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## NLAS4717 Analog Switch Permits USB 1.1 Switching

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### APPLICATION NOTE

ON Semiconductor has introduced a new low resistance analog switch suitable for interfacing with USB 1.1 (USB 2.0 Full Speed). The switch is completely bi-lateral and may be used to carry either digital or analog signals. The NLAS4717 is a dual Single Pole Double Throw (SPDT) switch capable of switching either two independent signals or a differential signal pair as with USB.

The USB 2.0 specification, completed in 2000, has now become the mainstay of peripheral connections. This specification fully encompasses the older USB 1.1 specification and adds a high speed rate. USB 2.0 now contains three speeds, Low, Full, and High. The Full Speed data rate is specified at 12.0 MBits/sec. Low Speed is 1.5 MBits/sec and High Speed is 640 MBits/sec.

The balance of this article will address the Full Speed specification only. The Full Speed rating is more than adequate for most handheld appliances. The reader may not understand why a device like a USB port needs signal switching at all; normally USB is expanded via active port expanders (hub). The value lies in the ability to reduce the number of pins that go to the outside world. For example, a digital camera almost assuredly needs a USB interface and the ability to deliver or receive other signals as well; video, audio, RS-232, charging, etc. The ability to reduce the number of pins going to the outside world, reduces the connector size, saves cost and improves reliability. In almost all cases, the equipment manufacturer supplies the required

cables. For example, a connector may be Series A with a subminiature Series B connector on the other end. Another cable would be used for other purposes, for example, charging, video, RS-232, audio etc. The designer may use the 5.0 V power available from the USB cable to supply the switch. Using the available 5.0 V supply saves precious battery charge whenever the USB cable is connected. The data lines D+ and D- must be capable of being shorted to the power pin (5.0 V) for 24 hours, without harm to the equipment. This would present a problem to most analog switch designs, however the use of a low  $V_f$  Schottky diode prevents the switch from shorting to the lower voltage battery. When used for other than USB, it is assumed that the device is powered from its battery or from an external power source, in this case there are no mismatched voltage concerns.

The USB Full Speed is a differential signal that varies between 0.8 V and 2.8 V, driving a 90  $\Omega$  balanced cable. The series resistance is approximately 3.5  $\Omega$  and each section is extremely well matched, so as not to introduce a common mode component. The small series resistance poses no problems to the USB signal, and the  $f_{3dB}$  is well above the 12 MBits/sec requirements. The threshold of the control signal on the NLAS4717 is adjusted lower than normal, so that when operating at 5.0 V (as in the case of USB) it can interface with almost any controller.

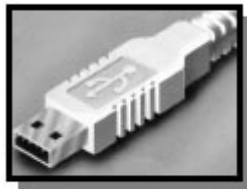


Figure 1. USB Series A Connector

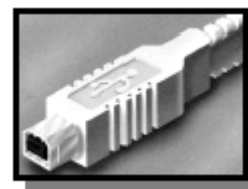


Figure 2. USB Series B Connector

## AND8158/D

**Other Considerations:** The signal pins should be protected from ESD with some form of energy absorbing device. The NUP2301 quad diode array provides 15 kV protection, while only loading the lines with an additional 3.0 pF of capacitance. All four diodes come in a single 2 x 3 mm, TSSOP-6 package and offer excellent protection.

Figure 3 shows the NLAS4717 used without the 5.0 V USB pin being connected. Only 3 wires are connected, Ground, D+, and D-. For use with other signaling, a

different cable assembly would be used, ground would be retained, but the other two wires are up to the user and can be used for analog information such as video/audio or other digital signals. In the USB mode, if the power and data lines are accidentally shorted, the 5.0 V from the USB is blocked from doing any harm by the Schottky diode. The analog switch will now be at  $\approx 4.3$  V nominally. The designer must make sure anything connected to the switch is able to withstand this voltage.

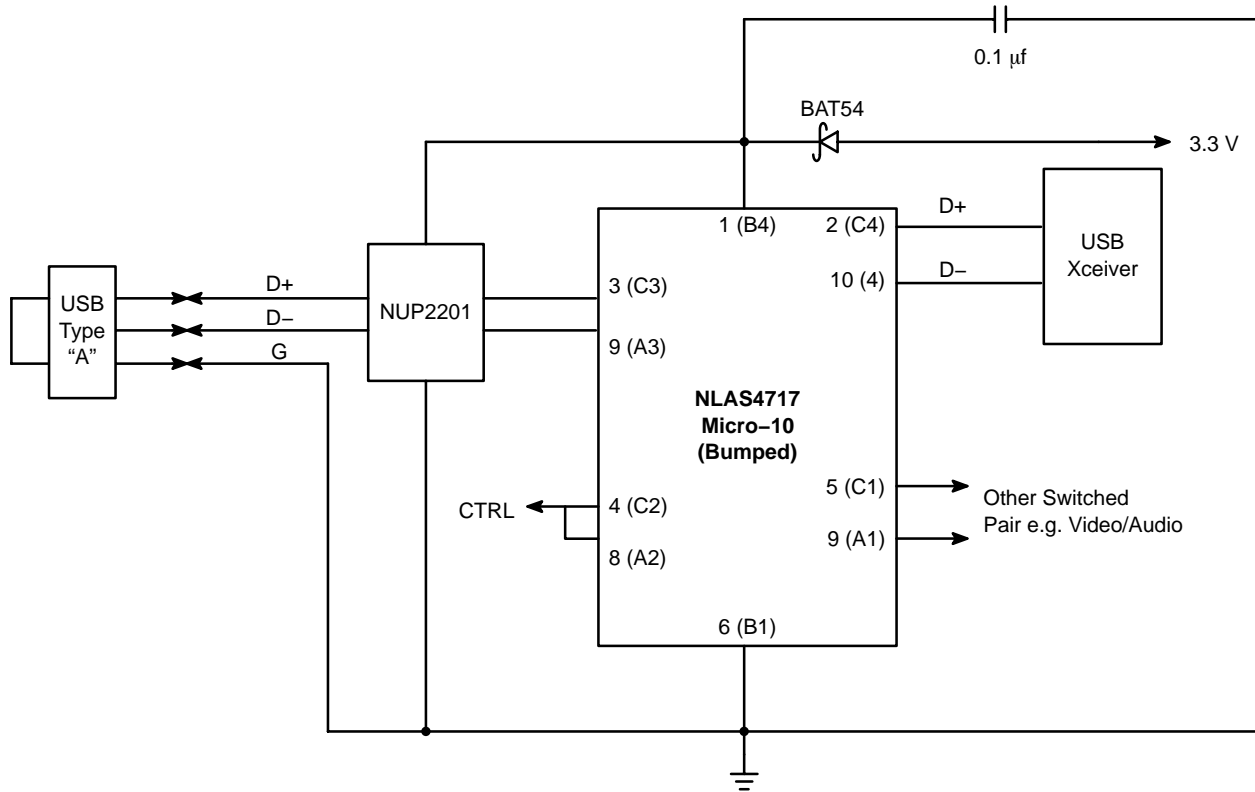


Figure 3. NLAS4717 USB 1.1 Switch

## AND8158/D

Figure 4 shows the NLAS4717 with the 5.0 V supply voltage from the USB port as the supply voltage for the switch. Again the Schottky diode is necessary to isolate the 5.0 V from the internal battery or regulator. The same cautions apply, any circuit connected to the switch, needs to

be able to withstand +5.0 V regardless of battery voltage. It should be noted that the NLAS4717 can be switched from one state to the next with only +2.0 V, so there should be no need for translators from a low level MCU, even with 5.0 V being applied.

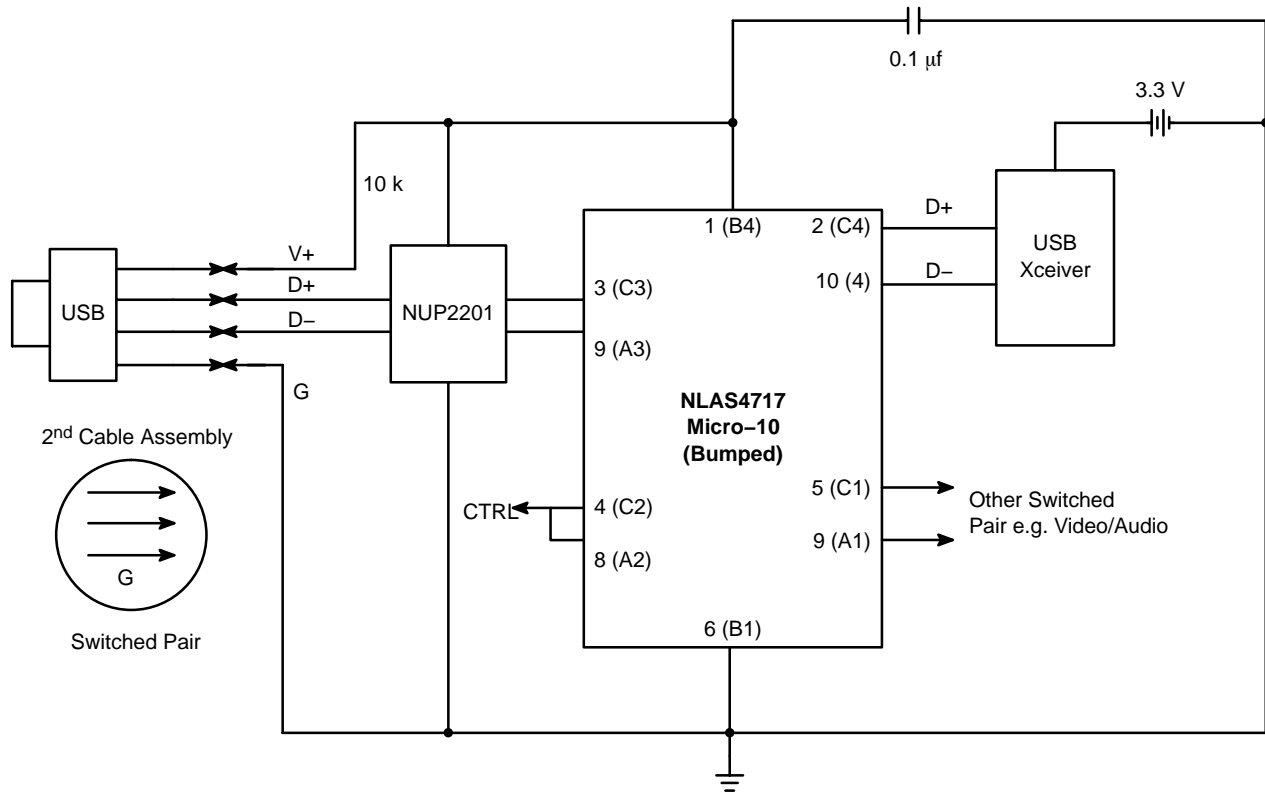



Figure 4. NLAS4717 USB 1.1 Switch with a 5.0 V Supply Voltage

### Summary

The NLAS4717 makes it easy to switch between USB 1.1 and any other 2 signals that stay within the bounds of the supply voltage and ground that the designer needs to switch. Switching enables less complex cables with fewer pins (cost saving) and smaller size. If the designer has the flexibility to manufacture or purchase a USB cable with only 3 pins, i.e. not including the 5.0 V pin, then the precautions taken to

handle the 5.0 V can be eliminated, e.g. the Schottky diode. The NLAS4717 can handle the 12.0 MBit/sec bandwidth of USB Full Bandwidth with no issues. The NLAS4717 can interface with any standard analog or digital signal, re-using the pins with a different cable assembly for non-USB applications thereby reducing pin count, size and cost, while increasing reliability.

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