

Migrating from TSC2003 to TSC2007

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ABSTRACT

This application report describes the issues of interest related to migrate from the Texas Instruments™ (TI) TSC2003 to the TSC2007 touch screen controller. The objective is to highlight differences between the two devices and to provide guidelines for hardware and software changes required for the migration.

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1 Introduction

Both the Texas Instruments™ TSC2003[1] and the TSC2007[2] are 4-wire resistive touch screen controllers with I²C™ interface. As one of TI's next generation of TSC devices, the TSC2007 provides more features and higher performance than the TSC2003.

Even though the two devices may be completely hardware compatible (with the TSSOP package) and software compatible in the most of the applications, there are a few hardware and software changes may be needed for migrating from the TSC2003 to the TSC2007.

This application report describes the issues of interest related to the migrating, from the following four points of view:

- differences between TSC2003 and TSC2007
- hardware changes needed for the migrating
- software changes needed for the migrating
- power up sequence

2 Device Differences

Even though TSC2003 and TSC2007 are both based on the command-based scheme [3], TSC2007 was built with the additional internal pre-processor, and therefore, it is a TSC device with the *advanced command-based scheme*. Compared to its predecessor (TSC2003), the TSC2007 is smarter, more powerful, has more features, and has higher performances.

In order to miniaturize the size and focus on the core function of a touch screen controller (TSC), TSC2007 has reduced the pin count. Thus several auxiliary analog input pins on the TSC2003 are eliminated on the TSC2007, as indicated in [Table 1](#).

[Table 1](#) also lists other hardware differences between the two devices.

Table 1. Hardware Differences between TSC2003 and TSC2007

Type of Differences	TSC2003	TSC2007	Additional Notes
Auxiliary Analog Inputs	V _{BAT1} , V _{BAT2} , IN ₁ and IN ₂	AUX (=IN ₁)	TSC2003 has 4 non-touch analog input pins TSC2007 has only 1
Internal V _{ref}	Yes	No	TSC2003 has separated external V _{ref} pin TSC2007 combines V _{ref} into V _{CC} pin
Internal MAV Filter	No	Yes	TSC2003 samples 1 data precommand TSC2007 samples 7 data, performs filter, and outputs a refined data (when MAVF is enabled)
Interrupt $\overline{\text{PENIRQ}}$	Need an external pullup resistor	With Internal pullup resistor, programmable 51K Ω or 90K Ω	TSC2007 needs one less external part than TSC2003
Power Supply Range	2.5 Vdc to 5.25 Vdc	1.2 Vdc to 3.6 Vdc	TSC2007 requires much lower voltage power supply than TSC2003
ESD Protection Level	2 KV	25 KV Air; 15 KV Contact	TSC2007 has much higher ESD protection level than TSC2003
Package	TSSOP-16 or VFBGA-48	TSSOP-16 or WCSP-12	The footprint of TSC2007 TSSOP is a subset of that of TSC2003 TSSOP. WCSP is the smallest and thinnest package

Both TSC2003 and TSC2007 are of the same I²C slave device address (90h) and the same format at their command byte. The definitions of the command byte of TSC2007 can be viewed as a subset of that of TSC2003, except for the filtering control and $\overline{\text{PENIRQ}}$ pull-up selection.

[Table 2](#) shows the command byte differences between the two devices, highlighted by yellow. The differences on the bit definitions of the command byte affect the command or software, from the host processor to the TSC devices.

Note: when the most significant 4 bits of the command byte, i.e.: C3=C0, is set to 1011b = Bh, TSC2007 is commanded to go to its *Setup* mode, and the least significant 4 bits here get totally difference definitions, and are used to setup the TSC2007 programmable features. The TSC2003 does NOT have *Setup* mode.

Table 2. Command/Software Differences between TSC2003 and TSC2007

Type of Differences		TSC2003	TSC2007	Additional Notes
Converter Function Select C3 ≈ C0 (bit 7 ~ bit 4 of Command byte)		0000 — Measure TEMP0	0000 — Measure TEMP0	
		0001 — Measure V _{BAT1}	0001 — Reserved	
		0010 — Measure IN ₁	0010 — Measure AUX	
		0100 — Measure TEMP1	0100 — Measure TEMP1	
		0101 — Measure V _{BAT2}	0101 — Reserved	
		0110 — Measure IN ₂	0110 — Reserved	
		1000 — X+/X- Driver ON	1000 — X+/X- Driver ON	
		1001 — Y+/Y- Driver ON	1001 — Y+/Y- Driver ON	
		1010 — Y+/X- Driver ON	1010 — Y+/X- Driver ON	
		1011 — Reserved	1011 — Setup	
		1100 — Measure X	1100 — Measure X	
		1101 — Measure Y	1101 — Measure Y	
		1110 — Measure Z1	1110 — Measure Z1	
	1111 — Measure Z2	1111 — Measure Z2		
Power-Down Select PD1 ~ PD0 (bit 3 ~ bit 2 of Command byte)		00 — ADC, V _{ref} PW Down (PENIRQ enabled)	00 — ADC, Power Down (PENIRQ enabled)	1. PD1 is for the internal V _{ref} , and thus it is not a matter for the TSC2007 2. "Power Down" means the "power down between converting cycles"; and "Power Up" means "always power up"
		01 — ADC Up, V _{ref} Down (PENIRQ disabled)	01 — ADC Power Up (PENIRQ disabled)	
		10 — ADC Down, V _{ref} Up (PENIRQ enabled)	10 == 00	
		11 — ADC, V _{ref} both Up (PENIRQ disabled)	11 == 01	
Filter Control ⁽¹⁾ (bit 1 of Command byte)	C3 ≈ C0 != Bh	0 — 12-bit resolution 1 — 8-bit resolution	0 — 12-bit resolution 1 — 8-bit resolution	When C3-C0 is NOT Bh
	C3 ≈ C0 = Bh	None	0 — Enable MAVF 1 — Disable MAVF	Only under setup mode (i.e. C3 ≈ C0 = Bh)
PENIRQ Pullup R _{IRQ} Select ⁽¹⁾ (bit 0 of Command byte)	C3 ≈ C0 != Bh	Reserved	Reserved	When C3 ≈ C0 is NOT Bh
	C3 ≈ C0 = Bh	None	0 — R _{IRQ} = 51KΩ 1 — R _{IRQ} = 90 KΩ	Only under setup mode (i.e. C3 ≈ C0 = Bh)

⁽¹⁾ In default status, the TSC2007 has the MAVF filter enabled, and the internal $\overline{\text{PENIRQ}}$ pullup R_{IRQ} = 51KΩ. Thus, the TSC2003 software is reusable for the TSC2007 if the user does not need to reprogram the MAVF and/or the R_{IRQ}.

3 Hardware Changes

TSC2003 and TSC2007 TSSOP packages are pin-to-pin compatible as shown in Figure 1. Where the differences are circled in **red**.

Corresponding to the hardware pinouts and other hardware differences listed in Table 1, a few hardware changes may be needed under some specific conditions, for migrating from TSC2003 to TSC2007. An example is presented to explain the hardware changes on schematics.

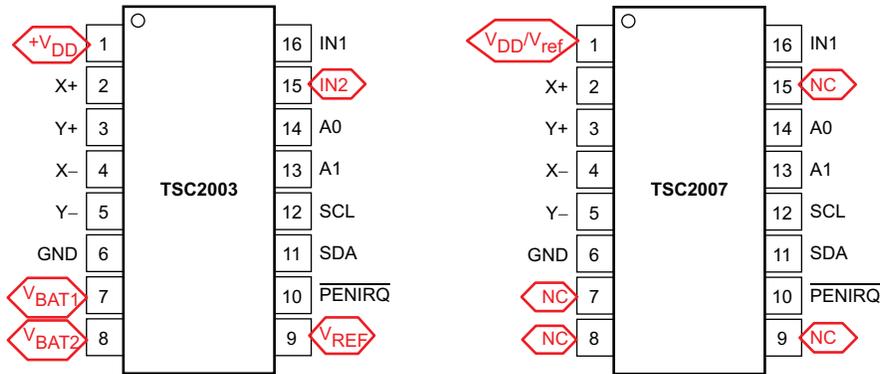


Figure 1. Comparing Pin-Outs of the TSC2300 and the TSC2007

Example 1: An application using the TSC2003 (TSSOP package) in its design with the schematic shown in Figure 2. If the design group plans to replace the TSC2003 with the TSC2007 TSSOP silicon, the TSC2007 can be directly dropped in, as shown in Figure 3.

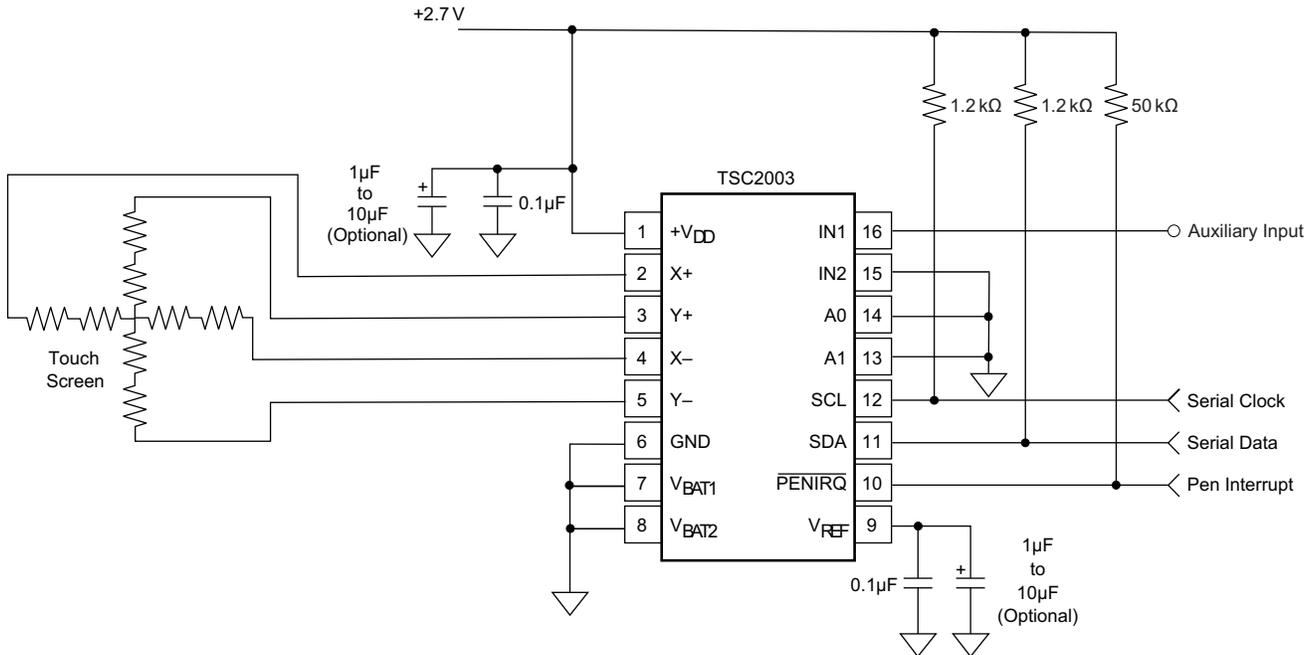


Figure 2. Old Design Schematic With TSC2003

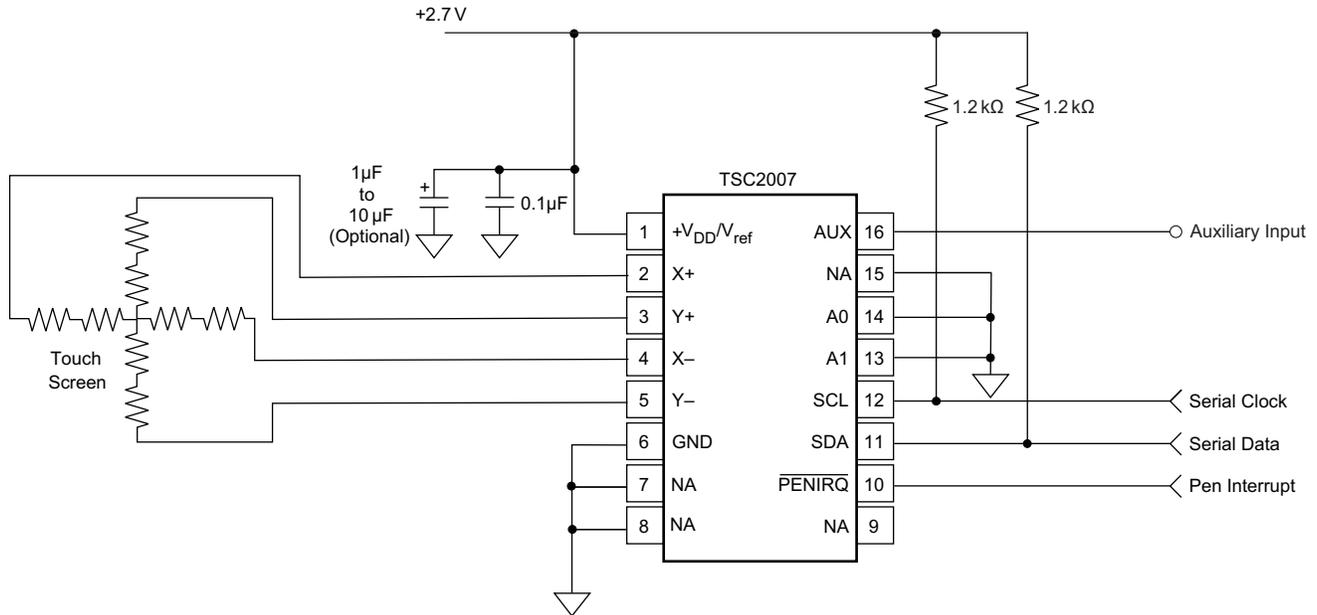


Figure 3. New Design Schematic With TSC2007

In this particular example, the 50-k Ω resistor for pulling-up the $\overline{\text{PENIRQ}}$ and the bypass capacitors for TSC2003 V_{ref} in the TSC2003 design (Figure 2) are eliminated in the new TSC2007 design (Figure 3).

The NA pins of TSC2007 are not connected anywhere internally, and can be grounded or kept floating.

4 Software Changes

There are no software change if:

- VBAT1, VBAT2, and IN2 pins are not used, as in Example 1; and
- the new design takes advantage of using the TSC2007 internal MAV filter.

Under the above conditions, the TSC2003 and the TSC2007 are totally software compatible.

The command for TSC2003 that calls VBAT1, VBAT2, or IN2 converting function is invalid for TSC2007. Otherwise, all commands for TSC2003 work with the same function as the TSC2007.

TSC2007 has the added "setup" mode. The "setup" mode or command is needed only if:

- the internal MAV filter needs to be bypassed; and/or
- the internal $\overline{\text{PENIRQ}}$ pull-up resistance needs to be changed (either 51 K Ω or 90 K Ω).

Example 2: Use command byte 1011 0010b (=B2h) to bypass the 7 data MAV filter inside TSC2007.

Example 3: Use command byte 1011 0000b (=B0h) to re-enabled the 7 data MAV filter inside TSC2007.

Example 4: Use command byte 1011 0001b (=B1h) to shift to 90K Ω internal pull-up resistor for touch panels that is of much higher resistance.

5 Power Up Sequence

The inside TSC2003, the state-machine checks the I²C line status when a power supply is applied on the TSC2003 +V_{DD} pin. TSC2003 performs a power on reset (or POR), and bring itself to a working condition if the state-machine does not detect an action on the I²C line. The POR may not implement if TSC2003 detects an action (one of the I²C lines is driven *low*) on an I²C line before its power up is finished.

Thus, for example, if SDA line is driven *low* during +V_{DD} ramping up, the TSC2003 does not perform the POR, and the I²C line is *low* or back to normal (both I²C lines high), depending on the final status the pin landing on after the power up.

Power Up Sequence

To ensure the POR implementation during the TSC2003 power-up:

- the power supply to TSC2003 +V_{DD} pin and to the I²C line pull-up resistors should be powered up simultaneously; or
- the power supply to the I²C line pull-up resistors should be powered up earlier/faster

Figure 4 provides some examples of proper power up sequences, and Figure 5 are some examples of improper power up sequences.

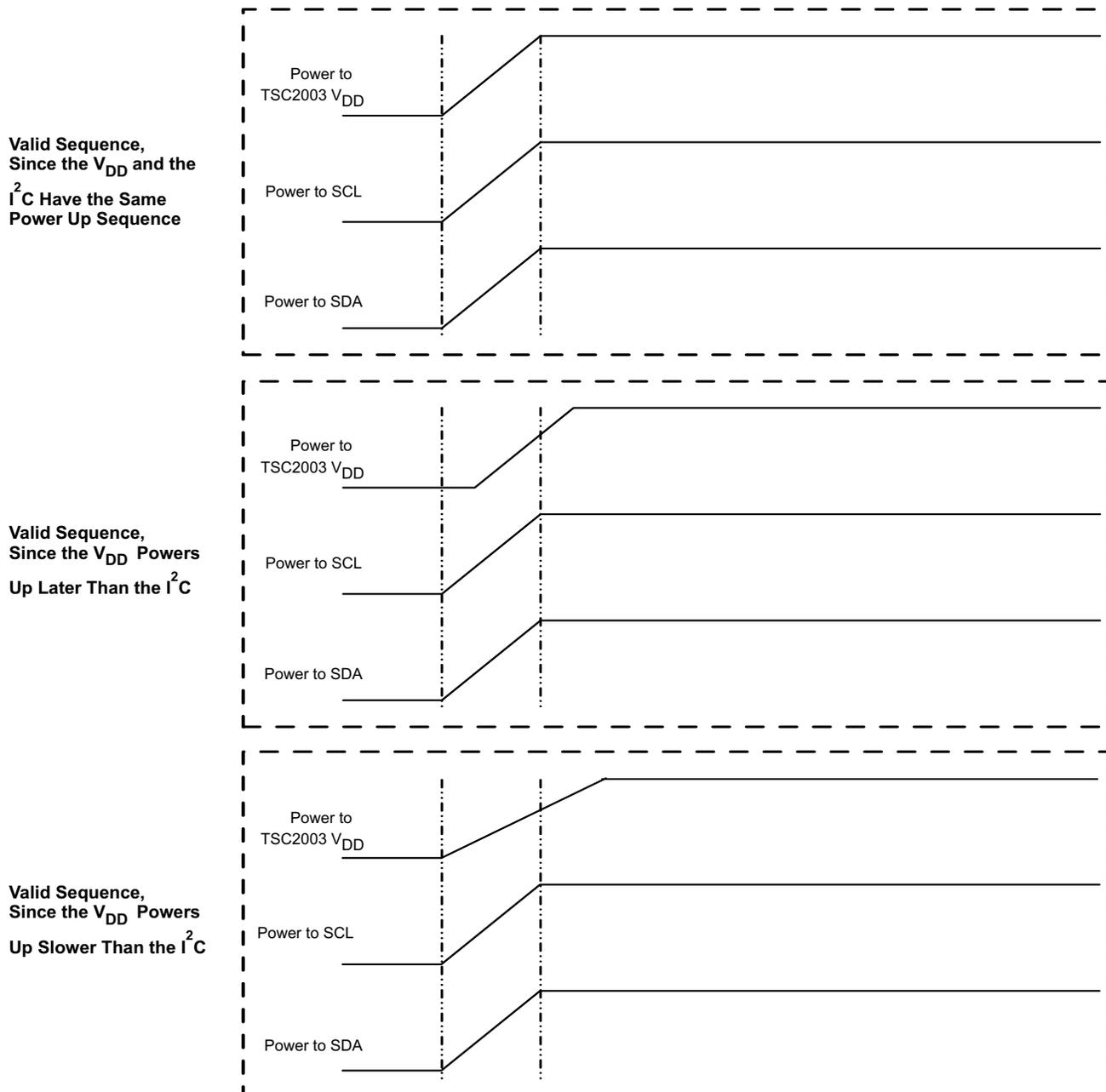
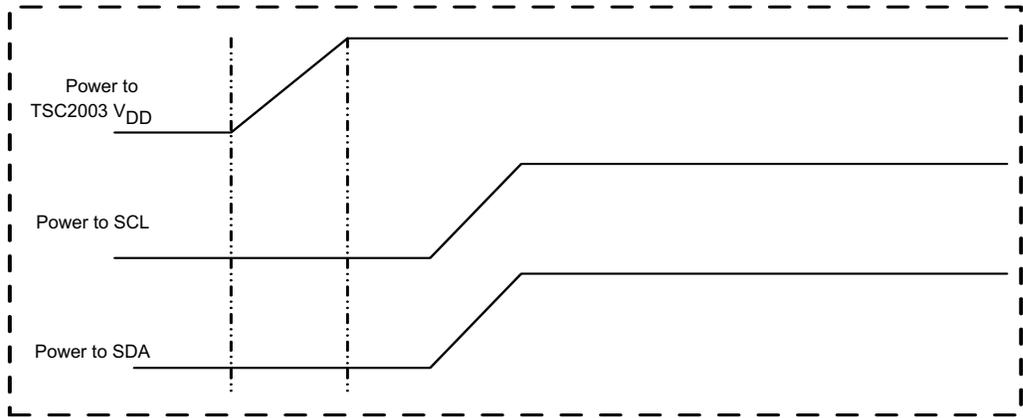
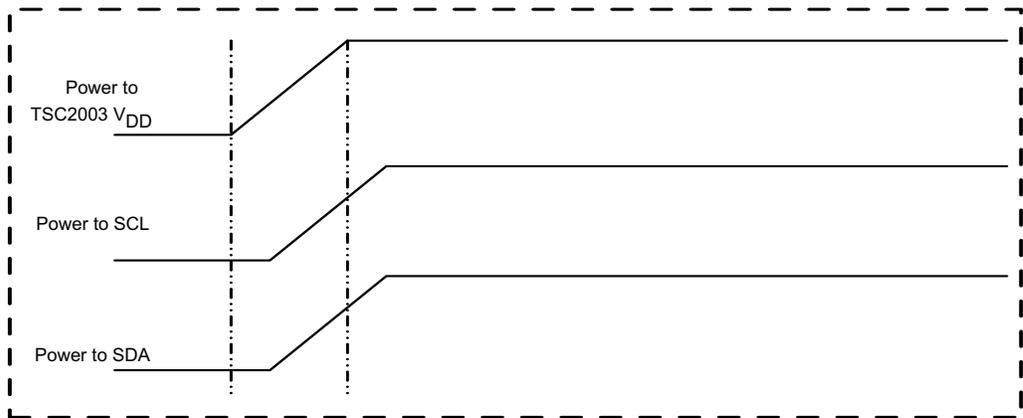


Figure 4. Examples of Proper TSC2003 Power Up Sequences

Invalid Sequence,
Since the V_{DD} Powers
Up Earlier Than the I^2C 's



Invalid Sequence,
Since the V_{DD} Powers
Up Later Than the I^2C 's



Invalid Sequence,
Since the V_{DD} Powers
Up Slower Than the I^2C 's

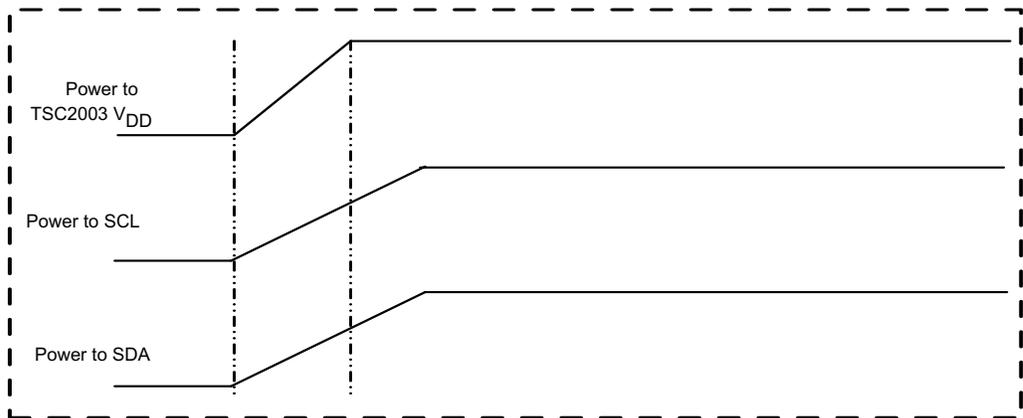


Figure 5. Examples of Improper TSC2003 Power Up Sequences

There is not any specific power up sequence requirement for the TSC2007 (Revision C or later). That is: the power supply to TSC2007 V_{DD} and to I^2C pull-ups can be brought up in any order: Simultaneously; V_{DD} first/faster; or V_{DD} last/slower.

6 Conclusions

In some applications, the hardware and software of the TSC2003 can be directly reusable in the TSC2007. In other applications, certain changes are required for migrating from the TSC2003 to the TSC2007. This application report summarizes the similarities and the differences of the two devices, presents how to migrate from TSC2003 to TSC2007, and presents the power up sequences.

7 References

1. TSC2003, *P²C™ Touch-Screen Controller* data sheet ([SBAS162](#))
2. TSC2007, *Nano-Power Touch Screen Controller with P²C™ Serial Interface* data sheet ([SBAS405](#))
3. *Operation Schemes of Touch Screen Controllers* application report [SLAA359](#)

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