Advanced Power Technologies for SSD Applications

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Portable Devices

Data Intensive
Processing power is increasing for future portable devices

Battery life
Device usage is increasing while battery capacity remain the same

More Features
More features are added with the same battery capacity and form factor
Computing/ Storage

Processing Power
- More processing power is required for next gen computing platform

Storage Technology
- Solid State Drives are emerging in datacenter storage segment

Lower OPEX
- Reduced operating cost (especially from power & cooling)
Solid State Drive Power Tree

- ESD
- Temp
- ASIC
- eFuse
- Boost
- Buck
- LDO
- Buck
- Boost
- µMCU
- FLASH
- FLASH
- FLASH
- FLASH
- FLASH
- µMCU
- Temp
- 12C
Solid State Drive Power Tree
Traditional Power Management Delivery

Fixed Voltage = Inefficient System!

- No temperature compensation
- No adjustment for lower voltages at lower frequencies
- No compensating for process variation
Silicon Process Guard-band

Guard-bands

1.0V

1.2V

0.9V

Fast

Typical

Slow
Silicon Process Guard-band
Adaptive Voltage Scaling (AVS)

Adaptive Voltage Scaling = Maximum power savings

- Process and Temperature Compensation
- No need for frequency-voltage lookup tables
- Real-time continuous closed-up

\[ E = (\alpha \cdot C \cdot f_{CLK} \cdot V^2 + V \cdot I_{LEAK}) \cdot t_{TASK} \]

DYNAMIC LEAKAGE

PWI = PowerWise® Interface
AVS Optimizing Power / Full Range

Published (Fixed) $V_{DD}$
- All silicon guaranteed to function
- Timing models for PTV corners at F

AVS_Vdd for Lowest Power
- Power controller maintains $V_{dd}$ to lowest level possible based on on-chip PTV performance measurement
- Slow silicon possible lower $V_{dd}$ based on slack timing

Clamp Minimum $V_{DD}$
- Independent clamp level for minimum $V_{dd}$ set with power controller
- Overrides monitor request to go to a lower $V_{dd}$
Adaptive Voltage Scaling Results

- ARM926EJ-S core
- Voltage and frequency scaling of CPU, Caches and TCMs
- Four performance points:
  - 60, 120, 180, 240 MHz
  - 0.6V – 1.2V Adaptive Voltage Range
- 40% energy savings with AVS
  - typical silicon verses fixed Vdd

- Dual ARM7 CPU cores
- Voltage and frequency scaling of ARM7 AHB clusters
- Performance points:
  - 96, 84, 72, 60, 12 MHz
  - 0.6V – 1.2V Adaptive Voltage Range
- 43% energy savings with AVS
  - typical silicon verses fixed Vdd
- 10% power savings of total eSSD power consumption
- Lower power consumption leads to better thermal dissipation and reliability
- AVS technology can also be used for over clocking to increase performance of SSD controller.
Power and Thermal Performance

Without AVS

With AVS

Average Power Saving ~ 40%
AVS System Impact

- **System Performance**
  - Once enabled AVS runs in background
  - No processing overhead

- **Energy Savings – Scaled Voltage Domain**
  - Savings vary depending on process geometry, design implementation, and frequency scaling profile
  - Expected energy savings for typical silicon will be 20-50% based on process and temperature variations

- **System Risk Mitigation**
  - AVS is an additional function in the ASIC/Processor and the power conversion device
  - AVS compliant ASIC/Processor and power conversion devices can still operate at fixed voltage or DVS without any design changes