Applications Drive Analog Technology Development and Innovation

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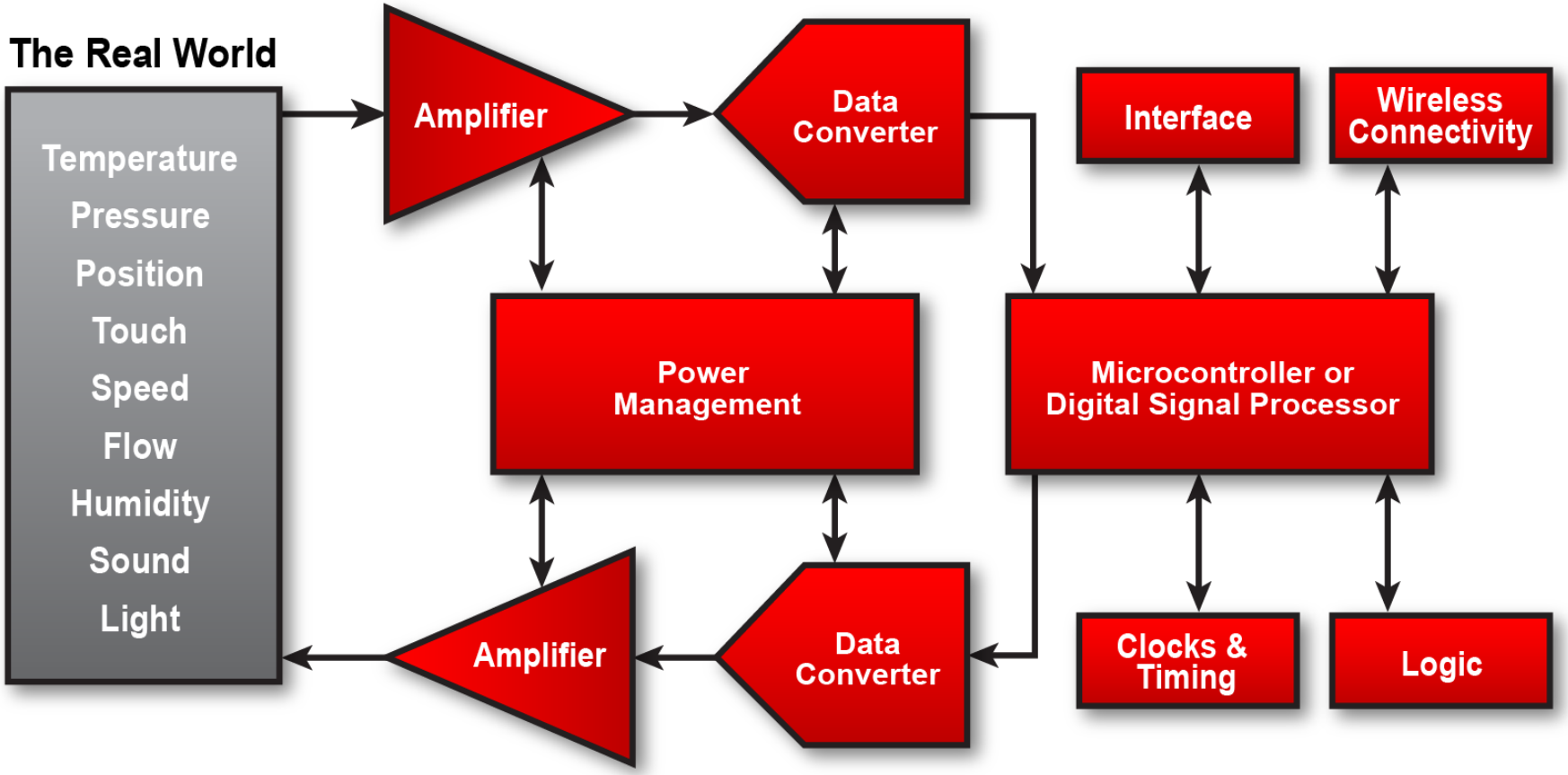
Vice President,
Analog Technology Development

March 20, 2012

Inside the box

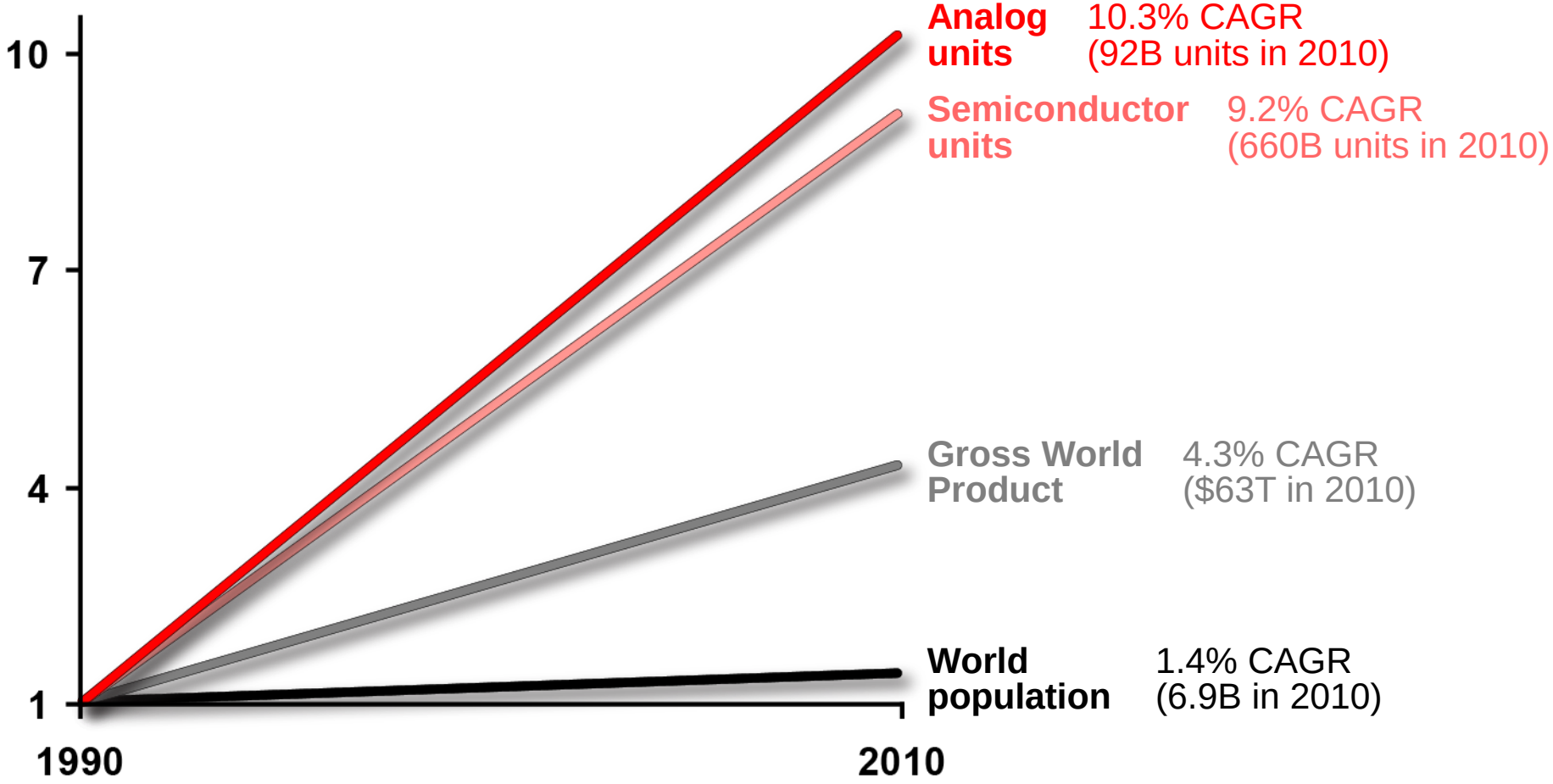


What can you do with these?

Nothing. Without analog!

Growing need for analog

More people entering the global economy and more electronics per person

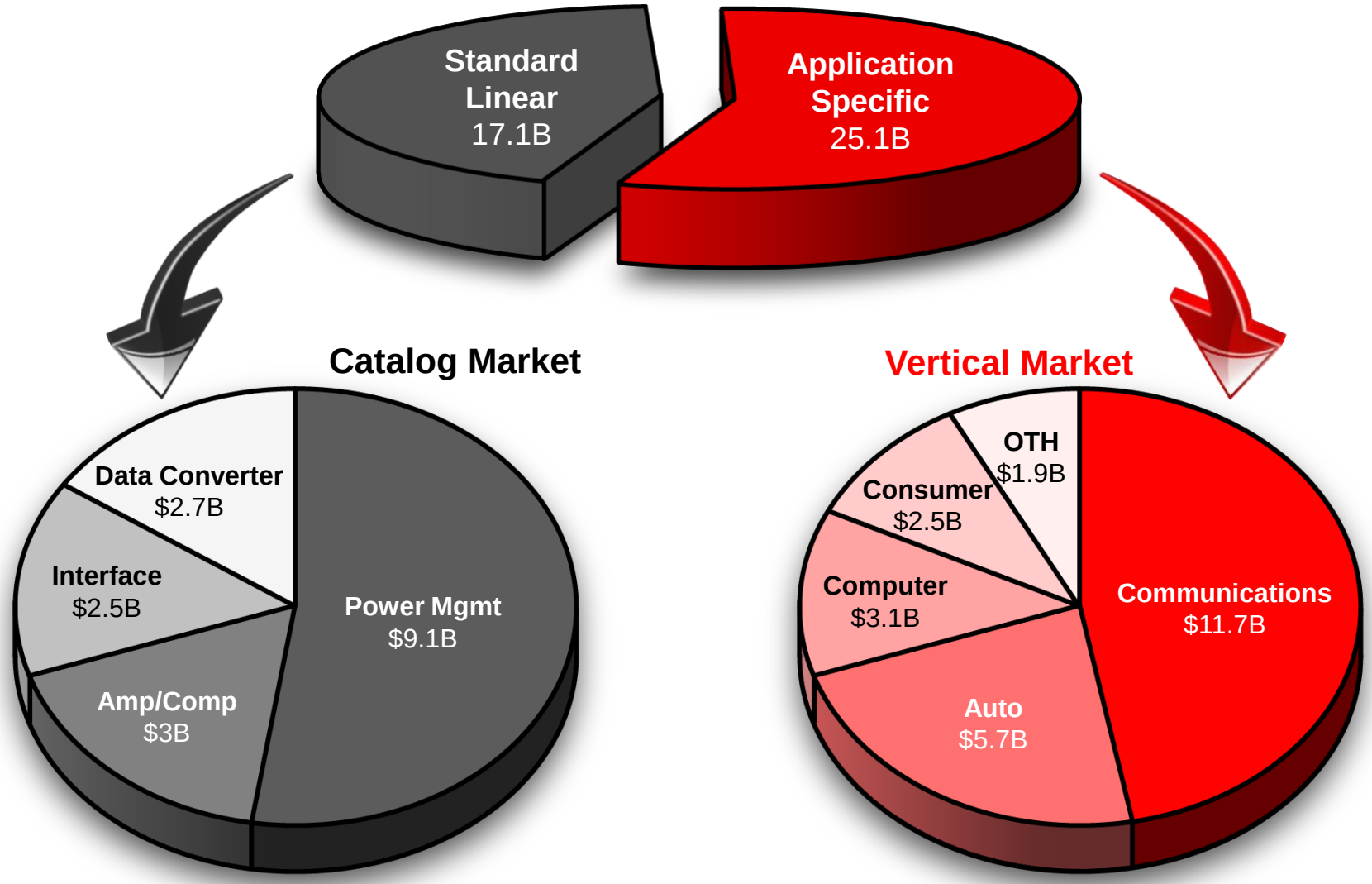


Sources: WSTS, International Monetary Fund, U.S. Census Bureau

New applications and new markets

Analog market

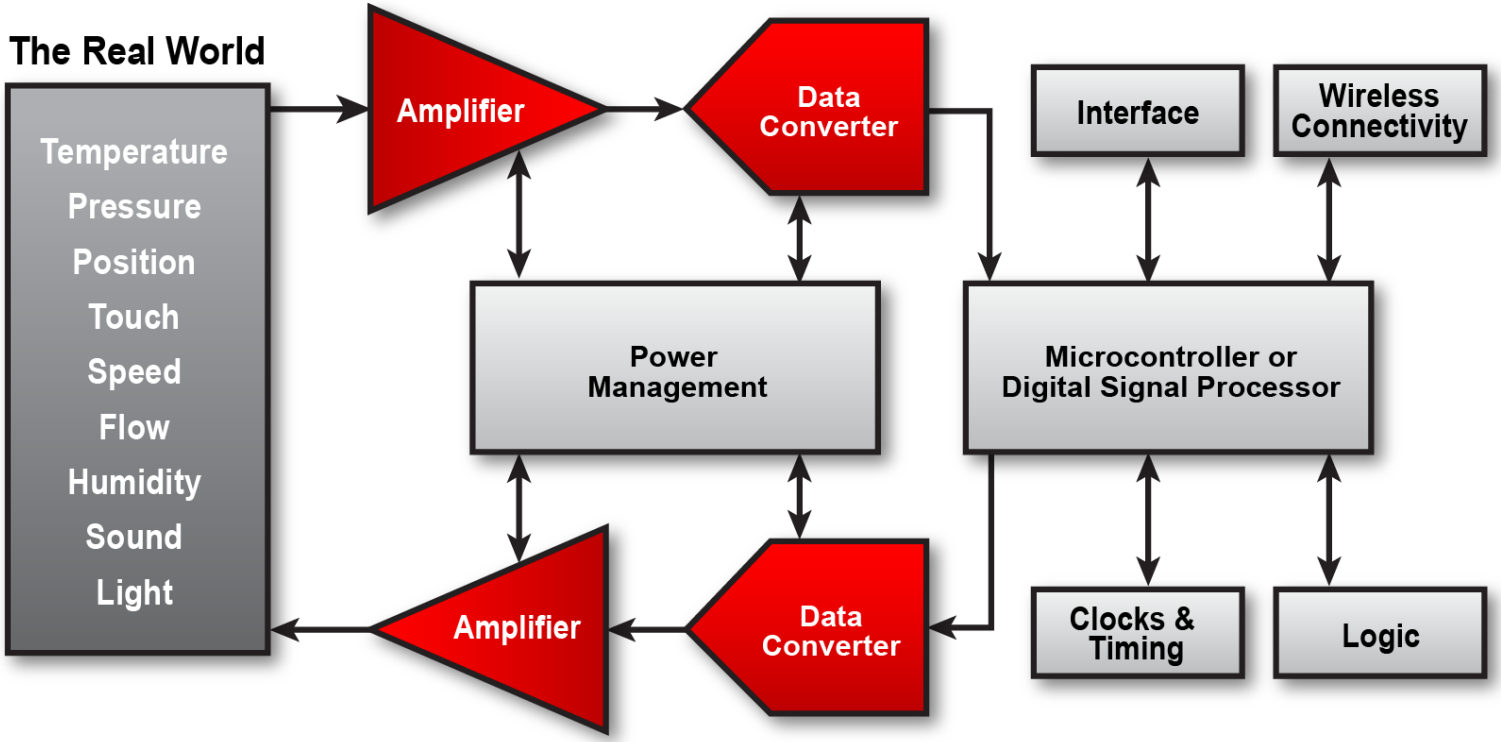
WSTS Total Analog TAM 2011 $42.3B



Source: WSTS, December 2011

Texas Instruments

Signal conditioning & data converter needs

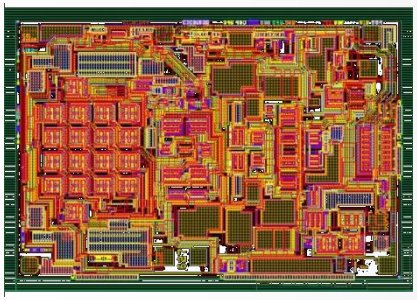


Customers Want

- Transistors
  - Low-Noise
  - Speed
  - Linearity
  - High-Accuracy
  - Noise
  - High-Speed
- Resistors
  - Temperature coefficient
  - Linearity
  - Matching
  - Widely Varying Voltage Ranges
- Capacitors
  - Low Power
  - Linearity
  - Matching
- Technology
  - Small Form Factors
  - HS BiCMOS
  - HV Bipolar
  - Prec. CMOS
  - Price Competitiveness
  - High Density Analog CMOS

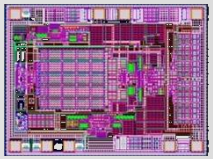
High speed bipolar technologies deliver smaller amplifiers

3.05mm x 2.10mm (6.4mm^2)



OPA627 ➔ SOIC-8

1.77mm x 1.38mm (2.4mm^2)



OPA827 ➔ MSOP-8

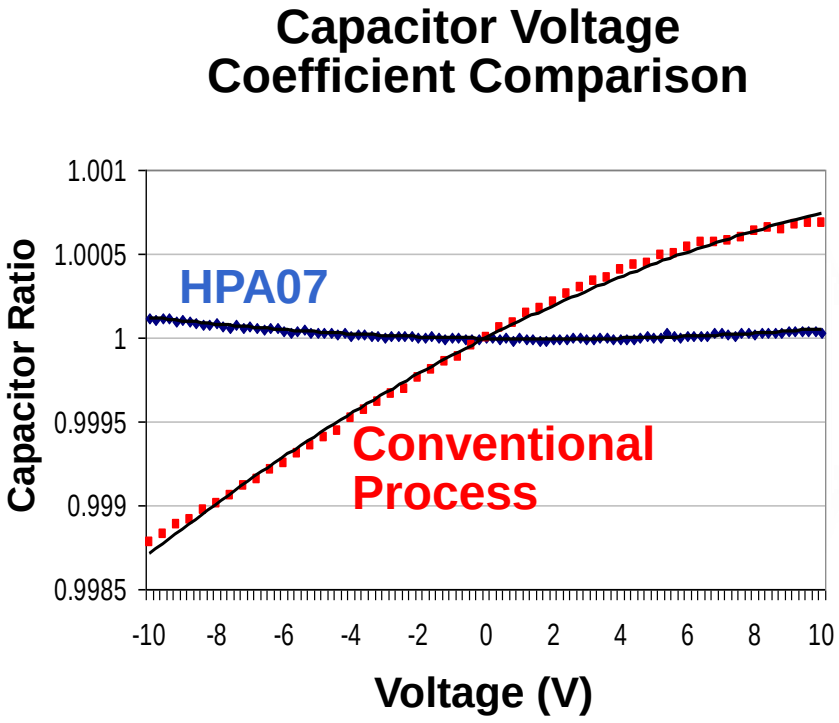
SOIC

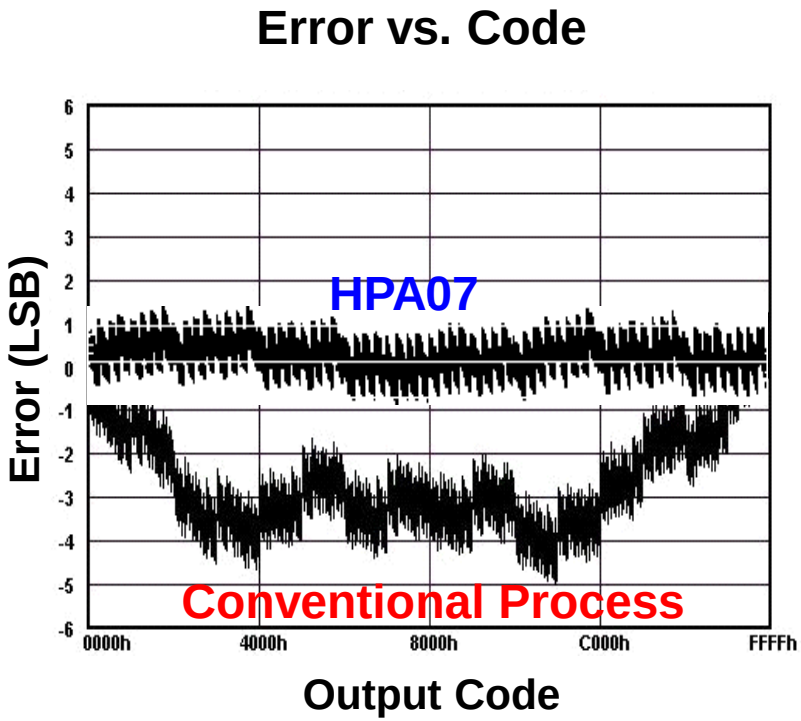
MSOP

SOT23

SC70

High precision capacitors
deliver better A/D converters

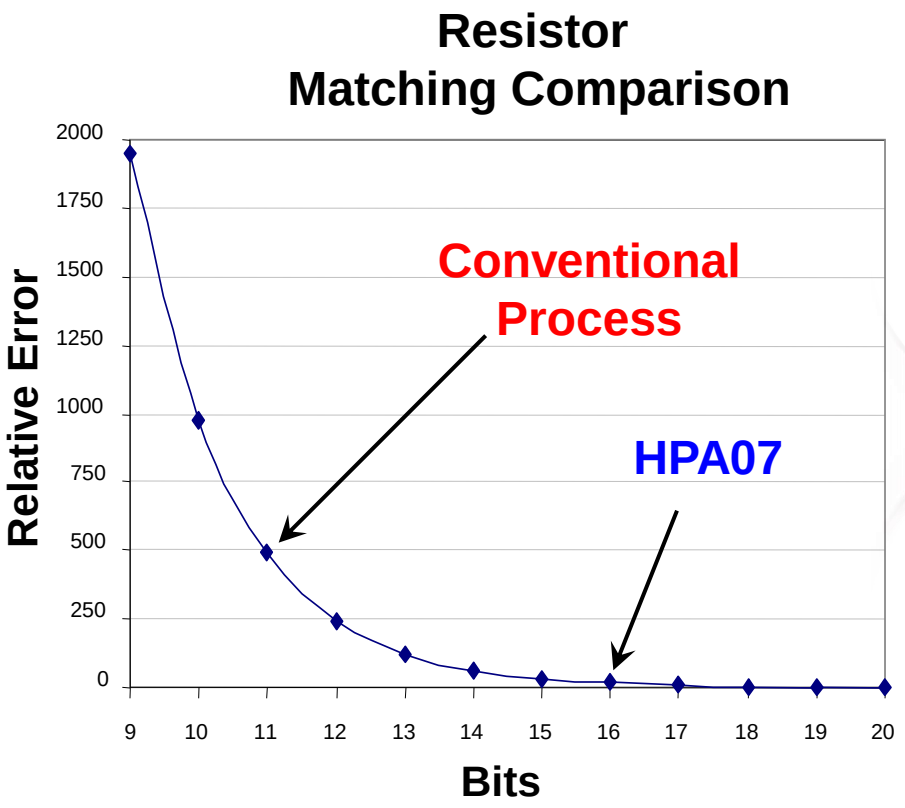


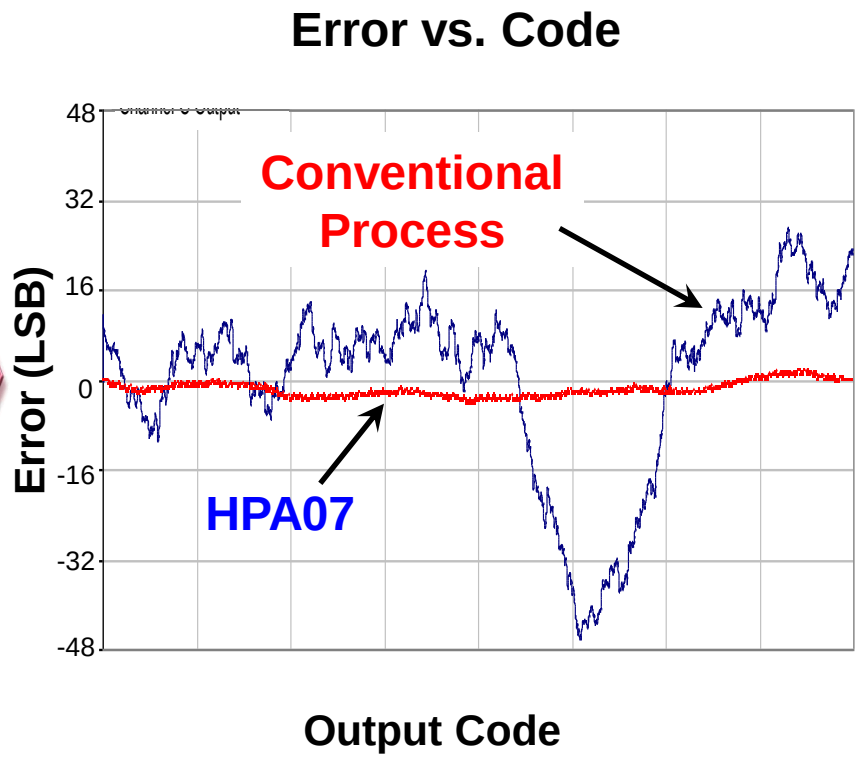


The Most Important Component in Precision A/D Converters

Texas Instruments

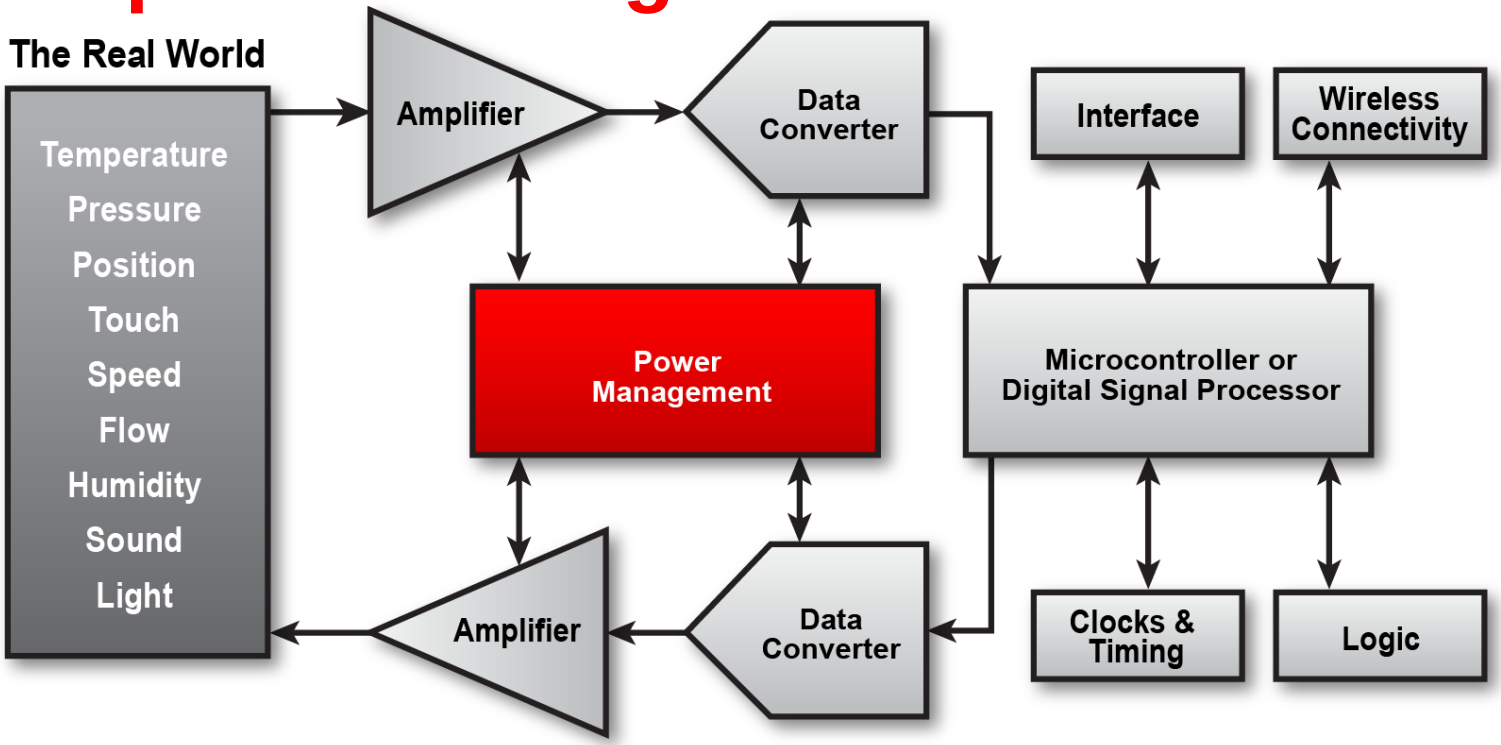
High precision resistors
deliver better D/A converters





The Most Important Component in Precision D/A Converters

Everything that uses electricity needs power management



Power Management Challenges

- Power FETs
  - LDMOS
  - Trench
  - Current
  - Drive
  - Power Metal
  - Package
- Analog mix
  - ADC
  - DE-CMOS
  - Bipolar
  - ESD
  - Passives
- Technology
  - LBCSOI
  - LBC4
  - LBC5
  - LBC7
  - Thick Cu

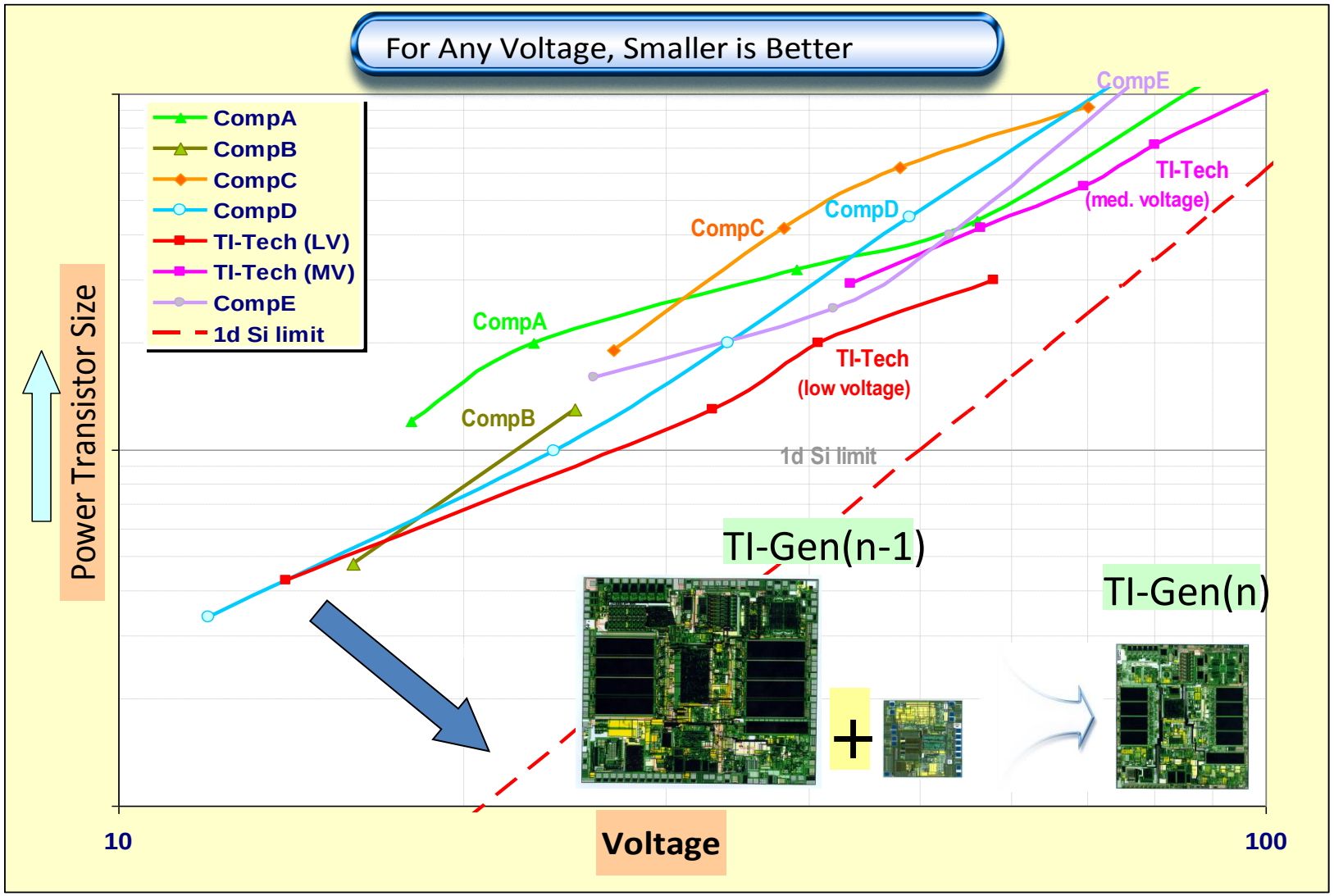
Efficiency, Control, Voltage Scaling, Form factors, Sequencing/Multiphase

Peripherals

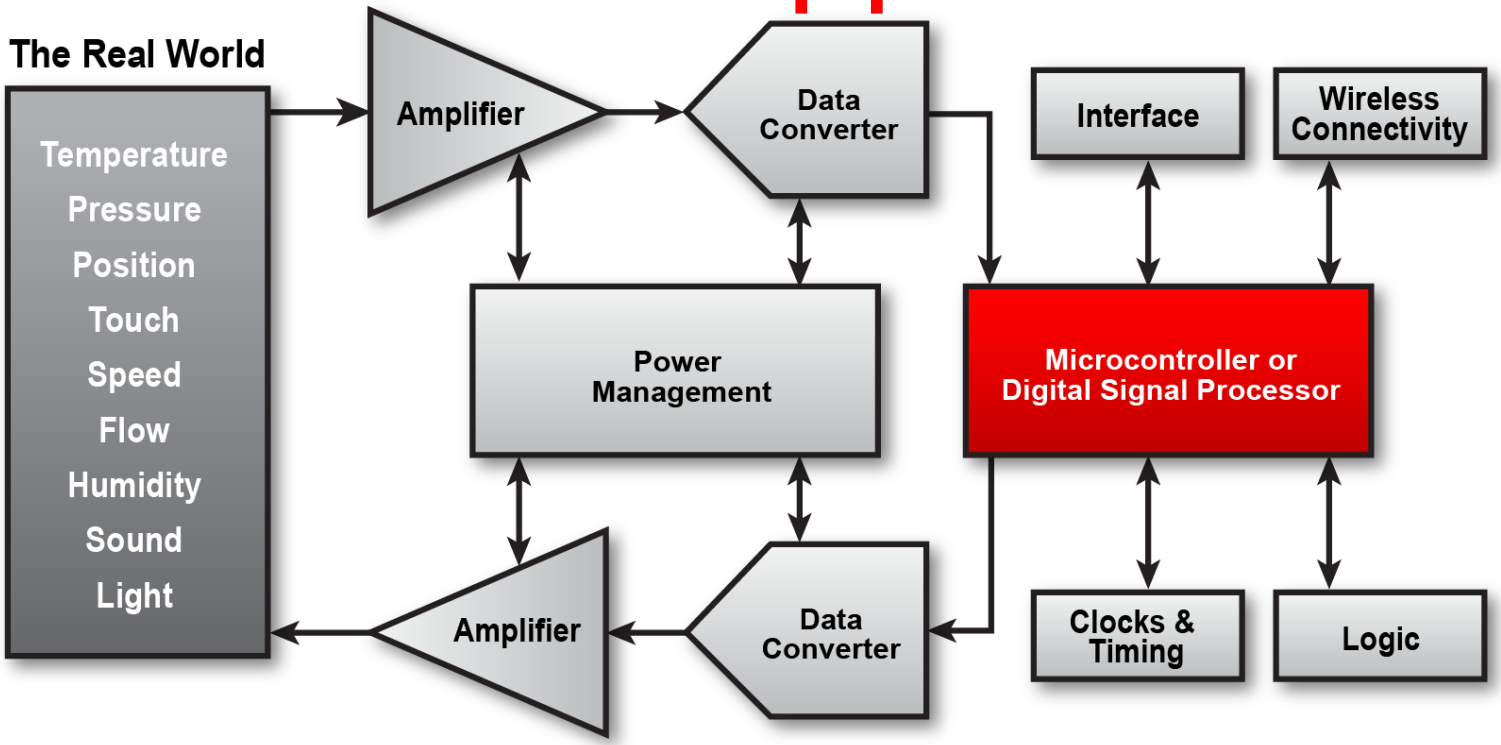
Batteries, Motors, Audio, Lighting

Automobiles etc.

High voltage, low Rdson devices deliver efficient power management



High density analog CMOS microcontrollers that sip power



MCU Customers Want

- Ultra-low leakage process
  - Active pwr
  - Standby pwr
  - Near sub-Vt operation
  - Passives
  - Low cost
- Embedded non-volatile memory
  - Fast write
  - Low power
  - High endurance
  - Low cost
- Technology
  - ULL CMOS+NVM
  - FRAM

MIPS

Low Power

Pwr source flexibility

Fast wake-up

Security

Voltage Scaling

Form factor

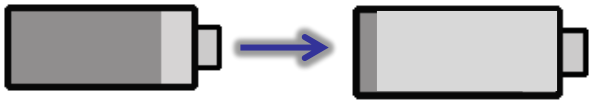
Low price

Ultra-low power MCU innovations

FRAM – Lowest power NVM

- 100X faster writes vs Flash
- 300X lower write energy
- 100uA/MHz Active Power

250x less energy per bit

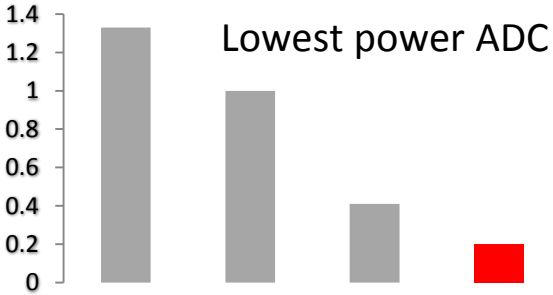


Advanced power management

- Power gating

Analog IP

- ADC12 at 75uA with 200 ksps
- 32kHz oscillator at 50nA

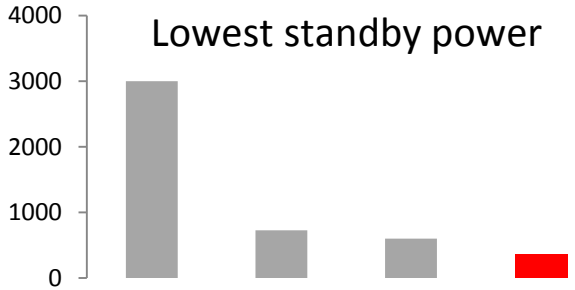


130nm ULL Process
0.9v,1.8v, 3.3v, 5v

Half the power of competing MCUs

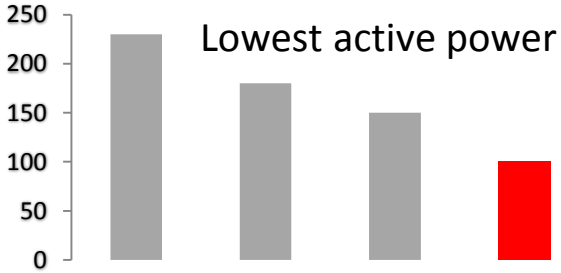
Digital standard cell library

- 360nA Standby w/ RTC
- 7 low-power modes
- Fine-grained standard cells



ULP SRAM

- 21X reduction in active leakage
- Advance power management
  - 50X lower leakage in deep sleep
  - 50nA LPM4 Retention Mode



Analog process technology platforms

High-Speed BiCMOS

- SOI & Bulk
- SiGe NPN and PNP
- Precision thin film resistors and capacitors
- Low parasitic capacitance

High-Precision Analog CMOS

- Low power, low parasitic CMOS
- Low 1/f noise
- Precision thin film resistors and capacitors
- Non-volatile memories

High-Voltage BiCMOS

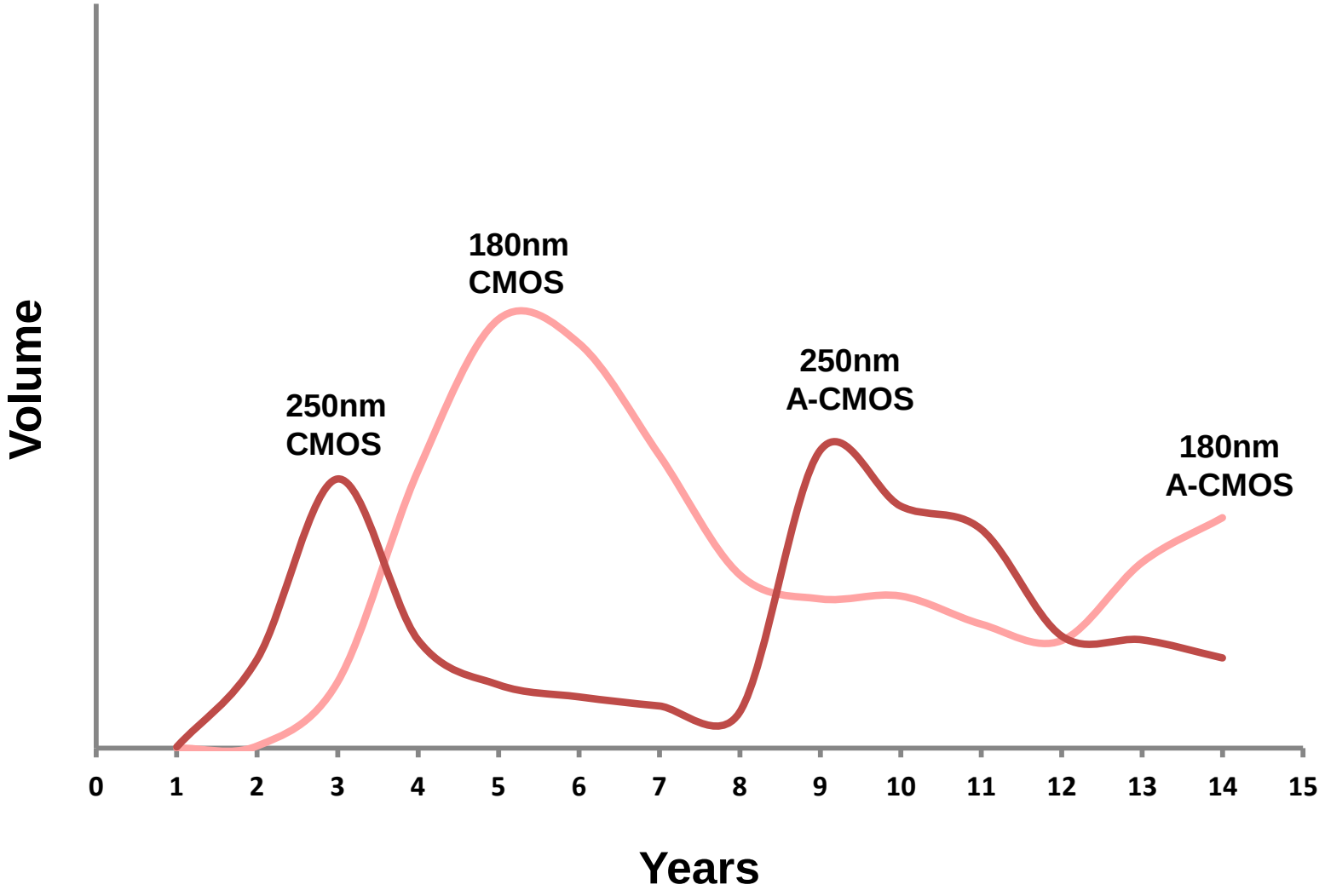
- Power LDMOS devices
- Broad and multi-voltage capability
- Thick metal technology
- SRAM and non-volatile memories

High-Density Analog CMOS

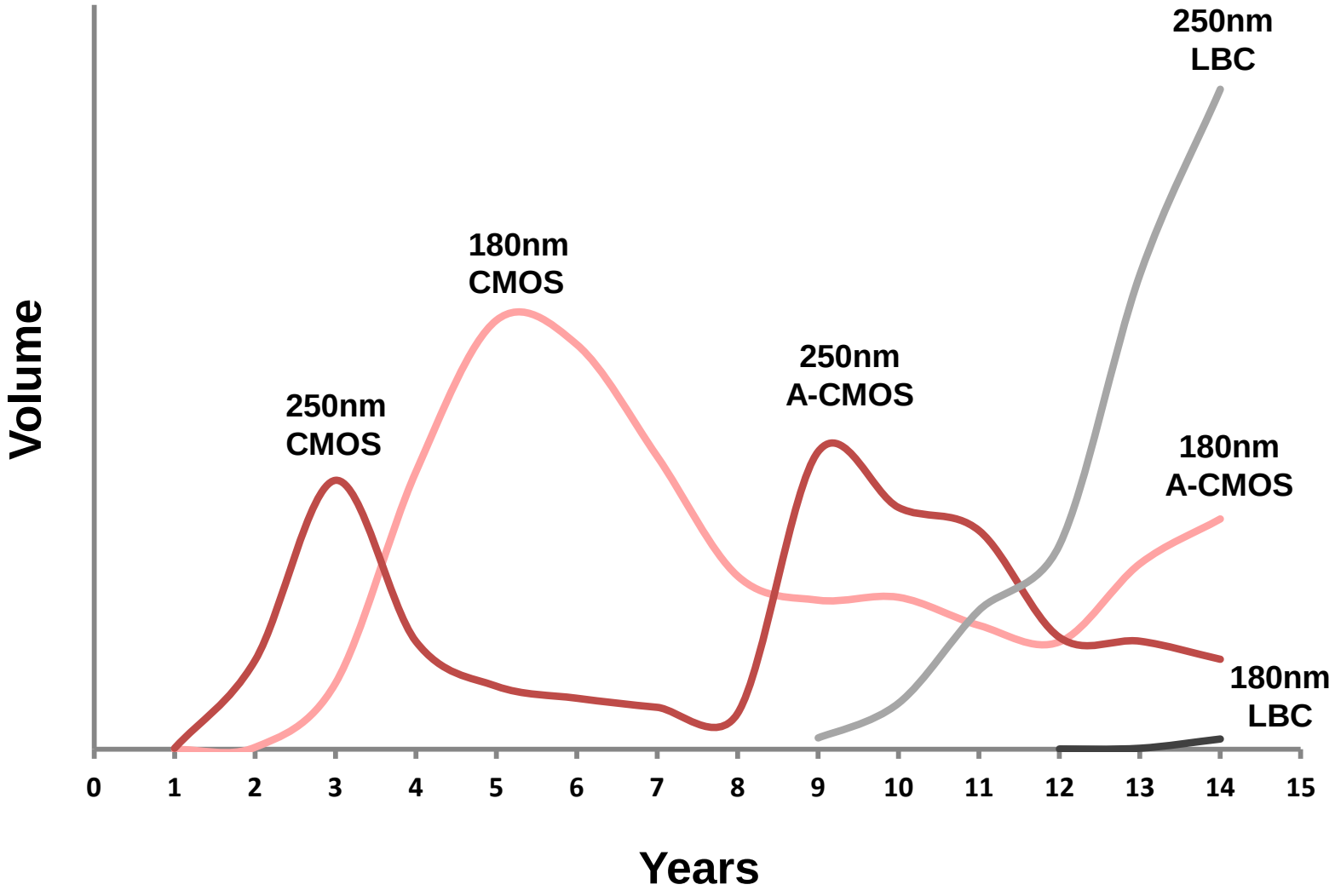
- Dense, low power CMOS
- Analog friendly CMOS
- Multi-Vt CMOS
- FRAM, SRAM & other low power memories

- Finely tuned analog process technology portfolio
- Significant differentiation through process and components
- Long process and product life-times. Continuous improvement is key
- Years of accumulated process/component IP
- Multiple factories useful for parallel development
- Use mostly depreciated equipment

Analog vs digital



Analog vs digital

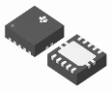


Product diversity drives package diversity

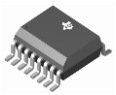
Small Outline Transistor Package (SOT23)

Transistor Outline (TO236)

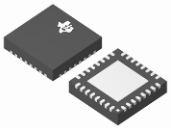
Mini Small Outline Package (MSOP)



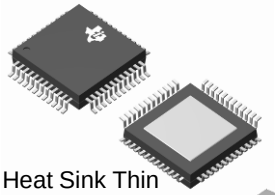
Small Outline No Leads (SON)



Shrink Small Outline Package (SSOP)

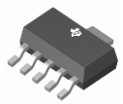


Quad Flatpack No Leads (QFN)

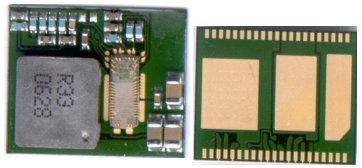


Heat Sink Thin Quad Flatpack (HTQFP)

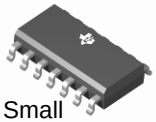
Thin Quad Flatpack



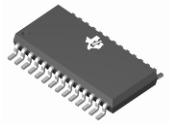
Small Outline Transistor (SOT223)



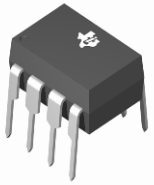
Power Modules



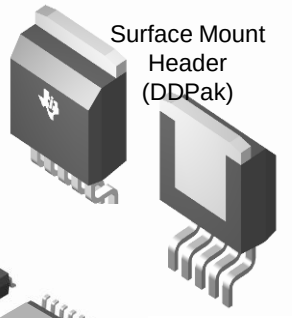
Small Outline Integrated Circuit (SOIC)



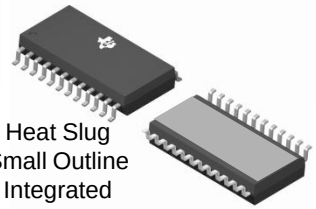
Thin Shrink Small Outline Package (TSSOP)



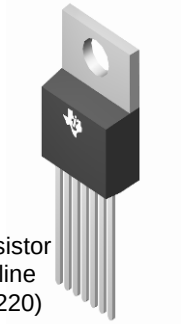
Plastic Dual-In-Line Package (PDIP)



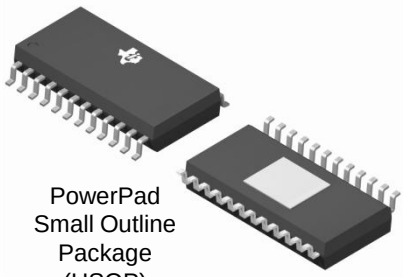
Surface Mount Header (DDPak)



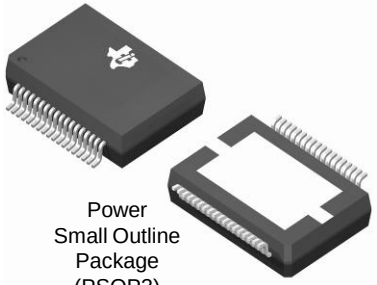
Heat Slug Small Outline Integrated Circuit



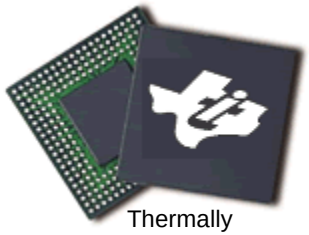
Transistor Outline (TO220)



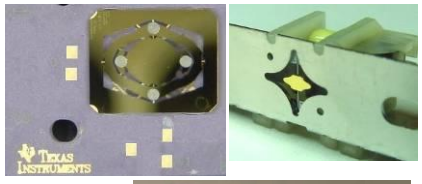
PowerPad Small Outline Package (HSOP)



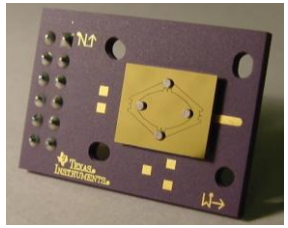
Power Small Outline Package (PSOP3)



Thermally Enhanced BGAs



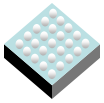
Analog Mirror Packages



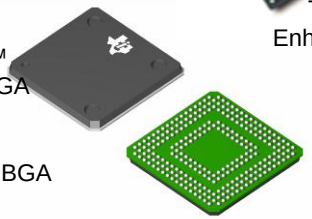
Wafer Scale Package (WSP)

MicroStar JR ™ Chip Scale Pkg (u*JR BGA)

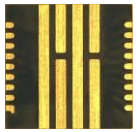
MicroStar Ultra Thin™ Land Grid Array Chip Scale Package (u*UT LGA)



MicroStar BGA ™ Chip Scale Tape BGA (u*BGA)



Laminate Chip Scale BGA (nFBGA)



Flip-Chip Power Packages

Thin is in

SOIC
1.75 mm

TSSOP
1.2 mm

QFN
1 mm

MicroStar
1 mm

WCSP (NanoStar)
0.6/0.5 mm

Thin QFN
0.8 mm

TWCSP
0.4/0.3 mm

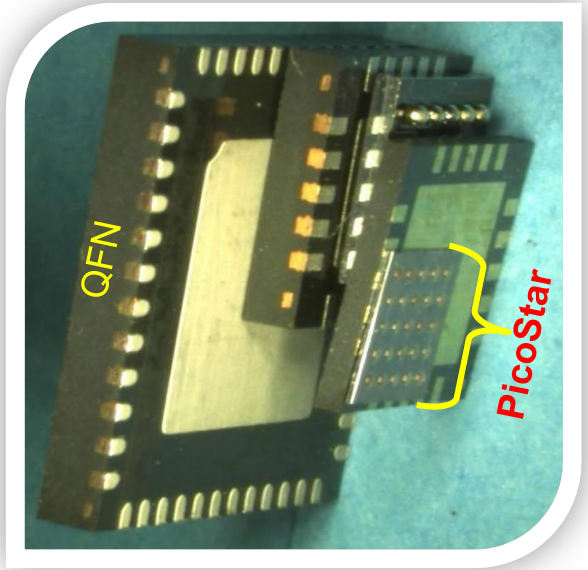
U*CSP
0.45mm

PicoStar
0.15/0.1 mm

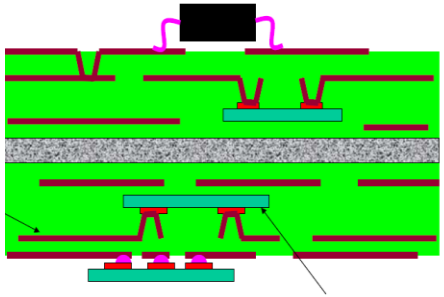
X-QFN
0.4 mm

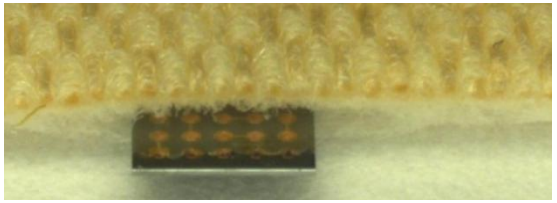
PicoStar-2G
0.075mm

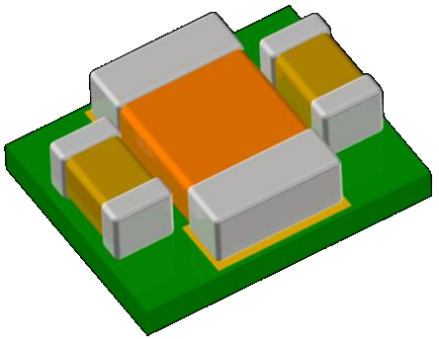
Invisible to naked eye
~0.04 mm

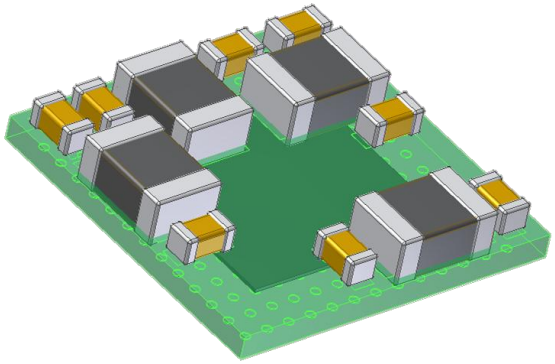


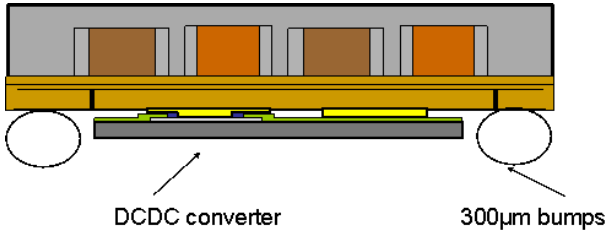
More chips in package

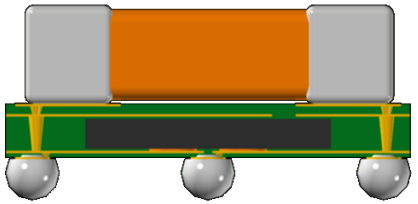


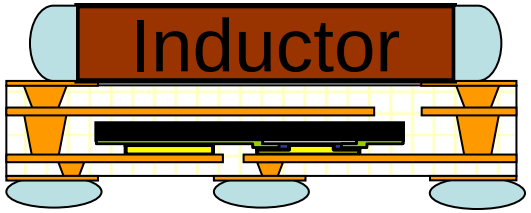


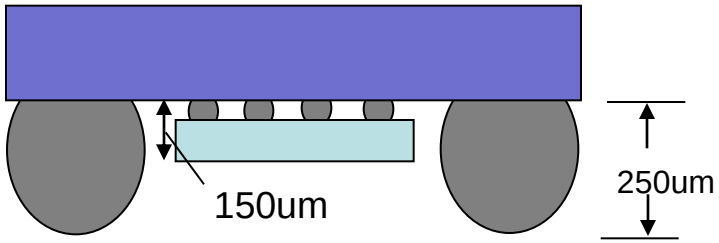


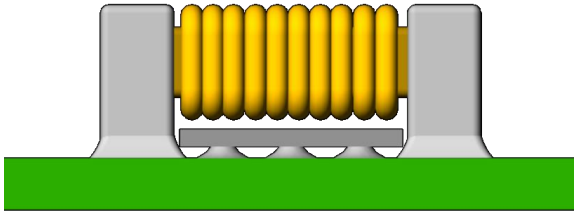












Challenges & opportunities

- Not limited by an industry roadmap. Significant opportunities to differentiate. Creative ideas welcome!
- Managing large diversity of process technologies in many factories
- Years of accumulated process/component/design IP. Maintaining & updating processes, SPICE models, PDKs and documentation is a challenge.
- Leveraging older equipment and factories drives challenges with process matching. Must “copy smart”
- Speed boats, not aircraft carriers

Thank You!