Application Note 120

Capacitive Coupling Ethernet Transceivers without Using Transformers

Micrel 10/100 Ethernet Products

General Description

It is a common practice to capacitive couple Ethernet transceivers (PHYs) together without the use of a transformer to reduce both the BOM cost and the required board area of the PCB. This application note describes methods for capacitive coupling Micrel's 10/100 Ethernet devices.

Micrel Devices for Capacitive Coupling

KS8695/X	CENTAUR - Integrated Multi-port Gateway Solution
KS8695P/PX	CENTAUR - Integrated Multi-port PCI Gateway Solution
KS8721B/BT	Single Port 10/100 PHY with Auto MDI/MDI-X Crossover
KS8721BL/SL	3.3V Single Power Supply 10/100 PHY with Auto MDI/MDI-X Crossover
KS8737	Single Port 10/100 PHY
KS8993	3-Port 10/100 Unmanaged Switch
KS8993F	3-Port 10/100 Managed/Unmanaged Switch/ Media Converter with TS-1000 OAM
KS8993M	3-Port 10/100 Managed/Unmanaged Switch
KS8995E	5-Port 10/100 Unmanaged Switch
KS8995M/X	5-Port 10/100 Managed/Unmanaged Switch
KS8995MA/XA	5-Port 10/100 Managed/Unmanaged Switch
KS8997	8-Port 10/100 Unmanaged Switch
KS8999	9-Port 10/100 Unmanaged Switch

Methods for Capacitive Coupling

The method for capacitive coupling depends upon whether or not the receiver circuit provides an internal DC bias offset.

Transmit Termination

Figures 1 and 2 show the capacitive coupling for transmit-side termination. In this method, the 50Ω pull-up resistors R1 and R2 are pulled up to V_{DD}. All Micrel devices listed in this application note require this output termination, except for the KS8993 device.

For the KS8993, R1 and R2 are tied together, but not to V_{DD}. The TXPx and TXMx differential signals are each terminated with 50Ω pull-ups to the port's VREFx pin.

Receive Termination for Devices with Internal DC Bias

Figure 1 shows the circuit diagram for capacitive coupling to a receiver with internal DC biasing. The 50Ω pull-up resistors R3 and R4 are capacitive coupled via C3 to V_{DD}, providing the correct receiver input termination. This method is applicable to the KS8737, KS8993, and KS8995E, all of which provide internal DC biasing.

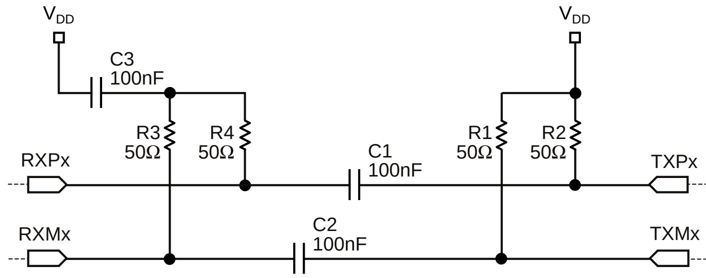

Figure 1. Capacitive Coupling Circuit Diagram for Receivers with Internal DC Bias

Receive Termination for Devices without Internal DC Bias

Figure 2 shows the circuit diagram for capacitive coupling to a receiver without internal DC biasing. In this illustration, the 50Ω pull-up resistors R3 and R4 on the receiver inputs provide the necessary DC offset. These 50Ω resistors also provide the input termination.

This method is applicable to the KS8695/X, KS8695P/PX, KS8721B/BT, KS8721BL/SL, KS8993M/F, KS8995M/X, KS8995MA/XA, KS8997, and KS8999, all of which do not provide internal DC biasing.

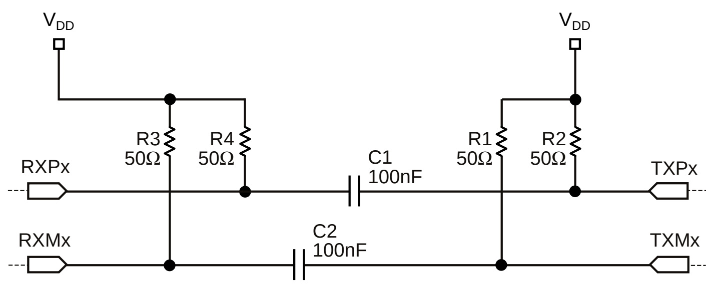

Figure 2. Capacitive Coupling Circuit Diagram for Receivers without Internal DC Bias

Recommended Link Configuration

Configure both link partners as follows:

Force Mode (auto-negotiation disabled)

100BASE-TX

The only exception to this recommendation is the KS8997. The KS8997 does not support Force Mode, and hence, auto-negotiation must be performed. Auto-negotiation has been verified under these circumstances.

The designer has the choice of half-duplex or full-duplex mode.

For additional support, contact your local Micrel Field Application Engineer or salesperson.

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10BASE-T Applications

If 10BASE-T configuration is required, the given methods for capacitive coupling are valid only if the 10BASE-T transmitter circuit design is voltage driven. The KS8695/X, KS8695P/PX, KS8737, KS8993, KS8993M/F, and KS8995MA/XA all have voltage drive 10BASE-T transmitter circuitry.

When using the standard 50Ω termination, current drive 10BASE-T transmitters are unable to provide a full 2.3V output amplitude swing. For example, with a 50mA output drive and two 50Ω pull-up resistors (R1, R2), the voltage drop is 2.5V (0.05A x 50Ω = 2.5V); thus, the signal is fully attenuated. To increase the output voltage swing at the receiver, it is recommended to implement the following resistor changes:

R1, R2 = 15Ω

R3, R4 = 75Ω

Using this method provides a voltage swing greater than the minimum 400mV receiver squelch threshold. The consequence of altering the pull-up resistor values to provide a minimum output voltage swing is a slight mismatch in the termination impedance. Signal traces should be kept to a minimum length to avoid poor signal integrity. The KS8721B/BT, KS8721BL/SL, KS8995E, KS8995M/X, KS8997, and KS8999 all have current drive 10BASE-T transmitter circuitry.

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