Application Report

Robust Voltage Level Translation with the LXC Family

ABSTRACT

As system designs become more complex, challenges with I/O voltage mismatch become more prevelent between the interfacing subsystems. Texas Instrument's LXC family of general purpose direction-controlled translators is an optimal solution for these challenges. With its wide operating voltage range and feature-packed performance, this family can be used in a variety of applications. This application report focuses on the benefits provided by the LXC family that system designers can utilize to create better performing and more robust digital subsytems.

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Trademarks

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1 Introduction

The LXC family is an addition to TI's Direction-controlled Level Translation portfolio. This family has a wide supply range of 1.1 V to 5.5 V making ideal for any system using common digital I/O voltages. The LXC family name comes from it being the next generation to the current popular LVC family of voltage translation devices. This allows for easy interchangeability while still maintaining the current circuit design and popular parameters like the high drive strength. However, the LXC family benefits from new design process advancments allowing it to have other improved parameters like lower power consumption making it better suited for battery powered applications. To take it a step further, the LXC family is packed with features making it robust for harsher noise environments that can be seen in both automotive and industrial systems.

2 Input/Output Architecture

This section covers the improved I/O architecture and characteristics of the LXC family. This new architecture is a piece of what makes the LXC family robust. In certain circumstances, it can also lead to a reduction in passive components. Figure 2-1 illustrates a simplified block diagram of the I/O structure along with the control circuity inputs.

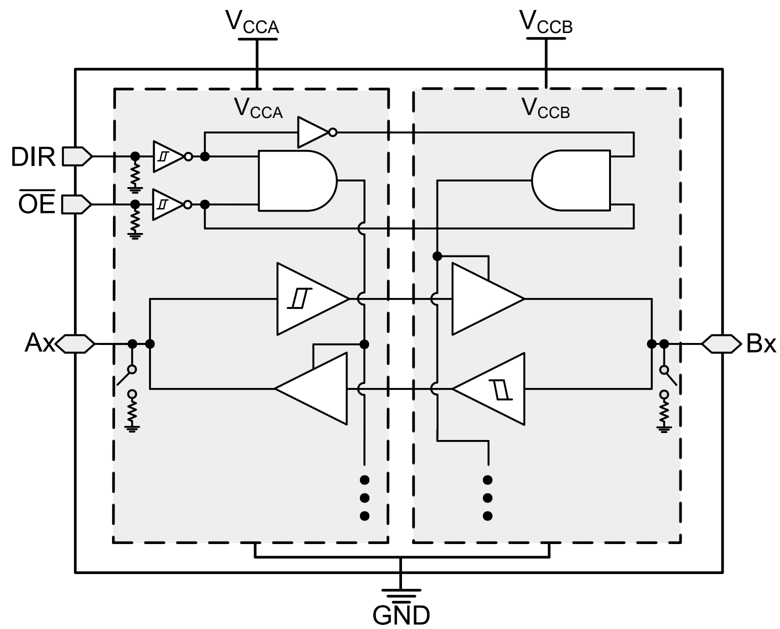

Figure 2-1. LXC I/O and Control Input Circuitry

2.1 Integrated Pull-Down Resistors

As shown in Figure 2-1, the LXC family of translators have integrated pull-down resistors to help avoid floating inputs. The A-port and B-port I/O have been equipped with dynamic pull-downs that are activated when the device is disabled. The control inputs, DIR and OE, will have 5 MΩ static pull-downs always present. If the control inputs are not actively driven by an external source, the default state of the device is enabled with direction set for B to A data flow. Refer to the *Feature Description* section of the data sheet for more info on these pull-downs.

2.2 Input Characteristics

2.2.1 Schmitt-Trigger Inputs

The LXC family of translators have schmitt-triggers integrated in all input buffers. Schmitt-triggers are key components in making the LXC family robust. They provide more noise immunity to accommodate all types application environments, and they eliminate any negative side effects of digital signals with slow edge rates as decribed in *Solving CMOS Transition Rate Issues Using Schmitt-Triggers*. Figure 2-2 and Figure 2-3 illustrate the dynamic power benefits provided by the Schmitt-trigger inputs.

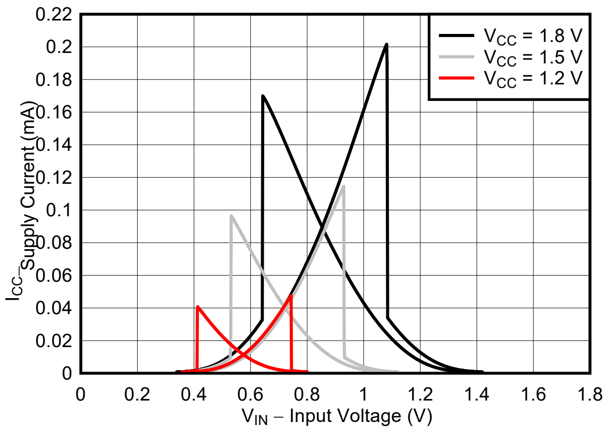

Figure 2-2. Supply Current Across Input Voltage (1.2 V, 1.5 V, and 1.8 V Supply)

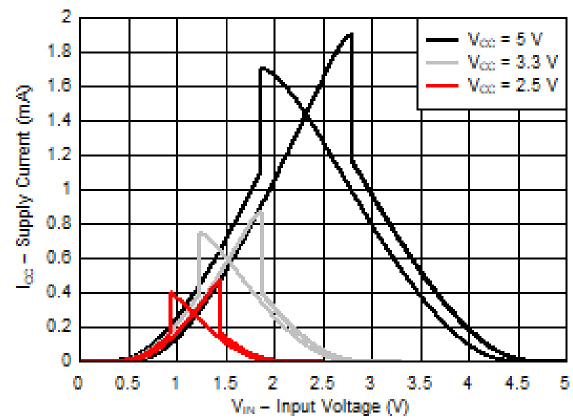

Figure 2-3. Supply Current Across Input Voltage (2.5 V, 3.3 V, and 5 V Supply)

2.3 Output Characteristics

The LXC family of translators have strong balanced output drive. This extra drive strength will make these level shifters ideal for systems with long trace lengths or applications like LED driving that require up to 20 mA. The plots below highlight the typical output characteristics of the LXC family.

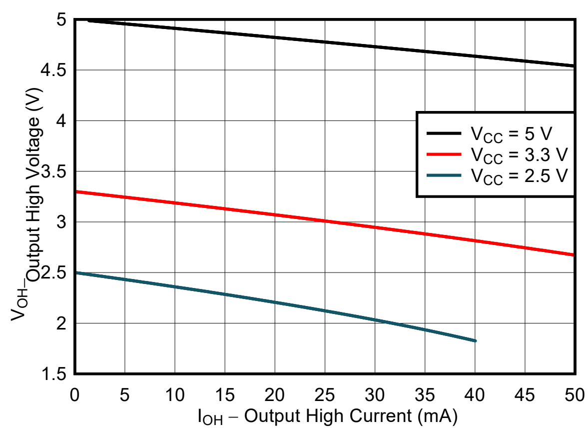

Figure 2-4. Typical (T_A=25°C) Output High Voltage (V_{OH}) vs Source Current (I_{OH})

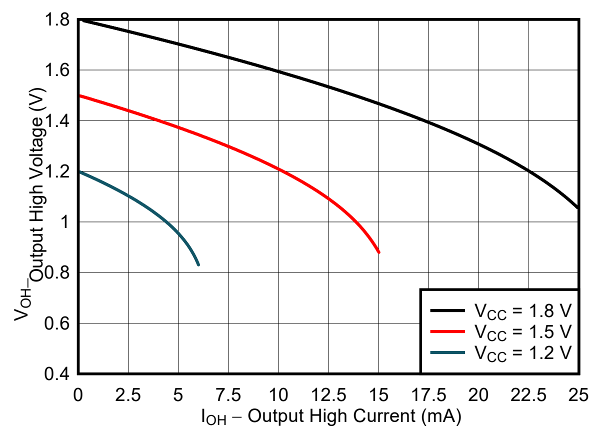

Figure 2-5. Typical (T_A=25°C) Output High Voltage (V_{OH}) vs Source Current (I_{OH})

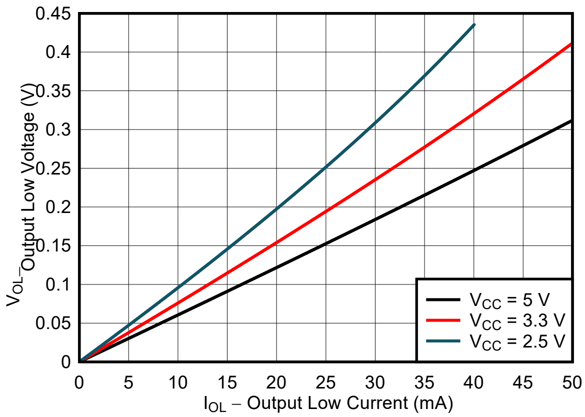

Figure 2-6. Typical (T_A=25°C) Output High Voltage (V_{OL}) vs Sink Current (I_{OL})

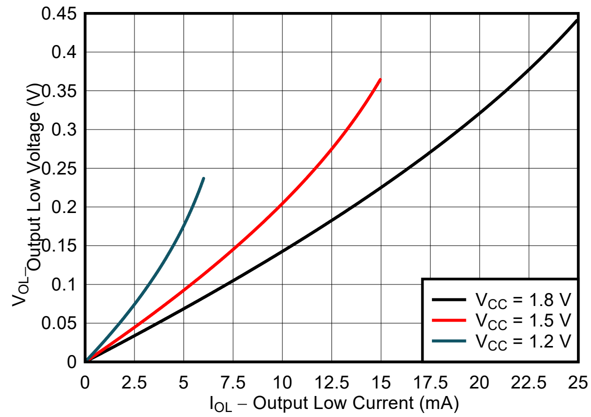

Figure 2-7. Typical (T_A=25°C) Output High Voltage (V_{OL}) vs Sink Current (I_{OL})

3 LXC Features

3.1 V_{CC} Isolation and V_{CC} Disconnect

In conjunction with the dyncamic pull-downs, the LXC family has introduced the new V_{CC} Disconnect feature. This feature is an improvement to the already existing V_{CC} Isolation and Partial Power Down features. As illustrated in Figure 3-1, the V_{CC} Disconnect feature will discharge any charge at the supply pin allowing the device to go into a disabled state whenever the supply node is *floated* rather than driven to ground.

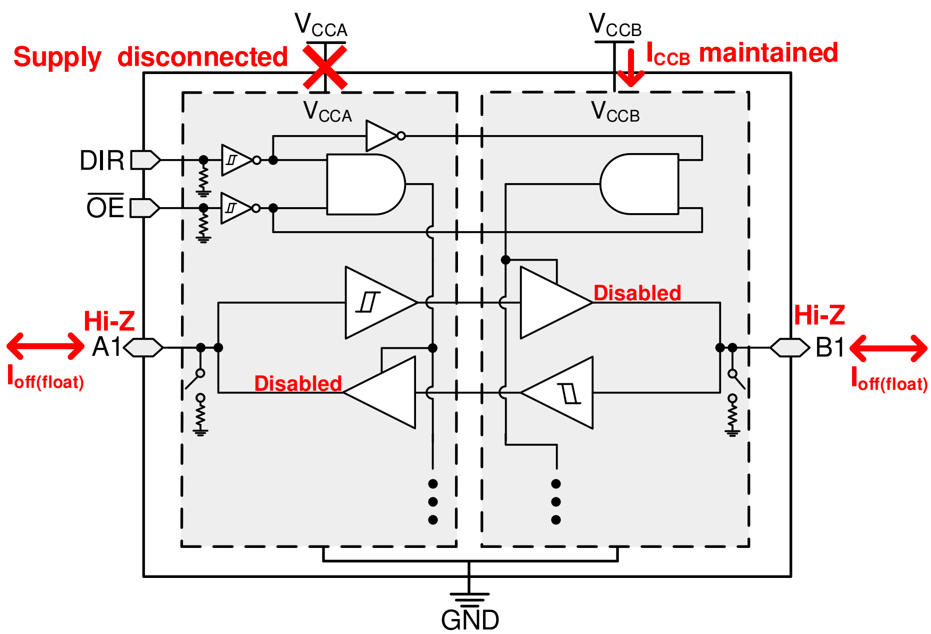

Figure 3-1. V_{CC} Disconnect Feature

This feature is beneficial for applications where the translation device is connected to a power source through a load switch. Refer to the *Feature Description* section of the data sheet for more info on the V_{CC} Disconnect feature.

4 LXC Applications

A large variety of applications can be supported with the LXC family of translators by leveraging the features below:

- Fully configurable dual-rail design allows each port to operate from 1.1 V to 5.5 V
- High drive strength (up to 32 mA at 5 V)
- Schmitt-trigger inputs allow for slow or noisy inputs

The wide operating voltage range allows for interfacing low-voltage ASICs with higher-voltage peripherals, a task commonly done with voltage translators. As illustrated in Figure 4-1however, coupled with the strong drive capabilities, the LXC translator enables the ASIC to directly control an arrary of LEDs.

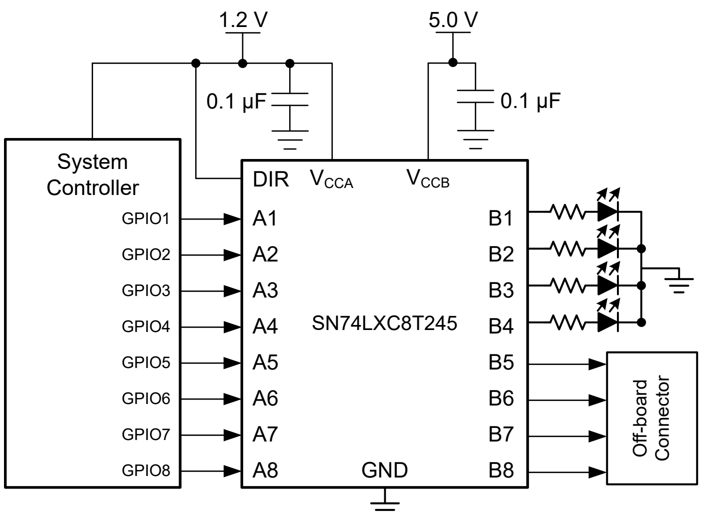

Figure 4-1. SN74LXC8T245 Example Application

It is common to see digital signals being passed between different printed circuit boards (PCB) with a connector and cable. Automotive systems provide a good example of this due to different areas of the vehicle needing a dedicated board for a specific operation. The cabling in these vehicles can get quite long which leads to large parasitic capacitance. This could potentially cause havoc for digital systems that typically favor clean square waves. Figure 4-1 highlights how the SN74LXC8T245 can be used to drive signals to an off-board connector that is expected to have a large capacitive load. This device also has some flexibility on how this is implemented due to the Schmitt-trigger inputs. If the PCB on the transmitting end of the cable is space constrained, then the translator can be placed on the receiving end PCB. Any signal degradation caused by the long transmission line would be cleaned up and shifted to the correct voltage level needed for the receiving device.

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