**Acronyms**

- 180W Cooling on Lidded AMD Ryzen CPU
- CNN: Convolutional Neural Network
- DUT: Device Under Test
- GPU: Graphics Processing Unit
- HLS: Hardware-Level Simulation
- I/O: Input/Output
- JTAG: Joint Test Action Group
- Linux for Tegra
- PIA: Peripheral Interface Adapter
- SDRAM: Synchronous Dynamic Random-access Memory
- Tera-FLOPs: Tera-Floating Point Operations
- TFLOPs: Tera-FLOATing Point Operations
- TLM: Transaction Level Modeling
- VCD: Verilog-Coverage Data
- YOLO: You Only Look Once
- COTS: Commercial Off-The-Shelf

**Figure 2: Obverse Side Modifications**

Sapphire window design (left), milled COTS footer (center), 3D printed mounts for the DUT and GPU (right), as well as power cables and a network switch.

**Figure 3: Test Execution and Logical Flow**

A simple mutex is being used within the kernel to allocate a single integer space, do nothing with it and then release the memory space. This process is repeated in the GPU for no less than 30 seconds per interval. The mutex can be adjusted to increase this by one to two orders of magnitude. The mutex allocation can only be performed in a serial fashion. Therefore, while all the computations can be done simultaneously, cooling must be done sequentially for each mutex.

**Figure 6: Software Payload Types**

Three types of payloads have been created for the GPU test bench. Neuronal Networks (NN) and Mathematical-Logic (ML) are the primary focus of the test. NN primarily benefit from GPU processing, whereas ML-Logic uses mathematics and conditional logic statements to exercise memory hierarchy. The Colors payload assesses computational efficiency in the output image presented to a display.

**Test Bench Configuration**

The test bench is designed to support PIA connectivity and FPGA-based test utilities for serving as a living test harness to support Xilinx PowerPC-Lite. The test bench can be setup to support both GPU and CPU co-processor test harnesses and can be seamlessly transitioned from one to the other.

**Device Preparation**

The test bench was designed to support memory mapping and local memory allocation and de-allocation. The test bench can be setup to support both GPU and CPU co-processor test harnesses and can be seamlessly transitioned from one to the other.

**Discussion & Conclusions**

Although the radiation environment is more susceptible to radiation effects, testing of the technology itself is more susceptible to radiation effects. The authors acknowledge the sponsorship of the effort: NASA Electronic Parts and Packaging Program (NEPP). The authors thank NASA’s GSFC’s Radiation Effects and Analysis Group (REAG) who contributed to the creation of the test bench. John Reddin, Hokon Ashun, Stephen Simpson, and Matthew Cauker.

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**References**


**Standardizing GPU Radiation Test Approaches**

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Abstract: A standardized test methodology has been created to characterize and stress graphics processing units (GPU) during radiation testing effects.

**Introduction**

While some Graphical Processing Units (GPU’s) are discrete components (i.e. GTX 1050), others take the form of an add-on board or embedded within a System on Module (SOM). Within it are Central Processing Unit (CPU) and GPU coprocessor. While the packaging is different, each one of these compute types is designed to co-exist with each other’s respective domain. It is imperative that each of these be tested using a standardized methodology. The test bench serves as a living test harness to support Xilinx PowerPC-Lite. The test bench can be setup to support both GPU and CPU co-processor test harnesses and can be seamlessly transitioned from one to the other.

**Figure 1: Comparison of GPU Types**

A universal test bench is under development to provide a standardized test approach to GPUs with minimal variation between device types. The test bench must perform comparably under proton, heavy-ion, and total-dose low levels.

**Table 1: Comparison of GPU Types**

<table>
<thead>
<tr>
<th>GPU Type</th>
<th>Memory Capacity</th>
<th>Operating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTX 1050</td>
<td>Windows 2016</td>
<td>Android 6 Marshmallow</td>
</tr>
<tr>
<td>APQ8096</td>
<td>Linux for Tegra</td>
<td></td>
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