

# AN781: Alternative Output Termination for Si5211x, Si5213x, Si5214x, Si5216x, Si522xx, Si5310x, Si5311x, and Si5315x PCIe Clock Generator and Buffer Families

---

This application note is intended to provide optional, alternative output terminations for converting a low-power HCSL output clock from a Skyworks PCIe clock generator or buffer device into a LVPECL, LVDS, or CML formatted clock. These optional terminations are particularly useful in applications that require both 100 MHz PCIe output clocks, as well as 100 MHz LVDS, LVPECL, or CML output clocks for FPGAs, SGMII, or other chipsets. Rather than using separate clock generators or oscillators to satisfy these system requirements, one can utilize a single-clock generator or buffer IC from Skyworks and employ different terminations on each output to achieve the desired results. It is relevant to note all Skyworks devices that provide HCSL PCIe outputs utilize low-power, push-pull buffers as opposed to constant current mode buffers. There are many advantages to using low-power, push-pull output buffers, including lower power consumption, elimination of external termination resistors, and overall reduction in total PCB area.

#### KEY FEATURES OR KEY POINTS

- Translate HCSL to LVPECL, LVDS or CML levels
- Reduce Power Consumption
- Simplify BOM AVL

## 1. Conversion of HCSL Signals to LVPECL Signals

A low-power, push-pull HCSL output clock can be converted to either 2.5 V or 3.3 V LVPECL standards by using an output termination as shown in Figure 1.1 Termination Scheme for HCSL to LVPECL Conversion on page 2. Figure 1.2 Oscilloscope Measurement of LVPECL Conversion on page 2 shows the output clock at the measurement point indicated in Figure 1.1 Termination Scheme for HCSL to LVPECL Conversion on page 2. VCC supply is required to set the common mode voltage at the receiver end. Table 1.1 Resistor Selection for Different VCC Standards (LVPECL Signal Conversion) on page 3 lists the resistor selection based on VCC.

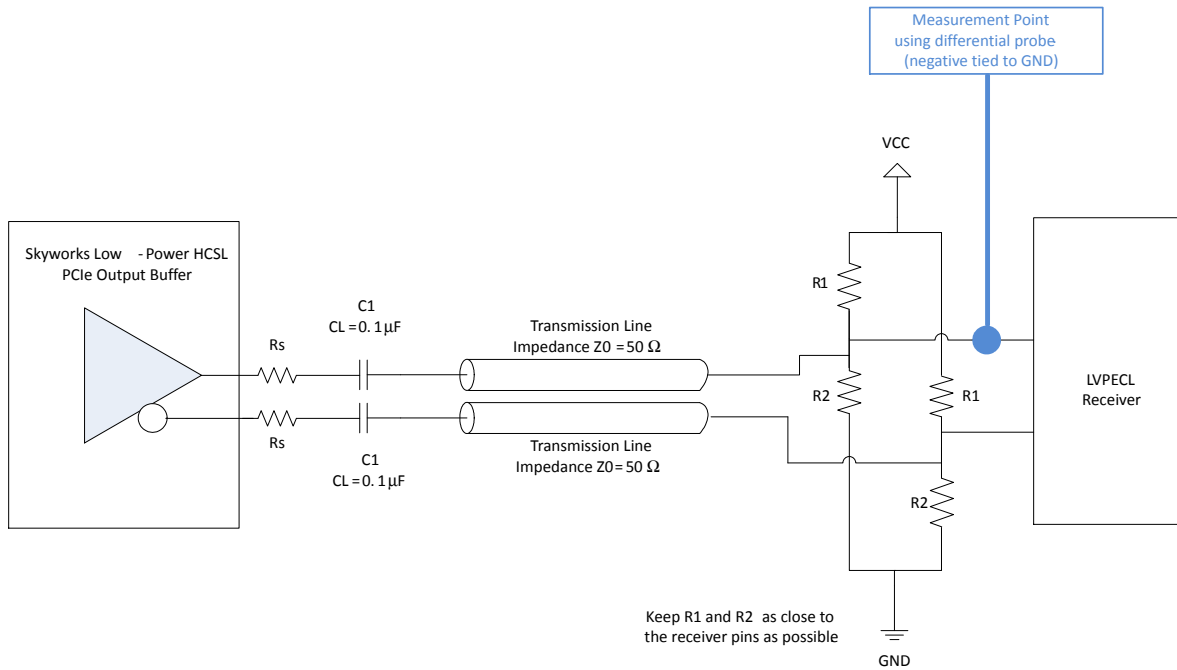


Figure 1.1. Termination Scheme for HCSL to LVPECL Conversion

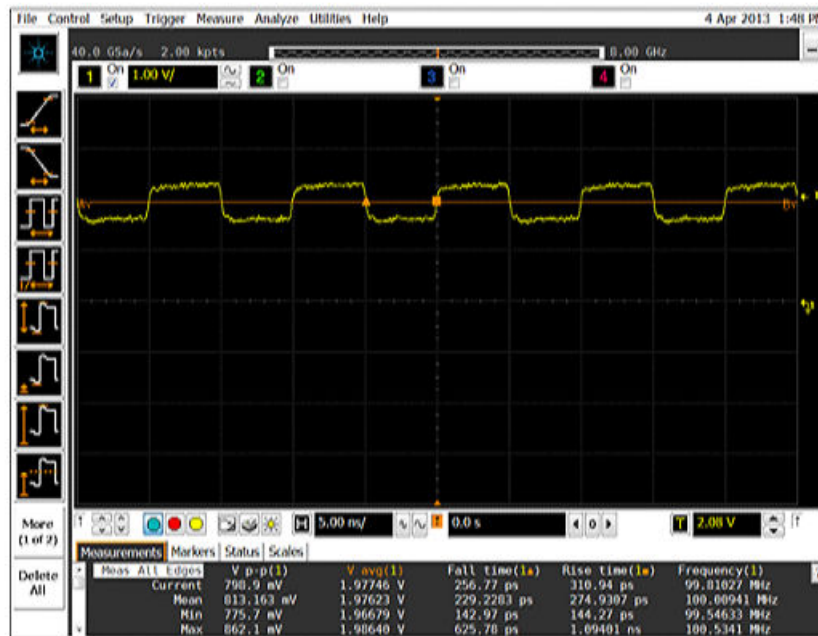


Figure 1.2. Oscilloscope Measurement of LVPECL Conversion

**Table 1.1. Resistor Selection for Different VCC Standards (LVPECL Signal Conversion)**

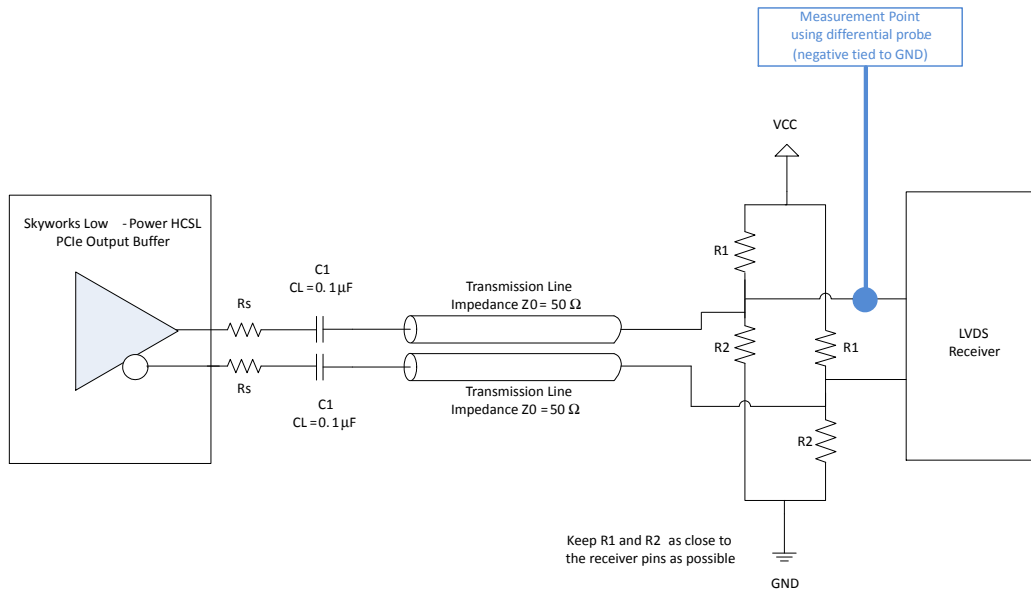
VCC	Expected Common Mode Voltage (V)	R1 (k $\Omega$ )	R2 (k $\Omega$ )
3.3	2	3	5
2.5	1.1	5	4

**Table 1.2. Series Resistor Selection for PCIe Clock Generators and Buffers**

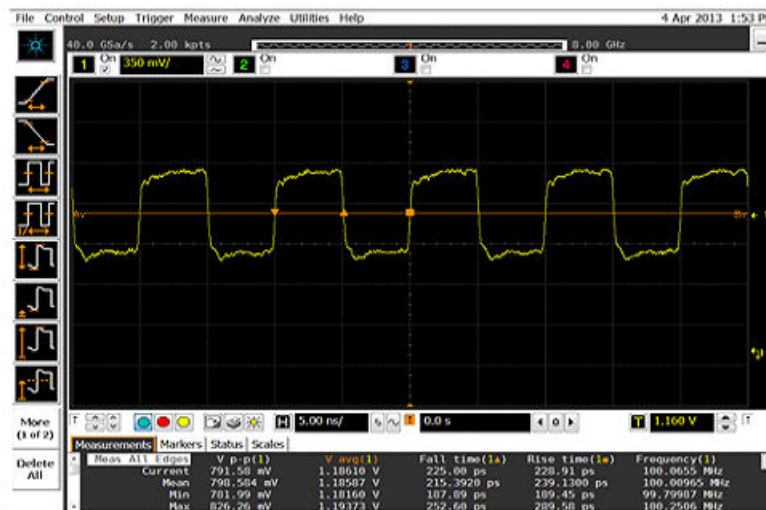
Device	Zdiff ( $\Omega$ )	Rs ( $\Omega$ )
Si5310x, Si5311x	100	33
Si5211x, Si5213x, Si5214x, Si5216x, Si5315x	100	0
Si52202/04/08/12	100	0

## 2. Conversion of HCSL Signals to LVDS Signals

One can also convert a low-power, push-pull HCSL clock output to a 1.8 V, 2.5 V, or 3.3 V LVDS clock output. The recommended termination scheme is shown in [Figure 2.1 Termination Scheme for Low-Power HCSL to LVDS Conversion \(When Receiver has no Termination or Internal 100 Ω Termination\)](#) on page 4, with the corresponding oscilloscope measurement shown in [Figure 2.2 Oscilloscope Measurement of LVDS Conversion \(When Receiver has no Internal Termination\)](#) on page 4 (at the measurement point indicated in [Figure 2.1 Termination Scheme for Low-Power HCSL to LVDS Conversion \(When Receiver has no Termination or Internal 100 Ω Termination\)](#) on page 4).

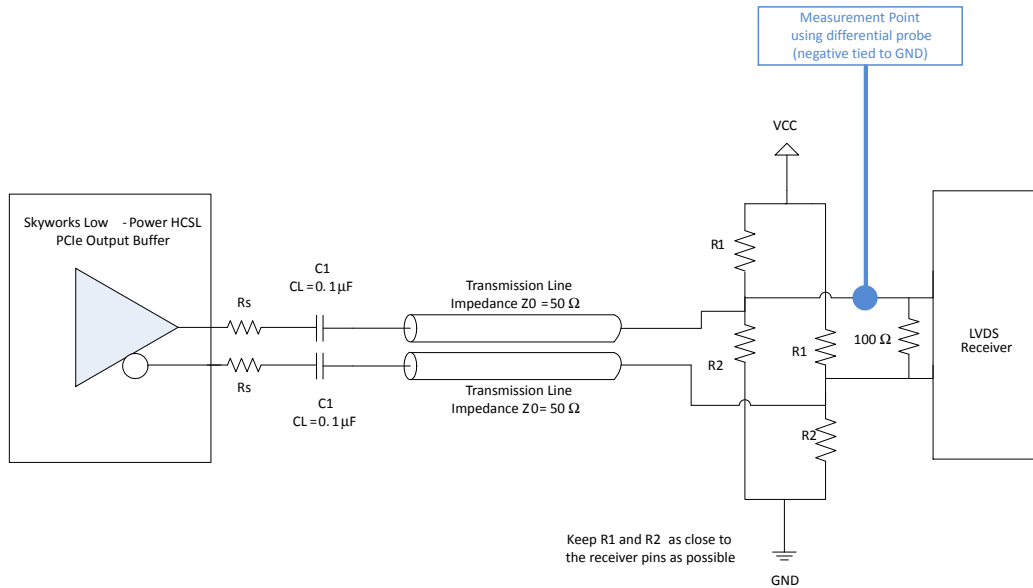


**Figure 2.1. Termination Scheme for Low-Power HCSL to LVDS Conversion (When Receiver has no Termination or Internal 100 Ω Termination)**

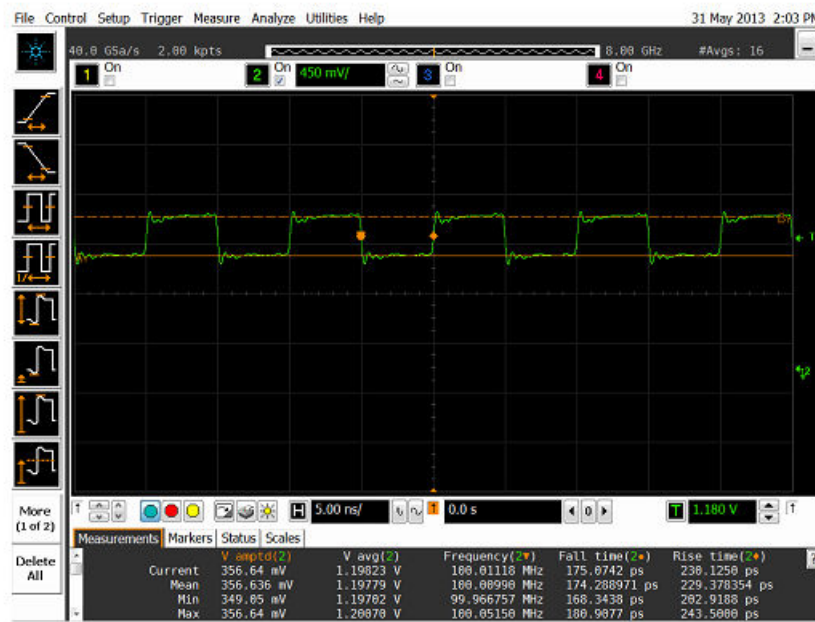


**Figure 2.2. Oscilloscope Measurement of LVDS Conversion (When Receiver has no Internal Termination)**

The swing will be reduced by 50% by an internal or external termination (the signal will be similar to the signal seen in [Figure 2.4 Oscilloscope Measurement of LVDS Conversion \(When Receiver has Internal or External 100 Ω Termination\)](#) on page 5). If the receiver does not have an internal 100 Ω termination, an external 100 Ω termination may be added, as shown in [Figure 2.3 Termination Scheme for Low-Power HCSL to LVDS Conversion \(When Receiver has no Internal 100 Ω Termination\)](#) on page 5.



**Figure 2.3. Termination Scheme for Low-Power HCSL to LVDS Conversion (When Receiver has no Internal 100 Ω Termination)**



**Figure 2.4. Oscilloscope Measurement of LVDS Conversion (When Receiver has Internal or External 100 Ω Termination)**

The resistor selection guide for different VCC values at the receiver end is given in [Table 2.1 Resistor Selection on page 5](#).

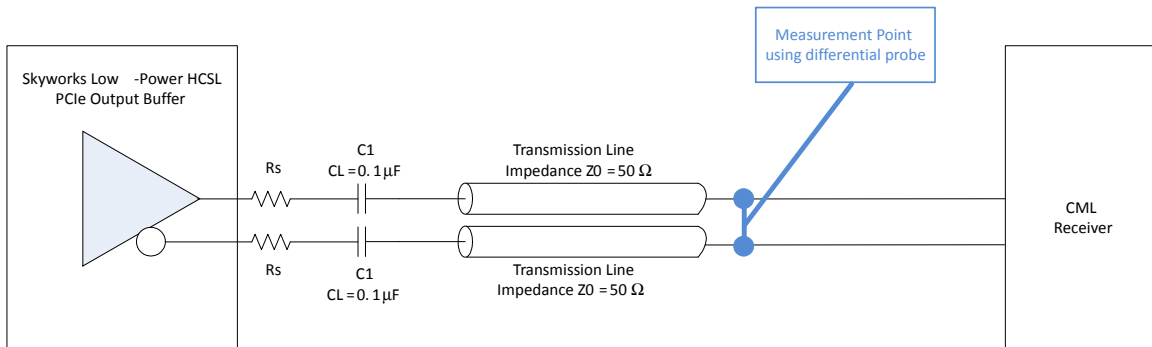
**Table 2.1. Resistor Selection**

Voltage Standard (V)	Expected Common Mode Voltage (V)	R1 (kΩ)	R2 (kΩ)
3.3	1.2	5	2.85
2.5	1.2	6	5.5
1.8	1.2	3	6

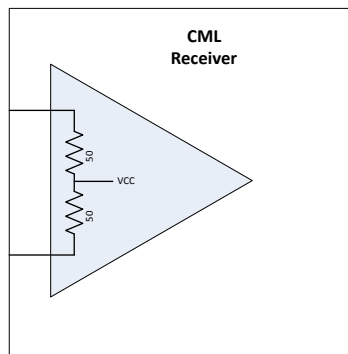
For series resistor selection of PCIe clock generators and buffers, see [Table 1.2 Series Resistor Selection for PCIe Clock Generators and Buffers on page 3](#).

### 3. Conversion of HCSL Signals to CML Signals (AC Coupled to Receivers)

AC coupling is the recommended method for converting low-power HCSL signals to CML. The receiver should be able to generate the references needed to generate the common mode for CML signals. The recommended schematic is shown in [Figure 3.1 Termination Scheme for HCSL to CML AC Coupling on page 6](#). It is also important to note that many CML receivers come with internal 50 Ω terminations to VCC, as shown in [Figure 3.2 Typical CML Receiver Circuit Structure on page 6](#). Such internal terminations can reduce the signal swing by 50%.



**Figure 3.1. Termination Scheme for HCSL to CML AC Coupling**



**Figure 3.2. Typical CML Receiver Circuit Structure**

## 4. Conclusion

This application note details methods in which low-power HCSL output clocks from the Si5211x, Si5213x, Si5214x, Si5216x, Si5310x, Si5311x, Si5315x, and Si522xx device families can be used to drive receivers that use other differential formats, specifically LVPECL, LVDS, and CML standards.



# SKYWORKS®

## ClockBuilder Pro

Customize Skyworks clock generators, jitter attenuators and network synchronizers with a single tool. With CBPro you can control evaluation boards, access documentation, request a custom part number, export for in-system programming and more!

[www.skyworksinc.com/CBPro](http://www.skyworksinc.com/CBPro)



**Portfolio**

[www.skyworksinc.com/ia/timing](http://www.skyworksinc.com/ia/timing)



**SW/HW**

[www.skyworksinc.com/CBPro](http://www.skyworksinc.com/CBPro)



**Quality**

[www.skyworksinc.com/quality](http://www.skyworksinc.com/quality)



**Support & Resources**

[www.skyworksinc.com/support](http://www.skyworksinc.com/support)

### Copyright © 2021 Skyworks Solutions, Inc. All Rights Reserved.

Information in this document is provided in connection with Skyworks Solutions, Inc. ("Skyworks") products or services. These materials, including the information contained herein, are provided by Skyworks as a service to its customers and may be used for informational purposes only by the customer. Skyworks assumes no responsibility for errors or omissions in these materials or the information contained herein. Skyworks may change its documentation, products, services, specifications or product descriptions at any time, without notice. Skyworks makes no commitment to update the materials or information and shall have no responsibility whatsoever for conflicts, incompatibilities, or other difficulties arising from any future changes.

No license, whether express, implied, by estoppel or otherwise, is granted to any intellectual property rights by this document. Skyworks assumes no liability for any materials, products or information provided hereunder, including the sale, distribution, reproduction or use of Skyworks products, information or materials, except as may be provided in Skyworks' Terms and Conditions of Sale.

THE MATERIALS, PRODUCTS AND INFORMATION ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR USE, MERCHANTABILITY, PERFORMANCE, QUALITY OR NON-INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHT; ALL SUCH WARRANTIES ARE HEREBY EXPRESSLY DISCLAIMED. SKYWOKS DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. SKYWOKS SHALL NOT BE LIABLE FOR ANY DAMAGES, INCLUDING BUT NOT LIMITED TO ANY SPECIAL, INDIRECT, INCIDENTAL, STATUTORY, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS THAT MAY RESULT FROM THE USE OF THE MATERIALS OR INFORMATION, WHETHER OR NOT THE RECIPIENT OF MATERIALS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Skyworks products are not intended for use in medical, lifesaving or life-sustaining applications, or other equipment in which the failure of the Skyworks products could lead to personal injury, death, physical or environmental damage. Skyworks customers using or selling Skyworks products for use in such applications do so at their own risk and agree to fully indemnify Skyworks for any damages resulting from such improper use or sale.

Customers are responsible for their products and applications using Skyworks products, which may deviate from published specifications as a result of design defects, errors, or operation of products outside of published parameters or design specifications. Customers should include design and operating safeguards to minimize these and other risks. Skyworks assumes no liability for applications assistance, customer product design, or damage to any equipment resulting from the use of Skyworks products outside of Skyworks' published specifications or parameters.

Skyworks, the Skyworks symbol, Sky5®, SkyOne®, SkyBlue™, Skyworks Green™, Clockbuilder®, DSPLL®, ISOModem®, ProSLIC®, and SiPHY® are trademarks or registered trademarks of Skyworks Solutions, Inc. or its subsidiaries in the United States and other countries. Third-party brands and names are for identification purposes only and are the property of their respective owners. Additional information, including relevant terms and conditions, posted at [www.skyworksinc.com](http://www.skyworksinc.com), are incorporated by reference.

Skyworks Solutions, Inc. | Nasdaq: SWKS | [sales@skyworksinc.com](mailto:sales@skyworksinc.com) | [www.skyworksinc.com](http://www.skyworksinc.com)

USA: 781-376-3000 | Asia: 886-2-2735 0399 | Europe: 33 (0)1 43548540 | [in](#) [f](#) [t](#) [v](#)