Rethink Your Next Design in One-Gate

by

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From a system design standpoint, architectures using standard logic as building blocks will continue to be an important piece of the total system design. Microprocessors, DSPs, ASICs, and custom circuits now fill many of the design slots traditionally filled by standard logic functions. However, because of the cost and complexity of more sophisticated solutions, designers continue to use standard logic for specific applications. One major use is to "tie things together." Discrete logic ICs, commonly called "glue logic," allow the individual sections of a system to talk to each other more efficiently. Simple circuit functions such as buffers, translators, and switches, for example, have continued to increase in design popularity. Example applications that require "glue logic" include circuit isolation, input/output translation, power supply translation, or signal bus line switching.

Impetus for One-Gate

One-Gate logic devices are the single-gate derivatives of their larger multi-gate cousins. Originally, One-Gate applications were pioneered in Japan to solve design problems faced by the consumer electronics industry there. Because of the high-volume production of consumer electronics equipment in Japan, Japanese circuit designers created an infrastructure to support rapid design of moderately sized gate arrays, as well as Application Specific Standard Products (ASSP). The impetus to create One-Gate devices arose when previously designed gate arrays or ASSPs needed one bit of buffering, logic, or switching to integrate them into the next design. Often, there was not enough room on the board to add an additional multi-gate logic device and retain the same board size. The designer had only one option: Re-design the entire chip or add additional IC components to the board layout to achieve the desired new product performance.

Additionally, companies making portable equipment found themselves under ever increasing pressure to reduce board sizes. Manufacturers of camcorders, digital cameras, cell phones, and disk drives, for example, face these size constraints (at reduced costs, of course) and competitive demands for increased functionality. Until the advent of One-Gate devices, the package size of traditional logic circuits dictated how the board would be designed and laid out.

Product technology platforms and circuit design density still dictate the size of the package. For example, (see fig. 1), a multi-gate device in an SSOP or TSSOP package consumes respectively 50 mm^2 and 80 mm^2 area on the board. With one small One-Gate logic device, the designer can make the circuit usable in a new system design. This pushed chip manufacturers to produce One-Gate versions of their industry-standard multi-gate devices. It also pushed chip suppliers to optimize a single function in as small a space as possible, while simultaneously conserving as much power as possible.

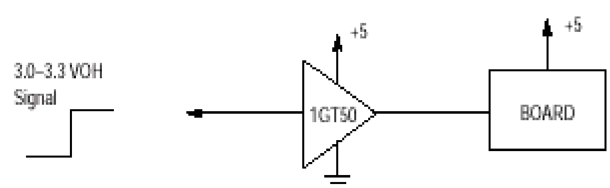
Product designers find themselves under increasing pressure to efficiently produce next-generation products in as rapid a time-to-market as possible. This provided the final market impetus to component vendors to produce and market One-Gate products. One-gate products are exactly what the name says, a single gate function in a super small package. One-Gate solutions were initially offered in the SOT-23 (SC59) five pin package and later in the current SOT 353 (SC88A/SC70) package. With an area of only 4.2 mm^2, the SOT 353 package takes up only 3% of the area of a traditional 20-lead SOIC package (see fig 1). The package is so small that it can be mounted "in-line" directly on the trace.

Because designers can place One-Gate devices exactly where they are needed, direct benefits for the design include: lower "ground bounce" effects, smaller number of de-coupling component requirements, and shorter signal routing lines. One-gate designs significantly reduce overall board space, reduce cross talk, deliver cleaner system signals, and eliminate previously required signal "clean-up components." Workstation and other non-portable computing systems are also using one-gate products to cut board space and reduce power dissipation.

One-Gate Applications

Example #1

<u>Problem:</u> Interface a 3.0 Volt logic level serial input to a 5.0 Volt older board.

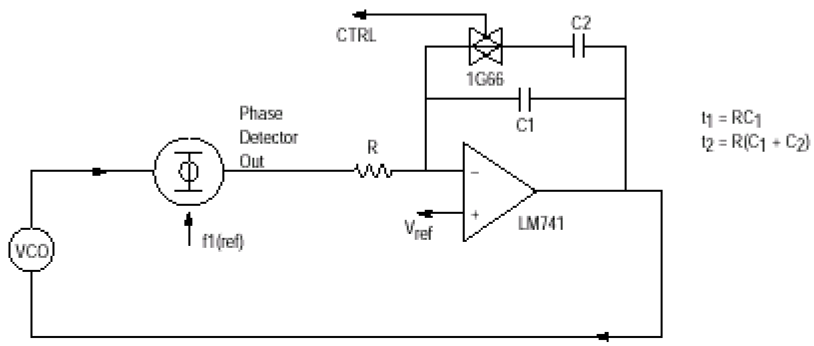


<u>Solution:</u> The 1GT50 provides an interface with no inversion.

This product is a new function in the industry standard family of one-gate products. The 1GT50 operates at 5.0-Volts and interfaces seamlessly with 3.0-Volt logic levels. No resistors or other additional components are necessary. The device occupies minimum board space and contributes almost no loading (<10 Pf). It also provides up to 8 mA of drive with minimum noise and ground bounce and only a small signal delay (~ 4 ns, depending on the load).

Example #2

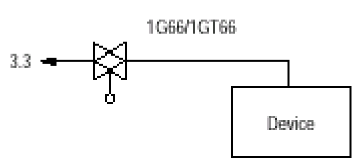
Problem: A Phase Locked Loop for a motor driver needs a fast attack time with a long steady state time constant.
Solution: The 1GT66 or 1G66 (standard industry functions) One-Gate analog switches.



Designers are familiar with this function in multi-gate devices. Either of these two One-Gate devices, the 1GT66 or 1G66 (depending on system requirements), allows the designer to specify two time constants. The first time constant is selected for fast attack with perhaps 15% overshoot. The second time constant delivers maximum stability and minimum ripple. The analog switch takes up almost no room on the board and only requires one resistor and two capacitors, as well. When the analog switch is turned "on," it selects the time constant equal to: $t = 2\pi\ (C_1 + C_2)$. The longer time constant is effective a few nanoseconds after being switched "on."

Example #3

Problem: How to switch a low power 3.3 Volt device "on" from a TTL level source.
Solution: Use a 1G66 One-Gate with V_{dd} connected to the supply voltage of 3.3 volts as a high-side analog switch.

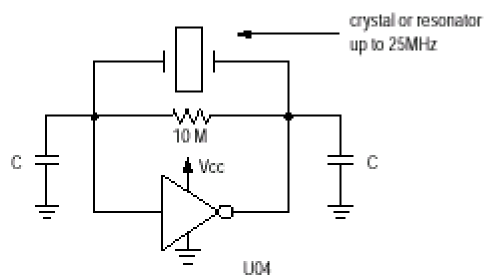


(Note on drawing: The device in the block diagram represents the system or some part of the system that runs at 3.3 Volts.)

The control pin on the industry standard 1G66 is over-voltage tolerant and may be driven by a 5.0 Volt logic driver. The switch will offer only 15 ohms of resistance, resulting in a drop of .15 Volts with a 10 mA load. This function can turn on a local oscillator, RF stage, small audio output, etc. This low cost switch provides an interface between the 5.0-Volt portion of the system and high-side switching. The One-Gate device occupies only 4.2 mm^2 and requires no external resistors or capacitors.

Example #4

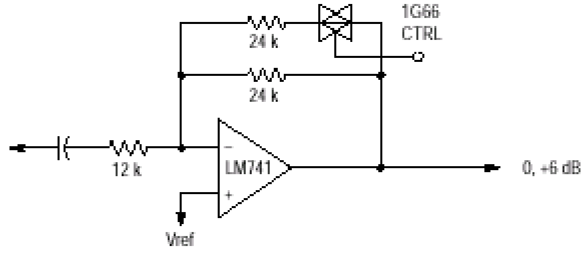
Problem: How to make a low-cost/area crystal-ceramic resonator oscillator.
Solution: The industry standard One-Gate device, the 1GU04 unbuffered inverter.



The 1GU04 makes a perfect oscillator for any fundamental mode crystal. A 10 Meg Ohm resistor placed from output to input puts the inverter in a Class-A state. The crystal manufacturer should determine the capacitor value. The oscillator should function up to the maximum value of a fundamental crystal (~ 25 MHz). The designer can use an overtone crystal to achieve higher frequencies. The designer should follow recommendations of the crystal manufacturer. If buffering is required, any of the VHC one-gates or multigate buffers or inverters will perform admirably.

Example #5

Problem: How to create a dual gain audio amplifier with either 0 db or +6 db gain.
Solution: The use of an operational amplifier with selectable feedback resistance provides constant input and output impedance. Use a single gate analog switch to select/de-select resistors and provide either unity gain or +6db.



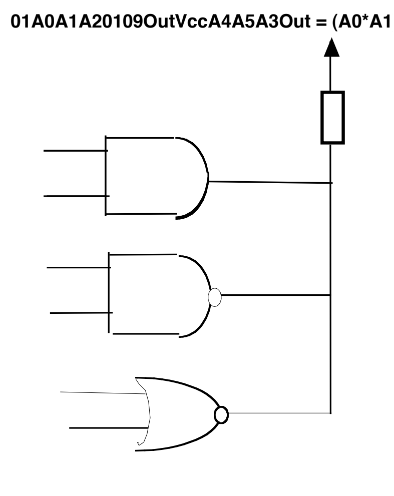
Example #6

<u>Problem:</u> For many years, programmable array logic (PAL's) were used to perform complex logic operations on multiple signals. In the wireless/hand-held world, PAL's consume too much power. An additional problem arises if the designer needs a complex set of "combinational" logic.

<u>Solution:</u> Depending on the number of terms needed, open drain single gate devices can provide an excellent solution. Open drain gates allow the outputs to be "wired-OR'ed" together so that the OR function is not only free, but is very low power, uses up very little space, and adds practically zero delay into the signal path.
The following is an illustration of a complex function:

OUT=(A0*A1) + (A2*A3) + (A4+A5)

Using three open drain One-Gate devices (09, 01, and 03), wire-OR the outputs. To attempt to accomplish this function with a PAL would be overkill in both power and board space. Using multi-gate logic would require four devices and >50 mm square of board space. The use of open drain devices provides a perfect solution, consuming only 13mm square of board space. Signal propagation delays would be <7ns, with minimum power consumption (determined by the value of R).



Summary

One-Gate devices are growing in popularity as a result of increasing design pressures to reduce board sizes. These new design solutions allow the designer to place a logic function precisely where it's needed in the system with absolutely minimal real estate requirements. One-gate devices are so small that a designer can readily add a logic function to upgrade an older design without major system modifications. One-Gates also offer designers the opportunity to reduce power dissipation, shrink their board sizes, and reduce noise and cross talk, to name just a few.