LVTC Logic family for live-insertion using standard CMOS process

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Introduction
This application note will provide details on how to easily design hot-plug and hot-swap circuits using the LVTC logic family.

Innovation: The first logic family in the industry for live-insertion, with bus hold, using standard CMOS process

The drivers in the PI74LVTCXX devices are designed with an innovative structure using standard CMOS process for hot-insertion. This differs from the traditional logic driver for hot-insertion that uses special BiCMOS technology.

Compared to the BiCMOS logic devices, the LVTC logic family has better performance, as well as lower cost because of the use of the standard CMOS process, which is available from most foundries. LVTC also has lower power consumption due to the nature of CMOS technology.

Hot-insertion
The two application conditions in hot-insertion are hot-plug and hot-swap. The LVTC logic family is suitable for both insertion methods.

Hot-plug: Indicates that the power and signals supplied to the hot-plug connectors on the motherboard (backplane) are turned off during the card insertion while the system is running. In hot-plug applications, the PI74LVTCXX chips are populated on the motherboard between the chipsets and the connectors in order to isolate the signals to the connectors during hot plug. The design of the card for hot-plug is generic without special device or circuits, but the motherboard is specially designed to isolate the power and signal to the connector during hot-plug. See Figure 1 for hot-plug application using PI74LVTCXX logic devices.
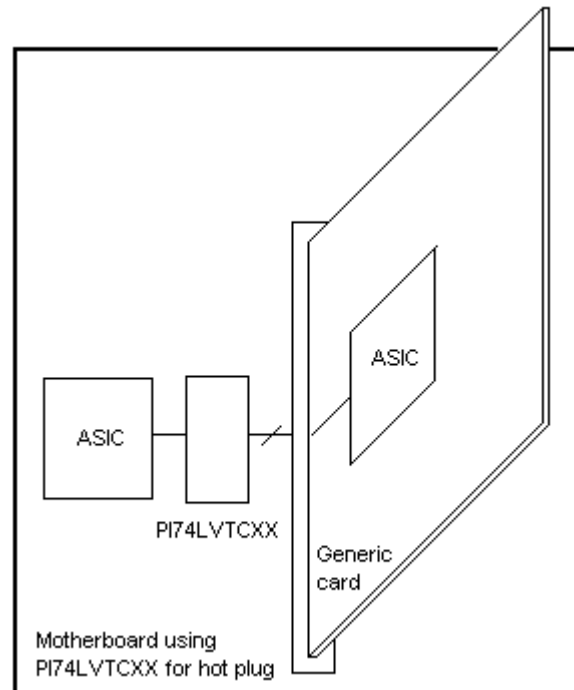

Figure 1: In hot-plug applications, the PI74LVTCXX logic device is populated between the ASIC and the connector on the motherboard to isolate the signal during hot plug. The card for hot-plug is generic.

Hot swap: Indicates that the hot-swap connectors on the motherboard (backplane) are alive with signal and power during hot-swap, and the logic device on the card should tolerate the impact from hot-swapping.

In hot-swap, the PI74LVTCXX chips are populated on the hot-swap card between the card's connector and the other devices on the card, and will tolerate the impact from the hot-swap without shorting, clamping or distorting the signal from motherboard.

The design of the motherboard for hot-swap is generic without special devices or circuits, but the card is specially designed using hot-swappable logic to tolerate the impact from the hot-swap.

The terminology of hot-plug and hot-swap described above are the industry standards. Please refer to the PCI standards "Compact PCI Hot Swap Specification R1.0" and "PCI Hot-Plug specification R1.0" for details. See Figure 2 for hot-swap application using PI74LVTCXX logic devices.
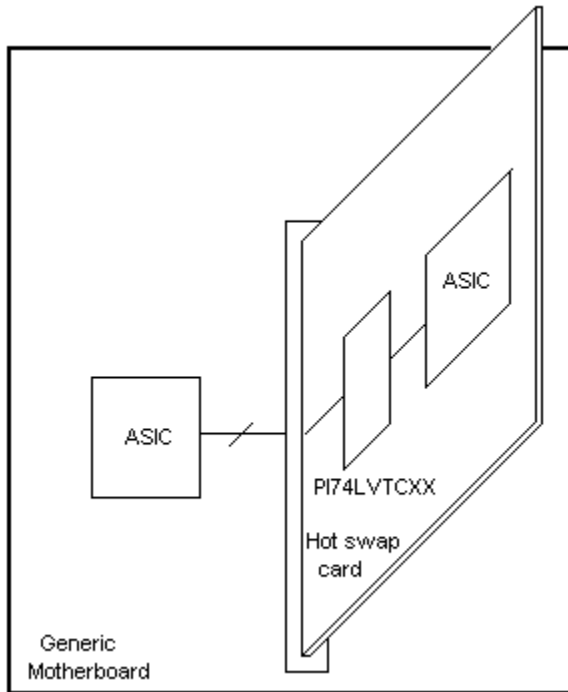
Figure 2: In hot-swap applications, the PI74LVTCXX logic device is populated on the card to tolerate the impact from hot-swap. The motherboard for hot-swap is generic

What happened during hot swap?

When live-insertion of a card into a hot-swap connector on a motherboard (backplane) occurs, the following is what happens. The signal from the motherboard will reach the output of the logic driver (set to High-Z) on the card before the V_{CC} voltage reaching the V_{CC} pin of the logic device due to the delay caused by the bypass capacitor on the hot-swap card.

A normal CMOS driver without special design can not tolerate the hot-swap condition. When a signal applied to the output of a normal CMOS driver, while its V_{CC} is 0V delayed by bypass capacitor, the PN junction of the PMOS in the CMOS driver will forward the signal to ground through the V_{CC} pin at 0V. The PMOS of the CMOS driver will also forward the signal to ground through V_{CC} pin at 0V. See Figure 3 for the current leakage paths of a normal CMOS during hot-swap.
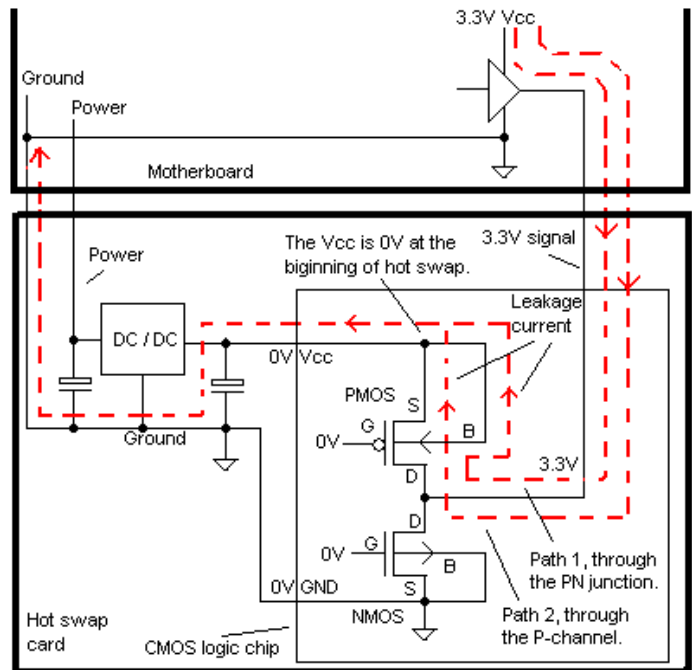

Figure 3: The current leakage paths of a normal CMOS during hot-swap.

There are some traditional logic devices in the market using BiCMOS technology that could tolerate the hot-swap condition without shorting, cutting, or distorting the signal from the motherboard while its V_{CC} voltage at V_{CC} pin is 0V.

The hot-swap suitability of a BiCMOS logic driver is either because of the BiCMOS's driver' structure, or from the isolation of a Schottky diode in series to the driver's output, both are not available in standard CMOS technology.

For more details of the behavior of CMOS in hot-insertion, please refer to Pericom's Application Brief #39 "The behavior of CMOS in hot-insertion" found at www.pericom.com.

Pericom's LVTC logic family has a specially designed CMOS driver suitable for hot-swap

The LVTC logic family has a specially designed CMOS driver to stop the current leakage caused by the PN junction of the PMOS in the CMOS driver and the PMOS transistor. It is using standard CMOS process, therefore all the features of standard CMOS, including low power consumption, lower cost, and high-performance are achieved.

LVTC logic family is also applicable for power sequencing applications

In a power sequencing condition, the signals are applied to the outputs of drivers at High-Z, while the V_{CC} voltage supplied to the chip is 0V or before reaching the nominal voltage. Therefore the PN junction of the PMOS in a normal CMOS driver will forward these signals to ground through the V_{CC} pin at 0V. It is the same with the hot-swap situation. But the LVTC logic family can tolerate this situation.

Design guideline for hot-swap applications using the LVTC logic family

- The major design guideline for hot-swap is that during hot-swapping, connect the ground pin of the inserting card to the ground pin of the motherboard before any other signal or power pins are connected. This is the main request for hot-swap. It is the industry standard for any hot-swap applications for both logic and switch devices. If the ground pins of the card and motherboard were not connected before any other pins during hot-swap, the voltage of the power and signal at connectors will go wild due to the lack of ground reference, and will burn the logic device designed for hot-swap.

- There is a Power-up/down V_{CC} voltage sensing circuit in PI74LVTCXX that will disable the drivers in PI74LVTCXX before the V_{CC} reaching 1.8V, and will release the control to the /OE pin tied to V_{CC} pin after the V_{CC} reaches 1.8V. Thus, these drivers will be at High-Z before and after V_{CC} reaches 1.8V and will avoid the interference from the unknown status generated by these drivers to the signals from the motherboard. **Therefore the /OE pin of the PI74LVTCXX device must be tied to the V_{CC} pin of the same PI74LVTCXX device though a 1K to 3.3K pull-up resistor during hot-swap.** Otherwise, after the V_{CC} of the PI74LVTCXX driver is reaching 1.8V, the logic drivers on the card and on the motherboard will both be enabled at the same time and will cause contention damage.

Conclusion

The LVTC logic family is designed for both hot-plug and hot-swap applications. The functionality of hot-swap for the LVTC logic family has been proven in hot-plug and hot-swap application conditions. The LVTC family is a very competitive logic family, in terms of better performance, lower power consumption and lower cost.

You can find Datasheets, IBIS, App Note, Samples, and more by visiting http://www.pericom.com/lvtc.