Results of Reactor and Co60 Radiation Tests of Various Devices

Notes:

1) Basic test design consisted of a Device Under Test (DUT) board and a Data Acquisition (DAQ) board separated by 30 to 50 feet of ribbon cable for signals and power.

2) There were 3 test board designs with multiple DUT's per board. The initial design (Brd 1) allowed some devices to saturate the ADC. Brd 2 was redesigned to address the issues of Brd 1. Brd 3 was for higher current devices and included negative voltage regulators on the same board.

3) Two copies of board 2 and board 3 were made. The copies were for testing in the Cobalt source and in the reactor separately.

4) Board 3 required 4.5 amps at 7 volts. The voltage drop on the 50 foot cable was 3 to 3.5 volts both ways. Thus we needed a power supply with 14 V at 4.5 Amps. Of the choices available to us, none had remote sensing.

5) Without remote sensing and with the large voltage drop in the cable, as devices failed, the voltage on the board would rise or fall. This change in voltage was monitored and adjusted by hand (when we noticed). This explains the large fluctuations in the supply voltage seen in the plots.

6) The negative voltage regulators were implemented on board 3 along with several positive regulators. They were wired "upside down" so that the output voltage was in the range for the ADC (0-5V). This meant that they were regulating relative to the supply voltage (i.e. when the supply changed so did the regulated output).

7) Due to the connections of the negative supplies, when they started to fail, power was transferred through the signal grounds back to the DAQ board causing the voltage on the DAQ board to be unpredictable and affecting the reference voltage to the ADC.

8) Because of the problem mentioned in note 7, all data taken with board 3 in the reactor after 1.1X10^12 N/cm^2 is suspect and difficult to interpret.

9) Plots are available at http://www.physics.ohio-state.edu/~cms/raddaq/*.pdf with the device name as the filename. The exception is the plot for the results of board 1 which are in brd1rslt.pdf and it contains one plot showing several devices in the same plot as a function of neutron fluence.

10) Most of the 'device'.pdf file contain 4 plots. The first 3 show the same data plotted 3 times with the x-axis scale in LHC years, neutron fluence, and total ionizing dose (TID) for photons. The 4th plot shows the results of the Co60 test data with the x-axis calibrated in TID.

11) The TID calibrations of the reactor photons compared to that of the Co 60 photons appears to be in disagreement by a factor of 2 to 3. I believe the Co 60 calibration to be more correct suggesting that the TID scale for reactor photons is a factor of 3 low.

Cathode FEB Components

Summary of Outcome				
Good Devices	Probable Good Devices	Maybe Useable Devices	Bad Devices *	As yet Untested Devices
LM1117-ADJ		LM1086-5	LT1129-5	LM4130
LM4120-3.3		LM1085-3.3	IRFU9110	
LM4120-1.8			LP3964-5	
LM4041				
SDA321				
Red LED				
AD8011				

* These devices have been removed from the CFEB design consideration.

Possible Low Voltage Distribution Board Components

(Voltage Regulators)

Summary of Outcome				
Good Devices	Probable Good Devices**	Maybe Useable Devices	Bad Devices	As yet Untested Devices
	OM7611ST		LP3966	OM3914ST
	PQ7DV10			TPS2012
	PQ7DV5			TPS2013
	LM2991			TPS2015

** These devices should be retested to be sure.

Device	Manufacturer	Part Description	Test Conditions	Effect of Co60 Photons	Effect of Reactor Neutrons and Photons
LT1129-5	Linear Technology	Fixed 5 V Regulator, 700 mA	5 V , 125 mA	Voltage increased slowly from 5 to 6 V over exposure to 100 kRads	Voltage increased from 5 to 5.4 V up to 8X10^11 N/cm^2 (just as with photons alone) then died (0V output) at 8.6X10^11 N/cm^2.
LM1085-3.3	National	Fixed 3.3 V Regulator, 3A	3.3 V, 100 mA	No changes observed up to 100 kRads	First test saw a slight increase in voltage up to 1.4X10^12 N/cm^2 then a rapid increase to 3.8-3.9 V. The second test (new part) only showed a mild increase over the test range of 2.8X10^12 N/cm^2.
LM1086-5	National	Fixed 5 V Regulator, 1.5A	5V, 100 mA	Voltage showed slight increase over exposure to 100 kRads	Voltage increase from 5 to 5.4 V over 2.8X10^12 N/cm^2
LM1117-ADJ	National	Adjustable Voltage Regulator	2.5 V, 5 mA	N/A	No change observed after 2.8X10^12 N/cm^2
LM4130	National	Voltage Reference, 20 mA	Not available for testing	N/A	N/A
LM4120-3.3	National	Voltage Reference 3.3 V 5mA	3.3 V, 100 mA , with pass transistor	Input voltage dropped due to changing threshold of pass transistor. When < dropout voltage, the output tracked the input.	Same behavior as with photons alone.
IRFU9110	International Rectifier	PMOS Pass Transistor for LM4120-3.3, 3.1A	Gate set to 4V below Vdd	Threshold started changing immediately and steadily increased.	Same behavior as with photons alone.
LM4120-1.8	National	Voltage Reference , 1.8 V, 5 mA	1.8 V, 0.5 mA, with DMOS FET pass transistor	N/A	No change observed after 2.8X10^12 N/cm^2
LM4041	National	Shunt Voltage Reference	1.5V, 0.5 mA	N/A	Slight increase in voltage after 2.5X10^12 N/cm^2.
SDA321	Zetex	Schottky Diode Array reversed biased	Reversed biased at 4V	No significant change in the leakage current was observed.	No significant change in the leakage current was observed. (Forward biasing conducts after exposure)
Red LED	N/A	red LED	in series with 2k resistor to power	N/A	No change in current or voltage observed.
OM7611ST	Omnirel	Adjustable Negative Voltage Regulator, 3 A	Wired "upside down" with input grounded and trim-pot at +7V. Adjusted for +1.6V output (i.e.. 5.4 V below	N/A	No indication of problems up to 1.1X10^12 N/cm^2 (i.e.. The output tracked the supply voltage); Possibly OK beyond 1.1X10^12 N/cm^2 but data is unreliable.
OM3914ST	Omnirel	Adjustable Negative Voltage Regulator, 3 A	Not available for testing	N/A	N/A

Device	Manufacturer	Part Description	Test Conditions	Effect of Co60 Photons	Effect of Reactor Neutrons and Photons
PQ7DV10	Sharp	Adjustable Voltage Regulator 10A	5 V, 750 mA	No indication of problems up to 100 kRads	No problems observed up to 1.1X10^12. Good indication that it is OK up to 2.8X10^12 N/cm^2.
PQ7DV5	Sharp	Adjustable Voltage Regulator 5A	6 V, 900 mA	No indication of problems up to 100 kRads	No problems observed up to 1.1X10^12. Good indication that it is OK up to 2.8X10^12 N/cm^2.
LP3964-5	National	5 V Regulator 800mA	5 V, 250 mA	Drop in voltage starts at 18kRad then sudden rise at 27kRad then dead at 31kRad	Same behavior as with photons alone starting at 3X10^11 N/cm^2. Dead at 8X10^11 N/cm^2. Behavior with neutrons alone ???
LP3966	National	Adjustable Voltage Regulator 3A	3.3 V, 660 mA	Rapid rise in voltage as 31kRads then dead at 35kRads	Same behavior as with photons alone starting at 6X10^11 N/cm^2. Dead at 8X10^11 N/cm^2. Behavior with neutrons alone ???
LM2991	National	Adjustable Negative Voltage Regulator 1A	Wired "upside down" with input grounded and trim-pot at +7V. Adjusted for +4.4V output (i.e.. 3.6V below supply)	No indication of problems up to 100 kRads	Tracking the positive supply up to 8.5X10^11 N/cm^2 at which point the ADC becomes saturated.
AD8011	Analog Devices	300MHz Current Feedback OpAmp	input was LM4120-3.3 with gain of 1	No indication of problems up to 100 kRads	No problems observed up to 2.8X10^12 N/cm^2.
TPS2012	Texas Instruments	Power Distribution Switches	Not yet tested		
TPS2013	Texas Instruments	Power Distribution Switches	Not yet tested		
TPS2015	Texas Instruments	Power Distribution Switches	Not yet tested		