Application Report
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Practical Tips to Get Accurate Readouts

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ABSTRACT

The TPS544B20, TPS544C20 and TPS544C25 devices use the PMBus interface to make non-invasive measurements of temperature, voltage and current available to the system or user through the commands READ_VOUT, READ_IOUT, and READ_TEMPERATURE2. In order to most effectively use this internal digital measurement system, users must understand some of the details about the measurement system.

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Trademarks

1 Introduction

In order to have a complete understanding on this topic it is important to review some details regarding the ADC and associated timing.

2 Device Overview

The ADC works on a 12-bit 4096-step dual slope ADC. The voltage signal of interest is forced on an internal resistor, and the resulting current is used to charge a capacitor for 4096 cycles of an 8-MHz clock. Then a reference voltage is forced across the same resistor to create a discharge current while a counter counts clock cycles until the capacitor is discharged back to its starting value and the current counter value is latched as the output. The latched count is equal to 4096 × Vsig / Vref, which can then be digitally scaled to provide telemetry values. To provide consistent timing, the counter is allowed to run out before the ADC is switched to the next signal of interest.

Each measurement of the ADC requires 8192 clock cycles (4096 × 2) on an 8-MHz clock that is trimmed ±5% for a measurement time of 0.97 ms – 1.07 ms.

In order to improve accuracies and eliminate analog measurement offsets, there is an ADC zero measurement for self-calibration and a “zero input” reference measurement for each signal that is subtracted from the measurement. There are also 4 measurements taken for each telemetry cycle: V_{OUT}, I_{OUT}, TEMP1, TEMP2. TEMP2 is an internally measured temperature that is used to temperature compensate the READ_IOUT function.

Thus, there are 9 measurement cycles: Self-Calibration, VOUT_ZERO, VOUT_SIGNAL, IOUT_ZERO, IOUT_SIGNAL, TEMP1_ZERO, TEMP1_SIGNAL, TEMP2_ZERO, TEMP2_SIGNAL. Each takes up to 1.074 ms for 9.666 ms per telemetry cycle.

In order to reduce the noise contribution to any single measurement, 16 measurements are accumulated, and then divided by 16 before updating the user readable READ_VOUT, READ_IOUT or READ_TEMPERATURE2 value. 16 cycles means that the user-readable registers are updated every 154 ms with a value that represents the average value over the prior 154 ms.

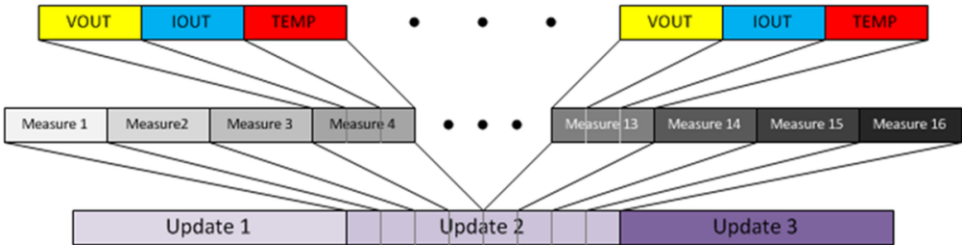

Figure 1.

This has a few implications:

1. Any two reads of a PMBus register less than 154 ms could be reads from the same update.
2. It can take 154 – 308 ms for a change in a value, such as V_{OUT}, to be reflected in the PMBus register readback.

Additionally, because the comparator that latches the counter is asynchronous to the clock, it is possible, through rare, that the register latch is set while the counter is transitioning between two clock values. This can result in the counter latching incorrect data, resulting in an ADC misread. In order to post-process such misreads, a system designer may find it useful to record 3, 5, or 7 repeated measurements of the same telemetry value, spaced at least 308 ms apart, and post-process them by disregarding the lowest and higher value, then averaging the remaining 1, 3, or 5 values.

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