Power Supply Considerations for High-Speed DSPs

Wanda Gass, Thanh Tran

Texas Instruments

Agenda

- DSP Market Categories
  - Broadband Infrastructure
- Roadmaps
  - MHz
  - Power Dissipation
  - Operating Voltage
- Power Supply Requirements
- Summary

DSP Market Categories

DSP
TEXAS INSTRUMENTS
TECHNOLOGY

Broadband Infrastructure

- Cellular Base Stations
- DSL Central Office
- Voice over Packet
- Audio/Video Transcoding

Automotive

- Antilock Brakes
- Entertainment
- Global Positioning System

Pluggable Consumer

- TV/DVD/Audio
- Games Consoles
- Cable Modem
- Wireless Router

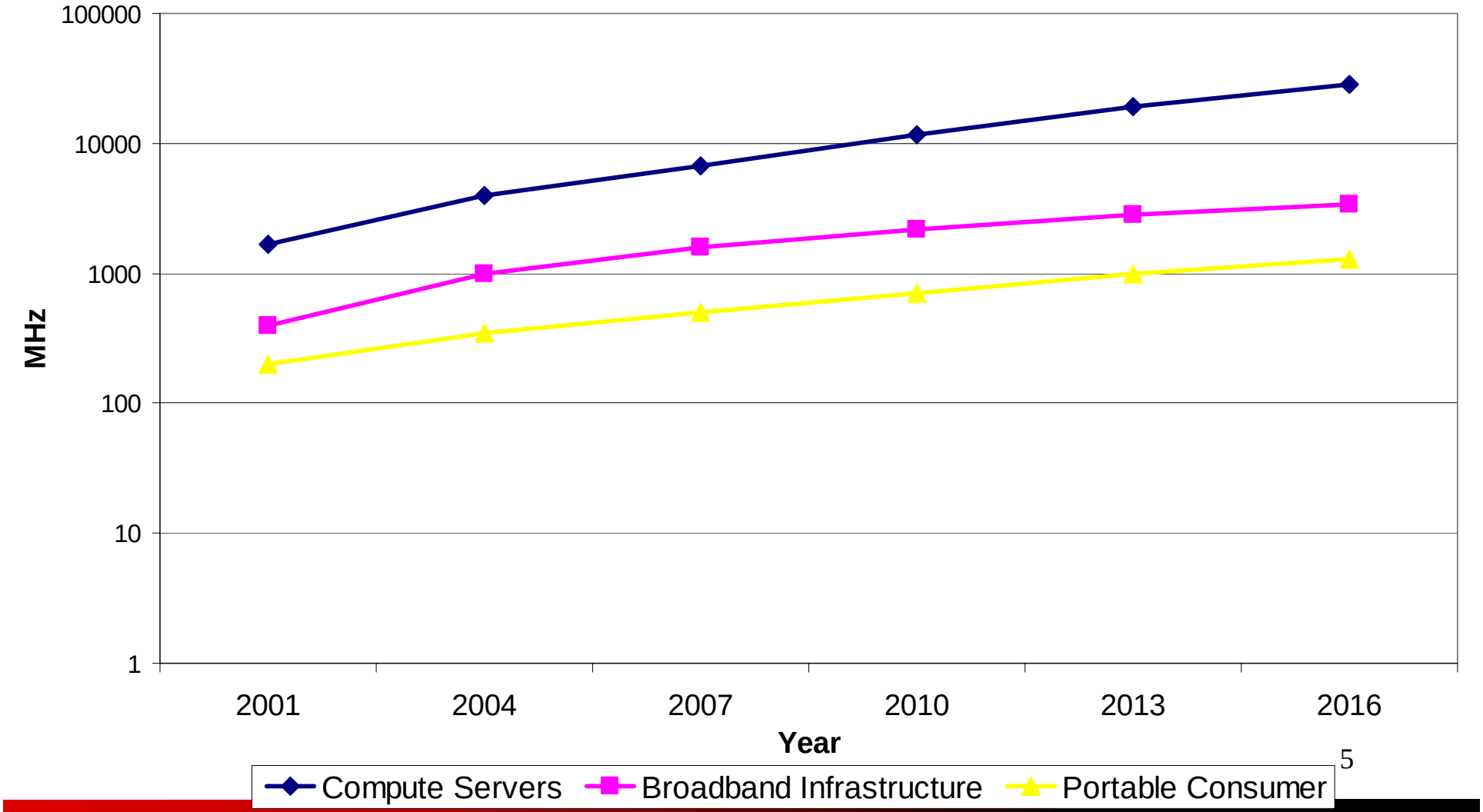
Portable Consumer

- Cell Phone
- PDA
- Digital Cameras
- Internet Audio

Broadband Infrastructure: Cellular Base Station

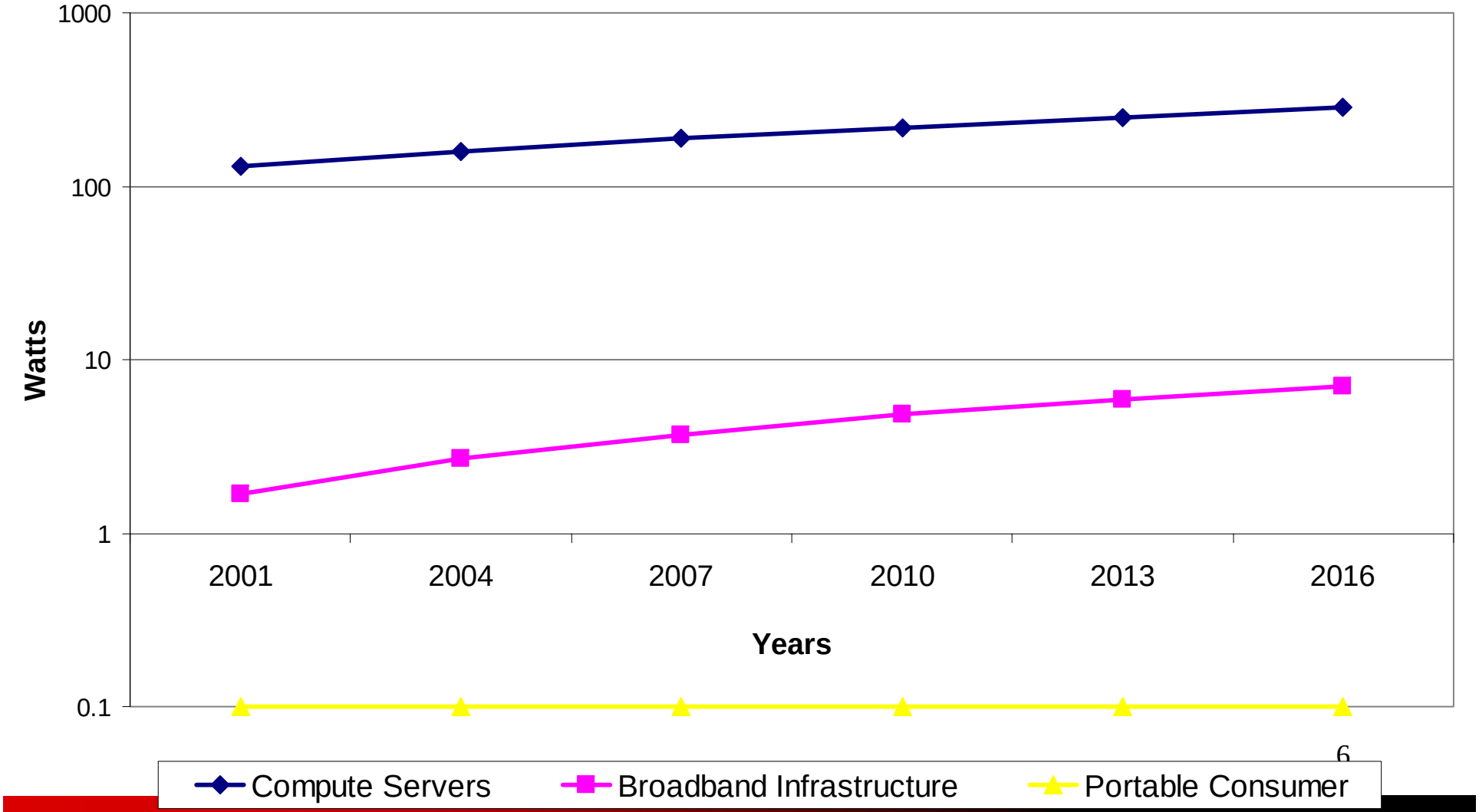
- Higher Bandwidth (2G->3G)
- Channel Density (Users/mm^3)
- Power Efficiency (mW/User)
- Long Product Life (15 years)
- High Reliability

MHz Roadmap

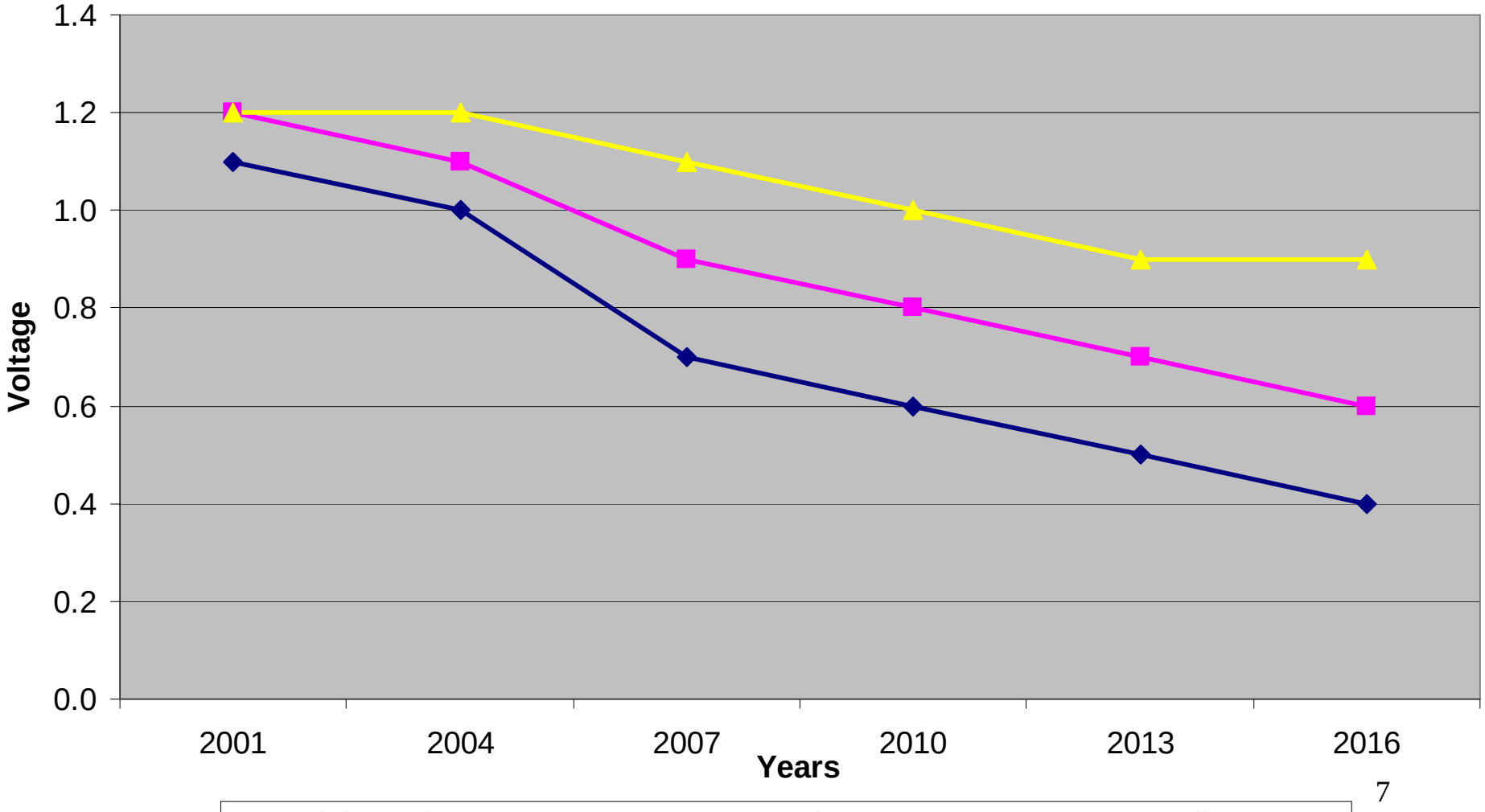

100000
10000
1000
100
10
1
MHz
2001
2004
2007
2010
2013
2016
Year
Compute Servers
Broadband Infrastructure
Portable Consumer

Power Dissipation Roadmap

DSP
TEXAS INSTRUMENTS
TECHNOLOGY



Operating Voltage Roadmap



Power Supply Requirements

- Inrush current limiter
- DC-DC converter isolation
- Switching converter synchronization
- Power supply sequencing
- Supply Voltage Supervisors
- Voltage Regulation

Inrush Current Limiter

- Plug-in cards are often removed and inserted into the system while the the power supply is on in order to keep the system running.
- The system needs to quickly suppress high voltage transients from lightning strikes (as high as 100V).

DC-DC Converter Isolation

- It is mandatory to isolate converters when stepping down from backplane voltage of -48V to 3.3V for safety reasons and to avoid ground currents.
- Isolation is part of the ETSI specification regarding powering telecom equipment.

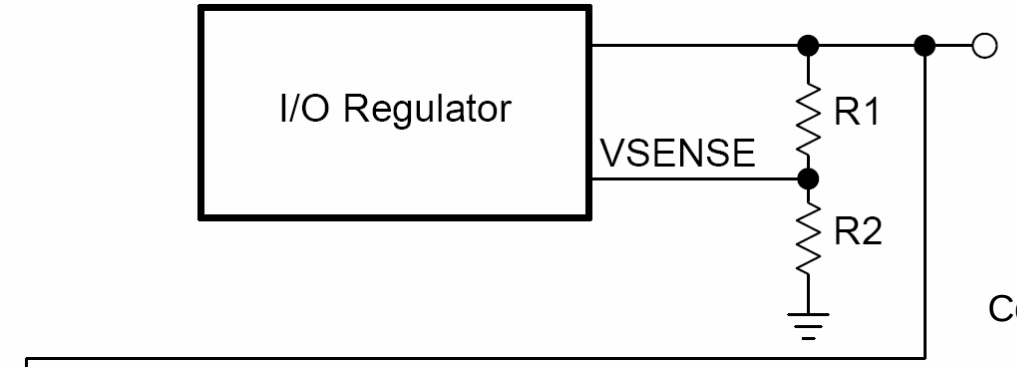
Converter Synchronization

- If all switched mode power converters are synchronized to the same frequency, then the signal can be filtered at the fundamental and harmonics frequencies in order to increases the S/N ratio.

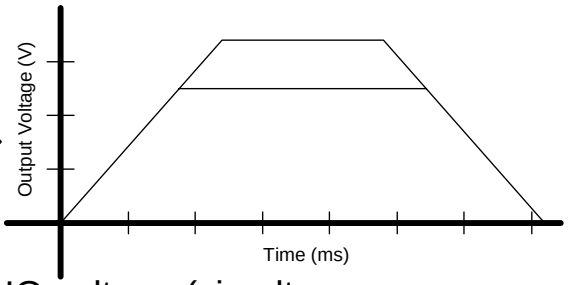
Power Supply Sequencing

- In the future multiple I/O power supplies will be required in order to provide high speed memory interfaces.
- Intelligent reset which monitors power supply voltages are required in order to guarantee system stability and reliability.

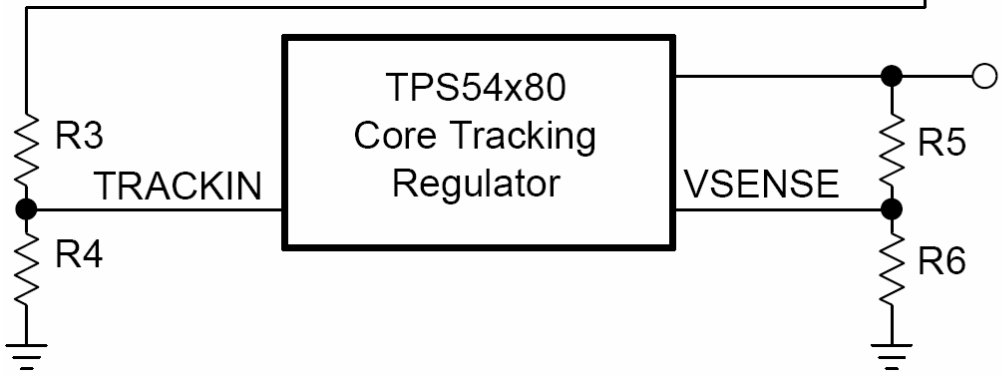
TPS54x80 Sequencing



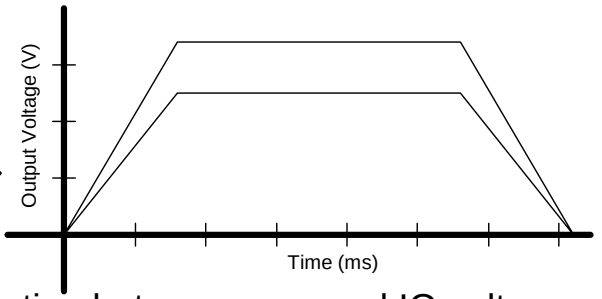
$$\frac{R3}{R4} = \frac{R5}{R6}$$



Core voltage tracks IO voltage (simultaneous power up)

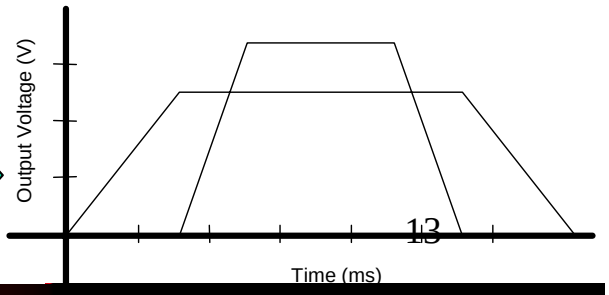


$$\frac{R3}{R4} = \frac{R1}{R2}$$



Ratiometric relation between core and IO voltage

$$\frac{R3}{R4} < \frac{R5}{R6}$$



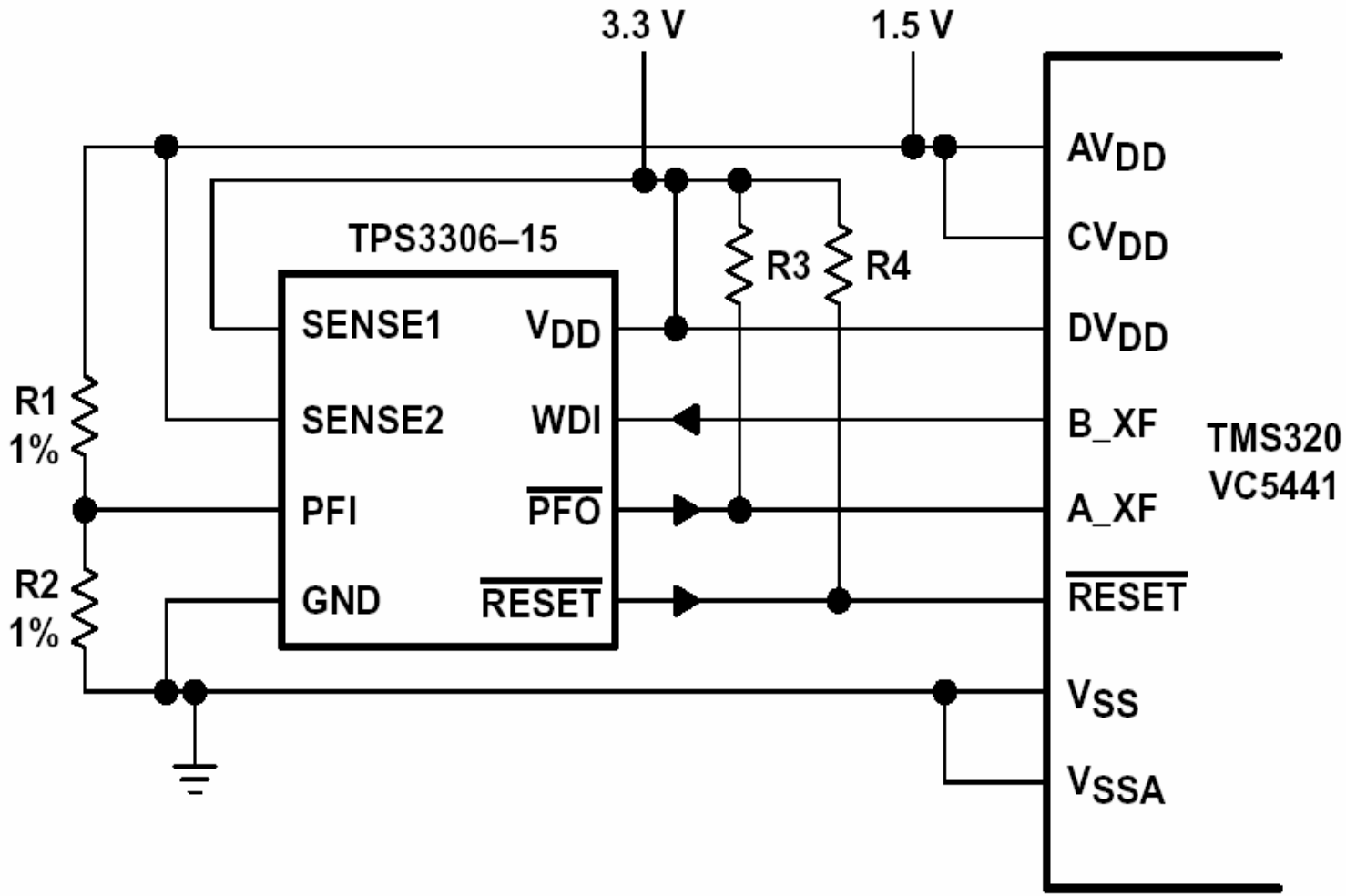
Core voltage rises first at power up

Features of Supply Voltage Supervisors (SVS)

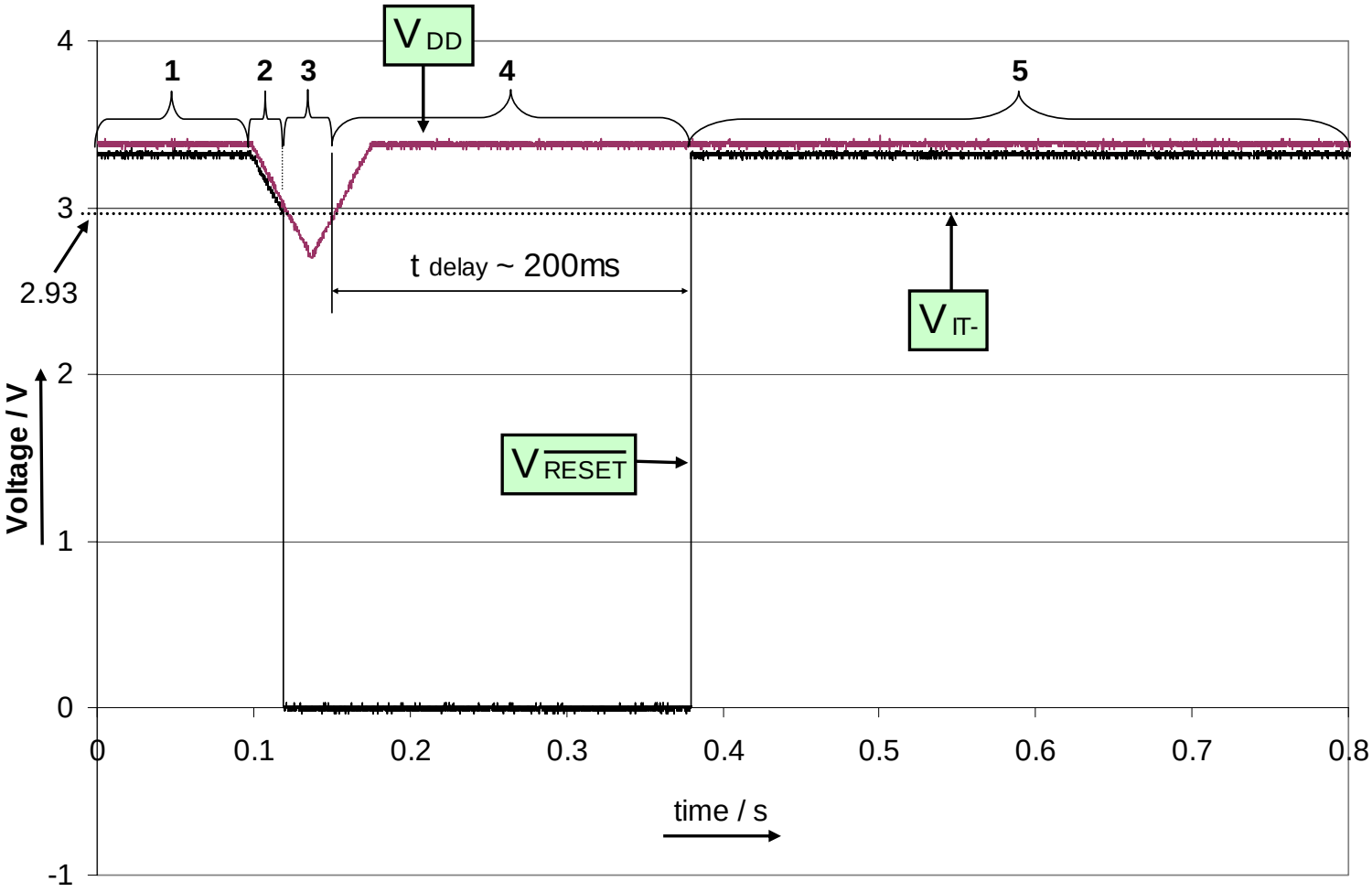
DSP TEXAS INSTRUMENTS TECHNOLOGY

- Monitoring the supply voltage
- Asserting a Reset if the supply voltage falls below the threshold voltage V IT-
- Possibility of Manual Resetting
- Controlling the correct working of a controller or a DSP with the watchdog
- Offering a high- and a low-active Reset
- Offering an adjustable supervision input
- Supervising two or three voltages at the same time
- Open Drain or Push-Pull output stage

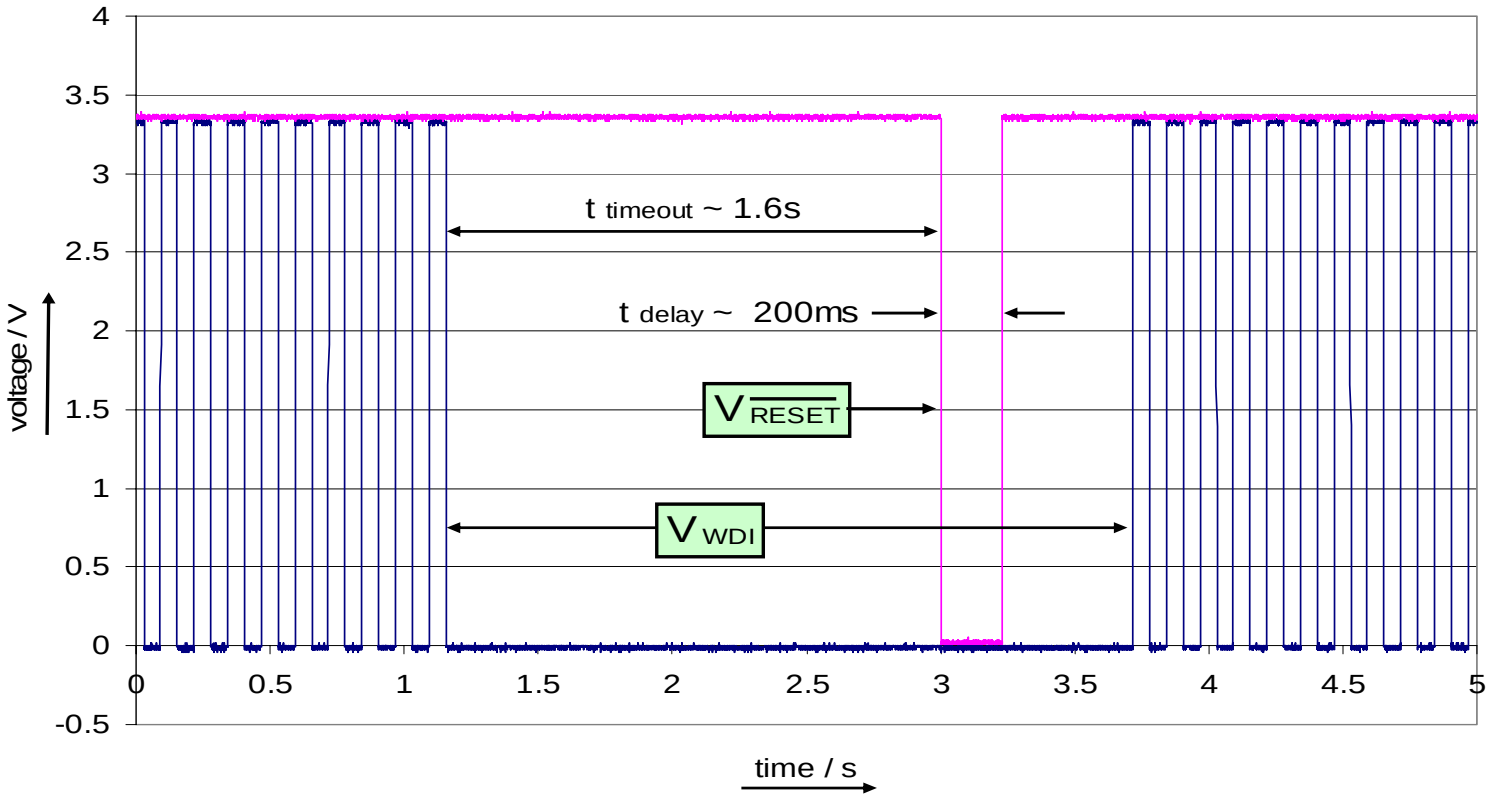
Dual Voltage Supervision



Voltage drop on 3.3V Power Line



Behaviour of the Watchdog



Voltage Regulation

For high performance DSPs, tolerance of core voltage supplies is +/- 3%.

- Power supplies should have remote sensors and fast transient response.
- Board design should have short, thick power supply traces and proper selection and placement of decoupling capacitors to minimize voltage dips due to load changes.

Summary

- The power constraints of DSP chips are 10x less than compute servers.
- Some power supply challenges of high-performance DSP systems are unique.
  - Inrush current limiter
  - DC-DC converter isolation
  - Switching converter synchronization

Acknowledgements

Marcus Zimnik, Dipl. Ing. (FH) and
Dirk Gehrke, Dipl. Ing. (FH),
Field Application Engineer Power
Management Products