Testing of Cables for KPiX Pulse Load

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Power Topics

- Voltage Kick / Overshoot @ turn off
- ICs Operating = 2.5 V Max Operating = 2.75V Abs max = 3 V Life tests
- Power Efficiency / Inefficiency / wasted Power
- Cable Tests. No KPiX Chip current
- DC-DC Converter with Air Core Coil
- Radiation Tolerance Why Thin Oxides ?

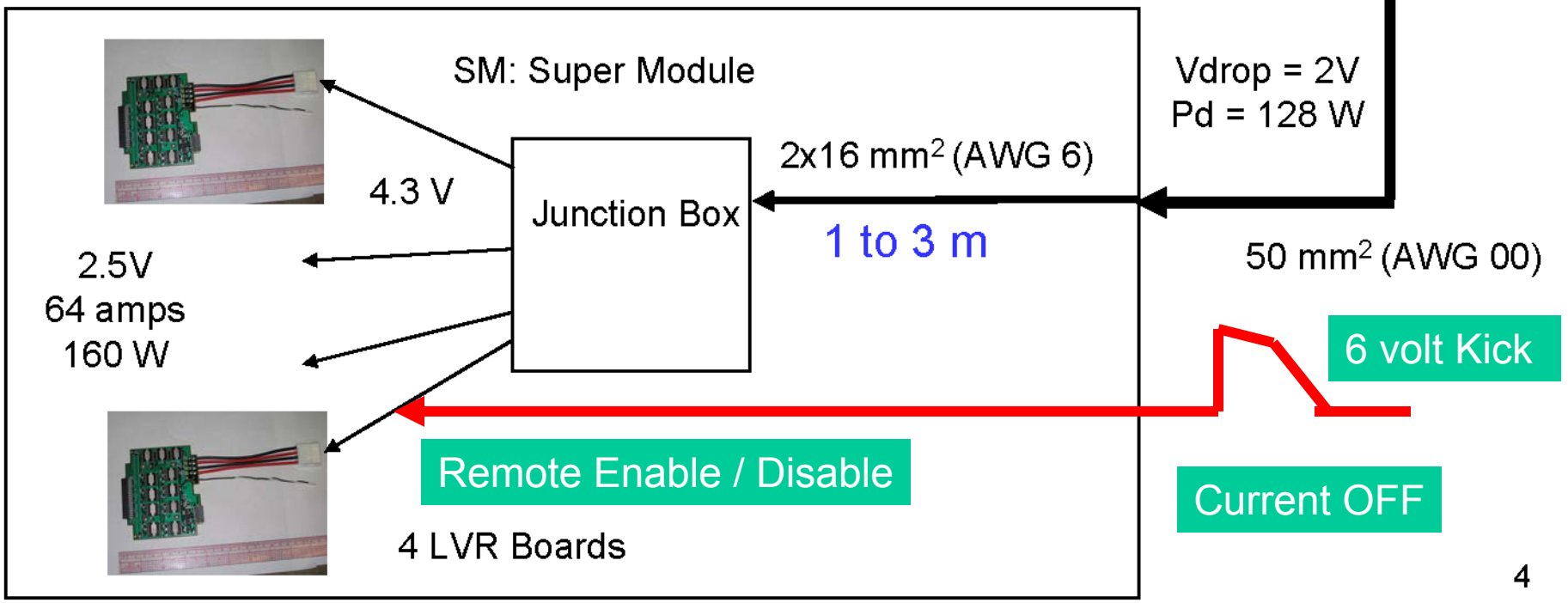
CMS ECAL: 5 Oodles (50 Kamps) .

Power Supply output = 315 KW
Power loss in Leads to SM = 100 KW
Power loss in Regulator Card = 90 KW
Power Delivered @ 2.5 V = 125 KW

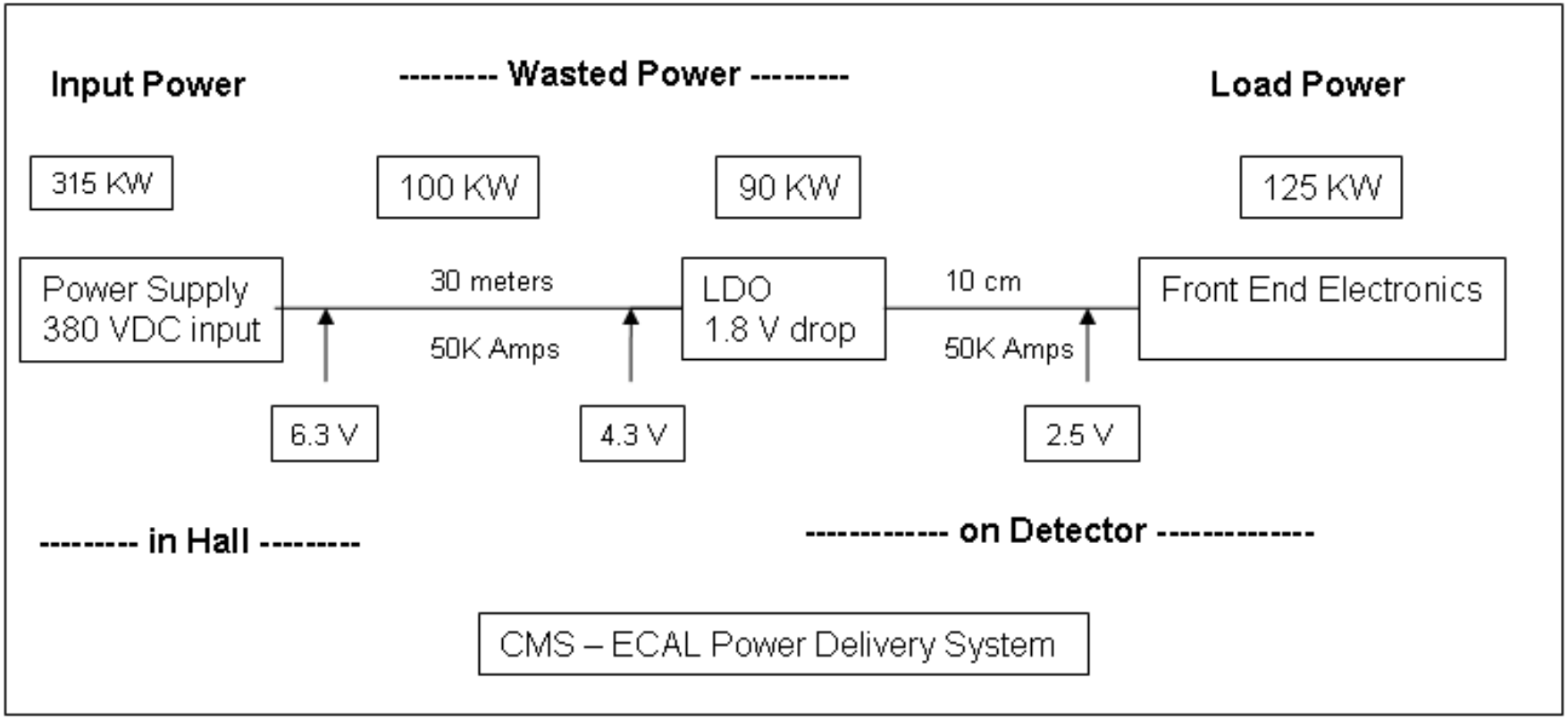
1 Oodle = 10,000 amps

# of Power Supplies ~ 700
# of ST LDO Chips = 35 K LHC Radiation Hard made by ST Microelectronics
# of LVR Cards = 3.1 K.

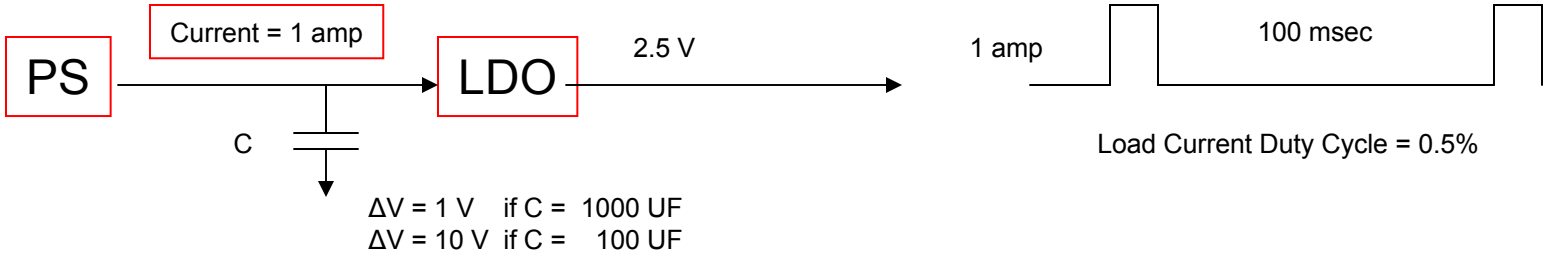
Yale: Designed, built, burn-in and Tested.

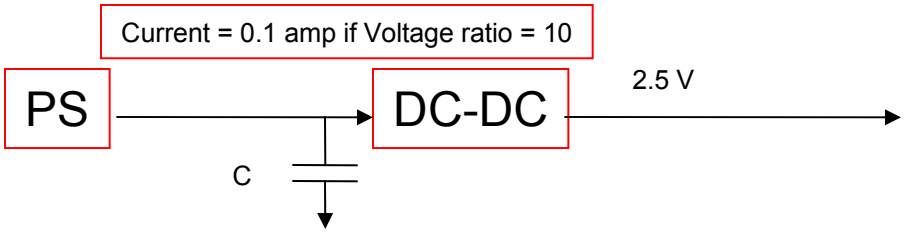


Power Efficiency _ Inefficiency _ Wasted Power



Why use DC-DC for Pulse powering ?





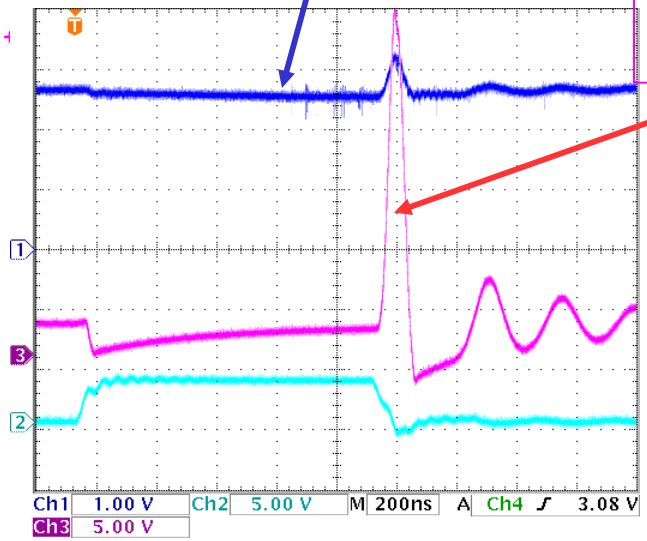
DC-DC Converter
Ferrite Inductor

2 meters Twisted pair AWG 24 transmission line

Vin 12 V

TPS
62130
Evaluation
PCB

Turn off Spike with
1 amp load = 27 V
FWHM = 80 nS



Load Resistor
2.5 Ω 10 W

Gate
+5V

50 Ω

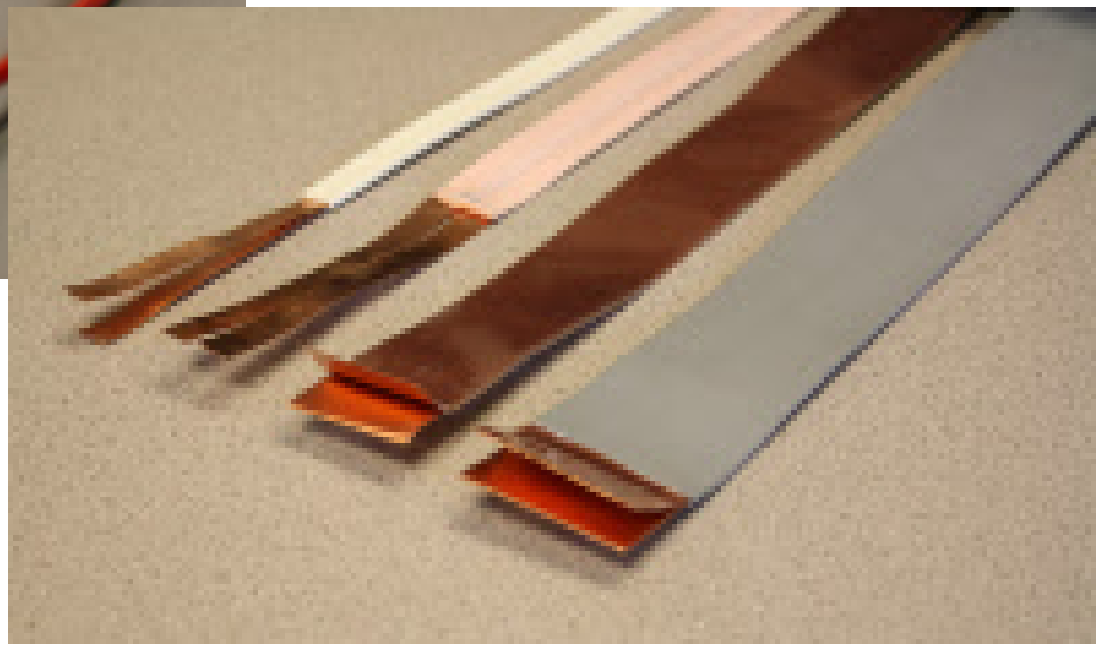
Gnd

KPiX 'Chip'

Waveforms when 1 amp flowing thru 130 Ohms twisted pair is interrupted /switched off. 27 Volt Spike appears across KPiX chip. In principle it should be 130 volts but due to finite switching time and cable length it is 27 V.

GOERTZ audiophile speaker cable

Copper or Silver (Need good ears & Deep pockets)



ALPHA-Core Interconnect Pairs

"Analogue-like dynamics from CD, seamless top-to-bottom smoothness, 3D imaging, dead silent background..."
Ed Osborne, Executive Producer BMG Special Products

JAN 14 2011

Stereo Pairs	.5m 1.6ft	1m 3.3ft	1.5m 4.9ft	2m 6.5ft	2.5m 8.1ft	3m 9.7ft	4m 13.1ft	5m 16.4ft	6m 19.7ft	7m 23ft	8m 26.2ft	9m 29.5ft	10m 32.8ft
COPPER INTERCONNECT (Micro Purl-25 awg,TQ2 Copper-21awgTourmaline - 18awg)													
Micro Purl Cu RCA	$68	$101	$121	$157	$194	$216	$255	$334	$413	$470	$549	$628	$708
Micro Purl Cu XLR	$97	$133	$166	$201	$243	$269	$318	$405	$502	$550	$664	$943	$1,077
Triode Quartz TQ2/Cu RCA	$100	$148	$190	$234	$280	$324	$381	$444	$539	$632	$702	$797	$893
Triode Quartz TQ2/Cu XLR	$142	$195	$242	$292	$342	$393	$460	$534	$640	$735	$872	$1,207	$1,367
Tourmaline RCA	$120	$178	$228	$280	$336	$388	$457	$533	$647	$759	$843	$956	$1,071
Tourmaline XLR	$170	$234	$291	$351	$410	$471	$552	$640	$768	$882	$1,046	$1,448	$1,640
SILVER INTERCONNECT (Micro Purl - 25 awg, TQ2 - 21awg, Sapphire - 18awg)													
Mico Purl Ag RCA	$111	$165	$198	$256	$316	$351	$416	$545	$673	$766	$894	$1,023	$1,153
Micro Purl Ag XLR	$157	$217	$270	$328	$397	$438	$517	$660	$818	$896	$1,082	$1,537	$1,754
Triode Quartz TQ2/Ag RCA	$163	$242	$309	$381	$456	$527	$621	$724	$878	$1,030	$1,143	$1,298	$1,454
Triode Quartz TQ2/Ag XLR	$231	$318	$395	$476	$557	$640	$749	$869	$1,042	$1,197	$1,420	$1,966	$2,226
Sapphire RCA	$250	$443	$633	$805	$848	$891	$1,188	$1,489	$1,599	$1,797	$2,053	$2,308	$2,566
Sapphire XLR	$333	$566	$793	$1,000	$1,040	$1,123	$1,453	$1,742	$2,032	$2,214	$2,490	$2,800	$3,111

Shaded area: Recommended Interconnects, function of length

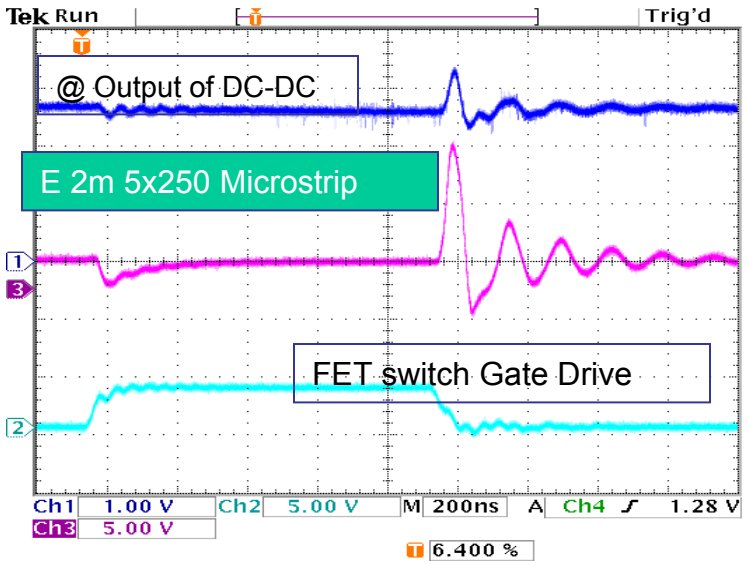
1/13/2011

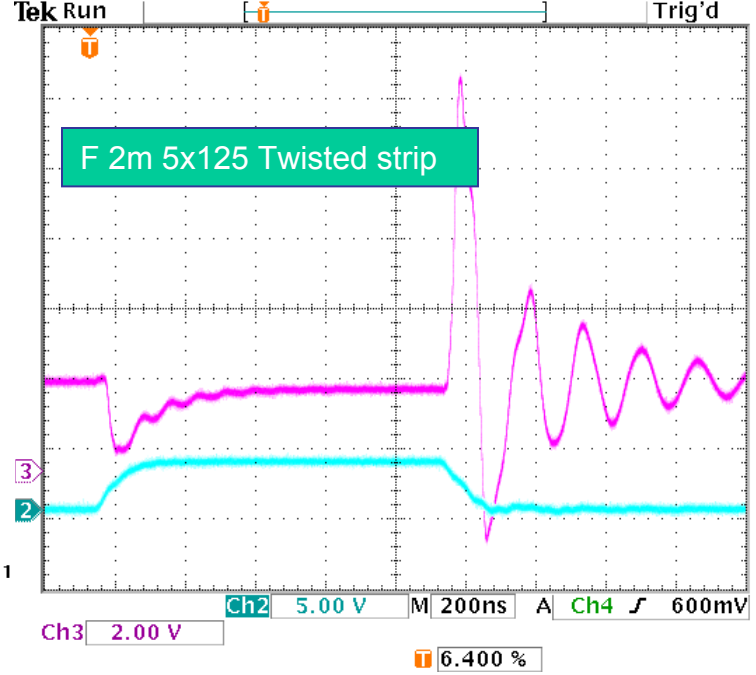
Cable Parameters

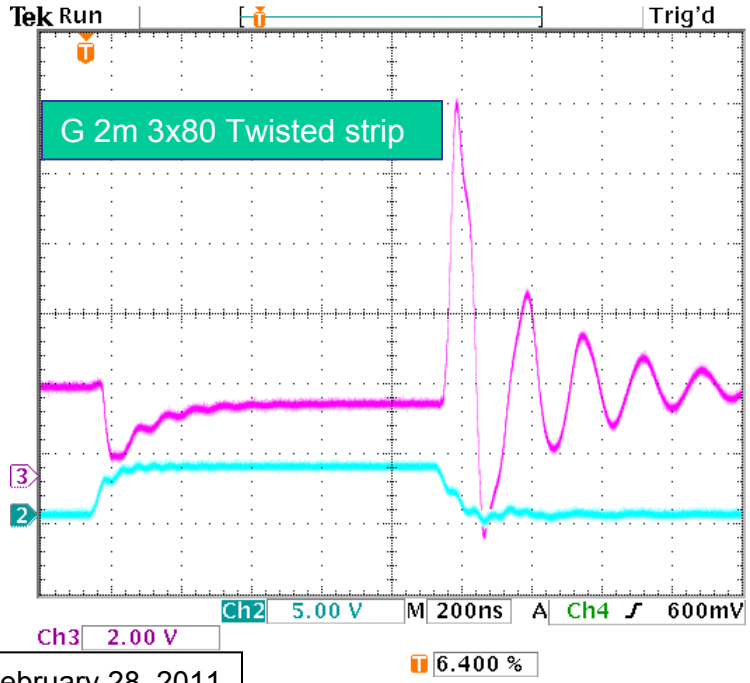
Cable Type	# of	Cross Section	C	L	R Ohms	DCR	Z	Reflection	Label
Length = 2 meters	**Conductors**	**mils**	**pF**	**nH**	**1 MHz**	**Ohms**	**Ohms**	**Peak V**	
Twisted Pair	2	AWG 22	95.6	1100	0.734	0.197	130	27	
Micro Strip	2	5 x 250	1440	168	0.171	0.105	10.8	10	E
Strip Line	3	5 x 250	4930	103	0.092	0.066	4.6	7.4	H
Strip Line -Twisted	3	5 x 125	2520	154	0.195	0.142	7.8	9	F
Strip Line -Twisted	3	3 x 80	2353	177	0.544	0.420	8.7	8.8	G

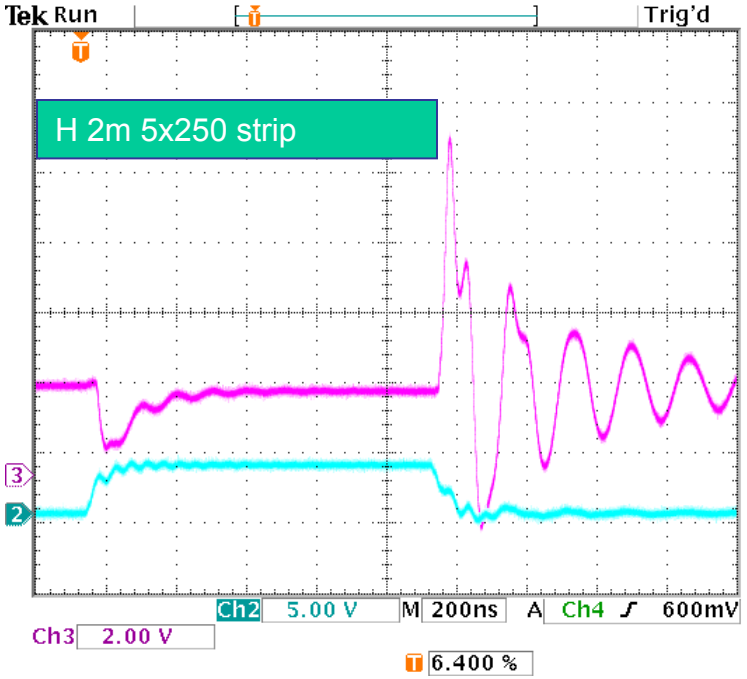
All Cables 2 meter long.
HP 4284A Precision LCR Meter 20 Hz - 1 MHz. Test Fixture 16047C

February 28, 2011

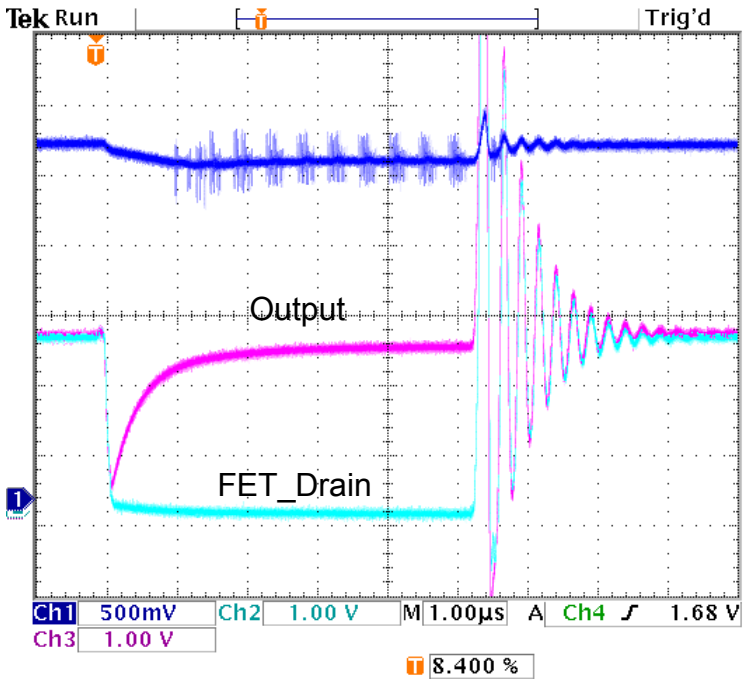


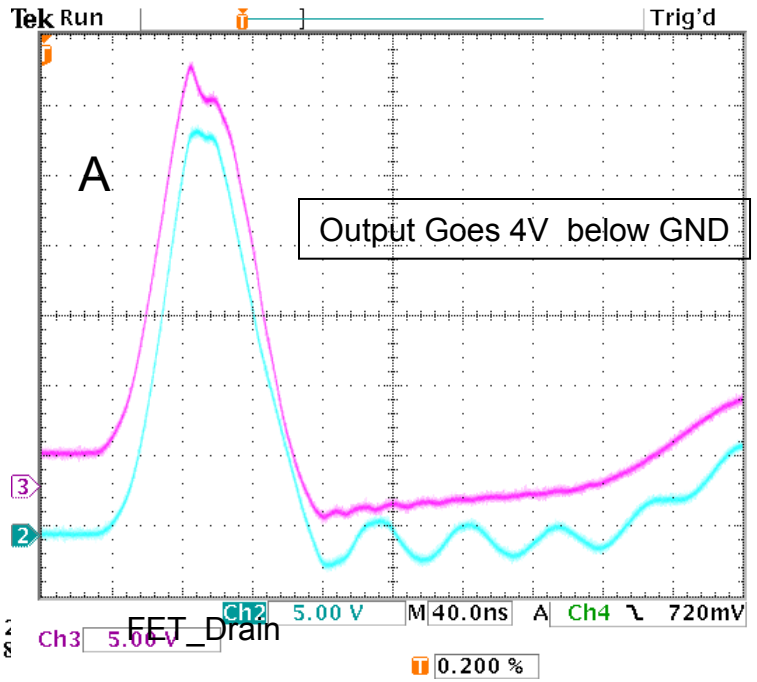


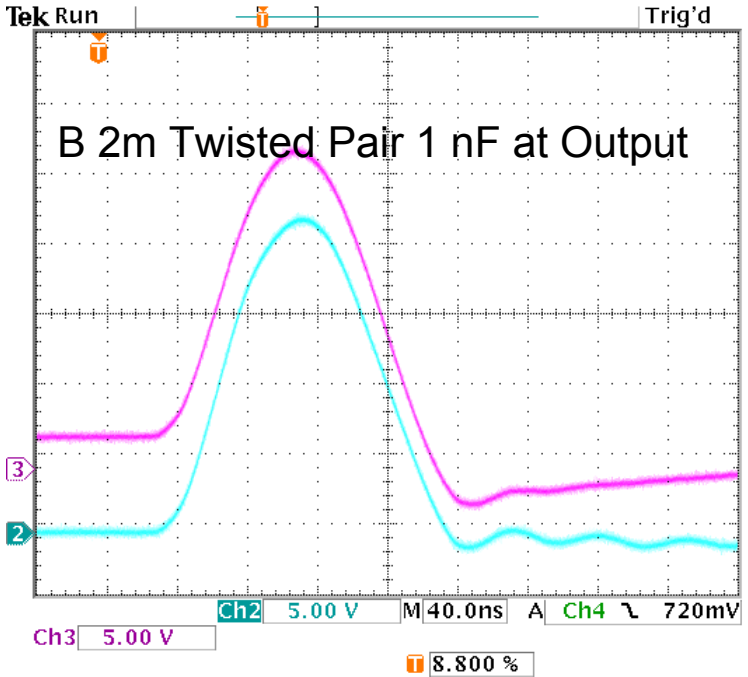


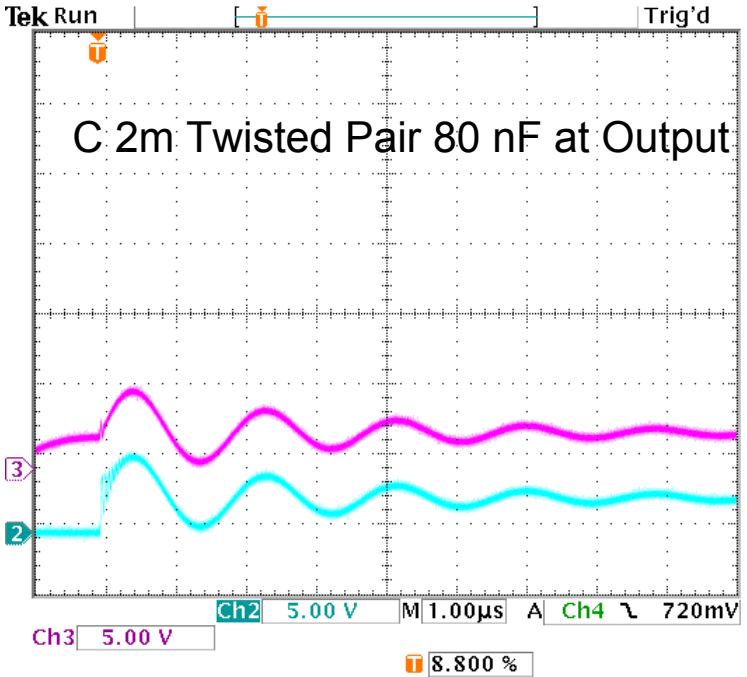


February 28, 2011


Tek Run
Trig'd
Output
FET_Drain
Ch1 500mV
Ch2 1.00 V
M 1.00µs
A Ch4 1.68 V
Ch3 1.00 V
8.400 %

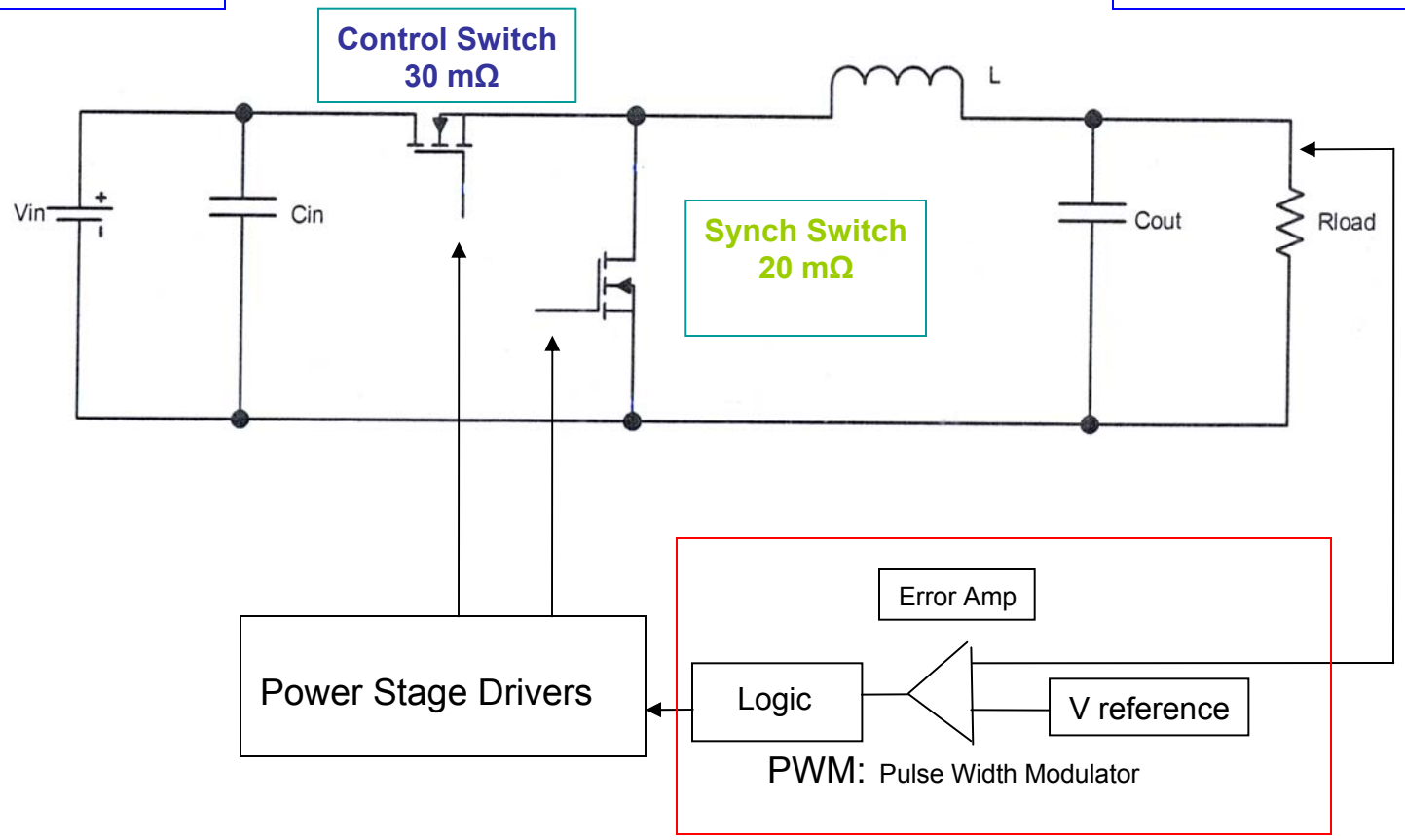

Tek Run
Trig'd
A
Output Goes 4V below GND
FET_Drain
Ch2 5.00 V
M 40.0ns
A Ch4 720mV
Ch3 5.00 V
0.200 %
27 Feb 2011
06:18:36


Tek Run
Trig'd
B 2m Twisted Pair 1 nF at Output
Ch2 5.00 V
M 40.0ns
A Ch4 720mV
Ch3 5.00 V
8.800 %
27 Feb 2011
07:01:50

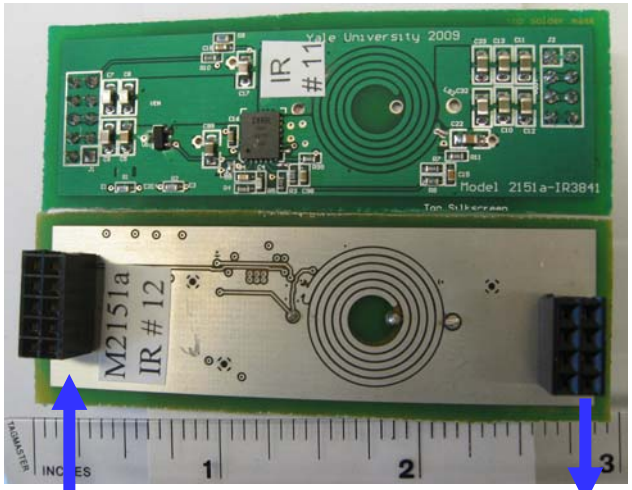

Tek Run
Trig'd
C 2m Twisted Pair 80 nF at Output
Ch2 5.00 V
M 1.00µs
A Ch4 720mV
Ch3 5.00 V
8.800 %
27 Feb 2011
07:04:16

High Voltage
Low Current
Input

Low Voltage
High Current
Output



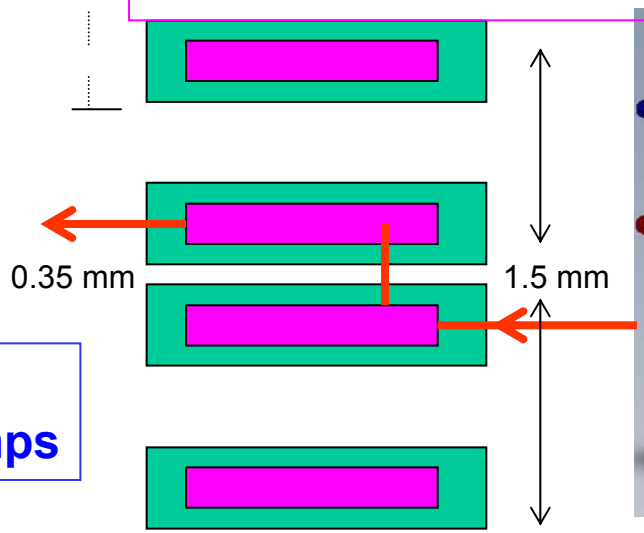
Plug In Card with Shielded Buck Inductor

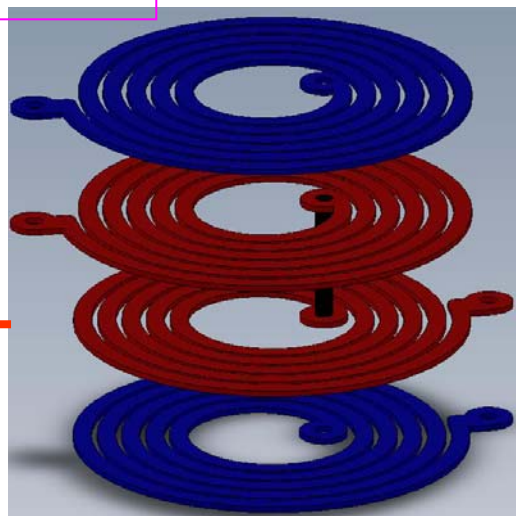


12 V

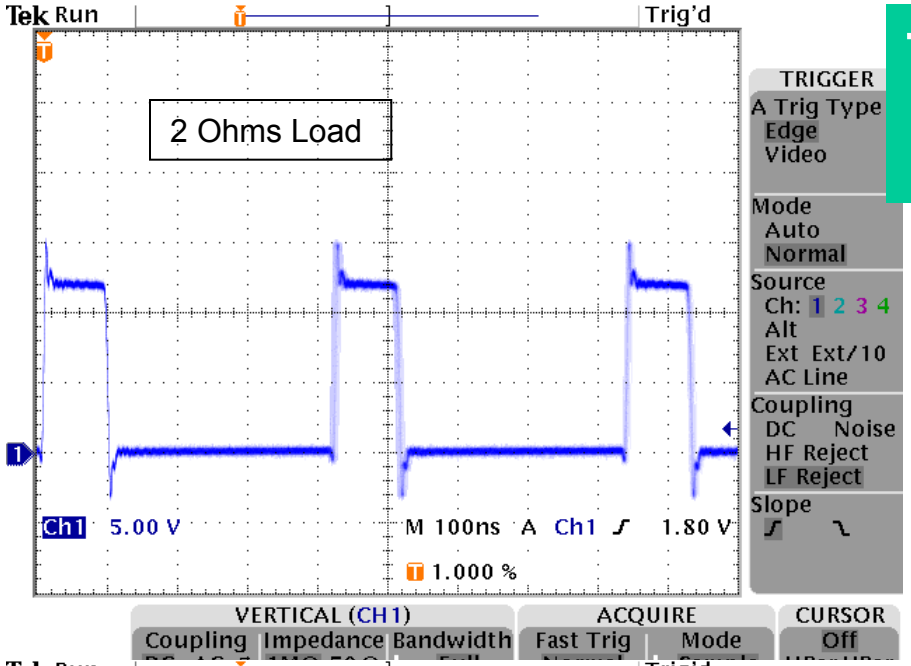
2.5 V
@ 6 amps

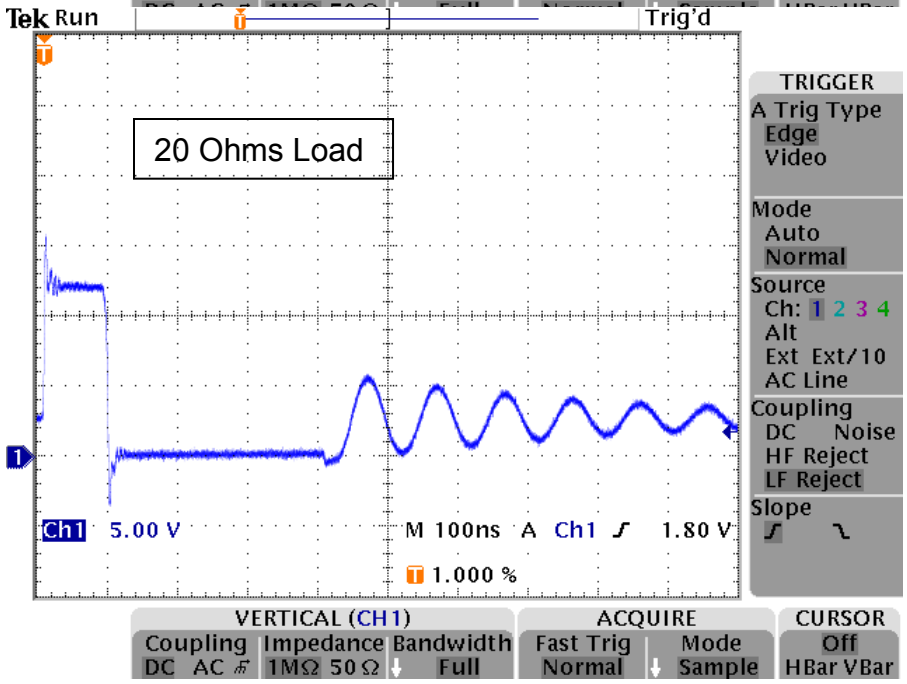
Coupled Air Core Inductor Connected in Series





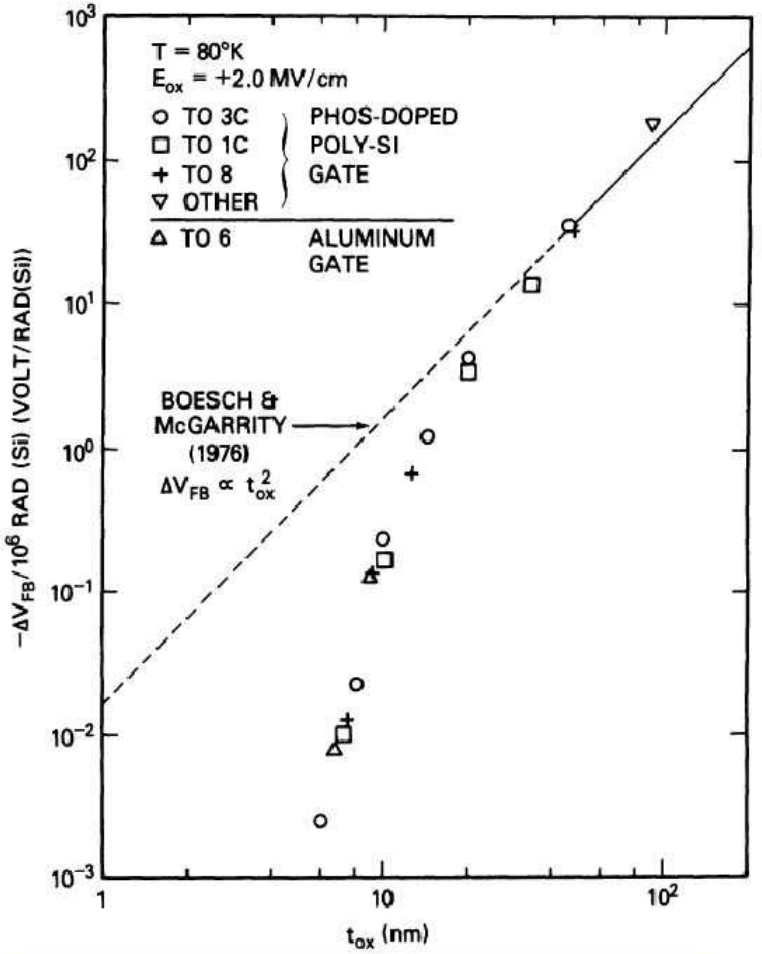
TI Device in Development
Fast Transient Response



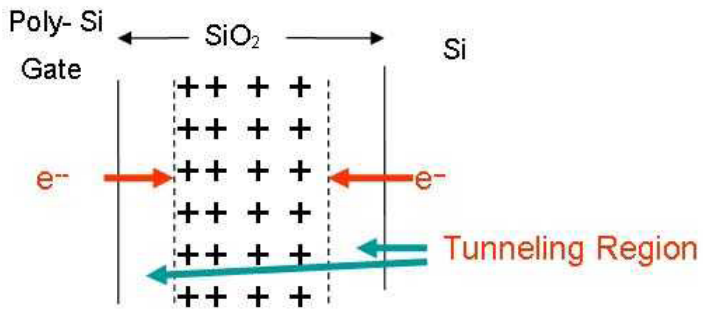


Threshold shift in MOS transistors with Radiation vs Oxide Thickness

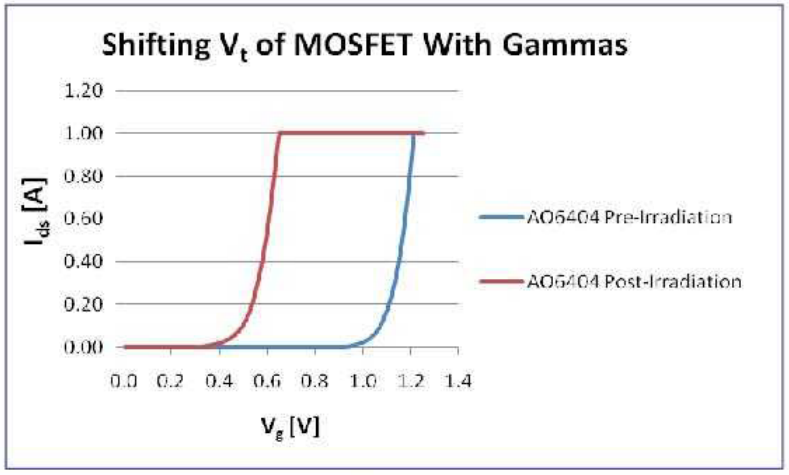
Threshold Shift vs Gate Oxide Thickness



Sachs et. al. IEEE Trans. Nuclear Science NS-31, 1249 (1984)



Hole removal process by tunneling in thin-oxide MOS Structures



Book. Timothy R Oldham "Ionizing Radiation Effects in MOS Oxides" 1999 World Scientific

Radiation Tolerance of CMOS Devices

Company	Device	Process	Foundry	Oxide	Dose before	Observation
		Name/ Number	Name	nm	Damage seen	Damage Mode
IHP	ASIC custom	SG25V GOD 12 V	IHP, Germany	5	53 MRads	Minimal Damage
XySemi	FET 2 A	HVMOS20080720 12 V	China	7	52 Mrads	Minimal Damage
XySemi	XP5062	HVMOS20080720	China	12	44 Krads	Loss of output regulation
Enpirion	EN5365	CMOS 0.25 µm	Dongbu HiTek, Korea	5	64 Krads	Increasing input current
Enpirion	EN5382	CMOS 0.25 µm	Dongbu HiTek, Korea	5	111 Krads	Loss of output regulation
Enpirion	EN5360	SG25V (IHP)	IHP, Germany	5	100 Mrads	Minimal Damage
National	LM2864	PVIP25	In House	11.8	3 Mrads	Loss of output. Short after power off/on

Table I. Radiation Tolerance of Devices with thin oxide

Next

- Measure KPiX turn off spikes
- Movement of Pulsed Current Conductors in 7T

  Suggestions are welcome
- Test new commercial converters oxides < 15 nm

More Information

http://shaktipower.sites.yale.edu/