Quality Control for the PACMAN Card

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1 Overview

The PACMAN card quality control regimen relies on several different techniques:

- **Loopback:** Loopback is generally the most effective method of feature verification. The loopback mindset first drives the design toward adequate feedback and test input mechanisms, and then tests both the feature and its corresponding feedback or test input mechanism simultaneously.
- **Accurate Blame Assessment:** Designing for blame assessment forces a modular design that lends itself to effective QC. For an important example, loopback can be performed in the hardware, or in firmware (just prior to leaving/ entering the device), or in the CPU, so that the source of a failure can immediately be localized to hardware, programmable logic, or software.
- **Design Review:** The PACMAN design team includes a lead engineer, and a consulting engineer, and a principile investigator. All three understand the board down to the last net list. The PACMAN design is also periodically subjected to independent review.
- **Prototype Systems:** The most effective form of quality control is operation in a working system, and the PACMAN card has been used continuously in prototype systems since the first version in 2020.

2 Feature Verification Overview

Here we list design features of the PACMAN card that are tested by a loopback mechanism. Specific details on performing the relevant tests are discussed in the hardware checkout section.

- The provision of tile voltages VDDD and VDDA is verified by onboard current and voltage monitoring ADCs.
- The POSI and PISO (Digital I/O to Tiles) signals are tested via loopback using both test patterns and pseudorandom numbers.
- The CLK, RESETN/SYNC, and TRIG signals (Digital I/O to Tiles) are tested by loopback to a PISO input.

- The Analog Monitor signals and MUX are tested by connecting the positive and negative signal at the ASIC end, then configuring the MUX to connect one side to a DAC channel and the other side to the onboard high-performance ADC.
- The onboard high-performance ADC is tested by connecting both the positive and negative terminals to independently controlled DAC outputs.
- The front-panel IO is tested via loopback by connecting board outputs back in as input using cables plugged into the front-panel.
- The LEDs are tested with blink patterns.

The PACMAN card hosts a linux system, so a broad spectrum of test software is immediately available to us. Here we list what we consider to the be the most important tests of the Linux host. Specific details on performing the relevant tests are discussed in the hardware checkout section.

- Successful system BOOT, visible via UART.
- Successful remote login via ethernet.
- Successful transfer of psuedo-random data via ethernet (scp) and the UART terminal (lrzsz).
- Repeated read and write of psuedo-random numbers to the SD card.

Some of the tests described in this section require configuring the PACMAN card in ways that are not appropriate for a card installed in the production system. For this reason, the PACMAN card includes an expert mode enable two pin jumper. When a PACMAN card is installed in the production system, this jumper is removed, and the software refuses to provide inappropriate test configurations.

3 Requirement Verification

In addition to feature operation, the PACMAN has several performance requirements which require quantitative verifications:

- The provision of voltage and power across the required ranges is tested by applying the appropriate load resistance VDDD and VDDA.
- The common mode rejection feature of the DC voltage supply is tested by injecting larger than expected common mode noise at the input and measuring the provided DC voltage.
- The bit error rate is measured during loopback testing of the digital I/O systems.
- The high-frequency noise rejection is tested by injecting a high-frequency signal at the input and measuring the signals after filtering. (Note: these are the most challenging tests proposed)

4 Hardware Checkout

This is under development.

Recorded currents for bare board:

Voltage	Current (No Jumper)	Current (Analog Power Enabled)
48	...	...