Keywords: undervoltage, undervoltage delay, ds2784, tuvd

APPLICATION NOTE 4062

Understanding the DS2784's Undervoltage-Protection Delay (t_{UVD})

Jul 18, 2007

Abstract: To prevent over discharging of a cell, the DS2784 provides undervoltage protection. This application note explains how the undervoltage-protection delay (t_{UVD}) is implemented.

Introduction

The DS2784 features undervoltage-protection circuitry that prevents over discharging of a cell. When an undervoltage condition is detected, the DS2784 shuts off the charge and discharge FETs and sets the UV flag in the protection register. This application note explains the functionality of the DS2784's voltage and temperature measurement ADC and how it relates to the device's undervoltage-protection delay (t_{UVD}).

Description

The DS2784 uses one ADC to measure both temperature and battery voltage. The ADC input is muxed between the two signals, alternating between temperature and voltage measurements every 220ms. With a sample rate of 18.6kHz, the ADC obtains 4092 samples every 220ms; it then reports the average of the samples to the user. The temperature and voltage measurements are updated every 440ms, at the end of their corresponding measurement period. **Figure 1** illustrates the mux timing of the ADC's temperature and voltage measurements.

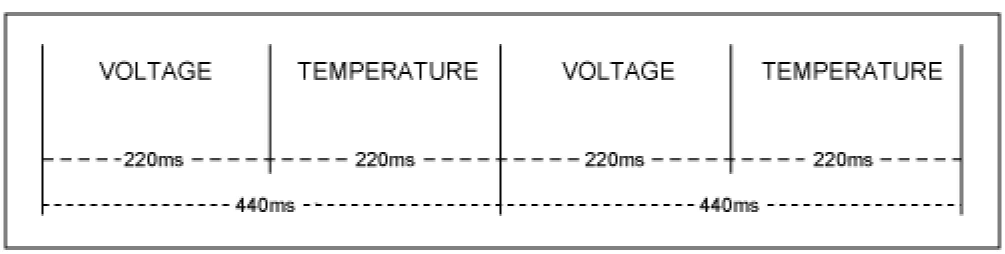

Figure 1. The mux timing of the ADC's measurements. The ADC alternates between voltage and temperature measurements every 220ms and updates the registers every 440ms.

There is no analog voltage comparator or manufactured delay associated with an undervoltage condition. The delay is inherent due to the averaging of the voltage measurement. If the value in the voltage register at the end of a 220ms period is less than V_{UV}, then the protector goes into UV protection mode. The time it takes for the user to see a response to an undervoltage condition can vary greatly because the voltage register is based on the average of the ADC's samples. For example, if the battery voltage is just above V_{UV} for the majority of a 220ms window, but drops drastically below V_{UV} just before the end of the 220ms window such that the average for that window is below the undervoltage threshold, then the undervoltage condition will be reported at the end of that window (**Figure 2**). However, if the battery voltage is well above V_{UV}, but drops to just below V_{UV} near the beginning of a 220ms window, then the average for that window could be above V_{UV}. In this case, the undervoltage condition would not be detected until the end of the next 220ms voltage measurement window (**Figure 3**).

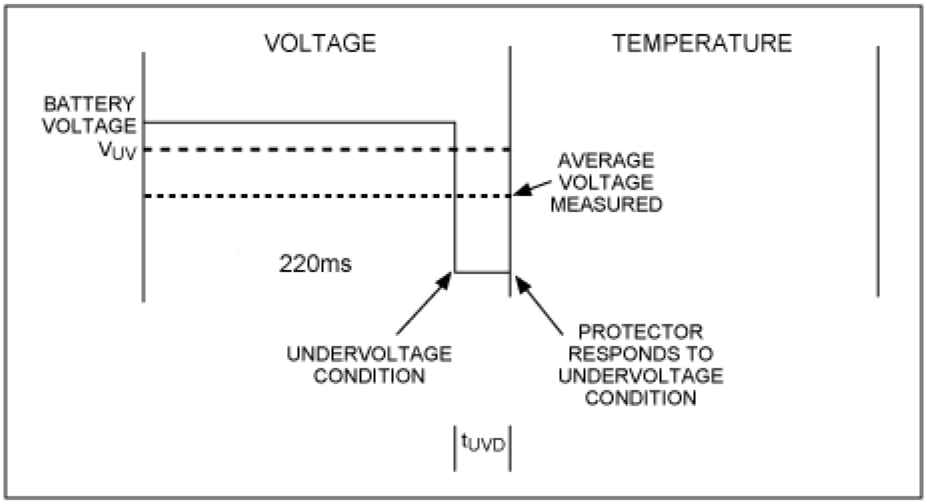

Figure 2. Conditions for minimum t_{UVD}. In this example, the battery voltage is above V_{UV} for the majority of the measurement window, but it then falls far enough below the undervoltage threshold to bring the average voltage measured during the 220ms window below V_{UV}.

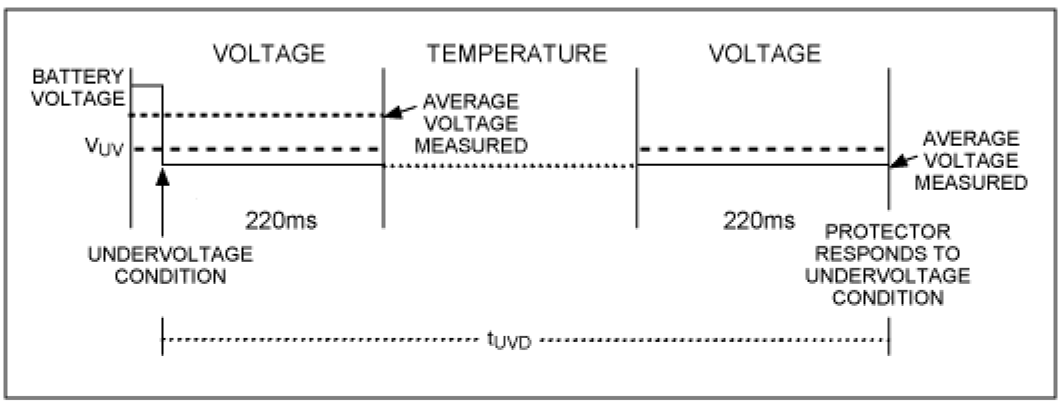

Figure 3. Conditions for maximum t_{UVD}. In this example, the battery voltage is far enough above V_{UV} that even when the voltage falls below the undervoltage threshold, the average voltage for the 220ms window remains above V_{UV}. Thus, an undervoltage condition is not registered until the next voltage measurement window.

Summary

Because the DS2784's ADC reports a 220ms average voltage measurement every 440ms, the undervoltage delay is inherent in the circuit's design. No additional internal circuitry is required for the undervoltage delay.

More Information
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