Technical Notes on using Analog Devices' DSP components and development tools
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Performing Level Conversion Between 5v and 3.3v ICs

***Q**: I am currently using the ADSP-2187L in my system and I want to interface a 5v FPGA to the DSP. However, I have concerns about potential interface issues caused by differing logic standards. Do you have any information on how to interface ICs that operate at different voltage/logic levels?*

A: There are a number of processors produced by Analog Devices that operate at 3.3v. The 3.3v fixed point processors include the ADSP-2183, ADSP-2184L, ADSP-2185L, ADSP-2186L and ADSP-2187L. Our 3.3v floating point processors are the ADSP-21060L, ADSP-21061L, ADSP-21062L, and the ADSP-21065L. Additionally, all of our "M" family processors are capable of supporting 3.3v I/O standards. However, none of these devices can tolerate greater than V_{cc}+0.5v on their inputs. Therefore, additional logic is necessary to connect our 3.3v and "M" family DSPs to 5v peripherals. One simple way of solving this problem is by adding a Bus Switch (QuickSwitch) to the system, which adds voltage tolerance between two ICs.

Bus Switches are essentially bus voltage level translators that are used to shunt the maximum voltage that is received by an IC. A typical transfer function of a Bus Switch is given below (Figure 1):

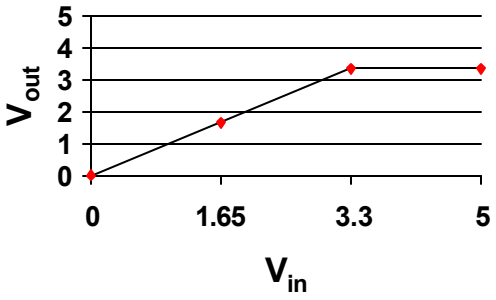

Figure 1: Voltage I/O Characteristic of a Bus Switch (V_{cc} = 4.3v)

The transfer function of a Bus Switch is as follows:

$$V_{out} = V_{in} \text{ when } V_{in} < V_{cc}-1 \quad (1)$$
$$V_{out} = V_{cc}-1 \text{ when } V_{in} > V_{cc}-1 \quad (2)$$

In this example, with V_{cc} set to 4.3v, the Bus Switch will pass V_{in} to V_{out} until V_{in} equals 3.3v. Once V_{in} rises higher than 3.3v, V_{out} continues to hold at 3.3v. Therefore, placing a Bus Switch between a 5v and 3.3v device will effectively remove voltage incompatibility issues.

Bus Switches are bi-directional ICs; therefore, no additional routing logic is needed for the connection of bi-directional buses. When the 3.3v DSP transmits information to the 5v device, its output voltage is not shunted or reduced by the Bus Switch.

A simple way of providing 4.3v to the Bus Switch is to place a diode between the 5v system voltage and the V_{cc} pin on the Bus Switch. The voltage drop across the diode will force V_{cc} to approximately 4.3v.

Once concern when adding glue logic to a system is the potential added propagation delay. Bus Switches have very low propagation delay, on the order of 0.25ns. Therefore, they can safely be used in a wide range of timing sensitive applications and systems.

Bus Switches are manufactured by a number of semiconductor companies, such as Pericom and Quality Semiconductor. For more information on the operation of these devices, please refer to the following resources:

www.pericom.com
www.qualitysemi.com

Bus Switches typically have a part number of 3384. Therefore, searching each companies' web site for this part number brings up datasheets and application notes fully describing their proper usage.

For more information on the electrical characteristics of the DSPs manufactured by Analog Devices, please refer to the appropriate DSP data sheet.