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Analog Switch Allows USB Switching at Low Voltages

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APPLICATION NOTE

EXECUTIVE SUMMARY

The new NLAS2066 is a dual SPST (Single Pole Single Throw) switch with over-voltage tolerance (OVT) in its input pins. The OVT feature permits the device to be used for the purpose of sharing of pins in size constrained applications. Shared pins permit the designer to have a smaller connector, saving cost on both male and female portions.

INTRODUCTION

Our modern world is filled with many new devices that permit the user to communicate, take photos and short videos, and listen to music and a whole host of features not yet on the market. The USB port of a modern computer is the most convenient, easiest to use, high performance connection point the consumer can deal with. Although there are other useful ports, the USB port offers simple hookup, up to 2.5 watts of power, and speeds from 100 Kbits/sec to 400 Mbits/sec.

A USB port has four wires: two for bidirectional data, and two for power. A USB port can supply as much as 500 mA at 5.0 V. Many devices simply plug into the USB port with no need for an external power supply. Most users are already familiar with USB peripherals such as printers, pointing devices, keyboards, and digital still cameras. Most peripherals just “plug and play”. Modern PCs take care of the interface with minimal effort, only requiring the installation of software drivers. In addition, the number of USB ports can be increased by adding a hub. USB simply works very well and is the simplest, most convenient port a consumer can deal with.

USB 1.1/2.0

USB 2.0 adds a High Speed specification to the original USB v. 1.1 specification. There are three speeds for USB v. 2.0. The three speed ranges are:

Low Speed:	10–100 Kbits/sec
Full Speed	500K–10 Mbits/sec
High Speed	25–400 Mbits/sec

All USB devices are backward and forward compatible with both the older 1.1 and 2.0 revisions. If the user had a device that he recently purchased that is rated as High Speed, he can still use it with an older PC that only supports the Full Speed mode.

With its ease of use, and inclusion on nearly all Windows, Mac and Linux systems built since 1998, it is the ideal interface for an enhanced feature cell phone. A phone with a 64 MB card can be updated in a few minutes, even in the Full Speed mode. Photos, music, and address books can all be updated in just a few seconds. When attempting to add USB to a device like a cell phone the designer has several issues. Adding an additional connector adds cost and takes up space. Adding 4 more pins to the existing connector adds cost to both the female portion in the phone and all the various male connectors that need to be supplied, in the form of “dongles”. One way to simplify the whole system is to multiplex some of the pins.

MULTIPLEXING PINS

This article will only concern itself with the multiplexing of the data pins. The power pins provide capability to re-charge the phone, without need for a wall mounted power supply. With the close proximity of the wires and the possibility of a potential fault from the power line to the data line, the specification assumes the data lines can handle a voltage up to 5.25 V at the data line¹ for up to 24 hours. The data is sent differentially as NRZI at a maximum of 10 Mbits/sec. The cell phone manufacturer must supply interface cables. The standard USB Type B, at approximately 11 x 11 mm, connector probably is too large for a cell phone. Normally a dongle² is provided with a non-standard plug on the one side and a standard USB type “A” plug on the other. Depending upon the features of the cell phone, the socket may provide audio, video, RS–232, or other interfaces.

1. Universal Serial Bus Specification, Revision 2.0 April 26, 2000.
2. A flexible cable with appropriate connectors on both ends.

If fewer pins are brought out on the cell phone, the size of the connector can be made smaller. In order to minimize the number of pins and reduce size and cost, it behooves the manufacturer to employ some form of multiplexing or sharing of pins on the connector. Pins must be capable of bilateral transmission of either analog or digital signals.

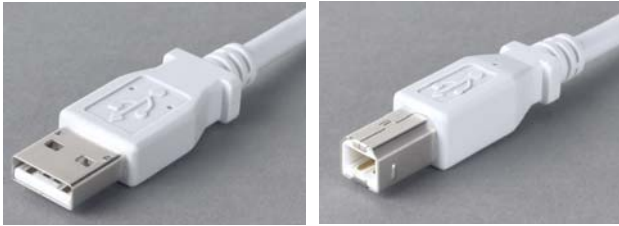


Figure 1. USB – Type “A” USB – Type “B”



Figure 2. Example of a Dongle

The semiconductor industry has been serving the need for bilateral switching for years with standard analog switches. Available analog switches can pass either digital or analog signals in two directions. More recently, analog switches have been fabricated in sub-micron silicon gate CMOS and exhibit resistance in 5–20 Ω range, and can pass signals 50 MHz or more. With R_{ON} values this low, an analog switch could be used to provide USB switching. Also, the frequency response of the switch should not affect overall performance of the USB transceiver. Several standard switches now available can meet the frequency and R_{ON} requirements. One additional requirement to meet USB safety specifications, states that the analog switch must be capable of a voltage “fault” of 5.25 V for 24 hours. One way to solve this requirement is simply to operate the switch at

a V_{CC} of 5.0 V, nominal. While this would work, it places a cost and component burden on the system. The need for 5.0 V in a product like a cell phone is rare today. If not otherwise needed, it would place a demand for a regulator and additional voltage from the dc/dc converter on board. Camera enabled cell phones have very limited space, so the 5.0 V option is not very desirable. In order to save space and component cost and minimize the number of power supplies, the analog switch would need to operate from a supply voltage of approximately 2.7 V and be able to accept a 5.25 V fault. If the designer could find a switch that could accept 5.25 V, while operating from 2.7 V, then the 5.0 V power supply could disappear. Ordinary analog switches have diodes connected to both the supply pin and ground pin, to protect the device against Electrostatic Discharge (ESD). If the switch were to be operated at 2.7 V and either USB data line had 5.25 V fault, the input diode connected to V_{CC} would be destroyed. This could cause damage, and could not be tolerated. A new device, the NLAS2066 dual analog switch has been introduced from ON Semiconductor, which permits operation at 2.7 V, while its inputs tolerate as much as 5.5 V, regardless of the operating voltage. This switch has an R_{ON} resistance low enough to permit use with USB 2.0 Full Speed specification.

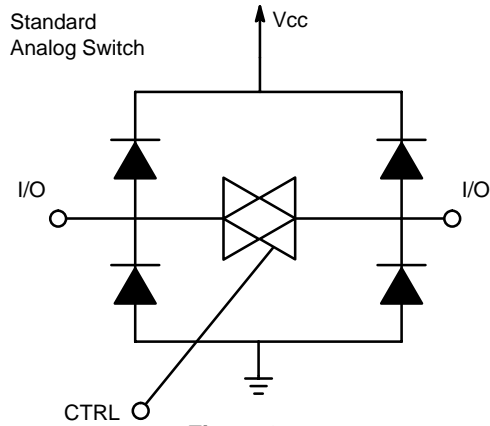


Figure 3.

AND8130/D

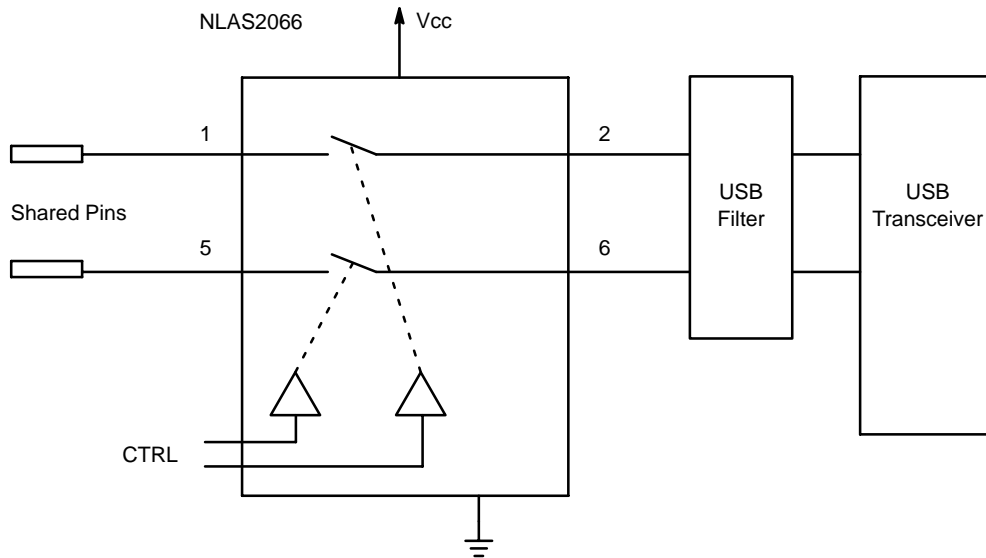



Figure 4.

One side of the switch is protected against high voltage. It is therefore possible to use this switch to disconnect the USB input from the pins. Since the Analog Switch provides a high impedance state, it is not necessary to do anything but open the USB input filter to the pins. The application drawing shows the implementation. The shared pins may be hooked to any high impedance device. This device should also be capable of withstanding 5.25 V.

CONCLUSION

The NLAS2066 is a tiny 8 pin device occupying only 6 mm² of board space that permits a designer to reduce the number of pins that go to the outside world connector. The diagram shows how to connect the NLAS2066 to permit shared pins. By reducing the number of pins, the designer can save both space and cost.

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