



# AN1772

## APPLICATION NOTE

### How to Control Power-up/Reset and Monitor the Voltage in Microprocessor Systems using ST Reset Circuits

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This Application Note describes the problems with monitoring the power supply during Power-up/Reset in a microprocessor system. It also explains how the family of ST family of Reset Circuits can be used to solve them.

Further information on Reset Circuits can be found in the STM809, STM810, STM811, STM812 datasheet on [www.st.com](http://www.st.com).

#### INTRODUCTION

Today, our microprocessor driven digital world, cannot exist without the correct power supply voltage. Every microprocessor needs its power supply to be within a predefined range, to be able to function properly. A small glitch in the power supply can cause the system to crash. Incorrect power-up sequences, slow ramp-up and glitches on the supply lines are common problems that designers must take into account to minimize the impact of faults resulting from the power supply.

There are several ways to solve these problems, some of which are outlined in this document, but they all have certain limitations and do not completely resolve the problem.

For this reason ST has developed a new family of low-power supervisory devices, called Reset Circuits, specifically to monitor power supplies. This new family, which includes the STM809, STM810, STM811 and STM812, asserts a reset signal whenever the power supply drops below a preset threshold value, and keeps it asserted, until the voltage rises above that threshold, for a minimum period of time. The STM811 and STM812 also provide a push-button reset input signal ( $\overline{MR}$ ).

### POWER-UP/ RESET

Power-up is the first thing that must be considered in a new design, as every system requires a time interval for internal initialization after the power supply has stabilized.

During the power-up sequence, microprocessors and other complex digital devices, wait for the clock signal to stabilize and load the internal registers and boot-code required for the microprocessor to function properly. For this reason, they always require a predefined time for power-up/reset. If the reset time is not long enough, the system may not function properly.

### Resistor-Capacitor Filter Circuit

One possible approach to delay the reset signal after power-up, is to use a Resistor-Capacitor (RC) low-pass filter at the microprocessor reset ( $\overline{RST}$ ) input. This solution is inexpensive, but cannot be guaranteed to work in all circumstances. It uses an exponential RC rise time for the reset delay after power-up (see Figure 1). The delay can be changed easily by selecting the appropriate RC circuit.

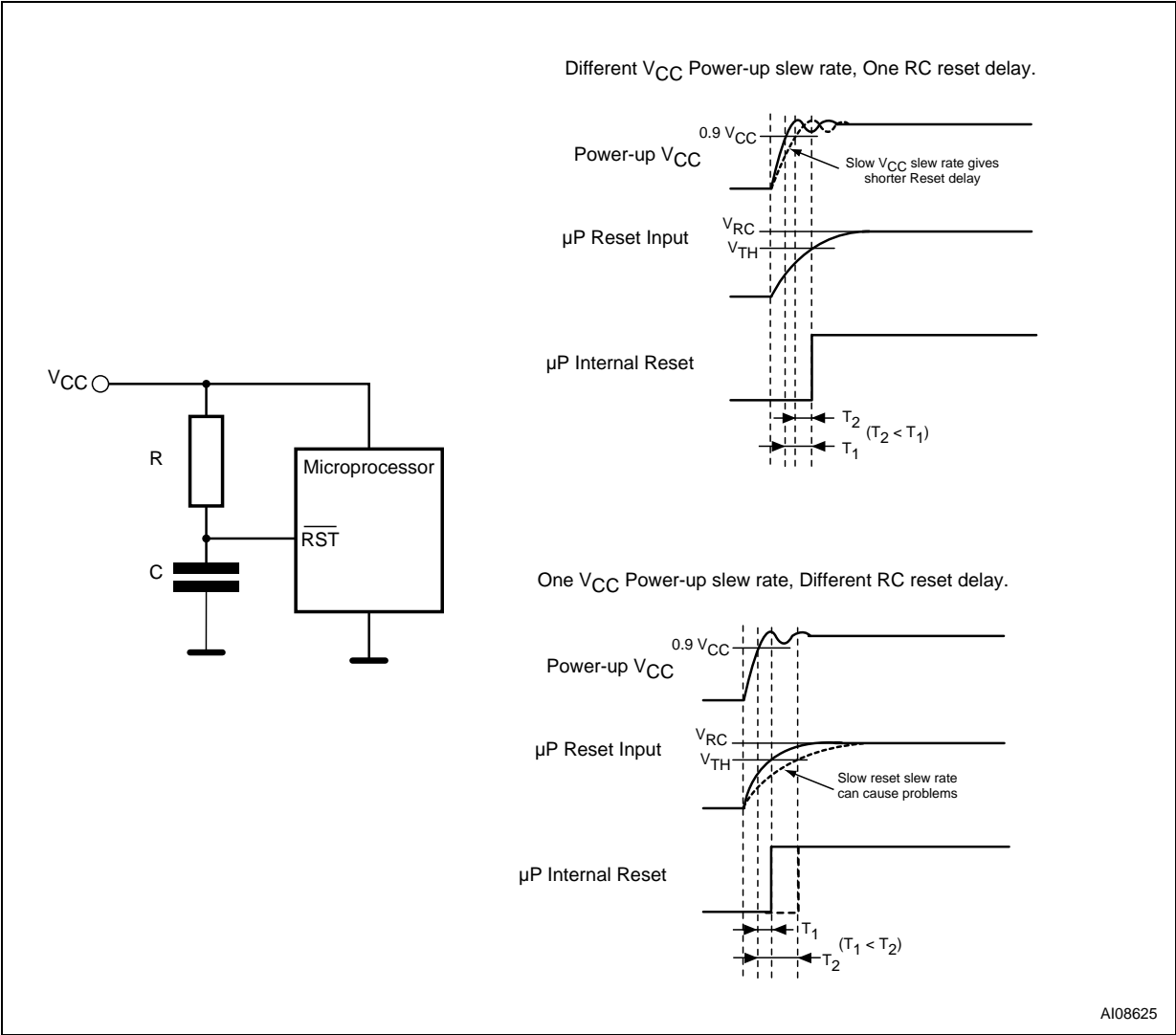
Unfortunately, this approach has two drawbacks.

- The reset delay depends on the power-up voltage slew rate - if the slew rate is too slow then the RC curve tracks this rising voltage and the reset delay may be inadequate (See the dashed line in top diagram in Figure 1).
- The slew rate of reset signal at the microprocessor's input depends on the reset time (typically 110-200 ms) - if longer pulses are required, the RC circuit values must be increased, which will slow the slew rate of the reset signal and may cause the microprocessor to malfunction, due to insufficient overdrive at the Reset input.

Some manufacturers implement power-up/reset functions in the microprocessor to avoid these problems, however in most cases the monitoring is not very precise.

Another solution is to use an external Reset Circuit device. ST Reset Circuits have precise, predefined voltage thresholds and reset delays and so do not encounter any of the drawbacks of the RC Filter Circuit (see Integrated Reset Circuits section).

Figure 1. Resistor-Capacitor Filter Circuit - Reset Delay



### MONITORING THE SUPPLY VOLTAGE DURING OPERATIONS

For the microprocessor and other devices in the system to function correctly, it is also necessary to monitor the supply voltage during operations.

Brownout conditions, or glitches on the power supply lines, can cause unwanted changes in the internal registers, which can lead to instructions being incorrectly executed, incorrect output signals and errors in the operations results.

The RC filter solution proposed for monitoring the voltage during power-up and reset is not sufficient to monitor the voltage correctly during operations. It can filter out fast undershoots, however, as the microprocessor is unaware that the voltage dropped below the threshold, due to the time constant of the RC delay, it continues to operate, which can lead to instructions being incorrectly executed.

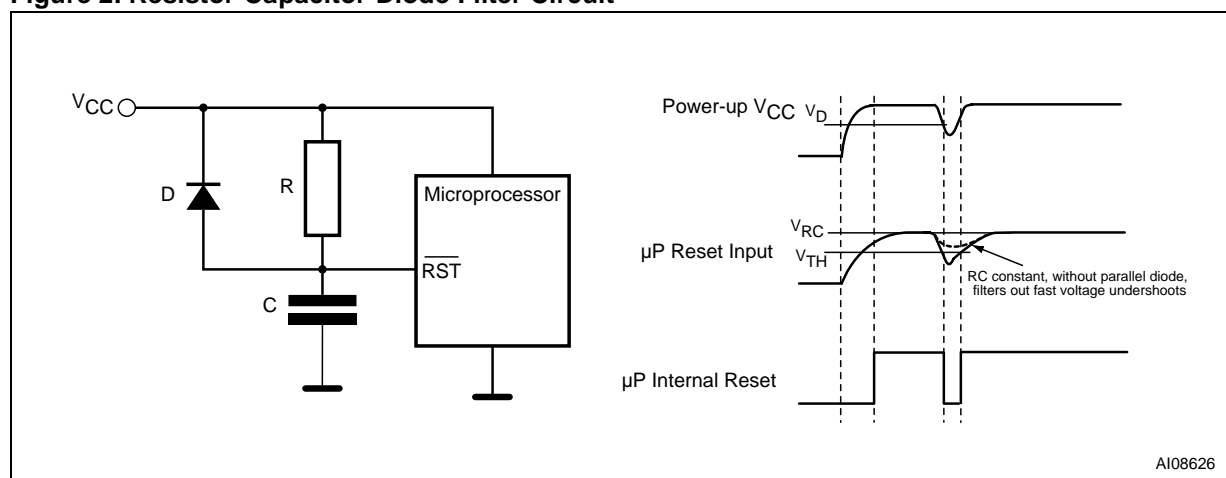
### Resistor-Capacitor-Diode Filter Circuit

A Resistor-Capacitor-Diode (RCD) filter circuit (the same as the RC circuit with a diode added parallel to the resistor), can improve the response time to fast undershoots, but the drop in the voltage level must be greater than the forward turn-on voltage of the diode, before the diode can start to pull  $\overline{RST}$  low.

Another limitation of this solution is that, the RCD filter circuit can only monitor drops in the voltage supply, that are greater than the microprocessor's tolerance voltage plus the diode drop.

As for the Power-up/Reset phase, a better solution is to use an external Reset device like the ST Reset Circuits, which are also ideal for monitoring the voltage level during operations (see Integrated Reset Circuits section).

**Figure 2. Resistor-Capacitor-Diode Filter Circuit**



Note:  $V_D$  = Voltage across diode,  $V_{RC}$  = voltage on capacitor.

### INTEGRATED RESET CIRCUITS

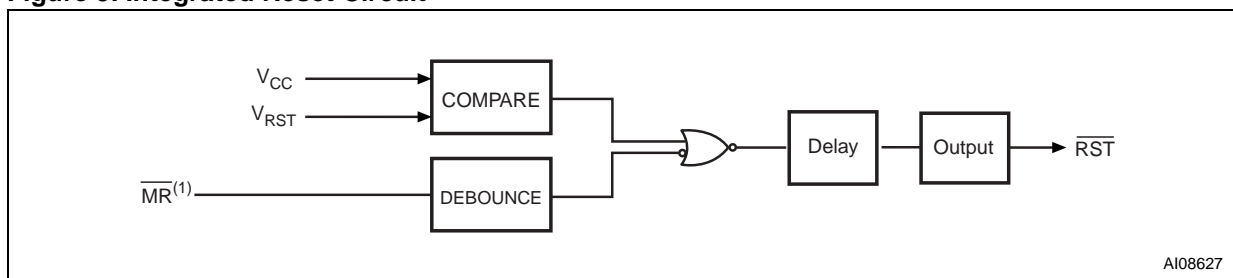
Integrated Reset Circuits, like the STM809-812, are devices that are dedicated for reset and monitoring purposes. They monitor the input voltage supply and send a reset signal to the microprocessor for a preset time interval, if the voltage supply goes outside the preset limit.

A typical reset device consists of a voltage reference, a voltage comparator, a supply voltage resistor-divider network, a fixed delay time circuit and an output driver (see Figure 3).

The internal voltage comparator monitors the input voltage supply and compares it with a predefined voltage reference. If the supply voltage is under the threshold, a reset signal  $\overline{RST}$ , is asserted. The signal remains asserted until the supply voltage reaches the threshold and stays above it for a preset time interval.

The output of the Reset Circuit is independent of the Power-up slew rate, glitches and other brownout conditions.

**Figure 3. Integrated Reset Circuit**



Note: 1. STM811/812 only.

### Reset Thresholds

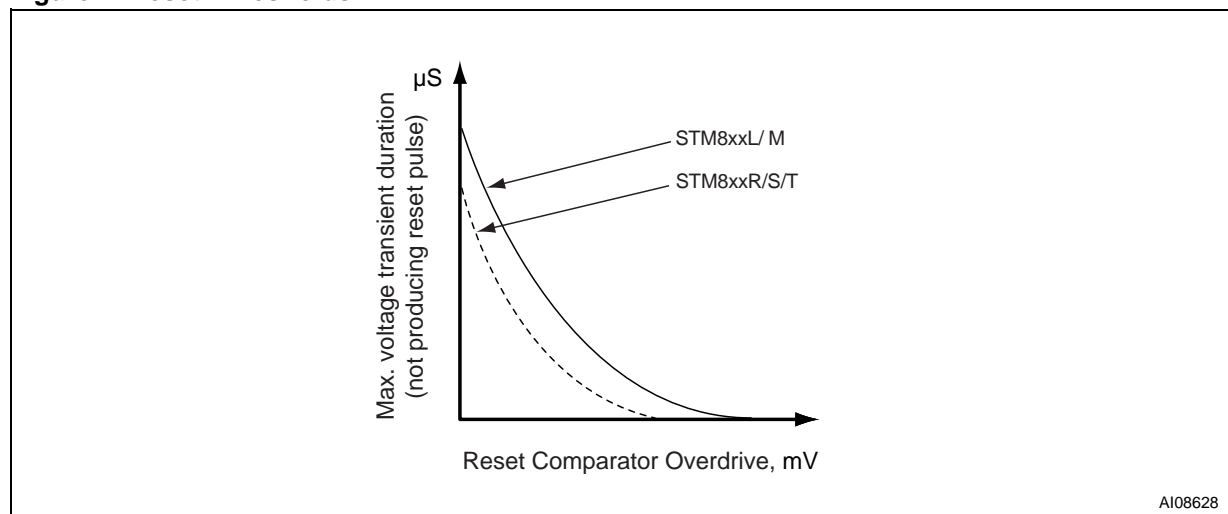
The Reset Circuits are available with multiple threshold voltages (refer to Table 1), so the designer can choose the reset threshold level best suited to the system's power supply.

The sensitivity of the Reset Circuit depends on:

- the duration of the voltage undershoot,
- the magnitude of the undershoot below the minimum threshold.

The generation of the reset signal depends on, the maximum voltage transient duration versus the reset comparator overdrive, as is shown in Figure 4. Conditions falling into the area below the curve are filtered and therefore do not generate a reset signal.

**Figure 4. Reset Thresholds**



**Table 1. Reset Threshold Levels**

Device	Reset Threshold Voltage		
	Min	Max	Unit
STM8xxL	4.50	4.75	V
STM8xxM	4.25	4.50	V
STM8xxT	3.00	3.15	V
STM8xxS	2.85	3.00	V
STM8xxR	2.55	2.70	V

### Manual Reset

A manual reset is useful in many applications, from debugging new systems to waking-up from an idle or sleep mode.

Usually an external reset is done with a switch, however switches are not ideal because of switching bounce (voltage spikes that can occur during the switching phase). The problem can be overcome by designing a specific circuit, but this requires additional discrete logic gates. The STM811 and STM812 Reset Circuits solve the problem with a push-button reset input signal ( $\overline{MR}$ ). These devices have an internal debounce circuit (see Figure 3), usually with an internal pull-up resistor, so there are no requirements for any other discrete circuits connected to the device.

**CONCLUSION**

ST Reset Circuits are small devices, that take little board space, but monitor the most important thing in the system - the power supply. They are becoming increasingly popular with designers, thanks to their dedicated features and low cost. They are available in small SOT23 and SOT143 packages; they require only a low supply current, typically in the 5-10  $\mu\text{A}$  range and offer a wide range of voltage thresholds.

They can be used in many different applications from battery devices with low power requirements to industrial machines with reliability constraints.

**REFERENCES**

- STM809, STM810, STM811, STM812 datasheet

**REVISION HISTORY****Table 2. Document Revision History**

Date	Version	Revision Details
27-Nov-2003	1.0	First Issue.

## AN1772 - APPLICATION NOTE

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