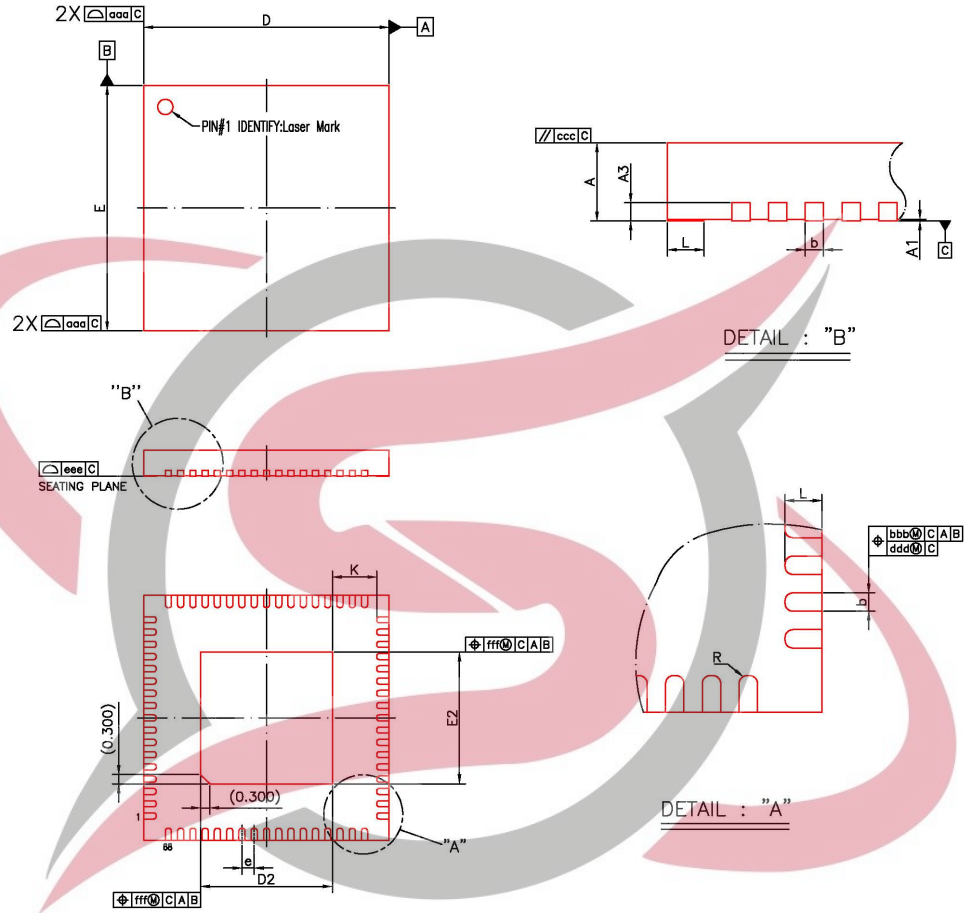
9 Package Detail

9.1 68 QFN Outline Dimensions



Symbol	Dimension in mm			Dimension in inch		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.85	0.90	0.031	0.033	0.035
A1	0.00	0.02	0.05	0.000	0.001	0.002
A3	0.20 REF			0.008 REF		
b	0.15	0.20	0.25	0.006	0.008	0.010
D/E	7.90	8.00	8.10	0.311	0.315	0.319
D2/E2	4.15	4.30	4.45	0.163	0.169	0.175
e	0.40 BSC			0.016 BSC		
L	0.30	0.40	0.50	0.012	0.016	0.020
R	0.075	---	---	0.003	---	---
K	0.20	---	---	0.008	---	---
aaa	0.10			0.004		
bbb	0.07			0.003		
ccc	0.10			0.004		
ddd	0.05			0.002		
eee	0.08			0.003		
fff	0.10			0.004		

NOTE:
1. CONTROLLING DIMENSION : MILLMETER
2. REFERENCE DOCUMENT : JEDEC MO-220 .

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