



KSZ8081MNX/KSZ8081RNB

10Base-T/100Base-TX Physical Layer Transceiver

Revision 1.4

General Description

The KSZ8081 is a single-supply 10Base-T/100Base-TX Ethernet physical-layer transceiver for transmission and reception of data over standard CAT-5 unshielded twisted pair (UTP) cable.

The KSZ8081 is a highly-integrated PHY solution. It reduces board cost and simplifies board layout by using on-chip termination resistors for the differential pairs and by integrating a low-noise regulator to supply the 1.2V core.

The KSZ8081MNX offers the Media Independent Interface (MII) and the KSZ8081RNB offers the Reduced Media Independent Interface (RMII) for direct connection with MII/RMII-compliant Ethernet MAC processors and switches.

A 25MHz crystal is used to generate all required clocks, including the 50MHz RMII reference clock output for the KSZ8081RNB.

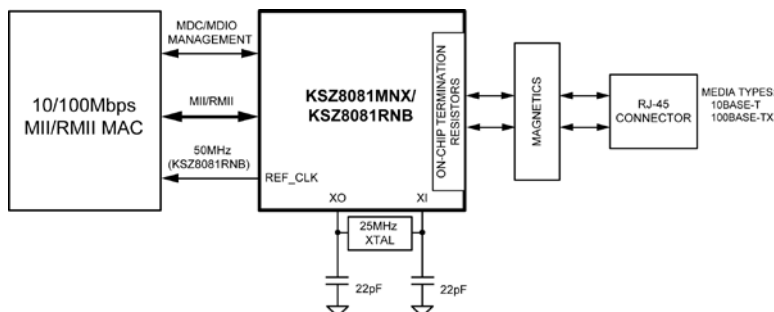
The KSZ8081 provides diagnostic features to facilitate system bring-up and debugging in production testing and in product deployment. Parametric NAND tree support enables fault detection between KSZ8081 I/Os and the board. Micrel LinkMD[®] TDR-based cable diagnostics identify faulty copper cabling.

The KSZ8081MNX and KSZ8081RNB are available in 32-pin, lead-free QFN packages (see "Ordering Information"). Datasheets and support documentation are available on website at: www.micrel.com.

Features

- Single-chip 10Base-T/100Base-TX IEEE 802.3 compliant Ethernet transceiver
- MII interface support (KSZ8081MNX)
- RMII v1.2 Interface support with a 50MHz reference clock output to MAC, and an option to input a 50MHz reference clock (KSZ8081RNB)
- Back-to-back mode support for a 100Mbps copper repeater
- MDC/MDIO management interface for PHY register configuration
- Programmable interrupt output
- LED outputs for link, activity, and speed status indication
- On-chip termination resistors for the differential pairs
- Baseline wander correction
- HP Auto MDI/MDI-X to reliably detect and correct straight-through and crossover cable connections with disable and enable option
- Auto-negotiation to automatically select the highest link-up speed (10/100Mbps) and duplex (half/full)
- Power-down and power-saving modes
- LinkMD TDR-based cable diagnostics to identify faulty copper cabling
- Parametric NAND Tree support for fault detection between chip I/Os and the board
- HBM ESD rating (6kV)

Functional Diagram



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Features (Continued)

- Loopback modes for diagnostics
- Single 3.3V power supply with VDD I/O options for 1.8V, 2.5V, or 3.3V
- Built-in 1.2V regulator for core
- Available in 32-pin (5mm × 5mm) QFN package

Applications

- Game console
- IP phone
- IP set-top box
- IP TV
- LOM
- Printer

Ordering Information

| Part Number | Temperature Range | Package | Lead Finish | Description |
|-----------------------------|-------------------|------------|-------------|---|
| KSZ8081MNXCA | 0°C to +70°C | 32-Pin QFN | Pb-Free | MII, Commercial Temperature. |
| KSZ8081MNXIA ⁽¹⁾ | −40°C to +85°C | 32-Pin QFN | Pb-Free | MII, Industrial Temperature. |
| KSZ8081RNBCA | 0°C to +70°C | 32-Pin QFN | Pb-Free | RMII with 25MHz crystal/clock input and 50MHz RMII REF_CLK output (power-up default), Commercial Temperature. |
| KSZ8081RNBIA ⁽¹⁾ | −40°C to +85°C | 32-Pin QFN | Pb-Free | RMII with 25MHz crystal/clock input and 50MHz RMII REF_CLK output (power-up default), Industrial Temperature. |
| KSZ8081MNX-EVAL | | | | KSZ8081MNX Evaluation Board (Mounted with KSZ8081MNX device in commercial temperature) |
| KSZ8081RNB-EVAL | | | | KSZ8081RNB Evaluation Board (Mounted with KSZ8081RNB device in commercial temperature) |

Note:

1. Contact factory for lead time.

Revision History

| Revision | Date | Summary of Changes |
|----------|----------|--|
| 1.0 | 11/5/12 | Initial release of datasheet. |
| 1.1 | 2/6/14 | <p>Removed copper wire bonding part numbers from Ordering Information.</p> <p>Added note for TXC (Pin 22) and Register 16h, Bit [15] regarding a Reserved Factory Mode for KSZ8081MNX device.</p> <p>Corrected TXC (Pin 22) pin type for KSZ8081MNX device.</p> <p>Removed TXC and RXC clock connections for MII Back-to-Back mode. This is a datasheet correction. There is no change to the silicon.</p> <p>Added series resistance and load capacitance for the crystal selection criteria.</p> |
| 1.2 | 12/18/14 | <p>Added silver wire bonding part numbers to Ordering Information.</p> <p>Updated Ordering Information to include Ordering Part Number and Device Marking.</p> |
| 1.3 | 04/14/15 | <p>Updated Table 7, add a note for Table 7.</p> <p>Updated Table 8, updated NAND tree I/O testing descriptions.</p> <p>Add Max frequency for MDC in MII Management (MIIM) Interface section.</p> <p>Updated Table 23, add a note for Table 23.</p> <p>Updated Figure 22 and Figure 22 descriptions.</p> <p>Updated descriptions under Figure 23 for LED strap pins, add a note for Figure 23.</p> <p>Fixed the missing value for maximum junction and thermal resistance (θ_{JC}).</p> |
| 1.4 | 08/19/15 | <p>Updated descriptions in local loopback section for data loopback path.</p> <p>Updated Table 17 and Table 21.</p> <p>Updated Ordering Information Table.</p> <p>Updated pin 22 TXC and register 16h bit [15] description for MNX part.</p> <p>Updated description and add an equation in LinkMD section.</p> <p>Add HBM ESD rating in Features.</p> |

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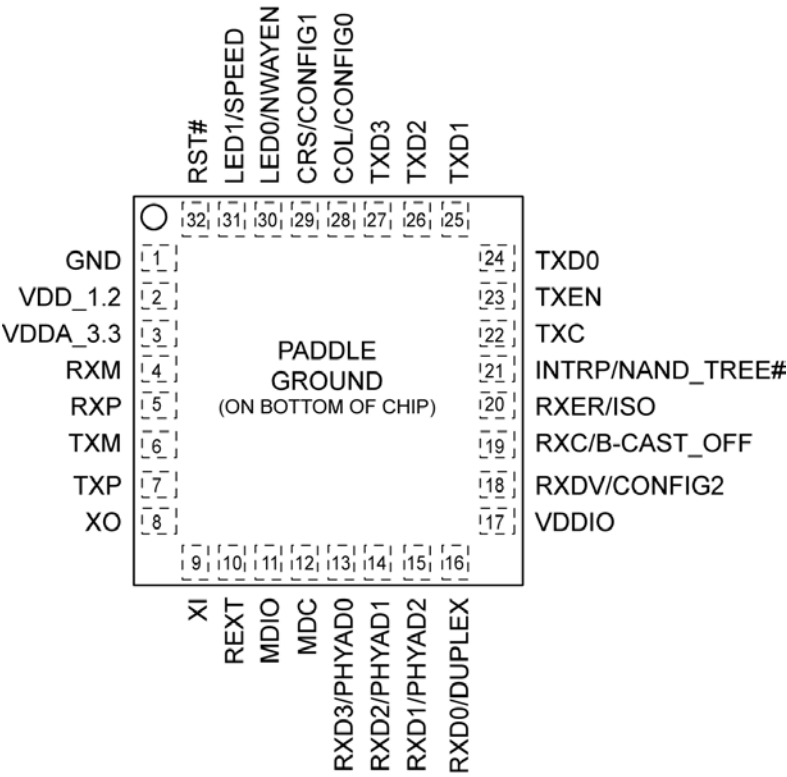
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Pin Configuration – KSZ8081MNX



32-Pin 5mm x 5mm QFN

Pin Description – KSZ8081MNX

| Pin Number | Pin Name | Type ⁽²⁾ | Pin Function |
|------------|-----------------|---------------------|---|
| 1 | GND | GND | Ground |
| 2 | VDD_1.2 | P | 1.2V core V _{DD} (power supplied by KSZ8081MNX). Decouple with 2.2μF and 0.1μF capacitors to ground. |
| 3 | VDDA_3.3 | P | 3.3V analog V _{DD} . |
| 4 | RXM | I/O | Physical receive or transmit signal (– differential). |
| 5 | RXP | I/O | Physical receive or transmit signal (+ differential). |
| 6 | TXM | I/O | Physical transmit or receive signal (– differential). |
| 7 | TXP | I/O | Physical transmit or receive signal (+ differential). |
| 8 | XO | O | Crystal feedback for 25MHz crystal. This pin is a no connect if an oscillator or external clock source is used. |
| 9 | XI | I | Crystal / Oscillator / External Clock Input. 25MHz ±50ppm. |
| 10 | REXT | I | Set PHY transmit output current. Connect a 6.49kΩ resistor to ground on this pin. |
| 11 | MDIO | Ipu/Opu | Management Interface (MII) Data I/O This pin has a weak pull-up, is open-drain, and requires an external 1.0kΩ pull-up resistor. |
| 12 | MDC | Ipu | Management Interface (MII) Clock Input. This clock pin is synchronous to the MDIO data pin. |
| 13 | RXD3/ PHYAD0 | Ipu/O | MII Mode: MII Receive Data Output[3] ⁽³⁾ . Config Mode: The pull-up/pull-down value is latched as PHYADDR[0] at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details. |
| 14 | RXD2/ PHYAD1 | Ipd/O | MII Mode: MII Receive Data Output[2] ⁽³⁾ . Config Mode: The pull-up/pull-down value is latched as PHYADDR[1] at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details. |
| 15 | RXD1/ PHYAD2 | Ipd/O | MII Mode: MII Receive Data Output[1] ⁽³⁾ . Config Mode: The pull-up/pull-down value is latched as PHYADDR[2] at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details. |

Notes:

2. P = Power supply.

GND = Ground.

I = Input.

O = Output.

I/O = Bi-directional.

Ipu = Input with internal pull-up (see [Electrical Characteristics](#) for value).

Ipu/O = Input with internal pull-up (see [Electrical Characteristics](#) for value) during power-up/reset; output pin otherwise.

Ipd/O = Input with internal pull-down (see [Electrical Characteristics](#) for value) during power-up/reset; output pin otherwise.

Ipu/Opu = Input with internal pull-up (see [Electrical Characteristics](#) for value) and output with internal pull-up (see [Electrical Characteristics](#) for value).

3. MII RX Mode: The RXD[3:0] bits are synchronous with RXC. When RXDV is asserted, RXD[3:0] presents valid data to the MAC. RXD[3:0] is invalid data from the PHY when RXDV is de-asserted.

Pin Description – KSZ8081MNX (Continued)

| Pin Number | Pin Name | Type ⁽²⁾ | Pin Function |
|------------|--------------------------|---------------------|---|
| 16 | RXD0/ DUPLEX | Ipu/O | MII Mode: MII Receive Data Output[0] ⁽³⁾ . Config Mode: The pull-up/pull-down value is latched as DUPLEX at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details. |
| 17 | VDDIO | P | 3.3V, 2.5V, or 1.8V digital V _{DD} |
| 18 | RXDV/ CONFIG2 | Ipd/O | MII Mode: MII Receive Data Valid Output. Config Mode: The pull-up/pull-down value is latched as CONFIG2 at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details. |
| 19 | RXC/ B-CAST_OFF | Ipd/O | MII Mode: MII Receive Clock Output. Config Mode: The pull-up/pull-down value is latched as B-CAST_OFF at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details. |
| 20 | RXER/ ISO | Ipd/O | MII mode: MII Receive Error Output. Config Mode: The pull-up/pull-down value is latched as ISOLATE at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details. |
| 21 | INTRP/ NAND_Tree# | Ipu/Opu | Interrupt Output: Programmable Interrupt Output. This pin has a weak pull-up, is open-drain, and requires an external 1.0kΩ pull-up resistor. Config Mode: The pull-up/pull-down value is latched as NAND Tree# at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details |
| 22 | TXC | Ipd/O | MII Mode: MII Transmit Clock Output. At the de-assertion of reset, this pin needs to latch in a pull-down value for normal operation. If MAC side pulls this pin high, see Register 16h, Bit [15] for solution. It is better having an external pull-down resistor to avoid MAC side pulls this pin high. |
| 23 | TXEN | I | MII Mode: MII Transmit Enable input. |
| 24 | TXD0 | I | MII Mode: MII Transmit Data Input[0] ⁽⁴⁾ . |
| 25 | TXD1 | I | MII Mode: MII Transmit Data Input[1] ⁽⁴⁾ . |
| 26 | TXD2 | I | MII Mode: MII Transmit Data Input[2] ⁽⁴⁾ . |
| 27 | TXD3 | I | MII Mode: MII Transmit Data Input[3] ⁽⁴⁾ . |
| 28 | COL/ CONFIG0 | Ipd/O | MII Mode: MII Collision Detect output. Config Mode: The pull-up/pull-down value is latched as CONFIG0 at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details. |
| 29 | CRS/ CONFIG1 | Ipd/O | MII mode: MII Carrier Sense output Config mode: The pull-up/pull-down value is latched as CONFIG1 at the de-assertion of reset. See the Strapping Options – KSZ8081MNX section for details. |

Note:

4. MII TX Mode: The TXD[3:0] bits are synchronous with TXC. When TXEN is asserted, TXD[3:0] presents valid data from the MAC. TXD[3:0] has no effect on the PHY when TXEN is de-asserted.

Pin Description – KSZ8081MNX (Continued)

| Pin Number | Pin Name | Type ⁽²⁾ | Pin Function | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|-----------------|---------------------|---|-----------------|--|--|---------------|-----------|----------------|----------|------|-----|------------|-----|----|-----------------|--------|----------|-----------------|-----------|----------------|-------------|-----------|----------------|----------|--------|----------|------|-----|----|
| 30 | LED0/ NWAYEN | Ipu/O | <p>LED Output: Programmable LED0 output.</p> <p>Config Mode: Latched as auto-negotiation enable (Register 0h, Bit [12]) at the de-assertion of reset.</p> <p>See the Strapping Options – KSZ8081MNX section for details.</p> <p>The LED0 pin is programmable using Register 1Fh bits [5:4], and is defined as follows:</p> <table><tr><th colspan="3">LED Mode = [00]</th></tr><tr><th>Link/Activity</th><th>Pin State</th><th>LED Definition</th></tr><tr><td>No link</td><td>High</td><td>OFF</td></tr><tr><td>Link</td><td>Low</td><td>ON</td></tr><tr><td>Activity</td><td>Toggle</td><td>Blinking</td></tr></table> <table><tr><th colspan="3">LED Mode = [01]</th></tr><tr><th>Link</th><th>Pin State</th><th>LED Definition</th></tr><tr><td>No link</td><td>High</td><td>OFF</td></tr><tr><td>Link</td><td>Low</td><td>ON</td></tr></table> <p>LED Mode = [10], [11] Reserved</p> | LED Mode = [00] | | | Link/Activity | Pin State | LED Definition | No link | High | OFF | Link | Low | ON | Activity | Toggle | Blinking | LED Mode = [01] | | | Link | Pin State | LED Definition | No link | High | OFF | Link | Low | ON |
| LED Mode = [00] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link/Activity | Pin State | LED Definition | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No link | High | OFF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Low | ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Activity | Toggle | Blinking | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LED Mode = [01] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Pin State | LED Definition | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No link | High | OFF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Low | ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | LED1/ SPEED | Ipu/O | <p>LED Output: Programmable LED1 Output.</p> <p>Config Mode: Latched as Speed (Register 0h, Bit [13]) at the de-assertion of reset.</p> <p>See the Strapping Options – KSZ8081MNX section for details.</p> <p>The LED1 pin is programmable using Register 1Fh bits [5:4], and is defined as follows:</p> <table><tr><th colspan="3">LED Mode = [00]</th></tr><tr><th>Speed</th><th>Pin State</th><th>LED Definition</th></tr><tr><td>10Base-T</td><td>High</td><td>OFF</td></tr><tr><td>100Base-TX</td><td>Low</td><td>ON</td></tr></table> <table><tr><th colspan="3">LED Mode = [01]</th></tr><tr><th>Activity</th><th>Pin State</th><th>LED Definition</th></tr><tr><td>No activity</td><td>High</td><td>OFF</td></tr><tr><td>Activity</td><td>Toggle</td><td>Blinking</td></tr></table> <p>LED Mode = [10], [11] Reserved</p> | LED Mode = [00] | | | Speed | Pin State | LED Definition | 10Base-T | High | OFF | 100Base-TX | Low | ON | LED Mode = [01] | | | Activity | Pin State | LED Definition | No activity | High | OFF | Activity | Toggle | Blinking | | | |
| LED Mode = [00] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Speed | Pin State | LED Definition | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10Base-T | High | OFF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 100Base-TX | Low | ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LED Mode = [01] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Activity | Pin State | LED Definition | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No activity | High | OFF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Activity | Toggle | Blinking | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32 | RST# | Ipu | Chip Reset (active low). | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PADDLE | GND | GND | Ground | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Strapping Options – KSZ8081MNX

The strap-in pins are latched at the de-assertion of reset. In some systems, the MAC MII receive input pins may drive high/low during power-up or reset, and consequently cause the PHY strap-in pins on the MII signals to be latched to unintended high/low states. In this case, external pull-ups (4.7kΩ) or pull-downs (1.0kΩ) should be added on these PHY strap-in pins to ensure that the intended values are strapped-in correctly.

| Pin Number | Pin Name | Type ⁽⁵⁾ | Pin Function | | | | | | | | |
|----------------|-------------------------------|-------------------------|--|-------------|------|-----|---------------|-----|------------------|----------------|---------------------|
| 15 14 13 | PHYAD2 PHYAD1 PHYAD0 | lpd/O lpd/O lpu/O | PHYAD[2:0] is latched at de-assertion of reset and is configurable to any value from 0 to 7 with PHY Address 1 as the default value. PHY Address 0 is assigned by default as the broadcast PHY address, but it can be assigned as a unique PHY address after pulling the B-CAST_OFF strapping pin high or writing a '1' to Register 16h, Bit [9]. PHY Address bits [4:3] are set to 00 by default. | | | | | | | | |
| 18 29 28 | CONFIG2 CONFIG1 CONFIG0 | lpd/O lpd/O lpd/O | <div>The CONFIG[2:0] strap-in pins are latched at the de-assertion of reset:</div> <table><tr><th>CONFIG[2:0]</th><th>Mode</th></tr><tr><td>000</td><td>MII (default)</td></tr><tr><td>110</td><td>MII back-to-back</td></tr><tr><td>001 – 101, 111</td><td>Reserved – not used</td></tr></table> | CONFIG[2:0] | Mode | 000 | MII (default) | 110 | MII back-to-back | 001 – 101, 111 | Reserved – not used |
| CONFIG[2:0] | Mode | | | | | | | | | | |
| 000 | MII (default) | | | | | | | | | | |
| 110 | MII back-to-back | | | | | | | | | | |
| 001 – 101, 111 | Reserved – not used | | | | | | | | | | |
| 20 | ISO | lpd/O | <div>Isolate Mode:</div> <div>Pull-up = Enable</div> <div>Pull-down (default) = Disable</div> <div>At the de-assertion of reset, this pin value is latched into Register 0h, Bit [10].</div> | | | | | | | | |
| 31 | SPEED | lpu/O | <div>Speed Mode:</div> <div>Pull-up (default) = 100Mbps</div> <div>Pull-down = 10Mbps</div> <div>At the de-assertion of reset, this pin value is latched into Register 0h, Bit [13] as the speed select, and also is latched into Register 4h (auto-negotiation advertisement) as the speed capability support.</div> | | | | | | | | |
| 16 | DUPLEX | lpu/O | <div>Duplex Mode:</div> <div>Pull-up (default) = Half-duplex</div> <div>Pull-down = Full-duplex</div> <div>At the de-assertion of reset, this pin value is latched into Register 0h, Bit [8].</div> | | | | | | | | |

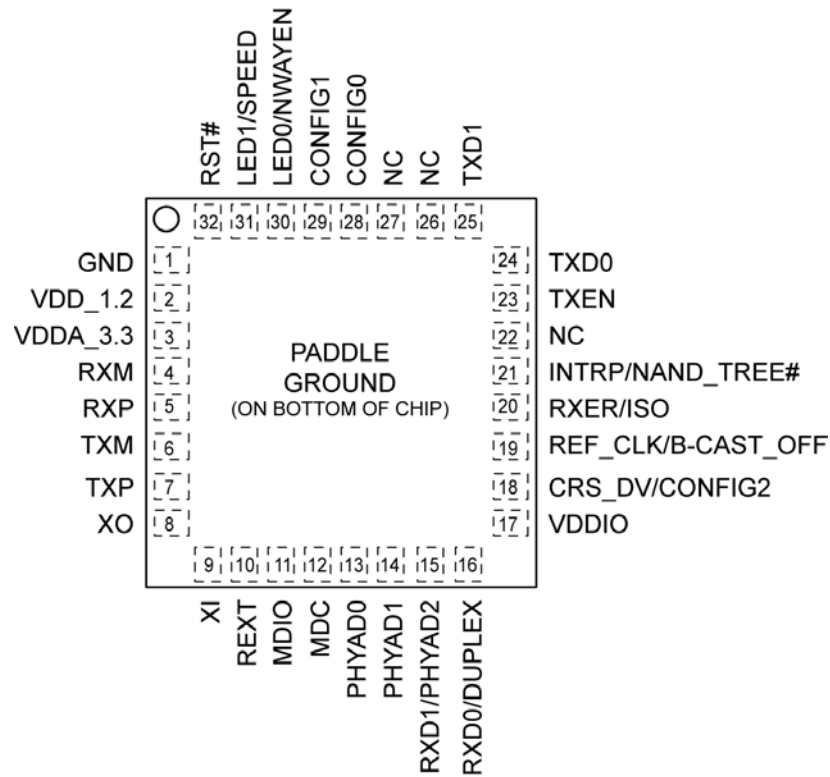
Note:

5. lpu/O = Input with internal pull-up (see [Electrical Characteristics](#) for value) during power-up/reset; output pin otherwise.
lpd/O = Input with internal pull-down (see [Electrical Characteristics](#) for value) during power-up/reset; output pin otherwise.
lpu/Opu = Input with internal pull-up (see [Electrical Characteristics](#) for value) and output with internal pull-up (see [Electrical Characteristics](#) for value).

Strapping Options – KSZ8081MNX (Continued)

| Pin Number | Pin Name | Type ⁽⁵⁾ | Pin Function |
|------------|------------|---------------------|---|
| 30 | NWAYEN | Ipu/O | <p>Nway Auto-Negotiation Enable:</p> <p>Pull-up (default) = Enable auto-negotiation</p> <p>Pull-down = Disable auto-negotiation</p> <p>At the de-assertion of reset, this pin value is latched into Register 0h, Bit [12].</p> |
| 19 | B-CAST_OFF | Ipd/O | <p>Broadcast Off – for PHY Address 0:</p> <p>Pull-up = PHY Address 0 is set as an unique PHY address</p> <p>Pull-down (default) = PHY Address 0 is set as a broadcast PHY address</p> <p>At the de-assertion of reset, this pin value is latched by the chip.</p> |
| 21 | NAND_Tree# | Ipu/Opu | <p>NAND Tree Mode:</p> <p>Pull-up (default) = Disable</p> <p>Pull-down = Enable</p> <p>At the de-assertion of reset, this pin value is latched by the chip.</p> |

Pin Configuration – KSZ8081RNB



32-Pin 5mm x 5mm QFN

Pin Description – KSZ8081RNB

| Pin Number | Pin Name | Type ⁽⁶⁾ | Pin Function |
|------------|-----------------|---------------------|--|
| 1 | GND | GND | Ground |
| 2 | VDD_1.2 | P | 1.2V core V _{DD} (power supplied by KSZ8081RNB). Decouple with 2.2μF and 0.1μF capacitors to ground. |
| 3 | VDDA_3.3 | P | 3.3V analog V _{DD} . |
| 4 | RXM | I/O | Physical receive or transmit signal (– differential). |
| 5 | RXP | I/O | Physical receive or transmit signal (+ differential). |
| 6 | TXM | I/O | Physical transmit or receive signal (– differential). |
| 7 | TXP | I/O | Physical transmit or receive signal (+ differential). |
| 8 | XO | O | Crystal feedback for 25MHz crystal. This pin is a no connect if an oscillator or external clock source is used. |
| 9 | XI | I | 25MHz Mode: 25MHz ±50ppm Crystal / Oscillator / External Clock Input 50MHz Mode: 50MHz ±50ppm Oscillator / External Clock Input |
| 10 | REXT | I | Set PHY transmit output current. Connect a 6.49kΩ resistor to ground on this pin. |
| 11 | MDIO | Ipu/Opu | Management Interface (MII) Data I/O. This pin has a weak pull-up, is open-drain, and requires an external 1.0kΩ pull-up resistor. |
| 12 | MDC | Ipu | Management Interface (MII) Clock Input. This clock pin is synchronous to the MDIO data pin. |
| 13 | PHYAD0 | Ipu/O | The pull-up/pull-down value is latched as PHYADDR[0] at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |
| 14 | PHYAD1 | Ipd/O | The pull-up/pull-down value is latched as PHYADDR[1] at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |
| 15 | RXD1/ PHYAD2 | Ipd/O | RMII Mode: RMII Receive Data Output[1] ⁽⁷⁾ . Config Mode: The pull-up/pull-down value is latched as PHYADDR[2] at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |
| 16 | RXD0/ DUPLEX | Ipu/O | RMII Mode: RMII Receive Data Output[0] ⁽⁷⁾ . Config Mode: The pull-up/pull-down value is latched as DUPLEX at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |

Notes:

6. P = Power supply.
GND = Ground.
I = Input.
O = Output.
I/O = Bi-directional.

Ipu = Input with internal pull-up (see [Electrical Characteristics](#) for value).

Ipu/O = Input with internal pull-up (see [Electrical Characteristics](#) for value) during power-up/reset; output pin otherwise.

Ipd/O = Input with internal pull-down (see [Electrical Characteristics](#) for value) during power-up/reset; output pin otherwise.

Ipu/Opu = Input with internal pull-up (see [Electrical Characteristics](#) for value) and output with internal pull-up (see [Electrical Characteristics](#) for value).

NC = Pin is not bonded to the die.

7. RMII RX Mode: The RXD[1:0] bits are synchronous with the 50MHz RMII Reference Clock. For each clock period in which CRS_DV is asserted, two bits of recovered data are sent by the PHY to the MAC.

Pin Description – KSZ8081RNB (Continued)

| Pin Number | Pin Name | Type ⁽⁶⁾ | Pin Function |
|------------|----------------------------|---------------------|---|
| 17 | VDDIO | P | 3.3V, 2.5V, or 1.8V digital V _{DD} . |
| 18 | CRS_DV/ CONFIG2 | Ipd/O | RMII Mode: RMII Carrier Sense/Receive Data Valid Output. Config Mode: The pull-up/pull-down value is latched as CONFIG2 at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |
| 19 | REF_CLK/ B-CAST_OFF | Ipd/O | RMII Mode: 25MHz Mode. This pin provides the 50MHz RMII reference clock output to the MAC. See also XI (Pin 9). 50MHz mode: This pin is a no connect. See also XI (Pin 9). Config Mode: The pull-up/pull-down value is latched as B-CAST_OFF at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |
| 20 | RXER/ ISO | Ipd/O | RMII Mode: RMII Receive Error Output. Config Mode: The pull-up/pull-down value is latched as ISOLATE at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |
| 21 | INTRP/ NAND_Tree# | Ipu/Opu | Interrupt Output: Programmable Interrupt Output. This pin has a weak pull-up, is open-drain, and requires an external 1.0kΩ pull-up resistor. Config Mode: The pull-up/pull-down value is latched as NAND_Tree# at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |
| 22 | NC | - | No Connect. This pin is not bonded and can be left floating. |
| 23 | TXEN | I | RMII Transmit Enable input. |
| 24 | TXD0 | I | RMII Transmit Data Input[0] ⁽⁸⁾ . |
| 25 | TXD1 | I | RMII Transmit Data Input[1] ⁽⁸⁾ . |
| 26 | NC | - | No Connect. This pin is not bonded and can be left floating. |
| 27 | NC | - | No Connect. This pin is not bonded and can be left floating. |
| 28 | CONFIG0 | Ipd/O | The pull-up/pull-down value is latched as CONFIG0 at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |
| 29 | CONFIG1 | Ipd/O | The pull-up/pull-down value is latched as CONFIG1 at the de-assertion of reset. See the Strapping Options – KSZ8081RNB section for details. |

Note:

8. RMII TX Mode: The TXD[1:0] bits are synchronous with the 50MHz RMII Reference Clock. For each clock period in which TXEN is asserted, two bits of data are received by the PHY from the MAC.

Pin Description – KSZ8081RNB (Continued)

| Pin Number | Pin Name | Type ⁽⁶⁾ | Pin Function | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|-----------------|---------------------|--|-----------------|--|--|---------------|-----------|----------------|----------|------|-----|------------|-----|----|-----------------|--------|----------|-----------------|-----------|----------------|-------------|-----------|----------------|----------|--------|----------|------|-----|----|
| 30 | LED0/ NWAYEN | Ipu/O | <p>LED Output: Programmable LED0 Output.</p> <p>Config Mode: Latched as auto-negotiation enable (Register 0h, Bit [12]) at the de-assertion of reset.</p> <p>See the Strapping Options – KSZ8081RNB section for details.</p> <p>The LED0 pin is programmable using Register 1Fh bits [5:4], and is defined as follows:</p> <table><tr><th colspan="3">LED Mode = [00]</th></tr><tr><th>Link/Activity</th><th>Pin State</th><th>LED Definition</th></tr><tr><td>No link</td><td>High</td><td>OFF</td></tr><tr><td>Link</td><td>Low</td><td>ON</td></tr><tr><td>Activity</td><td>Toggle</td><td>Blinking</td></tr></table> <table><tr><th colspan="3">LED Mode = [01]</th></tr><tr><th>Link</th><th>Pin State</th><th>LED Definition</th></tr><tr><td>No link</td><td>High</td><td>OFF</td></tr><tr><td>Link</td><td>Low</td><td>ON</td></tr></table> <p>LED Mode = [10], [11] Reserved</p> | LED Mode = [00] | | | Link/Activity | Pin State | LED Definition | No link | High | OFF | Link | Low | ON | Activity | Toggle | Blinking | LED Mode = [01] | | | Link | Pin State | LED Definition | No link | High | OFF | Link | Low | ON |
| LED Mode = [00] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link/Activity | Pin State | LED Definition | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No link | High | OFF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Low | ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Activity | Toggle | Blinking | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LED Mode = [01] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Pin State | LED Definition | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No link | High | OFF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Link | Low | ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | LED1/ SPEED | Ipu/O | <p>LED Output: Programmable LED1 Output.</p> <p>Config Mode: Latched as Speed (Register 0h, Bit [13]) at the de-assertion of reset.</p> <p>See the Strapping Options – KSZ8081RNB section for details.</p> <p>The LED1 pin is programmable using Register 1Fh bits [5:4], and is defined as follows:</p> <table><tr><th colspan="3">LED Mode = [00]</th></tr><tr><th>Speed</th><th>Pin State</th><th>LED Definition</th></tr><tr><td>10Base-T</td><td>High</td><td>OFF</td></tr><tr><td>100Base-TX</td><td>Low</td><td>ON</td></tr></table> <table><tr><th colspan="3">LED Mode = [01]</th></tr><tr><th>Activity</th><th>Pin State</th><th>LED Definition</th></tr><tr><td>No activity</td><td>High</td><td>OFF</td></tr><tr><td>Activity</td><td>Toggle</td><td>Blinking</td></tr></table> <p>LED Mode = [10], [11] Reserved</p> | LED Mode = [00] | | | Speed | Pin State | LED Definition | 10Base-T | High | OFF | 100Base-TX | Low | ON | LED Mode = [01] | | | Activity | Pin State | LED Definition | No activity | High | OFF | Activity | Toggle | Blinking | | | |
| LED Mode = [00] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Speed | Pin State | LED Definition | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10Base-T | High | OFF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 100Base-TX | Low | ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LED Mode = [01] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Activity | Pin State | LED Definition | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No activity | High | OFF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Activity | Toggle | Blinking | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32 | RST# | Ipu | Chip Reset (active low). | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PADDLE | GND | GND | Ground. | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Strapping Options – KSZ8081RNB

The strap-in pins are latched at the de-assertion of reset. In some systems, the MAC RMII receive input pins may drive high/low during power-up or reset, and consequently cause the PHY strap-in pins on the RMII signals to be latched to unintended high/low states. In this case, external pull-ups (4.7kΩ) or pull-downs (1.0kΩ) should be added on these PHY strap-in pins to ensure that the intended values are strapped-in correctly.

| Pin Number | Pin Name | Type ⁽⁹⁾ | Pin Function | | | | | | | | |
|--------------------------|---------------------|---------------------|--|-------------|------|-----|------|-----|-------------------|--------------------------|---------------------|
| 15 | PHYAD2 | lpd/O | PHYAD[2:0] is latched at de-assertion of reset and is configurable to any value from 0 to 7 with PHY Address 1 as the default value. PHY Address 0 is assigned by default as the broadcast PHY address, but it can be assigned as a unique PHY address after pulling the B-CAST_OFF strapping pin high or writing a '1' to Register 16h, Bit [9]. PHY Address bits [4:3] are set to 00 by default. | | | | | | | | |
| 14 | PHYAD1 | lpd/O | | | | | | | | | |
| 13 | PHYAD0 | lpu/O | | | | | | | | | |
| 18 | CONFIG2 | lpd/O | The CONFIG[2:0] strap-in pins are latched at the de-assertion of reset. <table><tr><th>CONFIG[2:0]</th><th>Mode</th></tr><tr><td>001</td><td>RMII</td></tr><tr><td>101</td><td>RMII back-to-back</td></tr><tr><td>000, 010 – 100, 110, 111</td><td>Reserved – not used</td></tr></table> | CONFIG[2:0] | Mode | 001 | RMII | 101 | RMII back-to-back | 000, 010 – 100, 110, 111 | Reserved – not used |
| CONFIG[2:0] | Mode | | | | | | | | | | |
| 001 | RMII | | | | | | | | | | |
| 101 | RMII back-to-back | | | | | | | | | | |
| 000, 010 – 100, 110, 111 | Reserved – not used | | | | | | | | | | |
| 29 | CONFIG1 | lpd/O | | | | | | | | | |
| 28 | CONFIG0 | lpd/O | | | | | | | | | |
| | | | | | | | | | | | |
| 20 | ISO | lpd/O | Isolate mode Pull-up = Enable Pull-down (default) = Disable At the de-assertion of reset, this pin value is latched into Register 0h, Bit [10]. | | | | | | | | |
| 31 | SPEED | lpu/O | Speed mode Pull-up (default) = 100Mbps Pull-down = 10Mbps At the de-assertion of reset, this pin value is latched into Register 0h, Bit [13] as the speed select, and also is latched into Register 4h (auto-negotiation advertisement) as the speed capability support. | | | | | | | | |
| 16 | DUPLEX | lpu/O | Duplex mode Pull-up (default) = Half-duplex Pull-down = Full-duplex At the de-assertion of reset, this pin value is latched into Register 0h, Bit [8]. | | | | | | | | |
| 30 | NWAYEN | lpu/O | Nway auto-negotiation enable Pull-up (default) = Enable auto-negotiation Pull-down = Disable auto-negotiation At the de-assertion of reset, this pin value is latched into Register 0h, Bit [12]. | | | | | | | | |
| 19 | B-CAST_OFF | lpd/O | Broadcast off – for PHY Address 0 Pull-up = PHY Address 0 is set as an unique PHY address Pull-down (default) = PHY Address 0 is set as a broadcast PHY address At the de-assertion of reset, this pin value is latched by the chip. | | | | | | | | |
| 21 | NAND_Tree# | lpu/Opu | NAND tree mode Pull-up (default) = Disable Pull-down = Enable At the de-assertion of reset, this pin value is latched by the chip. | | | | | | | | |

Note:

9. lpu/O = Input with internal pull-up (see [Electrical Characteristics](#) for value) during power-up/reset; output pin otherwise.
 lpd/O = Input with internal pull-down (see [Electrical Characteristics](#) for value) during power-up/reset; output pin otherwise.
 lpu/Opu = Input with internal pull-up (see [Electrical Characteristics](#) for value) and output with internal pull-up (see [Electrical Characteristics](#) for value).

Functional Description: 10Base-T/100Base-TX Transceiver

The KSZ8081 is an integrated single 3.3V supply Fast Ethernet transceiver. It is fully compliant with the IEEE 802.3 Specification, and reduces board cost and simplifies board layout by using on-chip termination resistors for the two differential pairs and by integrating the regulator to supply the 1.2V core.

On the copper media side, the KSZ8081 supports 10Base-T and 100Base-TX for transmission and reception of data over a standard CAT-5 unshielded twisted pair (UTP) cable, and HP Auto MDI/MDI-X for reliable detection of and correction for straight-through and crossover cables.

On the MAC processor side, the KSZ8081MNX offers the Media Independent Interface (MII) and the KSZ8081RNB offers the Reduced Media Independent Interface (RMII) for direct connection with MII and RMII compliant Ethernet MAC processors and switches, respectively.

The MII management bus option gives the MAC processor complete access to the KSZ8081 control and status registers. Additionally, an interrupt pin eliminates the need for the processor to poll for PHY status change.

The KSZ8081MNX/RNB is used to refer to both KSZ8081MNX and KSZ8081RNB versions in this datasheet.

100Base-TX Transmit

The 100Base-TX transmit function performs parallel-to-serial conversion, 4B/5B encoding, scrambling, NRZ-to-NRZI conversion, and MLT3 encoding and transmission.

The circuitry starts with a parallel-to-serial conversion, which converts the MII data from the MAC into a 125MHz serial bit stream. The data and control stream is then converted into 4B/5B coding and followed by a scrambler. The serialized data is further converted from NRZ-to-NRZI format, and then transmitted in MLT3 current output. The output current is set by an external 6.49kΩ 1% resistor for the 1:1 transformer ratio.

The output signal has a typical rise/fall time of 4ns and complies with the ANSI TP-PMD standard regarding amplitude balance, overshoot, and timing jitter. The wave-shaped 10Base-T output is also incorporated into the 100Base-TX transmitter.

100Base-TX Receive

The 100Base-TX receiver function performs adaptive equalization, DC restoration, MLT3-to-NRZI conversion, data and clock recovery, NRZI-to-NRZ conversion, de-scrambling, 4B/5B decoding, and serial-to-parallel conversion.

The receiving side starts with the equalization filter to compensate for inter-symbol interference (ISI) over the twisted pair cable. Because the amplitude loss and phase distortion is a function of the cable length, the equalizer must adjust its characteristics to optimize performance. In this design, the variable equalizer makes an initial estimation based on comparisons of incoming signal strength against some known cable characteristics, then tunes itself for optimization. This is an ongoing process and self-adjusts against environmental changes such as temperature variations.

Next, the equalized signal goes through a DC-restoration and data-conversion block. The DC-restoration circuit compensates for the effect of baseline wander and improves the dynamic range. The differential data-conversion circuit converts MLT3 format back to NRZI. The slicing threshold is also adaptive.

The clock-recovery circuit extracts the 125MHz clock from the edges of the NRZI signal. This recovered clock is then used to convert the NRZI signal to NRZ format. This signal is sent through the de-scrambler, then the 4B/5B decoder. Finally, the NRZ serial data is converted to MII format and provided as the input data to the MAC.

Scrambler/De-Scrambler (100Base-TX Only)

The scrambler spreads the power spectrum of the transmitted signal to reduce electromagnetic interference (EMI) and baseline wander. The de-scrambler recovers the scrambled signal.

10Base-T Transmit

The 10Base-T drivers are incorporated with the 100Base-TX drivers to allow for transmission using the same magnetic. The drivers perform internal wave-shaping and pre-emphasis, and output 10Base-T signals with a typical amplitude of 2.5V peak. The 10Base-T signals have harmonic contents that are at least 27dB below the fundamental frequency when driven by an all-ones Manchester-encoded signal.

10Base-T Receive

On the receive side, input buffer and level detecting squelch circuits are used. A differential input receiver circuit and a phase-locked loop (PLL) performs the decoding function. The Manchester-encoded data stream is separated into clock signal and NRZ data. A squelch circuit rejects signals with levels less than 400mV, or with short pulse widths, to prevent noise at the RXP and RXM inputs from falsely triggering the decoder. When the input exceeds the squelch limit, the PLL locks onto the incoming signal and the KSZ8081MNX/RNB decodes a data frame. The receive clock is kept active during idle periods between data receptions.

SQE and Jabber Function (10Base-T Only)

In 10Base-T operation, a short pulse is put out on the COL pin after each frame is transmitted. This SQE test is needed to test the 10Base-T transmit/receive path. If transmit enable (TXEN) is high for more than 20ms (jabbering), the 10Base-T transmitter is disabled and COL is asserted high. If TXEN is then driven low for more than 250ms, the 10Base-T transmitter is re-enabled and COL is de-asserted (returns to low).

PLL Clock Synthesizer

The KSZ8081MNX/RNB generates all internal clocks and all external clocks for system timing from an external 25MHz crystal, oscillator, or reference clock. For the KSZ8081RNB in RMII 50MHz clock mode, these clocks are generated from an external 50MHz oscillator or system clock.

Auto-Negotiation

The KSZ8081MNX/RNB conforms to the auto-negotiation protocol, defined in Clause 28 of the IEEE 802.3 Specification.

Auto-negotiation allows unshielded twisted pair (UTP) link partners to select the highest common mode of operation.

During auto-negotiation, link partners advertise capabilities across the UTP link to each other and then compare their own capabilities with those they received from their link partners. The highest speed and duplex setting that is common to the two link partners is selected as the mode of operation.

The following list shows the speed and duplex operation mode from highest to lowest priority.

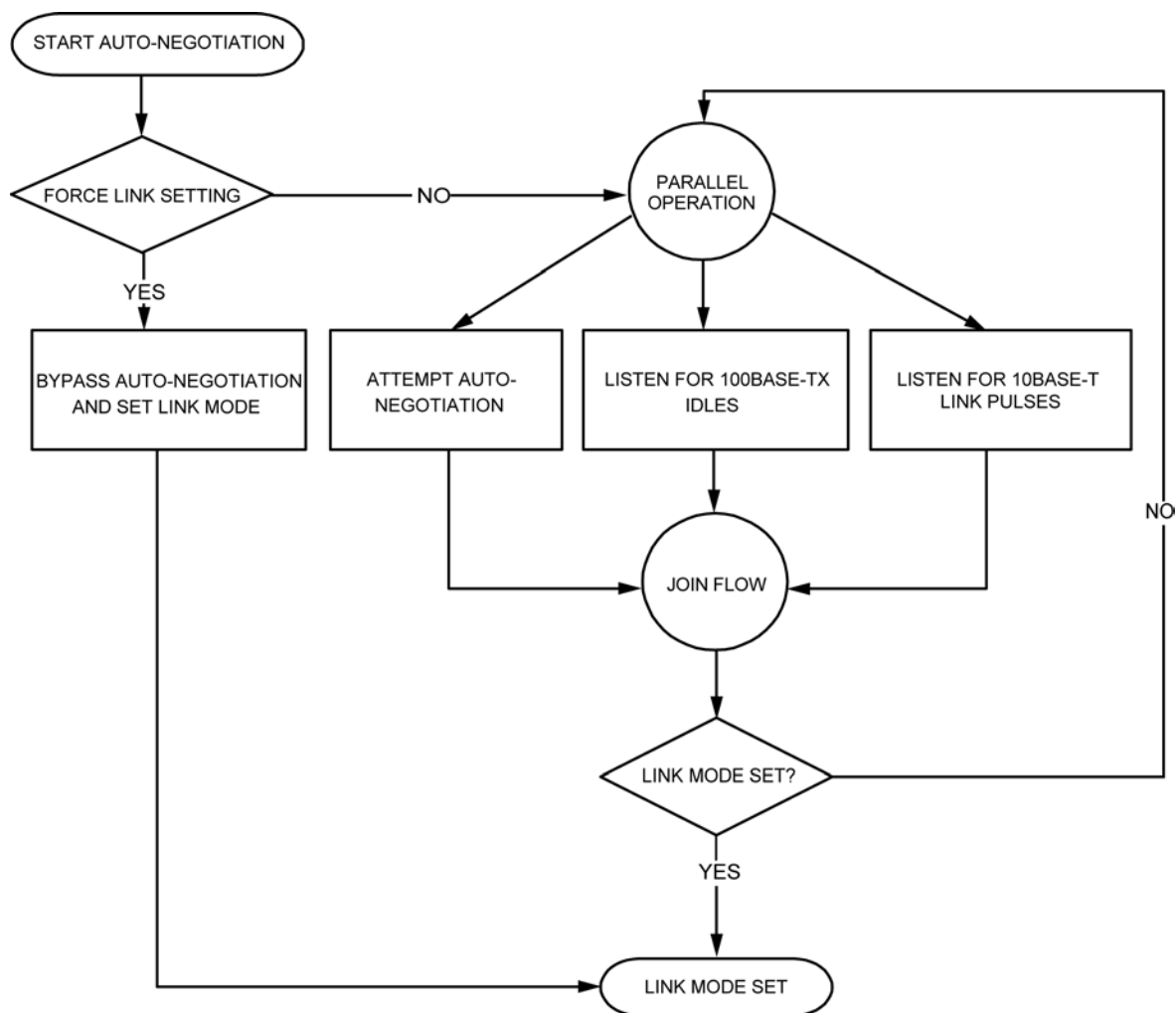
- Priority 1: 100Base-TX, full-duplex
- Priority 2: 100Base-TX, half-duplex
- Priority 3: 10Base-T, full-duplex
- Priority 4: 10Base-T, half-duplex

If auto-negotiation is not supported or the KSZ8081MNX/RNB link partner is forced to bypass auto-negotiation, then the KSZ8081MNX/RNB sets its operating mode by observing the signal at its receiver. This is known as parallel detection, which allows the KSZ8081MNX/RNB to establish a link by listening for a fixed signal protocol in the absence of the auto-negotiation advertisement protocol.

Auto-negotiation is enabled by either hardware pin strapping (NWAYEN, Pin 42) or software (Register 0h, Bit [12]).

By default, auto-negotiation is enabled after power-up or hardware reset. After that, auto-negotiation can be enabled or disabled by Register 0h, Bit [12]. If auto-negotiation is disabled, the speed is set by Register 0h, Bit [13], and the duplex is set by Register 0h, Bit [8].

The auto-negotiation link-up process is shown in [Figure 1](#).

**Figure 1. Auto-Negotiation Flow Chart**

MII Interface (KSZ8081MNX Only)

The Media Independent Interface (MII) is compliant with the IEEE 802.3 Specification. It provides a common interface between MII PHYs and MACs, and has the following key characteristics:

- Pin count is 15 pins (6 pins for data transmission, 7 pins for data reception, and 2 pins for carrier and collision indication).
- 10Mbps and 100Mbps data rates are supported at both half- and full-duplex.
- Data transmission and reception are independent and belong to separate signal groups.
- Transmit data and receive data are each 4 bits wide, a nibble.

By default, the KSZ8081MNX is configured to MII mode after it is powered up or hardware reset with the following:

- A 25MHz crystal connected to XI, XO (pins 9, 8), or an external 25MHz clock source (oscillator) connected to XI.
- The CONFIG[2:0] strapping pins (pins 18, 29, 28) set to 000 (default setting).

MII Signal Definition

[Table 1](#) describes the MII signals. Refer to Clause 22 of the IEEE 802.3 Specification for detailed information.

Table 1. MII Signal Definition

| MII Signal Name | Direction (with respect to PHY, KSZ8081MNX signal) | Direction (with respect to MAC) | Description |
|-----------------|--|------------------------------------|--|
| TXC | Output | Input | Transmit Clock (2.5MHz for 10Mbps; 25MHz for 100Mbps) |
| TXEN | Input | Output | Transmit Enable |
| TXD[3:0] | Input | Output | Transmit Data[3:0] |
| RXC | Output | Input | Receive Clock (2.5MHz for 10Mbps; 25MHz for 100Mbps) |
| RXDV | Output | Input | Receive Data Valid |
| RXD[3:0] | Output | Input | Receive Data[3:0] |
| RXER | Output | Input, or (not required) | Receive Error |
| CRS | Output | Input | Carrier Sense |
| COL | Output | Input | Collision Detection |

Transmit Clock (TXC)

TXC is sourced by the PHY. It is a continuous clock that provides the timing reference for TXEN and TXD[3:0]. TXC is 2.5MHz for 10Mbps operation and 25MHz for 100Mbps operation.

Transmit Enable (TXEN)

TXEN indicates that the MAC is presenting nibbles on TXD[3:0] for transmission. It is asserted synchronously with the first nibble of the preamble and remains asserted while all nibbles to be transmitted are presented on the MII. It is negated before the first TXC following the final nibble of a frame.

TXEN transitions synchronously with respect to TXC.

Transmit Data[3:0] (TXD[3:0])

TXD[3:0] transitions synchronously with respect to TXC. When TXEN is asserted, TXD[3:0] are accepted by the PHY for transmission. TXD[3:0] is 00 to indicate idle when TXEN is de-asserted. Values other than 00 on TXD[3:0] while TXEN is de-asserted are ignored by the PHY.

Receive Clock (RXC)

RXC provides the timing reference for RXDV, RXD[3:0], and RXER.

- In 10Mbps mode, RXC is recovered from the line while the carrier is active. RXC is derived from the PHY's reference clock when the line is idle or the link is down.
- In 100Mbps mode, RXC is continuously recovered from the line. If the link is down, RXC is derived from the PHY's reference clock.

RXC is 2.5MHz for 10Mbps operation and 25MHz for 100Mbps operation.

Receive Data Valid (RXDV)

RXDV is driven by the PHY to indicate that the PHY is presenting recovered and decoded nibbles on RXD[3:0].

- In 10Mbps mode, RXDV is asserted with the first nibble of the start-of-frame delimiter (SFD), 5D, and remains asserted until the end of the frame.
- In 100Mbps mode, RXDV is asserted from the first nibble of the preamble to the last nibble of the frame.

RXDV transitions synchronously with respect to RXC.

Receive Data[3:0] (RXD[3:0])

RXD[3:0] transitions synchronously with respect to RXC. For each clock period in which RXDV is asserted, RXD[3:0] transfers a nibble of recovered data from the PHY.

Receive Error (RXER)

RXER is asserted for one or more RXC periods to indicate that a symbol error (for example, a coding error that a PHY can detect that may otherwise be undetectable by the MAC sub-layer) was detected somewhere in the frame being transferred from the PHY.

RXER transitions synchronously with respect to RXC. While RXDV is de-asserted, RXER has no effect on the MAC.

Carrier Sense (CRS)

CRS is asserted and de-asserted as follows:

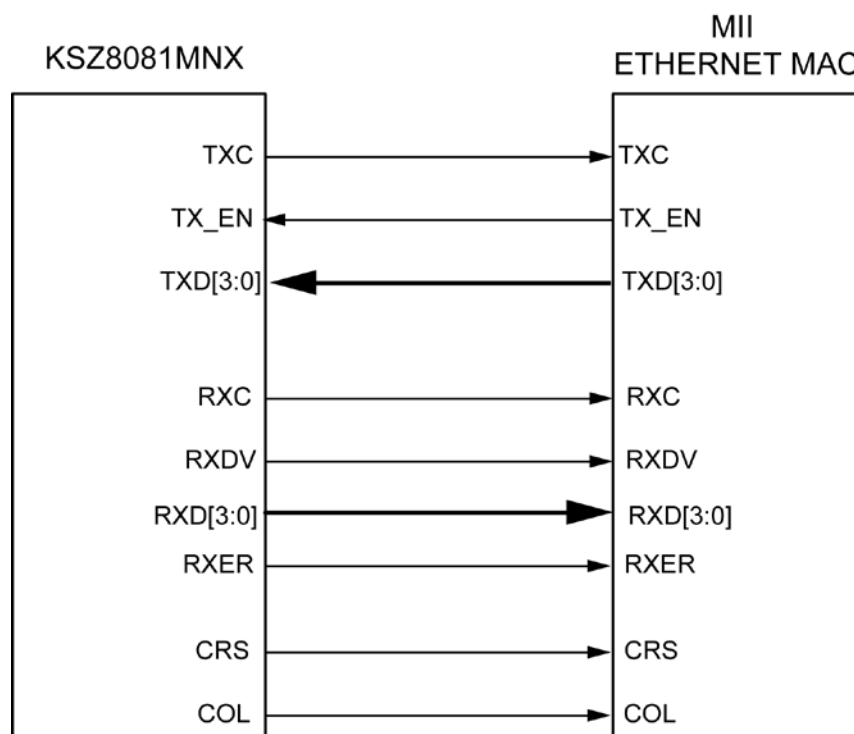
- In 10Mbps mode, CRS assertion is based on the reception of valid preambles. CRS de-assertion is based on the reception of an end-of-frame (EOF) marker.
- In 100Mbps mode, CRS is asserted when a start-of-stream delimiter or /J/K symbol pair is detected. CRS is de-asserted when an end-of-stream delimiter or /T/R symbol pair is detected. Additionally, the PMA layer de-asserts CRS if IDLE symbols are received without /T/R.

Collision (COL)

COL is asserted in half-duplex mode whenever the transmitter and receiver are simultaneously active on the line. This informs the MAC that a collision has occurred during its transmission to the PHY. COL transitions asynchronously with respect to TXC and RXC.

MII Signal Diagram

The KSZ8081MNX MII pin connections to the MAC are shown in [Figure 2](#).

**Figure 2. KSZ8081MNX MII Interface**

RMII Data Interface (KSZ8081RNB Only)

The Reduced Media Independent Interface (RMII) specifies a low pin count Media Independent Interface (MII). It provides a common interface between physical layer and MAC layer devices, and has the following key characteristics:

- Pin count is 8 pins (3 pins for data transmission, 4 pins for data reception, and 1 pin for the 50MHz reference clock).
- 10Mbps and 100Mbps data rates are supported at both half- and full-duplex.
- Data transmission and reception are independent and belong to separate signal groups.
- Transmit data and receive data are each 2 bits wide, a dibit.

RMII – 25MHz Clock Mode

The KSZ8081RNB is configured to RMII – 25MHz clock mode after it is powered up or hardware reset with the following:

- A 25MHz crystal connected to XI, XO (pins 9, 8), or an external 25MHz clock source (oscillator) connected to XI.
- The CONFIG[2:0] strapping pins (pins 18, 29, 28) set to 001.
- Register 1Fh, Bit [7] is set to 0 (default value) to select 25MHz clock mode.

RMII – 50MHz Clock Mode

The KSZ8081RNB is configured to RMII – 50MHz clock mode after it is powered up or hardware reset with the following:

- An external 50MHz clock source (oscillator) connected to XI (Pin 9).
- The CONFIG[2:0] strapping pins (pins 18, 29, 28) set to 001.
- Register 1Fh, Bit [7] is set to 1 to select 50MHz clock mode.

RMII Signal Definition

[Table 2](#) describes the RMII signals. Refer to RMII Specification v1.2 for detailed information.

Table 2. RMII Signal Definition

| RMII Signal Name | Direction (with respect to PHY, KSZ8081RNB signal) | Direction (with respect to MAC) | Description |
|------------------|--|------------------------------------|---|
| REF_CLK | Output (25MHz clock mode) / <no connect> (50MHz clock mode) | Input/ Input or <no connect> | Synchronous 50MHz reference clock for receive, transmit, and control interface |
| TXEN | Input | Output | Transmit Enable |
| TXD[1:0] | Input | Output | Transmit Data[1:0] |
| CRS_DV | Output | Input | Carrier Sense/Receive Data Valid |
| RXD[1:0] | Output | Input | Receive Data[1:0] |
| RXER | Output | Input, or (not required) | Receive Error |

Reference Clock (REF_CLK)

REF_CLK is a continuous 50MHz clock that provides the timing reference for TXEN, TXD[1:0], CRS_DV, RXD[1:0], and RX_ER.

For 25MHz clock mode, the KSZ8081RNB generates and outputs the 50MHz RMII REF_CLK to the MAC at REF_CLK (Pin 19).

For 50MHz clock mode, the KSZ8081RNB takes in the 50MHz RMII REF_CLK from the MAC or system board at XI (Pin 9) and leaves the REF_CLK (Pin 19) as a no connect.

Transmit Enable (TXEN)

TXEN indicates that the MAC is presenting dibits on TXD[1:0] for transmission. It is asserted synchronously with the first dibit of the preamble and remains asserted while all dibits to be transmitted are presented on the RMII. It is negated before the first REF_CLK following the final dibit of a frame.

TXEN transitions synchronously with respect to REF_CLK.

Transmit Data[1:0] (TXD[1:0])

TXD[1:0] transitions synchronously with respect to REF_CLK. When TXEN is asserted, the PHY accepts TXD[1:0] for transmission.

TXD[1:0] is 00 to indicate idle when TXEN is de-asserted. The PHY ignores values other than 00 on TXD[1:0] while TXEN is de-asserted.

Carrier Sense/Receive Data Valid (CRS_DV)

The PHY asserts CRS_DV when the receive medium is non-idle. It is asserted asynchronously when a carrier is detected. This happens when squelch is passed in 10Mbps mode, and when two non-contiguous 0s in 10 bits are detected in 100Mbps mode. Loss of carrier results in the de-assertion of CRS_DV.

While carrier detection criteria are met, CRS_DV remains asserted continuously from the first recovered dibit of the frame through the final recovered dibit. It is negated before the first REF_CLK that follows the final dibit. The data on RXD[1:0] is considered valid after CRS_DV is asserted. However, because the assertion of CRS_DV is asynchronous relative to REF_CLK, the data on RXD[1:0] is 00 until receive signals are properly decoded.

Receive Data[1:0] (RXD[1:0])

RXD[1:0] transitions synchronously with respect to REF_CLK. For each clock period in which CRS_DV is asserted, RXD[1:0] transfers two bits of recovered data from the PHY.

RXD[1:0] is 00 to indicate idle when CRS_DV is de-asserted. The MAC ignores values other than 00 on RXD[1:0] while CRS_DV is de-asserted.

Receive Error (RXER)

RXER is asserted for one or more REF_CLK periods to indicate that a symbol error (for example, a coding error that a PHY can detect that may otherwise be undetectable by the MAC sub-layer) was detected somewhere in the frame being transferred from the PHY.

RXER transitions synchronously with respect to REF_CLK. . While CRS_DV is de-asserted, RXER has no effect on the MAC.

Collision Detection (COL)

The MAC regenerates the COL signal of the MII from TXEN and CRS_DV.

RMII Signal Diagram

The KSZ8081RNB RMII pin connections to the MAC for 25MHz clock mode are shown in [Figure 3](#). The connections for 50MHz clock mode are shown in [Figure 4](#).

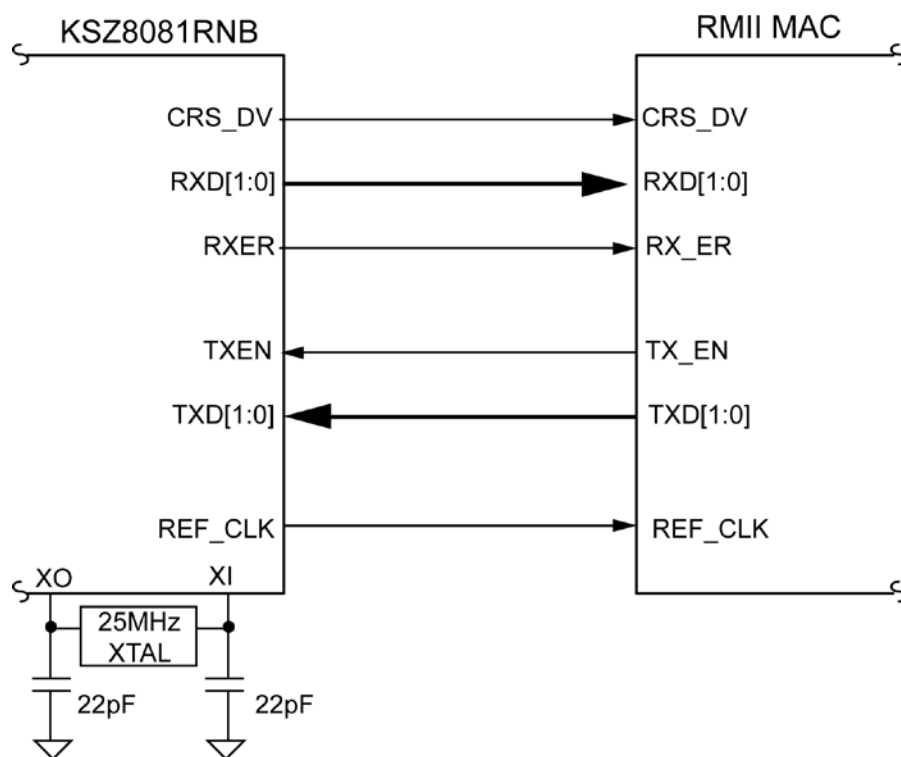


Figure 3. KSZ8081RNB RMII Interface (25MHz Clock Mode)

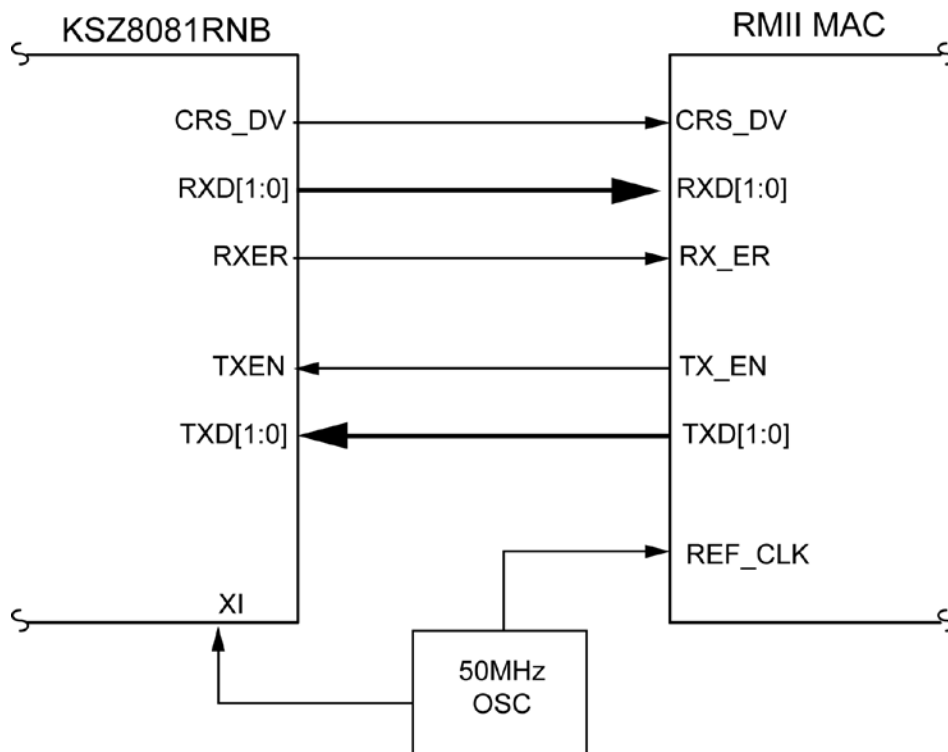


Figure 4. KSZ8081RNB RMII Interface (50MHz Clock Mode)

Back-to-Back Mode – 100Mbps Copper Repeater

Two KSZ8081MNX/RNB devices can be connected back-to-back to form a 100Base-TX copper repeater.

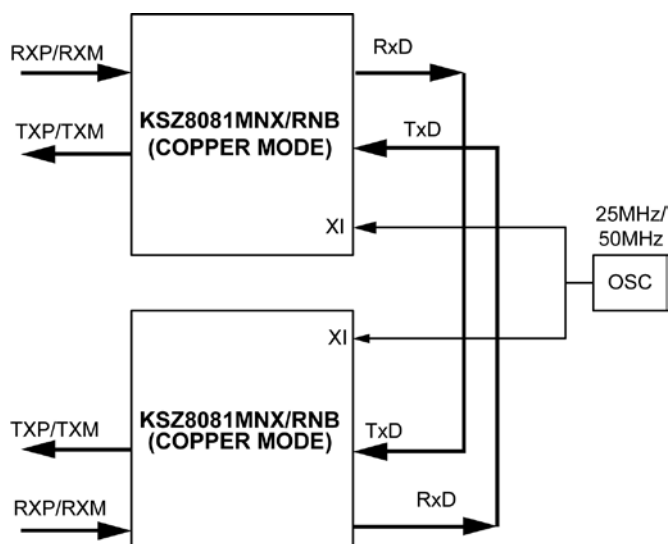


Figure 5. KSZ8081MNX/RNB to KSZ8081MNX/RNB Back-to-Back Copper Repeater

MII Back-to-Back Mode (KSZ8081MNX Only)

In MII back-to-back mode, a KSZ8081MNX interfaces with another KSZ8081MNX to provide a complete 100Mbps copper repeater solution.

The KSZ8081MNX devices are configured to MII back-to-back mode after power-up or reset with the following:

- Strapping pin CONFIG[2:0] (Pins 18, 29, 28) set to 110
- A common 25MHz reference clock connected to XI (Pin 9) of both KSZ8081MNX devices
- MII signals connected as shown in [Table 3](#).

Table 3. MII Signal Connection for MII Back-to-Back Mode (100Base-TX Copper Repeater)

| KSZ8081MNX (100Base-TX copper) [Device 1] | | | KSZ8081MNX (100Base-TX copper) [Device 2] | | |
|--|------------|----------|--|------------|----------|
| Pin Name | Pin Number | Pin Type | Pin Name | Pin Number | Pin Type |
| RXDV | 18 | Output | TXEN | 23 | Input |
| RXD3 | 13 | Output | TXD3 | 27 | Input |
| RXD2 | 14 | Output | TXD2 | 26 | Input |
| RXD1 | 15 | Output | TXD1 | 25 | Input |
| RXD0 | 16 | Output | TXD0 | 24 | Input |
| TXEN | 23 | Input | RXDV | 18 | Output |
| TXD3 | 27 | Input | RXD3 | 13 | Output |
| TXD2 | 26 | Input | RXD2 | 14 | Output |
| TXD1 | 25 | Input | RXD1 | 15 | Output |
| TXD0 | 24 | Input | RXD0 | 16 | Output |

RMII Back-to-Back Mode (KSZ8081RNB Only)

In RMII back-to-back mode, a KSZ8081RNB interfaces with another KSZ8081RNB to provide a complete 100Mbps copper repeater solution.

The KSZ8081RNB devices are configured to RMII back-to-back mode after power-up or reset with the following:

- Strapping pin CONFIG[2:0] (Pins 18, 29, 28) set to 101
- A common 50MHz reference clock connected to XI (Pin 9) of both KSZ8081RNB devices
- RMII signals connected as shown in [Table 4](#).

Table 4. RMII Signal Connection for RMII Back-to-Back Mode (100Base-TX Copper Repeater)

| KSZ8081RNB (100Base-TX copper) [Device 1] | | | KSZ8081RNB (100Base-TX copper) [Device 2] | | |
|--|------------|----------|--|------------|----------|
| Pin Name | Pin Number | Pin Type | Pin Name | Pin Number | Pin Type |
| CRSDV | 18 | Output | TXEN | 23 | Input |
| RXD1 | 15 | Output | TXD1 | 25 | Input |
| RXD0 | 16 | Output | TXD0 | 24 | Input |
| TXEN | 23 | Input | CRSDV | 18 | Output |
| TXD1 | 25 | Input | RXD1 | 15 | Output |
| TXD0 | 24 | Input | RXD0 | 16 | Output |

MII Management (MIIM) Interface

The KSZ8081MNX/RNB supports the IEEE 802.3 MII management interface, also known as the Management Data Input/Output (MDIO) interface. This interface allows an upper-layer device, such as a MAC processor, to monitor and control the state of the KSZ8081MNX/RNB. An external device with MIIM capability is used to read the PHY status and/or configure the PHY settings. More details about the MIIM interface can be found in Clause 22.2.4 of the IEEE 802.3 Specification.

The MIIM interface consists of the following:

- A physical connection that incorporates the clock line (MDC) and the data line (MDIO).
- A specific protocol that operates across the physical connection mentioned earlier, which allows the external controller to communicate with one or more PHY devices.
- A set of 16-bit MDIO registers. Registers [0:8] are standard registers, and their functions are defined in the IEEE 802.3 Specification. The additional registers are provided for expanded functionality. See the “[Register Map](#)” section for details.

As the default, the KSZ8081MNX/RNB supports unique PHY addresses 1 to 7, and broadcast PHY address 0. The latter is defined in the IEEE 802.3 Specification, and can be used to read/write to a single KSZ8081MNX/RNB device, or write to multiple KSZ8081MNX/RNB devices simultaneously.

PHY address 0 can optionally be disabled as the broadcast address by either hardware pin strapping (B-CAST_OFF, Pin 19) or software (Register 16h, Bit [9]), and assigned as a unique PHY address.

The PHYAD[2:0] strapping pins are used to assign a unique PHY address between 0 and 7 to each KSZ8081MNX/RNB device.

The MIIM interface can operate up to a maximum clock speed of 10MHz MAC clock.

[Table 5](#) shows the MII management frame format for the KSZ8081MNX/RNB.

Table 5. MII Management Frame Format for the KSZ8081MNX/RNB

| | Preamble | Start of Frame | Read/Write OP Code | PHY Address Bits [4:0] | REG Address Bits [4:0] | TA | Data Bits [15:0] | Idle |
|--------------|----------|----------------|--------------------|------------------------|------------------------|----|-------------------|------|
| Read | 32 1's | 01 | 10 | 00AAA | RRRRR | Z0 | DDDDDDDD_DDDDDDDD | Z |
| Write | 32 1's | 01 | 01 | 00AAA | RRRRR | 10 | DDDDDDDD_DDDDDDDD | Z |

Interrupt (INTRP)

INTRP (Pin 21) is an optional interrupt signal that is used to inform the external controller that there has been a status update to the KSZ8081MNX/RNB PHY register. Bits [15:8] of Register 1Bh are the interrupt control bits to enable and disable the conditions for asserting the INTRP signal. Bits [7:0] of Register 1Bh are the interrupt status bits to indicate which interrupt conditions have occurred. The interrupt status bits are cleared after reading Register 1Bh.

Bit [9] of Register 1Fh sets the interrupt level to active high or active low. The default is active low.

The MII management bus option gives the MAC processor complete access to the KSZ8081MNX/RNB control and status registers. Additionally, an interrupt pin eliminates the need for the processor to poll the PHY for status change.

HP Auto MDI/MDI-X

HP Auto MDI/MDI-X configuration eliminates the need to decide whether to use a straight cable or a crossover cable between the KSZ8081MNX/RNB and its link partner. This feature allows the KSZ8081MNX/RNB to use either type of cable to connect with a link partner that is in either MDI or MDI-X mode. The auto-sense function detects transmit and receive pairs from the link partner and assigns transmit and receive pairs to the KSZ8081MNX/RNB accordingly.

HP Auto MDI/MDI-X is enabled by default. It is disabled by writing a '1' to Register 1Fh, Bit [13]. MDI and MDI-X mode is selected by Register 1Fh, Bit [14] if HP Auto MDI/MDI-X is disabled.

An isolation transformer with symmetrical transmit and receive data paths is recommended to support Auto MDI/MDI-X.

[Table 6](#) shows how the IEEE 802.3 Standard defines MDI and MDI-X.

Table 6. MDI/MDI-X Pin Definition

| MDI | | MDI-X | |
|-----------|--------|-----------|--------|
| RJ-45 Pin | Signal | RJ-45 Pin | Signal |
| 1 | TX+ | 1 | RX+ |
| 2 | TX- | 2 | RX- |
| 3 | RX+ | 3 | TX+ |
| 6 | RX- | 6 | TX- |

Straight Cable

A straight cable connects an MDI device to an MDI-X device, or an MDI-X device to an MDI device. [Figure 6](#) shows a typical straight cable connection between a NIC card (MDI device) and a switch or hub (MDI-X device).

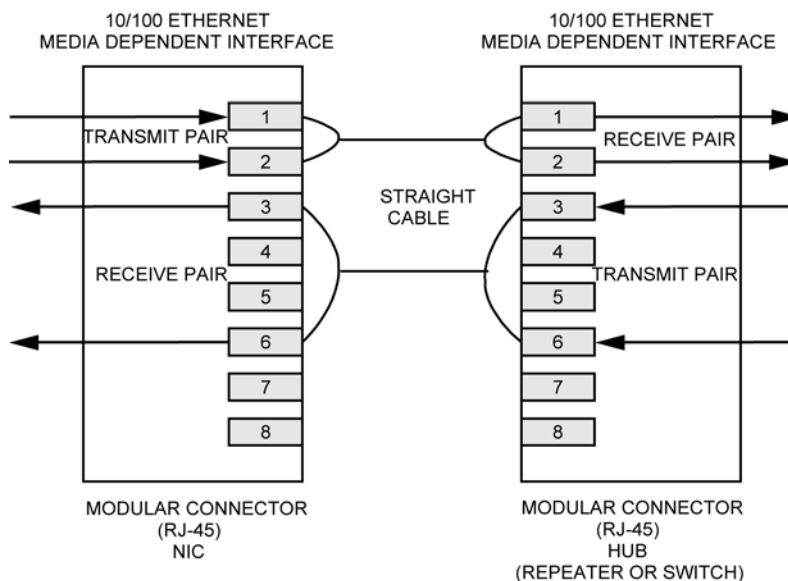


Figure 6. Typical Straight Cable Connection

Crossover Cable

A crossover cable connects an MDI device to another MDI device, or an MDI-X device to another MDI-X device. [Figure 7](#) shows a typical crossover cable connection between two switches or hubs (two MDI-X devices).

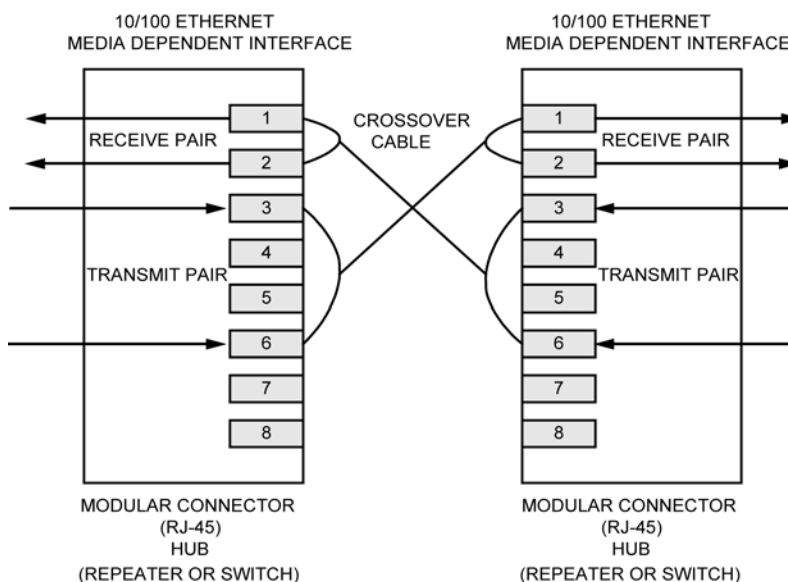


Figure 7. Typical Crossover Cable Connection

Loopback Mode

The KSZ8081MNX/RNB supports the following loopback operations to verify analog and/or digital data paths.

- Local (digital) loopback
- Remote (analog) loopback

Local (Digital) Loopback

This loopback mode checks the MII/RMII transmit and receive data paths between the KSZ8081MNX/RNB and the external MAC, and is supported for both speeds (10/100Mbps) at full-duplex.

The loopback data path is shown in [Figure 8](#).

1. The MII/RMII MAC transmits frames to the KSZ8081MNX/RNB.
2. Frames are wrapped around inside the KSZ8081MNX/RNB.
3. The KSZ8081MNX/RNB transmits frames back to the MII/RMII MAC.
4. Except the frames back to the RMII MAC, the transmit frames also go out from the copper port.

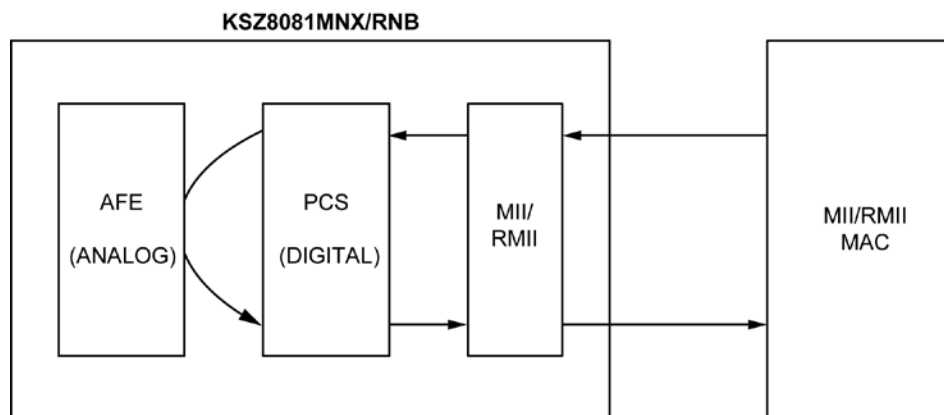


Figure 8. Local (Digital) Loopback

The following programming action and register settings are used for local loopback mode.

For 10/100Mbps loopback,

- Set Register 0h,
 - Bit [14] = 1 // Enable local loopback mode
 - Bit [13] = 0/1 // Select 10Mbps/100Mbps speed
 - Bit [12] = 0 // Disable auto-negotiation
 - Bit [8] = 1 // Select full-duplex mode

If don't want the frames go out from the copper port in the local loopback, please follow the steps as below.

1. Set register 1Fh bit [3] to '1' to disable the transmitter.
2. Run local loopback test as above.
3. Set register 1Fh bit [3] to '0' to enable the transmitter.

Remote (Analog) Loopback

This loopback mode checks the line (differential pairs, transformer, RJ-45 connector, Ethernet cable) transmit and receive data paths between the KSZ8081MNX/RNB and its link partner, and is supported for 100Base-TX full-duplex mode only.

The loopback data path is shown in [Figure 9](#).

1. The Fast Ethernet (100Base-TX) PHY link partner transmits frames to the KSZ8081MNX/RNB.
2. Frames are wrapped around inside the KSZ8081MNX/RNB.
3. The KSZ8081MNX/RNB transmits frames back to the Fast Ethernet (100Base-TX) PHY link partner.

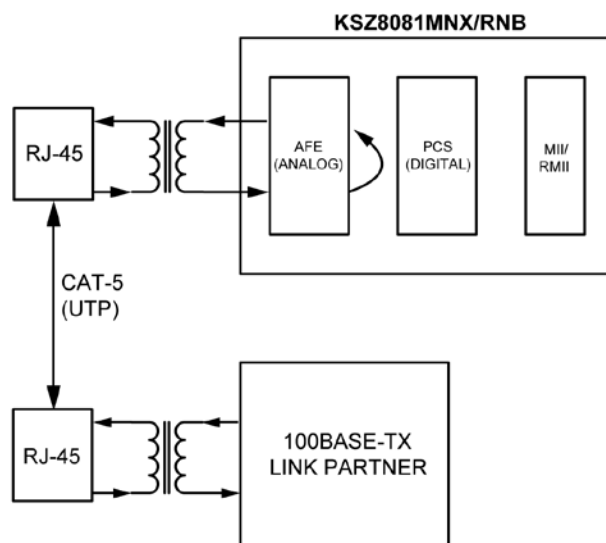


Figure 9. Remote (Analog) Loopback

The following programming steps and register settings are used for remote loopback mode.

1. Set Register 0h,
 Bits [13] = 1 // Select 100Mbps speed
 Bit [12] = 0 // Disable auto-negotiation
 Bit [8] = 1 // Select full-duplex mode
 or just auto-negotiate and link up at 100Base-TX full-duplex mode with the link partner.
2. Set Register 1Fh,
 Bit [2] = 1 // Enable remote loopback mode

LinkMD® Cable Diagnostic

The LinkMD function uses time-domain reflectometry (TDR) to analyze the cabling plant for common cabling problems. These include open circuits, short circuits, and impedance mismatches.

LinkMD works by sending a pulse of known amplitude and duration down the MDI or MDI-X pair, then analyzing the shape of the reflected signal to determine the type of fault. The time duration for the reflected signal to return provides the approximate distance to the cabling fault. The LinkMD function processes this TDR information and presents it as a numerical value that can be translated to a cable distance.

LinkMD is initiated by accessing Register 1Dh, the LinkMD Control/Status register, in conjunction with Register 1Fh, the PHY Control 2 register. The latter register is used to disable Auto MDI/MDI-X and to select either MDI or MDI-X as the cable differential pair for testing.

Usage

The following is a sample procedure for using LinkMD with Registers 1Dh and 1Fh:

3. Disable auto MDI/MDI-X by writing a '1' to Register 1Fh, bit [13].
4. Start cable diagnostic test by writing a '1' to Register 1Dh, bit [15]. This enable bit is self-clearing.
5. Wait (poll) for Register 1Dh, bit [15] to return a '0', and indicating cable diagnostic test is completed.
6. Read cable diagnostic test results in Register 1Dh, bits [14:13]. The results are as follows:
 - 00 = normal condition (valid test)
 - 01 = open condition detected in cable (valid test)
 - 10 = short condition detected in cable (valid test)
 - 11 = cable diagnostic test failed (invalid test)

The '11' case, invalid test, occurs when the device is unable to shut down the link partner. In this instance, the test is not run, since it would be impossible for the device to determine if the detected signal is a reflection of the signal generated or a signal from another source.

7. Get distance to fault by concatenating Register 1Dh, bits [8:0] and multiplying the result by a constant of 0.38. The distance to the cable fault can be determined by the following formula:

$$D \text{ (distance to cable fault)} = 0.38 \times (\text{Register 1Dh, bits [8:0]})$$

D (distance to cable fault) is expressed in meters.

Concatenated value of Registers 1Dh bits [8:0] should be converted to decimal before multiplying by 0.38.

The constant (0.38) may be calibrated for different cabling conditions, including cables with a velocity of propagation that varies significantly from the norm.

NAND Tree Support

The KSZ8081MNX/RNB provides parametric NAND tree support for fault detection between chip I/Os and board. The NAND tree is a chain of nested NAND gates in which each KSZ8081MNX/RNB digital I/O (NAND tree input) pin is an input to one NAND gate along the chain. At the end of the chain, the TXD1 pin provides the output for the nested NAND gates.

The NAND tree test process includes:

- Enabling NAND tree mode
- Pulling all NAND tree input pins high
- Driving each NAND tree input pin low, sequentially, according to the NAND tree pin order
- Checking the NAND tree output to make sure there is a toggle high-to-low or low-to-high for each NAND tree input driven low

[Table 7](#) and [Table 8](#) list the NAND tree pin orders for KSZ8081MNX and KSZ8081RNB, respectively.

Table 7. NAND Tree Test Pin Order for KSZ8081MNX

| Pin Number | Pin Name | NAND Tree Description |
|------------|----------|-----------------------|
| 11 | MDIO | Input |
| 12 | MDC | Input |
| 15 | RXD1 | Input |
| 16 | RXD0 | Input |
| 18 | CRS_DV | Input |
| 19 | REF_CLK | Input |
| 21 | INTRP | Input |
| 23 | TXEN | Input |
| 30 | LED0 | Input |
| 24 | TXD0 | Input |
| 25 | TXD1 | Output |

Note: KS8081MNX supports partial NAND tree test pins. [Table 7](#) lists partial NAND tree test pins. If full NAND tree testing is required, please use KSZ8091MNX device that supports all the required pins.

Table 8. NAND Tree Test Pin Order for KSZ8081RNB

| Pin Number | Pin Name | NAND Tree Description |
|------------|----------|-----------------------|
| 11 | MDIO | Input |
| 12 | MDC | Input |
| 15 | RXD1 | Input |
| 16 | RXD0 | Input |
| 18 | CRS_DV | Input |
| 19 | REF_CLK | Input |
| 21 | INTRP | Input |
| 23 | TXEN | Input |
| 31 | LED1 | Input |
| 30 | LED0 | Input |
| 24 | TXD0 | Input |
| 25 | TXD1 | Output |

NAND Tree I/O Testing

Use the following procedure to check for faults on the KSZ8081MNX/RNB digital I/O pin connections to the board:

1. Enable NAND tree mode using either hardware (NAND_Tree#, Pin 21) or software (Register 16h, Bit [5]).
2. Use board logic to drive all KSZ8081MNX/RNB NAND tree input pins high.
3. Use board logic to drive each NAND tree input pin, in KSZ8081MNX/RNB NAND tree pin order, as follows:
 - a. Toggle the first pin (MDIO) from high to low, and verify that the TXD1 pin switches from high to low to indicate that the first pin is connected properly.
 - b. Leave the first pin (MDIO) low.
 - c. Toggle the second pin (MDC) from high to low, and verify that the TXD1 pin switches from low to high to indicate that the second pin is connected properly.
 - d. Leave the first pin (MDIO) and the second pin (MDC) low.
 - e. Continue with this sequence until all KSZ8081MNX/RNB NAND tree input pins have been toggled.

Each KSZ8081MNX/RNB NAND tree input pin must cause the TXD1 output pin to toggle high-to-low or low-to-high to indicate a good connection. If the TXD1 pin fails to toggle when the KSZ8081MNX/RNB input pin toggles from high to low, the input pin has a fault.

Power Management

The KSZ8081MNX/RNB incorporates a number of power-management modes and features that provide methods to consume less energy. These are discussed in the following sections.

Power-Saving Mode

Power-saving mode is used to reduce the transceiver power consumption when the cable is unplugged. It is enabled by writing a '1' to Register 1Fh, Bit [10], and is in effect when auto-negotiation mode is enabled and the cable is disconnected (no link).

In this mode, the KSZ8081MNX/RNB shuts down all transceiver blocks, except for the transmitter, energy detect, and PLL circuits.

By default, power-saving mode is disabled after power-up.

Energy-Detect Power-Down Mode

Energy-detect power-down (EDPD) mode is used to further reduce transceiver power consumption when the cable is unplugged. It is enabled by writing a '0' to Register 18h, Bit [11], and is in effect when auto-negotiation mode is enabled and the cable is disconnected (no link).

EDPD mode works with the PLL off (set by writing a '1' to Register 10h, Bit [4] to automatically turn the PLL off in EDPD mode) to turn off all KSZ8081MNX/RNB transceiver blocks except the transmitter and energy-detect circuits.

Power can be reduced further by extending the time interval between transmissions of link pulses to check for the presence of a link partner. The periodic transmission of link pulses is needed to ensure the KSZ8081MNX/RNB and its link partner, when operating in the same low-power state and with Auto MDI/MDI-X disabled, can wake up when the cable is connected between them.

By default, energy-detect power-down mode is disabled after power-up.

Power-Down Mode

Power-down mode is used to power down the KSZ8081MNX/RNB device when it is not in use after power-up. It is enabled by writing a '1' to Register 0h, Bit [11].

In this mode, the KSZ8081MNX/RNB disables all internal functions except the MII management interface. The KSZ8081MNX/RNB exits (disables) power-down mode after Register 0h, Bit [11] is set back to '0'.

Slow-Oscillator Mode

Slow-oscillator mode is used to disconnect the input reference crystal/clock on XI (Pin 8) and select the on-chip slow oscillator when the KSZ8081MNX/RNB device is not in use after power-up. It is enabled by writing a '1' to Register 11h, Bit [5].

Slow-oscillator mode works in conjunction with power-down mode to put the KSZ8081MNX/RNB device in the lowest power state, with all internal functions disabled except the MII management interface. To properly exit this mode and return to normal PHY operation, use the following programming sequence:

1. Disable slow-oscillator mode by writing a '0' to Register 11h, Bit [5].
2. Disable power-down mode by writing a '0' to Register 0h, Bit [11].
3. Initiate software reset by writing a '1' to Register 0h, Bit [15].

Reference Circuit for Power and Ground Connections

The KSZ8081MNX/RNB is a single 3.3V supply device with a built-in regulator to supply the 1.2V core. The power and ground connections are shown in Figure 10 and Table 9 for 3.3V VDDIO.

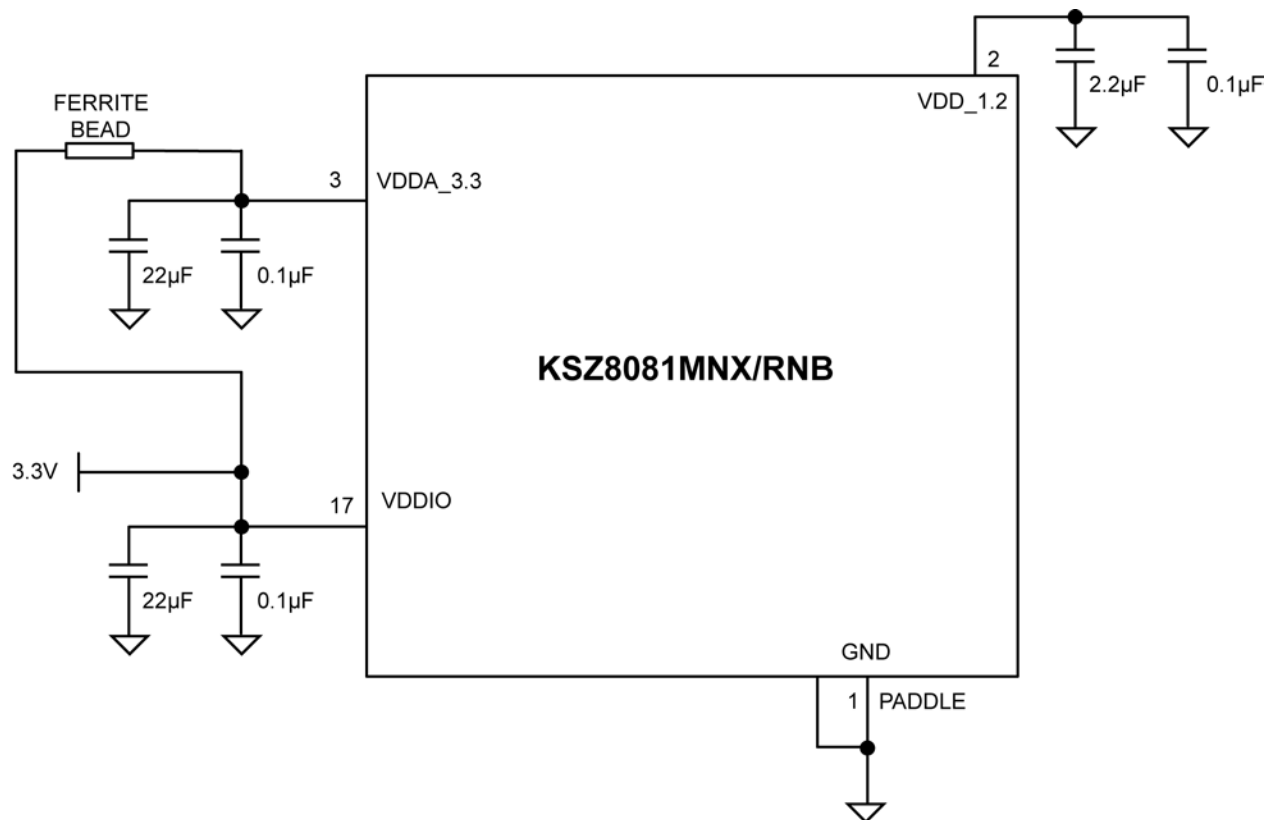


Figure 10. KSZ8081MNX/RNB Power and Ground Connections

Table 9. KSZ8081MNX/RNB Power Pin Descriptions

| Power Pin | Pin Number | Description |
|-----------|------------|--|
| VDD_1.2 | 2 | Decouple with 2.2µF and 0.1µF capacitors to ground. |
| VDDA_3.3 | 3 | Connect to board's 3.3V supply through a ferrite bead. Decouple with 22µF and 0.1µF capacitors to ground. |
| VDDIO | 17 | Connect to board's 3.3V supply for 3.3V VDDIO. Decouple with 22µF and 0.1µF capacitors to ground. |

Typical Current/Power Consumption

Table 10, Table 11, and Table 12 show typical values for current consumption by the transceiver (VDDA_3.3) and digital I/O (VDDIO) power pins and typical values for power consumption by the KSZ8081MNX/RNB device for the indicated nominal operating voltages. These current and power consumption values include the transmit driver current and on-chip regulator current for the 1.2V core.

Transceiver (3.3V), Digital I/Os (3.3V)

Table 10. Typical Current/Power Consumption (VDDA_3.3 = 3.3V, VDDIO = 3.3V)

| Condition | 3.3V Transceiver (VDDA_3.3) | 3.3V Digital I/Os (VDDIO) | Total Chip Power |
|---|--------------------------------|------------------------------|------------------|
| | mA | mA | mW |
| 100Base-TX Link-up (no traffic) | 34 | 12 | 152 |
| 100Base-TX Full-duplex @ 100% utilization | 34 | 13 | 155 |
| 10Base-T Link-up (no traffic) | 14 | 11 | 82.5 |
| 10Base-T Full-duplex @ 100% utilization | 30 | 11 | 135 |
| Power-saving mode (Reg. 1Fh, Bit [10] = 1) | 14 | 10 | 79.2 |
| EDPD mode (Reg. 18h, Bit [11] = 0) | 10 | 10 | 66.0 |
| EDPD mode (Reg. 18h, Bit [11] = 0) and PLL off (Reg. 10h, Bit [4] = 1) | 3.77 | 1.54 | 17.5 |
| Software power-down mode (Reg. 0h, Bit [11] = 1) | 2.59 | 1.51 | 13.5 |
| Software power-down mode (Reg. 0h, Bit [11] = 1) and slow-oscillator mode (Reg. 11h, Bit [5] = 1) | 1.36 | 0.45 | 5.97 |

Transceiver (3.3V), Digital I/Os (2.5V)

Table 11. Typical Current/Power Consumption (VDDA_3.3 = 3.3V, VDDIO = 2.5V)

| Condition | 3.3V Transceiver (VDDA_3.3) | 2.5V Digital I/Os (VDDIO) | Total Chip Power |
|---|--------------------------------|------------------------------|------------------|
| | mA | mA | mW |
| 100Base-TX Link-up (no traffic) | 34 | 11 | 140 |
| 100Base-TX Full-duplex @ 100% utilization | 34 | 12 | 142 |
| 10Base-T Link-up (no traffic) | 15 | 10 | 74.5 |
| 10Base-T Full-duplex @ 100% utilization | 27 | 10 | 114 |
| Power-saving mode (Reg. 1Fh, Bit [10] = 1) | 15 | 10 | 74.5 |
| EDPD mode (Reg. 18h, Bit [11] = 0) | 11 | 10 | 61.3 |
| EDPD mode (Reg. 18h, Bit [11] = 0) and PLL off (Reg. 10h, Bit [4] = 1) | 3.55 | 1.35 | 15.1 |
| Software power-down mode (Reg. 0h, Bit [11] = 1) | 2.29 | 1.34 | 10.9 |
| Software power-down mode (Reg. 0h, Bit [11] = 1) and slow-oscillator mode (Reg. 11h, Bit [5] = 1) | 1.15 | 0.29 | 4.52 |

Transceiver (3.3V), Digital I/Os (1.8V)**Table 12. Typical Current/Power Consumption (VDDA_3.3 = 3.3V, VDDIO = 1.8V)**

| Condition | 3.3V Transceiver (VDDA_3.3) | 1.8V Digital I/Os (VDDIO) | Total Chip Power |
|--|--------------------------------|------------------------------|------------------|
| | mA | mA | mW |
| 100Base-TX Link-up (no traffic) | 34 | 11 | 132 |
| 100Base-TX Full-duplex @ 100% utilization | 34 | 12 | 134 |
| 10Base-T Link-up (no traffic) | 15 | 9.0 | 65.7 |
| 10Base-T Full-duplex @ 100% utilization | 27 | 9.0 | 105 |
| Power-saving mode (Reg. 1Fh, Bit [10] = 1) | 15 | 9.0 | 65.7 |
| EDPD mode (Reg. 18h, Bit [11] = 0) | 11 | 9.0 | 52.5 |
| EDPD mode (Reg. 18h, Bit [11] = 0) and PLL off (Reg. 10h, Bit [4] = 1) | 4.05 | 1.21 | 15.5 |
| Software power-down mode (Reg. 0h, Bit [11] = 1) | 2.79 | 1.21 | 11.4 |
| Software power-down mode (Reg. 0h, Bit [11] = 1) and slow-oscillator mode (Reg. 11h, Bit [5] = 1) | 1.65 | 0.19 | 5.79 |

Register Map

| Register Number (Hex) | Description |
|-----------------------|---------------------------------------|
| 0h | Basic Control |
| 1h | Basic Status |
| 2h | PHY Identifier 1 |
| 3h | PHY Identifier 2 |
| 4h | Auto-Negotiation Advertisement |
| 5h | Auto-Negotiation Link Partner Ability |
| 6h | Auto-Negotiation Expansion |
| 7h | Auto-Negotiation Next Page |
| 8h | Link Partner Next Page Ability |
| 9h | Reserved |
| 10h | Digital Reserved Control |
| 11h | AFE Control 1 |
| 12h – 14h | Reserved |
| 15h | RXER Counter |
| 16h | Operation Mode Strap Override |
| 17h | Operation Mode Strap Status |
| 18h | Expanded Control |
| 19h – 1Ah | Reserved |
| 1Bh | Interrupt Control/Status |
| 1Ch | Reserved |
| 1Dh | LinkMD Control/Status |
| 1Eh | PHY Control 1 |
| 1Fh | PHY Control 2 |

Register Description

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|------------------------------------|--------------------------|---|----------------------|---|
| Register 0h – Basic Control | | | | |
| 0.15 | Reset | 1 = Software reset 0 = Normal operation This bit is self-cleared after a '1' is written to it. | RW/SC | 0 |
| 0.14 | Loopback | 1 = Loopback mode 0 = Normal operation | RW | 0 |
| 0.13 | Speed Select | 1 = 100Mbps 0 = 10Mbps This bit is ignored if auto-negotiation is enabled (Register 0.12 = 1). | RW | Set by the SPEED strapping pin. See the Strapping Options – KSZ8081MNX section for details. |
| 0.12 | Auto-Negotiation Enable | 1 = Enable auto-negotiation process 0 = Disable auto-negotiation process If enabled, the auto-negotiation result overrides the settings in registers 0.13 and 0.8. | RW | Set by the NWAYEN strapping pin. See the Strapping Options – KSZ8081MNX section for details. |
| 0.11 | Power-Down | 1 = Power-down mode 0 = Normal operation If software reset (Register 0.15) is used to exit power-down mode (Register 0.11 = 1), two software reset writes (Register 0.15 = 1) are required. The first write clears power-down mode; the second write resets the chip and re-latches the pin strapping pin values. | RW | 0 |
| 0.10 | Isolate | 1 = Electrical isolation of PHY from MII/RMII 0 = Normal operation | RW | Set by the ISO strapping pin. See the Strapping Options – KSZ8081MNX section for details. |
| 0.9 | Restart Auto-Negotiation | 1 = Restart auto-negotiation process 0 = Normal operation. This bit is self-cleared after a '1' is written to it. | RW/SC | 0 |
| 0.8 | Duplex Mode | 1 = Full-duplex 0 = Half-duplex | RW | The inverse of the DUPLEX strapping pin value. See the Strapping Options – KSZ8081MNX section for details. |
| 0.7 | Collision Test | 1 = Enable COL test 0 = Disable COL test | RW | 0 |
| 0.6:0 | Reserved | Reserved | RO | 000_0000 |

Note:

10. RW = Read/Write.

RO = Read only.

SC = Self-cleared.

LH = Latch high.

LL = Latch low.

Register Description (Continued)

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|---------------------------------------|---------------------------|---|----------------------|----------------------------|
| Register 1h – Basic Status | | | | |
| 1.15 | 100Base-T4 | 1 = T4 capable 0 = Not T4 capable | RO | 0 |
| 1.14 | 100Base-TX Full-Duplex | 1 = Capable of 100Mbps full-duplex 0 = Not capable of 100Mbps full-duplex | RO | 1 |
| 1.13 | 100Base-TX Half-Duplex | 1 = Capable of 100Mbps half-duplex 0 = Not capable of 100Mbps half-duplex | RO | 1 |
| 1.12 | 10Base-T Full-Duplex | 1 = Capable of 10Mbps full-duplex 0 = Not capable of 10Mbps full-duplex | RO | 1 |
| 1.11 | 10Base-T Half-Duplex | 1 = Capable of 10Mbps half-duplex 0 = Not capable of 10Mbps half-duplex | RO | 1 |
| 1.10:7 | Reserved | Reserved | RO | 000_0 |
| 1.6 | No Preamble | 1 = Preamble suppression 0 = Normal preamble | RO | 1 |
| 1.5 | Auto-Negotiation Complete | 1 = Auto-negotiation process completed 0 = Auto-negotiation process not completed | RO | 0 |
| 1.4 | Remote Fault | 1 = Remote fault 0 = No remote fault | RO/LH | 0 |
| 1.3 | Auto-Negotiation Ability | 1 = Can perform auto-negotiation 0 = Cannot perform auto-negotiation | RO | 1 |
| 1.2 | Link Status | 1 = Link is up 0 = Link is down | RO/LL | 0 |
| 1.1 | Jabber Detect | 1 = Jabber detected 0 = Jabber not detected (default is low) | RO/LH | 0 |
| 1.0 | Extended Capability | 1 = Supports extended capability registers | RO | 1 |
| Register 2h – PHY Identifier 1 | | | | |
| 2.15:0 | PHY ID Number | Assigned to the 3rd through 18th bits of the Organizationally Unique Identifier (OUI). KENDIN Communication's OUI is 0010A1 (hex). | RO | 0022h |
| Register 3h – PHY Identifier 2 | | | | |
| 3.15:10 | PHY ID Number | Assigned to the 19th through 24th bits of the Organizationally Unique Identifier (OUI). KENDIN Communication's OUI is 0010A1 (hex). | RO | 0001_01 |
| 3.9:4 | Model Number | Six-bit manufacturer's model number | RO | 01_0110 |
| 3.3:0 | Revision Number | Four-bit manufacturer's revision number | RO | Indicates silicon revision |

Register Description (Continued)

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|--|------------------------|---|----------------------|--|
| Register 4h – Auto-Negotiation Advertisement | | | | |
| 4.15 | Next Page | 1 = Next page capable 0 = No next page capability | RW | 0 |
| 4.14 | Reserved | Reserved | RO | 0 |
| 4.13 | Remote Fault | 1 = Remote fault supported 0 = No remote fault | RW | 0 |
| 4.12 | Reserved | Reserved | RO | 0 |
| 4.11:10 | Pause | [00] = No pause [10] = Asymmetric pause [01] = Symmetric pause [11] = Asymmetric and symmetric pause | RW | 00 |
| 4.9 | 100Base-T4 | 1 = T4 capable 0 = No T4 capability | RO | 0 |
| 4.8 | 100Base-TX Full-Duplex | 1 = 100Mbps full-duplex capable 0 = No 100Mbps full-duplex capability | RW | Set by the SPEED strapping pin. See the Strapping Options – KSZ8081MNX section for details. |
| 4.7 | 100Base-TX Half-Duplex | 1 = 100Mbps half-duplex capable 0 = No 100Mbps half-duplex capability | RW | Set by the SPEED strapping pin. See the Strapping Options – KSZ8081MNX section for details. |
| 4.6 | 10Base-T Full-Duplex | 1 = 10Mbps full-duplex capable 0 = No 10Mbps full-duplex capability | RW | 1 |
| 4.5 | 10Base-T Half-Duplex | 1 = 10Mbps half-duplex capable 0 = No 10Mbps half-duplex capability | RW | 1 |
| 4.4:0 | Selector Field | [00001] = IEEE 802.3 | RW | 0_0001 |
| Register 5h – Auto-Negotiation Link Partner Ability | | | | |
| 5.15 | Next Page | 1 = Next page capable 0 = No next page capability | RO | 0 |
| 5.14 | Acknowledge | 1 = Link code word received from partner 0 = Link code word not yet received | RO | 0 |
| 5.13 | Remote Fault | 1 = Remote fault detected 0 = No remote fault | RO | 0 |
| 5.12 | Reserved | Reserved | RO | 0 |
| 5.11:10 | Pause | [00] = No pause [10] = Asymmetric pause [01] = Symmetric pause [11] = Asymmetric and symmetric pause | RO | 00 |
| 5.9 | 100Base-T4 | 1 = T4 capable 0 = No T4 capability | RO | 0 |
| 5.8 | 100Base-TX Full-Duplex | 1 = 100Mbps full-duplex capable 0 = No 100Mbps full-duplex capability | RO | 0 |

Register Description (Continued)

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|--|------------------------------------|--|----------------------|---------------|
| Register 5h – Auto-Negotiation Link Partner Ability | | | | |
| 5.7 | 100Base-TX Half-Duplex | 1 = 100Mbps half-duplex capable 0 = No 100Mbps half-duplex capability | RO | 0 |
| 5.6 | 10Base-T Full-Duplex | 1 = 10Mbps full-duplex capable 0 = No 10Mbps full-duplex capability | RO | 0 |
| 5.5 | 10Base-T Half-Duplex | 1 = 10Mbps half-duplex capable 0 = No 10Mbps half-duplex capability | RO | 0 |
| 5.4:0 | Selector Field | [00001] = IEEE 802.3 | RO | 0_0001 |
| Register 6h – Auto-Negotiation Expansion | | | | |
| 6.15:5 | Reserved | Reserved | RO | 0000_0000_000 |
| 6.4 | Parallel Detection Fault | 1 = Fault detected by parallel detection 0 = No fault detected by parallel detection | RO/LH | 0 |
| 6.3 | Link Partner Next Page Able | 1 = Link partner has next page capability 0 = Link partner does not have next page capability | RO | 0 |
| 6.2 | Next Page Able | 1 = Local device has next page capability 0 = Local device does not have next page capability | RO | 1 |
| 6.1 | Page Received | 1 = New page received 0 = New page not received yet | RO/LH | 0 |
| 6.0 | Link Partner Auto-Negotiation Able | 1 = Link partner has auto-negotiation capability 0 = Link partner does not have auto-negotiation capability | RO | 0 |
| Register 7h – Auto-Negotiation Next Page | | | | |
| 7.15 | Next Page | 1 = Additional next pages will follow 0 = Last page | RW | 0 |
| 7.14 | Reserved | Reserved | RO | 0 |
| 7.13 | Message Page | 1 = Message page 0 = Unformatted page | RW | 1 |
| 7.12 | Acknowledge2 | 1 = Will comply with message 0 = Cannot comply with message | RW | 0 |
| 7.11 | Toggle | 1 = Previous value of the transmitted link code word equaled logic 1 0 = Logic 0 | RO | 0 |
| 7.10:0 | Message Field | 11-bit wide field to encode 2048 messages | RW | 000_0000_0001 |

Register Description (Continued)

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|---|-----------------------------|---|----------------------|--|
| Register 8h – Link Partner Next Page Ability | | | | |
| 8.15 | Next Page | 1 = Additional next pages will follow 0 = Last page | RO | 0 |
| 8.14 | Acknowledge | 1 = Successful receipt of link word 0 = No successful receipt of link word | RO | 0 |
| 8.13 | Message Page | 1 = Message page 0 = Unformatted page | RO | 0 |
| 8.12 | Acknowledge2 | 1 = Can act on the information 0 = Cannot act on the information | RO | 0 |
| 8.11 | Toggle | 1 = Previous value of transmitted link code word equal to logic 0 0 = Previous value of transmitted link code word equal to logic 1 | RO | 0 |
| 8.10:0 | Message Field | 11-bit wide field to encode 2048 messages | RO | 000_0000_0000 |
| Register 10h – Digital Reserved Control | | | | |
| 10.15:5 | Reserved | Reserved | RW | 0000_0000_000 |
| 10.4 | PLL Off | 1 = Turn PLL off automatically in EDPD mode 0 = Keep PLL on in EDPD mode. See also Register 18h, Bit [11] for EDPD mode | RW | 0 |
| 10.3:0 | Reserved | Reserved | RW | 0000 |
| Register 11h – AFE Control 1 | | | | |
| 11.15:6 | Reserved | Reserved | RW | 0000_0000_00 |
| 11.5 | Slow-Oscillator Mode Enable | Slow-oscillator mode is used to disconnect the input reference crystal/clock on the XI pin and select the on-chip slow oscillator when the KSZ8081MNX/RNB device is not in use after power-up. 1 = Enable 0 = Disable This bit automatically sets software power-down to the analog side when enabled. | RW | 0 |
| 11.4:0 | Reserved | Reserved | RW | 0_0000 |
| Register 15h – RXER Counter | | | | |
| 15.15:0 | RXER Counter | Receive error counter for symbol error frames | RO/SC | 0000h |
| Register 16h – Operation Mode Strap Override | | | | |
| 16.15 | Reserved Factory Mode | 0 = Normal operation 1 = Factory test mode If TXC (Pin 22) latches in a pull-up value at the de-assertion of reset, write a '0' to this bit to clear Reserved Factory Mode. This bit applies only to KSZ8081MNX. | RW | 0 Set by the pull-up/pull-down value of TXC (Pin 22). |
| 16.14:11 | Reserved | Reserved | RW | 000_0 |
| 16.10 | Reserved | Reserved | RO | 0 |
| 16.9 | B-CAST_OFF Override | 1 = Override strap-in for B-CAST_OFF If bit is '1', PHY Address 0 is non-broadcast. | RW | 0 |

Register Description (Continued)

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|---|-----------------------------|--|----------------------|---------|
| Register 16h – Operation Mode Strap Override | | | | |
| 16.8 | Reserved | Reserved | RW | 0 |
| 16.7 | MII B-to-B Override | 1 = Override strap-in for MII back-to-back mode (also set Bit 0 of this register to '1') This bit applies only to KSZ8081MNX. | RW | 0 |
| 16.6 | RMII B-to-B Override | 1 = Override strap-in for RMII Back-to-Back mode (also set Bit 1 of this register to '1') This bit applies only to KSZ8081RNB. | RW | 0 |
| 16.5 | NAND Tree Override | 1 = Override strap-in for NAND tree mode | RW | 0 |
| 16.4:2 | Reserved | Reserved | RW | 0_00 |
| 16.1 | RMII Override | 1 = Override strap-in for RMII mode This bit applies only to KSZ8081RNB. | RW | 0 |
| 16.0 | MII Override | 1 = Override strap-in for MII mode This bit applies only to KSZ8081MNX. | RW | 1 |
| Register 17h – Operation Mode Strap Status | | | | |
| 17.15:13 | PHYAD[2:0] Strap-In Status | [000] = Strap to PHY Address 0 [001] = Strap to PHY Address 1 [010] = Strap to PHY Address 2 [011] = Strap to PHY Address 3 [100] = Strap to PHY Address 4 [101] = Strap to PHY Address 5 [110] = Strap to PHY Address 6 [111] = Strap to PHY Address 7 | RO | |
| 17.12:10 | Reserved | Reserved | RO | |
| 17.9 | B-CAST_OFF Strap-In Status | 1 = Strap to B-CAST_OFF If bit is '1', PHY Address 0 is non-broadcast. | RO | |
| 17.8 | Reserved | Reserved | RO | |
| 17.7 | MII B-to-B Strap-In Status | 1 = Strap to MII back-to-back mode This bit applies only to KSZ8081MNX. | RO | |
| 17.6 | RMII B-to-B Strap-In Status | 1 = Strap to RMII Back-to-Back mode This bit applies only to KSZ8081RNB. | RO | |
| 17.5 | NAND Tree Strap-In Status | 1 = Strap to NAND tree mode | RO | |
| 17.4:2 | Reserved | Reserved | RO | |
| 17.1 | RMII Strap-In Status | 1 = Strap to RMII mode This bit applies only to KSZ8081RNB. | RO | |
| 17.0 | MII Strap-In Status | 1 = Strap to MII mode This bit applies only to KSZ8081MNX. | RO | |

Register Description (Continued)

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|--|---|--|----------------------|---------|
| Register 18h – Expanded Control | | | | |
| 18.15:12 | Reserved | Reserved | RW | 0000 |
| 18.11 | EDPD Disabled | Energy-detect power-down mode 1 = Disable 0 = Enable See also Register 10h, Bit [4] for PLL off. | RW | 1 |
| 18.10 | 100Base-TX Latency | 1 = MII output is random latency 0 = MII output is fixed latency For both settings, all bytes of received preamble are passed to the MII output. This bit applies only to KSZ8081MNX. | RW | 0 |
| 18.9:7 | Reserved | Reserved | RW | 00_0 |
| 18.6 | 10Base-T Preamble Restore | 1 = Restore received preamble to MII output 0 = Remove all seven bytes of preamble before sending frame (starting with SFD) to MII output This bit applies only to KSZ8081MNX, | RW | 0 |
| 18.5:0 | Reserved | Reserved | RW | 00_0000 |
| Register 1Bh – Interrupt Control/Status | | | | |
| 1B.15 | Jabber Interrupt Enable | 1 = Enable jabber interrupt 0 = Disable jabber interrupt | RW | 0 |
| 1B.14 | Receive Error Interrupt Enable | 1 = Enable receive error interrupt 0 = Disable receive error interrupt | RW | 0 |
| 1B.13 | Page Received Interrupt Enable | 1 = Enable page received interrupt 0 = Disable page received interrupt | RW | 0 |
| 1B.12 | Parallel Detect Fault Interrupt Enable | 1 = Enable parallel detect fault interrupt 0 = Disable parallel detect fault interrupt | RW | 0 |
| 1B.11 | Link Partner Acknowledge Interrupt Enable | 1 = Enable link partner acknowledge interrupt 0 = Disable link partner acknowledge interrupt | RW | 0 |
| 1B.10 | Link-Down Interrupt Enable | 1 = Enable link-down interrupt 0 = Disable link-down interrupt | RW | 0 |
| 1B.9 | Remote Fault Interrupt Enable | 1 = Enable remote fault interrupt 0 = Disable remote fault interrupt | RW | 0 |
| 1B.8 | Link-Up Interrupt Enable | 1 = Enable link-up interrupt 0 = Disable link-up interrupt | RW | 0 |

Register Description (Continued)

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|--|------------------------------------|---|----------------------|-------------|
| Register 1Bh – Interrupt Control/Status | | | | |
| 1B.7 | Jabber Interrupt | 1 = Jabber occurred 0 = Jabber did not occur | RO/SC | 0 |
| 1B.6 | Receive Error Interrupt | 1 = Receive error occurred 0 = Receive error did not occur | RO/SC | 0 |
| 1B.5 | Page Receive Interrupt | 1 = Page receive occurred 0 = Page receive did not occur | RO/SC | 0 |
| 1B.4 | Parallel Detect Fault Interrupt | 1 = Parallel detect fault occurred 0 = Parallel detect fault did not occur | RO/SC | 0 |
| 1B.3 | Link Partner Acknowledge Interrupt | 1 = Link partner acknowledge occurred 0 = Link partner acknowledge did not occur | RO/SC | 0 |
| 1B.2 | Link-Down Interrupt | 1 = Link-down occurred 0 = Link-down did not occur | RO/SC | 0 |
| 1B.1 | Remote Fault Interrupt | 1 = Remote fault occurred 0 = Remote fault did not occur | RO/SC | 0 |
| 1B.0 | Link-Up Interrupt | 1 = Link-up occurred 0 = Link-up did not occur | RO/SC | 0 |
| Register 1Dh – LinkMD Control/Status | | | | |
| 1D.15 | Cable Diagnostic Test Enable | 1 = Enable cable diagnostic test. After test has completed, this bit is self-cleared. 0 = Indicates cable diagnostic test (if enabled) has completed and the status information is valid for read. | RW/SC | 0 |
| 1D.14:13 | Cable Diagnostic Test Result | [00] = Normal condition [01] = Open condition has been detected in cable [10] = Short condition has been detected in cable [11] = Cable diagnostic test has failed | RO | 00 |
| 1D.12 | Short Cable Indicator | 1 = Short cable (<10 meter) has been detected by LinkMD | RO | 0 |
| 1D.11:9 | Reserved | Reserved | RW | 000 |
| 1D.8:0 | Cable Fault Counter | Distance to fault | RO | 0_0000_0000 |

Register Description (Continued)

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|-------------------------------------|-----------------------------|---|----------------------|---------|
| Register 1Eh – PHY Control 1 | | | | |
| 1E.15:10 | Reserved | Reserved | RO | 0000_00 |
| 1E.9 | Enable Pause (Flow Control) | 1 = Flow control capable 0 = No flow control capability | RO | 0 |
| 1E.8 | Link Status | 1 = Link is up 0 = Link is down | RO | 0 |
| 1E.7 | Polarity Status | 1 = Polarity is reversed 0 = Polarity is not reversed | RO | |
| 1E.6 | Reserved | Reserved | RO | 0 |
| 1E.5 | MDI/MDI-X State | 1 = MDI-X 0 = MDI | RO | |
| 1E.4 | Energy Detect | 1 = Signal present on receive differential pair 0 = No signal detected on receive differential pair | RO | 0 |
| 1E.3 | PHY Isolate | 1 = PHY in isolate mode 0 = PHY in normal operation | RW | 0 |
| 1E.2:0 | Operation Mode Indication | [000] = Still in auto-negotiation [001] = 10Base-T half-duplex [010] = 100Base-TX half-duplex [011] = Reserved [100] = Reserved [101] = 10Base-T full-duplex [110] = 100Base-TX full-duplex [111] = Reserved | RO | 000 |
| Register 1Fh – PHY Control 2 | | | | |
| 1F.15 | HP_MDIX | 1 = HP Auto MDI/MDI-X mode 0 = Micrel Auto MDI/MDI-X mode | RW | 1 |
| 1F.14 | MDI/MDI-X Select | When Auto MDI/MDI-X is disabled, 1 = MDI-X mode Transmit on RXP,RXM (pins 5, 4) and Receive on TXP,TXM (pins 7, 6) 0 = MDI mode Transmit on TXP,TXM (pins 7, 6) and Receive on RXP,RXM (pins 5, 4) | RW | 0 |
| 1F.13 | Pair Swap Disable | 1 = Disable Auto MDI/MDI-X 0 = Enable Auto MDI/MDI-X | RW | 0 |
| 1F.12 | Reserved | Reserved | RW | 0 |

Register Description (Continued)

| Address | Name | Description | Mode ⁽¹⁰⁾ | Default |
|-------------------------------------|-----------------------------------|--|----------------------|---------|
| Register 1Fh – PHY Control 2 | | | | |
| 1F.11 | Force Link | 1 = Force link pass 0 = Normal link operation This bit bypasses the control logic and allows the transmitter to send a pattern even if there is no link. | RW | 0 |
| 1F.10 | Power Saving | 1 = Enable power saving 0 = Disable power saving | RW | 0 |
| 1F.9 | Interrupt Level | 1 = Interrupt pin active high 0 = Interrupt pin active low | RW | 0 |
| 1F.8 | Enable Jabber | 1 = Enable jabber counter 0 = Disable jabber counter | RW | 1 |
| 1F.7 | RMII Reference Clock Select | 1 = RMII 50MHz clock mode; clock input to XI (Pin 9) is 50MHz 0 = RMII 25MHz clock mode; clock input to XI (Pin 9) is 25MHz This bit applies only to KSZ8081RNB. | RW | 0 |
| 1F.6 | Reserved | Reserved | RW | 0 |
| 1F.5:4 | LED Mode | [00] = LED1: Speed LED0: Link/Activity [01] = LED1: Activity LED0: Link [10], [11] = Reserved | RW | 00 |
| 1F.3 | Disable Transmitter | 1 = Disable transmitter 0 = Enable transmitter | RW | 0 |
| 1F.2 | Remote Loopback | 1 = Remote (analog) loopback is enabled 0 = Normal mode | RW | 0 |
| 1F.1 | Enable SQE Test | 1 = Enable SQE test 0 = Disable SQE test | RW | 0 |
| 1F.0 | Disable Data Scrambling | 1 = Disable scrambler 0 = Enable scrambler | RW | 0 |

Absolute Maximum Ratings⁽¹¹⁾

| | |
|-----------------------------------|-----------------|
| Supply Voltage (V_{IN}) | |
| ($V_{DD_1.2}$) | –0.5V to +1.8V |
| (V_{DDIO} , $V_{DDA_3.3}$) | –0.5V to +5.0V |
| Input Voltage (all inputs) | –0.5V to +5.0V |
| Output Voltage (all outputs) | –0.5V to +5.0V |
| Lead Temperature (soldering, 10s) | 260°C |
| Storage Temperature (T_S) | –55°C to +150°C |

Operating Ratings⁽¹²⁾

| | |
|---|--------------------|
| Supply Voltage | |
| ($V_{DDIO_3.3}$, $V_{DDA_3.3}$) | +3.135V to +3.465V |
| ($V_{DDIO_2.5}$) | +2.375V to +2.625V |
| ($V_{DDIO_1.8}$) | +1.710V to +1.890V |
| Ambient Temperature | |
| (T_A , Commercial) | 0°C to +70°C |
| (T_A , Industrial) | –40°C to +85°C |
| Maximum Junction Temperature ($T_{J(MAX)}$) | 125°C |
| Thermal Resistance (θ_{JA}) | 34°C/W |
| Thermal Resistance (θ_{JC}) | 6°C/W |

Electrical Characteristics⁽¹³⁾

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Units |
|--|--------------------------|---|------|------|------|---------|
| Supply Current (V_{DDIO}, $V_{DDA_3.3} = 3.3V$)⁽¹⁴⁾ | | | | | | |
| $I_{DD1_3.3V}$ | 10Base-T | Full-duplex traffic @ 100% utilization | | 41 | | mA |
| $I_{DD2_3.3V}$ | 100Base-TX | Full-duplex traffic @ 100% utilization | | 47 | | mA |
| $I_{DD3_3.3V}$ | EDPD Mode | Ethernet cable disconnected (reg. 18h.11 = 0) | | 20 | | mA |
| $I_{DD4_3.3V}$ | Power-Down Mode | Software power-down (reg. 0h.11 = 1) | | 4 | | mA |
| CMOS Level Inputs | | | | | | |
| V_{IH} | Input High Voltage | $V_{DDIO} = 3.3V$ | 2.0 | | | V |
| | | $V_{DDIO} = 2.5V$ | 1.8 | | | |
| | | $V_{DDIO} = 1.8V$ | 1.3 | | | |
| V_{IL} | Input Low Voltage | $V_{DDIO} = 3.3V$ | | | 0.8 | V |
| | | $V_{DDIO} = 2.5V$ | | | 0.7 | |
| | | $V_{DDIO} = 1.8V$ | | | 0.5 | |
| $ I_{IN} $ | Input Current | $V_{IN} = GND \sim V_{DDIO}$ | | | 10 | μA |
| CMOS Level Outputs | | | | | | |
| V_{OH} | Output High Voltage | $V_{DDIO} = 3.3V$ | 2.4 | | | V |
| | | $V_{DDIO} = 2.5V$ | 2.0 | | | |
| | | $V_{DDIO} = 1.8V$ | 1.5 | | | |
| V_{OL} | Output Low Voltage | $V_{DDIO} = 3.3V$ | | | 0.4 | V |
| | | $V_{DDIO} = 2.5V$ | | | 0.4 | |
| | | $V_{DDIO} = 1.8V$ | | | 0.3 | |
| $ I_{OZ} $ | Output Tri-State Leakage | | | | 10 | μA |
| LED Output | | | | | | |
| I_{LED} | Output Drive Current | Each LED pin (LED0, LED1) | | 8 | | mA |

Notes:

- Exceeding the absolute maximum ratings can damage the device. Stresses greater than the absolute maximum rating can cause permanent damage to the device. Operation of the device at these or any other conditions above those specified in the operating sections of this specification is not implied. Maximum conditions for extended periods may affect reliability.
- The device is not guaranteed to function outside its operating ratings.
- $T_A = 25^\circ C$. Specification for packaged product only.
- Current consumption is for the single 3.3V supply KSZ8081MNX/RNB device only, and includes the transmit driver current and the 1.2V supply voltage ($V_{DD_1.2}$) that are supplied by the KSZ8081MNX/RNB.

Electrical Characteristics⁽¹³⁾ (Continued)

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Units |
|---|--|--|------|------|-------|-------|
| All Pull-Up/Pull-Down Pins (including Strapping Pins) | | | | | | |
| pu | Internal Pull-Up Resistance | V _{DDIO} = 3.3V | 30 | 45 | 73 | kΩ |
| | | V _{DDIO} = 2.5V | 39 | 61 | 102 | |
| | | V _{DDIO} = 1.8V | 48 | 99 | 178 | |
| pd | Internal Pull-Down Resistance | V _{DDIO} = 3.3V | 26 | 43 | 79 | kΩ |
| | | V _{DDIO} = 2.5V | 34 | 59 | 113 | |
| | | V _{DDIO} = 1.8V | 53 | 99 | 200 | |
| 100Base-TX Transmit (measured differentially after 1:1 transformer) | | | | | | |
| V _O | Peak Differential Output Voltage | 100Ω termination across differential output | 0.95 | | 1.05 | V |
| V _{IMB} | Output Voltage Imbalance | 100Ω termination across differential output | | | 2 | % |
| t _r , t _f | Rise/Fall Time | | 3 | | 5 | ns |
| | Rise/Fall Time Imbalance | | 0 | | 0.5 | ns |
| | Duty Cycle Distortion | | | | ±0.25 | ns |
| | Overshoot | | | | 5 | % |
| | Output Jitter | Peak-to-peak | | 0.7 | | ns |
| 10Base-T Transmit (measured differentially after 1:1 transformer) | | | | | | |
| V _P | Peak Differential Output Voltage | 100Ω termination across differential output | 2.2 | | 2.8 | V |
| | Jitter Added | Peak-to-peak | | | 3.5 | ns |
| t _r , t _f | Rise/Fall Time | | | 25 | | ns |
| 10Base-T Receive | | | | | | |
| V _{SQ} | Squelch Threshold | 5MHz square wave | | 400 | | mV |
| Transmitter – Drive Setting | | | | | | |
| V _{SET} | Reference Voltage of I _{SET} | R(I _{SET}) = 6.49kΩ | | 0.65 | | V |
| REF_CLK Output | | | | | | |
| | 50MHz RMII Clock Output Jitter | Peak-to-peak. (Applies only to KSZ8081RNB in RMII – 25MHz clock mode) | | 300 | | ps |
| 100Mbps Mode – Industrial Applications Parameters | | | | | | |
| | Clock Phase Delay – XI Input to MII TXC Output | XI (25MHz clock input) to MII TXC (25MHz clock output) delay, referenced to rising edges of both clocks. (Applies only to KSZ8081MNX in MII mode) | 15 | 20 | 25 | ns |
| t _{llr} | Link Loss Reaction (Indication) Time | Link loss detected at receive differential inputs to PHY signal indication time for each of the following: 1. For LED mode 00, Speed LED output changes from low (100Mbps) to high (10Mbps, default state for link-down). 2. For LED mode 01, Link LED output changes from low (link-up) to high (link-down). 3. INTRP pin asserts for link-down status change. | | 4.4 | | μs |

Timing Diagrams

MII SQE Timing (10Base-T)

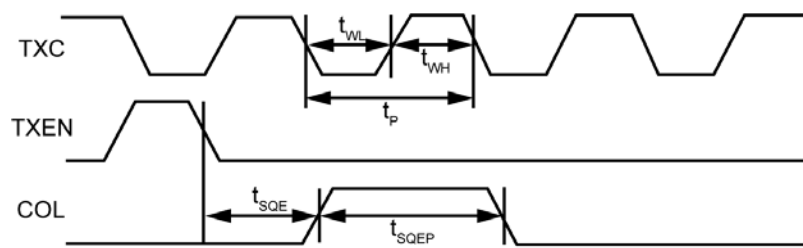


Figure 11. MII SQE Timing (10Base-T)

Table 13. MII SQE Timing (10Base-T) Parameters

| Timing Parameter | Description | Min. | Typ. | Max. | Units |
|------------------|--|------|------|------|---------|
| t_P | TXC period | | 400 | | ns |
| t_{WL} | TXC pulse width low | | 200 | | ns |
| t_{WH} | TXC pulse width high | | 200 | | ns |
| t_{SQE} | COL (SQE) delay after TXEN de-asserted | | 2.2 | | μ s |
| t_{SQEP} | COL (SQE) pulse duration | | 1.0 | | μ s |

MII Transmit Timing (10Base-T)

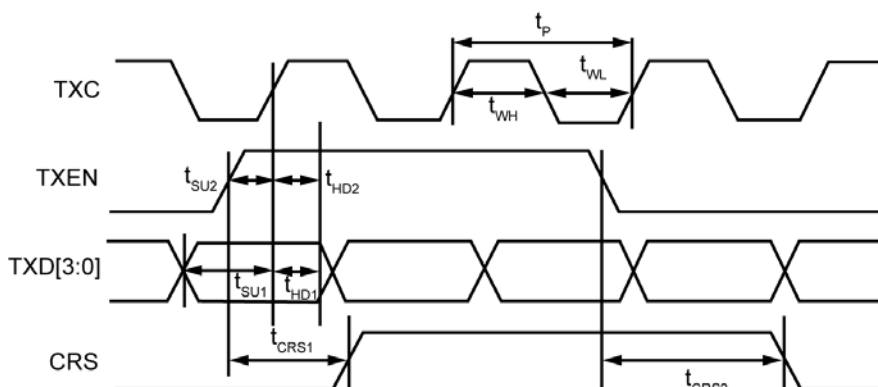
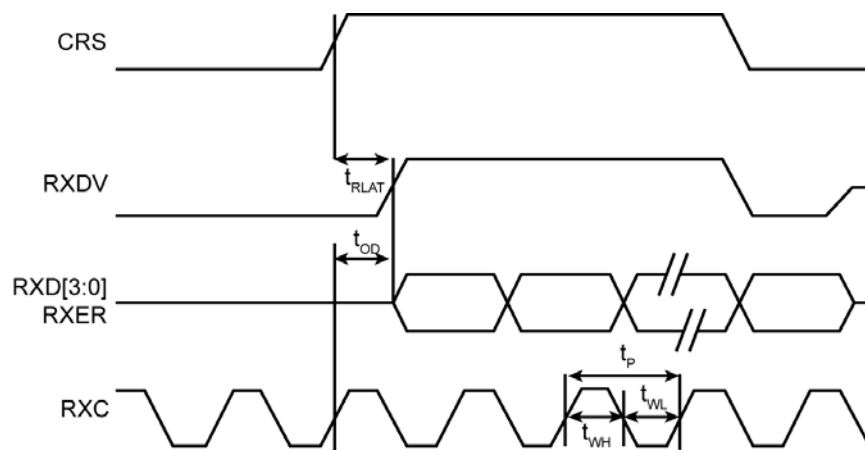


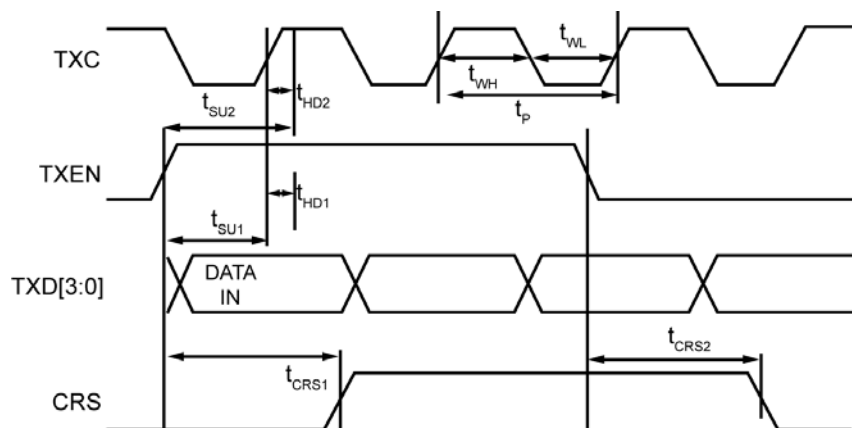
Figure 12. MII Transmit Timing (10Base-T)

Table 14. MII Transmit Timing (10Base-T) Parameters

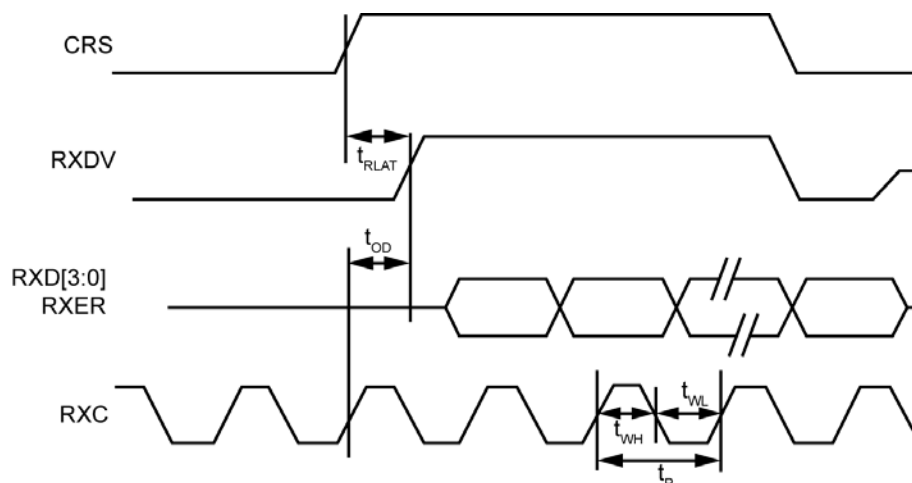
| Timing Parameter | Description | Min. | Typ. | Max. | Units |
|------------------|---------------------------------------|------|------|------|---------|
| t_P | TXC period | | 400 | | ns |
| t_{WL} | TXC pulse width low | | 200 | | ns |
| t_{WH} | TXC pulse width high | | 200 | | ns |
| t_{SU1} | TXD[3:0] setup to rising edge of TXC | 120 | | | ns |
| t_{SU2} | TXEN setup to rising edge of TXC | 120 | | | ns |
| t_{HD1} | TXD[3:0] hold from rising edge of TXC | 0 | | | ns |
| t_{HD2} | TXEN hold from rising edge of TXC | 0 | | | ns |
| t_{CRS1} | TXEN high to CRS asserted latency | | 600 | | ns |
| t_{CRS2} | TXEN low to CRS de-asserted latency | | 1.0 | | μ s |

MII Receive Timing (10Base-T)**Figure 13. MII Receive Timing (10Base-T)****Table 15. MII Receive Timing (10Base-T) Parameters**

| Timing Parameter | Description | Min. | Typ. | Max. | Units |
|------------------|---|------|------|------|---------|
| t_P | RXC period | | 400 | | ns |
| t_{WL} | RXC pulse width low | | 200 | | ns |
| t_{WH} | RXC pulse width high | | 200 | | ns |
| t_{OD} | (RXDV, RXD[3:0], RXER) output delay from rising edge of RXC | | 205 | | ns |
| t_{RLAT} | CRS to (RXDV, RXD[3:0]) latency | | 7.2 | | μ s |

MII Transmit Timing (100Base-TX)**Figure 14. MII Transmit Timing (100Base-TX)****Table 16. MII Transmit Timing (100Base-TX) Parameters**

| Timing Parameter | Description | Min. | Typ. | Max. | Units |
|------------------|---------------------------------------|------|------|------|-------|
| t_P | TXC period | | 40 | | ns |
| t_{WL} | TXC pulse width low | | 20 | | ns |
| t_{WH} | TXC pulse width high | | 20 | | ns |
| t_{SU1} | TXD[3:0] setup to rising edge of TXC | 10 | | | ns |
| t_{SU2} | TXEN setup to rising edge of TXC | 10 | | | ns |
| t_{HD1} | TXD[3:0] hold from rising edge of TXC | 0 | | | ns |
| t_{HD2} | TXEN hold from rising edge of TXC | 0 | | | ns |
| t_{CRS1} | TXEN high to CRS asserted latency | | 72 | | ns |
| t_{CRS2} | TXEN low to CRS de-asserted latency | | 72 | | ns |

MII Receive Timing (100Base-TX)**Figure 15. MII Receive Timing (100Base-TX)****Table 17. MII Receive Timing (100Base-TX) Parameters**

| Timing Parameter | Description | Min. | Typ. | Max. | Units |
|------------------|---|------|------|------|-------|
| t_P | RXC period | | 40 | | ns |
| t_{WL} | RXC pulse width low | | 20 | | ns |
| t_{WH} | RXC pulse width high | | 20 | | ns |
| t_{OD} | (RXDV, RXD[3:0], RXER) output delay from rising edge of RXC | 16 | 21 | 25 | ns |
| t_{RLAT} | CRS to (RXDV, RXD[3:0]) latency | | 170 | | ns |

RMII Timing

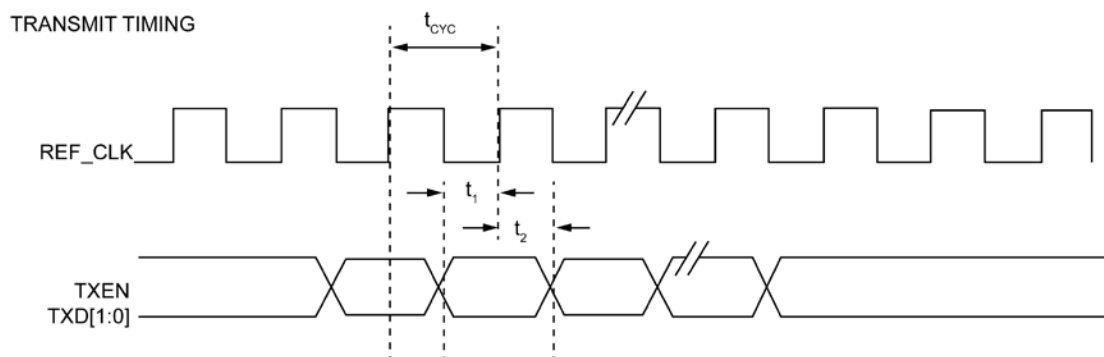


Figure 16. RMII Timing – Data Received from RMII

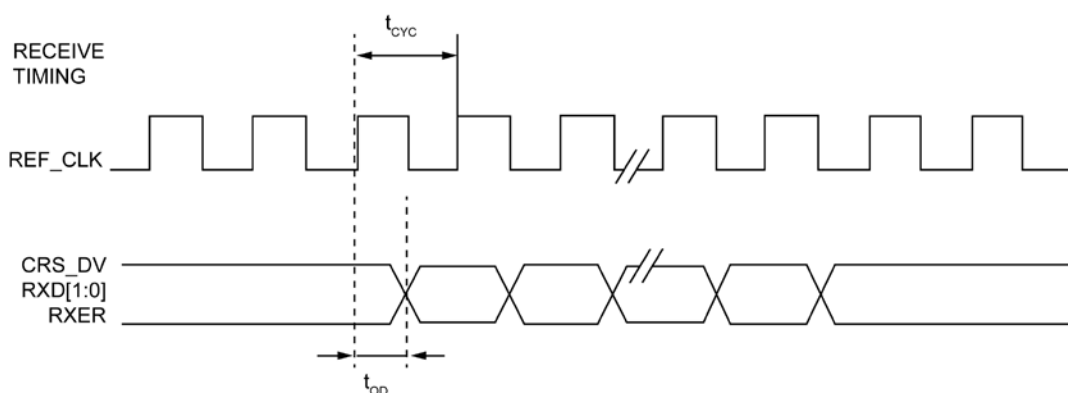


Figure 17. RMII Timing – Data Input to RMII

Table 18. RMII Timing Parameters – KSZ8081RNB (25MHz input to XI pin, 50MHz output from REF_CLK pin)

| Timing Parameter | Description | Min. | Typ. | Max. | Units |
|------------------|--------------|------|------|------|-------|
| t_{CYC} | Clock cycle | | 20 | | ns |
| t_1 | Setup time | 4 | | | ns |
| t_2 | Hold time | 2 | | | ns |
| t_{OD} | Output delay | 7 | 10 | 13 | ns |

Table 19. RMII Timing Parameters – KSZ8081RNB (50MHz input to XI pin)

| Timing Parameter | Description | Min. | Typ. | Max. | Units |
|------------------|--------------|------|------|------|-------|
| t_{CYC} | Clock cycle | | 20 | | ns |
| t_1 | Setup time | 4 | | | ns |
| t_2 | Hold time | 2 | | | ns |
| t_{OD} | Output delay | 8 | 11 | 13 | ns |

Auto-Negotiation Timing

AUTO -NEGOTIATION FAST LINK PULSE (FLP) TIMING

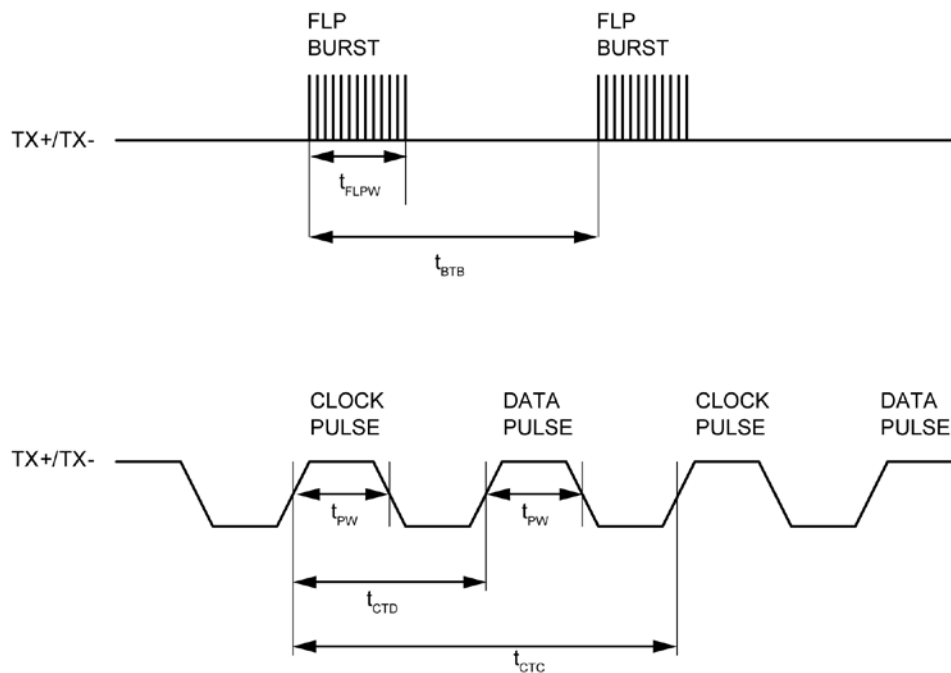


Figure 18. Auto-Negotiation Fast Link Pulse (FLP) Timing

Table 20. Auto-Negotiation Fast Link Pulse (FLP) Timing Parameters

| Timing Parameter | Description | Min. | Typ. | Max. | Units |
|------------------|---|------|------|------|---------|
| t_{BTB} | FLP burst to FLP burst | 8 | 16 | 24 | ms |
| t_{FLPW} | FLP burst width | | 2 | | ms |
| t_{PW} | Clock/Data pulse width | | 100 | | ns |
| t_{CTD} | Clock pulse to data pulse | 55.5 | 64 | 69.5 | μ s |
| t_{CTC} | Clock pulse to clock pulse | 111 | 128 | 139 | μ s |
| | Number of clock/data pulses per FLP burst | 17 | | 33 | |

MDC/MDIO Timing

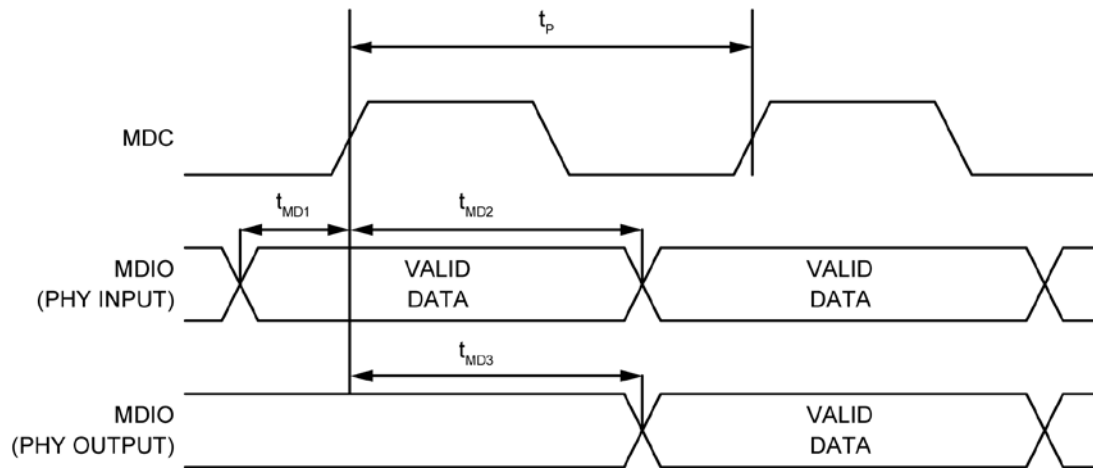


Figure 19. MDC/MDIO Timing

Table 21. MDC/MDIO Timing Parameters

| Timing Parameter | Description | Min. | Typ. | Max. | Units |
|------------------|---|------|------|------|-------|
| f_c | MDC Clock Frequency | | 2.5 | 10 | MHz |
| t_P | MDC period | | 400 | | ns |
| t_{MD1} | MDIO (PHY input) setup to rising edge of MDC | 10 | | | ns |
| t_{MD2} | MDIO (PHY input) hold from rising edge of MDC | 4 | | | ns |
| t_{MD3} | MDIO (PHY output) delay from rising edge of MDC | 5 | 222 | | ns |

Power-up/Reset Timing

The KSZ8081MNX/RNB reset timing requirement is summarized in [Figure 20](#) and [Table 22](#).

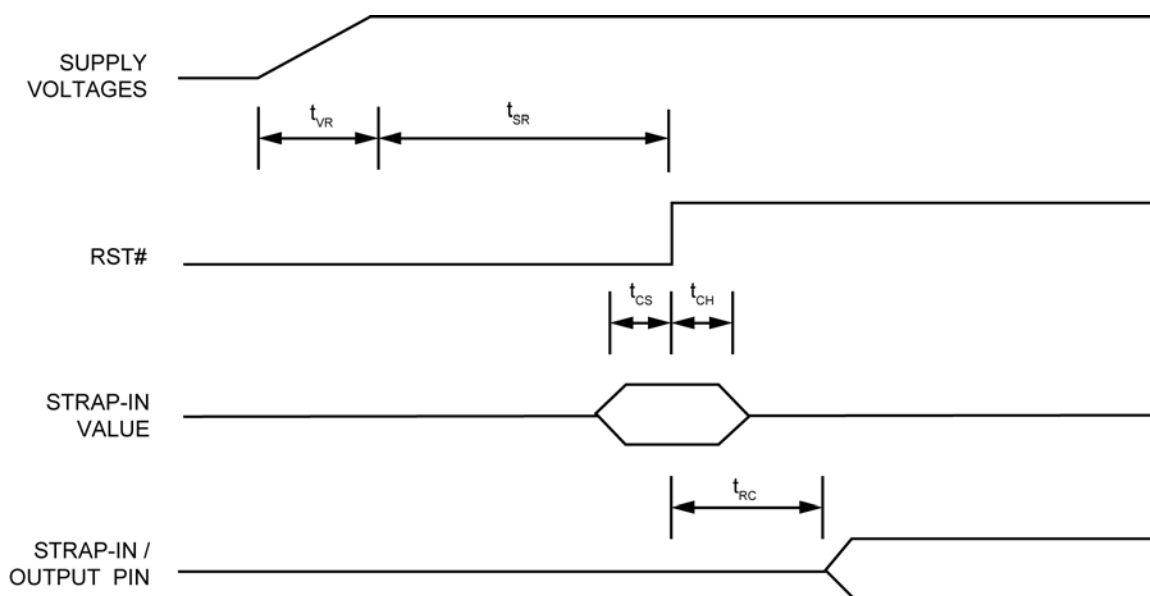


Figure 20. Power-up/Reset Timing

Table 22. Power-up/Reset Timing Parameters

| Parameter | Description | Min. | Max. | Units |
|-----------|---|------|------|---------|
| t_{VR} | Supply voltage (V_{DDIO} , $V_{DDA_3.3}$) rise time | 300 | | μs |
| t_{SR} | Stable supply voltage (V_{DDIO} , $V_{DDA_3.3}$) to reset high | 10 | | ms |
| t_{CS} | Configuration setup time | 5 | | ns |
| t_{CH} | Configuration hold time | 5 | | ns |
| t_{RC} | Reset to strap-in pin output | 6 | | ns |

The supply voltage (V_{DDIO} and $V_{DDA_3.3}$) power-up waveform should be monotonic. The 300 μs minimum rise time is from 10% to 90%.

For warm reset, the reset (RST#) pin should be asserted low for a minimum of 500 μs . The strap-in pin values are read and updated at the de-assertion of reset.

After the de-assertion of reset, wait a minimum of 100 μs before starting programming on the MIIM (MDC/MDIO) interface.

Reset Circuit

Figure 21 shows a reset circuit recommended for powering up the KSZ8081MNX/RNB if reset is triggered by the power supply.

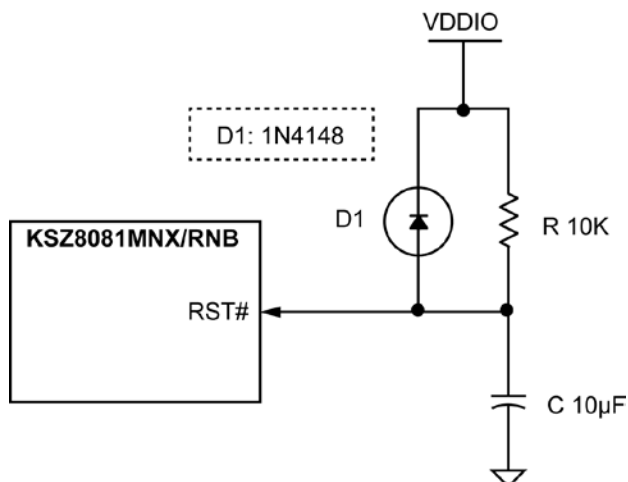


Figure 21. Recommended Reset Circuit

Figure 22 Shows a reset circuit recommended for applications where reset is driven by another device (for example, the CPU or an FPGA). The reset out RST_OUT_n from CPU/FPGA provides the warm reset after power up reset. D2 is used if using different VDDIO between the switch and CPU/FPGA, otherwise, the different VDDIO will fight each other. If different VDDIO have to use in a special case, a low VF (<0.3V) diode is required (For example, VISHAY's BAT54, MSS1P2L and so on), or a level shifter device can be used too. If Ethernet device and CPU/FPGA use same VDDIO voltage, D2 can be removed to connect both devices directly. Usually, Ethernet device and CPU/FPGA should use same VDDIO voltage.

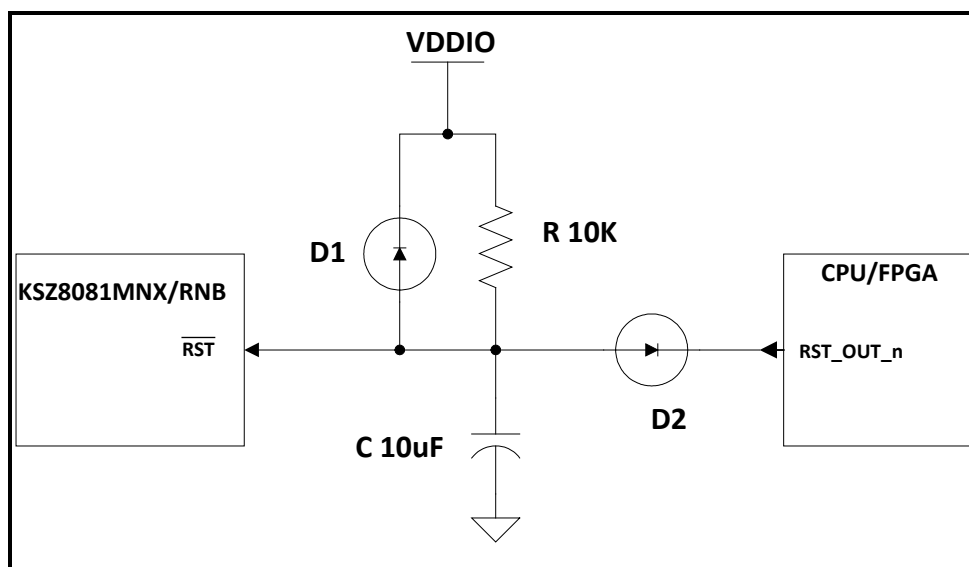


Figure 22. Recommended Reset Circuit for Interfacing with CPU/FPGA Reset Output

Reference Circuits – LED Strap-In Pins

The pull-up, float, and pull-down reference circuits for the LED1/SPEED and LED0/NWAYEN strapping pins are shown in [Figure 23](#) for 3.3V and 2.5V VDDIO.

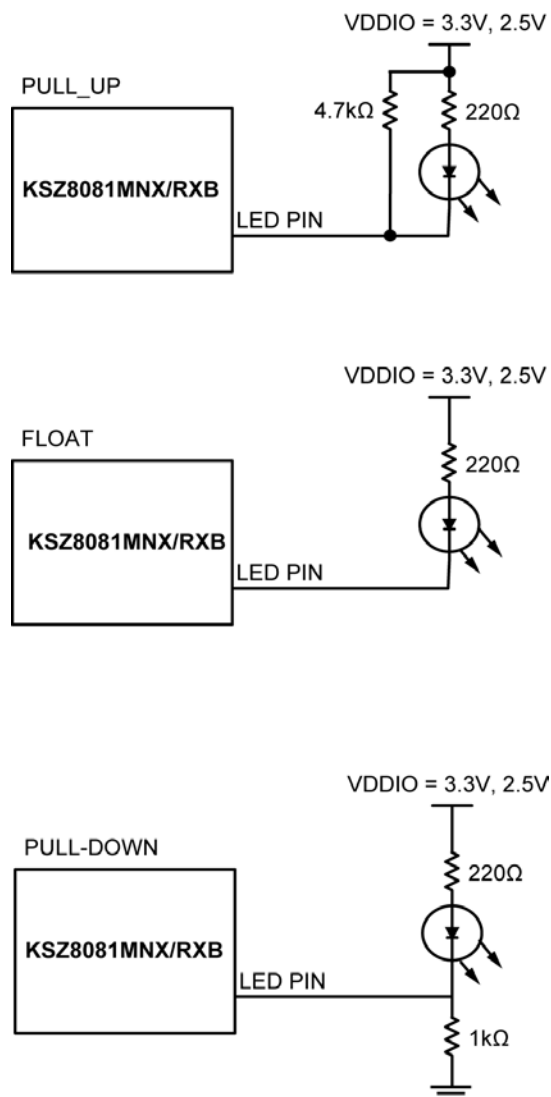


Figure 23. Reference Circuits for LED Strapping Pins

For using 1.8V VDDIO, should select parts with low 1.8V operation voltage and forwarding current I_F about 2mA LED indicator. It is ok using internal pull-up or external pull-up resistor for the LED pin pull-up strap function, and use an external 0.75K to 1K pull-down resistor for the LED pin pull-down strap function.

Note: If using RJ45 jacks with integrated LEDs and 1.8V VDDIO, a level shifting is required from LED 3.3V to 1.8V. For example, use a bipolar transistor or a level shift device.

Reference Clock – Connection and Selection

A crystal or external clock source, such as an oscillator, is used to provide the reference clock for the KSZ8081MNX/RNB. For the KSZ8081MNX in all operating modes and for the KSZ8081RNB in RMII – 25MHz Clock Mode, the reference clock is 25MHz. The reference clock connections to XI (Pin 9) and XO (Pin 8), and the reference clock selection criteria, are provided in [Figure 24](#) and [Table 23](#).

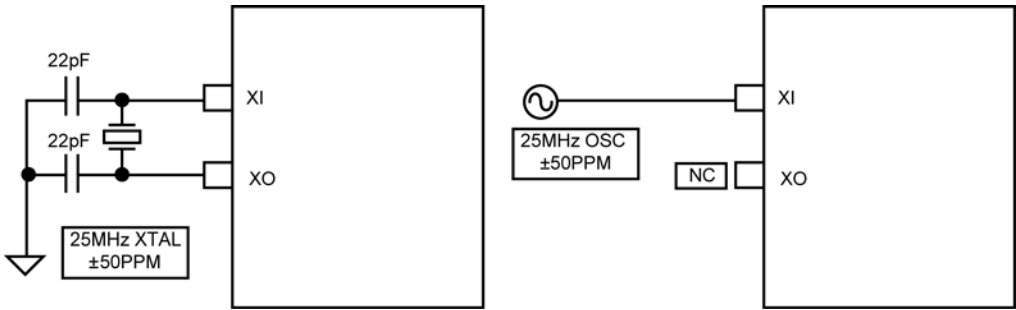


Figure 24. 25MHz Crystal/Oscillator Reference Clock Connection

Table 23. 25MHz Crystal/Reference Clock Selection Criteria

| Characteristics | Value | Units |
|---|-------|-------|
| Frequency | 25 | MHz |
| Frequency tolerance (max) ⁽¹⁵⁾ | ±50 | ppm |
| Crystal series resistance (typ) | 40 | Ω |
| Crystal load capacitance (typ) | 22 | pF |

Note:

15. ±60ppm for overtemperature crystal.

For the KSZ8081RNB in RMII – 50MHz clock mode, the reference clock is 50MHz. The reference clock connections to XI (Pin 9), and the reference clock selection criteria are provided in [Figure 25](#) and [Table 24](#).

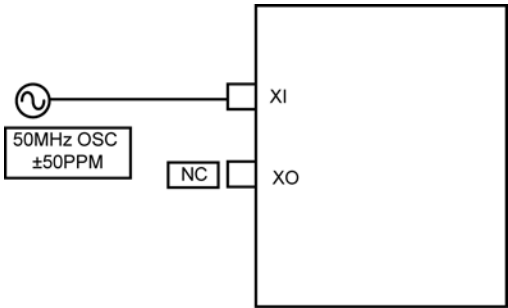


Figure 25. 50MHz Oscillator Reference Clock Connection

Table 24. 50MHz Oscillator/Reference Clock Selection Criteria

| Characteristics | Value | Units |
|-------------------------------|-------|-------|
| Frequency | 50 | MHz |
| Frequency tolerance (maximum) | ±50 | ppm |

Magnetic – Connection and Selection

A 1:1 isolation transformer is required at the line interface. Use one with integrated common-mode chokes for designs exceeding FCC requirements.

The KSZ8081MNX/RNB design incorporates voltage-mode transmit drivers and on-chip terminations.

With the voltage-mode implementation, the transmit drivers supply the common-mode voltages to the two differential pairs. Therefore, the two transformer center tap pins on the KSZ8081MNX/RNB side should not be connected to any power supply source on the board; instead, the center tap pins should be separated from one another and connected through separate $0.1\mu\text{F}$ common-mode capacitors to ground. Separation is required because the common-mode voltage is different between transmitting and receiving differential pairs.

Figure 26 shows the typical magnetic interface circuit for the KSZ8081MNX/RNB.

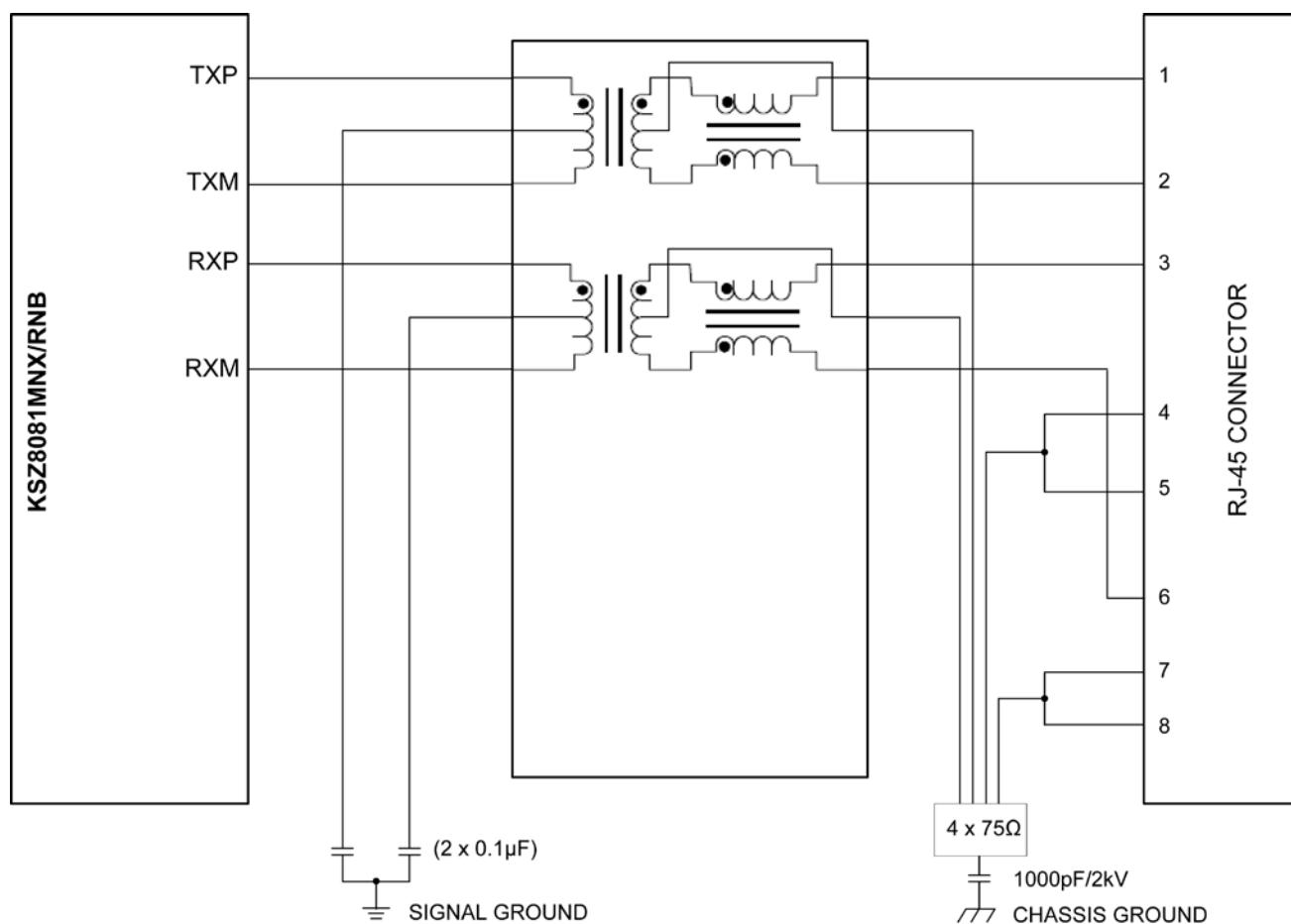


Figure 26. Typical Magnetic Interface Circuit

Table 25 lists recommended magnetic characteristics.

Table 25. Magnetics Selection Criteria

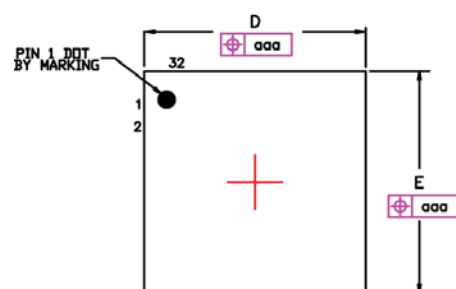
| Parameter | Value | Test Condition |
|-----------------------------------|-------------|--------------------|
| Turns ratio | 1 CT : 1 CT | |
| Open-circuit inductance (minimum) | 350 μ H | 100mV, 100kHz, 8mA |
| Insertion loss (typical) | -1.1dB | 100kHz to 100MHz |
| HIPOT (minimum) | 1500Vrms | |

Table 26 is a list of compatible single-port magnetics with separated transformer center tap pins on the PHY chip side that can be used with the KSZ8081MNX/RNB.

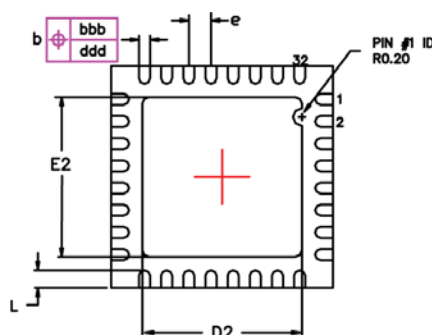
Table 26. Compatible Single-Port 10/100 Magnetics

| Manufacturer | Part Number | Temperature Range | Magnetic + RJ-45 |
|--------------|------------------|-------------------|------------------|
| Bel Fuse | S558-5999-U7 | 0°C to 70°C | No |
| Bel Fuse | SI-46001-F | 0°C to 70°C | Yes |
| Bel Fuse | SI-50170-F | 0°C to 70°C | Yes |
| Delta | LF8505 | 0°C to 70°C | No |
| HALO | HFJ11-2450E | 0°C to 70°C | Yes |
| HALO | TG110-E055N5 | -40°C to 85°C | No |
| LANKom | LF-H41S-1 | 0°C to 70°C | No |
| Pulse | H1102 | 0°C to 70°C | No |
| Pulse | H1260 | 0°C to 70°C | No |
| Pulse | HX1188 | -40°C to 85°C | No |
| Pulse | J00-0014 | 0°C to 70°C | Yes |
| Pulse | JX0011D21NL | -40°C to 85°C | Yes |
| TDK | TLA-6T718A | 0°C to 70°C | Yes |
| Transpower | HB726 | 0°C to 70°C | No |
| Würth/Midcom | 000-7090-37R-LF1 | -40°C to 85°C | No |

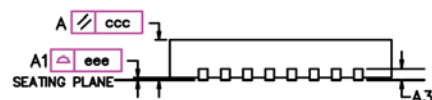
Package Information and Recommended Land Pattern⁽¹⁶⁾



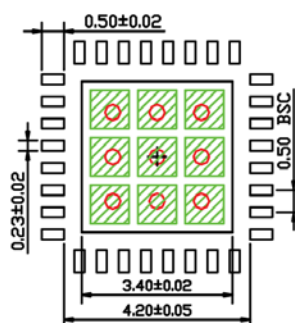
TOP VIEW
NOTE 9, 10



BOTTOM VIEW
NOTE 9, 10



SIDE VIEW
NOTE 9, 10



RECOMMENDED LAND PATTERN
NOTE 11, 12

| DIMENSION IN mm | | | |
|-----------------|------------|------|------|
| SYMBOL | MIN | NOM | MAX |
| A | 0.80 | 0.85 | 1.00 |
| A1 | 0.00 | 0.02 | 0.05 |
| A3 | 0.20 (REF) | | |
| D | 5.00 BSC | | |
| D2 | 3.00 | 3.10 | 3.20 |
| E | 5.00 BSC | | |
| E2 | 3.00 | 3.10 | 3.20 |
| L | 0.35 | 0.40 | 0.45 |

| N | b (mm) | | | e (mm) | | |
|----|--------|------|------|--------|-----|-----|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| 32 | 0.18 | 0.25 | 0.30 | 0.50 | BSC | |

| TOLERANCE OF FORM AND POSITION | |
|--------------------------------|------|
| aaa | 0.15 |
| bbb | 0.10 |
| ccc | 0.10 |
| ddd | 0.05 |
| eee | 0.08 |

NOTE:

- REFER TO JEDEC STANDARD MO-220 VHDD-2.
- DIMENSION 'b' APPLIES TO METALIZED TERMINAL AND IS MEASURED BETWEEN 0.15mm TO 0.30mm FROM THE TERMINAL TIP.
- 'aaa' THE BILATERAL PROFILE TOLERANCE THAT CONTROLS THE POSITION OF THE PLASTIC BODY SIDES. THE CENTERS OF THE PROFILE ZONES ARE DEFINED BY THE BASIC DIMENSIONS 'D' AND 'E'.
- 'bbb' THE TOLERANCE THAT CONTROLS THE POSITION OF THE ENTIRE TERMINAL PATTERN WITH RESPECT TO DATUM'S A AND B. THE CENTER OF THE TOLERANCE ZONE OF EACH TERMINAL IS DEFINED BY THE BASIC DIMENSION 'e' AS RELATED TO DATUM A AND B.
- 'ccc' THE TOLERANCE LOCATED PARALLEL TO THE SEATING PLANE IN WHICH THE TOP SURFACE OF THE PACKAGE MUST BE LOCATED.
- 'ddd' THE TOLERANCE THAT CONTROLS THE POSITION OF THE TERMINALS TO EACH OTHER. THE CENTERS OF THE PROFILE ZONES ARE DEFINED BY BASIC DIMENSION 'e'.
- 'eee' THE UNILATERAL TOLERANCE LOCATED ABOVE THE SEATING PLANE WHEREIN THE BOTTOM SURFACE OF THE TERMINALS MUST BE LOCATED.
- THE TOLERANCE THAT CONTROLS THE POSITION OF THE EXPOSED METAL HEAT FEATURE. THE CENTER OF THE TOLERANCE ZONE WILL BE THE DATUM'S DEFINED BY THE CENTERLINES OF THE PACKAGE BODY.
- MAX PACKAGE WARPAGE IS 0.05 MM.
- PIN #1 IS ON TOP WILL BE LASER MARKED.
- RED CIRCLE IN LAND PATTERN INDICATE THERMAL VIA. SIZE SHOULD BE 0.30-0.35mm IN DIAMETER AND SHOULD BE CONNECTED TO GND FOR MAX THERMAL PERFORMANCE.
- GREEN RECTANGLES (SHADED AREA) INDICATE SOLDER STENCIL OPENING ON EXPOSED PAD AREA. SIZE SHOULD BE 0.87x0.87 mm IN SIZE, 1.07 mm PITCH.
- THIS DOCUMENT IS FOR AUTOMOTIVE PRODUCT USE ONLY.

32-Pin 5mm x 5mm QFN

Note:

- Package information is correct as of the publication date. For updates and most current information, go to www.micrel.com.

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