Analysis of FAT33 Flasherboard Failure Modes

1. Introduction

A recent analysis by Hagar of new STF flasherboard failure modes indicated that the failures in flasher_width and flasher_brightness are new types of failures; specifically:

- LEDs with large "missing widths" (no width setting achieved this pulse width), in the 60-95 ns range
- LEDs with large linearity failures in the flasher brightness scan (> 17%)

I have analyzed these failure modes using two sample DOMs from FAT33 ("Washoe_Nation" and "Hidatsa_Nation"), both at –20C. Interactive runs of the STF tests indicate that these each exhibit one or both of the failure modes above. Furthermore, with the interactive STF runs, recording of the individual LED current pulses has provided insight into each of these failure modes.

2. Analysis

"Missing width" failure mode: Analysis of this failure mode using data from "Washoe_Nation" suggests that the current pulse is indeed skipping widths in a non-linear fashion as the width setting is increased. The following plots show this behavior:

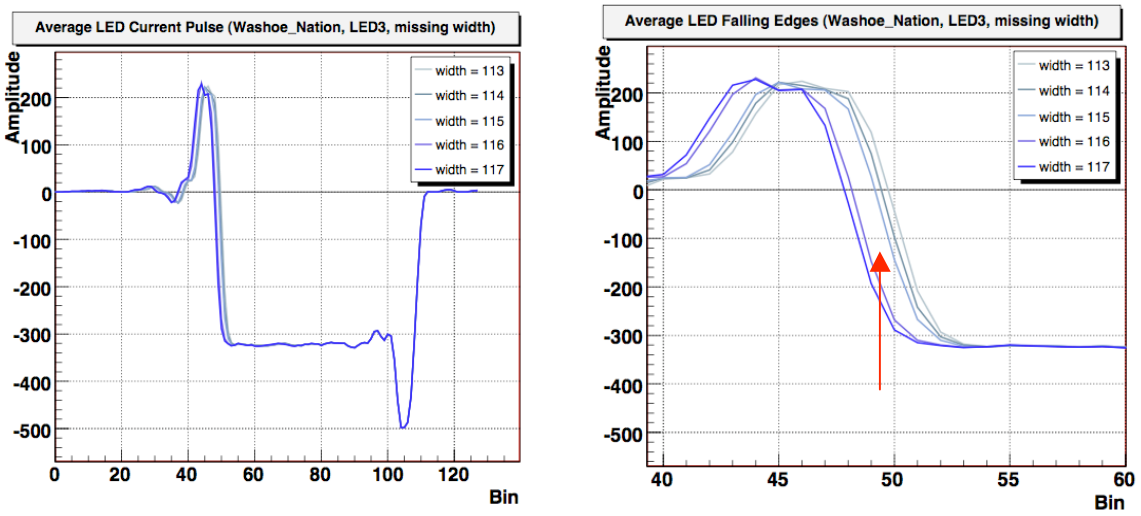

Figure 1: LED current pulse as measured by ATWD channel 3 (reminder: ATWD time flows from R to L). Plots show varying-width pulses for 5 consecutive width settings (ZOOM on falling edge in right plot). Note jump from width=115 to width=116.

The STF test detects this discontinuity and fails the LED. However, one should note that this jump in width is still small — just over 1 ns.

Brightness linearity failure mode: Analysis of this failure mode using data from "Hidatsa_Nation" suggests the failure is not real, but is instead an artifact of spikes in the LED current pulse not seen in older flasherboards. The following plot shows the average current pulse from one LED at low brightness setting:

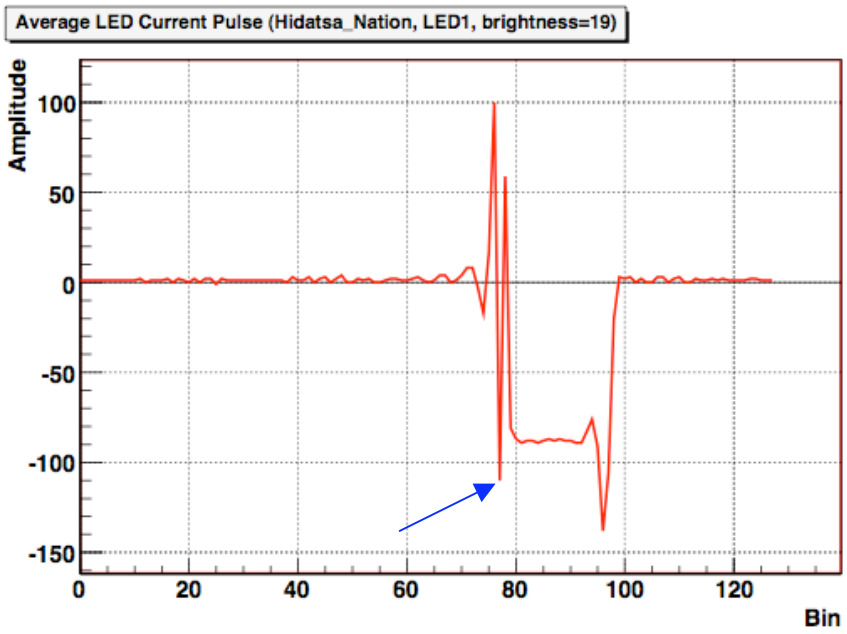

Figure 2: Low-brightness LED current pulse of Hidatsa_Nation as measured by ATWD channel 3. Note large spike after falling edge (on left).

The STF test is not robust against these new spikes and confuses the spike for the main pulse. For reference, here is a current pulse of a flasherboard from FAT7:

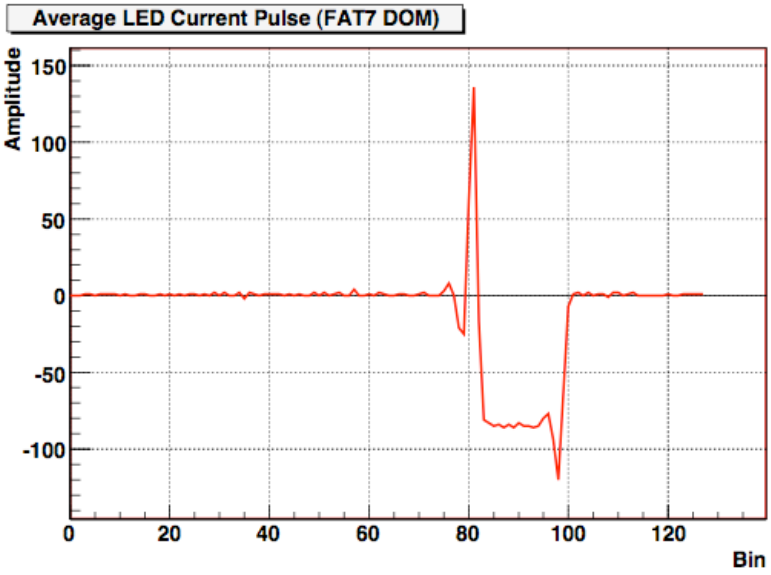

Figure 3: Average LED current pulse from a FAT7 DOM. Note absence of trailing spikes of the same polarity as the pulse.

3. Summary and Recommendations

In summary, the "missing width" failure mode is caused by jumps in the LED current pulse width with increasing width settings. The flasher_width test is behaving as designed and flagging these jumps as failures, as it requires width measurements with granularity of <= ~1ns.

However, it is questionable whether we really need or use LED pulse width resolution on the order of a nanosecond. I propose relaxing the test to double the granularity, allowing jumps of ~2ns in width setting.

The brightness linearity failure mode is not a real failure, in the sense that new spikes in the current pulse have violated the flasher_brightness test assumptions about the shape of the pulse, and thus have broken its feature extraction algorithm. However, it is relatively straightforward to modify the test to make it more robust against these artifacts.

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