XC87x and XC85x Family

Orderly Power-up of XC87x and XC85x Devices

AP08125

Application Note

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Microcontrollers

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Revision History

Revision History: V1.0, 2013-04	
Previous Version: none	
Page	**Subjects (major changes since last revision)**

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Table of Contents

1 Overview

This Application note explains the pre-conditions that need to be satisfied before a microcontroller from the XC87x and XC85x family of products can be powered up reliably.

The following points need to be taken into consideration:

- Voltage level of VDDP before power-up
- Risetime of VDDP
- Voltage levels at any pin prior to power-up
- RESET delay with reference to VDDP

These basic requirements are mandatory for ensuring orderly start-up of the microcontroller and are explained by way of examples. These are guidelines with specific reference to XC87x family of devices, but are also examples of good practice in any microcontroller based design.

These examples are not exhaustive and an application developer may use his or her own methods as long as the pre-conditions can be met.

By not satisfying those conditions, reliable start-up can not be guaranteed.

2 Pre-Condition for Orderly Start-up

*Note: **<u>All</u>** pins should be 0V, or at least below 0.3V, but the most important pins are VDDP and RESET.*

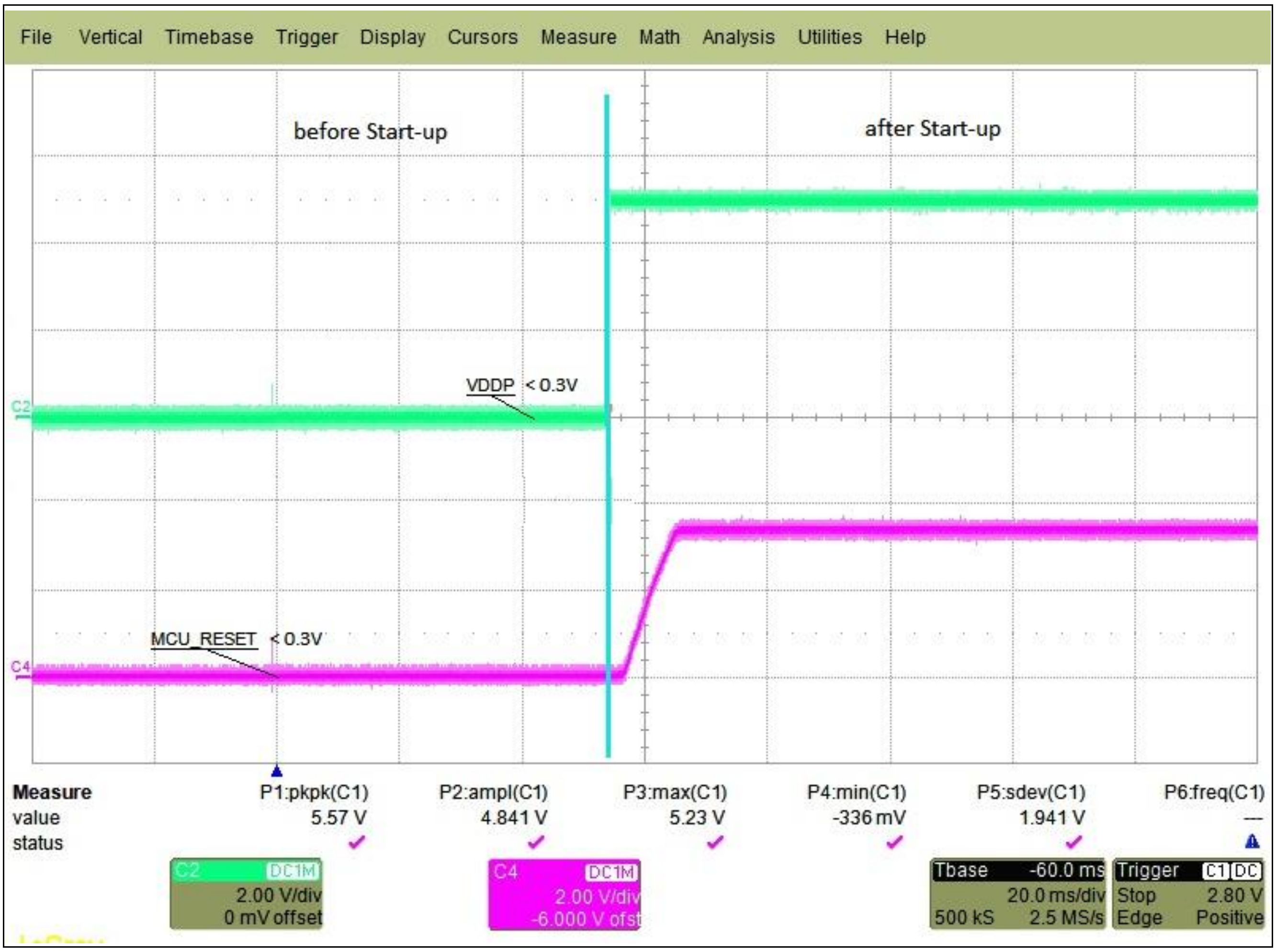

Figure 1 Start-up Conditions

RESET needs to stay below 0.4V until the VDDC pin reaches 2.25V, then RESET can follow VDDP.

A simple and inexpensive way to achieve this is by adding a capacitor to the RESET pin.

An internal pull-up resistor then charges this capacitor (**Figure 2**). The pull-up is anything between 64K and 186K.

The following formula can be used to calculate the required capacitor:

$$V_C = V \times \left(1 - e^{-\frac{t}{RC}}\right)$$

Where:

- Vc is the voltage at the capacitor and therefore at the RESET pin
- V is VDDP
- R is the internal resistor
- C is the external capacitor
- t is the time taken to get VDDC to 2.25V

An external pull-up resistor can also be added if required, to reduce the time constant of RC.

Example

Given that:

- V=5V
- Pull-up is 64K
- Capacitor is 220nF

How long does it take for Vc to reach 0.4V?

Measure the slope of VDDC risetime and compare with the result.

Is this long enough delay to allow VDDC to reach 2.25V?

Using we want to know 't'

RC = 64K x 220nF = 14.08mS

⇨ $0.4=5\left(1 - e^{-\frac{t}{RC}}\right)$

⇨ $\frac{0.4}{5} = 1 - e^{-\frac{t}{RC}}$

⇨ $0.08 = 1 - e^{-\frac{t}{RC}}$

⇨ $0.92 = e^{-\frac{t}{RC}}$

⇨ $ln(0.92) = \frac{-t}{14.08}$

⇨ $-0.083 = \frac{-t}{14.08}$

⇨ **$t =$ 1.17 ms -> in this time VDDC needs to get to 2.25V**

2.1 Why Any Pin < 0.3V ?

Microcontrollers usually have some form of ESD protection on all pins, often in the form of two diodes as illustrated in **Figure 2**.

If there is any voltage above 0.3V, this then leaks into VDDP via the diode from Pin to VDDP.

It is actually possible to un-intentionally power up a microcontroller in this way. Therefore it is a basic requirement to ensure that all pins are below 0.3V when the device is powered off.

Figure 3 shows an example of both good and bad practice.

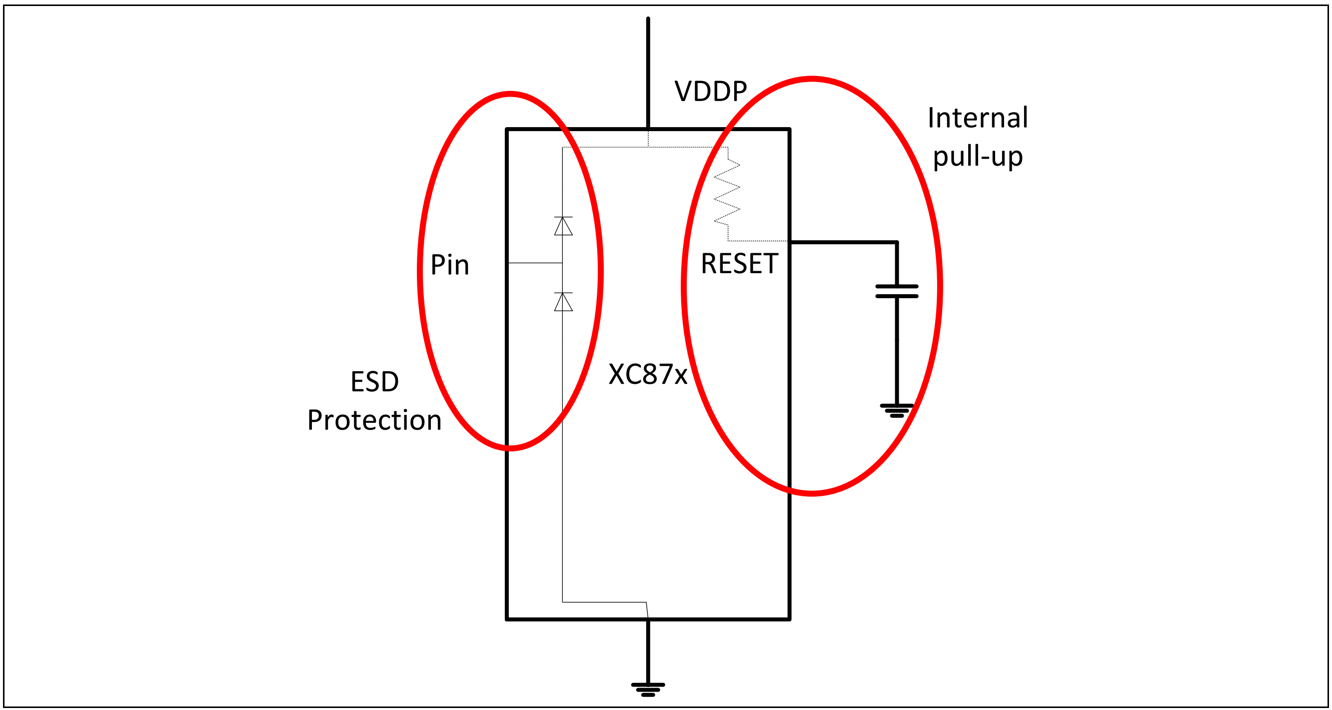

Figure 2 ESD Protection and RESET Pull-up

2.2 Example of Good and Bad Practice

The normal situation, where power is applied to the application and it stays on for a long period, is not a problem providing that all inputs to the device are kept within the VDDP limits.

An example scenario is pictured in **Figure 3** ('Bad Practice') and **Figure 4** ('Good Practice'), where there is an external voltage regulator and where the microcontroller needs to be switched off.

In Figure 3 a sense input needs to detect a switch closure on the 12V side of the external voltage regulator.

At times the microcontroller needs to be switched off by applying a control signal to transistor T2, which in turn switches T1 on and off.

When the microcontroller is powered off, it can be seen that at GPIO1 voltage can be leaking into the device via the potential divider between 12V and GND when the switch is open. This is not a desired effect and should be avoided.

The situation in **Figure 4** at GPIO2 is different. In that example a transistor isolates GPIO from the 12V. The resistor is used to effectively sense the presence (or not) of VDDP at GPIO2, depending on the switch state. This arrangement ensures that at all times GPIO2 will not have any voltages leaking into the device when the microcontroller is powered off.

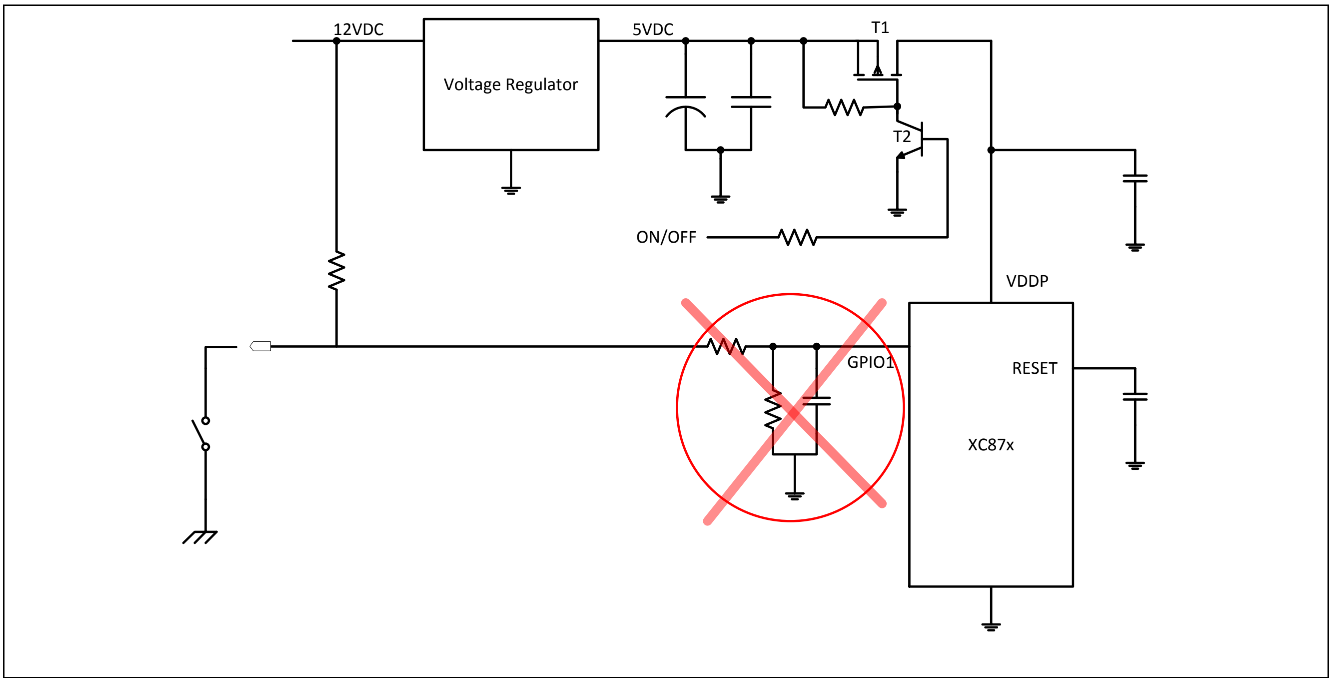

Figure 3 An Example of 'Bad Practice'

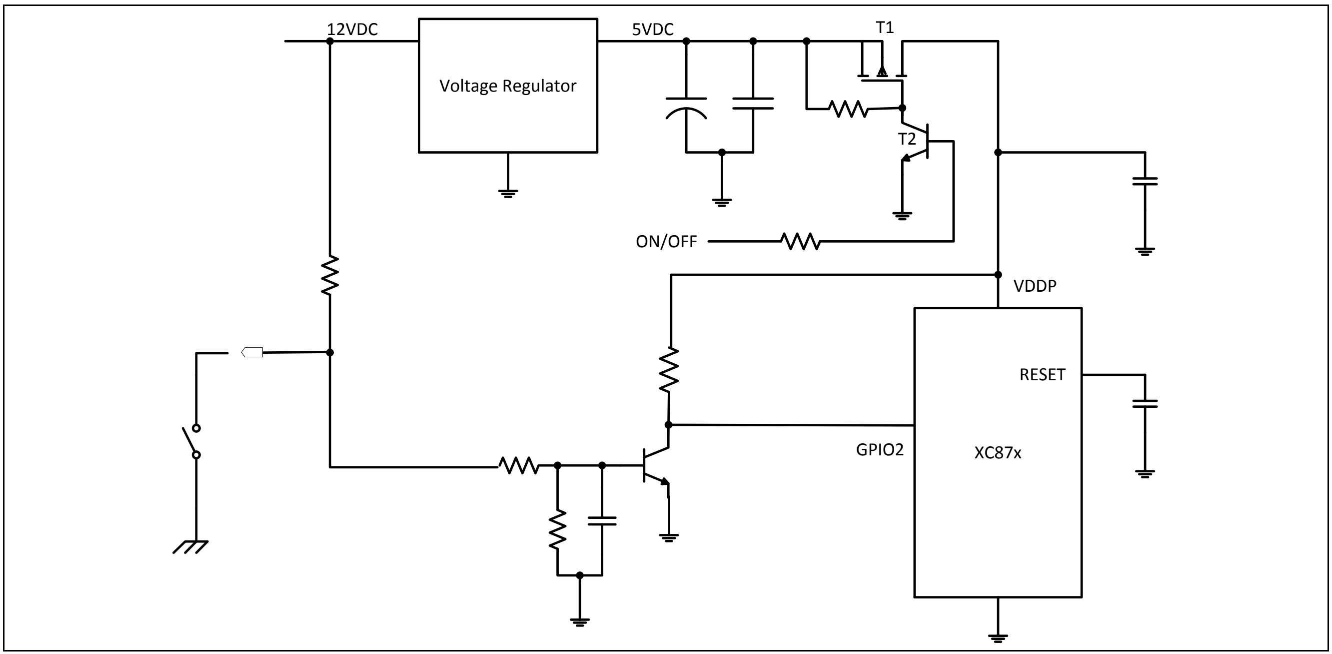

Figure 4 An Example of 'Good Practice'

w w w . i n f i n e o n . c o m

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