# KSZ9031RNX

## Gigabit Ethernet Transceiver with RGMII Support

## KSZ9031RNX-EVAL Board User's Guide

**Revision 1.1 / August 2012**

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# Revision History

| Revision | Date | Summary of Changes |
|---|---|---|
| 1.0 | 6/15/12 | Initial Release |
| 1.1 | 8/17/12 | Removed 5V DC Adapter from EVAL Kit.<br>Updated Micrel MDIO Configuration Software installation and usage sections. |

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# 1.0 Introduction

The KSZ9031RNX is a completely integrated triple speed (10Base-T/100Base-TX/1000Base-T) Ethernet Physical Layer Transceiver for transmission and reception of data over standard CAT-5 unshielded twisted pair (UTP) cable.

The KSZ9031RNX reduces board cost and simplifies board layout by using on-chip termination resistors for the four differential pairs and by integrating a LDO controller to drive a low cost MOSFET to supply the 1.2V core.

On the copper media interface, the KSZ9031RNX can automatically detect and correct for differential pair misplacements and polarity reversals, and correct propagation delays and re-sync timing between the four differential pairs, as specified in the IEEE 802.3 standard for 1000Base-T operation.

The KSZ9031RNX provides the Reduced Gigabit Media Independent Interface (RGMII) for direct connection to RGMII MACs in Gigabit Ethernet Processors and Switches for data transfer at 10/100/1000 Mbps speed.

The KSZ9031RNX Evaluation Board (KSZ9031RNX-EVAL) provides a comprehensive platform to evaluate the KSZ9031RNX features. All KSZ9031RNX configuration pins are accessible either by jumpers, test points or interface connectors.

# 2.0 Board Features

- Micrel KSZ9031RNX 10Base-T/100Base-TX/1000Base-T Physical Layer Transceiver
- RJ-45 Jack for Ethernet cable interface
- Auto MDI/MDI-X for automatic detection and correction for straight-through and crossover cables
- RGMII Loopback for standalone evaluation
- LED Indicators for link status and activity
- Jumpers to configure strapping pins
- Manual Reset Button for quick reboot after re-configuration of strapping pins
- USB port for MDC/MDIO programming access to KSZ9031RNX PHY registers

# 3.0 Evaluation Kit Contents

The KSZ9031RNX Evaluation Kit includes the following hardware:

- KSZ9031RNX-EVAL Board (a.k.a. KSZ9031RNX Socket Board)

And a design package with the following collaterals:

- KSZ9031RNX Evaluation-Socket Board Schematic (PDF and OrCAD DSN file)
- KSZ9031RNX Evaluation-Socket Board Gerber & PADS PowerPCB Files
- KSZ9031RNX Evaluation-Socket Board BOM
- KSZ9031RNX Evaluation-Socket Board User's Guide (this document)
- KSZ9031RNX IBIS Model (separate files for 1.8V, 2.5V, and 3.3V VDD I/O voltages)
- Micrel MDIO Configuration Software

# 4.0 Hardware Description

The KSZ9031RNX-EVAL board provides a standalone evaluation platform for the KSZ9031RNX Gigabit Ethernet Transceiver. Configuration of the KSZ9031RNX is accomplished through on-board jumper selections and/or by PHY register access via the KSZ9031RNX MDC/MDIO management pins via the USB port (CN1).

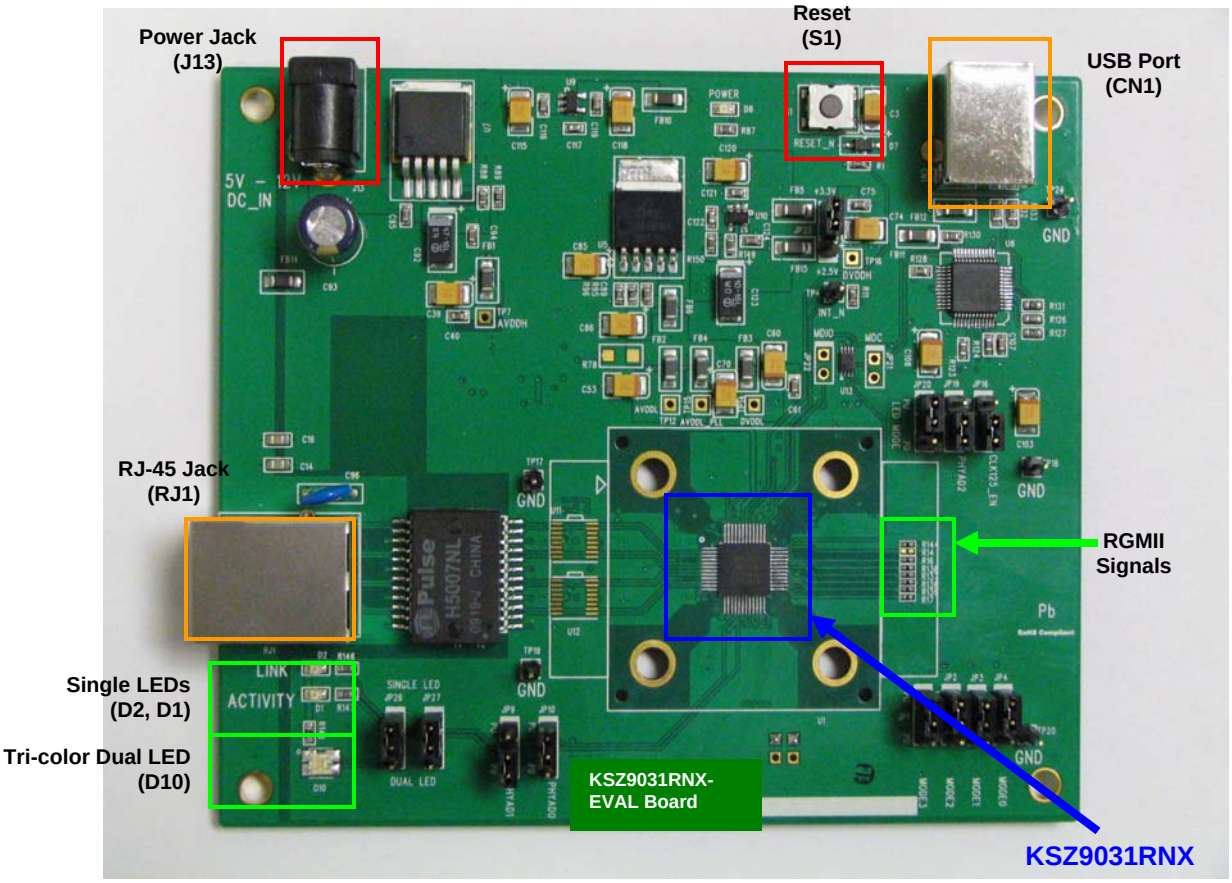



**Figure 1. KSZ9031RNX-EVAL Board**

Features include a RJ-45 Jack for 10/100/1000 Ethernet speed cable connection, programmable LED indicators for reporting link status and activity, and a manual reset button for quick reboot after re-configuration of strapping pins.

On-board, RGMII receive output clock and signals are looped back to RGMII transmit input clock and signals to provide a standalone evaluation platform for the KSZ9031RNX device. Optionally, the RGMII loop back path can be opened to allow the RGMII signals to be wired to a Gigabit MAC on another board.

The KSZ9031RNX-EVAL board receives power from a DC power jack (J13). Any DC power adapter in the range of 5V to 12V with a current rating of 2 Amp or better can be used.

## 4.1 Jumper Setting & Definition

At power-up, the KSZ9031RNX device is configured via strapping pins that are set by external pull-up and pull-down resistors. The KSZ9031RNX-EVAL board provides jumpers for the KSZ9031RNX device strap-in settings and for selective board options.

Jumpers allow for quick configuration and re-configuration. To override the current KSZ9031RNX device and board settings, simply select and close the desired jumper setting(s) and toggle the on-board manual reset button (S1) for the new setting(s) to take effect.

The KSZ9031RNX-EVAL board jumper settings are defined in the table below.

| Jumper | KSZ9031RNX Pin Name | Setting | Function |
|---|---|---|---|
| **KSZ9031RNX Device Strapping Pins** | | | |
| JP1 | MODE3 | Close pins (1, 2) | Set MODE3 = 1 |
| | | Close pins (2, 3) | Set MODE3 = 0 |
| JP2 | MODE2 | Close pins (1, 2) | Set MODE2 = 1 |
| | | Close pins (2, 3) | Set MODE2 = 0 |
| JP3 | MODE1 | Close pins (1, 2) | Set MODE1 = 1 |
| | | Close pins (2, 3) | Set MODE1 = 0 |
| JP4 | MODE0 | Close pins (1, 2) | Set MODE0 = 1 |
| | | Close pins (2, 3) | Set MODE0 = 0 |
| JP19 | PHYAD2 | Close pins (1, 2) | Set PHYAD2 = 1 |
| | | Close pins (2, 3) | Set PHYAD2 = 0 |
| JP9 | PHYAD1 | Close pins (1, 2) | Set PHYAD1 = 1 |
| | | Close pins (2, 3) | Set PHYAD1 = 0 |
| JP10 | PHYAD0 | Close pins (1, 2) | Set PHYAD0 = 1 |
| | | Close pins (2, 3) | Set PHYAD0 = 0 |
| JP16 | CLK125_EN | Close pins (1, 2) | Enable 125 MHz Clock Output |
| | | Close pins (2, 3) | Disable 125 MHz Clock Output |
| JP20 | LED_MODE | Close pins (1, 2) | Select Single LED Mode |
| | | Close pins (2, 3) | Select Tri-color Dual LED Mode |
| **KSZ9031RNX-EVAL Board Settings** | | | |
| JP26 | LED2 | Close pins (1, 2) | Use for Single LED Mode |
| | | Close pins (2, 3) | Use for Tri-color Dual LED Mode |
| JP27 | LED1 | Close pins (1, 2) | Use for Single LED Mode |
| | | Close pins (2, 3) | Use for Tri-color Dual LED Mode |
| JP23 | DVDDH | Close pins (1, 2) | Select 2.5V for KSZ903RNX digital I/Os |
| | | Close pins (2, 3) | Select 3.3V for KSZ9031RNX digital I/Os |
| JP21 [1] | MDC | Close Jumper | Close MDC signal to USB Controller (U8) |
| | | Open Jumper | Open MDC signal to USB Controller (U8) |
| JP22 [1] | MDIO | Close Jumper | Close MDIO signal to USB Controller (U8) |
| | | Open Jumper | Open MDIO signal to USB Controller (U8) |

**Note:** [1] JP21 and JP22 connect the MDC/MDIO signals to U8 when U13 is not populated.

**Table 1. KSZ9031RNX-EVAL Board – Jumper Definition**

The following table lists the strapping pin definitions for the KSZ9031RNX-EVAL board jumpers.

<table>
<tr><th>Jumper</th><th>Pin</th><th>Pin Name</th><th>Pin Function</th></tr>
<tr><td>JP1<br>JP2<br>JP3<br>JP4</td><td>27<br>28<br>31<br>32</td><td>MODE3<br>MODE2<br>MODE1<br>MODE0</td><td>The MODE[3:0] strap-in pins are latched at power-up / reset and are defined as follows:<br><br><table><tr><th>MODE[3:0]</th><th>Mode</th></tr><tr><td>0100</td><td>NAND Tree</td></tr><tr><td>0111</td><td>Chip Power Down</td></tr><tr><td>1100</td><td>RGMII – advertise 1000Base-T full-duplex only</td></tr><tr><td>1101</td><td>RGMII – advertise 1000Base-T full and half-duplex only</td></tr><tr><td>1110</td><td>RGMII – advertise all capabilities (10/100/1000 speed half/full duplex), except 1000Base-T half-duplex</td></tr><tr><td>1111</td><td>RGMII – advertise all capabilities (10/100/1000 speed half/full duplex)</td></tr></table><br>All other MODE[3:0] settings not listed are reserved and are not used by the KSZ9031RNX-EVAL.<br><br>MODE[3:0] = 1111 is the normal RGMII setting and is set as the default for the board.</td></tr>
<tr><td>JP19<br>JP9<br>JP10</td><td>35<br>15<br>17</td><td>PHYAD2<br>PHYAD1<br>PHYAD0</td><td>The PHY Address is latched at power-up / reset and is configurable to any value from 0 to 7.<br>PHY Address bits [4:3] are always set to '00'.<br><br>PHYAD[2:0] = 001 is set as the default for the board.</td></tr>
<tr><td>JP16</td><td>33</td><td>CLK125_EN</td><td>CLK125_EN is latched at power-up / reset and is defined as follows:<br>Pull-up (1) = Enable 125MHz Clock Output<br>Pull-down (0) = Disable 125MHz Clock Output<br>Pin 41 (CLK125_NDO) provides the 125MHz reference clock output option for use by the MAC.<br><br>CLK125_EN = 0 is set as the default for the board.</td></tr>
<tr><td>JP20</td><td>41</td><td>LED_MODE</td><td>LED_MODE is latched at power-up / reset and is defined as follows:<br>Pull-up (1) = Single LED Mode<br>Pull-down (0) = Tri-color Dual LED Mode<br><br>LED_MODE = 1 is set as the default for the board.</td></tr>
</table>

**Table 2. Strapping Pin Definitions for KSZ9031RNX-EVAL Board Jumpers**

## 4.2 Test Point Definition

The KSZ9031RNX-EVAL board has 16 usable test points, as defined in the following table.

| Test Point | Definition |
|---|---|
| TP4 | Interrupt Signal (KSZ9031RNX pin 38) with 4.7K external pull-up |
| TP7 | AVDDH voltage – KSZ9031RNX power pins |
| TP12 | AVDDL voltage – KSZ9031RNX power pins |
| TP14 | DVDDL – KSZ9031RNX power pins |
| TP15 | AVDDL_PLL – KSZ9031RNX power pin |
| TP16 | DVDDH – KSZ9031RNX power pins |
| TP17 | Signal Ground |
| TP18 | Signal Ground |
| TP19 | Signal Ground |
| TP20 | Signal Ground |
| TP24 | Signal Ground |
| TP33 | Exposed ground connection to KSZ9031RNX paddle ground (bottom of chip); Test point is located on solder side of PCB. |
| TP34 | End point for board trace delay for RGMII RX_CLK output clock; Refer to KSZ9031RNX-EVAL Board Schematic for more details. |
| TP35 | 1.8ns (10000 mils) board trace delay for RGMII RX_CLK output clock, starting from resistor R144; Refer to KSZ9031RNX-EVAL Board Schematic for more details. |
| TP36-TP37 | 450ps (2500 mils) board trace delay for RGMII RX_CLK output clock; Refer to KSZ9031RNX-EVAL Board Schematic for more details. |

**Table 3. KSZ9031RNX-EVAL Board – Test Point Definition**

## 4.3 RJ-45 Copper Interface

The RJ-45 copper interface (RJ1) connects to standard unshielded twisted pair (UTP) CAT-5 Ethernet cable to interface with 10Base-T/100Base-TX/1000Base-T network devices.

The KSZ9031RNX copper media interface can automatically detect and correct for differential pair misplacements and polarity reversals, and correct propagation delays and re-sync timing between the four differential pairs, as specified in the IEEE 802.3 standard for 1000Base-T operation.

Auto MDI/MDI-X is supported for automatic detection and correction for straight and crossover cables when interfacing to link partners with fixed MDI or MDI-X setting.

## 4.4 LED Indicators

The KSZ9031RNX device provides two programmable LED output pins, LED2 (pin 15) and LED1 (pin 17). On the KSZ9031RNX-EVAL board, these two LED pins are connected to two sets of LEDs to support two LED configurations: Single LED mode and Tri-color Dual LED mode.

### 4.4.1 Single LED Mode

To enable Single LED mode,

- Close pins (1, 2) of jumpers JP26 and JP27 to select D2 and D1, respectively for the single LEDs.
- Close pins (1, 2) of jumper JP20 to set the LED_MODE strap-in for Single LED mode.
- Power-up the board.

After board power-up, the on-board D2 and D1 LEDs are defined as follows:

| LED | LED Definition | Link / Activity |
|---|---|---|
| **D2** | OFF | Link off |
| | Green – ON | Link on (any speed) |
| **D1** | OFF | No Activity |
| | Green – Blinking | Activity (RX, TX) |

**Table 4: Single LED Mode – LED Definition**

### 4.4.2 Tri-color Dual LED Mode

To enable Tri-color Dual LED mode,

- Close pins (2, 3) of jumpers JP26 and JP27 to select D10 for the tri-color dual LED.
- Close pins (2, 3) of jumper JP20 to set the LED_MODE strap-in for Tri-color Dual LED mode.
- Power-up the board.

After board power-up, the on-board D10 LED is defined as follows:

| LED: D10 | Link / Activity |
|---|---|
| OFF | Link off |
| Green – ON | 1000Mbps Link / No Activity |
| Green – Blinking | 1000Mbps Link / Activity (RX, TX) |
| Red – ON | 100Mbps Link / No Activity |
| Red – Blinking | 100Mbps Link / Activity (RX, TX) |
| Orange – ON | 10Mbps Link / No Activity |
| Orange – Blinking | 10Mbps Link / Activity (RX, TX) |

**Table 5: Tri-color Dual LED Mode – LED Definition**

## 4.5 Reduced Gigabit Media Independent Interface (RGMII)

The KSZ9031RNX-EVAL board provides open access to the KSZ9031RNX device's RGMII signals, and enables the RGMII signals to be wired for the following two usages:

- RGMII Loop Back
- RGMII Connection to GMAC

### 4.5.1 RGMII Loop Back

The KSZ9031RNX-EVAL board is shipped with the RGMII signals configured for RGMII Loop Back. Resistors [R14, R16, R136-R139] are populated to connect the RGMII output clock and signals to their respective RGMII input clock and signals, thru resistors [R18, R17, R143, R142, R141, R140], respectively. Refer to KSZ9031RNX-EVAL Board Schematic for details.

RGMII Loop Back enables the KSZ9031RNX device to operate as a standalone evaluation platform without the need of an external GMAC. Ethernet traffic from the link partner (Spirent SmartBits 6000B in the following figure) are received by the KSZ9031RNX device, looped back externally via RGMII pins, and transmitted back to the link partner.

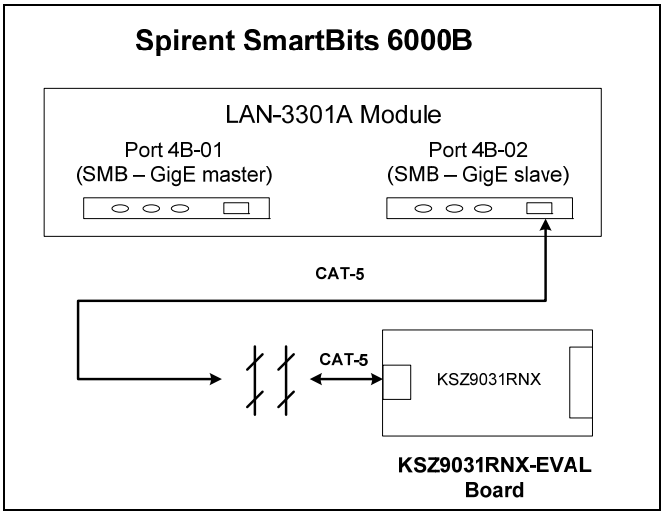



**Figure 2. KSZ9031RNX-EVAL Board – RGMII Loop Back**

RGMII Loop Back is supported for 1000Base-T and 100Base-TX only. 10Base-T requires a MAC due to preamble consumption, and therefore is not supported.

### 4.5.2 RGMII Connection to GMAC

The KSZ9031RNX-EVAL board exposes the RGMII signals at the following series termination (49.9 Ohm) / jumper (0 Ohm) resistor locations, as indicated in the following table.

| Resistor (PCB location) | KSZ9031RNX-EVAL Signal Name | RGMII Signal Name (per spec) |
|---|---|---|
| R14 left pad (PCB – top side) | RX_CLK | RXC |
| R16 left pad (PCB – top side) | RX_DV | RX_CTL |
| R136 left pad (PCB – top side) | RXD0 | RXD0 |
| R137 left pad (PCB – top side) | RXD1 | RXD1 |
| R138 left pad (PCB – top side) | RXD2 | RXD2 |
| R139 left pad (PCB – top side) | RXD3 | RXD3 |
| | | |
| R18 top pad (PCB – bottom side) | GTX_CLK | TXC |
| R17 left pad (PCB – top side) | TX_EN | TX_CTL |
| R143 top pad (PCB – bottom side) | TXD0 | TXD0 |
| R142 top pad (PCB – bottom side) | TXD1 | TXD1 |
| R141 top pad (PCB – bottom side) | TXD2 | TXD2 |
| R140 top pad (PCB – bottom side) | TXD3 | TXD3 |

**Table 6. RGMII Signals access at series termination / jumper resistor locations**

Resistors [R14, R16, R136-R139] for the RGMII output clock and signals and the corresponding resistors [R18, R17, R143, R142, R141, R140] for the RGMII input clock and signals can be removed to open the RGMII Loop Back path and allow the RGMII signals (in the above table) to be wired to a GMAC on another board for evaluation and testing.

## 4.6 USB Port

The USB port (CN1) provides programming access to the KSZ9031RNX device's PHY registers through its MDC/MDIO management pins.

See following software section for PHY register access.

# 5.0 Micrel MdioConfig Software – Installation

The Micrel MDIO Configuration Software (**MdioConfig.exe** program) runs on a PC/NOTEBOOK with the Window XP or 7 Operating System. It communicates with the KSZ9031RNX-EVAL board via USB to provide programming access to the KSZ9031RNX PHY registers.

The Micrel software is provided in a Microsoft Windows Installer installation package file (*.msi file) with the following file name.

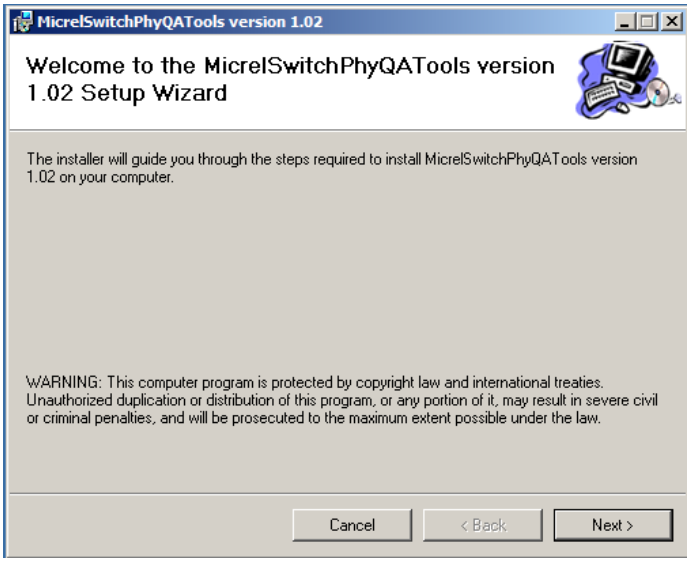
**MicrelSwitchPhyQATools_x.xx.msi** // where x.xx is the release version number

## 5.1 MicrelSwitchPhyQATools Installation

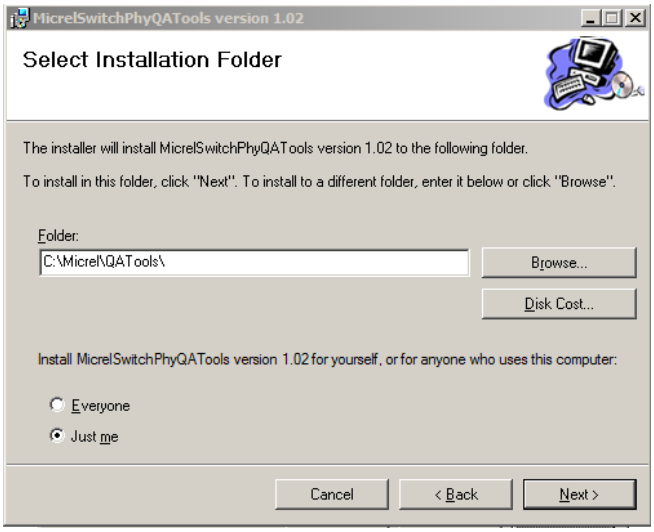
Before running the **MicrelSwitchPhyQATools** installation, make sure previously installed version of the **MicrelSwitchPhyQATools** software has been removed and the USB cable to the KSZ9031RNX-EVAL board is unplugged.

To unpack the **MicrelSwitchPhyQATools_x.xx.msi** file and start the installation, double click on the file name from Windows Explorer, and proceed with the following steps:

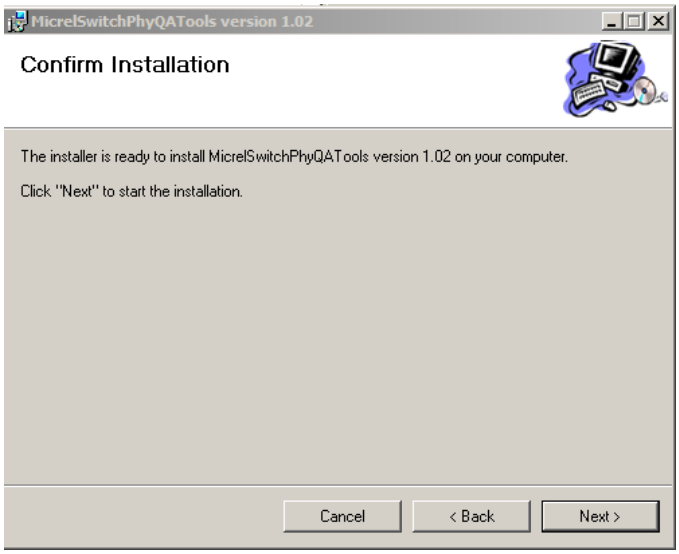
1. At the "**Welcome"** screen, press the **Next>** button.



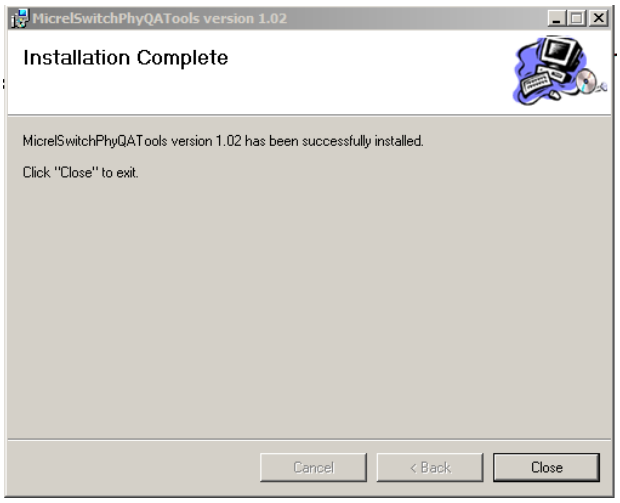
2. At the "**Select Installation Folder"** screen,
    a. Select the folder for the software installation (c:\Micrel\QATools\ is the default installation folder).
    b. Press the **Next>** button.




3. At the "**Confirm Installation"** screen,
    a. Press the **Next>** button for the installation to proceed.
    b. Wait a few seconds for the installation to finish.



4. When the installation is finished, the "**Installation Complete"** screen is returned. Press the **Close>** button to exit.




After the **MicrelSwitchPhyQATools** installation, an installation folder (c:\Micrel\QATools\ is the default installation folder) is created containing the **mdioConfig** application program and software drivers for the KSZ9031RNX-EVAL board's USB port.

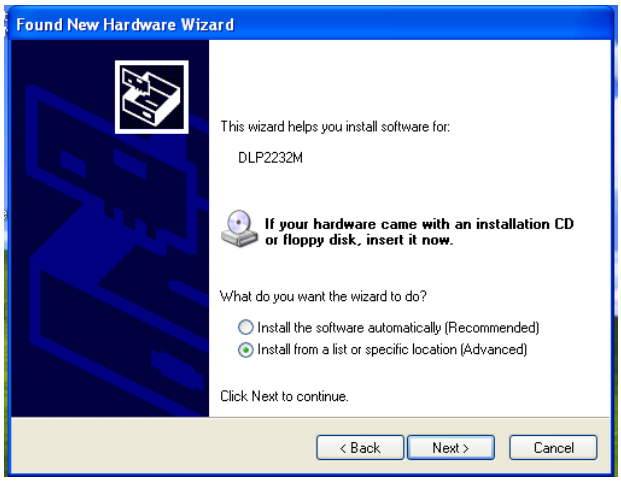
## 5.2 USB Driver Installation

Before installing the USB driver, complete the **MicrelSwitchPhyQATools** software installation in the previous section to extract the USB driver from the **MicrelSwitchPhyQATools_x.xx.msi** installation file and have it copied to the created installation folder.

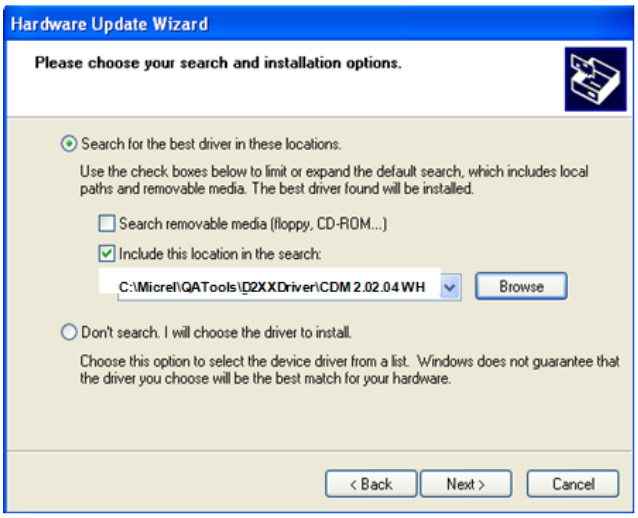
Power-up the KSZ9031RNX-EVAL Board and connect USB cable from board to PC/NOTEBOOK with the Windows XP or 7 Operating System to initiate the USB driver installation, and proceed with the following steps:

1. Windows XP detects the KSZ9031RNX-EVAL board's USB device. At the "**Welcome to the Found New Hardware Wizard"** screen,
    a. Select "**No, not this time".**
    b. Press the **Next>** button.

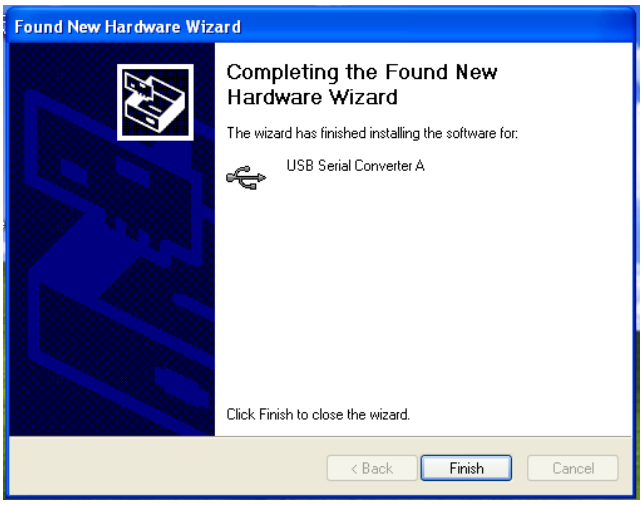
2. At the "**… install software for:"** screen,
    a. Select "**Install from a list or specific location (Advanced)".**
    b. Press the **Next>** button.



3. At the "**Please choose your search and installation options"** screen,
    a. Select **"Include this location in the search:"**
    b. Press the **Browse** button and navigate to and select the USB driver directory (**C:\Micrel\QATools\D2XXDriver\CDM 2.02.04 WHQL Certified** is the USB driver directory for the default installation folder).
    c. Press the **Next>** button for the USB driver installation to proceed.
    d. Wait for the USB driver installation to finish.

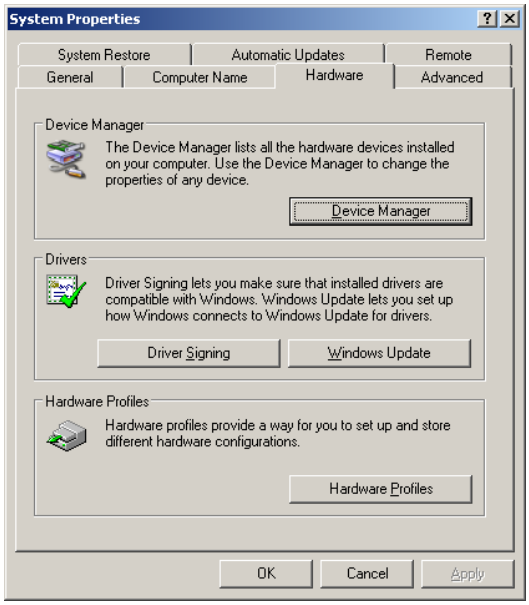



4. At the "**Completing the Found New Hardware Wizard"** screen, press the **Finish** button to close the wizard and exit.



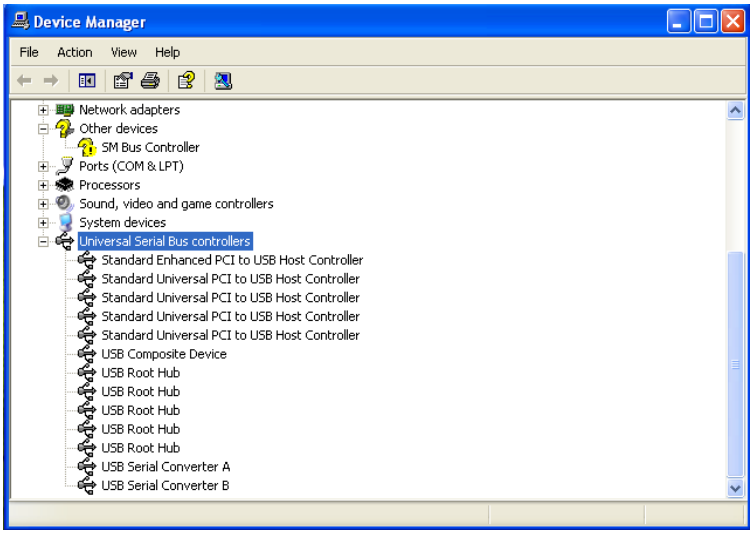
5. After the USB driver installation, verify the USB driver is installed.

    a. Go to the **Windows System Properties** box (select the System icon under Windows Start Menu -> Settings -> Control Panel).




    b. Press the **Device Manager** button

    c. Scroll down to the end of Universal Serial Bus controllers to verify "**USB Serial Converter A**" and "**USB Serial Converter B**" are installed.



# 6.0 Micrel MdioConfig Software – Application Program

The **Micrel MdioConfig** application program resides in the software installation folder created in the previous section (c:\Micrel\QATools\ is the default installation folder). The following application program in the folder will be used to provide read/write access to the KSZ9031RNX PHY registers.

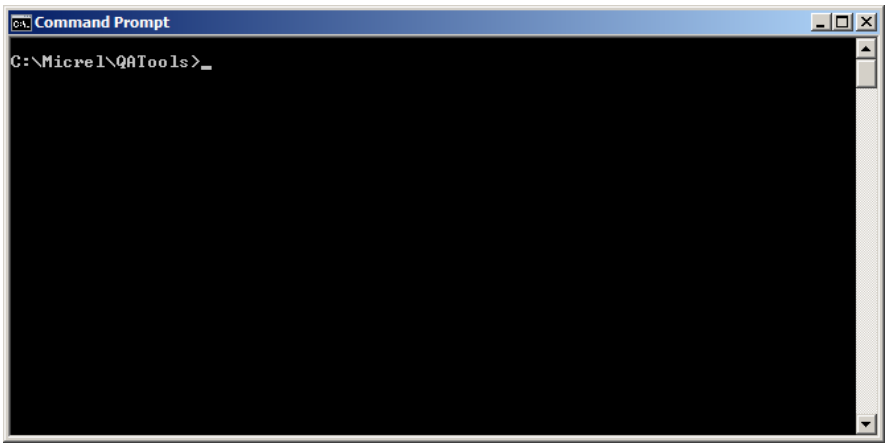
- **mdioConfig.exe** // Windows Command Prompt program

## 6.1 Windows Command Prompt – Command Line program

The **mdioConfig.exe** program is a command line interface program.

### 6.1.1 Running the program

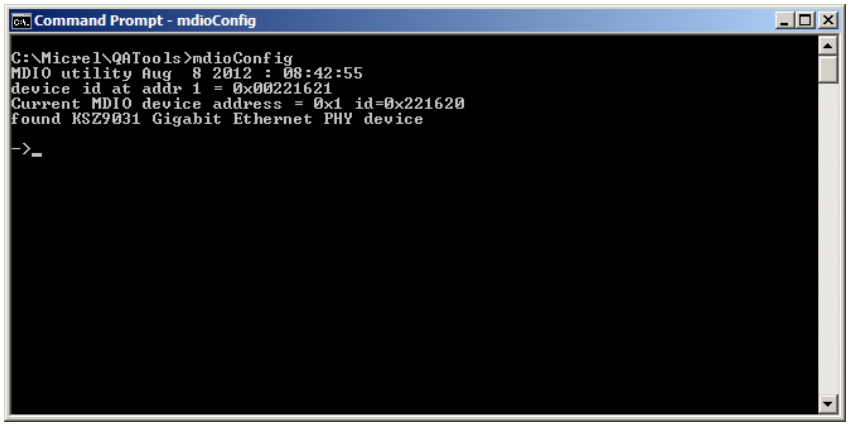
The **mdioConfig.exe** program is executed from a Windows Command Prompt. Open a Windows Command Prompt (select the Command Prompt under Windows Start Menu -> Programs -> Accessories) and go to the **mdioConfig.exe** program directory (c:\Micrel\QATools\ is the program directory for the default installation folder), as shown in the following figure.




**mdioConfig.exe Program – Windows Command Prompt**

The **mdioConfig.exe** program is started by typing the **mdioConfig.exe** program name at the Windows Command Prompt and pressing the **<ENTER>** key.

After pressing the **<ENTER>** key at the previous screen, the program will automatically detect and set the KSZ9031RNX PHY address for the programming session, and then display the command line prompt, "->", as shown in the following figure.




mdioConfig.exe Program – Command Line Prompt

### 6.1.2 Read/Write access to KSZ9031RNX PHY registers

Direct register read and direct register write can be used to check and/or update individual PHY register setting, as needed. The following are the commands and parameters:

*Direct Register Read*

**r** [register address (hex)]

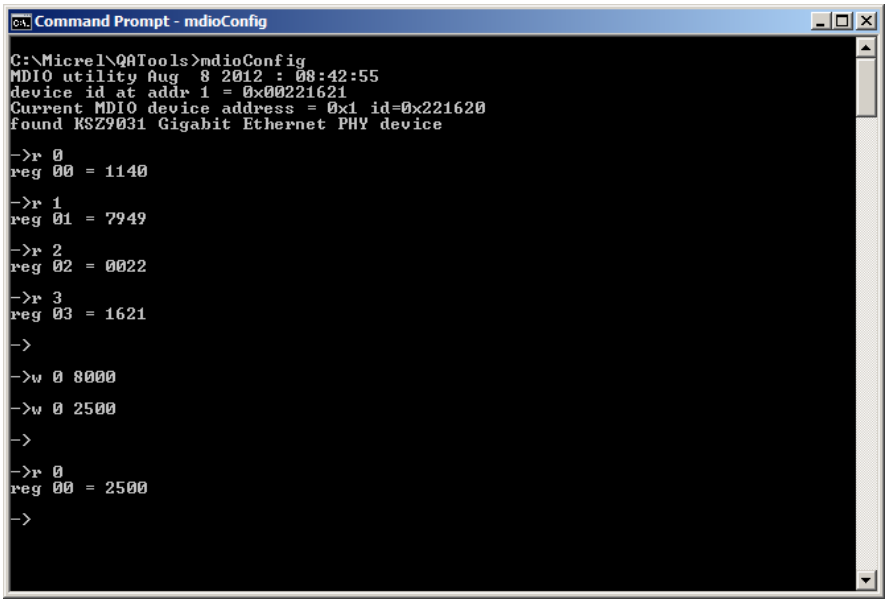
| | |
|---|---|
| **r 0** | // Read PHY register 0h |
| **r 1** | // Read PHY register 1h |
| **r 2** | // Read PHY register 2h |
| **r 3** | // Read PHY register 3h |

*Direct Register Write*

**w** [register address (hex)] [written value (hex)]

| | |
|---|---|
| **w 0 8000** | // Write PHY register 0h with value 0x8000h |
| **w 0 2500** | // Write PHY register 0h with value 0x2500h |

The following screen shows the execution of the direct register read/write commands.




**mdioConfig.exe Program – Direct Register Read / Write Examples**

### 6.1.3 Creating and running a script file

A group of single command lines can be put in a text file (*.txt) to produce a PHY configuration script file. The script file can then be run to program a set of PHY registers.

The script file format is as follow:

- Lines starting with the "#" symbol are ignored and can be used to provide comments
- Empty lines with just the **<ENTER>** key are ignored
- Each command line for register read or register write is entered on a separate line and followed by the **<ENTER>** key

For example, the following is the content of a script file called "**sample.txt**".

```
# Sample script file to read PHY registers 0-3 and write to PHY registers 0 twice
#

r 0
r 1
r 2
r 3
w 0 8000
w 0 2500
```

Copy the script file into the software installation folder created earlier in section 5.0 (c:\Micrel\QATools\ is the default installation folder).

Type the following script file command line and press the **ENTER** key to execute the script file.

**run sample.txt**

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