TND304

Low Voltage Devices in the Real World

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TECHNICAL NOTE

Many microprocessor and DSPs need to operate at very low Voltage, in order to conserve power and not over–dissipate. Issues arise when the designer has a device like a DSP operating at 1.6 Volts and needs to interface with other semiconductors operating at 3 Volts or more.

The problem stems from the output of the DSP only pulling up to its supply voltage. For nearly all CMOS devices, the a logic level high (V_{IH}) is guaranteed to be 70% of V_{CC}, and logic level low (V_{IL}) is 30% of. If a DSP/MCU is operating at 1.6 Volts, a no–load output can be guaranteed to V_{CC} − 0.2 V, so the output will be ≈1.5 Volts. This level of output cannot match a 3.0 V. CMOS device, e.g. ASIC. The DSP/MCU simply cannot pull up high enough.

Solutions: ON Semiconductor has many different gates, buffers, inverters that are called “T” versions in the VHC family. The VHC family is a 0.6 μm CMOS family of single gate, and multigate devices. They offer good speed and low cost. We offer many devices available in the single gate family. The “T” version VHC devices are full/Low Voltage TTL compatible when operating at 5.0 Volts, however, ON Semiconductor has fully characterized its VHCT family at 3.0 Volts as well. VHC/VHCT is considered to be a transitional family, providing logic, buffering and switch–ing, either to a lower or higher voltage.

Translation of the output of a low Voltage device (1.6 to 2.0 V) to 3.0 V. or higher requires some sort of active device. The simplest solution possible is a single gate, or multiple gate solution (for multiple outputs) that has a low threshold. The “T” version devices are fully specified to operate at 3.0 V. At this Voltage, they are low threshold. Table 1 shows the V_{IH}, V_{IL} for standard and “T” devices. V_{IH}, V_{IL} represent the requirements for a logic low and logic high. A CMOS device, lightly loaded will generally pull up/down to within 5% of V_{CC} and ground. A DSP/MCU operating at 1.7 V will pull up to 1.5 V, and down to 0.2 V (at 100μA). ON Semiconductor has many devices in the VHCT/LVXT family, such as **MC74VHC1GT66**, **NLAST4501**, **NLAST4599**, **MC74LVXT4051**, etc., that can be con–trolled without the need of translators.

Table 1. VHC/VHCT Device Comparison

Parameter	VHC	VHCT	V_{CC}
V_{IL}	1.5	0.8	5.0
V_{IH}	3.5	2.0	5.0
V_{IL}	0.9	0.53	3.0
V_{IH}	2.1	1.4	3.0

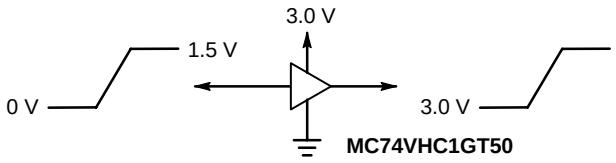

Figure 1. 1.5 V to 3.0 V Translator

CMOS logic becomes extremely slow below 2 V. Most families are not characterized below 2 V. We have come up with a simple solution to translate any 3–5 V input safely and with small delay. The only extra component is a single resistor. The device specified, is in the LCX family and is tolerant to voltages in excess of V_{CC}. The resistor can be as low as 100 Ω. The tradeoff is current and speed. A 100 Ω value would draw as high as 12 mA. Higher value resistors, would draw less current, but would add delay to the circuit. A 100 Ω resistor would add only 0.5 ns. As with the other illustrations, the Open Drain is available as a single gate (MC74VHC1G07) and hex version (MC74LCX07). The

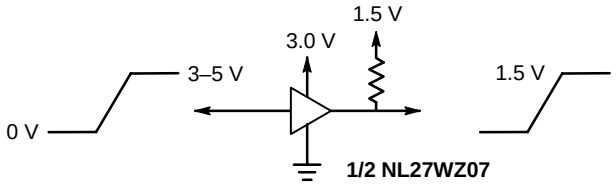

Figure 2. 3 V to 5 V Translator

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device shown has a propagation delay of < 4.0 ns operating at 3.0 V, and a 1 KΩ pull–up would exhibit ≈ 5 ns delay with a light (5–10 pf) load. Inverting and non–inverting versions are also available, as well as open drain logic, in the MiniGate™ Logic family.

Conclusions: Logic level translation from extremely low voltages can be quite easy. ON Semiconductor offers, inverting/non–inverting buffers, gates and analog switches in single, dual, triple (2H2001), hex, and octal. Open Drain devices in the VHC and LCX families will allow interface from higher voltages (as high as 5.5V) down to any voltage desired. These are also available in single, dual, triple (2H2001) and hex.

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