

Is the Golden Age of Analog circuit Design Over?

My answer:

Yes, the golden age of **pure analog circuit design is **over**.**

But, the golden age of **mixed signal technology is **coming**.**

**Some important works might be done in pure analog circuit design.
performance increases in basic analog circuits.**

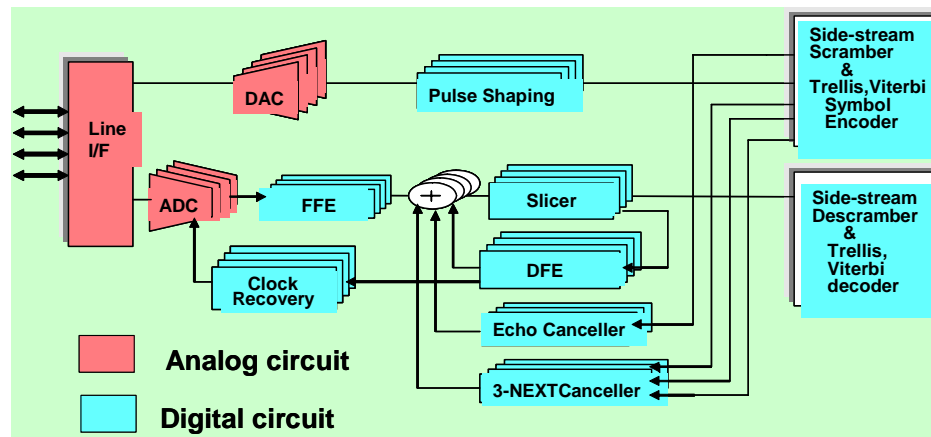
**However, many important progresses will be accomplished by the
mixed signal technology.**

Current role of analog technology

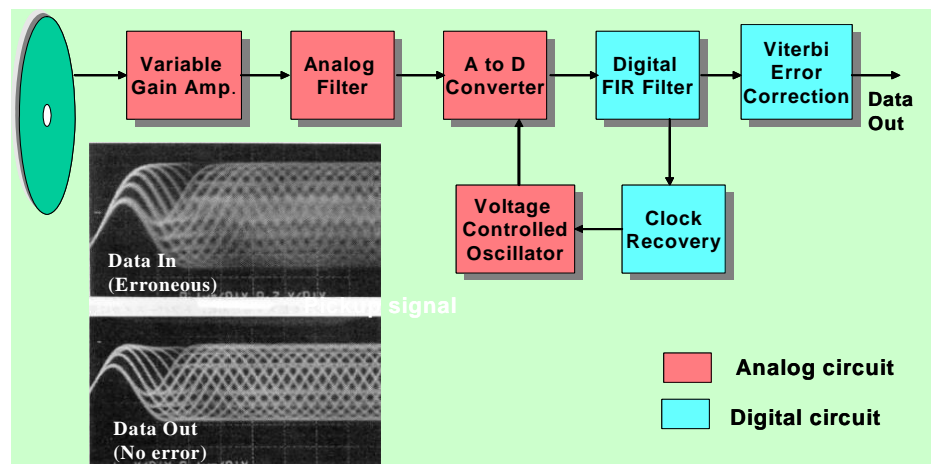
The current major role of analog is to sustain digital technologies.

Digital communications, networkings, broadcastings, recordings, displays,.... .

Gb Ethernet



DVD recording



All systems will be integrated on mixed signal SoCs

“Global system design and optimization over digital and analog”

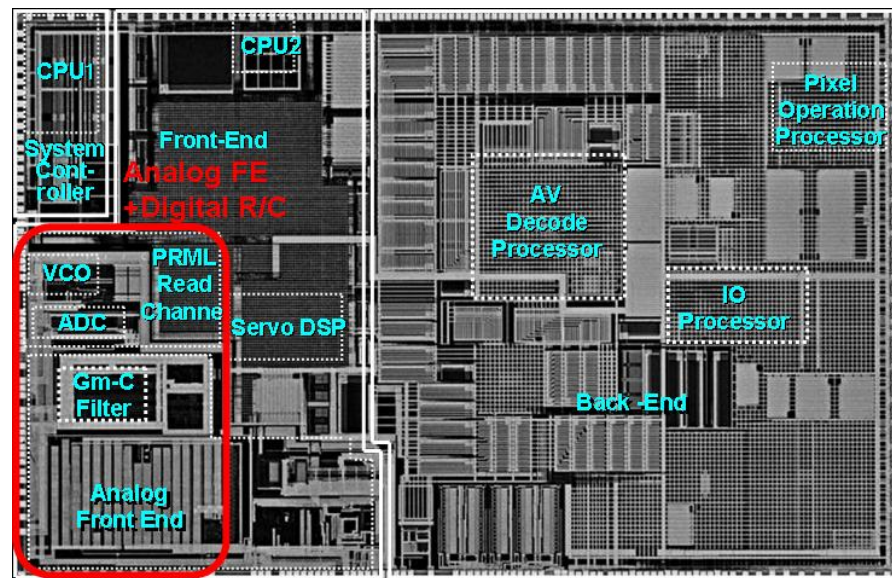
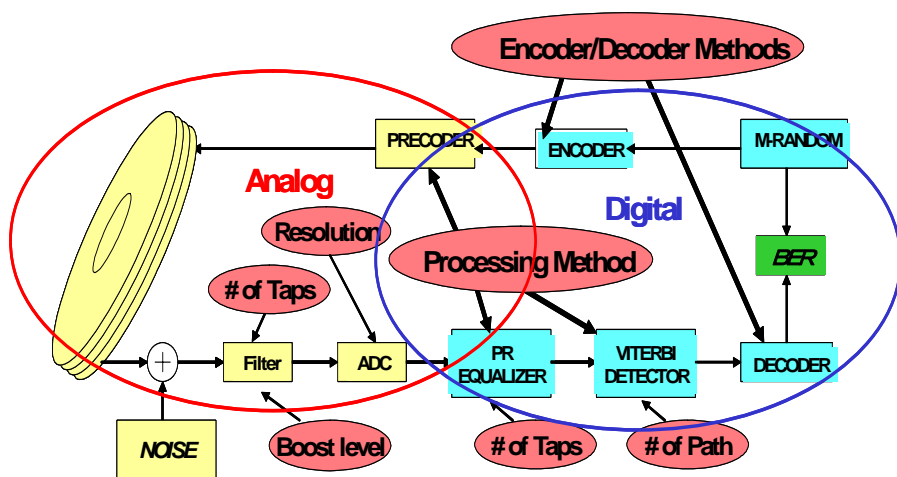
must be the most important works for the designer.
The performance of SoC depends on it, greatly.

Corroborations: Digital and analog System and circuit

Mixed signal SoC can integrate full DVD system

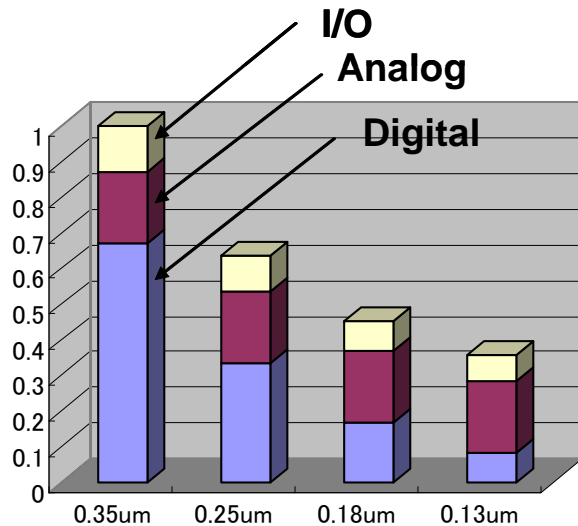
K. Okamoto, et. al., ISSCC 2003.

Global optimization: digital and analog



Analog issue in mixed signal SoC

If analog area can not be scaled along with digital, Chip cost will increase.



Analog should be scaled !
Otherwise, can't be integrated.

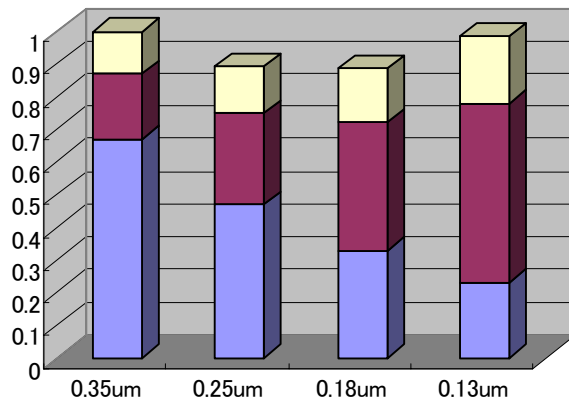
Only the essential analog will survive

Chip area

Digital calibration realized drastic power and area saving!

Wafer cost increases 1.3x
for one generation

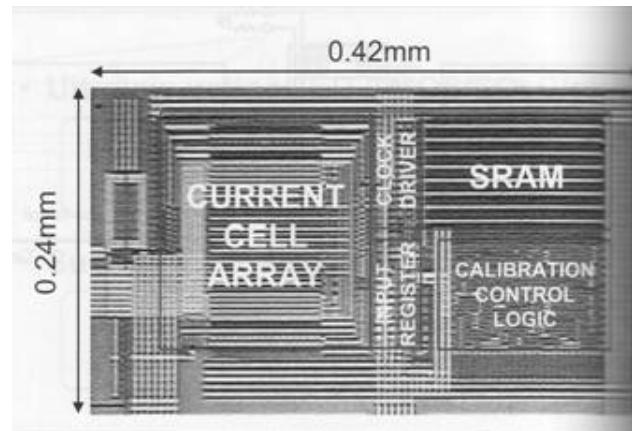
(0.35um : 1)



Chip cost

14b 100MS/s DAC

1.5V, 17mW, 0.1mm², 0.13um



Area: 1/50

Pd: 1/20

Y. Cong and R. L. Geiger,
ISSCC 2003

Digital give us the breakthrough of analog circuit

- Static accuracy: digital calibration
- Dynamic accuracy: timing adjustment
- High speed conv. : parallelism
- DLL
- timing adjustment

Noise limitation

$$V_n^2 = \frac{kT}{C}$$

Conventional

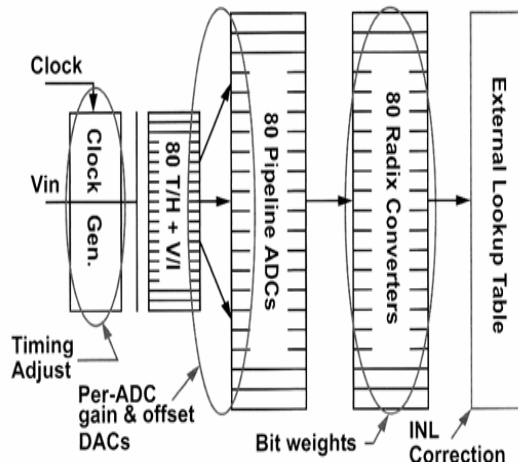
$$V_n^2 = \frac{kT}{C} \cdot \frac{1}{M}$$

Over sampling

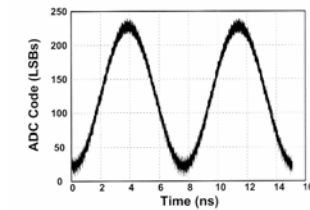
M: over sampling ratio

Enable low voltage operation

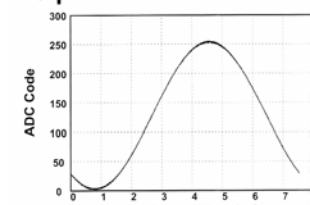
8bit, 20GHz, ADC



K. Paulton, et al., ISSCC 2003



Acquisition With Calibrati

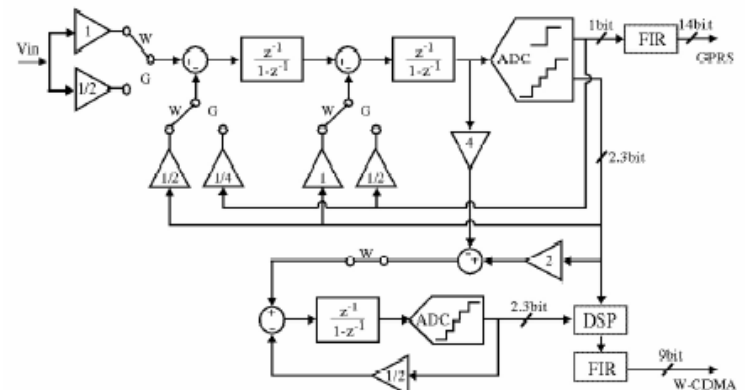


ISSCC 2004 panel A. Matsuzawa

1.2V Dual-mode WCDMA/GPRS ΣΔ Modulator

GPRS: 82dB, WCDMA: 70dB

0.13umCMOS, Pd=3mW



A. Dezzani and E. Andre, ISSCC 2003

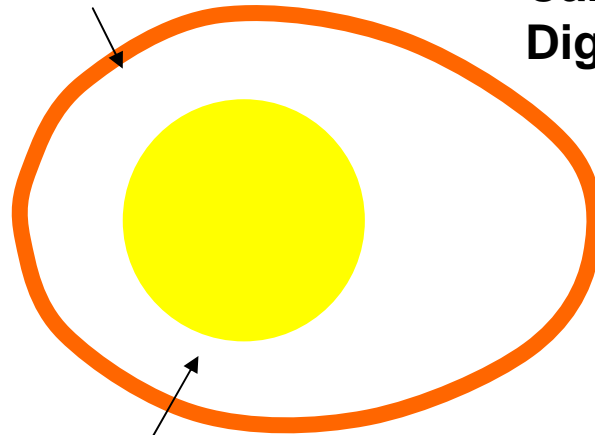
Mixed signal egg

Analog helps digital (digital network and storage...).
Next step is digital should help analog.

Mixed signal egg (Analog yolk and white with digital shell)

Digital shell

Sustain the analog egg.
Calibration and adjustment,
Digital filtering



Analog yolk and white

Delicious and nutritious

But, very delicate and fancy

Golden age designers for analog circuits will be over

New golden designers age are expected

They can work in;

Digital technology and analog technology

System, circuit, and device

Electromagnetism as well as conventional circuit theory



Progress in A/D converter; video-rate 10b ADC

ADC is a key for mixed signal technology.

We have reduced the cost and power of ADC drastically;

Power consumption: **1/2,000**

Price: **1/200,000**

1980

Conventional product

Board Level (Disc.+Bip)

20W

\$ 8,000

1982

World 1st Monolithic

Bipolar (3um)

2W

\$ 800

1993

World lowest power

CMOS (1.2um)

30mW

\$ 2.00

Now

SoC Core

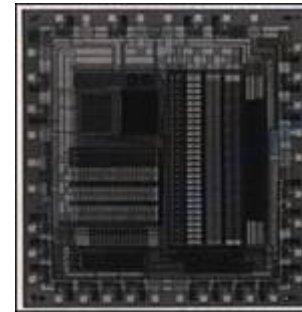
CMOS (0.15um)

10mW

\$0.04



Our developed.

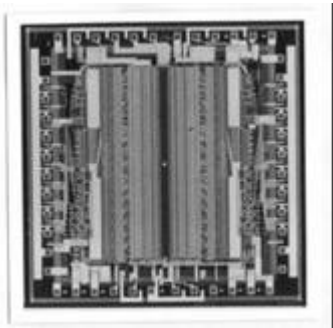


Our developed.



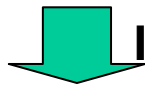
Progress in high-speed ADC

High speed ADC has reduced its power and area down to be embedded.

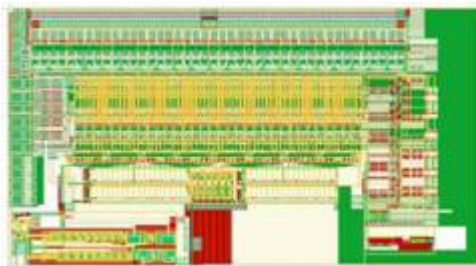


World fastest 6b ADC

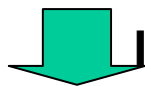
6b, 1GHz ADC ISSCC 1991
2W,
1.5um Bipolar



ISSCC 2000 World fastest CMOS ADC



6b, 800MHz ADC
400mW, 2mm²
0.25umCMOS



ISSCC 2002 World lowest Pd HS ADC



Technology : 0.18um CMOS(3AL,1PS)
Area : 0.88mm X 0.34mm

7b, 400MHz ADC
50mW, 0.3mm²
0.18umCMOS

