DC DC Converters meets the FPGA

Jack Shue
GSFC
Start with some Quotes

Nobody trust a computer simulation except the guy that did it, and everybody trust experimental data, except the guy who did it. Why not combine the two and get results everybody can mistrust a little.

Tony Kordyban
Hot Air Rises and Heat Sinks
Start with some Quotes

If it were not for the FPGA, the DC DC Converter would be the number one problem on Center
What can we gain?

So why not combine the FPGA and the DC-DC Converter for everyone to use and mis-use a little?
Historical Note: A Lesson from the Phone Industry

The Beginning, Crude and Direct

One Line

Mr. Watson

Come here.

Historical Note a Lesson from the Phone Industry

The Analog and Analog Switch

Party Line

Hello, Operator, can I help you?

Wikipedia

U.S. Air Force operator works a switchboard in the underground command post at Strategic Air Command headquarters, Offutt Air Force Base, Nebraska in 1967.
Historical Note a Lesson from the Phone Industry
The Original Voltage Control

The Battery
1 Frog Leg
1.5 Volts

The Battery
Lead Acid
1.5 Volts

The Battery
More Voltage, More Cells

80 cells in series and you have enough for a Neon Lamp Computer!
Buck Converter
Quick Tutorial on DCDC Converters

Analog Feedback

Feedback Signal

Clock Ramp

Clock On

Ramp Determined off

Pulse Width Modulated

Quick Tutorial on DCDC Converters

The PWM

Feedback Signal Low Voltage

Feedback Signal

Clock On

Clock Ramp

Ramp Determined off

Pulse Width Modulated

Controls - Active

Signal filtering (Feedback Loop Analog)
Quick Tutorial on DCDC Converters

Analog / Current Controlled Feedback

Feedback Signal

Clock On

Current Ramp

Ramp Determined off

Quick Tutorial on DCDC Converters

Digital Feedback

Feedback Signal

Clock On

Count X

256 Counts

Or other counts for different granularity

FPGA

> X - 1 PWM count

< X +1 PWM count

FPGA Controls – Simple Passive

• Monitor Voltages
• Make adjustments in PWM.

For:
Lower voltage = X – 1 count
Same voltage = X
Higher voltage = X + 1 count
FPGA Controls - Active

FPGA joins TWITTER!

FPGA can talk to themselves.
FPGA Controls - Active

With self-monitoring, an FPGA could be able to ask for more power before normal feedback loop could respond, or even just before it needs it.
FPGA Controls - Active

With FPGA protection, circuits could be added with no extra parts.

Voltage Protection
Current Limiting
Power Correction
FPGA Controls - Active

Digital Filtering

Internal Noise Filtering      External Noise Filtering

Input          Output
FPGA could enable.

Active Noise Suppression

Use of Power Lines for Signal Lines
FPGA Control

We are now at the beginning

Where it will take us is at the moment unknown.