

**ENT-AN1224**  
**User Guide**  
**VSC8541 Evaluation Board**  
December 2018



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# 1 **Revision History**

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The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

## 1.1 **Revision 1.0**

Revision 1.0 was the first publication of this document.

## 2 Overview

The VSC8541 and VSC8531 devices are low-power, small form-factor Gigabit Ethernet PHYs. They feature integrated, line-side termination to conserve board space, lower EMI, and improve system performance. Additionally, integrated RGMII timing compensation eliminates the need for on-board delay lines. The devices support the industry's widest range of LVCMOS levels for a parallel MAC interface. They also optimize power consumption in all link operating speeds and feature Wake-on-LAN power management using magic packets.

This document describes the architecture and usage of the VSC8541 Evaluation Board (VSC8541EV).

The evaluation board provides a way to evaluate the VSC8541 and VSC8531 devices in multiple configurations. Two RJ-45 connectors are provided for the copper media interface from each device. The MAC interface is exposed through 0.1 inch pin-headers, J206, J202, and J203. For standalone access to all device features, an external microcontroller is used to configure both the VSC8541 and the VSC8531 through the MDIO bus. The graphical user interface (GUI) enables the user to read and write device registers.

**Figure 1 • VSC8541EV—Top View**

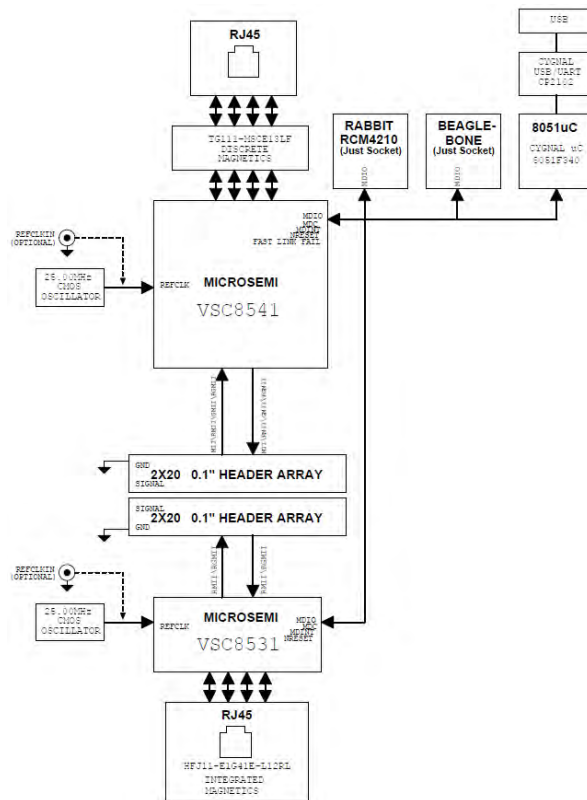


**Figure 2 • VSC8541EV—Bottom View**



The following illustration shows a simplified block diagram of the VSC8541EV.

**Figure 3 • VSC8541EV Simplified Block Diagram**



Other collateral for the VSC8541/VSC8531 devices and VSC8541EV—including schematics, layout, GUI, and application notes—can be downloaded from the Microsemi website.

## 3 Key Features

The following sections describe key features of the VSC8541EV.

### 3.1 Copper Port RJ45 Connections

The VSC8541 media dependent interface (MDI) uses generic RJ-45 connectors with an open-source, hardware-compliant HALO® Electronics Genesys™ TG111-MS13LF 8-core discrete transformer. The VSC8531 MDI uses a HALO® Electronics integrated magnetics R-J45 connector, HFJ11-1G41E-L12RL.

### 3.2 MAC Interface Connector

The parallel MAC interface signals are available through 0.1 inch pin-headers.

#### 3.2.1 RGMII Interface

RGMII signals from VSC8541 and VSC8531 are routed to J200 and J201, respectively. J200 and J201 are placed face-to-face in such a way that 0.1 inch shunt jumpers can be used to connect RXD and TXD between the two PHYs. This will allow traffic flow between the two PHYs so that Ethernet traffic tests (such as Iperf or Ping-Test) can be easily performed. The RXD and TXD within VSC8541 are routed to allow traffic to be looped back within a single PHY. The routing for VSC8531 is similar.

The following table shows the RGMII connector layout.

**Table 1 • RGMII Connector Layout**

| VSC8541 (J200) |            | VSC8531 (J201) |     |
|----------------|------------|----------------|-----|
| GND            | TXD3       | RXD3           | GND |
| GND            | RXD3       | TXD3           | GND |
| GND            | TXD2       | RXD2           | GND |
| GND            | RXD2       | TXD2           | GND |
| GND            | GTX_CLK    | RX_CLK         | GND |
| GND            | RX_CLK_ext | RX_CLK_ext     | GND |
| GND            | RX_CLK     | GTX_CLK        | GND |
| GND            | TXD1       | RXD1           | GND |
| GND            | RXD1       | TXD1           | GND |
| GND            | TXD0       | RXD0           | GND |
| GND            | RXD0       | TXD0           | GND |
| GND            | TX_CTL     | RX_DV          | GND |
| GND            | RX_DV      | TX_CTL         | GND |

#### 3.2.2 RMII Interface

The RMII interface uses a subset of RGMII signals, and so RMII signals are available through 0.1 inch pin-headers on J200 and J201 for VSC8541 and VSC8531, respectively.

#### 3.2.3 MII/GMII Interface (VSC8541 only)

The rest of the VSC8541's MAC interface signals for MII and/or GMII modes are routed to J202 and J203. The RXD signals are on J203 and TXD signals are on J202. They are also placed side-by-side to allow traffic to be looped back within the VSC8541.

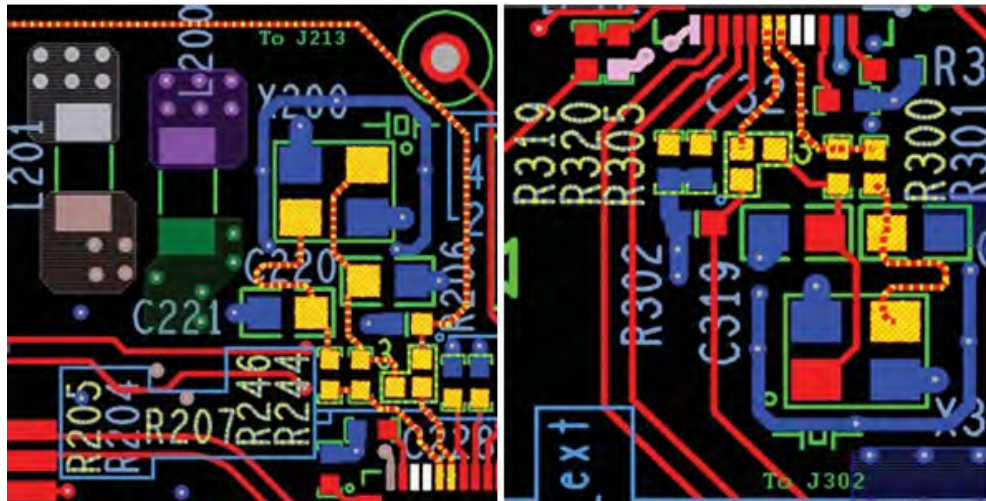
### 3.3 Reference Clock

By default, both PHYs are configured for 25 MHz on-chip oscillator-enabled mode. The user may choose to provide an external reference clock through the SMA connector to J213 and J302 (as shown in [VSC8541EV—Top View](#)) for VSC8541 and VSC8531, respectively.

The following steps are required to route the SMA signal to the device.

1. Configure the REFCLK\_SEL\_0 and REFCLK\_SEL\_1 state according to the desired reference clock frequency. By default, there are pull-down resistors (R246 and R244 for VSC8541, and R319 and R320 for VSC8531) as needed for 25 MHz on-chip oscillator-enabled mode.
2. Reorient the dual-position 0  $\Omega$  resistors R207 (for VSC8541) and R305 (for VSC8531), as shown from the PCB layout view in the following illustration.

**Figure 4 • REFCLK Input Options—R207 and R305 Dual-Position Orientation**



**Note:** The external reference clock must be a 2.5 V LVTTTL or similar type of signal because the REFCLK signal is referenced to VDD25A.

The reference clock selection for VSC8541 is independent of that for VSC8531.

**Note:** SMA connectors are not normally populated. If this is desired, please contact your local Microsemi representative and request this when placing the evaluation board order.

### 3.4 Recovered Clock and Clockout

The VSC8541 offers both a recovered clock output and a clockout signal that is available on the 0.1 inch pin-header J208. VSC8531 has a clockout signal available on the 0.1 inch pin-header J301. In the default configuration, CLK\_SQUELCH\_IN is left floating with an accessible test point on J207, which disables the clock squelching.

### 3.5 Bootstrapping Option

The reserved external pull-up resistors are located at the bottom side of the board. By default, VSC8541 and VSC8531 are bootstrapped to the following configuration.

- Unmanaged mode
- 10/100/1000 FDX/HDX
- ANEG enabled
- RGMII MAC with 2.0 ns internal delay setting
- PHY address of 0x0 (for VSC8531) and 0x1 (for VSC8541)

### 3.6 LEDs

LED0 from each PHY is connected to the LED on RJ-45 as well as discrete LEDs (LED1 for VSC8541 and LED2 for VSC8531). LED1 from each PHYs is connected to the other LED on the RJ-45.

### 3.7 MDINT, Fast Link Fail

MDINT from each PHY is available through a 0.1 inch pin-header on J206. Fastlink\_Fail from VSC8541 is also connected to one of the pin-headers on J206.

### 3.8 Software Interface Microcontroller

A Silabs F340 microcontroller is included to facilitate a software interface to the registers on the VSC8541 and VSC8531 through the USB port.

**Note:** Alternatively, a Rabbit card is available for an IP-based manager of the PHY register space, to be installed onto the U402 connector of the board's bottom side. Another option is for MDC and MDIO to be accessed on pin-header, J206, if it is desired for another microcontroller to host the PHY register space.

### 3.9 Power Supply Options

There are three power supply options for the evaluation board, described in the following sections.

#### 3.9.1 Single 5.0 V Input for DUT and Other Components

In this option, the VSC8541EV is powered by plugging in a USB cable to the board and to a PC. The board has three on-board switching regulators that will convert the 5.0 V supplied by the PC to 1.0 V and 2.5 V for the DUT (VSC8541 and VSC8531) and 3.3 V for the other components. The 1.0 V supply is used to power VDD1, and the 2.5 V supply is used to power VDD25A, VDDIO, VDDMAC, and VDDMDIO.

If desired, VDDIO, VDDMAC, and VDDMDIO can be individually supplied with external power supplies.

#### 3.9.2 DUT Power Rails Isolated from non-DUT Power

This option allows for the multi-rails DUT power supplies—VDDIO, VDDMAC, and VDDMDIO—to be isolated from the rest of the board power, as follows:

1. Remove the desired shunt jumper(s) between VDD25 and VDDIO on J211, VDD25 and VDDMAC on J212, and/or VDD25 and VDDMDIO on J204.
2. Connect the proper supply to pin2 of J211, J212, or J204 for the desired VDDIO, VDDMAC, or VDDMDIO, respectively.

**Note:** This change will impact both VSC8541 and VSC8531

#### 3.9.3 External 5.0 V DC Supply

Alternatively, the user can provide an external 5.0 V DC supply to the board instead of getting it from the USB. Remove the shunt jumpers between 5V0 and VBUS on J501, then provide the external 5.0 V DC supply to the 5V0 pin-headers.



## 4 Quick Start

This section describes how to install and run the GUI to fully control the evaluation board.

### 4.1 Connecting the Power Supply

The evaluation board is powered by the USB and the on-board switching regulators convert the 5.0 V USB power to the required supplies for the devices on the board. The user should immediately see LED3 illuminate (located by U501) when turned on, which confirms that the proper 5.0 V and 2.5 V are now available. This would indicate that the proper 1.0 V and 3.3 V are also up, assuming the switching regulators (U500 and U502) are working as expected.

### 4.2 Installing the PC Software

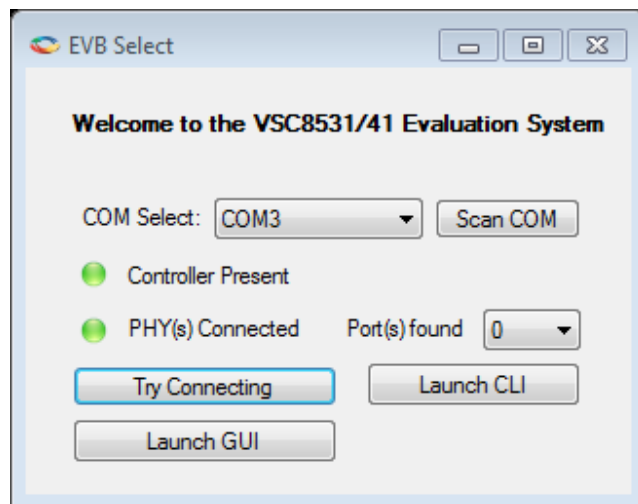
1. Download the ZIP file from Microsemi's website onto a PC that has a USB port.
2. Install the GUI by launching setup.exe or VSC8541EV\_Install.msi.
3. At the end of the GUI installation, the VSC8541EV GUI shortcut will be put onto the desktop.
4. Double click the desktop icon to launch the GUI.

### 4.3 Connecting the Board to the PC

Launch the GUI by either clicking on the VSC8541EV desktop shortcut or clicking the VSC8541EV icon under Start-Programs. The initial window will detect the attached USB devices automatically.

The following illustration shows a typical GUI welcome window.

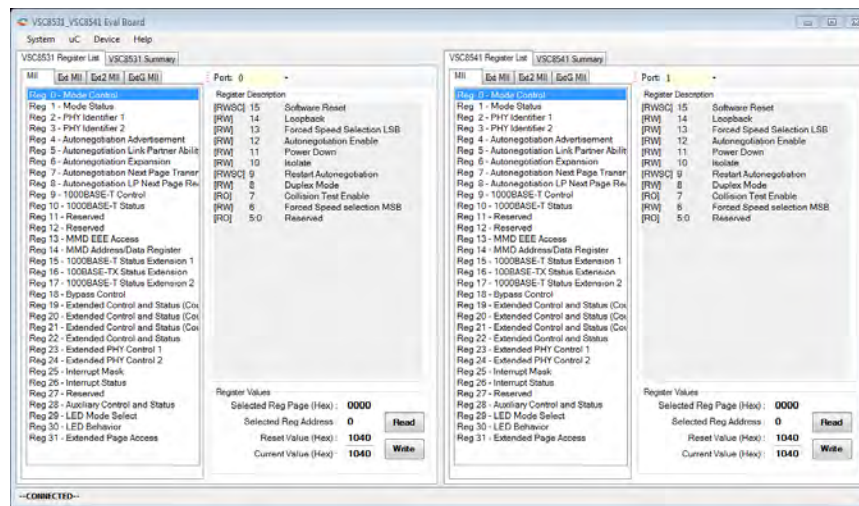
Figure 5 • GUI Welcome Window



Choose the correct COM port from the drop-down menu and then click **Try Connecting**.

In a short moment, the **Controller Present** and **PHY(s) Connected** green LEDs will light up. Next, click **Launch GUI** and the VSC8531\_VSC8541 Eval Board GUI window will appear.

Figure 6 • GUI Window



For ease of use, the GUI window displays two controllers—the left side (port 0) is for VSC8531 and the right side (port 1) is for VSC8541. The Port drop-down menu can also be used to select a different PHY (port) address.

**Note:** If port 1 is selected on both the left and the right controller, then both controllers will be accessing VSC8541 and the same register value will be seen on both sides.

Verify the devices are up and running by reading MII register 0—it should read back 0x1040. Reading back all 0s or all 1s indicates a problem. As indicated in the preceding figure, the extended MII register pages can be accessed to read or write by clicking on one of the ExtMII/Ext2MII/ExtGMII tabs.

VSC8531 Summary and VSC8541 Summary can be used as a register dump mechanism.

## 4.4 Board Initialization

VSC8541 and VSC8531 are configured on the evaluation board using the hardware strapping feature with the following initial settings.

- Unmanaged mode with auto-negotiation enabled and 10/100/1000 FDX/HDX advertised
- RGMII MAC mode with 2.0 ns internal delay setting
- The PHY addresses for VSC8541 and VSC8531 are 0x1 and 0x0, respectively

Once the evaluation board connectivity has been established and confirmed, the PHY should be initialized.

**Note:** A proper NRESET will be issued to both VSC8541 and VSC8531 by the Silabs F340 microcontroller during the board power-up process.

### 4.4.1 MAC Interface Reconfiguration

VSC8541 and VSC8531 are boot-strapped as RGMII mode. To reconfigure the MAC interface, set MII register 23 bit2 12:11 as follows:

- 00: GMII/MII (only valid for VSC8541)
- 01: RMII
- 10: RGMII

**Note:** After configuring bits 12:11 of MII register 23, a software reset (register 0.15) must be asserted to change the device operating mode.

**Note:** In order to perform Ethernet traffic testing in RMII mode, an actual MAC device (or similar) must be used or internal loopback (near-end loop) mode shall be used.

#### 4.4.2 Copper Media Interface (Auto-negotiation Enabled)

The easiest configuration for passing traffic is with Auto-neg enabled (MII register 0, bit 12= 1). Use MII registers 0, 4, and 9 to change the speed and restart auto-neg (register 0, bit 9) to advertise new settings.

As per the datasheet descriptions, the commonly-used speed advertisement definitions are listed in the following table.

**Table 2 • Auto-negotiation Advertisements**

| Mode                    | MII reg 4 bits 8:7 | MII reg 4 bits 6:5 | MII reg 9 bits 12:11 | MII reg 9 bits 9:8 |
|-------------------------|--------------------|--------------------|----------------------|--------------------|
| 1000BT Master Mode      | N/A                | N/A                | 11                   | 11                 |
| 1000BT Slave Mode       | N/A                | N/A                | 10                   | 11                 |
| 100 BASE-TX Full Duplex | 11                 | N/A                | N/A                  | 00                 |
| 10 BASE-T Full Duplex   | 00                 | 11                 | N/A                  | 00                 |

The following steps should be followed to configure a link.

1. Set up the copper traffic source (for instance, IXIA or Smartbits).
2. Connect Ethernet cable(s) to a single or multiple RJ-45 port(s).
3. Configure auto-negotiation as previously described and re-start ANEG (MII bit 0.12).
4. The linkup bit is in MII register 1, bit 2. Read it twice to update.

Traffic should now be flowing, assuming the MAC interface is properly configured and connected as discussed in [MAC Interface Reconfiguration](#).

### 4.5 Useful Test Features

VSC8541EV provides several useful test features, as described in the following sections

#### 4.5.1 Ethernet Packet Generator

ExtMII 29 is the internal Ethernet Packet Generator (EPG) register. The EPG has the option to transmit traffic in multiples of 10,000 frames, regardless of when you stop transmit activity or transmit a burst of 30,000,000 packets. Refer to the datasheet for configuration options.

A Good CRC packet counter is in ExtMII 18.13:0. The Good CRC packet counter is a modulo 10,000 counter, so values will always be between 0 and 9,999. A read of the register reads-back the good CRC packets and then clears the register so the subsequent reads will be 0 if no traffic has been received. If traffic has been received since the last read, bit 15 will be set.

#### 4.5.2 Copper PHY Error Counters

- Idle errors= MII 10.7:0
- RX errors= MII 19.7:0
- False carrier= MII 20.7:0
- Disconnects= MII 21.7:0
- CRC errors= ExtMII 23.7:0

#### 4.5.3 Near-End Loopback

When the near-end loopback test feature is enabled, the transmitted data is looped back in the PCS block on the receive data signals. To enable the loopback, set MII register 0 bit 14 to 1. Near-end loopback requires proper configuration of J200 and/or J201.

#### **4.5.4 Far-End Loopback**

When the far-end loopback test feature is enabled, incoming data from a link partner on the copper interface is transmitted back to the link partner on the copper interface. To enable the loopback, set register bit 23.3 to 1.

#### **4.5.5 Transmitter Test Mode**

1000BASE-T PMA test control can be configured through MII register 9, bits 15:13. Refer to the PMA Test application note for additional information on performing the PMA conformance test.

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