Applications Drive Analog Technology Development and Innovation

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Inside the box

The Real World

Temperature
Pressure
Position
Touch
Speed
Flow
Humidity
Sound
Light

Amplifier
Data Converter
Power Management
Microcontroller or Digital Signal Processor
Clocks & Timing
Logic
Interface
Wireless Connectivity
What can you do with these?

Nothing. Without analog!
Growing need for analog

More people entering the global economy and more electronics per person

- Analog units: 10.3% CAGR (92B units in 2010)
- Semiconductor units: 9.2% CAGR (660B units in 2010)
- Gross World Product: 4.3% CAGR ($63T in 2010)
- World population: 1.4% CAGR (6.9B in 2010)

Sources: WSTS, International Monetary Fund, U.S. Census Bureau
New applications and new markets

New applications

New solutions to old applications

New markets
Analog market
WSTS Total Analog TAM 2011 $42.3B

Standard Linear 17.1B
Application Specific 25.1B

Catalog Market
- Power Mgmt $9.1B
- Interface $2.5B
- Data Converter $2.7B
- Amp/Comp $3B

Vertical Market
- Communications $11.7B
- Auto $5.7B
- Computer $3.1B
- Consumer $2.5B
- OTH $1.9B

Source: WSTS, December 2011
Signal conditioning & data converter needs

Customer Needs:
- Transistors
  - Low Noise
  - Speed
  - High Linearity
  - High Speed
- Resistors
  - Low Power
  - Temperature Coefficient
  - Linearity
  - Matching
- Capacitors
  - Widely Varying Voltage Ranges
  - Matching
- Technology
  - Small Form Factors
  - HS BICMOS
  - HV Bipolar
  - Prec. CMOS
  - High Density Analog CMOS

Technology

The Real World
- Amplifier
- Data Converter
- Power Management
- Microcontroller or Digital Signal Processor
- Interface
- Wireless Connectivity
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- Logic

Applications:
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High speed bipolar technologies deliver smaller amplifiers

OPA627 → SOIC-8

3.05mm x 2.10mm (6.4mm²)

OPA827 → MSOP-8

1.77mm x 1.38mm (2.4mm²)

SOIC

MSOP

SOT23

SC70
High precision capacitors deliver better A/D converters

Capacitor Voltage Coefficient Comparison

The Most Important Component in Precision A/D Converters
High precision resistors deliver better D/A converters

Resistor Matching Comparison

The Most Important Component in Precision D/A Converters
Everything that uses electricity needs power management:

- Efficiency
- Control
- Voltage Scaling
- Form factor
- Sequencing/Multiphase

Customers want:
- Batteries
- Motors
- Lighting
- Automobiles etc.

In Audio Peripherals, Power IC Care about:

- Power Fets
  - LDMOS
  - Voltage
  - Current
  - Temperature
  - Resistance
  - Power Metal
  - Package

- Analog mixers
  - ACMOS
  - DE-CMOS
  - Audio
  - ESD
  - Passives

- Technology
  - LBCSOI
  - LBC4
  - LBC5
  - LBC7
  - Thick Cu
  - Automobiles etc.
High voltage, low Rdson devices deliver efficient power management.
High density analog CMOS microcontrollers that sip power

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Logic

MIPS
Low Power
Pwr source flexibility
Fast wake-up

ULL CMOS+NVM
FRAM

Technology

Voltage Scaling
Form factor
Low price

Security

Technology

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

MCU Features About

• 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

• 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

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

Advanced power management
- Power gating

Analog IP
- ADC12 at 75uA with 200 kbps
- 32kHz oscillator at 50nA

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

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

Lowest standby power

Lowest active power

Half the power of competing MCUs

250x less energy per bit

210nm ULL Process
0.9v, 1.8v, 3.3v, 5v

Lowest power ADC
Analog process technology platforms

- 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

Volume

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Analog vs digital

Years

Volume

250nm CMOS
180nm CMOS
250nm A-CMOS
180nm A-CMOS
250nm LBC
180nm LBC
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
- Surface Mount Header (DDPak)
- Power Modules
- Small Outline Transistor (SOT223)
- PowerPad Small Outline Package (HSOP)
- Small Outline Integrated Circuit (SOIC)
- Thin Shrink Small Outline Package (TSSOP)
- Plastic Dual-In-Line Package (PDIP)
- Heat Slug Small Outline Integrated Circuit
- Transistor Outline (TO220)
- PowerPad Small Outline Package (HSOP)
- Power Small Outline Package (PSOP3)
- Thermally Enhanced BGAs
- Power Modules
- 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)
- Analog Mirror Packages
- Flip-Chip Power Packages

Texas INSTRUMENTS
Thin is in

- SOIC 1.75 mm
- TSSOP 1.2 mm
- MicroStar 1 mm
- Thin QFN 0.8 mm
- WCSP (NanoStar) 0.6/0.5 mm
- X-QFN 0.4 mm
- U*CSP 0.45 mm
- TW CSP 0.4/0.3 mm
- PicoStar 0.15/0.1 mm
- MicroStar 1 mm
- PicoStar 0.075 mm

Invisible to naked eye ~0.04 mm
More chips in package

- 250um
- 150um
- Inductor
- DCDC converter
- 300um bumps
- 150um
- 250um
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!