

ENPIRION POL Radiation Tests

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Initial work performed by Satish Dahwan, Yale University

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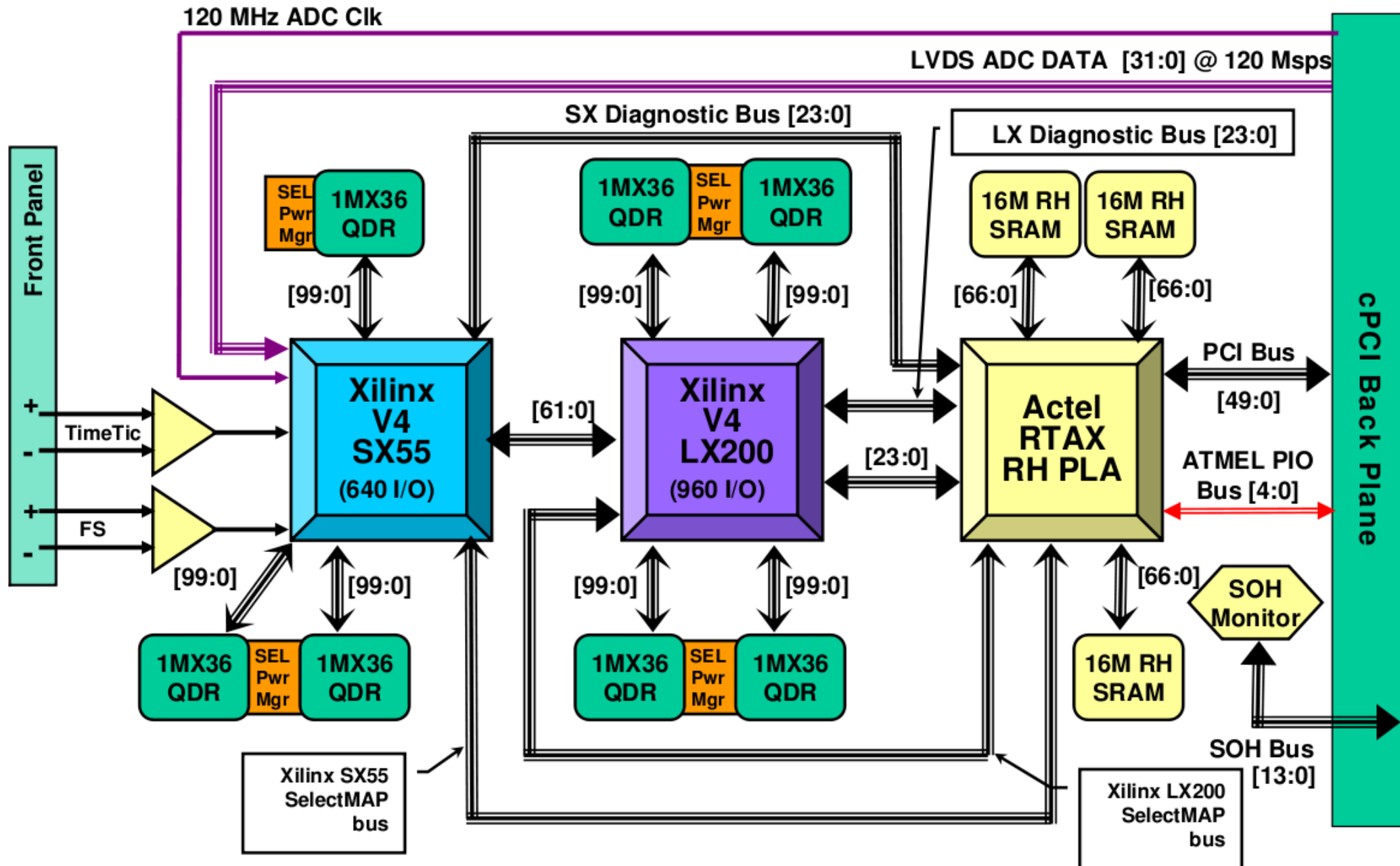
15/9/2008

Overview

- EN5360 and EN5365 converters tested
 - Initial qualification for space (LEO) usage
 - Total dose tested at BNL (Satish), cobalt 60 source
 - Greater than 100MRad for EN5360
 - Approximately 180 Krad for EN5365
 - Proton tests at UC Davis
 - Latchup and SEU
 - Both devices exhibited transients, but no latchup
 - EN5365 total dose confirmed
 - Heavy Ion tests at TAMU (Texas A&M)
 - Latchup and SEU
 - Transients, but no latchup
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Motivation

- Experimental Space Payload under development
 - SDR with FPGA processing for low earth orbit
 - Direct conversion RF receiver
 - Xilinx Virtex 4 FPGA processor
 - SX55
 - LX200
 - FPGA processing system requires rad hard POLs
 - 28V Spacecraft power
 - 1.2V FPGA core at >10A
 - 1.8V QDR RAM / FPGA I/O at >6A
 - Space grade converters initially selected
 - These units failed independent radiation qualification
 - Failed at ~10KRad!
 - Project success in Jeopardy
 - Decision to expand on Satish's work (TWEPP 07)
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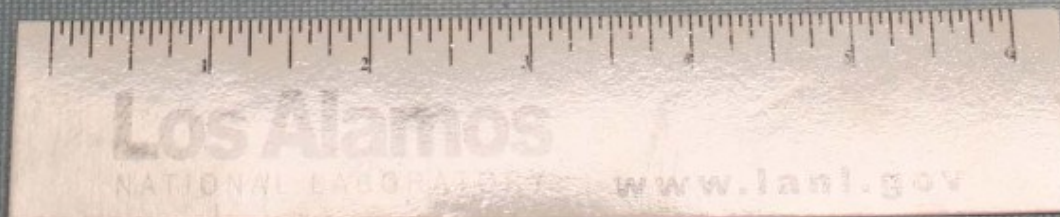


**Samsung
QDR SRAM**

**Compliant
Pad ton Top
Of V5**

**Xilinx S
SoPC**

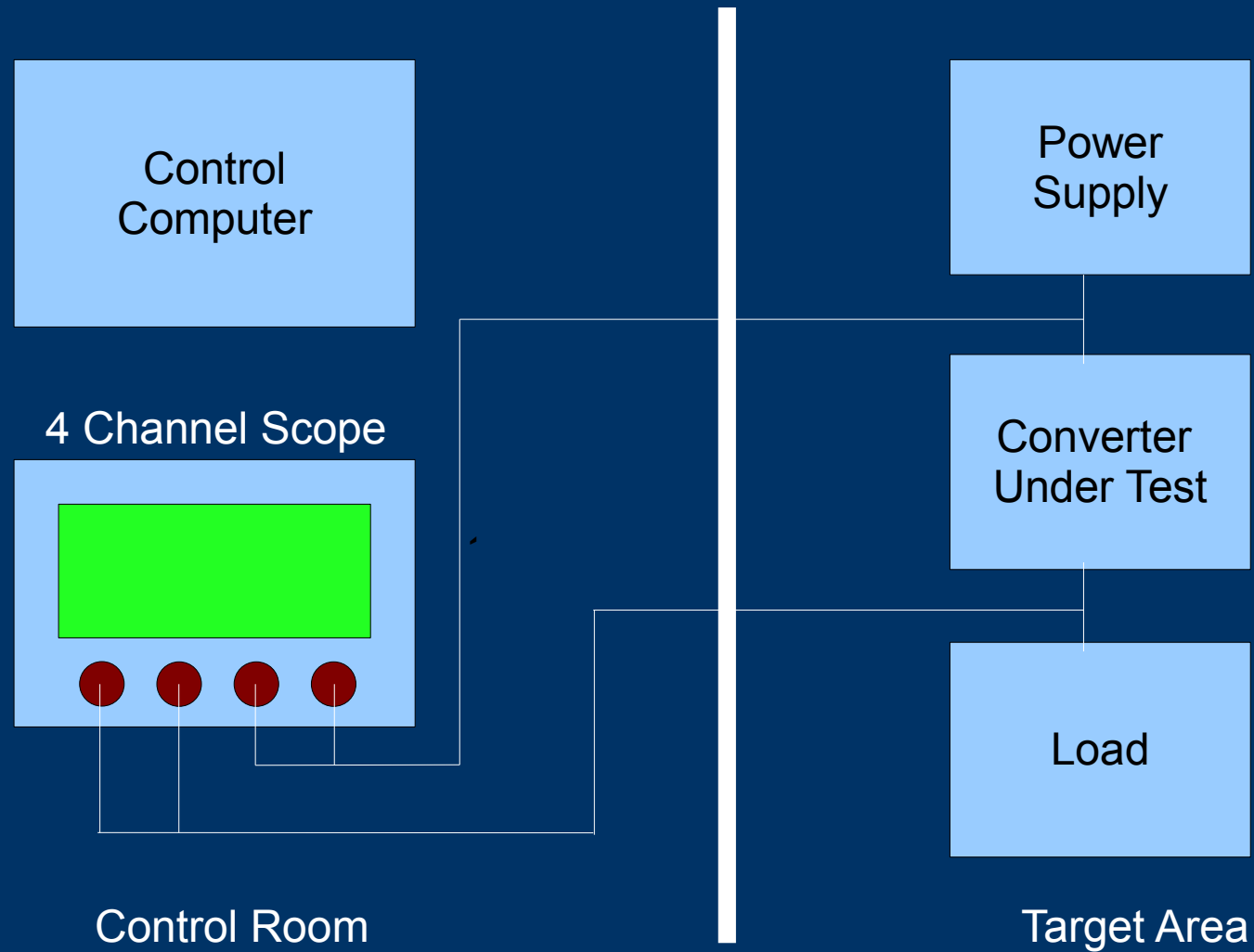
**Met-Graf
Composite
Heatsink**



Testing Plan

- Abbreviated testing approved
 - Total Dose results of Satish's tests accepted
 - Standard SEL and SEL tests
 - Heavy ion (Xenon) and proton
 - Transient and overall operation
 - Criteria for acceptance (LEO)
 - Total dose of $> 120\text{KRad}$
 - No SEL
 - Transients acceptable to Xilinx specifications
 - $\pm 10\%$ published for commercial parts
 - $\pm 20\%$ tolerance for MIL/Aero (unpublished)
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Test Setup



Limitations and Notes

- Scope set for 20MHz bandwidth
 - 200KRad test duration
 - Test board Limitations
 - Produced very quickly due to compressed schedule
 - Marginal POL decoupling
 - Smallest Stabilizing caps allowed by Empirion
 - Sub optimal placement
 - Poor performance (before radiation)
 - Only about 50% efficiency
 - Due to poor layout and choice of components
 - Small caps with higher ESR than recommended
 - These were space qualifed components
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5360 #1 Run 20

Ch#2 & Ch#4 = Vin

Ch#1 & Ch#3 = Vout

4

3

C3 200mV/div

B_W

C4 1.0V/div

B_W

C3 Mean 1.168V



C4 Mean 4.824V



C1 -20.0mV

5.0μs

20.0MS/s

50.0ns/pt

Run Sample

993 acqs

RL:1.0k

August 15, 2008

18:18:41

Results

- SEL
 - Both units showed no latchup in all testing
- SEU
 - Transients observed
 - Rapid (uS range)
 - Within tolerable range
 - Can be mitigated by better decoupling
- Total Dose
 - Minimal effect on performance
 - EN5360 verified to 200KRad
 - EN5365 failed between 164 and 166 KRad

Conclusions

- The EN5360 and EN5365 are hard enough to fly in LEO missions
 - EN5360 will fly on the MRM mission
 - However it is an obsolete part
 - Satish is following up on further use of this design
 - Process and foundary identified and contacted
 - The only part which could be considered for CMS use
 - EN5365 will continue in the qualification process
 - Enpirion tolerates this usage
 - Will not actively support unless a larger market is identified
 - No plans on altering the process for greater rad tolerance