SimpliPHY Transformerless Ethernet Designs

Application Note

Subject to Change

AN0114

Revision 01–01

14 Nov 2007

Confidential

Vitesse
Corporate Headquarters
741 Calle Plano
Camarillo, California 93012
United States

www.vitesse.com

Contents

Document History

The following table lists the history of this document.

Table 1 Document History

Revision	Date	Description
01-00	12 July 2006	Initial document release
01-01	14 Nov 2007	Updated Figure 5

1 Introduction

This applications note describes a specific application called Transformerless Ethernet. Transformerless Ethernet is used for primarily two purposes:

- To support backplane applications such as PICMG
- To support Point-to-Point on-board copper media Ethernet connections

1.1 Terms and Abbreviations

The following table lists any special terms and abbreviations used in this document.

Table 2 Terms and Abbreviations

Term	Description
BOM	Bill of Material
PICMG	PCI Industrial Computers Manufacturers Group
UTP	Unshielded Twisted Pair

2 Transformerless Overview

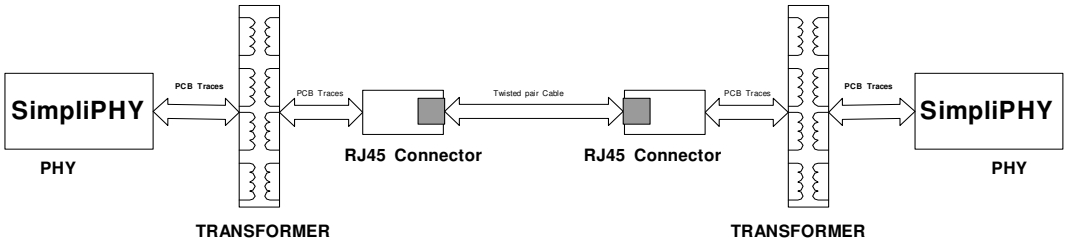
2.1 Typical Ethernet Application (using Transformers)

In a typical Ethernet application, connections between PHYs are made over unshielded twisted pair (UTP), 100-ohm, category 5E cable. The front-end interface components

consist of a transformer, an RJ-45 connector, as well as several termination resistors and bypass capacitors.

The purpose of the transformer is to eliminate the DC component introduced in the transmission signals as a result of different ground references between the two communicating entities. The transformer is not required if the communicating devices share a common ground and the transceivers do not use the magnetics for any other purpose like sourcing current or providing a common mode voltage into the transceiver which is typical to current mode line driver PHYs.

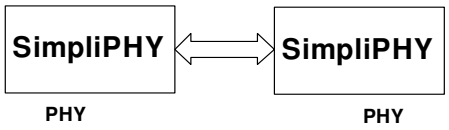
Figure 1 Typical Ethernet Application Using a Transformer



2.2 Transformerless Applications

Given the need for a transformer in a typical Ethernet application where two transceivers are connected between category 5 UTP cabling located on two different systems, it is also acceptable to not be required to use a transformer when two transceivers are contained within a single system. This can either be two PHYs on the same board permanently linked together via signal traces, or it can be PHYs on blade cards connected together via backplane bus within a single chassis system. The removal of the transformer and the RJ45 connector allows for BOM cost savings and can simplify PCB layout.

Figure 2 Transformerless Ethernet Application



It's important to note that there is a specification developed by the PICMG group (http://www.picmg.org) that specifies using Gigabit Ethernet transceivers on backplanes. Specifically, PICMG versions 2.16 and 3.1. It is very conceivable to consider using the transformerless option for this application. For more information about this specification, please visit their website.

3 Transformerless Design Overview

Output line drivers of transceivers can be classified as current mode or voltage mode based. Typical current mode PHYs generate their output waveforms by sinking a current via the center tap of the primary winding of the transformer. The transformer is also used to provide the necessary common mode voltage for the PHY. Current mode line driver technology is a legacy method used by 10/100BASE-T PHY vendors.

SimpliPHY transceivers, on the other hand, use voltage mode drivers where a center tap voltage and current is not needed from the transformer. Therefore SimpliPHY transceivers support 10/100/1000BASE-T transformerless operation without the addition of extra circuitry.

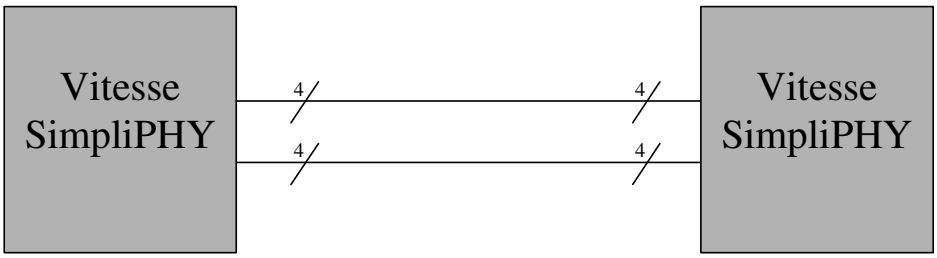
For more information about the differences between voltage mode and common mode based PHYs, please refer to the SimpliPHY Advantages white paper.

It is important to distinguish the two different line driver methods used by PHYs because the method of connecting them together requires slightly different design techniques. This will be described in the next sections.

3.1 Connecting Two SimpliPHYs Together

In this scenario if two SimpliPHYs are on the same board design and they also share the same ground reference, then the two PHY's copper interfaces can be directly connected together with 100-ohm differential PCB signal traces. If the PHYs are on different boards within a backplane, consider adding series capacitors to prevent any common mode mismatches.

Figure 3 Connecting Two SimpliPHYs Together



3.2 Connecting a SimpliPHY to a Current Mode PHY

In this scenario unlike a SimpliPHY device, a current mode PHY requires a common mode voltage. It has a distinct disadvantage with transformerless applications because of this legacy architecture. To workaround this issue there are two methods

that can be employed: An acceptable method (Figure 4) and the safest method (Figure 5).

Figure 4 Connecting a SimpliPHY to a Current Mode Line Driver (Acceptable Method)

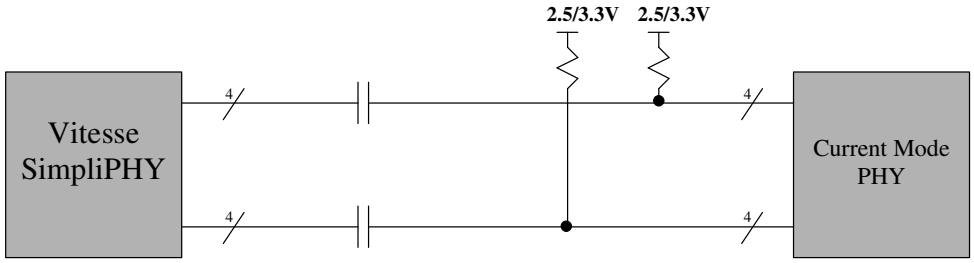
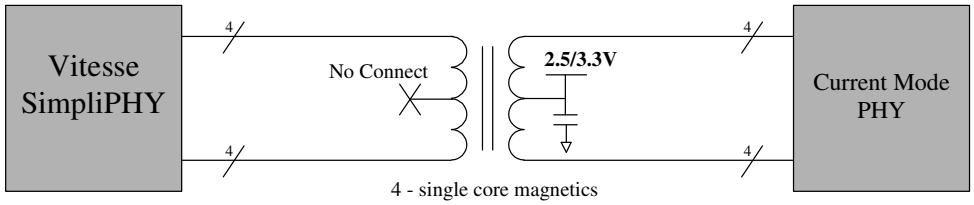


Figure 5 Connecting a SimpliPHY to a Current Mode Line Driver (Safest Method)



Both correct the need of the current mode PHY requiring a common mode voltage on its differential interface. The acceptable method uses pull-up resistors to emulate the use of the center tap of the transformer. The safest method still employs a transformer, but since EMI and other issues usually corrected by a transformer when connected to a cable are not present, a very simple 4-core (single core on 4-pairs) transformer can be used as opposed to a standard magnetic. A good example of a simple 4-core transformer is the one from Delta (http://www.delta.com.tw). We usually recommend this magnetic module for Copper SFP (Small Form-factor Pluggable) applications. This can be used on the current mode PHY. The module P/N is LF9231 and it is a very small and cost-effective, BGA-style module.

If these two PHYs are on different boards (such as in a backplane application), then series capacitors are needed between the SimpliPHY device and the backplane connector. The 4-core transformer will be then located on the card with the current mode PHY.