**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<sub>DD</sub> pin ramps up to 0.9 V, as illustrated in Figure 1.

![Figure 1. TSC2003 Power-Up Sequence Requirements](chart)

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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 I²C port in order to reset that port only if there is no activity on the I²C 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 accidentally 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 I²C 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 I²C 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 I²C bus interface supply are supplied with different power sources, the I²C 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 I²C interface supply to power-up and settle. Multiple I²C devices on the bus will impact this time.

2. Software.
   If the I²C 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 of 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 I²C port into the proper operating state.
3 References

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

1. **TSC2003** I²C Touch Screen Controller product data sheet. TI literature number SBAS162G.
2. **TSC2003-Q1** I²C Touch Screen Controller product data sheet. TI literature number SBAS454.
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