



Application Note 10.6

**USB Device Interface to V_{BUS}
with the SMSC GT3200**



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1 General Description

The Universal Serial Bus (USB) transfers power in the cable as a signal named V_{BUS} . This power is generated by the downstream facing port (host) and is supplied on pin 1 of the USB connector. V_{BUS} is nominally +5V referenced to the GND signal (pin 4) of the USB connector, and is capable of sourcing up to 500 mA.

The V_{BUS} signal does not connect to the GT3200. The controller (sometimes referred to as the Serial Interface Engine or SIE) must detect the presence of V_{BUS} as a way to determine connection/disconnection with a host. This application note discusses methods of interfacing the V_{BUS} signal to the controller.

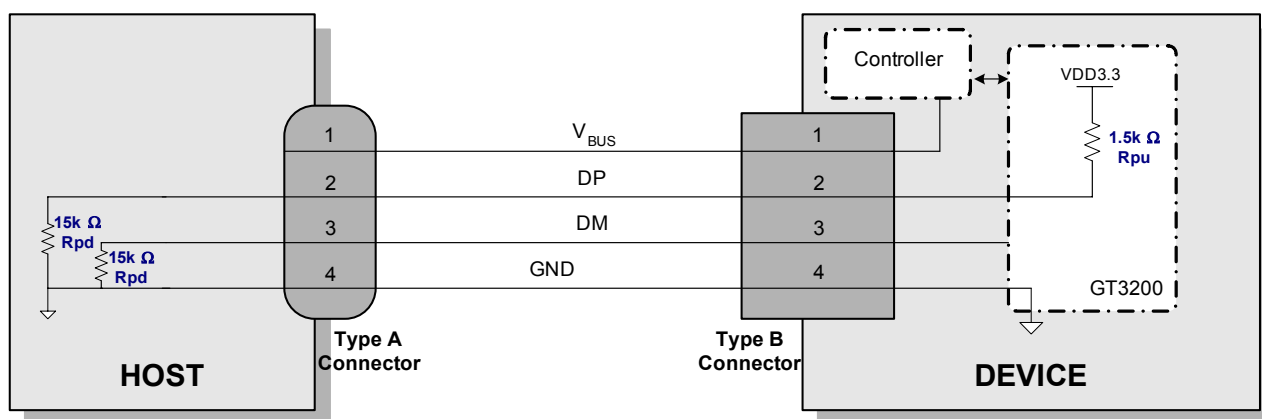


Figure 1 - General Diagram

2 Powering Methods for USB Devices

There are two ways to power a USB device: self-power and bus-power.

A self-powered device is a device that satisfies its power needs from a battery, ac adaptor, or alternate source other than the USB. Although a device may be considered self-powered, it is still allowed to draw up to 100mA from the USB via V_{BUS} .

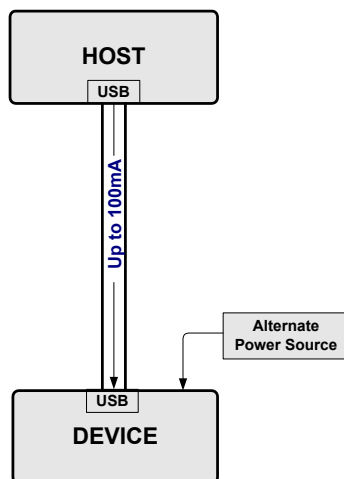


Figure 2 - Self Powered Device

A bus-powered device is a device that draws all of its necessary power from the USB. A bus-powered device is allowed to draw 100mA from the USB before configuration. Upon successful enumeration, a bus-powered device is allowed to draw 500mA from the USB if the host supports high-power functions. If the host does not support high-power functions, the device is limited to drawing 100mA from V_{BUS} . A high-power bus-powered device will draw up to 500mA from V_{BUS} during normal operation, while a low-power bus-powered device will only draw up to 100mA from V_{BUS} during normal operation.

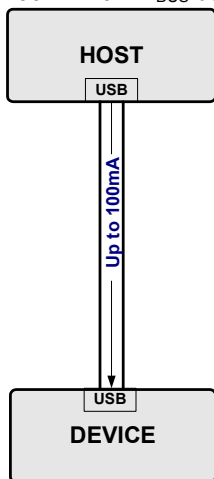


Figure 3 - Low-Power Bus-Powered Device

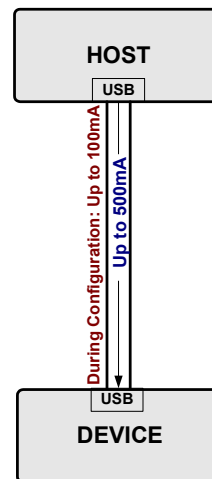


Figure 4 - High-Power Bus-Powered Device

A subclass of bus-powered devices are dual-powered devices. A dual-powered device is a device that uses the USB to supply its power when connected to a host, but uses a battery or such to supply power to the device when disconnected from the host. Ideally, a dual-powered device would recharge its battery while connected to the USB.

3 Detecting V_{BUS}

Every USB device, whether it is self or bus-powered, must detect the V_{BUS} signal on the USB connector as a way to determine connection/disconnection with a host. Even a device that is designed to be completely self-powered must recognize when it has been plugged into a host. Upon initial connection of host and device, the host looks for either one of its data lines to be pulled high as a sign that a device has been attached to it. The GT3200 has a pull up resistor on DP that will overpower the host's pull down resistor (See Figure 1 - General Diagram). Once the host detects one of the data lines has been pulled high, it will begin communication with the device.

It is the responsibility of the device to monitor V_{BUS} to insure that a stable interconnect has been made between device and host before enabling a pull-up resistor on a data line. A self-powered device would only need the ability to detect V_{BUS} level. This could be accomplished with multiple methods.

A controller with 5.25V tolerant inputs can be connected directly to the V_{BUS} signal of the USB connector. The controller input pin must withstand direct connection to the outside world at the USB connector.

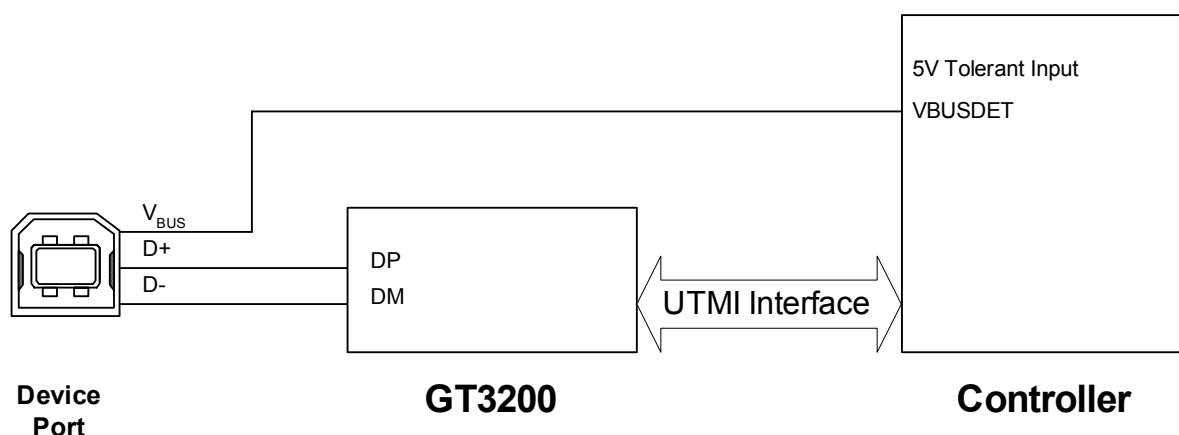


Figure 5 - Direct Connection

A resistor divider may be used to reduce the V_{BUS} level to a valid logic level and then connect to the controller. The series resistor provides some isolation to the outside world. The resistor values must be selected to prevent the voltage at the input pin of the controller from exceeding the limit.

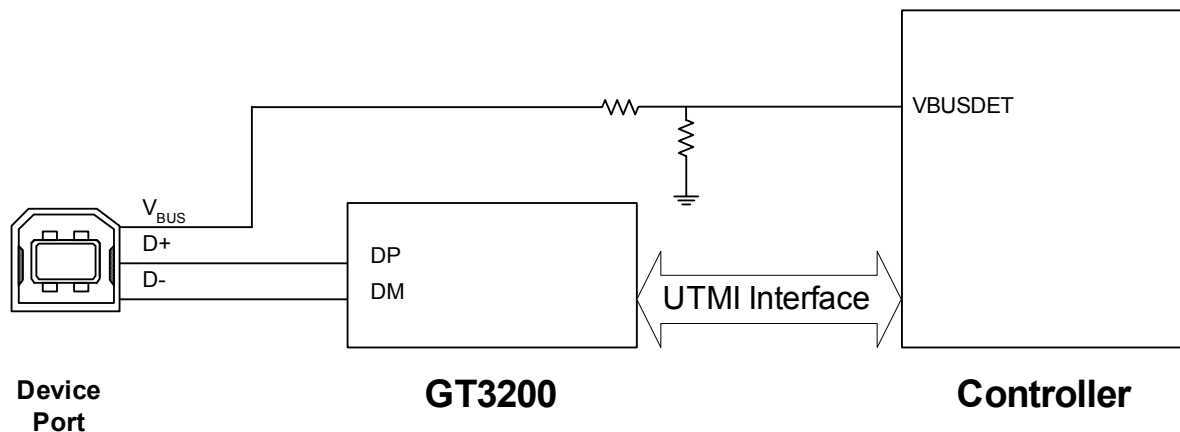


Figure 6 - Resistive Divider reduces the voltage at the controller

A more robust solution would employ a power on reset (POR) device to monitor the V_{BUS} level and provide a signal to the controller when a stable voltage is reached.

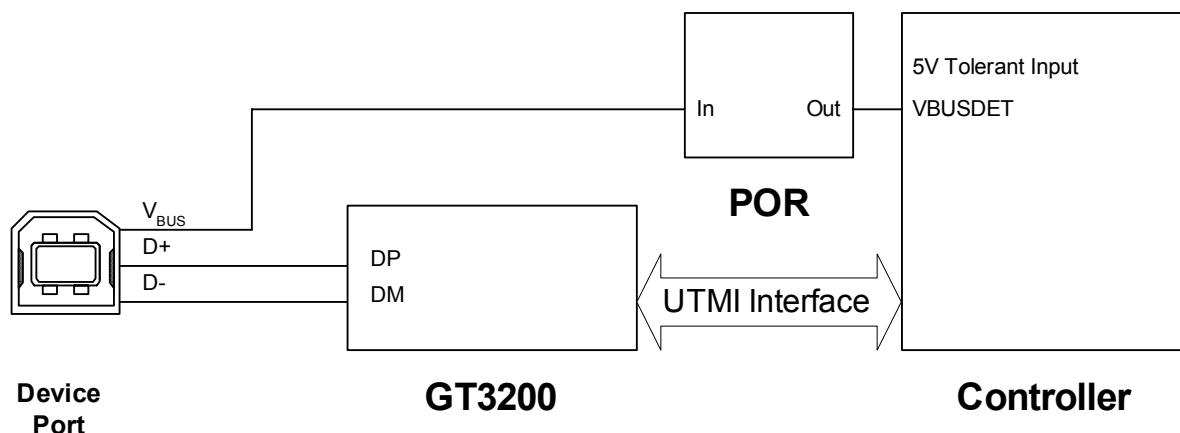


Figure 7 - POR Device Monitors V_{BUS} level

Bus-powered devices require a method to regulate the V_{BUS} signal to the required voltages. The GT3200 transceiver requires 3.3V and 1.8V supplies. This requirement may be satisfied through separate regulators or a single IC that generates both supplies from V_{BUS} . The controller logic could use the output of a regulator as a flag for connection/disconnection from the host.

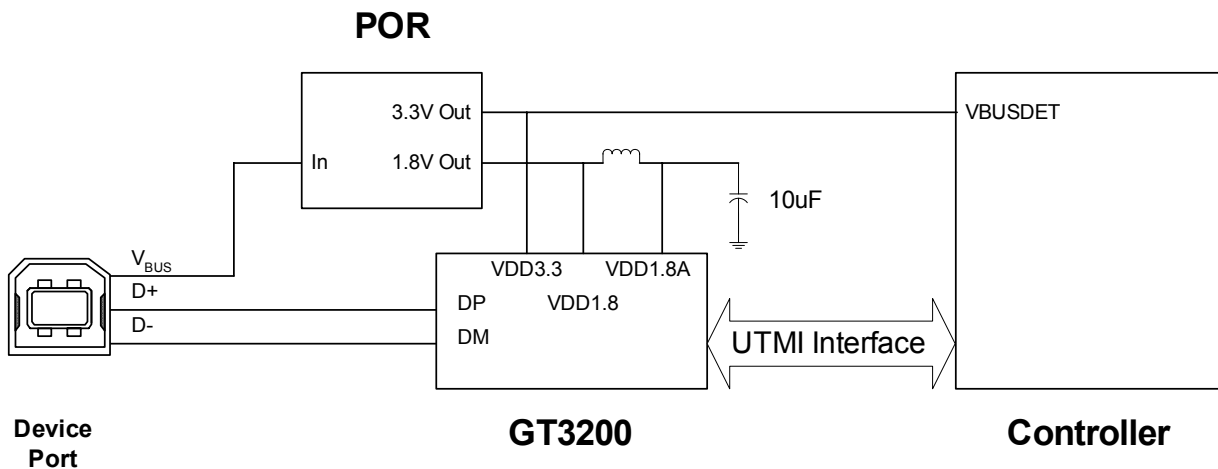


Figure 8 - Voltage Regulators used to provide power to GT3200

Listed below are examples of ICs that perform some of these functions.

- Texas Instruments TPS2148/58
- Intersil ISL6110
- Micrel MIC2545A
- Maxim MAX1931



4 Real World Protection

The device designer needs also to consider protection of the controller, regulators, or any function blocks that connect directly to the V_{BUS} pin from possible electrical surges and ESD events. Because the V_{BUS} signal is on the USB connector, it is directly susceptible to the outside world. This being the case, whatever circuitry V_{BUS} is connected to is also directly susceptible to the outside world. Consideration needs to be taken in selecting regulators and other interfacing circuitry with adequate protection or selection of additional device protection.

The USB 2.0 Specification states that a device must be able to survive a short between the V_{BUS} line and either or both of the DP/DM data lines. This case could come about from a faulty cable or connector. A short on the data lines could affect circuit blocks deeper into the function than the transceiver. In the case that the GT3200 is not powered and voltage is forced on the data lines, the voltage becomes transparent at the GT3200 3.3V supply pins through ESD protection diodes. A worst case condition would force the VDD3.3 supply pins to approximately 3.5V with current drive capability of around 100mA. These supply pins are connected to a regulator or source which could possibly be damaged or destroyed if this unexpected voltage appears. Regulators and sources must be carefully selected with proper reverse leakage protection. If a regulator is used that does not contain proper reverse leakage protection, it is recommended that a diode be placed between the input and output of the regulator.