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**SKMAG** Siscofer Technology(ShenZhen)Co.,Ltd.

# SK8211FS    Datasheet

INTEGRATED 10/100/1000 GIGABIT ETHERNET TRANSCEIVER

VERSION   V1.10  
DATE       2023-12-21

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## Revision History

| Revision | Release Date | Summary                     |
|----------|--------------|-----------------------------|
| Draft 01 | 2021/07/12   | First version.              |
| Draft 02 | 2021/08/04   | Add mechanical information. |
| Draft 03 | 2023/12/21   | Add mechanical information. |

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# 1. General Description

The SK8211FS is a highly integrated Ethernet transceiver that complies with 10BASE-Te, 100BASE-TX, and 1000BASE-T IEEE 802.3 standards. It provides all the necessary physical layer functions to transmit and receive Ethernet packets over CAT.5E UTP cable.

The SK8211FS uses state-of-the-art DSP technology and an Analog Front End (AFE) to enable high-speed data transmission and reception over UTP cable. Functions such as Crossover Detection & Auto-Correction, polarity correction, adaptive equalization, cross-talk cancellation, echo cancellation, timing recovery, and error correction are implemented in the SK8211FS to provide robust transmission and reception capabilities at 10Mbps, 100Mbps, or 1000Mbps.

Data transfer between MAC and PHY is via the Reduced Gigabit Media Independent Interface (RGMII), or Serial Gigabit Media Independent Interface (SGMII) for 1000BASE-T, 100BASE-TX and 10BASE-Te. The SK8211FS supports various RGMII signaling voltages, including 3.3V, 2.5V, and 1.8V.

The SK8211FS also supports a SerDes interface that can be configured as SGMII, 1000BASE-X or 100BASE-FX.

## 1.1. TARGET APPLICATIONS

- DTV (Digital TV)
- MAU (Media Access Unit)
- CNR (Communication and Network Riser)
- Game Console
- Printer and Office Machine
- DVD Player and Recorder
- Ethernet Hub
- Ethernet Switch
- Base Stations and Controllers
- Routers, DSLAMs, PON Equipment
- Test and Measurement Systems
- Industrial and Factory Automation Equipment
- Multimedia synchronization and Real Time Networking
- Any embedded system with an Ethernet MAC that needs a UTP physical connection.

## 2. Features

- 1000BASE-T IEEE 802.3ab Compliant
- 100BASE-TX IEEE 802.3u Compliant
- 10BASE-T IEEE 802.3 Compliant
- Support 1000BASE-X / 100BASE-FX
- Supports RGMII/SGMII MAC interface
- Supports IEEE 802.3az-2010 (Energy Efficient Ethernet)
- Supports Synchronous Ethernet (Sync-E)
- Built-in Wake-on-LAN (WOL) over UTP/Fiber
- Supports interrupt function over UTP/Fiber
- Supports Parallel Detection
- Crossover Detection & Auto-Correction
- Automatic polarity correction
- Baseline Wander Correction
- Supports 120m for CAT.5E cable in 1000BASE-T
- Selectable 3.3V/2.5V/1.8V signaling for RGMII.
- Supports 25MHz external crystal or OSC
- Provides 25MHz/125MHz clock source for MAC
- Provides 3 network status LEDs
- Supports Link Down Power Saving (Sleep Mode)
- Supports SERDES (SGMII/1000BASE-X/100BASE-FX )
- Supports 1000BASE-X/100FX unidirection
- Supports Fiber-to-UTP Media Convertor mode or SGMII-to-RGMII Bridge mode
- Supports UTP/Fiber Auto Detection
- Supports 18k bytes jumbo frame when 1000BASE-T and 100BASE-TX, and 10k bytes when 10BASE-T
- Built-in Switching Regulator for core power 1.1V
- Built-in LDO for RGMII IO power 2.5V/1.8V
- Industrial grade manufacturing process
- 3.3V and 1.1V power supply
- 48-pin QFN Green Package

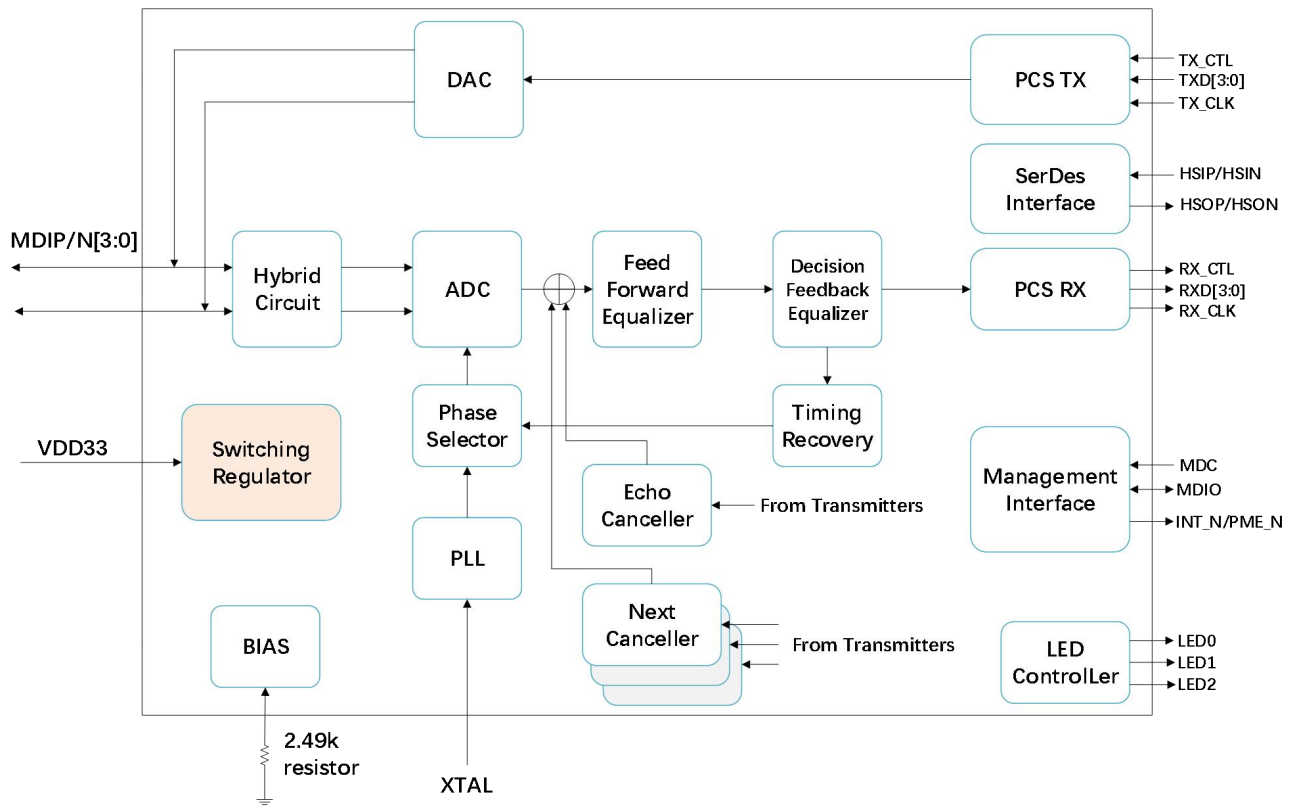


Figure 1. Block Diagram

### 3. Pin Assignment

#### 3.1. SK8211FS QFN48 6x6mm

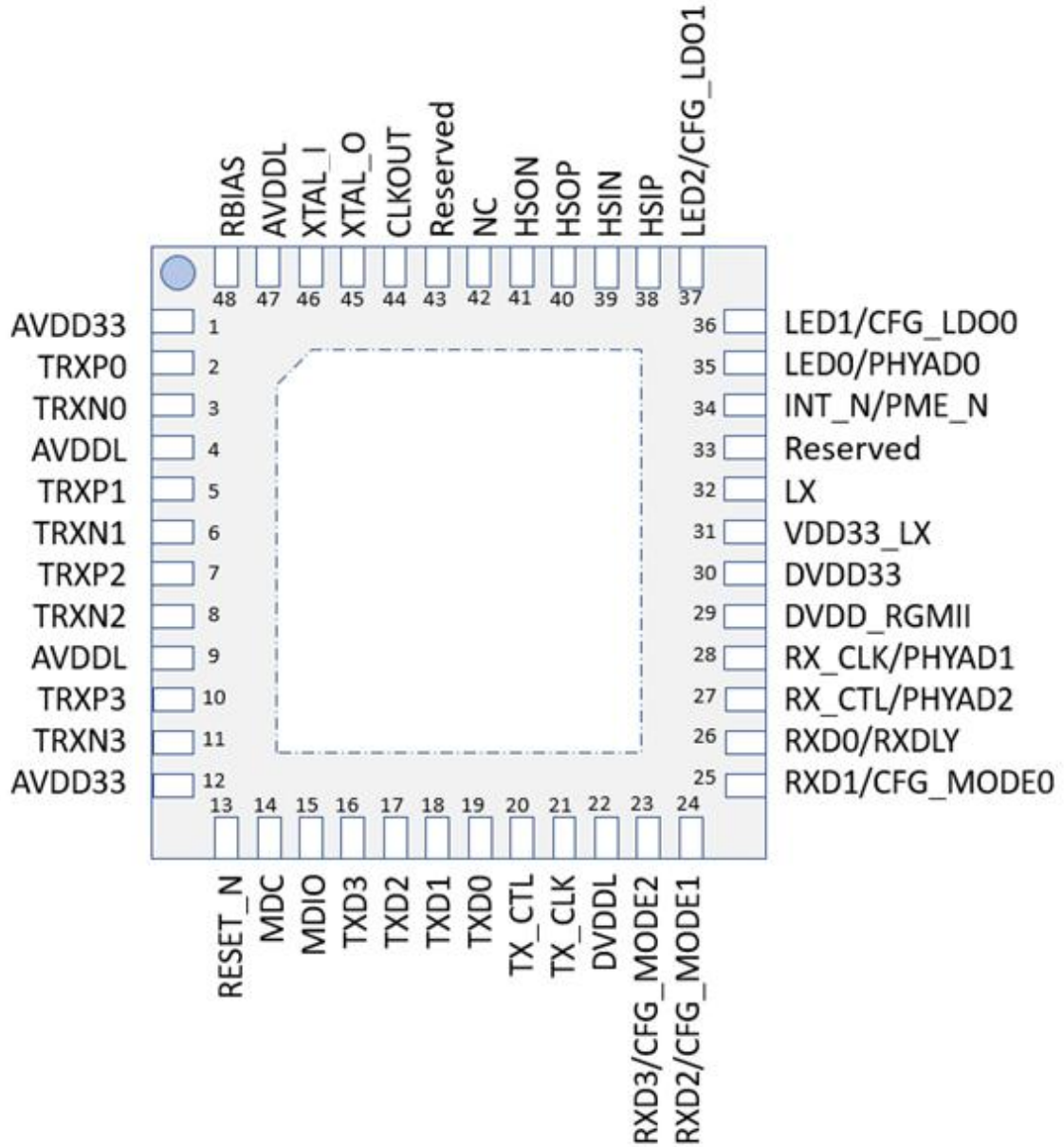


Figure 2. Pin Assignment Diagram

### 3.2. Pin Descriptions

Some pins have multiple functions.

Refer to the Pin Assignment figures for a graphical representation.

- I: Input
- O: Output
- IO: Bidirectional Input and Output
- LI: Latched Input During Power UP
- P: Power
- PU: Internal pull up
- PD: Internal pull down
- G: Ground
- OD: Open Drain
- XT: Crystal Related

### 3.3. Pin Assignment

**Table 1. Pin Assignment**

| No. | Pin Name       | Type    |
|-----|----------------|---------|
| 1   | AVDD33         | P       |
| 2   | TRXP0          | IO      |
| 3   | TRXN0          | IO      |
| 4   | AVDDL          | P       |
| 5   | TRXP1          | IO      |
| 6   | TRXN1          | IO      |
| 7   | TRXP2          | IO      |
| 8   | TRXN2          | IO      |
| 9   | AVDDL          | P       |
| 10  | TRXP3          | IO      |
| 11  | TRXN3          | IO      |
| 12  | AVDD33         | P       |
| 13  | RESET_N        | I/PU    |
| 14  | MDC            | I/PD    |
| 15  | MDIO           | IO/PU   |
| 16  | TXD3           | I/PD    |
| 17  | TXD2           | I/PD    |
| 18  | TXD1           | I/PD    |
| 19  | TXD0           | I/PD    |
| 20  | TX_CTL         | I/PD    |
| 21  | TX_CLK         | I/PD    |
| 22  | DVDDL          | P       |
| 23  | RXD3/CFG_MODE2 | O/LI/PD |
| 24  | RXD2/CFG_MODE1 | O/LI/PD |
| 25  | RXD1/CFG_MODE0 | O/LI/PD |

| No. | Pin Name      | Type    |
|-----|---------------|---------|
| 26  | RXD0/RXDLY    | O/LI/PU |
| 27  | RX_CTL/PHYAD2 | O/LI/PD |
| 28  | RX_CLK/PHYAD1 | O/LI/PD |
| 29  | DVDD_RGMII    | P       |
| 30  | DVDD33        | P       |
| 31  | VDD33_LX      | P       |
| 32  | LX            | P/O     |
| 33  | Reserved      | IO/PD   |
| 34  | INT_N/PME_N   | O/OD    |
| 35  | LED0/PHYAD0   | O/LI/PU |
| 36  | LED1/CFG_LDO0 | O/LI/PU |
| 37  | LED2/CFG_LDO1 | O/LI/PD |
| 38  | HSIP          | I       |
| 39  | HSIN          | I       |
| 40  | HSOP          | O       |
| 41  | HSON          | O       |
| 42  | NC            | -       |
| 43  | Reserved      | G       |
| 44  | CLKOUT        | O       |
| 45  | XTAL_O        | XT      |
| 46  | XTAL_I        | XT      |
| 47  | AVDDL         | P       |
| 48  | RBIAS         | O       |
| 49  | GND           | G       |

### 3.4. Transceiver Interface

**Table 2. Transceiver Interface**

| No. | Pin Name | Type | Description                                         |
|-----|----------|------|-----------------------------------------------------|
| 2   | TRXP0    | IO   | Media-dependent interface 0, 100Ω transmission line |
| 3   | TRXN0    | IO   | Media-dependent interface 0, 100Ω transmission line |
| 5   | TRXP1    | IO   | Media-dependent interface 1, 100Ω transmission line |
| 6   | TRXN1    | IO   | Media-dependent interface 1, 100Ω transmission line |
| 7   | TRXP2    | IO   | Media-dependent interface 2, 100Ω transmission line |
| 8   | TRXN2    | IO   | Media-dependent interface 2, 100Ω transmission line |
| 10  | TRXP3    | IO   | Media-dependent interface 3, 100Ω transmission line |
| 11  | TRXN3    | IO   | Media-dependent interface 3, 100Ω transmission line |

### 3.5. Clock

**Table 3. Clock**

| No. | Pin Name | Type | Description                                                                                                                                                                                                                                                                                                                                                  |
|-----|----------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44  | CLKOUT   | O    | <p>1. Reference Clock Generated from Internal PLL. This pin should be kept floating if the clock is not used by the MAC.</p> <p>2. UTP recovery receive clock for Sync Ethernet.</p> <p>3. Fiber recovery receive clock for Sync Ethernet.</p> <p>4. 25MHz reference clock.</p> <p>This pin should be kept floating if the clock is not used by the MAC.</p> |
| 45  | XTAL_O   | XT   | <p>25Mhz Crystal Output pin.</p> <p>If use external oscillator or clock from another device.</p> <p>1. When connect an external 25MHz oscillator or clock from another device to XTAL_O pin, XTAL_I must be shorted to GND.</p> <p>2. When connect an external 25MHz oscillator or clock from another device to XTAL_I pin, keep the XTAL_O floating.</p>    |
| 46  | XTAL_I   | XT   | <p>25MHz Crystal Input pin.</p> <p>If use external oscillator or clock from another device.</p> <p>1. When connect an external 25MHz oscillator or clock from another device to XTAL_O pin, XTAL_I must be shorted to GND.</p> <p>2. When connect an external 25MHz oscillator or clock from another device to XTAL_I pin, keep the XTAL_O floating.</p>     |

### 3.6. RGMII

**Table 4. RGMII**

| No. | Pin Name | Type | Description                                                                       |
|-----|----------|------|-----------------------------------------------------------------------------------|
| 16  | TXD3     | I/PD | Transmit Data.<br>Data is transmitted from MAC to PHY via TXD[3:0].               |
| 17  | TXD2     | I/PD |                                                                                   |
| 18  | TXD1     | I/PD |                                                                                   |
| 19  | TXD0     | I/PD |                                                                                   |
| 20  | TX_CTL   | I/PD | Transmit Control Signal from the MAC.                                             |
| 21  | TX_CLK   | I/PD | The transmit reference clock will be 125MHz, 25MHz, or 2.5MHz depending on speed. |

|    |        |         |                                                                                                                        |
|----|--------|---------|------------------------------------------------------------------------------------------------------------------------|
| 23 | RXD3   | O/LI/PD | Receive Data.<br>Data is transmitted from PHY to MAC via RXD[3:0].                                                     |
| 24 | RXD2   | O/LI/PD |                                                                                                                        |
| 25 | RXD1   | O/LI/PD |                                                                                                                        |
| 26 | RXD0   | O/LI/PU |                                                                                                                        |
| 28 | RX_CLK | O/LI/PD | The continuous receive reference clock will be 125MHz, 25MHz, or 2.5MHz, and is derived from the received data stream. |
| 27 | RX_CTL | O/LI/PD | Receive Control Signal to the MAC.                                                                                     |

### 3.7. SerDes

**Table 5. SerDes**

| No. | Pin Name | Type | Description                                                                                                                                                                                                                                                       |
|-----|----------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 38  | HSIP     | I    | SerDes Differential Input: 1.25GHz serial interfaces to receive data from an External device that supports the SGMII interface.<br>The differential pair has an internal 100 ohm termination resistor.                                                            |
| 39  | HSIN     | I    |                                                                                                                                                                                                                                                                   |
| 40  | HSOP     | O    | SerDes Differential Output: 1.25GHz serial interfaces to transfer data from an External device that supports the SGMII interface.<br>Both HSOP and HSON have an internal 50 ohm termination resistor to AVDDL, which means the differential impedance is 100 ohm. |
| 41  | HSON     | O    |                                                                                                                                                                                                                                                                   |

### 3.8. Reset

**Table 6. Reset**

| No. | Pin Name | Type | Description                                                       |
|-----|----------|------|-------------------------------------------------------------------|
| 13  | RESET_N  | I/PU | Hardware reset, active low. Requires an external pull-up resistor |

### 3.9. Mode Selection

**Table 7. Mode Selection**

| No. | Name      | Type    | Description                                                                                                                                                                                    |
|-----|-----------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 35  | PHYAD0    | O/LI/PU | PHYAD[2:0]. PHY address config                                                                                                                                                                 |
| 28  | PHYAD1    | O/LI/PD |                                                                                                                                                                                                |
| 27  | PHYAD2    | O/LI/PD |                                                                                                                                                                                                |
| 26  | RXDLY     | O/LI/PU | RGMII receiver clock timing control<br>Pull-up to add 2ns delay on RX_CLK, when RX_CLK is 125MHz or, to add 8ns delay on RX_CLK when RX_CLK is 25MHz/2.5MHz, which shall be used to latch RXD. |
| 36  | CFG_LDO0  | O/LI/PU | CFG_LDO[1:0], Voltage selection for RGMII I/O pad<br>2'b00: 3.3V<br>2'b01: 2.5V<br>2'b10 or 2'b11: 1.8V                                                                                        |
| 37  | CFG_LDO1  | O/LI/PD |                                                                                                                                                                                                |
| 25  | CFG_MODE0 | O/LI/PD |                                                                                                                                                                                                |
| 24  | CFG_MODE1 | O/LI/PD | CFG_MODE[2:0]: Operation Mode Configuration.<br>3'b000: UTP <-> RGMII<br>3'b001: FIBER <-> RGMII<br>3'b010: UTP/FIBER <-> RGMII (Media Auto Detection)<br>3'b011: UTP <-> SGMII                |

|    |           |         |                                                                                                                                                                                                              |
|----|-----------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 23 | CFG_MODE2 | O/LI/PD | 3'b100: SGMII (PHY side) <-> RGMII (MAC side),<br>3'b101: SGMII (MAC side) <-> RGMII (PHY side)<br>3'b110: UTP <-> FIBER (Media Conversion auto mode)<br>3'b111: UTP <-> FIBER (Media Conversion force mode) |
|----|-----------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### 3.10. LED Default Settings

**Table 8. LED Default Settings**

| No. | Pin Name | Type    | Description                                                       |
|-----|----------|---------|-------------------------------------------------------------------|
| 35  | LED0     | O/LI/PU | Light = Link up at 10Mbps<br>Blinking = Transiting or Receiving   |
| 36  | LED1     | O/LI/PU | Light = Link up at 100Mbps<br>Blinking = Transiting or Receiving  |
| 37  | LED2     | O/LI/PD | Light = Link up at 1000Mbps<br>Blinking = Transiting or Receiving |

### 3.11. Regulator and Reference

**Table 9. Regulator and Reference**

| No. | Pin Name | Type | Description                                                                                       |
|-----|----------|------|---------------------------------------------------------------------------------------------------|
| 48  | RBIAS    | O    | Bias Resistor.<br>An external 2.49 kΩ±1% resistor must be connected between the RBIAS pin and GND |
| 32  | LX       | P/O  | Switch regulator 1.1V output.<br>Connect to an external 2.2 uH power inductor directly            |

### 3.12. Power Related

**Table 10. Power Related**

| No.      | Pin Name   | Type | Description                                                                                                                                                                                                                                                                                                                                                                                         |
|----------|------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30       | DVDD33     | P    | 3.3V Power<br>Digital non-RGMII I/O power                                                                                                                                                                                                                                                                                                                                                           |
| 31       | VDD33_LX   | P    | 3.3V power for switching regulator                                                                                                                                                                                                                                                                                                                                                                  |
| 29       | DVDD_RGMII | P    | Digital RGMII I/O, MDC/MDIO power, adjusted by CFG_LDO[1:0].<br><i>Note: When CFG_LDO[1:0] = 00, the I/O pad power is supplied from the external 3.3V power connected to DVDD_RGMII pin. Otherwise, it is supplied from the internal LDO.</i><br><i>No matter whether the I/O pad power form external or internal, a bulk capacitor and a decoupling capacitor should be connected to this pin.</i> |
| 22       | DVDDL      | P    | Digital power 1.1V                                                                                                                                                                                                                                                                                                                                                                                  |
| 1, 12    | AVDD33     | P    | Analog Power 3.3V                                                                                                                                                                                                                                                                                                                                                                                   |
| 4, 9, 47 | AVDDL      | P    | Analog power 1.1V                                                                                                                                                                                                                                                                                                                                                                                   |
| 49       | GND        | G    | Exposed PAD                                                                                                                                                                                                                                                                                                                                                                                         |

### 3.13. Management

**Table 11. Management**

| No. | Pin Name    | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----|-------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14  | MDC         | I/PD  | Management Data Clock.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 15  | MDIO        | IO/PU | Input/Output of Management Data.<br>Pull up 3.3V/2.5V/1.8V for 3.3V/2.5V/1.8V I/O respectively                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 34  | INT_N/PME_N | O/OD  | <p>This pin is shared by two functions, the default pin setting is INT_N. Keep this pin floating if either of the functions is not used. The pin type depends on function selected:</p> <ol style="list-style-type: none"> <li>1. Interrupt (should be 3.3V pulled up).<br/>Set low if the specified events occurred; active low.</li> <li>2. Power Management Event (should be 3.3V pulled up).<br/>Set low if received a magic packet; active low.</li> </ol> <p><i>Note 1: The behavior of INT_N is level-triggered, the behavior of PME_N is level-triggered or pulse-triggered which is controlled by EXT 0xA00A bit[0].</i></p> <p><i>Note 2: The function of INT_N/PME_N can be assigned by EXT 0xA00a bit[6].</i></p> <p><i>1: Pin 34 functions as PME_N.</i></p> <p><i>0: Pin 34 functions as INT_N (default).</i></p> |

### 3.14. Miscellaneous Pins

**Table 12. Miscellaneous Pins**

| No. | Pin Name | Type  | Description                                                                                        |
|-----|----------|-------|----------------------------------------------------------------------------------------------------|
| 33  | Reserved | IO/PD | Reserved for internal use.<br>Keep floating or external pull down.<br>Should not external pull up. |
| 42  | NC       | -     | NC, keep floating or connect to GND                                                                |
| 43  | Reserved | G     | Keep floating or connect to GND.<br>Should not connect to VDD or be pulled up.                     |

## 4. Function Description

### 4.1. Application Diagram

#### 4.1.1. UTP (UTP<->RGMII / UTP<->SGMII) Application



Figure 3. UTP (UTP<->RGMII / UTP<->SGMII) Application

#### 4.1.2. Fiber (FIBER<->RGMII) Application

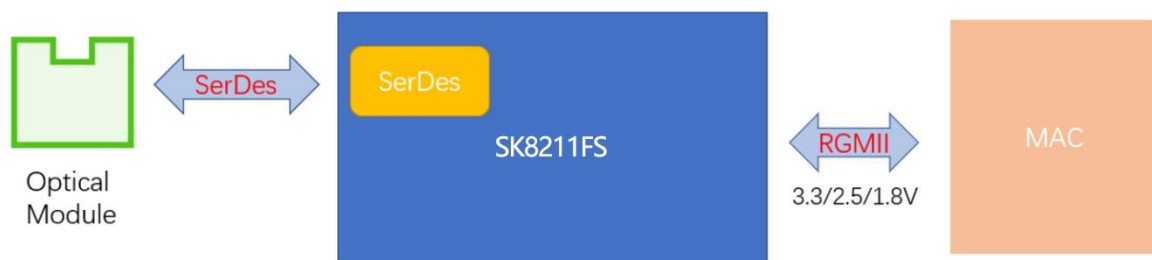


Figure 4. Fiber (FIBER<->RGMII) Application

#### 4.1.3. UTP/Fiber to RGMII (UTP/FIBER Media Auto Detection RGMII) Application

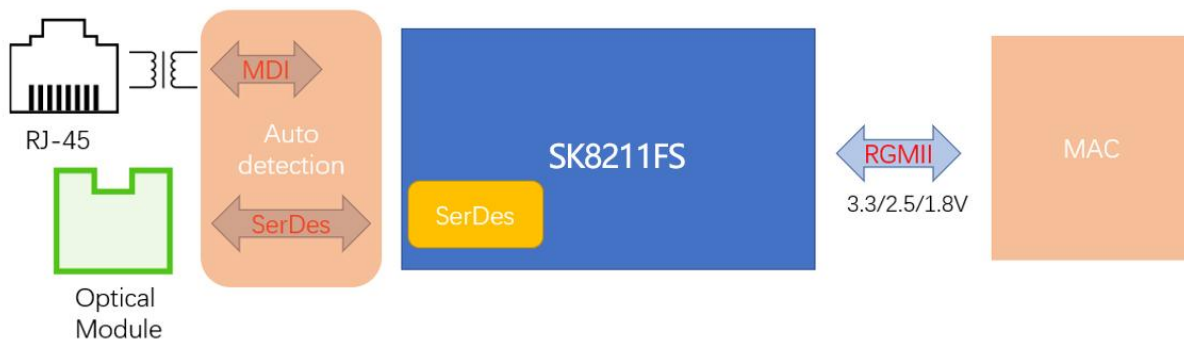


Figure 5. UTP/Fiber to RGMII Application

#### 4.1.4. SGMII to RGMII (SGMII <->RGMII Bridge Mode) Application

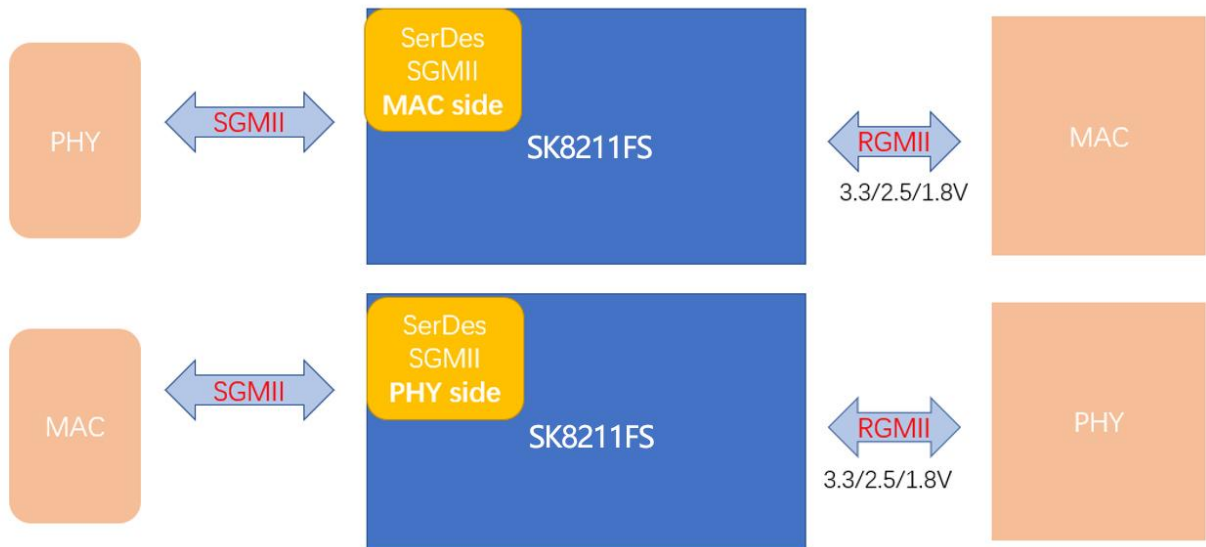


Figure 6. SGMII to RGMII Application

#### 4.1.5. Fiber to UTP (UTP<->FIBER Media Converter) Application

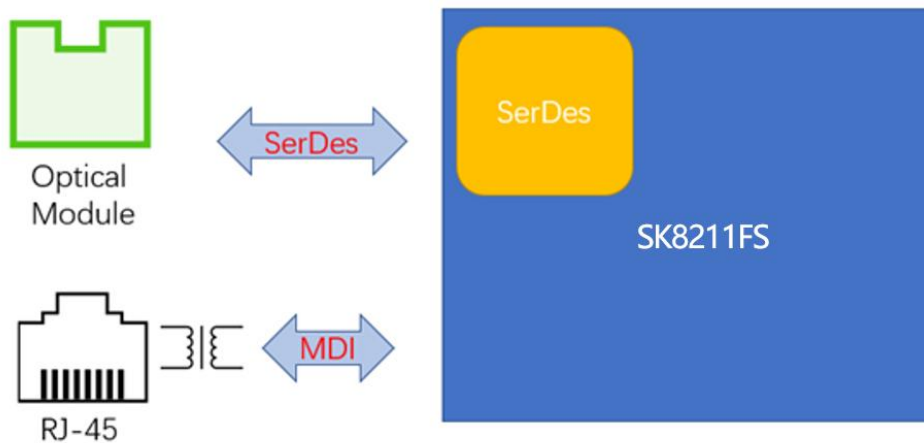


Figure 7. Fiber to UTP Application

There are two modes for Fiber applications. Media Conversion auto mode and Media Conversion force mode.

In Media Conversion auto mode, SerDes can choose speed automatically between 1000BASE-X and 100BASE-FX based on signal received and type of fiber module. Then UTP will choose the speed which is matched with SerDes automatically.

In Media Conversion force mode, UTP only has 1000BASE-T ability and SerDes is configured as 1000BASE-X by default. To manually choose UTP speed, please configure UTP MII register 0x4 and 0x9. To manually choose SerDes speed, please configure common EXT\_Reg\_0xA006 bit[0].

In FIBER <-> RGMII, UTP/FIBER to RGMII and UTP <->FIBER (Media Conversion auto mode) mode, fiber works in Media Conversion auto mode. In UTP <->FIBER (Media Conversion force mode) mode, fiber works in Media Conversion force mode.

## 4.2. Transmit Functions

### 4.2.1. Transmit Encoder Modes

#### 4.2.1.1. 1000BASE-T

In 1000BASE-T mode, the SK8211FS scrambles transmit data bytes from the MAC interfaces to 9-bit symbols and encodes them into 4D five-level PAM signals over the four pairs of CAT.5E UTP cable.

#### 4.2.1.2. 100BASE-TX

In 100BASE-TX mode, 4-bit data from the MII is 4B/5B serialized, scrambled, and encoded to a three-level MLT3 sequence transmitted by the PMA.

#### 4.2.1.3. 10BASE-Te

In 10BASE-Te mode, the SK8211FS transmits and receives Manchester-encoded data.

## 4.3. Receive Functions

### 4.3.1. Receive Decoder Modes

#### 4.3.1.1. 1000BASE-T

In 1000BASE-T mode, the PMA recovers the 4D PAM signals after accounting for the cabling conditions such as skew among the four pairs, the pair swap order, and the polarity of the pairs. The resulting code group is decoded into 8-bit data values. Data stream delimiters are translated appropriately and data is output to the MAC interfaces.

#### 4.3.1.2. 100BASE-TX

In 100BASE-TX mode, the receive data stream is recovered and descrambled to align to the symbol boundaries. The aligned data is then parallelized and 5B/4B decoded to 4-bit data. This output runs to MAC interfaces after data stream delimiters have been translated.

#### 4.3.1.3. 10BASE-Te

In 10BASE-Te mode, the recovered 10BASE-Te signal is decoded from Manchester then aligned.

## 4.4. Echo Canceller

A hybrid circuit is used to transmit and receive simultaneously on each pair. A signal reflects back as an echo if the transmitter is not perfectly matched to the line. Other connector or cable imperfections, such as patch panel discontinuity and variations in cable impedance along the twisted pair cable, also result in drastic SNR degradation on the receive signal. The SK8211FS device implements a digital echo canceller to adjust for echo and is adaptive to compensate for the varied channel conditions.

## 4.5. NEXT Canceller

The 1000BASE-T physical layer uses all four pairs of wires to transmit data. Because the four twisted pairs are bundled together, significant high frequency crosstalk occurs between adjacent pairs in the bundle. The SK8211FS device uses three parallel NEXT cancellers on each receive channel to cancel high frequency crosstalk. The SK8211FS cancels NEXT by subtracting an estimate of these signals from the equalizer output.

## 4.6. Baseline Wander Canceller

Baseline wander results from Ethernet links that AC-couple to the transceivers and from AC coupling that cannot maintain voltage levels for longer than a short time. As a result, transmitted pulses are distorted, resulting in

erroneous sampled values for affected pulses. Baseline wander is more problematic in the 1000BASE-T environment than in 100BASE-TX due to the DC baseline shift in the transmit and receive signals. The SK8211FS device uses an advanced baseline wander cancellation circuit that continuously monitors and compensates for this effect, minimizing the impact of DC baseline shift on the overall error rate.

## 4.7. Digital Adaptive Equalizer

The digital adaptive equalizer removes inter-symbol interference at the receiver. The digital adaptive equalizer takes unequalized signals from ADC output and uses a combination of feedforward equalizer (FFE) and decision feedback equalizer (DFE) for the best optimized signal-to-noise (SNR) ratio.

## 4.8. Management Interface

The Status and Control registers of the device are accessible through the MDIO and MDC serial interface. The functional and electrical properties of this management interface comply with IEEE 802.3, Section 22 and also support MDC clock rates up to 12.5 MHz.

## 4.9. Auto-Negotiation

The SK8211FS negotiates its operation mode using the auto negotiation mechanism according to IEEE 802.3 clause 28 over the copper media. Auto negotiation supports choosing the mode of operation automatically by comparing its own abilities and received abilities from link partner. The advertised abilities include:

- Speed: 10/100/1000Mbps
- Duplex mode: full duplex and/or half duplex

Auto negotiation is initialized when the following scenarios happen:

- Power-up/Hardware/Software reset
- Auto negotiation restart
- Transition from power-down to power up
- Link down

Auto negotiation is enabled for SK8211FS by default, and can be disabled by software control.

## 4.10. Polarity Detection and Auto Correction

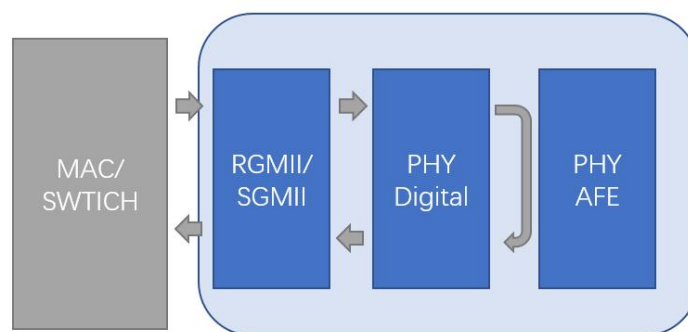
SK8211FS can detect and correct two types of cable errors: swapping of pairs within the UTP cable (swapping between pair 0 and pair 1, and/or swapping between pair 2 and pair 3) and swapping of wires within a pair.

## 4.11. Loopback Mode

There are three loopback modes in SK8211FS

### 4.11.1. Digital Loopback

Digital loopback provides the ability to loop transmitted data back to the receiver using digital circuitry in SK8211FS.



**Figure 8. Digital Loopback**

#### 4.11.2. External loopback

External cable loopback loops Tx to Rx through a complete digital and analog path and an external cable, thus testing all the digital data paths and all the analog circuits. Figure shows a block diagram of external cable loopback.

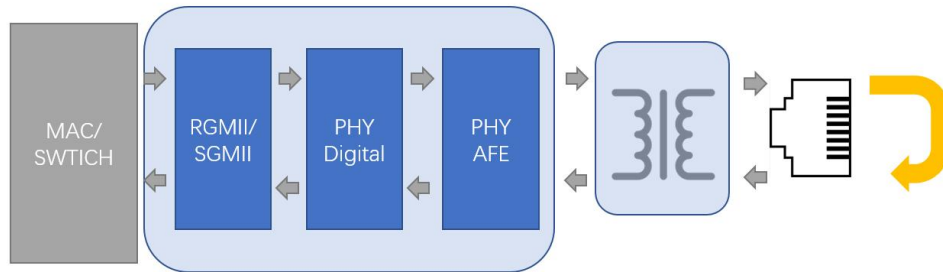


Figure 9. External Loopback

#### 4.11.3. Remote PHY loopback

The Remote loopback connects the MDI receive path to the MDI transmit path, near the RGMII interface, thus the remote link partner can detect the connectivity in the resulting loop. Figure below, shows the path of the remote loopback.

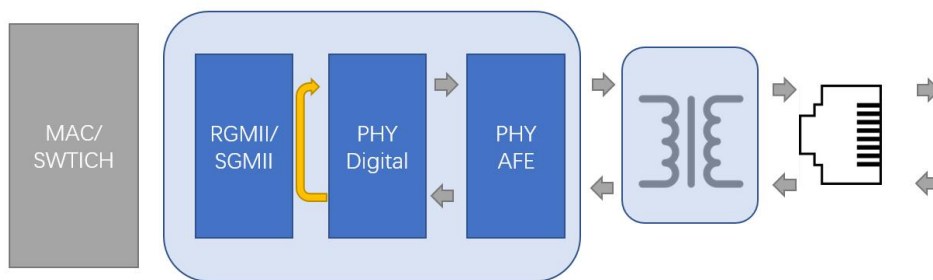


Figure 10. Remote PHY Loopback

### 4.12. Energy Efficient Ethernet (EEE)

EEE is IEEE 802.3az, an extension of the IEEE 802.3 standard. EEE defines support for the PHY to operate in Low Power Idle (LPI) mode which, when enabled, supports QUIET times during low link utilization allowing both link partners to disable portions of each PHY's circuitry and save power.

### 4.13. Synchronous Ethernet (Sync-E)

SK8211FS provides Synchronous Ethernet (Sync-E) support when the device is operating in 1000BASE-T, 100BASE-TX, 1000BASE-X and 100BASE-FX on the transmission media. The CLKOUT pin can be assigned to output the recovered clock.

The recovery clock for Sync-E can be either a 125MHz or 25MHz clock.

If the CLKOUT pin is assigned to output the recovered clock from PHY and PHY is working at 1000BASE-T mode, when the PHY is in SLAVE mode, the CLKOUT will output the recovered clock from the MDI. If the device is in MASTER mode, the CLKOUT will output the clock based on the local free run PLL.

### 4.14. Wake-On-LAN (WOL)

Wake-on-LAN (WOL) is a mechanism to manage and regulate the total network power consumption. SK8211FS supports automatic detection of a specific frame and notification via dedicated hardware interrupt pin. The specific frame contains a specific data sequence located anywhere inside the packet. The data sequence consists of

6 bytes of consecutive 1 (0xFFFFFFFFFFFF), followed by 16 repetitions of the MAC address of the computer to be waked up. The 48-bit MAC address can be set in *MAC\_Address\_Cfg1~3* common registers.

#### 4.15. Link Down Power Saving (Sleep Mode)

SK8211FS supports link down power saving, also called sleep mode. When UTP port link down and no signals over UTP cable for 40 seconds, SK8211FS will enter sleep mode.

For most of time in sleep mode, SK8211FS will disable almost all the circuits except crystal clock and comparators for channel 0/1 of 10BASE-Te. Access by MDC/MDIO interface is available.

At a time interval in sleep mode, SK8211FS will wake to transmit signals over TRXP1/TRXN1. The time interval is a random value around 2.7s.

Once detect signals over UTP cable, SK8211FS will exit sleep mode.

#### 4.16. Interrupt

SK8211FS provides an active low interrupt output pin (INT\_N) based on change of the PHY status. Every interrupt condition is represented by the read-only general interrupt status register (section 6.2.18. Interrupt Status Register (UTP MII register 0x13)).

The interrupts can be individually enable or disable by setting or clearing bits in the interrupt enable register (section 6.2.17. Interrupt Mask Register (UTP MII register 0x12)).

*Note 1: The interrupt of the SK8211FS is a level-triggered mechanism.*

*Note 2: The INT\_N and PME\_N functions share the same pin (pin 34). Refer to section 5.5. INT\_N/PME\_N Pin Usage.*

## 5. Operational Description

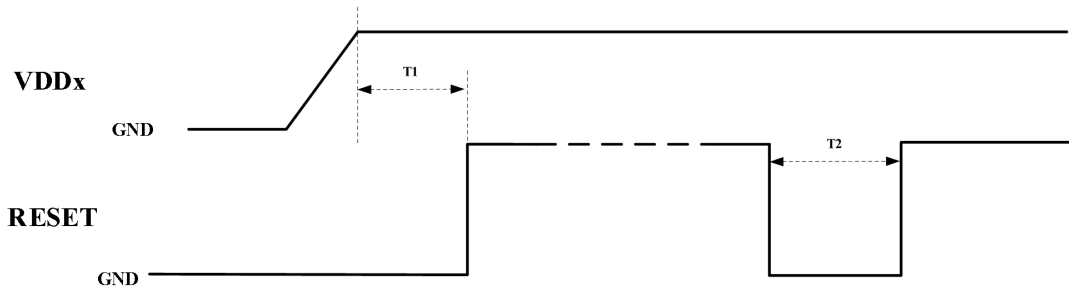
### 5.1. Reset

SK8211FS have a hardware reset pin(RESET\_N) which is low active. RESET\_N should be active for at least 10ms to make sure all internal logic is reset to a known state. Hardware reset should be applied after power up. RESET\_N is also used for power on strapping. After RESET\_N is released, SK8211FS latches input value on strapping pins which are used as configuration information to provide flexibility in application without mdio access.

SK8211FS also provides two software reset control registers. One of them are used to reset all UTP internal logic except some mdio configuration registers, by setting bit 15 of UTP mii register (address 0x0). And the other is used to reset all SerDes internal logic except CDR and some mdio configuration registers, by setting bit15 of SerDes mii register(address 0x0) to 1. These two bits are self-clear after reset process is done. For detailed information about what register will be reset by software reset, please refer to register table.

**Table 13. Reset Timing Characteristics**

| Symbol | Description                                                         | Min | Typ | Max | Units |
|--------|---------------------------------------------------------------------|-----|-----|-----|-------|
| T1     | The duration from all powers steady to reset signal release to high | 10  | -   | -   | ms    |
| T2     | The duration of reset signal remain low timing                      | 10  | -   | -   | ms    |



**Figure 11. Reset Timing Diagram**

### 5.2. PHY Address

For SK8211FS, Strapping PHYAD[2:0] is used to generate phy address.

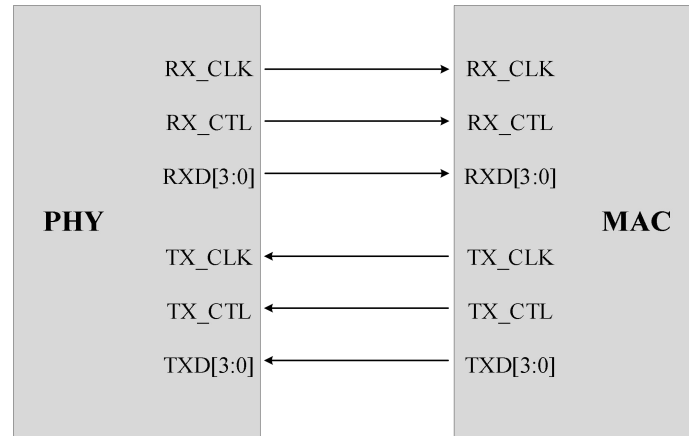
SK8211FS always responses to phy address 0. It can be disabled by configure bit[6] to 1'b0 of common register EXT\_0xA005. It also has another broadcast phy address which is configurable through mdio. Bit[4:0] of common register EXT\_0xA005 is broadcast phy address and its default value is 5'b11111. Bit[5] of common register EXT\_0xA005 is enable control for broadcast phy address and its default value is 1'b0.

### 5.3. RGMII Interface

Reduced gigabit media independent interface is a subset of GMII which is used for gigabit Ethernet. For 100M/10M application, RGMII is similar to MII. The only difference is that tx\_er/rx\_er is transmitted by TX\_CTL/RX\_CTL on the falling edge of clock. TXD[3:0] and RXD[3:0] will be duplicated on both rising and falling edge of clock.

For 100M application, TX\_CLK and RX\_CLK are 25MHz.

For 10M application, TX\_CLK and RX\_CLK are 2.5MHz.



**Figure 12. Connection Diagram of RGMII**

## 5.4. LED

The LED interface can either be controlled by the PHY or controlled manually, independent of the state of the PHY. Three status LEDs are available. These can be used to indicate operation speed, duplex mode, and link status. The LEDs can be programmed to different status functions from their default value. They can also be controlled directly from the register interface.

## 5.5. INT\_N/PME\_N Pin Usage

The INT\_N/PME\_N pin (pin 34) is designed to notify both interrupt and WOL events. The default mode of this pin is INT\_N (common register EXT\_0xA00A, bit[6]=0). For general use, indication of a WOL event is also integrated into one of the interrupt events which is triggered when any specified WOL event occurs. However, the 'Pulse Low' waveform format is not supported during this mode; only the Active Low, level-triggered waveform is provided.

If PME\_N mode is selected (common register EXT\_0xA00A, bit[6]=1), pin 34 becomes a fully functional PME\_N pin. Note that the interrupt function is disabled in this mode.

## 5.6. Power Supplies

The SK8211FS device requires only one external power supply: 3.3 V. Inside the chip there is a 3.3V rail, 1.1V rail, 2.5V or 1.8V rail.

### 5.6.1. Internal Switch Regulator

SK8211FS integrates a switch regulator which converts 3.3V to 1.1V at a high-efficiency for core power rail. It is optional for an external regulator to provide this core voltage.

### 5.6.2. Internal LDO

SK8211FS also integrates a LDO which converts 3.3V to 2.5V or 1.8V for RGMII I/O power rail and configured by CFG\_LDO[1:0].

**Table 14. CFG\_LDO[1:0] Configuration**

| Configuration  | Description                                                       |
|----------------|-------------------------------------------------------------------|
| 2'b01          | LDO is set to 2.5V                                                |
| 2'b10 or 2'b11 | LDO is set to 1.8V                                                |
| 2'b00          | Use external 3.3V to supply to DVDD_RGMII pin.<br>LDO is disabled |

## 6. Register Overview

**Table 15. Register Access Types**

| Type | Description                                                                                                                                                                                              |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RW   | Read and write                                                                                                                                                                                           |
| SC   | Self-clear.<br>If default value is '0' ('1'), writing a '1' ('0') to this register field causes the function to be activated immediately, and then the field will be automatically cleared to '0' ('1'). |
| RO   | Read only.                                                                                                                                                                                               |
| LH   | Latch high.                                                                                                                                                                                              |
| LL   | Latch Low.                                                                                                                                                                                               |
| RC   | Read clear.                                                                                                                                                                                              |
| SWC  | Software reset to 0.                                                                                                                                                                                     |
| SWS  | Software reset to 1.                                                                                                                                                                                     |
| POS  | Default value depends on power on strapping.                                                                                                                                                             |

### 6.1. Common Register

#### 6.1.1. SMI\_SDS\_PHY (EXT\_0xA000)

**Table 16. SMI\_SDS\_PHY (EXT\_0xA000)**

| Bit  | Symbol      | Access | Default | Description                                                                                                                                                                                |
|------|-------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:2 | Reserved    | RO     | 0x0     | Reserved                                                                                                                                                                                   |
| 1    | Smi_sds_phy | RW POS | 0x0     | to control access whether UTP register or SDS register.<br>1 to access SDS;<br>0 to access UTP.<br>Default value depend on chip mode. When the UTP port exists, default 0; else default 1. |
| 0    | Reserved    | RO     | 0x0     | Reserved                                                                                                                                                                                   |

#### 6.1.2. Chip\_Config (EXT\_0xA001)

**Table 17. Chip\_Config (0xA001)**

| Bit   | Symbol               | Access | Default | Description                                                                                          |
|-------|----------------------|--------|---------|------------------------------------------------------------------------------------------------------|
| 15    | Sw_rst_n_mode        | RW SC  | 0x1     | A whole chip software reset, it will also be asserted when chip mode changed, low active, self clear |
| 14:12 | Reserved             | RO     | 0x0     | Reserved                                                                                             |
| 11    | Iddq_mode            | RW     | 0x0     | 1: Iddq test mode                                                                                    |
| 10    | Reserved             | RO     | 0x0     | Reserved                                                                                             |
| 9     | En_gate_rx_clk_rgmii | RW     | 0x0     | 1: to close RXC when PHY link down;<br>0: do not close RXC when PHY link down.                       |
| 8     | Rxc_dly_en           | RW POS | 0x1     | rgmii clk 2ns delay control, depends on strapping                                                    |
| 7     | Reserved             | RO     | 0x0     | Reserved                                                                                             |
| 6     | En_ldo               | RW     | 0x1     | rgmii ldo enable, default is 0 and will be set to 1                                                  |

|     |          |        |     |                                                                                                                                                                                                                                                                |
|-----|----------|--------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |          |        |     | after power on strapping is done                                                                                                                                                                                                                               |
| 5:4 | Cfg_ldo  | RW POS | 0x0 | Rgmii ldo voltage and RGMII/MDC/MDIO PAD's level shifter control. Depends on strapping.<br>2'b11: 1.8v<br>2'b10: 1.8v<br>2'b01: 2.5v<br>2'b00: 3.3v                                                                                                            |
| 3   | Reserved | RO     | 0x0 | Reserved                                                                                                                                                                                                                                                       |
| 2:0 | Mode_sel | RW POS | 0x0 | chip mode, depend on strapping.<br>3'b000: UTP_TO_RGMII;<br>3'b001: FIBER_TO_RGMII;<br>3'b010: UTP_FIBER_TO_RGMII;<br>3'b011: UTP_TO_SGMII;<br>3'b100: SGPHY_TO_RGMAC;<br>3'b101: SGMAC_TO_RGPHY;<br>3'b110: UTP_TO_FIBER_AUTO;<br>3'b111: UTP_TO_FIBER_FORCE. |

### 6.1.3. SDS\_Config (EXT\_0xA002)

**Table 18. SDS\_Config (EXT\_0xA002)**

| Bit   | Symbol            | Access | Default | Description                                                                                                                                                  |
|-------|-------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:13 | Reserved          | RO     | 0x0     | Reserved                                                                                                                                                     |
| 12    | En_surppress_txer | RW     | 0x1     | 1: to surppress the RX_ER generated by the serdes when it works in SGMII PHY full duplex mode and RX_DV is 0 and rx_lpi_active is 0;<br>0: to not surppress. |
| 11    | Reserved          | RW     | 0x1     | Reserved                                                                                                                                                     |
| 10:8  | Reserved          | RO     | 0x0     | Reserved                                                                                                                                                     |
| 7:0   | Reserved          | RW     | 0x80    | Reserved                                                                                                                                                     |

### 6.1.4. RGMII\_Config1 (EXT\_0xA003)

**Table 19. RGMII\_Config1 (EXT\_0xA003)**

| Bit | Symbol         | Access | Default | Description                                                                                                                                                                                                                                                                                                                                       |
|-----|----------------|--------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15  | Rgmac_cfg_mode | RW     | 0x0     | When chip mode is SGPHY_TO_RGMAC, it controls the source of the RGMII's speed, duplex and link status. These information will be sent to the SGMII PHY.<br>1: RGMII's speed, deplex, link status information comes from common register EXT_0xA004;<br>0: these information comes from RGMII OOB. Refer to common register EXT_0xA005 for detail. |
| 14  | Tx_clk_sel     | RW     | 0x0     | 0: use original RGMII TX_CLK to drive the RGMII TX_CLK delay train;<br>1: use inverted RGMII TX_CLK to drive the RGMII TX_CLK delay train.                                                                                                                                                                                                        |

|       |                 |    |     |                                                                                                                                                 |
|-------|-----------------|----|-----|-------------------------------------------------------------------------------------------------------------------------------------------------|
|       |                 |    |     | Used for debug                                                                                                                                  |
| 13:10 | Rx_delay_sel    | RW | 0x0 | RGMII RX_CLK delay train configuration, about 150ps per step                                                                                    |
| 9     | En_rgmii_fd_crs | RW | 0x0 | See EXT 0xA003 bit[8].                                                                                                                          |
| 8     | En_rgmii_crs    | RW | 0x0 | 0: to not encode GMII/MII CRS into RGMII OOB;<br>1: to encode GMII/MII CRS into RGMII OOB when it's half duplex mode or EXT 0xA003 bit[9] is 1. |
| 7:4   | Tx_delay_sel_fe | RW | 0xf | RGMII TX_CLK delay train configuration when speed is 100Mbps or 10Mbps, it's 150ps per step typically.                                          |
| 3:0   | Tx_delay_sel    | RW | 0x1 | RGMII TX_CLK delay train configuration when speed is 1000Mbps, it's 150ps per step typically.                                                   |

#### 6.1.5. RGMII\_Config2 (EXT\_0xA004)

**Table 20. rgmii cfg2 (0xA004)**

| Bit   | Symbol               | Access | Default | Description                                                                               |
|-------|----------------------|--------|---------|-------------------------------------------------------------------------------------------|
| 15:14 | Speed_rgphy          | RO     | 0x0     | RGMII's speed information when it works as RGMII PHY. It's also the source of RGMII OOB.  |
| 13    | Duplex_rgphy         | RO     | 0x0     | RGMII's duplex information when it works as RGMII PHY. It's also the source of RGMII OOB. |
| 12    | Link_up_rgphy        | RO     | 0x0     | RGMII's linkup information when it works as RGMII PHY. It's also the source of RGMII OOB. |
| 11:10 | Pause_rgphy          | RO     | 0x0     | RGMII's pause information when it works as RGMII PHY.                                     |
| 9     | Eee_cap_rgphy        | RO     | 0x0     | RGMII's EEE capability information when it works as RGMII PHY.                            |
| 8     | Eee_clkstp_cap_rgphy | RO     | 0x0     | RGMII's EEE clock stopable capability information when it works as RGMII PHY.             |
| 7:6   | Speed_rgmac          | RW     | 0x0     | RGMII's speed configuration when it works as RGMII MAC and EXT A003 bit[15] is 1.         |
| 5     | Duplex_rgmac         | RW     | 0x0     | RGMII's duplex configuration when it works as RGMII MAC and EXT A003 bit[15] is 1.        |
| 4     | Link_up_rgmac        | RW     | 0x0     | RGMII's linkup configuration when it works as RGMII MAC and EXT A003 bit[15] is 1.        |
| 3:2   | Pause_rgmac          | RW     | 0x0     | RGMII's pause configuration when it works as RGMII MAC.                                   |
| 1     | Eee_cap_rgmac        | RW     | 0x0     | RGMII's EEE capability configuration when it works as RGMII MAC.                          |
| 0     | Eee_clkstp_cap_mac   | RW     | 0x0     | RGMII's EEE clock stopable capability configuration when it works as RGMII MAC.           |

#### 6.1.6. MDIO\_Cfg\_And\_RGMII\_OOB\_Mon (EXT\_0xA005)

**Table 21. MDIO\_Cfg\_And\_RGMII\_OOB\_Mon (EXT\_0xA005)**

| Bit   | Symbol         | Access | Default | Description                                  |
|-------|----------------|--------|---------|----------------------------------------------|
| 15:14 | Speed_rgmac_ob | RO     | 0x0     | speed information RGMII MAC decodes from the |

|     |                      |    |     |                                                                                                                                                    |
|-----|----------------------|----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------|
|     |                      |    |     | OOB                                                                                                                                                |
| 13  | Duplex_rgmac_ob      | RO | 0x0 | duplex information RGMII MAC decodes from the OOB                                                                                                  |
| 12  | Link_up_rgmac_ob     | RO | 0x0 | linkup information RGMII MAC decodes from the OOB                                                                                                  |
| 11  | Reserved             | RO | 0x0 | Reserved                                                                                                                                           |
| 10  | Bypass_mdio_watchdog | RW | 0x0 | bypass mdio watch dog                                                                                                                              |
| 9:8 | Reserved             | RO | 0x0 | Reserved                                                                                                                                           |
| 7   | En_mdc_la            | RW | 0x1 | enable mdc latch for read data                                                                                                                     |
| 6   | En_phyaddr0          | RW | 0x1 | 1: to always respond to MDIO command whose PHYAD field is 0; 0: to only respond to MDIO command whose PHYAD field equals to PHY address strapping. |
| 5   | En_bdcst_addr        | RW | 0x0 | enable broadcast address                                                                                                                           |
| 4:0 | Bdcst_addr           | RW | 0x0 | broadcast address                                                                                                                                  |

#### 6.1.7. Misc\_Config (EXT\_0xA006)

**Table 22. Misc\_Config (EXT\_0xA006)**

| Bit  | Symbol              | Access | Default | Description                                                                                                                                                                                                                                                                                |
|------|---------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:9 | Reserved            | RW     | 0x0     | Reserved                                                                                                                                                                                                                                                                                   |
| 8    | Fiber_high_pri_cmb  | RW     | 0x0     | 1: fiber has higher priority in UTP_FIBER_TO_RGMII mode<br>0: UTP has higher priority                                                                                                                                                                                                      |
| 7    | Jumbo_enable        | RW     | 0x0     | 1: To enable jumbo frame<br>0: To disable jumbo frame<br>If this register is 1, the frame transfer delay will increase a little.                                                                                                                                                           |
| 6    | Rem_lpbk_sds        | RW     | 0x0     | 1: Enable remote loopback on Serdes side.<br>0: Disable remote loopback on Serdes side.                                                                                                                                                                                                    |
| 5    | Rem_lpbk_phy        | RW     | 0x0     | 1: Enable remote loopback on UTP side<br>0: Disable remote loopback on UTP side                                                                                                                                                                                                            |
| 4    | Uldata_rloopback    | RW     | 0x0     | 1: remain upload data when rem lpbk is set for phy or sds                                                                                                                                                                                                                                  |
| 3    | Bp_gmii_fatal_rst   | RW     | 0x1     | 1: Disable to reset GMII FIFO when overflow or underflow happen<br>0: Enable to reset GMII FIFO automatic when overflow or underflow happen                                                                                                                                                |
| 2:1  | Comb_wait_timer_sel | RW     | 0x2     | It's valid in UTP_FIBER_TO_RGMII mode, to select wait timer for first priority media after second priority media is link up;<br>2'b00: 1s;<br>2'b01: 5s;<br>2'b10: 15s;<br>2'b11: 25s<br>If the first priority media links up after this timer is out, link will not switch to this media. |
| 0    | Fib_speed_sel       | RW     | 0x1     | Select fiber speed when auto sensing is disable.                                                                                                                                                                                                                                           |

|  |  |  |  |                        |
|--|--|--|--|------------------------|
|  |  |  |  | 1: 1000BX;<br>0: 100FX |
|--|--|--|--|------------------------|

#### 6.1.8. MAC\_Address\_Cfg1 (EXT\_0xA007)

**Table 23. MAC\_Address\_Cfg1 (EXT\_0xA007)**

| Bit  | Symbol             | Access | Default | Description                                 |
|------|--------------------|--------|---------|---------------------------------------------|
| 15:0 | mac_addr_loc_47_32 | RW     | 0x0     | highest 16 bits of MAC address used for WOL |

#### 6.1.9. MAC\_Address\_Cfg2 (EXT\_0xA008)

**Table 24. MAC\_Address\_Cfg2 (EXT\_0xA008)**

| Bit  | Symbol             | Access | Default | Description                                |
|------|--------------------|--------|---------|--------------------------------------------|
| 15:0 | mac_addr_loc_31_16 | RW     | 0x0     | middle 16 bits of MAC address used for WOL |

#### 6.1.10. MAC\_Address\_Cfg3 (EXT\_0xA009)

**Table 25. MAC\_Address\_Cfg3 (EXT\_0xA009)**

| Bit  | Symbol            | Access | Default | Description                                |
|------|-------------------|--------|---------|--------------------------------------------|
| 15:0 | mac_addr_loc_15_0 | RW     | 0x0     | lowest 16 bits of MAC address used for WOL |

#### 6.1.11. WOL\_Cfg (EXT\_0xA00A)

**Table 26. WOL\_Cfg (EXT\_0xA00A)**

| Bit  | Symbol         | Access | Default | Description                                                                                                                                                                                                                                                                                     |
|------|----------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:8 | Reserved       | RO     | 0x0     | Reserved                                                                                                                                                                                                                                                                                        |
| 7    | Sw_close_rgmii | RW     | 0x0     | 1.disable rgmii interface<br>0.enable rgmii interface                                                                                                                                                                                                                                           |
| 6    | Pmeb_intb_sel  | RW     | 0x0     | 1: Pin 34 functions as PME_N.<br>0: Pin 34 functions as INT_N.                                                                                                                                                                                                                                  |
| 5    | Wol_src_manual | RW     | 0x0     | 1: control manually the source of the WOL event<br>coms from which media;<br>0: the source of the WOL event is controlled<br>automatically by chip mode: when UTP is present,<br>it comes UTP; otherwise, it comes from SDS.                                                                    |
| 4    | Wol_src_sel    | RW     | 0x0     | It's valid when EXT_0xA00A bit[5] is 1.<br>1: WOL event comes from SDS;<br>0: WOL event comes from UTP.                                                                                                                                                                                         |
| 3    | Wol_en         | RW     | 0x0     | enable WOL.                                                                                                                                                                                                                                                                                     |
| 2:0  | Wol_lth_sel    | RW     | 0x2     | wol_lth_sel[0],<br>1: PME_N is level triggerd and active LOW; When<br>PME_N is LOW, EXT_0xA00A bit3 wol_en<br>should be set to 0 to clear the PME_N.<br>0: PME_N is pulse triggered and active LOW, the<br>pusel width is controlled by wol_lth_sel[2:1].<br><br>Wol_lth_sel[2:1]:<br>00: 84ms; |

|  |  |  |  |                                        |
|--|--|--|--|----------------------------------------|
|  |  |  |  | 01: 168ms;<br>10: 336ms;<br>11: 672ms. |
|--|--|--|--|----------------------------------------|

#### 6.1.12. LED\_GENERAL\_CFG (EXT\_0xA00B)

**Table 27. LED\_GENERAL\_CFG (EXT\_0xA00B)**

| Bit  | Symbol           | Access | Default | Description                                                                                                                                                                                                                                                                                                                                                                                       |
|------|------------------|--------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15   | Col_blk_sel      | RW     | 0x1     | 1: when collision happens, and related LEDn cfg (n is 0/1/2) register's bit3 led_col_blk_en is 1, LED blink at Blink Mode2;<br>0: when collision happens, and related LEDn cfg (n is 0/1/2) register's bit3 led_col_blk_en is 0, LED blink at Blink Mode1.<br>LED could blinks at different frequency in Blink Mode1 and Blink Mode2. Refer to EXT A00F[3:0] for the Blink Mode2 and Blink Mode1. |
| 14   | Jabber_led_dis   | RW     | 0x1     | 1: when 10Mb/s Jabber happens, LED will not blink;                                                                                                                                                                                                                                                                                                                                                |
| 13   | Lpbk_led_dis     | RW     | 0x1     | 1: In internal loopback mode, LED will not blink;                                                                                                                                                                                                                                                                                                                                                 |
| 12   | Dis_led_an_try   | RW     | 0x0     | 1: LED will be ON when auto-negotiation is at LINK_GOOD_CHECK status, in which status, the link is not up already.                                                                                                                                                                                                                                                                                |
| 11:9 | Reserved         | RO     | 0x0     | Reserved                                                                                                                                                                                                                                                                                                                                                                                          |
| 8    | Led_2_force_en   | RW     | 0x0     | 1: enable LED2 force mode.                                                                                                                                                                                                                                                                                                                                                                        |
| 7:6  | Led_2_force_mode | RW     | 0x0     | Valid when bit8 is set.<br>00: force LED OFF;<br>01: force LED ON;<br>10: force LED Blink at Blink Mode1;<br>11: force LED Blink at Blink Mode2.<br>LED could blinks at different frequency in Blink Mode1 and Blink Mode2. Refer to EXT A00F[3:0] for the Blink Mode2 and Blink Mode1.                                                                                                           |
| 5    | Led_1_force_en   | RW     | 0x0     | 1: enable LED1 force mode.                                                                                                                                                                                                                                                                                                                                                                        |
| 4:3  | Led_1_force_mode | RW     | 0x0     | Valid when bit5 is set.<br>Refer EXT A00B[7:6] for the force mode description.                                                                                                                                                                                                                                                                                                                    |
| 2    | Led_0_force_en   | RW     | 0x0     | 1: enable LED0 force mode.                                                                                                                                                                                                                                                                                                                                                                        |
| 1:0  | Led_0_force_mode | RW     | 0x0     | Valid when bit2 is set.<br>Refer EXT A00B[7:6] for the force mode description.                                                                                                                                                                                                                                                                                                                    |

#### 6.1.13. LED0\_CFG (EXT\_0xA00C)

**Table 28. LED0\_CFG (EXT\_0xA00C)**

| Bit   | Symbol        | Access | Default | Description                                                           |
|-------|---------------|--------|---------|-----------------------------------------------------------------------|
| 15:14 | Led_src_sel_0 | RW     | 0x0     | select the source of internal signals controlling LED0.<br>2'b00: UTP |

|    |                    |    |     |                                                                                                                                                           |
|----|--------------------|----|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                    |    |     | 2'b01: serdes<br>2'b10: UTP and serdes<br>2'b11: UTP or serdes<br>Default value of LED0 cfg depends on the strapping of chip mode.                        |
| 13 | Led_act_blk_ind_0  | RW | 0x0 | When traffic is present, make LED0 BLINK no matter the previous LED0 status is ON or OFF, or make LED0 blink only when the previous LED0 is ON.           |
| 12 | Led_fdx_on_en_0    | RW | 0x0 | 1: If BLINK status is not activated, when PHY link up and duplex mode is full duplex, LED0 will be ON.                                                    |
| 11 | Led_hdx_on_en_0    | RW | 0x0 | 1: If BLINK status is not activated, when PHY link up and duplex mode is half duplex, LED0 will be ON.                                                    |
| 10 | Led_txact_blk_en_0 | RW | 0x1 | 1: If bit[13] is 1, or bit[13] is 0 and ON at certain speed or duplex more is/are activated, when PHY link up and TX is active, make LED0 blink at mode2. |
| 9  | Led_rxact_blk_en_0 | RW | 0x1 | 1: If bit[13] is 1, or bit[13] is 0 and ON at certain speed or duplex more is/are activated, when PHY link up and RX is active, make LED0 blink at mode2. |
| 8  | Led_txact_on_en_0  | RW | 0x0 | 1: if BLINK status is not activated, when PHY link up and TX is active, make LED0 ON at least 10ms.                                                       |
| 7  | Led_rxact_on_en_0  | RW | 0x0 | 1: if BLINK status is not activated, when PHY link up and RX is active, make LED0 ON at least 10ms.                                                       |
| 6  | Led_gt_on_en_0     | RW | 0x0 | 1: if BLINK status is not activated, when PHY link up and speed mode is 1000Mbps, make LED0 ON.                                                           |
| 5  | Led_ht_on_en_0     | RW | 0x0 | 1: if BLINK status is not activated, when PHY link up and speed mode is 100Mbps, make LED0 ON;                                                            |
| 4  | Led_bt_on_en_0     | RW | 0x1 | 1: if BLINK status is not activated, when PHY link up and speed mode is 10Mbps, make LED0 ON;                                                             |
| 3  | Led_col_blk_en_0   | RW | 0x0 | 1: if PHY link up and collision happen, make LED0 BLINK;                                                                                                  |
| 2  | Led_gt_blk_en_0    | RW | 0x0 | 1: if PHY link up and speed mode is 1000Mbps, make LED0 BLINK;                                                                                            |
| 1  | Led_ht_blk_en_0    | RW | 0x0 | 1: if PHY link up and speed mode is 100Mbps, make LED0 BLINK;                                                                                             |
| 0  | Led_bt_blk_en_0    | RW | 0x0 | 1: if PHY link up and speed mode is 10Mbps, make LED0 BLINK;                                                                                              |

#### 6.1.14. LED1\_CFG (EXT\_0xA00D)

**Table 29. LED1\_CFG (EXT\_0xA00D)**

| Bit   | Symbol            | Access | Default | Description                 |
|-------|-------------------|--------|---------|-----------------------------|
| 15:14 | Led_src_sel_1     | RW POS | 0x0     | Same logic as LED0 control. |
| 13    | Led_act_blk_ind_1 | RW POS | 0x0     | Same logic as LED0 control. |
| 12    | Led_fdx_on_en_1   | RW POS | 0x0     | Same logic as LED0 control. |

|    |                    |        |     |                             |
|----|--------------------|--------|-----|-----------------------------|
| 11 | Led_hdx_on_en_1    | RW POS | 0x0 | Same logic as LED0 control. |
| 10 | Led_txact_blk_en_1 | RW POS | 0x1 | Same logic as LED0 control. |
| 9  | Led_rxact_blk_en_1 | RW POS | 0x1 | Same logic as LED0 control. |
| 8  | Led_txact_on_en_1  | RW POS | 0x0 | Same logic as LED0 control. |
| 7  | Led_rxact_on_en_1  | RW POS | 0x0 | Same logic as LED0 control. |
| 6  | Led_gt_on_en_1     | RW POS | 0x0 | Same logic as LED0 control. |
| 5  | Led_ht_on_en_1     | RW POS | 0x1 | Same logic as LED0 control. |
| 4  | Led_bt_on_en_1     | RW POS | 0x0 | Same logic as LED0 control. |
| 3  | Led_col_blk_en_1   | RW POS | 0x0 | Same logic as LED0 control. |
| 2  | Led_gt_blk_en_1    | RW POS | 0x0 | Same logic as LED0 control. |
| 1  | Led_ht_blk_en_1    | RW POS | 0x0 | Same logic as LED0 control. |
| 0  | Led_bt_blk_en_1    | RW POS | 0x0 | Same logic as LED0 control. |

#### 6.1.15. LED2\_CFG (EXT\_0xA00E)

**Table 30. LED2\_CFG (EXT\_0xA00E)**

| Bit   | Symbol             | Access | Default | Description                 |
|-------|--------------------|--------|---------|-----------------------------|
| 15:14 | Led_src_sel_2      | RW POS | 0x0     | Same logic as LED0 control. |
| 13    | Led_act_blk_ind_2  | RW POS | 0x0     | Same logic as LED0 control. |
| 12    | Led_fdx_on_en_2    | RW POS | 0x0     | Same logic as LED0 control. |
| 11    | Led_hdx_on_en_2    | RW POS | 0x0     | Same logic as LED0 control. |
| 10    | Led_txact_blk_en_2 | RW POS | 0x1     | Same logic as LED0 control. |
| 9     | Led_rxact_blk_en_2 | RW POS | 0x1     | Same logic as LED0 control. |
| 8     | Led_txact_on_en_2  | RW POS | 0x0     | Same logic as LED0 control. |
| 7     | Led_rxact_on_en_2  | RW POS | 0x0     | Same logic as LED0 control. |
| 6     | Led_gt_on_en_2     | RW POS | 0x1     | Same logic as LED0 control. |
| 5     | Led_ht_on_en_2     | RW POS | 0x0     | Same logic as LED0 control. |
| 4     | Led_bt_on_en_2     | RW POS | 0x0     | Same logic as LED0 control. |
| 3     | Led_col_blk_en_2   | RW POS | 0x0     | Same logic as LED0 control. |
| 2     | Led_gt_blk_en_2    | RW POS | 0x0     | Same logic as LED0 control. |
| 1     | Led_ht_blk_en_2    | RW POS | 0x0     | Same logic as LED0 control. |
| 0     | Led_bt_blk_en_2    | RW POS | 0x0     | Same logic as LED0 control. |

#### 6.1.16. LED\_BLINK\_CFG (EXT\_0xA00F)

**Table 31. LED\_BLINK\_CFG (EXT\_0xA00F)**

| Bit  | Symbol   | Access | Default | Description                                                                                                                                                                                                                     |
|------|----------|--------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:7 | Reserved | RO     | 0x0     | Reserved                                                                                                                                                                                                                        |
| 6:4  | Led_duty | RW     | 0x0     | Select duty cycle of Blink:<br>000: 50% ON and 50% OFF;<br>001: 67% ON and 33% OFF;<br>010: 75% ON and 25% OFF;<br>011: 83% ON and 17% OFF;<br>100: 50% ON and 50% OFF;<br>101: 33% ON and 67% OFF;<br>110: 25% ON and 75% OFF; |

|     |            |    |     |                                                                                   |
|-----|------------|----|-----|-----------------------------------------------------------------------------------|
|     |            |    |     | 111: 17% ON and 83% OFF.                                                          |
| 3:2 | Freq_sel_2 | RW | 0x1 | Select frequency of Blink Mode2:<br>00: 2Hz;<br>01: 4Hz;<br>10: 8Hz;<br>11: 16Hz. |
| 1:0 | Freq_sel_1 | RW | 0x2 | Select frequency of Blink Mode1:<br>00: 2Hz;<br>01: 4Hz;<br>10: 8Hz;<br>11: 16Hz. |

#### 6.1.17. Pad Drive Strength Cfg (EXT\_0xA010)

**Table 32. Pad Drive Strength Cfg (EXT\_0xA010)**

| Bit   | Symbol           | Access | Default | Description                                                                                                                         |
|-------|------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| 15:13 | Rgmii_sw_dr_rxc  | RW     | 0x3     | Drive strenght of RX_CLK pad.<br>3'b111: strongest;<br>3'b000: weakest.                                                             |
| 12    | Rgmii_sw_dr[2]   | RW     | 0x0     | Bit 2 of Rgmii_sw_dr[2:0], refer to EXT_0xA010 bit[5:4]                                                                             |
| 11    | Int_od_en        | RW     | 0x1     | 1'b1: INT_N/PME_N pin acts as a open drain pad<br>1'b0: INT_N/PME_N pin acts as a normal output pad                                 |
| 10    | Int_act_hi       | RW     | 0x0     | It's valid only when bit11 int_od_en is 0.<br>1'b1: INT_N/PME_N pin acts as high active<br>1'b0: INT_N/PME_N pin acts as low active |
| 9:8   | Dr_sync_e        | RW     | 0x3     | Drive strenght of sync e pad.<br>2'b11: strongest;<br>2'b00: weakest                                                                |
| 7:6   | Dr_mdio          | RW     | 0x3     | Drive strenght of mdio pad.<br>2'b11: strongest;<br>2'b00: weakest                                                                  |
| 5:4   | Rgmii_sw_dr[1:0] | RW POS | 0x3     | Bit 1 and 0 of Rgmii_sw_dr, drive strength of RXD[3:0]/RX_CTL rgmii pad.<br>3'b111: strongest;<br>3'b000: weakest                   |
| 3:2   | Dr_int_io        | RW     | 0x3     | Drive strenght of interrupt pad.<br>2'b11: strongest;<br>2'b00: weakest                                                             |
| 1:0   | Dr_led           | RW     | 0x3     | Drive strenght of led pad.<br>2'b11: strongest;<br>2'b00: weakest                                                                   |

#### 6.1.18. SyncE\_CFG (EXT\_0xA012)

**Table 33. SyncE\_CFG (EXT\_0xA012)**

| Bit  | Symbol   | Access | Default | Description |
|------|----------|--------|---------|-------------|
| 15:8 | Reserved | RO     | 0x0     | Reserved    |

|     |                        |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----|------------------------|----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7   | Phy_do_fib             | RW | 0x1 | 1: In UTP_TO_FIBER mode, do not enable UTP until fiber links up<br>0: always enable UTP                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 6   | En_sync_e              | RW | 0x1 | 1: enable SyncE clock output<br>0: disable SyncE clock output                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5   | En_sync_e_during_lnkdn | RW | 0x0 | always output SyncE clock even when link is down                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 4   | Clk_fre_sel            | RW | 0x0 | 1: output 125m clock;<br>0: output 25m clock                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 3:1 | Clk_src_sel            | RW | 0x4 | select clock source of sync.<br>3'b000: internal 125MHz PLL output clock<br>3'b001: UTP recovered RX clock (when {en_adc_1, en_adc_0} == 2'b10, output adc1; when {en_adc_1, en_adc_0} == 2'b01 or 2'b11 output adc0 clock, else disable output)<br>3'b010: SerDes 125MHz RX output clock<br>3'b011: clock from digital (RGMII TX delayed clock, or debug clock out)<br>3'b100: reference 25MHz clock (default)<br>3'b101: 25MHz SSC.<br>source of 3'b000, 3'b001 and 3'b010 can be controlled by clk_fre_sel. |
| 0   | Ptp_clk_to_sds_sel     | RW | 0x0 | 1=output internal RGMII TXC to SyncE clock; used for template test; 1'b0=output one of internal clock, including any channel's DA/AD clock, to SyncE clock                                                                                                                                                                                                                                                                                                                                                     |

## 6.2. UTP MII Register

### 6.2.1. Basic Control Register (0x00)

**Table 34. Basic Control Register (0x00)**

| Bit | Symbol               | Access | Default | Description                                                                                                                                                                                                                                                                                      |
|-----|----------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15  | Reset                | RW SC  | 0x0     | PHY Software Reset. Writing 1 to this bit causes immediate PHY reset. Once the operation is done, this bit is cleared automatically.<br>0: Normal operation<br>1: PHY reset                                                                                                                      |
| 14  | Loopback             | RW SWC | 0x0     | Internal loopback control<br>1'b0: disable loopback<br>1'b1: enable loopback                                                                                                                                                                                                                     |
| 13  | Speed_Selection(LSB) | RW     | 0x0     | LSB of speed_selection[1:0]. Link speed can be selected via either the Auto-Negotiation process, or manual speed selection speed_selection[1:0]. Speed_selection[1:0] is valid when Auto-Negotiation is disabled by clearing bit 0.12 to zero.<br>Bit6 bit13<br>1 1 = Reserved<br>1 0 = 1000Mb/s |

|     |                      |              |     |                                                                                                                                                                                                                                                          |
|-----|----------------------|--------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |                      |              |     | 0 1 = 100Mb/s<br>0 0 = 10Mb/s                                                                                                                                                                                                                            |
| 12  | Autoneg_En           | RW           | 0x1 | 1: to enable auto-negotiation;<br>0: auto-negotiation is disabled.                                                                                                                                                                                       |
| 11  | Power_down           | RW SWC       | 0x0 | 1 = Power down<br>0 = Normal operation<br>When the port is switched from power down to normal operation, software reset and Auto-Negotiation are performed even bit[15] RESET and bit[9] RESTART_AUTO_NEGOTIATION are not set by the user.               |
| 10  | Isolate              | RW SWC       | 0x0 | Isolate phy from RGMII/SGMII/FIBER.<br>1'b0: Normal mode<br>1'b1: Isolate mode                                                                                                                                                                           |
| 9   | Re_Autoneg           | RW SC<br>SWS | 0x0 | Auto-Negotiation automatically restarts after hardware or software reset regardless of bit[9] RESTART.<br>1 = Restart Auto-Negotiation Process<br>0 = Normal operation                                                                                   |
| 8   | Duplex_Mode          | RW           | 0x1 | The duplex mode can be selected via either the Auto-Negotiation process or manual duplex selection. Manual duplex selection is allowed when Auto-Negotiation is disabled by setting bit[12] AUTO_NEGOTIATION to 0.<br>1 = Full Duplex<br>0 = Half Duplex |
| 7   | Collision_Test       | RW SWC       | 0x0 | Setting this bit to 1 makes the COL signal asserted whenever the TX_EN signal is asserted.<br>1 = Enable COL signal test<br>0 = Disable COL signal test                                                                                                  |
| 6   | Speed_Selection(MSB) | RW           | 0x1 | See bit13.                                                                                                                                                                                                                                               |
| 5:0 | Reserved             | RO           | 0x0 | Reserved. Write as 0, ignore on read                                                                                                                                                                                                                     |

### 6.2.2. Basic Status Register (0x01)

**Table 35. Basic Status Register (0x01)**

| Bit | Symbol            | Access | Default | Description                                                                                |
|-----|-------------------|--------|---------|--------------------------------------------------------------------------------------------|
| 15  | 100BASE-T4        | RO     | 0x0     | PHY doesn't support 100BASE-T4                                                             |
| 14  | 100BASE-X_Fd      | RO     | 0x1     | PHY supports 100BASE-X_FD                                                                  |
| 13  | 100BASE-X_Hd      | RO     | 0x1     | PHY supports 100BASE-X_HD                                                                  |
| 12  | 10Mbps_Fd         | RO     | 0x1     | PHY supports 10Mbps_Fd                                                                     |
| 11  | 10Mbps_Hd         | RO     | 0x1     | PHY supports 10Mbps_Hd                                                                     |
| 10  | 100BASE-T2_Fd     | RO     | 0x0     | PHY doesn't support 100BASE-T2_Fd                                                          |
| 9   | 100BASE-T2_Hd     | RO     | 0x0     | PHY doesn't support 100BASE-T2_Hd                                                          |
| 8   | Extended_Status   | RO     | 0x1     | Whether support EXTended status register in MII<br>0xF<br>0: Not supported<br>1: Supported |
| 7   | Unidirect_Ability | RO     | 0x0     | 1'b0: PHY able to transmit from MII only when                                              |

|   |                         |                 |     |                                                                                                                                                                                          |
|---|-------------------------|-----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |                         |                 |     | the PHY has determined that a valid link has been established<br>1'b1: PHY able to transmit from MII regardless of whether the PHY has determined that a valid link has been established |
| 6 | Mf_Preamble_Suppression | RO              | 0x1 | 1'b0: PHY will not accept management frames with preamble suppressed<br>1'b1: PHY will accept management frames with preamble suppressed                                                 |
| 5 | Autoneg_Complete        | RO SWC          | 0x0 | 1'b0: Auto-negotiation process not completed<br>1'b1: Auto-negotiation process completed                                                                                                 |
| 4 | Remote_Fault            | RO RC<br>SWC LH | 0x0 | 1'b0: no remote fault condition detected<br>1'b1: remote fault condition detected                                                                                                        |
| 3 | Autoneg_Ability         | RO              | 0x1 | 1'b0: PHY not able to perform Auto-negotiation<br>1'b1: PHY able to perform Auto-negotiation                                                                                             |
| 2 | Link_Status             | RO LL<br>SWC    | 0x0 | Link status<br>1'b0: Link is down<br>1'b1: Link is up                                                                                                                                    |
| 1 | Jabber_Detect           | RO RC<br>SWC LH | 0x0 | 10BASE-Te jabber detected. It would assert if TX activity lasts longer than 42ms.<br>1'b0: no jabber condition detected<br>1'b1: Jabber condition detected.                              |
| 0 | Extended_Capability     | RO              | 0x1 | To indicate whether support EXTended registers, to access from address register 0x1E and data register 0x1F<br>1'b0: Not supported<br>1'b1: Supported                                    |

### 6.2.3. PHY Identification Register1 (0x02)

**Table 36. PHY Identification Register1 (0x02)**

| Bit  | Symbol | Access | Default | Description                                            |
|------|--------|--------|---------|--------------------------------------------------------|
| 15:0 | Phy_Id | RO     | 0x0000  | Bits 3 to 18 of the Organizationally Unique Identifier |

### 6.2.4. PHY Identification Register2 (0x03)

**Table 37. PHY Identification Register2 (0x03)**

| Bit   | Symbol      | Access | Default | Description                                             |
|-------|-------------|--------|---------|---------------------------------------------------------|
| 15:10 | Phy_Id      | RO     | 0x0     | Bits 19 to 24 of the Organizationally Unique Identifier |
| 9:4   | Type_No     | RO     | 0x11    | 6 bits manufacturer's type number                       |
| 3:0   | Revision_No | RO     | 0xa     | 4 bits manufacturer's revision number                   |

### 6.2.5. Auto-Negotiation Advertisement (0x04)

**Table 38. Auto-Negotiation Advertisement (0x04)**

| Bit | Symbol    | Access | Default | Description                                                                                          |
|-----|-----------|--------|---------|------------------------------------------------------------------------------------------------------|
| 15  | NEXT_Page | RW     | 0x0     | This bit is updated immediately after the writing operation; however the configuration does not take |

|    |                    |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----|--------------------|----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                    |    |     | <p>effect until any of the following occurs:<br/>This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:</p> <ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> <p>If 1000BASE-T is advertised, the required next pages are automatically transmitted. This bit must be set to 0 if no additional next page is needed.<br/>1 = Advertise<br/>0 = Not advertised</p> |
| 14 | Ack                | RO | 0x0 | Always 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 13 | Remote_Fault       | RW | 0x0 | <p>1 = Set Remote Fault bit<br/>0 = Do not set Remote Fault bit</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 12 | Extended_NEXT_Page | RW | 0x1 | <p>Extended nEXT page enable control bit<br/>1 = Local device supports transmission of extended next pages<br/>0 = Local device does not support transmission of extended next pages.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11 | Asymmetric_Pause   | RW | 0x0 | <p>This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:</p> <ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> <p>1 = Asymmetric Pause<br/>0 = No asymmetric Pause</p>                                                                                                                                                                                           |
| 10 | Pause              | RW | 0x0 | <p>This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:<br/>This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:</p> <ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> <p>1 = MAC PAUSE implemented<br/>0 = MAC PAUSE not implemented</p>                             |

|   |                        |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---|------------------------|----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9 | 100BASE-T4             | RO | 0x0 | 1 = Able to perform 100BASE-T4<br>0 = Not able to perform 100BASE-T4<br>Always 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 8 | 100BASE-TX_Full_Duplex | RW | 0x1 | This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:<br><ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> 1 = Advertise<br>0 = Not advertised                                                                                                                                                   |
| 7 | 100BASE-TX_Half_Duplex | RW | 0x1 | This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:<br>This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:<br><ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> 1 = Advertise<br>0 = Not advertised |
| 6 | 10BASE-Te_Full_Duplex  | RW | 0x1 | This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:<br><ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> 1 = Advertise<br>0 = Not advertised                                                                                                                                                   |
| 5 | 10BASE-Te_Half_Duplex  | RW | 0x1 | This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:<br><ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul>                                                                                                                                                                                       |

|     |                |    |     |                                            |
|-----|----------------|----|-----|--------------------------------------------|
|     |                |    |     | 1 = Advertise<br>0 = Not advertised        |
| 4:0 | Selector_Field | RW | 0x1 | Selector Field mode.<br>00001 = IEEE 802.3 |

#### 6.2.6. Auto-Negotiation Link Partner Ability (0x05)

**Table 39. Auto-Negotiation Link Partner Ability (0x05)**

| Bit | Symbol                 | Access | Default | Description                                                                                                                                                        |
|-----|------------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15  | 1000BASE-X_Fd          | RO SWC | 0x0     | Received Code Word Bit 15<br>1 = Link partner is capable of next page<br>0 = Link partner is not capable of next page                                              |
| 14  | ACK                    | RO SWC | 0x0     | Acknowledge. Received Code Word Bit 14<br>1 = Link partner has received link code word<br>0 = Link partner has not received link code word                         |
| 13  | REMOTE_FAULT           | RO SWC | 0x0     | Remote Fault. Received Code Word Bit 13<br>1 = Link partner has detected remote fault<br>0 = Link partner has not detected remote fault                            |
| 12  | RESERVED               | RO SWC | 0x0     | Technology Ability Field. Received Code Word Bit 12                                                                                                                |
| 11  | ASYMMETRIC_PAUSE       | RO SWC | 0x0     | Technology Ability Field. Received Code Word Bit 11<br>1 = Link partner requests asymmetric pause<br>0 = Link partner does not request asymmetric pause            |
| 10  | PAUSE                  | RO SWC | 0x0     | Technology Ability Field. Received Code Word Bit 10<br>1 = Link partner supports pause operation<br>0 = Link partner does not support pause operation              |
| 9   | 100BASE-T4             | RO SWC | 0x0     | Technology Ability Field. Received Code Word Bit 9<br>1 = Link partner supports 100BASE-T4<br>0 = Link partner does not support 100BASE-T4                         |
| 8   | 100BASE-TX_FULL_DUPLEX | RO SWC | 0x0     | Technology Ability Field. Received Code Word Bit 8<br>1 = Link partner supports 100BASE-TX full-duplex<br>0 = Link partner does not support 100BASE-TX full-duplex |
| 7   | 100BASE-TX_HALF_DUPLEX | RO SWC | 0x0     | Technology Ability Field. Received Code Word Bit 7<br>1 = Link partner supports 100BASE-TX half-duplex<br>0 = Link partner does not support 100BASE-TX half-duplex |
| 6   | 10BASE-Te_FULL_DUPLEX  | RO SWC | 0x0     | Technology Ability Field. Received Code Word Bit 6<br>1 = Link partner supports 10BASE-Te full-duplex<br>0 = Link partner does not support 10BASE-Te full-duplex   |
| 5   | 10BASE-Te_HALF_DUPLEX  | RO SWC | 0x0     | Technology Ability Field. Received Code Word                                                                                                                       |

|     |                |        |     |                                                                                                                   |
|-----|----------------|--------|-----|-------------------------------------------------------------------------------------------------------------------|
|     | X              |        |     | Bit 5<br>1 = Link partner supports 10BASE-T half-duplex<br>0 = Link partner does not support 10BASE-T half-duplex |
| 4:0 | SELECTOR_FIELD | RO SWC | 0x0 | Selector Field Received Code Word Bit 4:0                                                                         |

### 6.2.7. Auto-Negotiation Expansion Register (0x06)

**Table 40. Auto-Negotiation Expansion Register (0x06)**

| Bit  | Symbol                             | Access          | Default | Description                                                                                      |
|------|------------------------------------|-----------------|---------|--------------------------------------------------------------------------------------------------|
| 15:5 | Reserved                           | RO              | 0x0     | Reserved                                                                                         |
| 4    | Parallel Detection fault           | RO RC<br>LH SWC | 0x0     | 1 = Fault is detected<br>0 = No fault is detected                                                |
| 3    | Link partner nEXT page able        | RO LH<br>SWC    | 0x0     | 1 = Link partner supports NEXT page<br>0 = Link partner does not support next page               |
| 2    | Local NEXT Page able               | RO              | 0x1     | 1 = Local Device supports NEXT Page<br>0 = Local Device does not support Next Page               |
| 1    | Page received                      | RO RC<br>LH     | 0x0     | 1 = A new page is received<br>0 = No new page is received                                        |
| 0    | Link Partner Auto negotiation able | RO              | 0x0     | 1 = Link partner supports auto-negotiation<br>0 = Link partner does not support auto-negotiation |

### 6.2.8. Auto-Negotiation NEXT Page Register (0x07)

**Table 41. Auto-Negotiation NEXT Page Register (0x07)**

| Bit  | Symbol             | Access | Default | Description                                                                                                                                                       |
|------|--------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15   | NEXT Page          | RW     | 0x0     | Transmit Code Word Bit 15<br>1 = The page is not the last page<br>0 = The page is the last page                                                                   |
| 14   | Reserved           | RO     | 0x0     | Reserved                                                                                                                                                          |
| 13   | Message page mode  | RW     | 0x1     | Transmit Code Word Bit 13<br>1 = Message Page<br>0 = Unformatted Page                                                                                             |
| 12   | Ack2               | RW     | 0x0     | Transmit Code Word Bit 12<br>1 = Comply with message<br>0 = Cannot comply with message                                                                            |
| 11   | Toggle             | RO     | 0x0     | Transmit Code Word Bit 11<br>1 = This bit in the previously exchanged Code Word is logic 0<br>0 = The Toggle bit in the previously exchanged Code Word is logic 1 |
| 10:0 | Message/Unformatte | RW     | 0x1     | Transmit Code Word Bits [10:0].<br>These bits are encoded as Message Code Field when bit[13] is set to 1, or as Unformatted Code Field when bit[13] is set to 0.  |

### 6.2.9. Auto-Negotiation Link Partner Received NEXT Page Register (0x08)

**Table 42. Auto-Negotiation Link Partner Received NEXT Page Register (0x08)**

| Bit  | Symbol             | Access | Default | Description                                                                                                                                                       |
|------|--------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15   | NEXT Page          | RO     | 0x0     | Received Code Word Bit 15<br>1 = This page is not the last page<br>0 = This page is the last page                                                                 |
| 14   | Ack                | RO     | 0x0     | Received Code Word Bit 14<br>1 = successfully received its Link Partner's ack<br>0 = didn't receive its Link Partner's ack                                        |
| 13   | Message page mode  | RO     | 0x0     | Received Code Word Bit 13<br>1 = Message Page<br>0 = Unformatted Page                                                                                             |
| 12   | Ack2               | RO     | 0x0     | Received Code Word Bit 12<br>1 = Comply with message<br>0 = Cannot comply with message                                                                            |
| 11   | Toggle             | RO     | 0x0     | Received Code Word Bit 11<br>1 = This bit in the previously exchanged Code Word is logic 0<br>0 = The Toggle bit in the previously exchanged Code Word is logic 1 |
| 10:0 | Message/Unformatte | RO     | 0x0     | Received Code Word Bit 10:0<br>These bits are encoded as Message Code Field when bit[13] is set to 1, or as Unformatted Code Field when bit[13] is set to 0.      |

#### 6.2.10. MASTER-SLAVE control register (0x09)

**Table 43. MASTER-SLAVE control register (0x09)**

| Bit   | Symbol                                   | Access | Default | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------|------------------------------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:13 | Test mode                                | RW     | 0x0     | The TX_TCLK signals from the RX_CLK pin is for jitter testing in test modes 2 and 3. When exiting the test mode, hardware reset or software reset through writing MII register 0x0 bit[15] must be performed to ensure normal operation.<br>000 = Normal Mode<br>001 = Test Mode 1 - Transmit Waveform Test<br>010 = Test Mode 2 - Transmit Jitter Test (MASTER mode)<br>011 = Test Mode 3 - Transmit Jitter Test (SLAVE mode)<br>100 = Test Mode 4 - Transmit Distortion Test<br>110, 111 = Reserved, normal operation. |
| 12    | Master/Slave Manual configuration Enable | RW     | 0x0     | This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs: <ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul>                                              |

|    |                            |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----|----------------------------|----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                            |    |     | 1 = Manual MASTER/SLAVE configuration<br>0 = Automatic MASTER/SLAVE configuration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 11 | Master/Slave configuration | RW | 0x0 | <p>This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:</p> <ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> <p>This bit is ignored if bit[12] is 0.<br/>1 = Manual configuration as MASTER<br/>0 = Manual configuration as SLAVE.</p>       |
| 10 | Port Type                  | RW | 0x0 | <p>This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:</p> <ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> <p>This bit is ignored if bit[12] is 1.<br/>1 = Prefer multi-port device (MASTER)<br/>0 = Prefer single port device (SLAVE)</p> |
| 9  | 1000BASE-T Full            | RW | 0x1 | <p>This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:</p> <ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> <p>1 = Advertise<br/>0 = Not advertised</p>                                                                                     |
| 8  | 1000BASE-T Half-           | RW | 0x0 | <p>This bit is updated immediately after the writing operation; however the configuration does not take effect until any of the following occurs:</p> <ul style="list-style-type: none"> <li>• Software reset is asserted by writing register 0x0 bit[15]</li> <li>• Restart Auto-Negotiation is triggered by writing register 0x0 bit[9]</li> <li>• The port is switched from power down to normal operation by writing register 0x0 bit[11]</li> <li>• Link goes down</li> </ul> <p>1 = Advertise<br/>0 = Not advertised (default)</p>                                                                           |

|     |          |    |     |                             |
|-----|----------|----|-----|-----------------------------|
| 7:0 | Reserved | RW | 0x0 | Write as 0, ignore on read. |
|-----|----------|----|-----|-----------------------------|

#### 6.2.11. MASTER-SLAVE Status Register (0x0A)

**Table 44. MASTER-SLAVE Status Register (0x0A)**

| Bit | Symbol                 | Access          | Default | Description                                                                                                                                                                           |
|-----|------------------------|-----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15  | Master/Slave_cfg_error | RO RC<br>SWC LH | 0x0     | This register bit will clear on read, rising of MII 0.12 and rising of AN complete.<br>1 = Master/Slave configuration fault detected<br>0 = No fault detected                         |
| 14  | Master/Slave           | RO              | 0x0     | This bit is not valid unless register 0x1 bit5 is 1.<br>1 = Local PHY configuration resolved to Master<br>0 = Local PHY configuration resolved to Slave                               |
| 13  | Local Receiver Status  | RO              | 0x0     | 1 = Local Receiver OK<br>0 = Local Receiver not OK                                                                                                                                    |
| 12  | Remote Receiver        | RO              | 0x0     | 1 = Remote Receiver OK<br>0 = Remote Receiver not OK                                                                                                                                  |
| 11  | Link Partner           | RO              | 0x0     | This bit is not valid unless register 0x1 bit5 is 1.<br>1 = Link Partner supports 1000BASE-T half duplex<br>0 = Link Partner does not support 1000BASE-T half duplex                  |
| 10  | Link Partner           | RO              | 0x0     | This bit is not valid unless register 0x1 bit5 is 1.<br>1 = Link Partner supports 1000BASE-T full duplex<br>0 = Link Partner does not support 1000BASE-T full duplex                  |
| 9:8 | Reserved               | RO              | 0x0     | Reserved                                                                                                                                                                              |
| 7:0 | Idle Error Count       | RO RC           | 0x0     | MSB of Idle Error Counter. The register indicates the idle error count since the last read operation performed to this register. The counter pegs at 11111111 and does not roll over. |

#### 6.2.12. MMD Access Control Register (0x0D)

**Table 45. MMD Access Control Register (0x0D)**

| Bit   | Symbol   | Access | Default | Description                                                                                                                               |
|-------|----------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 15:14 | Function | RW     | 0x0     | 00 = Address<br>01 = Data, no post increment<br>10 = Data, post increment on reads and writes<br>11 = Data, post increment on writes only |
| 13:5  | Reserved | RO     | 0x0     | Reserved                                                                                                                                  |
| 4:0   | DEVAD    | RW     | 0x0     | MMD register device address.<br>00001 = MMD1<br>00011 = MMD3<br>00111 = MMD7                                                              |

**6.2.13. MMD Access Data Register (0x0E)****Table 46. MMD Access Data Register (0x0E)**

| Bit  | Symbol       | Access | Default | Description                                                                                                                                                                                    |
|------|--------------|--------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Address data | RW     | 0x0     | If register 0xD bits [15:14] are 00, this register is used as MMD DEVAD address register.<br>Otherwise, this register is used as MMD DEVAD data register as indicated by its address register. |

**6.2.14. Extended status register (0x0F)****Table 47. Extended status register (0x0F)**

| Bit  | Symbol                 | Access | Default | Description                                                                                              |
|------|------------------------|--------|---------|----------------------------------------------------------------------------------------------------------|
| 15   | 1000BASE-X Full Duplex | RO     | 0x0     | 1 = PHY supports 1000BASE-X Full Duplex<br>0 = PHY does not supports 1000BASE-X Full Duplex<br>Always 0. |
| 14   | 1000BASE-X Half Duplex | RO     | 0x0     | 1 = PHY supports 1000BASE-X Half Duplex.<br>0 = PHY does not support 1000BASE-X Half Duplex.<br>Always 0 |
| 13   | 1000BASE-T Full Duplex | RO     | 0x1     | 1 = PHY supports 1000BASE-T Full Duplex<br>0 = PHY does not supports 1000BASE-T Full Duplex<br>Always 1  |
| 12   | 1000BASE-T Half Duplex | RO     | 0x0     | 1 = PHY supports 1000BASE-T Half Duplex<br>0 = PHY does not support 1000BASE-T Half Duplex<br>Always 0.  |
| 11:0 | Reserved               | RO     | 0x0     | Reserved                                                                                                 |

**6.2.15. PHY Specific Function Control Register (0x10)****Table 48. PHY Specific Function Control Register (0x10)**

| Bit  | Symbol    | Access | Default | Description                                                                                                                                                                                                                                                                                                     |
|------|-----------|--------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:7 | Reserved  | RO     | 0x0     | Reserved                                                                                                                                                                                                                                                                                                        |
| 6:5  | Cross_md  | RW     | 0x3     | Changes made to these bits disrupt normal operation, thus a software reset is mandatory after the change. And the configuration does not take effect until software reset.<br>00 = Manual MDI configuration<br>01 = Manual MDIX configuration<br>10 = Reserved<br>11 = Enable automatic crossover for all modes |
| 4    | Reserved  | RO     | 0x0     | Reserved                                                                                                                                                                                                                                                                                                        |
| 3    | Crs_on_tx | RW     | 0x0     | This bit is effective in 10BASE-Te half-duplex mode and 100BASE-TX mode:<br>1 = Assert CRS on transmitting or receiving<br>0 = Never assert CRS on transmitting, only assert it on receiving.                                                                                                                   |

|   |             |    |     |                                                                                                                                                        |
|---|-------------|----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 | En_sqe_test | RW | 0x0 | 1 = SQE test enabled, 0 = SQE test disabled<br>Note: SQE Test is automatically disabled in full-duplex mode regardless the setting in this bit.        |
| 1 | En_pol_inv  | RW | 0x1 | If polarity reversal is disabled, the polarity is forced to be normal in 10BASE-Te.<br>1 = Polarity Reversal Enabled<br>0 = Polarity Reversal Disabled |
| 0 | Dis_jab     | RW | 0x0 | 1 = Disable 10BASE-Te jabber detection function<br>0 = Enable 10BASE-Te jabber detection function                                                      |

#### 6.2.16. PHY Specific Status Register (0x11)

**Table 49. PHY Specific Status Register (0x11)**

| Bit   | Symbol                    | Access | Default | Description                                                                                                                                                                                                                                                                                                                         |
|-------|---------------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:14 | Speed_mode                | RO     | 0x0     | These status bits are valid only when bit11 is 1. Bit11 is set when Auto-Negotiation is completed or Auto-Negotiation is disabled.<br>11 = Reserved<br>10 = 1000 Mbps<br>01 = 100 Mbps<br>00 = 10 Mbps                                                                                                                              |
| 13    | Duplex                    | RO     | 0x0     | This status bit is valid only when bit11 is 1. Bit11 is set when Auto-Negotiation is completed or Auto-Negotiation is disabled.<br>1 = Full-duplex<br>0 = Half-duplex                                                                                                                                                               |
| 12    | Page Received real-time   | RO     | 0x0     | 1 = Page received<br>0 = Page not received                                                                                                                                                                                                                                                                                          |
| 11    | Speed and Duplex Resolved | RO     | 0x0     | When Auto-Negotiation is disabled, this bit is set to 1 for force speed mode.<br>1 = Resolved<br>0 = Not resolved                                                                                                                                                                                                                   |
| 10    | Link status real-time     | RO     | 0x0     | 1 = Link up<br>0 = Link down                                                                                                                                                                                                                                                                                                        |
| 9:7   | Reserved                  | RO     | 0x0     | Reserved                                                                                                                                                                                                                                                                                                                            |
| 6     | MDI Crossover Status      | RO     | 0x0     | This status bit is valid only when bit11 is 1. Bit11 is set when Auto-Negotiation is completed or Auto-Negotiation is disabled.<br>The bit value depends on register 0x10 “PHY specific function control register” bits6~bit5 configurations. Register 0x10 configurations take effect after software reset.<br>1 = MDIX<br>0 = MDI |
| 5     | Wirespeed downgrade       | RO     | 0x0     | 1 = Downgrade<br>0 = No Downgrade                                                                                                                                                                                                                                                                                                   |
| 4     | Reserved                  | RO     | 0x0     | Reserved                                                                                                                                                                                                                                                                                                                            |
| 3     | Transmit Pause            | RO     | 0x0     | This status bit is valid only when bit11 is 1. Bit11 is set when Auto-Negotiation is completed.<br>This bit indicates MAC pause resolution. This bit                                                                                                                                                                                |

|   |                    |    |     |                                                                                                                                                                                                                                                                                                                               |
|---|--------------------|----|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |                    |    |     | is for information purposes only and is not used by the device. When in force mode, this bit is set to be 0.<br>1 = Transmit pause enabled<br>0 = Transmit pause disabled                                                                                                                                                     |
| 2 | Receive Pause      | RO | 0x0 | This status bit is valid only when bit[11] is 1. Bit[11] is set when Auto-Negotiation is completed. This bit indicates MAC pause resolution. This bit is for information purposes only and is not used by the device. When in force mode, this bit is set to be 0.<br>1 = Receive pause enabled<br>0 = Receive pause disabled |
| 1 | Polarity Real Time | RO | 0x0 | 1 = Reverted polarity<br>0 = Normal polarity                                                                                                                                                                                                                                                                                  |
| 0 | Jabber Real Time   | RO | 0x0 | 1 = Jabber<br>0 = No jabber                                                                                                                                                                                                                                                                                                   |

#### 6.2.17. Interrupt Mask Register (0x12)

**Table 50. Interrupt Mask Register (0x12)**

| Bit | Symbol                          | Access | Default | Description                                 |
|-----|---------------------------------|--------|---------|---------------------------------------------|
| 15  | Auto-Negotiation Error INT mask | RW     | 0x0     | 1: Interrupt enable<br>0: Interrupt disable |
| 14  | Speed Changed INT mask          | RW     | 0x0     | same as bit 15                              |
| 13  | Duplex changed INT mask         | RW     | 0x0     | same as bit 15                              |
| 12  | Page Received INT mask          | RW     | 0x0     | same as bit 15                              |
| 11  | Link Failed INT mask            | RW     | 0x0     | same as bit 15                              |
| 10  | Link Succeed INT mask           | RW     | 0x0     | same as bit 15                              |
| 9:7 | reserved                        | RW     | 0x0     | No used.                                    |
| 6   | WOL INT mask                    | RW     | 0x0     | same as bit 15                              |
| 5   | Wirespeed downgraded INT mask   | RW     | 0x0     | same as bit 15                              |
| 4   | RX CRC Error INT mask           | RW     | 0x0     | same as bit 15                              |
| 3   | Serdes Link Failed INT mask     | RW     | 0x0     | same as bit 15                              |
| 2   | Serdes Link Success INT mask    | RW     | 0x0     | same as bit 15                              |
| 1   | Polarity changed INT mask       | RW     | 0x0     | same as bit 15                              |
| 0   | Jabber Happened INT mask        | RW     | 0x0     | same as bit 15                              |

#### 6.2.18. Interrupt Status Register (0x13)

**Table 51. Interrupt Status Register (0x13)**

| Bit | Symbol                     | Access | Default | Description                                                                                                                     |
|-----|----------------------------|--------|---------|---------------------------------------------------------------------------------------------------------------------------------|
| 15  | Auto-Negotiation Error INT | RO RC  | 0x0     | Error can take place when any of the following happens:<br>• MASTER/SLAVE does not resolve correctly<br>• Parallel detect fault |

|     |                          |       |     |                                                                                                                                                                                                                                                                                                                                                     |
|-----|--------------------------|-------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |                          |       |     | <ul style="list-style-type: none"> <li>• No common HCD</li> <li>• Link does not come up after negotiation is complete</li> <li>• Selector Field is not equal</li> <li>• flp_receive_idle=true while Autoneg Arbitration FSM is in NEXT PAGE WAIT state</li> </ul> 1: Auto-Negotiation Error takes place<br>0: No Auto-Negotiation Error takes place |
| 14  | Speed Changed INT        | RO RC | 0x0 | 1: Speed changed<br>0: Speed not changed                                                                                                                                                                                                                                                                                                            |
| 13  | Duplex changed INT       | RO RC | 0x0 | 1: duplex changed<br>0: duplex not changed                                                                                                                                                                                                                                                                                                          |
| 12  | Page Received INT        | RO RC | 0x0 | 1: Page received<br>0: Page not received                                                                                                                                                                                                                                                                                                            |
| 11  | Link Failed INT          | RO RC | 0x0 | 1: Phy link down takes place<br>0: No link down takes place                                                                                                                                                                                                                                                                                         |
| 10  | Link Succeed INT         | RO RC | 0x0 | 1: Phy link up takes place<br>0: No link up takes place                                                                                                                                                                                                                                                                                             |
| 9:7 | reserved                 | RO RC | 0x0 | No used.                                                                                                                                                                                                                                                                                                                                            |
| 6   | WOL INT                  | RO RC | 0x0 | 1: PHY received WOL magic frame.<br>0: PHY didn't receive WOL magic frame                                                                                                                                                                                                                                                                           |
| 5   | Wirespeed downgraded INT | RO RC | 0x0 | 1: speed downgraded.<br>0: Speed didn't downgrade.                                                                                                                                                                                                                                                                                                  |
| 4   | RX CRC Error INT         | RO RC | 0x0 | 1 = CRC error takes place for the packages received from the wire<br>0 = No CRC error takes place<br>This INT is only activated when package checker is eabled. See UTP EXT register EXT_0xA0 for how to enable the package checker.                                                                                                                |
| 3   | Serdes Link Failed INT   | RO RC | 0x0 | 1: Sds link down takes place<br>0: No Sds link down takes place                                                                                                                                                                                                                                                                                     |
| 2   | Serdes Link Success INT  | RO RC | 0x0 | 1: Sds link up takes place<br>0: No Sds link up takes place                                                                                                                                                                                                                                                                                         |
| 1   | Polarity changed INT     | RO RC | 0x0 | 1: PHY revered MDI polarity<br>0: PHY didn't revert MDI polarity                                                                                                                                                                                                                                                                                    |
| 0   | Jabber Happened INT      | RO RC | 0x0 | 1: 10BASE-Te TX jabber happened<br>0: 10BASE-Te TX jabber didn't happen<br>Please refer to UTP MII Register 0x1 bit[1] Jabber_Detect.                                                                                                                                                                                                               |

### 6.2.19. Speed Auto Downgrade Control Register (0x14)

**Table 52. Speed Auto Downgrade Control Register (0x14)**

| Bit   | Symbol             | Access | Default | Description                                                                                                                                         |
|-------|--------------------|--------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:12 | Reserved           | RO     | 0x0     | Reserved                                                                                                                                            |
| 11:6  | Reserved           | RW     | 0x20    | Reserved                                                                                                                                            |
| 5     | En_speed_downgrade | RW POS | 0x1     | When this bit is set to 1, the PHY enables smart-speed function. Writing this bit requires a software reset to update. This bit will be set to 1'b0 |

|     |                                   |    |     |                                                                                                                                                                                                     |
|-----|-----------------------------------|----|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |                                   |    |     | in UTP_TO_FIBER mode; else set to 1'b1, only take effect after software reset                                                                                                                       |
| 4:2 | Autoneg retry limit pre-downgrade | RW | 0x3 | If these bits are set to 3, the PHY attempts five times (set value 3 + additional 2) before downgrading. The number of attempts can be changed by these bits. Only take effect after software reset |
| 1   | Reserved                          | RW | 0x0 | Reserved                                                                                                                                                                                            |
| 0   | Reserved                          | RO | 0x0 | Reserved                                                                                                                                                                                            |

### 6.2.20. Rx Error Counter Register (0x15)

**Table 53. Rx Error Counter Register (0x15)**

| Bit  | Symbol         | Access | Default | Description                                                                                                                         |
|------|----------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Rx_err_counter | RO SWC | 0x0     | This counter increase by 1 at the 1st rising of RX_ER when RX_DV is 1. The counter will hold at maximum 16'hFFFF and not roll over. |

### 6.2.21. Extended Register's Address Offset Register (0x1E)

**Table 54. Extended Register's Address Offset Register (0x1E)**

| Bit  | Symbol                           | Access | Default | Description                                                                 |
|------|----------------------------------|--------|---------|-----------------------------------------------------------------------------|
| 15:8 | Reserved                         | RO     | 0x0     | Reserved                                                                    |
| 7:0  | Extended Register Address Offset | RW     | 0x0     | It's the address offset of the extended register that will be Write or Read |

### 6.2.22. Extended Register's Data Register (0x1F)

**Table 55. Extended Register's Data Register (0x1F)**

| Bit  | Symbol                 | Access | Default | Description                                                                                                                                              |
|------|------------------------|--------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Extended Register Data | RW     | 0x0     | It's the data to be written to the extended register indicated by the address offset in register 0x1E, or the data read out from that extended register. |

## 6.3. UTP MMD Register

### 6.3.1. PCS Control 1 Register (MMD3, 0x0)

**Table 56. PCS Control 1 Register (MMD3, 0x0)**

| Bit   | Symbol   | Access | Default | Description                                                                                                                                                                                        |
|-------|----------|--------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15    | Pcs_rst  | RW SC  | 0x0     | Setting this bit will set all PCS registers to their default states. This action also initiate a software reset as setting MII 0x0 bit15 and a reset as setting MMD1 0x0 bit15 and MMD7 0x0 bit15. |
| 14:11 | Reserved | RO     | 0x0     | Reserved                                                                                                                                                                                           |
| 10    | Reserved | RO     | 0x0     | Not used.                                                                                                                                                                                          |
| 9:0   | Reserved | RO     | 0x0     | Reserved                                                                                                                                                                                           |

**6.3.2. PCS Status 1 Register (MMD3, 0x1)****Table 57. PCS Status 1 Register (MMD3, 0x1)**

| Bit   | Symbol           | Access | Default | Description                                                                                                                                              |
|-------|------------------|--------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:12 | Reserved         | RO     | 0x0     | Reserved                                                                                                                                                 |
| 11    | Tx_lpi_rxed      | RO LH  | 0x0     | When read as 1, it indicates that the transmit PCS has received low power idle signaling one or more times since the register was last read. Latch High. |
| 10    | Rx_lpi_rxed      | RO LH  | 0x0     | When read as 1, it indicates that the receive PCS has received low power idle signaling one or more times since the register was last read. Latch High.  |
| 9     | Tx_lpi_indic     | RO     | 0x0     | When read as 1, it indicates that the transmit PCS is currently receiving low power idle signals.                                                        |
| 8     | Rx_lpi_indic     | RO     | 0x0     | When read as 1, it indicates that the receive PCS is currently receiving low power idle signals.                                                         |
| 7:3   | Reserved         | RO     | 0x0     | Reserved                                                                                                                                                 |
| 2     | Pcsrx_lnk_status | RO LL  | 0x0     | PCS status, latch low.                                                                                                                                   |
| 1:0   | Reserved         | RO     | 0x0     | Reserved                                                                                                                                                 |

**6.3.3. EEE Control and Capability Register (MMD3, 0x14)****Table 58. EEE Control and Capability Register (MMD3, 0x14)**

| Bit  | Symbol         | Access | Default | Description                               |
|------|----------------|--------|---------|-------------------------------------------|
| 15:3 | Reserved       | RO     | 0x0     | Reserved                                  |
| 2    | 1000BASE-T EEE | RO     | 0x1     | Always 1. EEE is supported for 1000BASE-T |
| 1    | 100BASE-TX EEE | RO     | 0x1     | Always 1. EEE is supported for 100BASE-TX |
| 0    | Reserved       | RO     | 0x0     | Reserved                                  |

**6.3.4. EEE Wake Error Counter (MMD3, 0x16)****Table 59. EEE Wake Error Counter (MMD3, 0x16)**

| Bit  | Symbol           | Access       | Default | Description                                                                                                                         |
|------|------------------|--------------|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Lpi_wake_err_cnt | RO RC<br>SWC | 0x0     | Count wake time faults where the PHY fails to complete its normal wake sequence within the time required for the specific PHY type. |

**6.3.5. Local Device EEE Ability (MMD7, 0x3C)****Table 60. Local Device EEE Ability (MMD7, 0x3C)**

| Bit  | Symbol     | Access | Default | Description                   |
|------|------------|--------|---------|-------------------------------|
| 15:3 | Reserved   | RO     | 0x0     | Reserved                      |
| 2    | EEE_1000BT | RW     | 0x0     | PHY's 1000BASE-T EEE ability. |
| 1    | EEE_100BT  | RW     | 0x0     | PHY's 100BASE-TX EEE ability. |
| 0    | Reserved   | RO     | 0x0     | Reserved                      |

**6.3.6. Link Partner EEE Ability (MMD7, 0x3D)****Table 61. Link Partner EEE Ability (MMD7, 0x3D)**

| Bit | Symbol | Access | Default | Description |
|-----|--------|--------|---------|-------------|
|-----|--------|--------|---------|-------------|

|      |                   |    |     |                                        |
|------|-------------------|----|-----|----------------------------------------|
| 15:3 | Reserved          | RO | 0x0 | Reserved                               |
| 2    | LP_ge_eee_ability | RO | 0x0 | Link partner's 1000BASE-T EEE ability. |
| 1    | LP_ge_eee_ability | RO | 0x0 | Link partner's 100BASE-TX EEE ability. |
| 0    | Reserved          | RO | 0x0 | Reserved                               |

## 6.4. UTP EXT Register

### 6.4.1. Pkgen Cfg1 (EXT\_0x38)

**Table 62. Pkgen Cfg1 (EXT\_0x38)**

| Bit   | Symbol           | Access | Default | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------|------------------|--------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:13 | Reserved         | RO     | 0x0     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 12    | En_pkgen_da_sa   | RW     | 0x0     | 1: set the DA/SA of the packet generated by pkg_gen to a programmed value; For DA, if UTP EXT 0x38 bit[11] is 1, the DA is set to broadcast address FF-FF-FF-FF-FF-FF; else, the DA is set to fix value, the highest 5 Bytes are 00-00-00-00-00, and the lowest 1 Byte is programmed by UTP EXT 0x3A bit[15:8]. For SA, the highest 5 Bytes are 00-00-00-00-00, and the lowest 1 Byte is programmed by UTP EXT 0x3A bit[7:0].<br>0: the DA/SA is not programmed value |
| 11    | Pkgen_brdest     | RW     | 0x0     | Valid when UTP EXT 0x38 bit12 is 1.<br>1: set the DA to broadcast address FF-FF-FF-FF-FF-FF<br>0: set the DA to a fixed programmed value.                                                                                                                                                                                                                                                                                                                             |
| 10    | Pkgchk_txsrc_sel | RW     | 0x0     | 1'b1: the package checker on TX side will check the tx data generated by pkg_gen;<br>1'b0: the package checker on TX side will check the tx data of UTP GMII/MII.                                                                                                                                                                                                                                                                                                     |
| 9     | Pkgen_en_az      | RW     | 0x0     | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 8:0   | Pkgen_in_az_t    | RW     | 0x1ff   | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### 6.4.2. Pkgen Cfg2 (0x39)

**Table 63. Pkgen Cfg2 (EXT\_0x39)**

| Bit  | Symbol         | Access | Default | Description |
|------|----------------|--------|---------|-------------|
| 15:8 | Pkgen_pre_az_t | RW     | 0x20    | None        |
| 7:0  | Pkgen_aft_az_t | RW     | 0x19    | None        |

### 6.4.3. Pkgen Cfg3 (EXT\_0x3A)

**Table 64. Pkgen Cfg3 (EXT\_0x3A)**

| Bit  | Symbol   | Access | Default | Description                                                                    |
|------|----------|--------|---------|--------------------------------------------------------------------------------|
| 15:8 | Pkgen_da | RW     | 0x0     | Lowest 8 bits of DA, others is zero. Refer to UTP EXT 0x38 bit[12] for detail. |
| 7:0  | Pkgen_sa | RW     | 0x0     | Lowest 8 bits of SA, others is zero. Refer to UTP EXT 0x38 bit[12] for detail. |

#### 6.4.4. Pkgen Cfg4 (0x3B)

**Table 65. Pkgen Cfg4 (EXT\_0x3B)**

| Bit  | Symbol       | Access | Default | Description |
|------|--------------|--------|---------|-------------|
| 15:8 | Reserved     | RO     | 0x0     | Reserved    |
| 7:0  | Pkg_data_fix | RW     | 0x0     | None        |

#### 6.4.5. Pkg Cfg0 (EXT\_0xA0)

**Table 66. Pkg Cfg0 (EXT\_0xA0)**

| Bit  | Symbol          | Access | Default | Description                                                                                                                                                                                                                                                                                                                                                    |
|------|-----------------|--------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15   | Pkg_chk_en      | RW     | 0x0     | 1: to enable UTP RX/TX package checker. RX checker checks the UTP GMII/MII RX data; TX checker checks the UTP GMII/MII TX data.                                                                                                                                                                                                                                |
| 14   | Pkg_en_gate     | RW     | 0x1     | 1: to enable gate all the clocks to package self-test module when bit15 pkg_chk_en is 0, bit13 bp_pkg_gen is 1 and bit12 pkg_gen_en is 0; 0: not gate the clocks.                                                                                                                                                                                              |
| 13   | Bp_pkg_gen      | RW     | 0x1     | 1: normal mode, to send GMII/MII TX data from RGMII;<br>0: test mode, to send out the GMII/MII data generated by UTP pkg_gen module.                                                                                                                                                                                                                           |
| 12   | Pkg_gen_en      | RW SC  | 0x0     | 1: to enable pkg_gen generating GMII/MII packages. But, the data will only be sent to transceiver when Bit13 bp_pkg_gen is 1'b0. If pkg_burst_size is 0, continuous packages will be generated and will be stopped only when pkg_gen_en is set to 0; Otherwise, after the expected packages are generated, pkg_gen will stop, pkg_gen_en will be self-cleared. |
| 11:8 | Pkg_prm_lth     | RW     | 0x8     | The preamble length of the generated packages, in Byte unit. Pkg_gen function only support >=2 Byte preamble length. Values smaller than 2 will be ignored by the pkg_gen module.                                                                                                                                                                              |
| 7:4  | Pkg_ipg_lth     | RW     | 0xd     | The IPG of the generated packages, in Byte unit for setting smaller than 12. For setting 13, ipg is 2ms; for setting 14, ipg is 20ms; for 15, ipg is 400ms; Pkg_gen function only support >=2 Byte preamble length. Values smaller than 2 will be ignored by the pkg_gen module.                                                                               |
| 3    | Reserved        | RW     | 0x0     | Reserved                                                                                                                                                                                                                                                                                                                                                       |
| 2    | Pkg_corrupt_crc | RW     | 0x0     | 1: to make pkg_gen to send out CRC error packages.<br>0: pkg_gen sends out CRC good packages.                                                                                                                                                                                                                                                                  |
| 1:0  | Pkg_payload     | RW     | 0x0     | Control the payload of the generated packages.<br>00: increased Byte payload;<br>01: random payload;<br>10: fix pattern 0x5AA55AA5...<br>11: reserved.                                                                                                                                                                                                         |

**6.4.6. Pkg Cfg1 (EXT\_0xA1)****Table 67. Pkg Cfg1 (EXT\_0xA1)**

| Bit  | Symbol     | Access | Default | Description                                  |
|------|------------|--------|---------|----------------------------------------------|
| 15:0 | Pkg_length | RW     | 0x40    | To set the length of the generated packages. |

**6.4.7. Pkg Cfg2 (EXT\_0xA2)****Table 68. Pkg Cfg2 (EXT\_0xA2)**

| Bit  | Symbol         | Access | Default | Description                                                     |
|------|----------------|--------|---------|-----------------------------------------------------------------|
| 15:0 | Pkg_burst_size | RW     | 0x0     | To set the number of packages in a burst of package generation. |

**6.4.8. Pkg Rx Valid0 (EXT\_0xA3)****Table 69. Pkg Rx Valid0 (EXT\_0xA3)**

| Bit  | Symbol            | Access | Default | Description                                                                                                                         |
|------|-------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_valid_high | RO RC  | 0x0     | Pkg_ib_valid[31:16], pkg_ib_valid is the number of RX packages from wire whose CRC are good and length are >=64Byte and <=1518Byte. |

**6.4.9. Pkg Rx Valid1 (EXT\_0xA4)****Table 70. Pkg Rx Valid1 (EXT\_0xA4)**

| Bit  | Symbol           | Access | Default | Description                                                                                                                        |
|------|------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_valid_low | RO RC  | 0x0     | Pkg_ib_valid[15:0], pkg_ib_valid is the number of RX packages from wire whose CRC are good and length are >=64Byte and <=1518Byte. |

**6.4.10. Pkg Rx Os0 (EXT\_0xA5)****Table 71. Pkg Rx Os0 (EXT\_0xA5)**

| Bit  | Symbol              | Access | Default | Description                                                                                                               |
|------|---------------------|--------|---------|---------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_os_good_high | RO RC  | 0x0     | Pkg_ib_os_good[31:16], pkg_ib_os_good is the number of RX packages from wire whose CRC are good and length are >1518Byte. |

**6.4.11. Pkg Rx Os1 (EXT\_0xA6)****Table 72. Pkg Rx Os1 (EXT\_0xA6)**

| Bit  | Symbol             | Access | Default | Description                                                                                                              |
|------|--------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_os_good_low | RO RC  | 0x0     | Pkg_ib_os_good[15:0], pkg_ib_os_good is the number of RX packages from wire whose CRC are good and length are >1518Byte. |

**6.4.12. Pkg Rx Us0 (EXT\_0xA7)****Table 73. Pkg Rx Us0 (EXT\_0xA7)**

| Bit  | Symbol              | Access | Default | Description                                                                                                             |
|------|---------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_us_good_high | RO RC  | 0x0     | Pkg_ib_us_good[31:16], pkg_ib_us_good is the number of RX packages from wire whose CRC are good and length are <64Byte. |

**6.4.13. Pkg Rx Us1 (EXT\_0xA8)****Table 74. Pkg Rx Us1 (EXT\_0xA8)**

| Bit  | Symbol             | Access | Default | Description                                                                                                            |
|------|--------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_us_good_low | RO RC  | 0x0     | Pkg_ib_us_good[15:0], pkg_ib_us_good is the number of RX packages from wire whose CRC are good and length are <64Byte. |

**6.4.14. Pkg Rx Err (EXT\_0xA9)****Table 75. Pkg Rx Err (EXT\_0xA9)**

| Bit  | Symbol     | Access | Default | Description                                                                                                |
|------|------------|--------|---------|------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_err | RO RC  | 0x0     | pkg_ib_err is the number of RX packages from wire whose CRC are wrong and length are >=64Byte, <=1518Byte. |

**6.4.15. Pkg Rx Os Bad (EXT\_0xAA)****Table 76. Pkg Rx Os Bad (EXT\_0xAA)**

| Bit  | Symbol        | Access | Default | Description                                                                                         |
|------|---------------|--------|---------|-----------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_os_bad | RO RC  | 0x0     | pkg_ib_os_bad is the number of RX packages from wire whose CRC are wrong and length are >=1518Byte. |

**6.4.16. Pkg Rx Fragment (EXT\_0xAB)****Table 77. Pkg Rx Fragment (EXT\_0xAB)**

| Bit  | Symbol      | Access | Default | Description                                                                  |
|------|-------------|--------|---------|------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_frag | RO RC  | 0x0     | pkg_ib_frag is the number of RX packages from wire whose length are <64Byte. |

**6.4.17. Pkg Rx Nosfd (EXT\_0xAC)****Table 78. Pkg Rx Nosfd (EXT\_0xAC)**

| Bit  | Symbol       | Access | Default | Description                                                              |
|------|--------------|--------|---------|--------------------------------------------------------------------------|
| 15:0 | Pkg_ib_nosfd | RO RC  | 0x0     | pkg_ib_nosfd is the number of RX packages from wire whose SFD is missed. |

**6.4.18. Pkg Tx Valid0 (EXT\_0xAD)****Table 79. Pkg Tx Valid0 (EXT\_0xAD)**

| Bit  | Symbol            | Access | Default | Description                                                                                                                        |
|------|-------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_valid_high | RO RC  | 0x0     | Pkg_ob_valid[31:16], pkg_ob_valid is the number of TX packages from MII whose CRC are good and length are >=64Byte and <=1518Byte. |

#### 6.4.19. Pkg Tx Valid1 (EXT\_0xAE)

**Table 80. Pkg Tx Valid1 (EXT\_0xAE)**

| Bit  | Symbol           | Access | Default | Description                                                                                                                       |
|------|------------------|--------|---------|-----------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_valid_low | RO RC  | 0x0     | Pkg_ob_valid[15:0], pkg_ob_valid is the number of TX packages from MII whose CRC are good and length are >=64Byte and <=1518Byte. |

#### 6.4.20. Pkg Tx Os0 (EXT\_0xAF)

**Table 81. Pkg Tx Os0 (EXT\_0xAF)**

| Bit  | Symbol              | Access | Default | Description                                                                                                              |
|------|---------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_os_good_high | RO RC  | 0x0     | Pkg_ob_os_good[31:0], pkg_ob_os_good is the number of TX packages from GMII whose CRC are good and length are >1518Byte. |

#### 6.4.21. Pkg Tx Os1 (EXT\_0xB0)

**Table 82. Pkg Tx Os1 (EXT\_0xB0)**

| Bit  | Symbol             | Access | Default | Description                                                                                                              |
|------|--------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_os_good_low | RO RC  | 0x0     | Pkg_ob_os_good[15:0], pkg_ob_os_good is the number of TX packages from GMII whose CRC are good and length are >1518Byte. |

#### 6.4.22. Pkg Tx Us0 (EXT\_0xB1)

**Table 83. Pkg Tx Us0 (EXT\_0xB1)**

| Bit  | Symbol              | Access | Default | Description                                                                                                            |
|------|---------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_us_good_high | RO RC  | 0x0     | Pkg_ob_us_good[31:0], pkg_ob_us_good is the number of TX packages from GMII whose CRC are good and length are <64Byte. |

#### 6.4.23. Pkg Tx Us1 (EXT\_0xB2)

**Table 84. Pkg Tx Us1 (EXT\_0xB2)**

| Bit  | Symbol             | Access | Default | Description                                                                                                            |
|------|--------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_us_good_low | RO RC  | 0x0     | Pkg_ob_us_good[15:0], pkg_ob_us_good is the number of TX packages from GMII whose CRC are good and length are <64Byte. |

#### 6.4.24. Pkg Tx Err (EXT\_0xB3)

**Table 85. Pkg Tx Err (EXT\_0xB3)**

| Bit  | Symbol     | Access | Default | Description                                                                                                |
|------|------------|--------|---------|------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_err | RO RC  | 0x0     | pkg_ob_err is the number of TX packages from GMII whose CRC are wrong and length are >=64Byte, <=1518Byte. |

#### 6.4.25. Pkg Tx Os Bad (EXT\_0xB4)

**Table 86. Pkg Tx Os Bad (EXT\_0xB4)**

| Bit  | Symbol        | Access | Default | Description                                                                                        |
|------|---------------|--------|---------|----------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_os_bad | RO RC  | 0x0     | pkg_ob_os_bad is the number of TX packages from GMII whose CRC are wrong and length are >1518Byte. |

#### 6.4.26. Pkg Tx Fragment (EXT\_0xB5)

**Table 87. Pkg Tx Fragment (EXT\_0xB5)**

| Bit  | Symbol      | Access | Default | Description                                                                  |
|------|-------------|--------|---------|------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_frag | RO RC  | 0x0     | pkg_ob_frag is the number of TX packages from GMII whose length are <64Byte. |

#### 6.4.27. Pkg Tx Nosfd (EXT\_0xB6)

**Table 88. Pkg Tx Nosfd (EXT\_0xB6)**

| Bit  | Symbol       | Access | Default | Description                                                              |
|------|--------------|--------|---------|--------------------------------------------------------------------------|
| 15:0 | Pkg_ob_nosfd | RO RC  | 0x0     | pkg_ob_nosfd is the number of TX packages from GMII whose SFD is missed. |

## 6.5. SDS MII Register

#### 6.5.1. Basic Control Register (0x00)

**Table 89. Basic Control Register (0x00)**

| Bit | Symbol               | Access | Default | Description                                                                                                                                                                                           |
|-----|----------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15  | Reset                | RW SC  | 0x0     | SDS Software Reset. Writing 1 to this bit causes immediate PHY reset. Once the operation is done, this bit is cleared automatically.<br>0: Normal operation<br>1: SDS reset                           |
| 14  | Loopback             | RW SWC | 0x0     | Internal loopback control<br>1'b0: disable loopback<br>1'b1: enable loopback                                                                                                                          |
| 13  | Speed_Selection(LSB) | RW     | 0x0     | Valid only when the SerDes works as SGMII MAC, for example, when the chip mode is SGMAC_TO_RGPHY.<br>LSB of speed_selection[1:0]. Link speed can be selected via either the Auto-Negotiation process, |

|     |                      |        |     |                                                                                                                                                                                                                                                                                                                                                         |
|-----|----------------------|--------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |                      |        |     | or manual speed selection speed_selection[1:0].<br>Speed_selection[1:0] is valid when Auto-Negotiation is disabled by clearing bit 0.12 to zero.<br>Bit6 bit13<br>1 1 = Reserved<br>1 0 = 1000Mb/s<br>0 1 = 100Mb/s<br>0 0 = 10Mb/s                                                                                                                     |
| 12  | Autoneg_En           | RW     | 0x1 | 1: enable auto-negotiation;<br>0: disable auto-negotiation.                                                                                                                                                                                                                                                                                             |
| 11  | Power_down           | RW SWC | 0x0 | 1 = Power down<br>0 = Normal operation                                                                                                                                                                                                                                                                                                                  |
| 10  | Isolate              | RW SWC | 0x0 | Isolate SerDes from RGMII/UTP.                                                                                                                                                                                                                                                                                                                          |
| 9   | Re_Autoneg           | RW SC  | 0x0 | 1 = Restart SGMII/1000BASE-X Auto-Negotiation;<br>0 = Normal operation.<br>It's self clear.                                                                                                                                                                                                                                                             |
| 8   | Duplex_Mode          | RW     | 0x1 | Valid only when the SerDes works as SGMII MAC, for example, when the chip mode is SGMAC_TO_RGPHY.<br>The duplex mode can be selected via either the Auto-Negotiation process or manual duplex selection. Manual duplex selection is allowed when Auto-Negotiation is disabled by setting bit[12] Autoneg_En to 0.<br>1 = Full Duplex<br>0 = Half Duplex |
| 7   | Reserved             | RW     | 0x0 | Reserved                                                                                                                                                                                                                                                                                                                                                |
| 6   | Speed_Selection(MSB) | RW     | 0x1 | See bit13.                                                                                                                                                                                                                                                                                                                                              |
| 5:0 | Reserved             | RW     | 0x0 | Reserved. Write as 0, ignore on read                                                                                                                                                                                                                                                                                                                    |

### 6.5.2. Basic Status Register (0x01)

**Table 90. Basic Status Register (0x01)**

| Bit | Symbol            | Access | Default | Description                                                                                      |
|-----|-------------------|--------|---------|--------------------------------------------------------------------------------------------------|
| 15  | 100BASE-T4        | RO     | 0x0     | PHY doesn't support 100BASE-T4                                                                   |
| 14  | 100BASE-X_Fd      | RO     | 0x0     | PHY supports 100BASE-X_FD                                                                        |
| 13  | 100BASE-X_Hd      | RO     | 0x0     | PHY supports 100BASE-X_HD                                                                        |
| 12  | 10Mbps_Fd         | RO     | 0x0     | PHY supports 10Mbps_Fd                                                                           |
| 11  | 10Mbps_Hd         | RO     | 0x0     | PHY supports 10Mbps_Hd                                                                           |
| 10  | 100BASE-T2_Fd     | RO     | 0x0     | PHY doesn't support 100BASE-T2_Fd                                                                |
| 9   | 100BASE-T2_Hd     | RO     | 0x0     | PHY doesn't support 100BASE-T2_Hd                                                                |
| 8   | Extended_Status   | RO     | 0x0     | Whether support Extended status register in MII register 0xF<br>0: Not supported<br>1: Supported |
| 7   | Unidirect_Ability | RO     | 0x0     | 1'b0: PHY able to transmit from MII only when                                                    |

|   |                         |                 |     |                                                                                                                                                                                          |
|---|-------------------------|-----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |                         |                 |     | the PHY has determined that a valid link has been established<br>1'b1: PHY able to transmit from MII regardless of whether the PHY has determined that a valid link has been established |
| 6 | Mf_Preamble_Suppression | RO              | 0x1 | 1'b0: PHY will not accept management frames with preamble suppressed<br>1'b1: PHY will accept management frames with preamble suppressed                                                 |
| 5 | Autoneg_Complete        | RO SWC          | 0x0 | 1'b0: Auto-negotiation process not completed<br>1'b1: Auto-negotiation process completed                                                                                                 |
| 4 | Remote_Fault            | RO RC<br>SWC LH | 0x0 | 1'b0: no remote fault condition detected<br>1'b1: remote fault condition detected                                                                                                        |
| 3 | Autoneg_Ability         | RO              | 0x1 | 1'b0: PHY not able to perform Auto-negotiation<br>1'b1: PHY able to perform Auto-negotiation                                                                                             |
| 2 | Link_Status             | RO LL<br>SWC    | 0x0 | Link status<br>1'b0: Link is down<br>1'b1: Link is up                                                                                                                                    |
| 1 | Reserved                | RO              | 0x0 | always 0                                                                                                                                                                                 |
| 0 | Extended_Capability     | RO              | 0x1 | To indicate whether support EXTended registers, to access from address register MII 0x1E and data register MII 0x1F<br>1'b0: Not supported<br>1'b1: Supported                            |

### 6.5.3. Sds Identification Register1 (0x02)

**Table 91. Sds Identification Register1 (0x02)**

| Bit  | Symbol | Access | Default | Description                                            |
|------|--------|--------|---------|--------------------------------------------------------|
| 15:0 | Phy_Id | RO     | 0x0     | Bits 3 to 18 of the Organizationally Unique Identifier |

### 6.5.4. Sds Identification Register2 (0x03)

**Table 92. Sds Identification Register2 (0x03)**

| Bit   | Symbol      | Access | Default | Description                                             |
|-------|-------------|--------|---------|---------------------------------------------------------|
| 15:10 | Phy_Id      | RO     | 0x0     | Bits 19 to 24 of the Organizationally Unique Identifier |
| 9:4   | Type_No     | RO     | 0x11    | 6 bits manufacturer's type number                       |
| 3:0   | Revision_No | RO     | 0xa     | 4 bits manufacturer's revision number                   |

### 6.5.5. Auto-Negotiation Advertisement (0x04)

**Table 93. Auto-Negotiation Advertisement (0x04)**

| Bit | Symbol    | Access | Default | Description                                                                 |
|-----|-----------|--------|---------|-----------------------------------------------------------------------------|
| 15  | NEXT_Page | RW     | 0x0     | Not used. ZGP1KTQA0 SGMII and 1000BASE-X autoneg doesn't support NEXT page. |

|       |                  |    |     |                           |
|-------|------------------|----|-----|---------------------------|
| 14    | Ack              | RO | 0x0 | Always 0                  |
| 13:12 | Remote_Fault     | RO | 0x0 | Always 0                  |
| 11:9  | Reserved         | RO | 0x0 | Reserved                  |
| 8     | Asymmetric_Pause | RW | 0x0 | Asymmetric_Pause ability. |
| 7     | Pause            | RW | 0x0 | Pause ability.            |
| 6     | Half_duplex      | RW | 0x0 | Half duplex ability       |
| 5     | Full_duplex      | RW | 0x1 | Full duplex ability       |
| 4:0   | Reserved         | RO | 0x0 | Reserved                  |

#### 6.5.6. Auto-Negotiation Link Partner Ability (0x05)

**Table 94. Auto-Negotiation Link Partner Ability (0x05)**

| Bit   | Symbol       | Access | Default | Description                                |
|-------|--------------|--------|---------|--------------------------------------------|
| 15    | NEXT Page    | RO SWC | 0x0     | NEXT page. Received Code Word Bit 15       |
| 14    | ACK          | RO SWC | 0x0     | Acknowledge. Received Code Word Bit 14     |
| 13:12 | REMOTE_FAULT | RO SWC | 0x0     | Remote Fault. Received Code Word Bit 13:12 |
| 11:9  | RESERVED     | RO     | 0x0     | Reserved. Received Code Word Bit 11:9      |
| 8:7   | PAUSE        | RO SWC | 0x0     | Pause. Received Code Word Bit 8:7          |
| 6     | HALF_DUPLEX  | RO SWC | 0x0     | Half duplex. Received Code Word Bit 6      |
| 5     | FULL_DUPLEX  | RO SWC | 0x0     | Full duplex. Received Code Word Bit 5      |
| 4:0   | RESERVED     | RO     | 0x0     | Reserved. Received Code Word Bit 4:0       |

#### 6.5.7. Auto-Negotiation Expansion Register (0x06)

**Table 95. Auto-Negotiation Expansion Register (0x06)**

| Bit  | Symbol               | Access      | Default | Description                                                                        |
|------|----------------------|-------------|---------|------------------------------------------------------------------------------------|
| 15:3 | Reserved             | RO          | 0x0     | Reserved                                                                           |
| 2    | Local NEXT Page able | RO          | 0x0     | 1 = Local Device supports NEXT Page<br>0 = Local Device does not support Next Page |
| 1    | Page received        | RO RC<br>LH | 0x0     | 1 = A new page is received                                                         |
| 0    | Reserved             | RO          | 0x0     | Reserved                                                                           |

#### 6.5.8. Auto-Negotiation NEXT Page Register (0x07)

**Table 96. Auto-Negotiation NEXT Page Register (0x07)**

| Bit  | Symbol    | Access | Default | Description |
|------|-----------|--------|---------|-------------|
| 15:0 | NEXT Page | RO     | 0x0     | always be 0 |

#### 6.5.9. Auto-Negotiation Link Partner Received NEXT Page Register (0x08)

**Table 97. Auto-Negotiation Link Partner Received NEXT Page Register (0x08)**

| Bit  | Symbol                 | Access | Default | Description |
|------|------------------------|--------|---------|-------------|
| 15:0 | Link Partner NEXT Page | RO     | 0x0     | always be 0 |

### 6.5.10. Extended status register (0x0F)

**Table 98. Extended status register (0x0F)**

| Bit  | Symbol                 | Access | Default | Description                              |
|------|------------------------|--------|---------|------------------------------------------|
| 15   | 1000BASE-X Full Duplex | RO     | 0x1     | 1 = PHY supports 1000BASE-X Full Duplex  |
| 14   | 1000BASE-X Half Duplex | RO     | 0x0     | 1 = PHY supports 1000BASE-X Half Duplex. |
| 13   | 1000BASE-T Full Duplex | RO     | 0x0     | 1 = PHY supports 1000BASE-T Full Duplex  |
| 12   | 1000BASE-T Half Duplex | RO     | 0x0     | 1 = PHY supports 1000BASE-T Half Duplex  |
| 11:0 | Reserved               | RO     | 0x0     | Always 0                                 |

### 6.5.11. Sds Specific Status Register (0x11)

**Table 99. Sds Specific Status Register (0x11)**

| Bit   | Symbol                | Access | Default | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|-----------------------|--------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:14 | Speed_mode            | RO     | 0x0     | When SerDes works as SGMII MAC, if Auto-Negotiation is enabled, the speed_mode is sourced from Auto-Negotiation process with SGMII PHY, otherwise, it's from SDS MII 0x0 Speed_Selection;<br>When SerDes works as SGMII PHY, it equals to the UTP speed mode;<br>When SerDes works as 1000BASE-X, it equals to 10;<br>When SerDes works as 100BASE-FX, it equals to 01.<br>Refer to SDS MII 0x11 bit5:4 for SerDes' working mode.                                                |
| 13    | Duplex                | RO     | 0x0     | When SerDes works as SGMII MAC, if Auto-Negotiation is enabled, the duplex is sourced from Auto-Negotiation process with SGMII PHY, otherwise, it's from SDS MII 0x0 Duplex_Mode;<br>When SerDes works as SGMII PHY, it equals to the UTP duplex mode;<br>When SerDes works as 1000BASE-X, it's the result of 1000BASE-X half/full priority resolution function;<br>When SerDes works as 100BASE-FX, it equals to 1.<br>Refer to SDS MII 0x11 bit[5:4] for SerDes' working mode. |
| 12:11 | Pause                 | RO     | 0x0     | Pause to mac                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 10    | Link status real-time | RO     | 0x0     | 1 = SGMII Link up<br>0 = SGMII link down                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 9     | Rx_lpi_active         | RO     | 0x0     | rx lpi is active                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 8     | Duplex_error          | RO     | 0x0     | realtime duplex error                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 7     | En_flowctrl_rx        | RO     | 0x0     | realtime en_flowctrl_rx                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 6     | En_flowctrl_tx        | RO     | 0x0     | realtime en_flowctrl_tx                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5:4   | Ser_mode_cfg          | RO     | 0x0     | realtime serdes working mode,<br>00: SGMII MAC;                                                                                                                                                                                                                                                                                                                                                                                                                                  |

|     |            |    |     |                                                                                            |
|-----|------------|----|-----|--------------------------------------------------------------------------------------------|
|     |            |    |     | 01: SGMII PHY;<br>10: 1000BASE-X;<br>11: 100BASE-FX.                                       |
| 3:1 | Xmit       | RO | 0x0 | realtime transmit statemachine,<br>001: Xmit Idle;<br>010: Xmit Config;<br>100: Xmit Data. |
| 0   | Syncstatus | RO | 0x0 | realtime SerDes PCS sync status                                                            |

### 6.5.12. Receive Err Counter (0x15)

**Table 100. Receive Err Counter (0x15)**

| Bit  | Symbol           | Access | Default | Description                                                                                                                         |
|------|------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | error_counter_rx | RO SWC | 0x0     | This counter increase by 1 at the 1st rising of RX_ER when RX_DV is 1. The counter will hold at maximum 16'hFFFF and not roll over. |

### 6.5.13. Link Fail Counter (0x16)

**Table 101. Link Fail Counter (0x16)**

| Bit  | Symbol        | Access    | Default | Description       |
|------|---------------|-----------|---------|-------------------|
| 15:8 | Reserved      | RO        | 0x0     | Reserved          |
| 7:0  | Link_fail_cnt | RO RC SWC | 0x0     | link fail counter |

## 6.6. SDS EXT Register

### 6.6.1. Pkgen Cfg1 (EXT\_0x38)

**Table 102. Pkgen Cfg1 (EXT\_0x38)**

| Bit   | Symbol         | Access | Default | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------|----------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:13 | Reserved       | RW     | 0x0     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 12    | En_pkgen_da_sa | RW     | 0x0     | 1: set the DA/SA of the packet generated by pkg_gen in SerDes to a programmed value; For DA, if SDS EXT_0x38 bit11 is 1, the DA is set to broadcast address FF-FF-FF-FF-FF-FF; else, the DA is set to fix value, the highest 5 Bytes are 00-00-00-00-00, and the lowest 1 Byte is programmed by SDS EXT_0x3A bit[15:8]. For SA, the highest 5 Bytes are 00-00-00-00-00, and the lowest 1 Byte is programmed by SDS EXT_0x3A bit[7:0].<br>0: the DA/SA is not programmed value |
| 11    | Pkgen_brdest   | RW     | 0x0     | Valid when SDS EXT_0x38 bit12 is 1.<br>1: set the DA to broadcast address FF-FF-FF-FF-FF-FF<br>0: set the DA to a fixed programmed value.                                                                                                                                                                                                                                                                                                                                     |

|     |                  |    |       |                                                                                                                                                                                |
|-----|------------------|----|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10  | Pkgchk_txsrc_sel | RW | 0x0   | 1'b1: the package checker on SerDes TX side will check the tx data generated by pkg_gen;<br>1'b0: the package checker on SerDes TX side will check the tx data of SerDes GMII. |
| 9   | Pkgen_en_az      | RW | 0x0   | 1: to enable send LPI pattern during the IPG of the packages sent by pkg_gen<br>0: do not send LPI pattern during the IPG of the packages sent by pkg_gen                      |
| 8:0 | Pkgen_in_az_t    | RW | 0x1ff | The time how long LPI pattern is sent, unit is us.                                                                                                                             |

#### 6.6.2. Pkgen Cfg2 (EXT\_0x39)

**Table 103. Pkgen Cfg2 (EXT\_0x39)**

| Bit  | Symbol         | Access | Default | Description                                                                        |
|------|----------------|--------|---------|------------------------------------------------------------------------------------|
| 15:8 | Pkgen_pre_az_t | RW     | 0x20    | The time from the end of last package to the beginning of LPI pattern, unit is us. |
| 7:0  | Pkgen_aft_az_t | RW     | 0x19    | The time from the end of LPI pattern to the beginning of next package, unit is us. |

#### 6.6.3. Pkgen Cfg3 (EXT\_0x3A)

**Table 104. Pkgen Cfg3 (EXT\_0x3A)**

| Bit  | Symbol   | Access | Default | Description                                                                    |
|------|----------|--------|---------|--------------------------------------------------------------------------------|
| 15:8 | Pkgen_da | RW     | 0x0     | Lowest 8 bits of DA, others is zero. Refer to SDS EXT_0x38 bit[12] for detail. |
| 7:0  | Pkgen_sa | RW     | 0x0     | Lowest 8 bits of SA, others is zero. Refer to SDS EXT_0x38 bit[12] for detail. |

#### 6.6.4. Pkgen Cfg3 (EXT\_0x3B)

**Table 105. Pkgen Cfg3 (EXT\_0x3B)**

| Bit  | Symbol       | Access | Default | Description                                                                    |
|------|--------------|--------|---------|--------------------------------------------------------------------------------|
| 15:8 | Reserved     | RO     | 0x0     | Reserved                                                                       |
| 7:0  | Pkg_data_fix | RW     | 0x0     | Lowest 8 bits of SA, others is zero. Refer to SDS EXT_0x38 bit[12] for detail. |

#### 6.6.5. Pkg Cfg0 (EXT\_0x1A0)

**Table 106. Pkg Cfg0 (EXT\_0x1A0)**

| Bit | Symbol      | Access | Default | Description                                                                                                                                                            |
|-----|-------------|--------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15  | Pkg_chk_en  | RW     | 0x0     | 1: to enable SerDes RX/TX package checker. RX checker checks the SerDes GMII RX data; TX checker checks the SerDes GMII TX data.<br>0: to disable the package checker. |
| 14  | Pkg_en_gate | RW     | 0x1     | 1: to enable gate all the clocks to package self-test module when bit15 pkg_chk_en is 0, bit13 bp_pkg_gen is 1 and bit12 pkg_gen_en is 0;<br>0: not gate the clocks.   |
| 13  | Bp_pkg_gen  | RW     | 0x1     | 1: normal mode, to send GMII TX data from upstream MAC;                                                                                                                |

|      |                 |       |     |                                                                                                                                                                                                                                                                                                                                                                  |
|------|-----------------|-------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      |                 |       |     | 0: test mode, to send out the GMII data generated by pkg_gen module.                                                                                                                                                                                                                                                                                             |
| 12   | Pkg_gen_en      | RW SC | 0x0 | 1: to enable pkg_gen generating GMII packages. But, the data will only be sent to transceiver when Bit13 bp_pkg_gen is 1'b0.<br>If pkg_burst_size is 0, continuous packages will be generated and will be stopped only when pkg_gen_en is set to 0;<br>Otherwise, after the expected packages are generated, pkg_gen will stop, pkg_gen_en will be self-cleared. |
| 11:8 | Pkg_prm_lth     | RW    | 0x8 | The preamble length of the generated packages, in Byte unit. Pkg_gen function only support >=2 Byte preamble length. Values smaller than 2 will be ignored by the pkg_gen module.                                                                                                                                                                                |
| 7:4  | Pkg_ipg_lth     | RW    | 0xd | The IPG of the generated packages, in Byte unit. Pkg_gen function only support >=2 Byte preamble length. Values smaller than 2 will be ignored by the pkg_gen module.                                                                                                                                                                                            |
| 3    | Reserved        | RW    | 0x0 | Reserved                                                                                                                                                                                                                                                                                                                                                         |
| 2    | Pkg_corrupt_crc | RW    | 0x0 | 1: to make pkg_gen to send out CRC error packages.                                                                                                                                                                                                                                                                                                               |
| 1:0  | Pkg_payload     | RW    | 0x0 | Control the payload of the generated packages.<br>00: increased Byte payload;<br>01: random payload;<br>10: fix pattern 0x5AA55AA5...<br>11: fix pattern set by EXT_0x3B bit7:0..                                                                                                                                                                                |

#### 6.6.6. Pkg Cfg1 (EXT\_0x1A1)

**Table 107. Pkg Cfg1 (EXT\_0x1A1)**

| Bit  | Symbol     | Access | Default | Description                                  |
|------|------------|--------|---------|----------------------------------------------|
| 15:0 | Pkg_length | RW     | 0x40    | To set the length of the generated packages. |

#### 6.6.7. Pkg Cfg2 (EXT\_0x1A2)

**Table 108. Pkg Cfg2 (EXT\_0x1A2)**

| Bit  | Symbol         | Access | Default | Description                                                                                                                 |
|------|----------------|--------|---------|-----------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_burst_size | RW     | 0x0     | To set the number of packages in a burst of package generation. If this signal is 0, continuous packages will be generated. |

#### 6.6.8. Pkg Rx Valid0 (EXT\_0x1A3)

**Table 109. Pkg Rx Valid0 (EXT\_0x1A3)**

| Bit  | Symbol            | Access | Default | Description                                                                                                                         |
|------|-------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_valid_high | RO RC  | 0x0     | Pkg_ib_valid[31:16], pkg_ib_valid is the number of RX packages from wire whose CRC are good and length are >=64Byte and <=1518Byte. |

**6.6.9. Pkg Rx Valid1 (EXT\_0x1A4)****Table 110. Pkg Rx Valid1 (EXT\_0x1A4)**

| Bit  | Symbol           | Access | Default | Description                                                                                                                        |
|------|------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_valid_low | RO RC  | 0x0     | Pkg_ib_valid[15:0], pkg_ib_valid is the number of RX packages from wire whose CRC are good and length are >=64Byte and <=1518Byte. |

**6.6.10. Pkg Rx Os0 (EXT\_0x1A5)****Table 111. Pkg Rx Os0 (EXT\_0x1A5)**

| Bit  | Symbol              | Access | Default | Description                                                                                                               |
|------|---------------------|--------|---------|---------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_os_good_high | RO RC  | 0x0     | Pkg_ib_os_good[31:16], pkg_ib_os_good is the number of RX packages from wire whose CRC are good and length are >1518Byte. |

**6.6.11. Pkg Rx Os1 (EXT\_0x1A6)****Table 112. Pkg Rx Os1 (EXT\_0x1A6)**

| Bit  | Symbol             | Access | Default | Description                                                                                                              |
|------|--------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_os_good_low | RO RC  | 0x0     | Pkg_ib_os_good[15:0], pkg_ib_os_good is the number of RX packages from wire whose CRC are good and length are >1518Byte. |

**6.6.12. Pkg Rx Us0 (EXT\_0x1A7)****Table 113. Pkg Rx Us0 (EXT\_0x1A7)**

| Bit  | Symbol              | Access | Default | Description                                                                                                             |
|------|---------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_us_good_high | RO RC  | 0x0     | Pkg_ib_us_good[31:16], pkg_ib_us_good is the number of RX packages from wire whose CRC are good and length are <64Byte. |

**6.6.13. Pkg Rx Us1 (EXT\_0x1A8)****Table 114. Pkg Rx Us1 (EXT\_0x1A8)**

| Bit  | Symbol             | Access | Default | Description                                                                                                            |
|------|--------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_us_good_low | RO RC  | 0x0     | Pkg_ib_us_good[15:0], pkg_ib_us_good is the number of RX packages from wire whose CRC are good and length are <64Byte. |

**6.6.14. Pkg Rx Err (EXT\_0x1A9)****Table 115. Pkg Rx Err (EXT\_0x1A9)**

| Bit  | Symbol     | Access | Default | Description                                                                                                |
|------|------------|--------|---------|------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_err | RO RC  | 0x0     | pkg_ib_err is the number of RX packages from wire whose CRC are wrong and length are >=64Byte, <=1518Byte. |

**6.6.15. Pkg Rx Os Bad (EXT\_0x1AA)****Table 116. Pkg Rx Os Bad (EXT\_0x1AA)**

| Bit  | Symbol        | Access | Default | Description                                                                                        |
|------|---------------|--------|---------|----------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_os_bad | RO RC  | 0x0     | pkg_ib_os_bad is the number of RX packages from wire whose CRC are wrong and length are >1518Byte. |

**6.6.16. Pkg Rx Fragment (EXT\_0x1AB)****Table 117. Pkg Rx Fragment (EXT\_0x1AB)**

| Bit  | Symbol      | Access | Default | Description                                                                  |
|------|-------------|--------|---------|------------------------------------------------------------------------------|
| 15:0 | Pkg_ib_frag | RO RC  | 0x0     | pkg_ib_frag is the number of RX packages from wire whose length are <64Byte. |

**6.6.17. Pkg Rx Nosfd (EXT\_0x1AC)****Table 118. Pkg Rx Nosfd (EXT\_0x1AC)**

| Bit  | Symbol       | Access | Default | Description                                                              |
|------|--------------|--------|---------|--------------------------------------------------------------------------|
| 15:0 | Pkg_ib_nosfd | RO RC  | 0x0     | pkg_ib_nosfd is the number of RX packages from wire whose SFD is missed. |

**6.6.18. Pkg Tx Valid0 (EXT\_0x1AD)****Table 119. Pkg Tx Valid0 (EXT\_0x1AD)**

| Bit  | Symbol            | Access | Default | Description                                                                                                                         |
|------|-------------------|--------|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_valid_high | RO RC  | 0x0     | Pkg_ob_valid[31:16], pkg_ob_valid is the number of TX packages from GMII whose CRC are good and length are >=64Byte and <=1518Byte. |

**6.6.19. Pkg Tx Valid1 (EXT\_0x1AE)****Table 120. Pkg Tx Valid1 (EXT\_0x1AE)**

| Bit  | Symbol           | Access | Default | Description                                                                                                                        |
|------|------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_valid_low | RO RC  | 0x0     | Pkg_ob_valid[15:0], pkg_ob_valid is the number of TX packages from GMII whose CRC are good and length are >=64Byte and <=1518Byte. |

**6.6.20. Pkg Tx Os0 (EXT\_0x1AF)****Table 121. Pkg Tx Os0 (EXT\_0x1AF)**

| Bit  | Symbol              | Access | Default | Description                                                                                                              |
|------|---------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_os_good_high | RO RC  | 0x0     | Pkg_ob_os_good[31:0], pkg_ob_os_good is the number of TX packages from GMII whose CRC are good and length are >1518Byte. |

**6.6.21. Pkg Tx Os1 (EXT\_0x1B0)****Table 122. Pkg Tx Os1 (EXT\_0x1B0)**

| Bit  | Symbol             | Access | Default | Description                                                                                                              |
|------|--------------------|--------|---------|--------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_os_good_low | RO RC  | 0x0     | Pkg_ob_os_good[15:0], pkg_ob_os_good is the number of TX packages from GMII whose CRC are good and length are >1518Byte. |

**6.6.22. Pkg Tx Us0 (EXT\_0x1B1)****Table 123. Pkg Tx Us0 (EXT\_0x1B1)**

| Bit  | Symbol              | Access | Default | Description                                                                                                            |
|------|---------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_us_good_high | RO RC  | 0x0     | Pkg_ob_us_good[31:0], pkg_ob_us_good is the number of TX packages from GMII whose CRC are good and length are <64Byte. |

**6.6.23. Pkg Tx Us1 (EXT\_0x1B2)****Table 124. Pkg Tx Us1 (EXT\_0x1B2)**

| Bit  | Symbol             | Access | Default | Description                                                                                                            |
|------|--------------------|--------|---------|------------------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_us_good_low | RO RC  | 0x0     | Pkg_ob_us_good[15:0], pkg_ob_us_good is the number of TX packages from GMII whose CRC are good and length are <64Byte. |

**6.6.24. Pkg Tx Err (EXT\_0x1B3)****Table 125. Pkg Tx Err (EXT\_0x1B3)**

| Bit  | Symbol     | Access | Default | Description                                                                                                |
|------|------------|--------|---------|------------------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_err | RO RC  | 0x0     | pkg_ob_err is the number of TX packages from GMII whose CRC are wrong and length are >=64Byte, <=1518Byte. |

**6.6.25. Pkg Tx Os Bad (EXT\_0x1B4)****Table 126. Pkg Tx Os Bad (EXT\_0x1B4)**

| Bit  | Symbol        | Access | Default | Description                                                                                        |
|------|---------------|--------|---------|----------------------------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_os_bad | RO RC  | 0x0     | pkg_ob_os_bad is the number of TX packages from GMII whose CRC are wrong and length are >1518Byte. |

**6.6.26. Pkg Tx Fragment (EXT\_0x1B5)****Table 127. Pkg Tx Fragment (EXT\_0x1B5)**

| Bit  | Symbol      | Access | Default | Description                                                                  |
|------|-------------|--------|---------|------------------------------------------------------------------------------|
| 15:0 | Pkg_ob_frag | RO RC  | 0x0     | pkg_ob_frag is the number of TX packages from GMII whose length are <64Byte. |

**6.6.27. Pkg Tx Nosfd (EXT\_0x1B6)****Table 128. Pkg Tx Nosfd (EXT\_0x1B6)**

| Bit | Symbol | Access | Default | Description |
|-----|--------|--------|---------|-------------|
|-----|--------|--------|---------|-------------|

|      |              |       |     |                                                                          |
|------|--------------|-------|-----|--------------------------------------------------------------------------|
| 15:0 | Pkg_ob_nosfd | RO RC | 0x0 | pkg_ob_nosfd is the number of TX packages from GMII whose SFD is missed. |
|------|--------------|-------|-----|--------------------------------------------------------------------------|

## 7. Power Requirements

### 7.1. Absolute Maximum Ratings

**Table 129. Absolute Maximum Ratings**

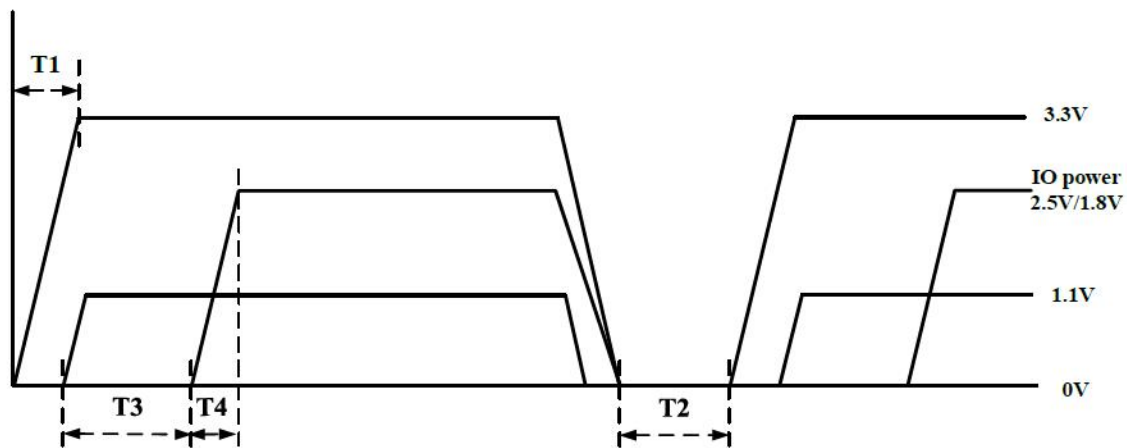
| Symbol        | Description         | Mini | Max | Unit |
|---------------|---------------------|------|-----|------|
| VDD33/AVDD33  | Supply Voltage 3.3V | -0.3 | 3.7 | V    |
| AVDDL/DVDDL   | Supply Voltage 1.1V | -0.2 | 1.4 | V    |
| 2.5V RGMII    | Supply Voltage 2.5V | -0.3 | 2.8 | V    |
| 1.8V RGMII    | Supply Voltage 1.8V | -0.3 | 2.3 | V    |
| 3.3V DC input | Input Voltage       | -0.3 | 3.7 | V    |
| VDDL DC input | Input Voltage       | -0.3 | 1.4 | V    |

### 7.2. Recommended Operating Conditions

**Table 130. Recommended Operating Conditions**

| Description                  | Pins           | Min   | Typ | Max  | Unit |
|------------------------------|----------------|-------|-----|------|------|
| Supply Voltage               | DVDD33, AVDD33 | 2.97  | 3.3 | 3.63 | V    |
|                              | AVDDL, DVDDL   | 1.045 | 1.1 | 1.32 | V    |
|                              | 2.5V RGMII     | 2.25  | 2.5 | 2.75 | V    |
|                              | 1.8V RGMII     | 1.62  | 1.8 | 1.98 | V    |
| Maximum Junction Temperature |                |       |     | 125  | °C   |

### 7.3. Power Sequence



**Table 131. Power Sequence Timing Parameters**

| Symbol | Description                       | Min | Typ | Max | Units |
|--------|-----------------------------------|-----|-----|-----|-------|
| T1     | 3.3V rising time                  | 0.5 | -   | -   | ms    |
| T2     | 3.3V and 1.1V power down duration | 100 | -   | -   | ms    |
| T3     | Core power 1.1V ready time        | -   | -   | 2.5 | ms    |
| T4     | Internal LDO ready time           | -   | -   | 100 | us    |

## 7.4. Maximum Power Consumption

**Table 132. Maximum Power Consumption**

| Condition         | DVDD_RGMII<br>(mA) | DVDD33 + VDD33_LX<br>(mA) | AVDD33<br>(mA) | Power Consumption<br>(mW) |
|-------------------|--------------------|---------------------------|----------------|---------------------------|
| Traffic @1000Mbps | 31.2               | 62.2                      | 67.6           | 531.3                     |

Note: Test **UTP TO RGMII** mode.

## 8. Timing and AC/DC Characteristics

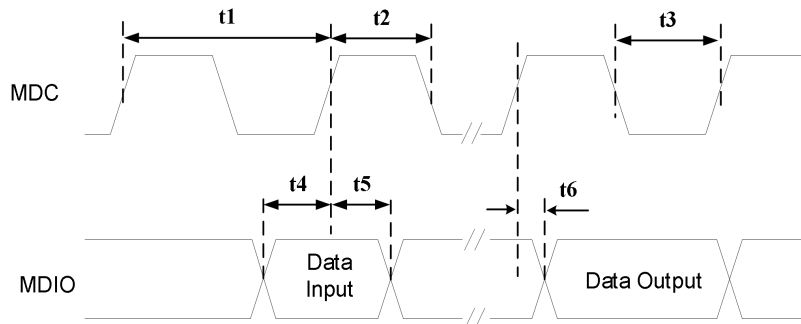
### 8.1. DC Characteristics

**Table 133. DC Characteristics**

| Symbol     | Parameter                         | Min  | Typ | Max  | Units |
|------------|-----------------------------------|------|-----|------|-------|
| Voh (3.3V) | Minimum High Level Output Voltage | 2.4  | -   | 3.63 | V     |
| Vol (3.3V) | Maximum Low Level Output Voltage  | -0.3 | -   | 0.4  | V     |
| Voh (2.5V) | Minimum High Level Output Voltage | 2    | -   | 2.8  | V     |
| Vol (2.5V) | Maximum Low Level Output Voltage  | -0.3 | -   | 0.4  | V     |
| Voh (1.8V) | Minimum High Level Output Voltage | 1.62 | -   | 2.1  | V     |
| Vol (1.8V) | Maximum Low Level Output Voltage  | -0.3 | -   | 0.4  | V     |
| Vih (3.3V) | Minimum High Level Input Voltage  | 2    | -   | -    | V     |
| Vil (3.3V) | Maximum Low Level Input Voltage   | -    | -   | 0.8  | V     |
| Vih (2.5V) | Minimum High Level Input Voltage  | 1.7  | -   | -    | V     |
| Vil (2.5V) | Maximum Low Level Input Voltage   | -    | -   | 0.7  | V     |
| Vih (1.8V) | Minimum High Level Input Voltage  | 1.2  | -   | -    | V     |
| Vil (1.8V) | Maximum Low Level Input Voltage   | -    | -   | 0.5  | V     |

### 8.2. AC Characteristics

#### 8.2.1. SMI (MDC/MDIO) Interface Characteristics



**Figure 13. SMI (MDC/MDIO) Timing**

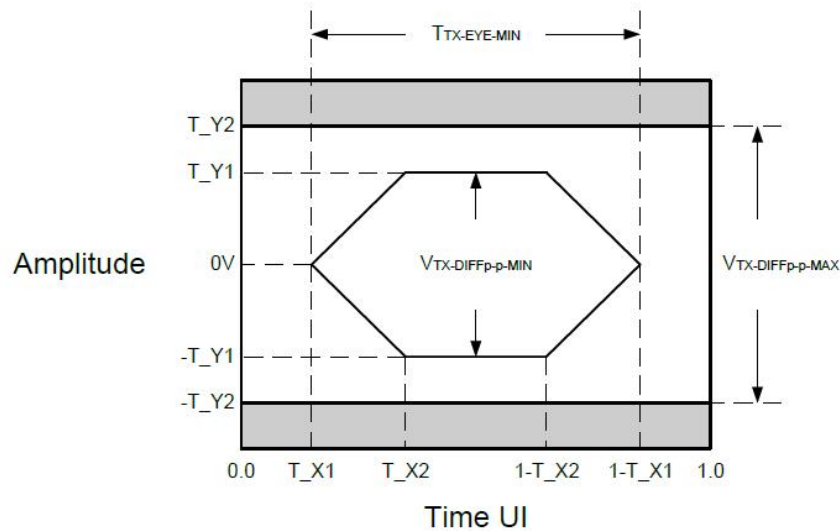
**Table 134. SMI (MDC/MDIO) Interface Characteristics**

| Symbol | Description                                   | Min | Typ | Max | Units |
|--------|-----------------------------------------------|-----|-----|-----|-------|
| t1     | MDC Clock Period                              | 80  | -   | -   | ns    |
| t2     | MDC High Time                                 | 32  | -   | -   | ns    |
| t3     | MDC Low Time                                  | 32  | -   | -   | ns    |
| t4     | MDIO to MDC Rising Setup Time (Data Input)    | 10  | -   | -   | ns    |
| t5     | MDIO to MDC Rising Hold Time (Data Input)     | 10  | -   | -   | ns    |
| t6     | MDIO Valid from MDC rising edge (Data Output) | 0   | -   | 20  | ns    |

#### 8.2.2. SGMII Differential Transmitter Characteristics

**Table 135. SGMII Differential Transmitter Characteristics**

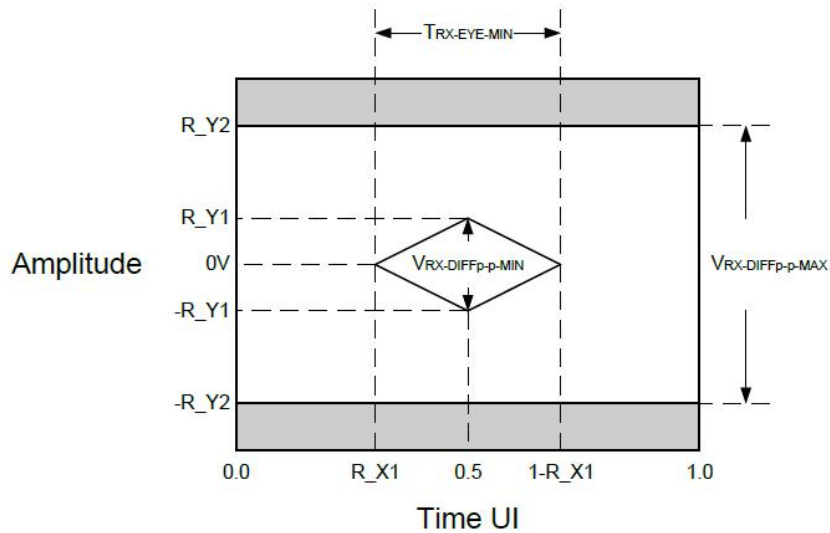
| Symbol                  | Parameter                   | Min       | Typ   | Max       | Units | Notes                                                              |
|-------------------------|-----------------------------|-----------|-------|-----------|-------|--------------------------------------------------------------------|
| UI                      | Unit Interval               | 799.94    | 800   | 800.06    | ps    | 800ps $\pm$ 75ppm                                                  |
| T_X1                    | Eye Mask                    | -         | -     | 0.1875    | UI    | -                                                                  |
| T_X2                    | Eye Mask                    | -         | -     | 0.4       | UI    | -                                                                  |
| T_Y1                    | Eye Mask                    | 0.4*AVDDL | -     | -         | mV    | -                                                                  |
| T_Y2                    | Eye Mask                    | -         | -     | 0.6*AVDDL | mV    | -                                                                  |
| V <sub>TX-DIFFp-p</sub> | Output Differential Voltage | 0.8*AVDDL | AVDDL | 1.2*AVDDL | mV    | -                                                                  |
| T <sub>TX-EYE</sub>     | Minimum TX Eye Width        | 0.625     | -     | -         | UI    | -                                                                  |
| T <sub>TX-JITTER</sub>  | Output Jitter               | -         | -     | 0.375     | UI    | T <sub>TX-JITTER-MAX</sub> = 1 - T <sub>TX-EYE-MIN</sub> = 0.375UI |
| R <sub>TX</sub>         | Differential Resistance     | 80        | 100   | 120       | ohm   | -                                                                  |
| C <sub>TX</sub>         | AC Coupling Capacitor       | 75        | 100   | 200       | nF    | -                                                                  |
| L <sub>TX</sub>         | Transmit Length in PCB      | -         | -     | 10        | inch  | -                                                                  |



### 8.2.3. SGMII Differential Receiver Characteristics

**Table 136. SGMII Differential Receiver Characteristics**

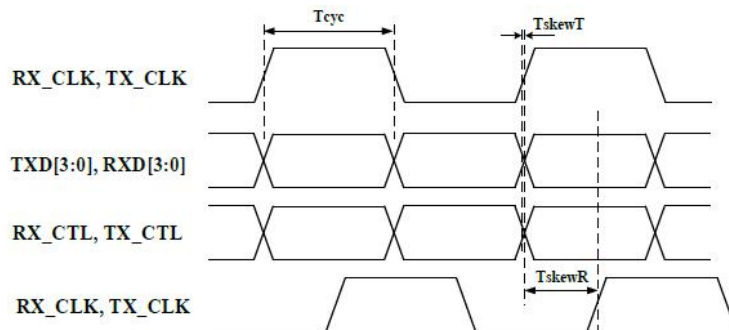
| Symbol                  | Parameter                  | Min    | Typ | Max       | Units | Notes                                                              |
|-------------------------|----------------------------|--------|-----|-----------|-------|--------------------------------------------------------------------|
| UI                      | Unit Interval              | 799.94 | 800 | 800.06    | ps    | 800ps $\pm$ 75ppm                                                  |
| R_X1                    | Eye Mask                   | -      | -   | 0.3125    | UI    | -                                                                  |
| R_Y1                    | Eye Mask                   | 50     | -   | -         | mV    | -                                                                  |
| R_Y2                    | Eye Mask                   | -      | -   | 0.6*AVDDL | mV    | -                                                                  |
| V <sub>RX-DIFFp-p</sub> | Input Differential Voltage | 100    | -   | 1.2*AVDDL | mV    | -                                                                  |
| T <sub>RX-EYE</sub>     | Minimum RX Eye Width       | 0.375  | -   | -         | UI    | -                                                                  |
| T <sub>RX-JITTER</sub>  | Input Jitter Tolerance     | -      | -   | 0.625     | UI    | T <sub>RX-JITTER-MAX</sub> = 1 - T <sub>RX-EYE-MIN</sub> = 0.625UI |
| R <sub>RX</sub>         | Differential Resistance    | 80     | 100 | 120       | ohm   | -                                                                  |



#### 8.2.4. RGMII Timing w/o delay

**Table 137. RGMII Timing w/o delay**

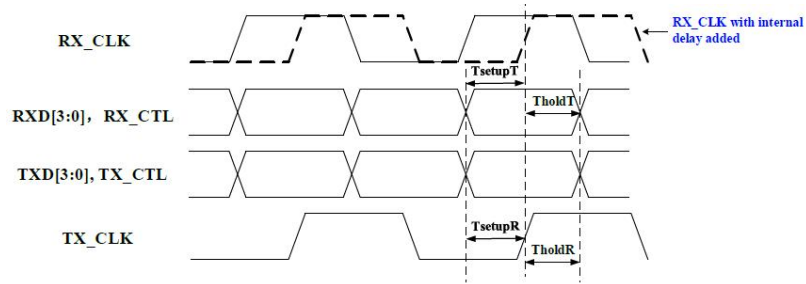
| Symbol | Parameter                                  | Min  | Typ | Max | Unit |
|--------|--------------------------------------------|------|-----|-----|------|
| TskewT | Data to clock output skew (at Transmitter) | -500 | 0   | 500 | ps   |
| TskewR | Data to clock output skew (at Receiver)    | 1    | -   | -   | ns   |
| Tcyc   | Clock cycle duration                       | 7.2  | 8.0 | 8.8 | ns   |
| Duty_G | Duty cycle for Gigabit                     | 45   | 50  | 55  | %    |
| Duty_T | Duty cycle for 10/100T                     | 40   | 50  | 60  | %    |



#### 8.2.5. RGMII Timing with internal delay

**Table 138. RGMII Timing with internal delay**

| Symbol  | Parameter                                                         | Min | Typ | Max | Unit |
|---------|-------------------------------------------------------------------|-----|-----|-----|------|
| TsetupT | Data to Clock output Setup Time (at Transmitter integrated delay) | 1.0 | 2.0 | -   | ns   |
| TholdT  | Clock to Data output Hold Time (at Transmitter integrated delay)  | 1.0 | 2.0 | -   | ns   |
| TsetupR | Data to Clock input Setup Time (at Receiver integrated delay)     | 1.0 | 2.0 | -   | ns   |
| TholdR  | Data to Clock input Hold Time (at Receiver integrated delay)      | 1.0 | 2.0 | -   | ns   |



### 8.3. Crystal Requirement

**Table 139. Crystal Requirement**

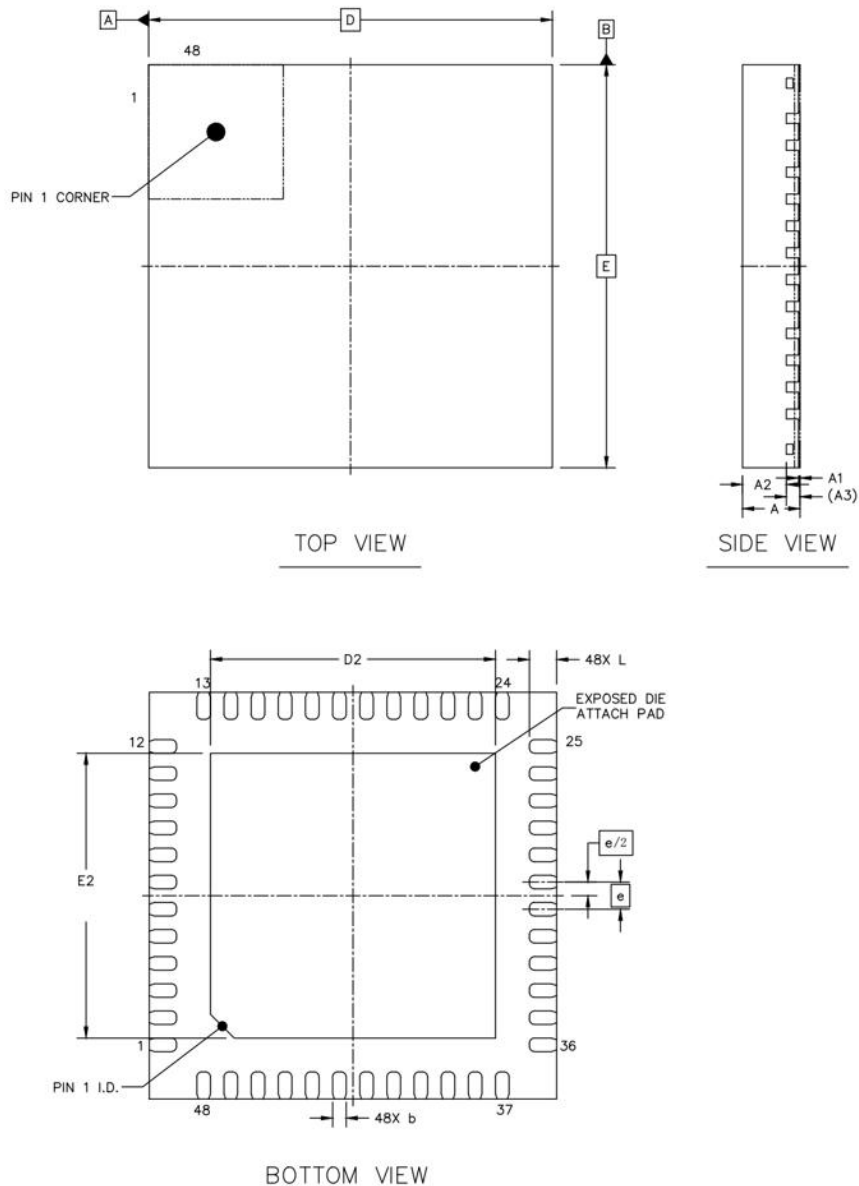
| Symbol          | Description                                             | Min | Typ | Max | Unit |
|-----------------|---------------------------------------------------------|-----|-----|-----|------|
| Fref            | Parallel Resonant Crystal Reference Frequency           | -   | 25  | -   | MHz  |
| Fref Tolerance  | Parallel Resonant Crystal Reference Frequency Tolerance | -50 | -   | 50  | ppm  |
| Fref Duty Cycle | Reference Clock Input Duty Cycle                        | 40  | -   | 60  | %    |
| ESR             | Equivalent Series Resistance                            | -   | -   | 50  | ohm  |
| DL              | Drive Level                                             | -   | -   | 0.5 | mW   |
| Vih             | Crystal output high level                               | 1.4 | -   | -   | V    |
| Vil             | Crystal output low level                                | -   | -   | 0.7 | V    |

### 8.4. Oscillator/External Clock Requirement

**Table 140. Oscillator/External Clock Requirement**

| Parameter           | Min | Typ | Max        | Unit |
|---------------------|-----|-----|------------|------|
| Frequency           | -   | 25  | -          | MHz  |
| Frequency tolerance | -50 | -   | 50         | PPM  |
| Duty Cycle          | 40  | -   | 60         | %    |
| Vih                 | 1.4 | -   | AVDD33+0.3 | V    |
| Vil                 | -   | -   | 0.7        | V    |
| Rise Time (10%~90%) | -   | -   | 10         | ns   |
| Fall Time (10%~90%) | -   | -   | 10         | ns   |

## 9. Mechanical Information



**Table 141. Mechanical Dimensions**

|                 |   | SYMBOL | MIN       | NOM  | MAX  |
|-----------------|---|--------|-----------|------|------|
| TOTAL THICKNESS |   | A      | 0.70      | 0.75 | 0.80 |
| STAND OFF       |   | A1     | 0         | 0.02 | 0.05 |
| MOLD THICKNESS  |   | A2     | ---       | 0.55 | ---  |
| L/F THICKNESS   |   | A3     | 0.203 REF |      |      |
| LEAD WIDTH      |   | b      | 0.15      | 0.20 | 0.25 |
| BODY SIZE       | X | D      | 6.00 BSC  |      |      |
|                 | Y | E      | 6.00 BSC  |      |      |
| LEAD PITCH      |   | e      | 0.40 BSC  |      |      |
| EP SIZE         | X | D2     | 4.10      | 4.20 | 4.30 |
|                 | Y | E2     | 4.10      | 4.20 | 4.30 |
| LEAD LENGTH     |   | L      | 0.35      | 0.40 | 0.45 |

## 10. Ordering Information

Siscofer offers a RoHS package that is compliant with RoHS.

**Table 142. Ordering Information**

| Part Number  | Grade      | Package       | Pack | Status | Operation Temp |
|--------------|------------|---------------|------|--------|----------------|
| SK8211FS     | Consumer   | QFN 48 6x6 mm |      |        | 0 ~70°C        |
| SK8211FS (i) | Industrial | QFN 48 6x6 mm |      |        | -40 ~ 85°C     |