LV1T Family of Single Supply Translators

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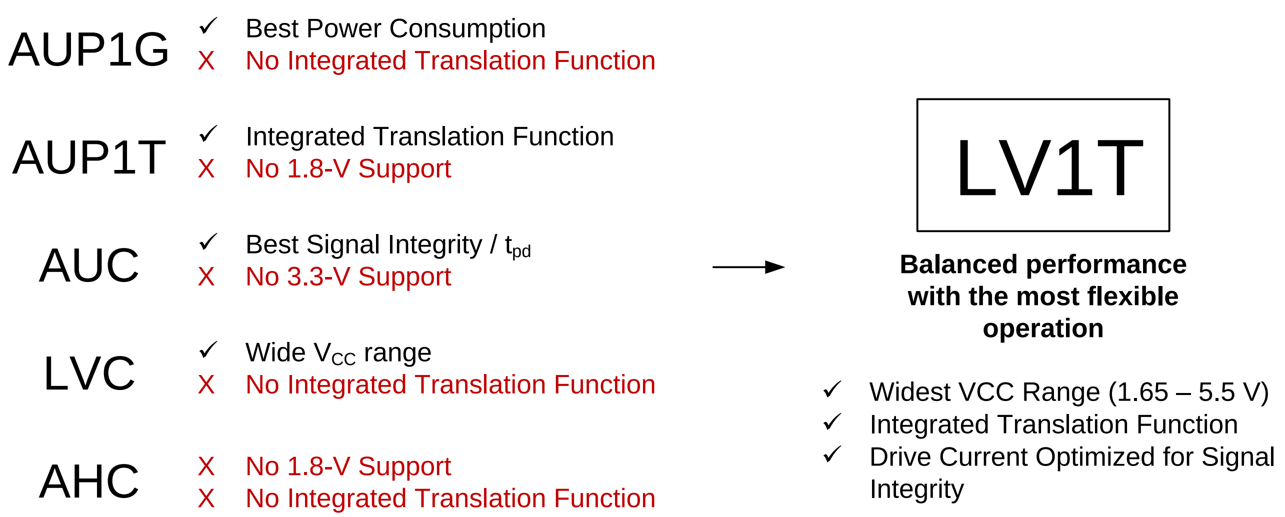
ABSTRACT

The LV1T family of devices is unique, combining a wide V_{IH} range with a wide V_{CC} range. The LV1T family was created to allow up or down voltage translation with only one power rail. The family has overvoltage-tolerant inputs that allow down translation from 5.5 V to V_{CC}, which can be as low as 1.8 V. This family has an optimized and balanced output drive of 7 mA at 3.3-V Vcc, which reduces line reflection, over/under-shoot, and eliminates the need for a damping resistor.

Compared to other logic families, the LV1T family is the most well-rounded and universal in terms of specifications. While there are other logic devices with wide-V_{IH} TTL inputs, the LV1T family also has the widest V_{CC} range.

The family also has a lowered switching threshold that allows it to translate up to the Vcc level, as high as 5.5 V. See the following chart for the allowable translation levels.



	Vcc	INPUT	OUTPUT
UP		1.2 V	
Down	1.8 V	1.8 V	1.8 V
		2.5 V	
		3.3 V	
		5 V	

Vcc	INPUT	OUTPUT
	1.8 V	
	2.5 V	
3.3 V	3.3 V	3.3 V
	5 V	

Vcc	INPUT	OUTPUT
	1.8 V	
2.5 V	2.5 V	2.5 V
	3.3 V	
	5 V	

Vcc	INPUT	OUTPUT
	2.5 V	
	3.3 V	
5 V	5 V	5 V

Advantages of Using the LV1T Gates and Buffers to Translate

1. Ease of use, with just a single power supply
2. Small packages (DCK package is 2 mm × 1.25 mm, 46% smaller than DBV)
3. No pullups or pull downs required
4. Optimized output driving capability
5. 5-V tolerance for Industrial applications
6. Space and BOM savings (the gate can translate by itself, rather than using the gate plus translators)

Translating Down

Using these parts to translate down is very simple. Because the inputs are tolerant to 5.5 V at any valid Vcc, they can be used to down translate. The input can be any level above Vcc and up to 5.5 V, and the output equals the Vcc level, which can be as low as 1.8 V. One advantage to down translating using this part is that the ICC current remains less than or equal to the specified value. The current draw when translating can be seen in Figure 2.

Down translation possibilities with LV1T family:

With 1.8-V Vcc from 2.5 V, 3.3 V, or 5 V down to 1.8 V.

With 2.5-V Vcc from 3.3 V, to 5 V down to 2.5 V.

With 3.3-V Vcc from 5 V down to 3.3 V

Translating Up

Using the LV1T family to translate up is very simple. The input switching threshold is lowered, thus the high level of the input voltage can be much lower than a typical CMOS V_{IH}. For example, if the Vcc is 3.3-V, the typical CMOS switching threshold would be VCC/2 or 1.65 V. Thus the input high level must be at least Vcc × 0.7 or 2.31 V. On the LV1T devices, the input threshold for 3.3-V Vcc is approximately 1 V. This allows a signal with a 1.8-V V_{IH} to be translated up to the Vcc level of 3.3 V. See an example of this in Figure 1.

With 2.5-V Vcc from 1.8 V to 2.5 V

With 3.3-V Vcc from 1.8 V or 2.5 V to 3.3 V

With 5-V Vcc from 2.5 V or 3.3 V to 5 V

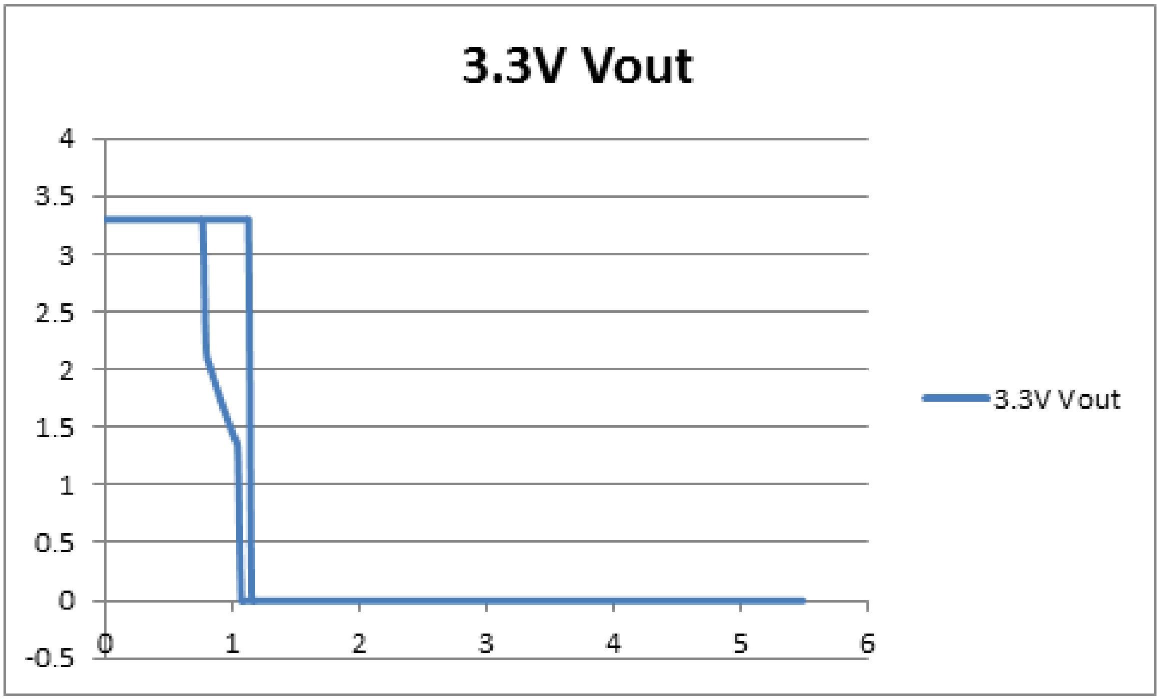


Figure 1. Switching Threshold with 3.3-V Vcc

Because these parts are CMOS, there is more Icc current consumption only when the input is lower than Vcc and signal translating. An example of this is shown in Figure 2.

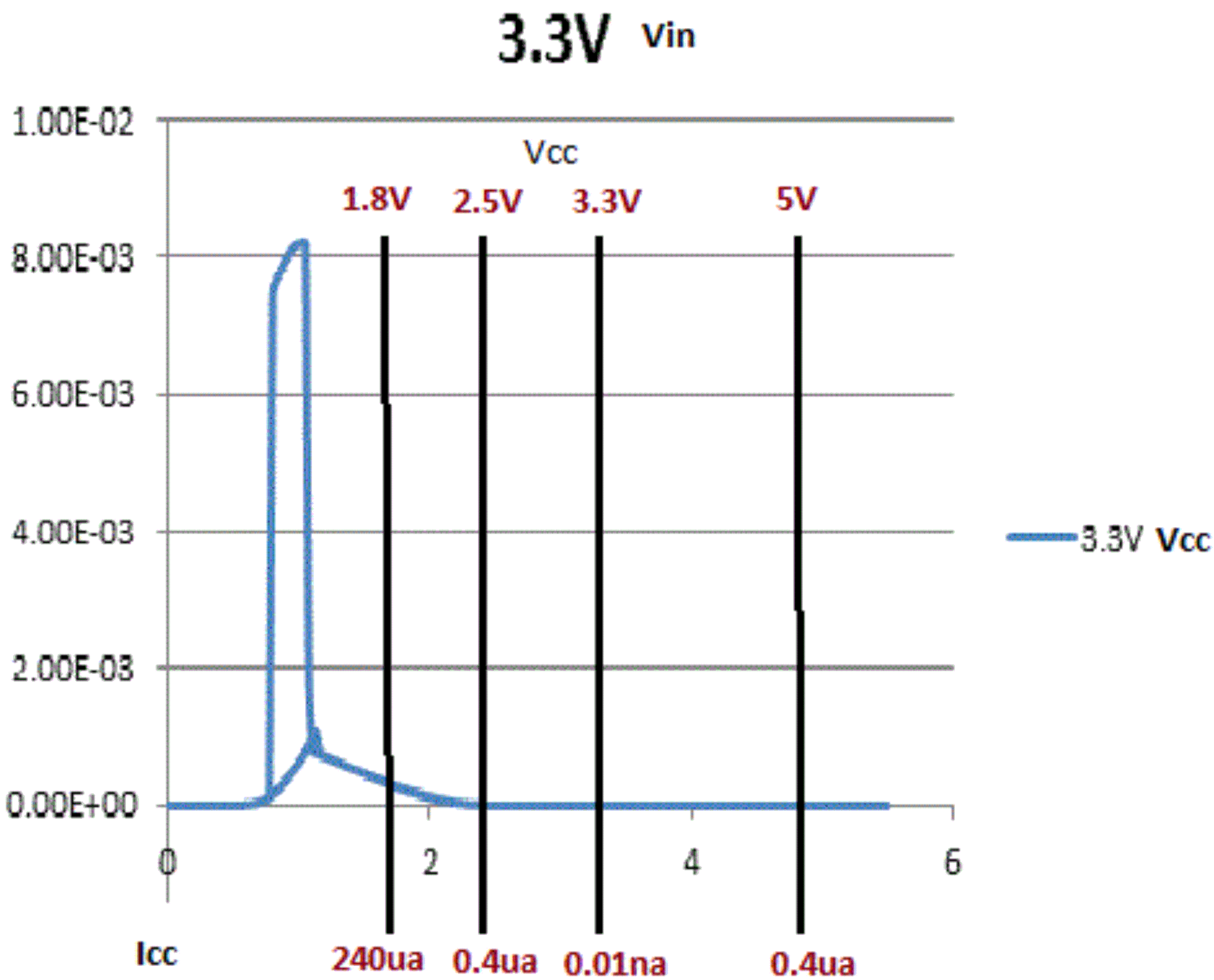


Figure 2. Power Consumption when Translating

Example Application 1: PWM with Filter

An application where the LV1T can be useful is in a PWM translation application. In this example, the amplifier accepts a 5-V PWM into its input filter, but the MCU can only supply 3.3 V on its GPIOs. The SN74LV1T34 is used in this example to translate the PWM signal to a 5-V level. It also serves to isolate the MCU from excess line capacitance, making the signal cleaner at higher speeds.

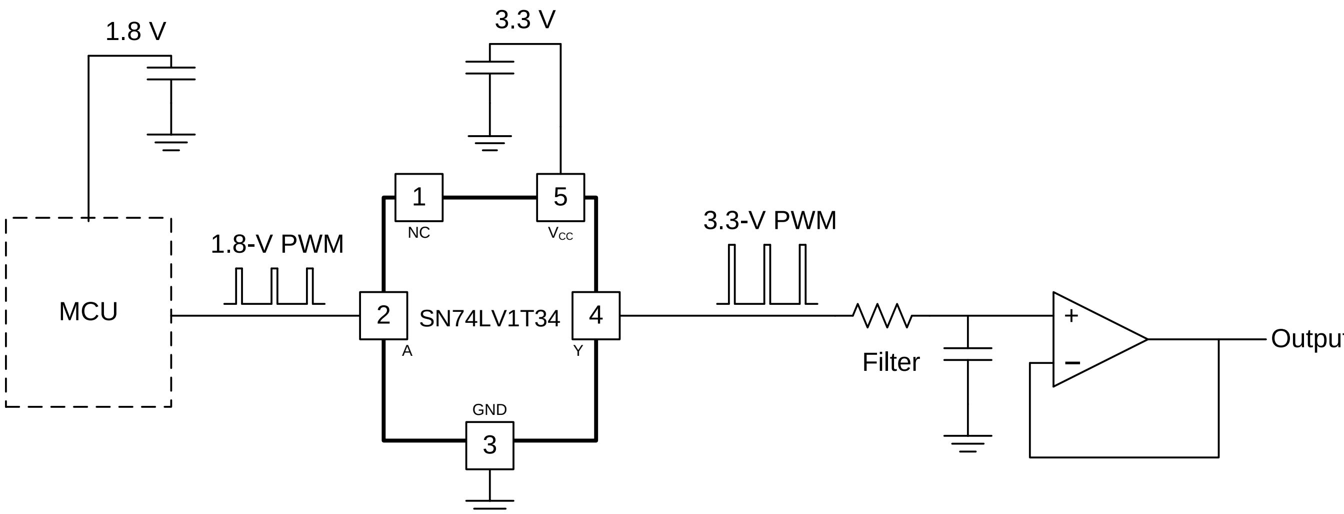


Figure 3. Example Schematic for LV1T PWM Circuit

Example Application 2: PGOOD Circuit

In this example, the engineer wants to send a signal to the MCU when both power ICs have been ramped to their appropriate output levels. Normally, this application would require an AND gate, combined with appropriate translators for each level. The SN74LV1T08 positive AND gate can accept input voltages different than VCC, even when the A and B inputs are at different levels. The LV1T device replace allows the engineer to use a single device in the place of the AND gate and translators, which could have previously required up to three devices.

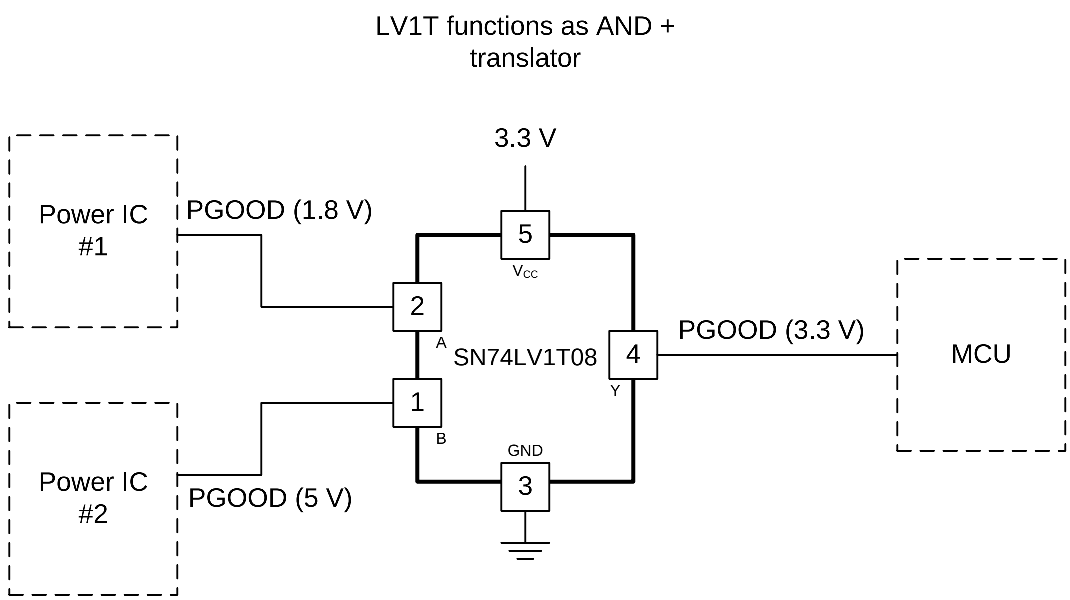


Figure 4. PGOOD Circuit with LV1T Acting as Several Devices

Conclusion

The LV1T family of devices is a simple way to perform a function and translate to another voltage level, whether translating up or down.

There will be a small amount of extra power consumption when translating up: consult the datasheet specs if the power consumption is critical, as in a battery-powered device.

Revision History

Changes from Original (November 2013) to A Revision **Page**