Powering Up the TSC2003 Correctly

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ABSTRACT

The TSC2003 is a four-wire resistive touch screen controller with an I²C™ digital interface that requires a specific power-up sequence. This application report addresses these power-up related concerns and discusses how to ensure a safe TSC2003 start-up process.

1 TSC2003 Power-Up Sequence

Based on design principles and extensive tests with the TSC2003, power for the device must adhere to a specific power-up sequence in order to make sure that the TSC2003 is reset to a default working state after every power up occurs.

During the power-up process, the I²C bus must be in an idle (logic *high*) state. That is, the TSC2003 SDA and SCL pins must be high before the device power-supply $+V_{DD}$ pin ramps up to 0.9 V, as illustrated in Figure 1.

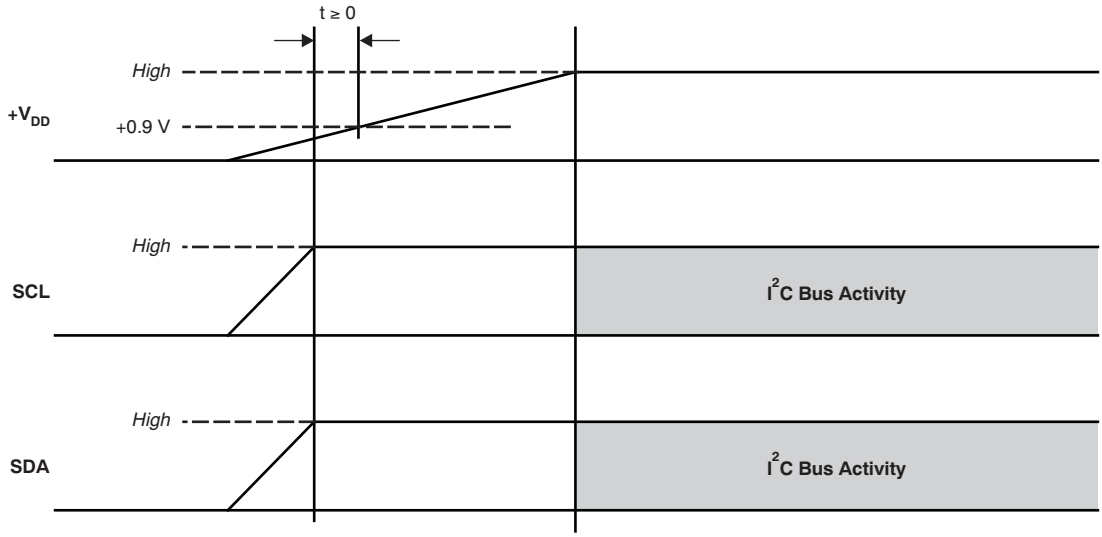

Figure 1. TSC2003 Power-Up Sequence Requirements

1.1 Logic High

What exact voltage is considered to be logic *high*, as indicated in Figure 1? Logic *high* may be different during the power-up process and after the device is at 100% power.

As defined in the product data sheet, the TSC2003 power supply ($+V_{DD}$) operates in the range from +2.5 V to +5.25 V. When $+V_{DD}$ reaches 0.9 V during the power-up process, the TSC2003 internal circuitry wakes up. It then checks the status of both SCL and SDA to determine whether they are *high* (that is, idle or inactive) or *low* (that is, working or active). If the status of both SCL and SDA is *high*, a power-on reset (POR) command is issued. If the status of either SCL or SDA is *low*, no POR is issued, which could result in the device locking up (see Section 1.2). In other words, before $+V_{DD}$ at 100% power, the TSC2003 device begins to operate based on the status of the SCL and SDA lines.

In order for the TSC2003 to work with the minimum $+V_{DD}$ voltage, the logic *high* level in Figure 1 must be at least the value specified by Equation 1.

$$0.8 \times (+V_{DD})\text{min} = +2 \text{ V} \quad (1)$$

So then, logic *high* in Figure 1 can be replaced by +2 V.

1.2 Possible Problems if Power-up Sequence Cannot Be Satisfied

What could occur if the power-up sequence defined in Figure 1 cannot be met?

During the TSC2003 power-up process, an internal reset circuit wakes up when $+V_{DD}$ ramps up to approximately +0.9 V. A reset signal is then sent to the TSC2003 internal I^2C port in order to reset that port only if there is no activity on the I^2C bus lines (that is, both SCL and SDA are at logic *high*).

If the TSC2003 SCL or SDA pins have not reached logic *high* when $+V_{DD}$ ramps up to approximately +0.9 V, the TSC2003 internal reset circuit may not issue the reset. This failure to issue the power-on reset could, in turn, cause the TSC2003 to accidently hold the SDA pin low.

If the SDA pin is held low (a condition also known as *TSC2003 SDA lock-up*), abnormal system operation occurs, and the I^2C bus cannot be accessed by the master device in the system.

2 Ensure a Proper Start-Up

To ensure the safe and proper start-up of the TSC2003, these design guidelines should be followed:

1. **Hardware.**

   If the TSC2003 $+V_{DD}$ and the I^2C bus interface supply share the same power source, place one or more capacitors (with proper capacitance) next to the TSC2003 $+V_{DD}$ pin to slow down the $+V_{DD}$ ramp-up.

   If the TSC2003 $+V_{DD}$ and the I^2C bus interface supply are supplied with different power sources, the I_2C bus interface supply power source should be turned on first ***before*** the TSC2003 $+V_{DD}$ is powered up.

   Both of these points emphasize the need to satisfy the power-up sequence requirement as shown in Figure 1. Moreover, allow adequate time for the I^2C interface supply to power-up and settle. Multiple I^2C devices on the bus will impact this time.

2. **Software.**

   If the I^2C interface supply cannot be activated before the TSC2003 supply, as specified in Figure 1, and therefore the TSC2003 holds the SDA line *low*, the following software fix can be applied in order to bring the TSC2003 out off the SDA lock-up state and back to normal operation:

   (a) Toggle the SCL line at least nine times.
   (b) Issue a START/STOP condition after the SDA bus is released.

   The first step causes the TSC2003 to release the SDA line, and the second step places the TSC2003 I^2C port into the proper operating state.

3 References

The following documents are available through the Texas Instruments website (www.ti.com):

1. TSC2003 I^2C Touch Screen Controller product data sheet. TI literature number SBAS162G.
2. TSC2003-Q1 I^2C Touch Screen Controller product data sheet. TI literature number SBAS454.

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