

*Lecture 22:*

# CMOS-MEMS (2)

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# Case study: ADXL05/50



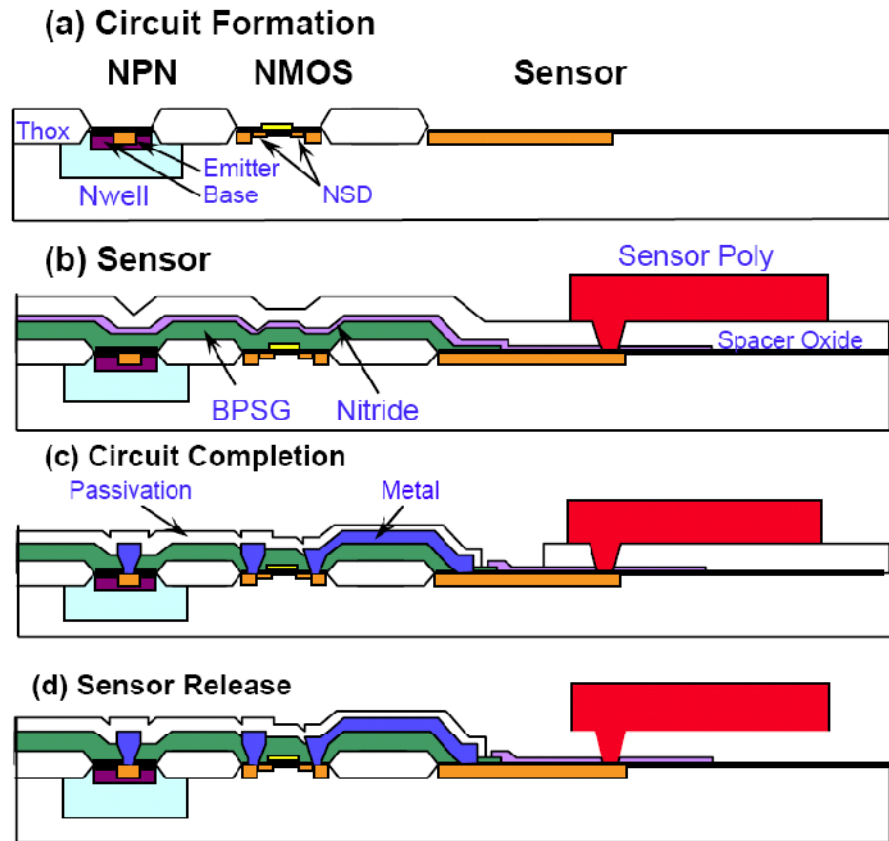
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# Intermediate-CMOS accelerometer

- iMEMS process by Analog Devices, Inc.
  - Intermediate-CMOS process



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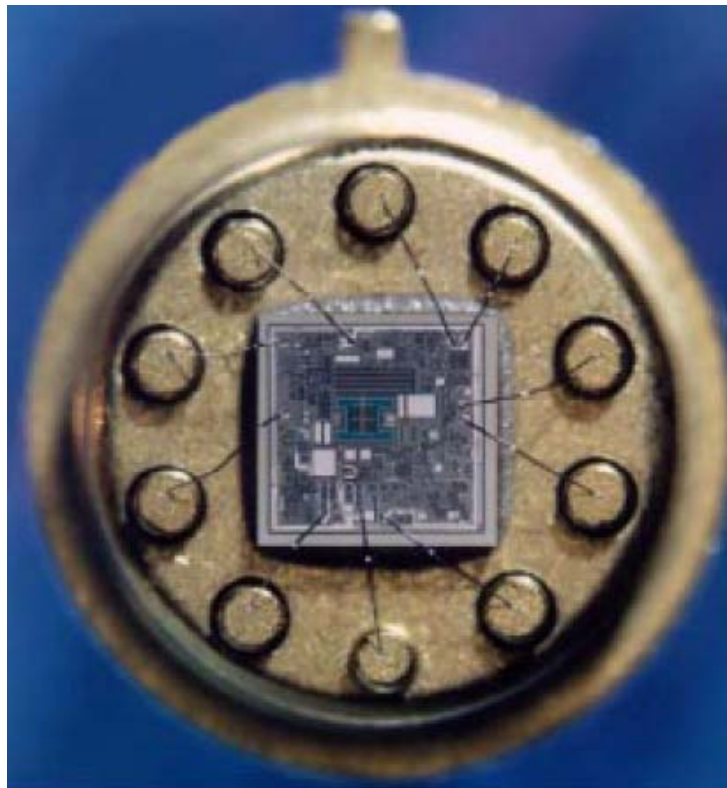
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# Intermediate-CMOS accelerometer (Cont'd)

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- ADXL05/50
  - First commercialized microaccelerometer



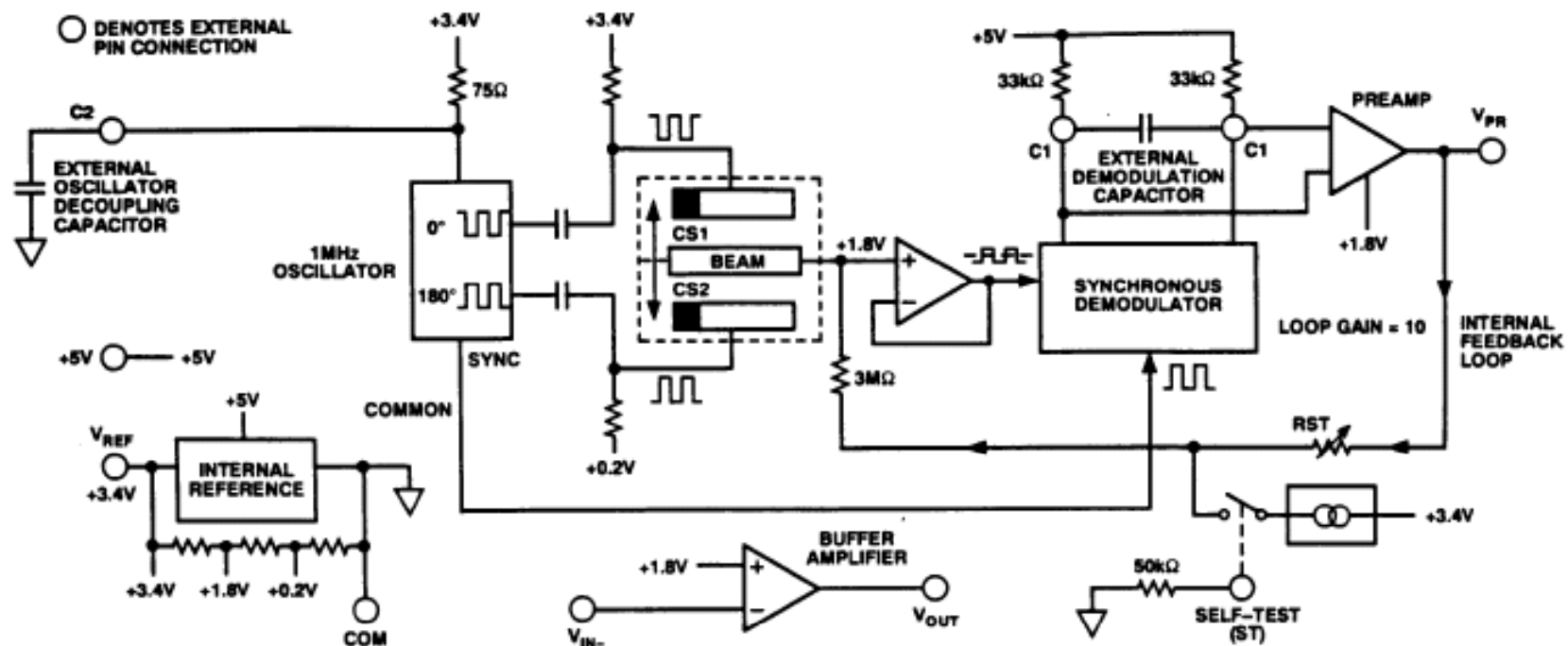
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# Intermediate-CMOS accelerometer (Cont'd)

- Functional block diagram



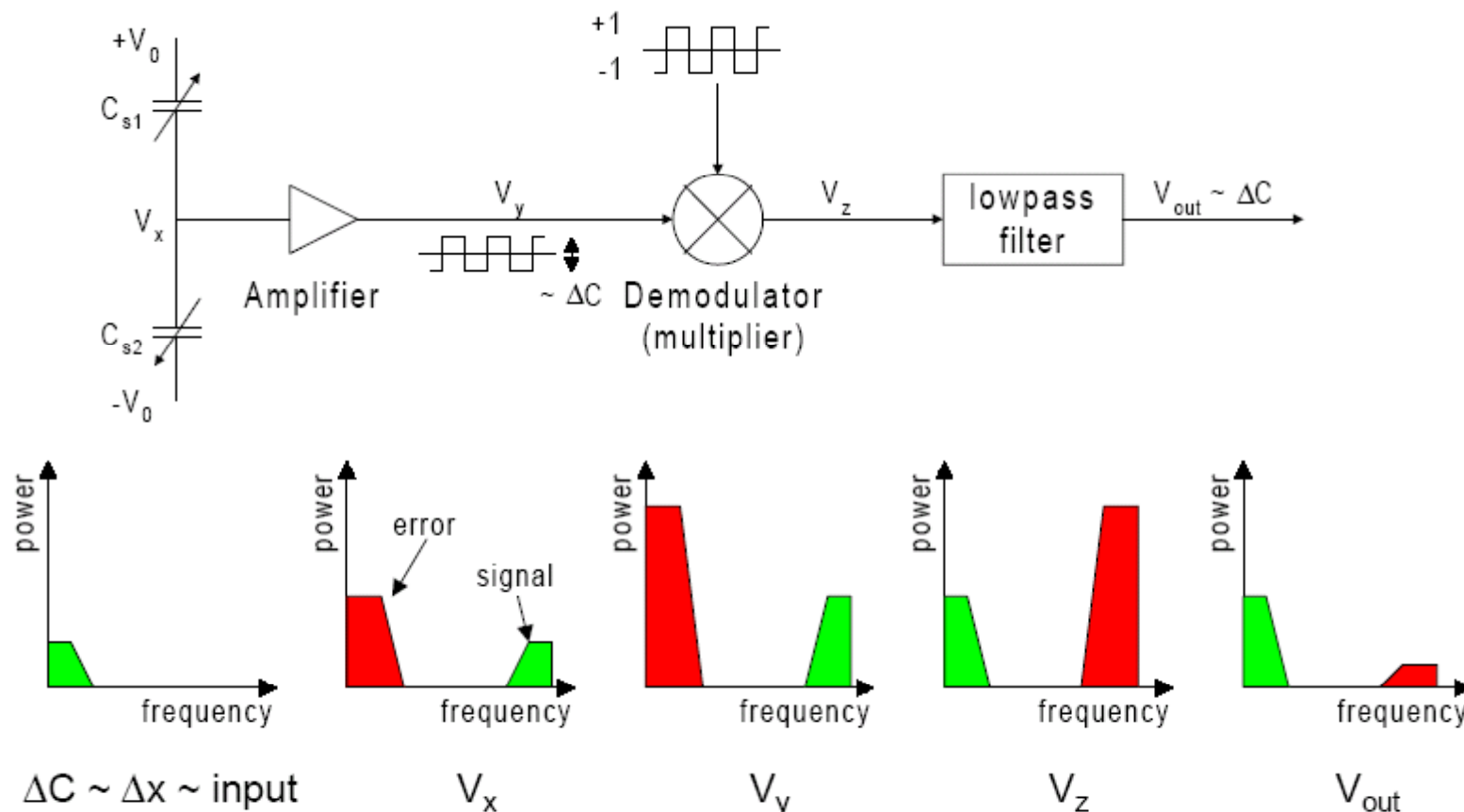
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# Intermediate-CMOS accelerometer (Cont'd)

- Noise & drift reduction



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# Case study: ADXRS150/300



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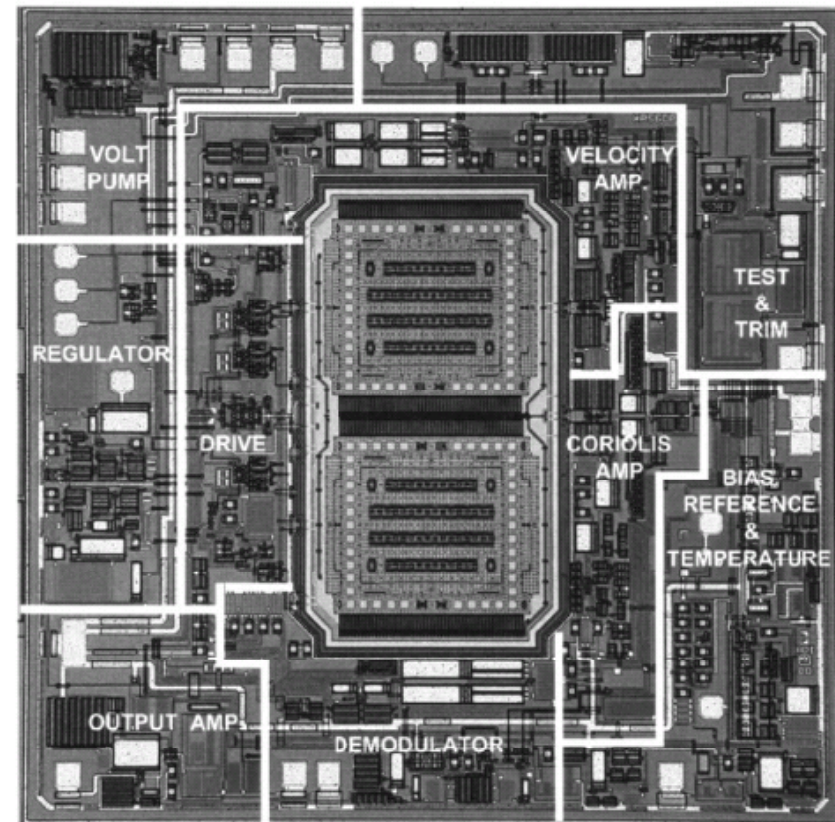
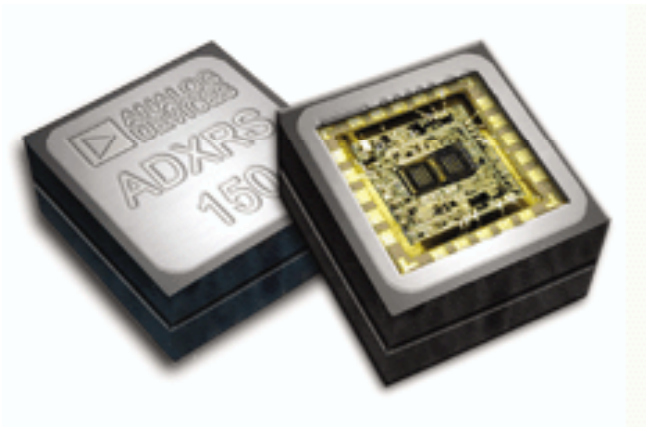
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# Intermediate-CMOS gyroscope

- ADXRS150/300
  - First monolithic-integrated microgyroscope by ADI



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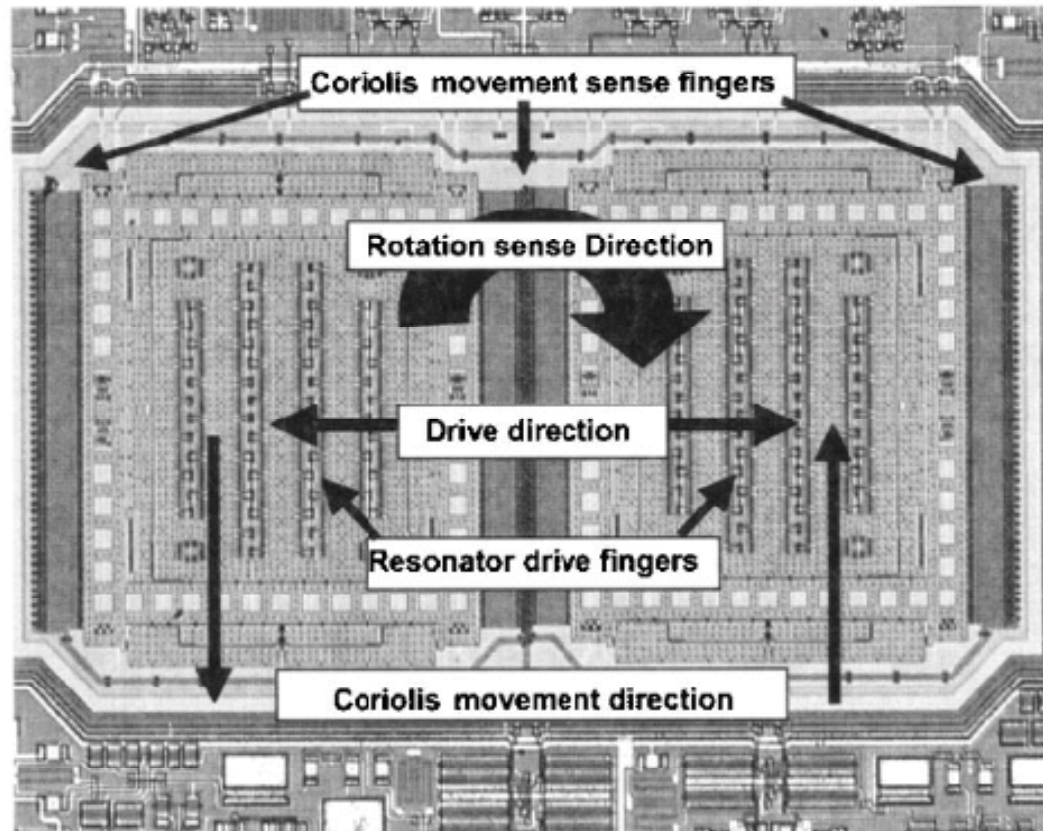
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# Intermediate-CMOS gyroscope (Cont'd)

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- Mechanical structure overview



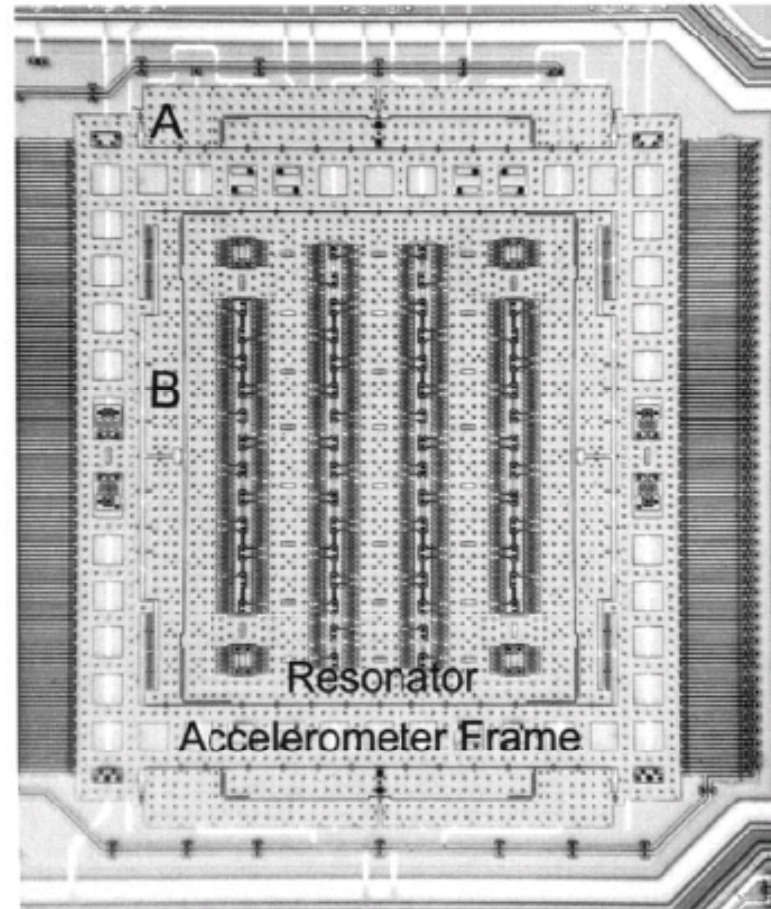
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# Intermediate-CMOS gyroscope (Cont'd)

- Mechanical structure (Half of tuning fork)
  - Quadrature control levers



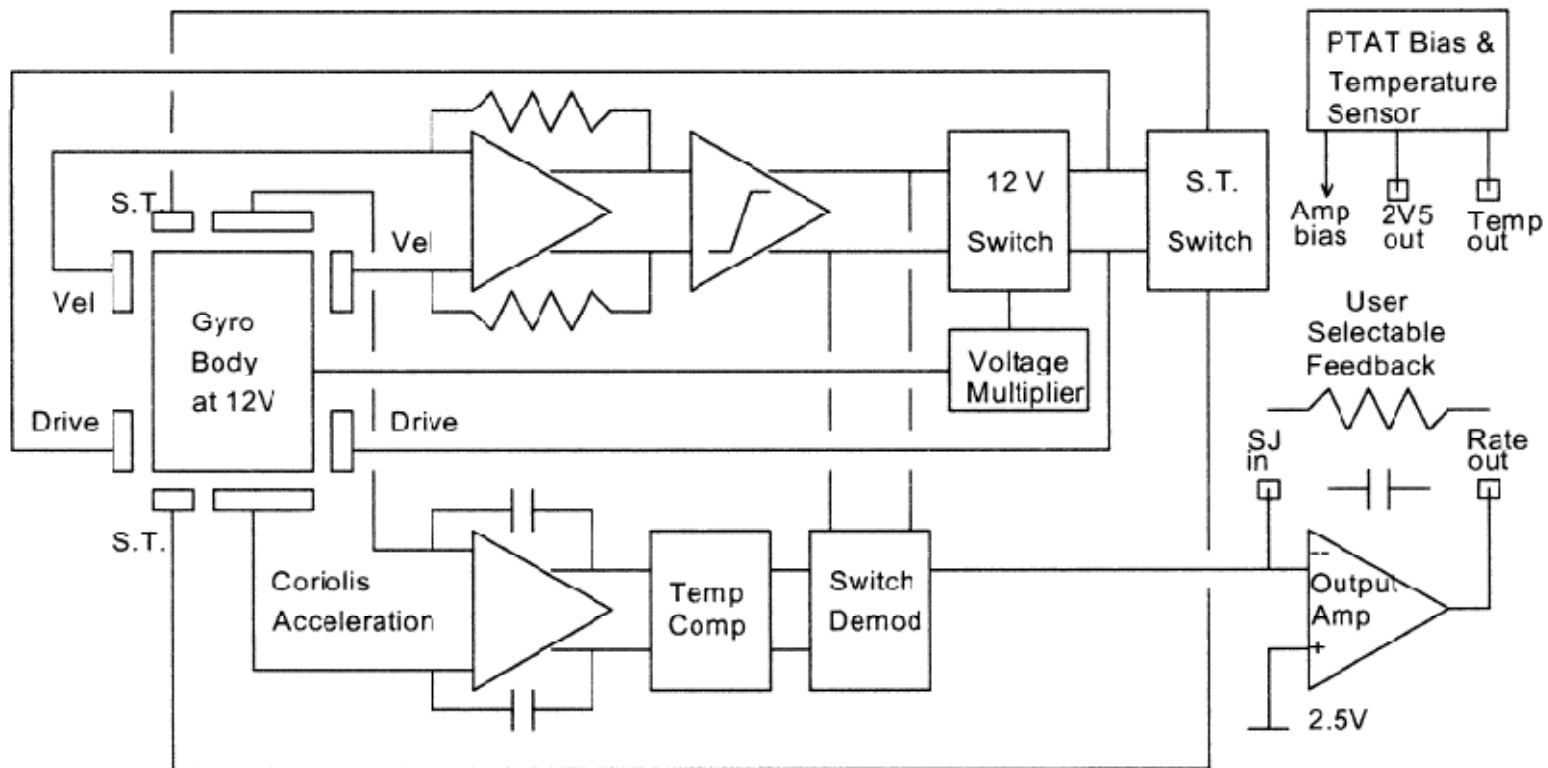
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# Intermediate-CMOS gyroscope (Cont'd)

- Block diagram



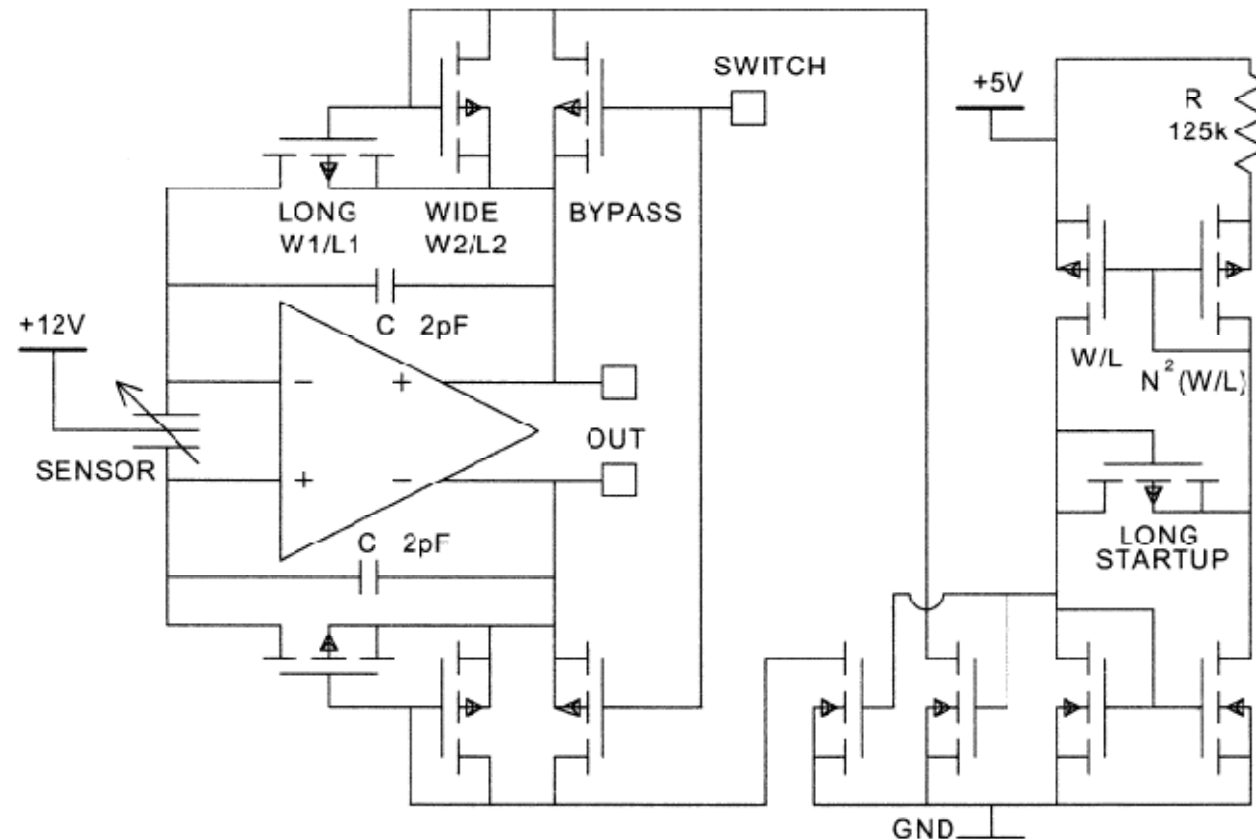
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# Intermediate-CMOS gyroscope (Cont'd)

- Analog front-end design



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# Case study: 3-axis Accelerometer



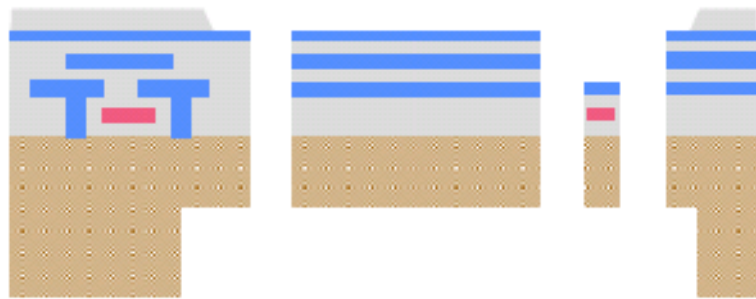
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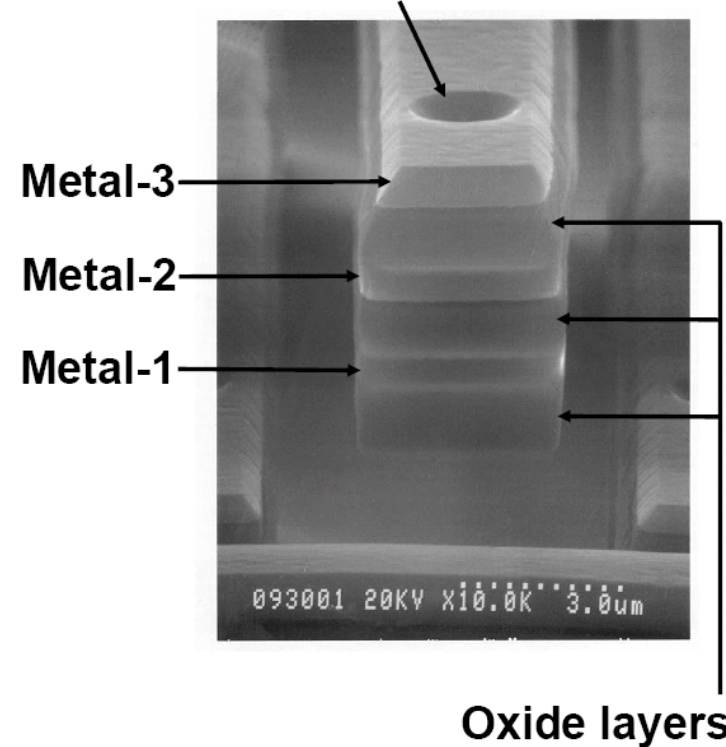
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# Post-CMOS 3-axis Accelerometer

- Fabrication process



Via from Metal-3 to Metal-2



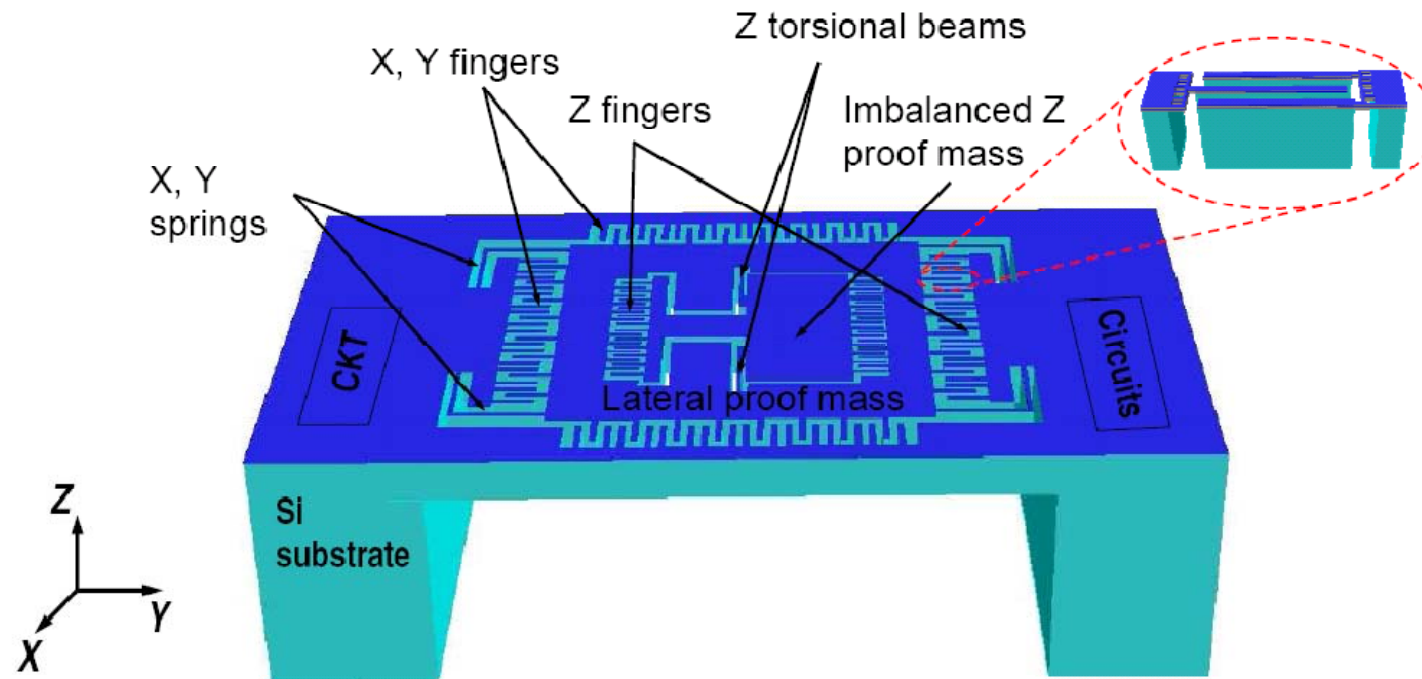
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# Post-CMOS 3-axis Accelerometer (Cont'd)

- 3-axis accelerometer
  - H. Qu, et al, Solid State Sensors Workshop, Hilton Head Island, 2006



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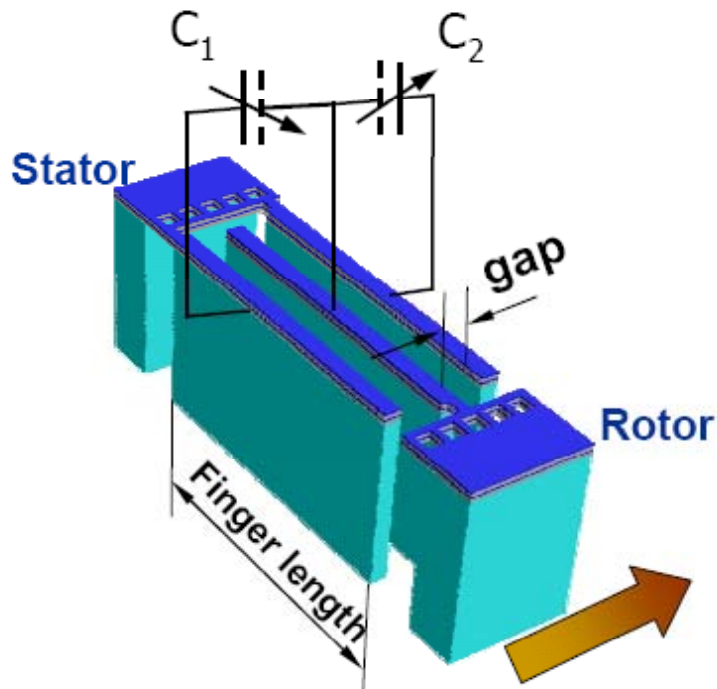
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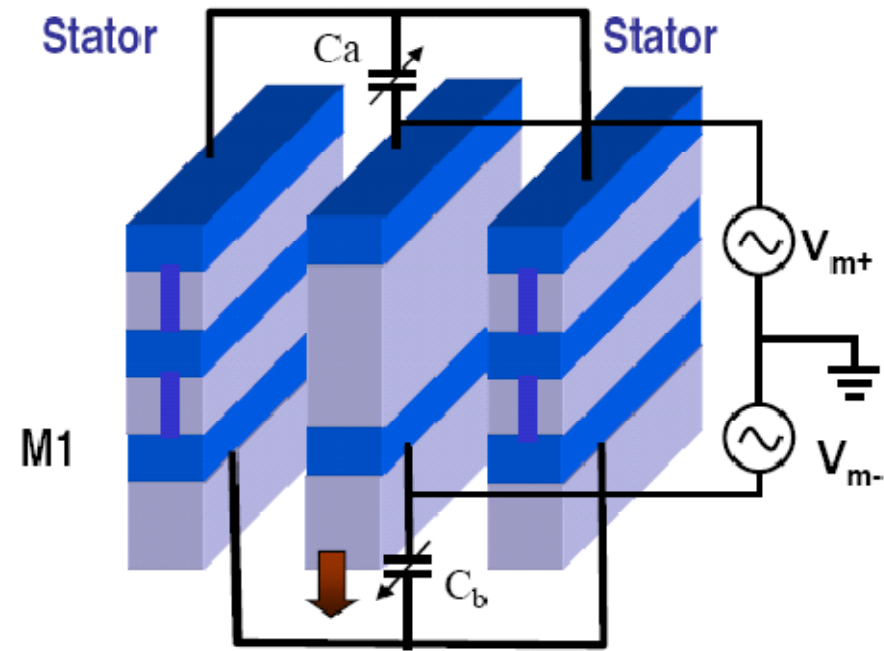


# Post-CMOS 3-axis Accelerometer (Cont'd)

- Sensing mechanism



Lateral sensing



Vertical sensing



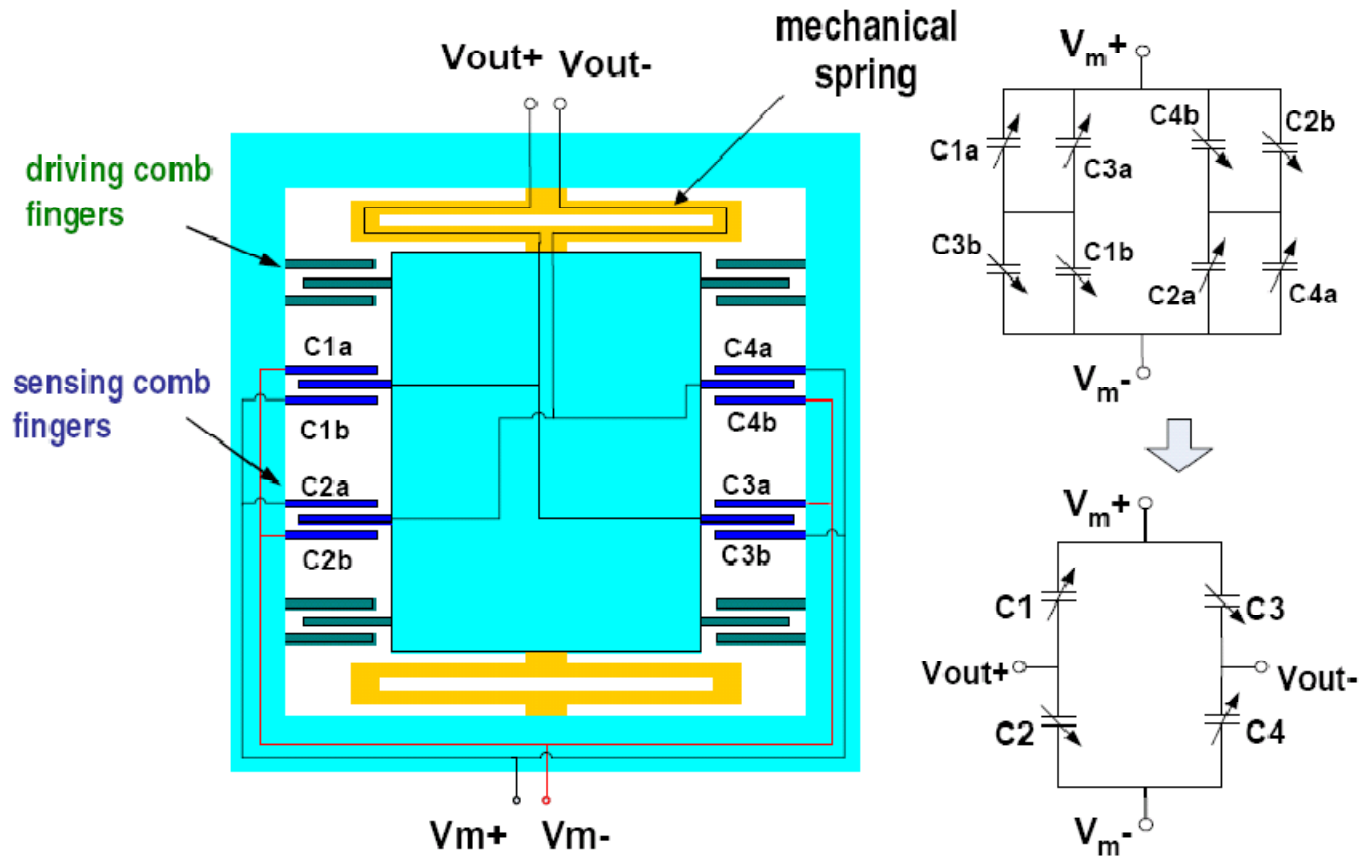
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# Post-CMOS 3-axis Accelerometer (Cont'd)

- Lateral accelerometer



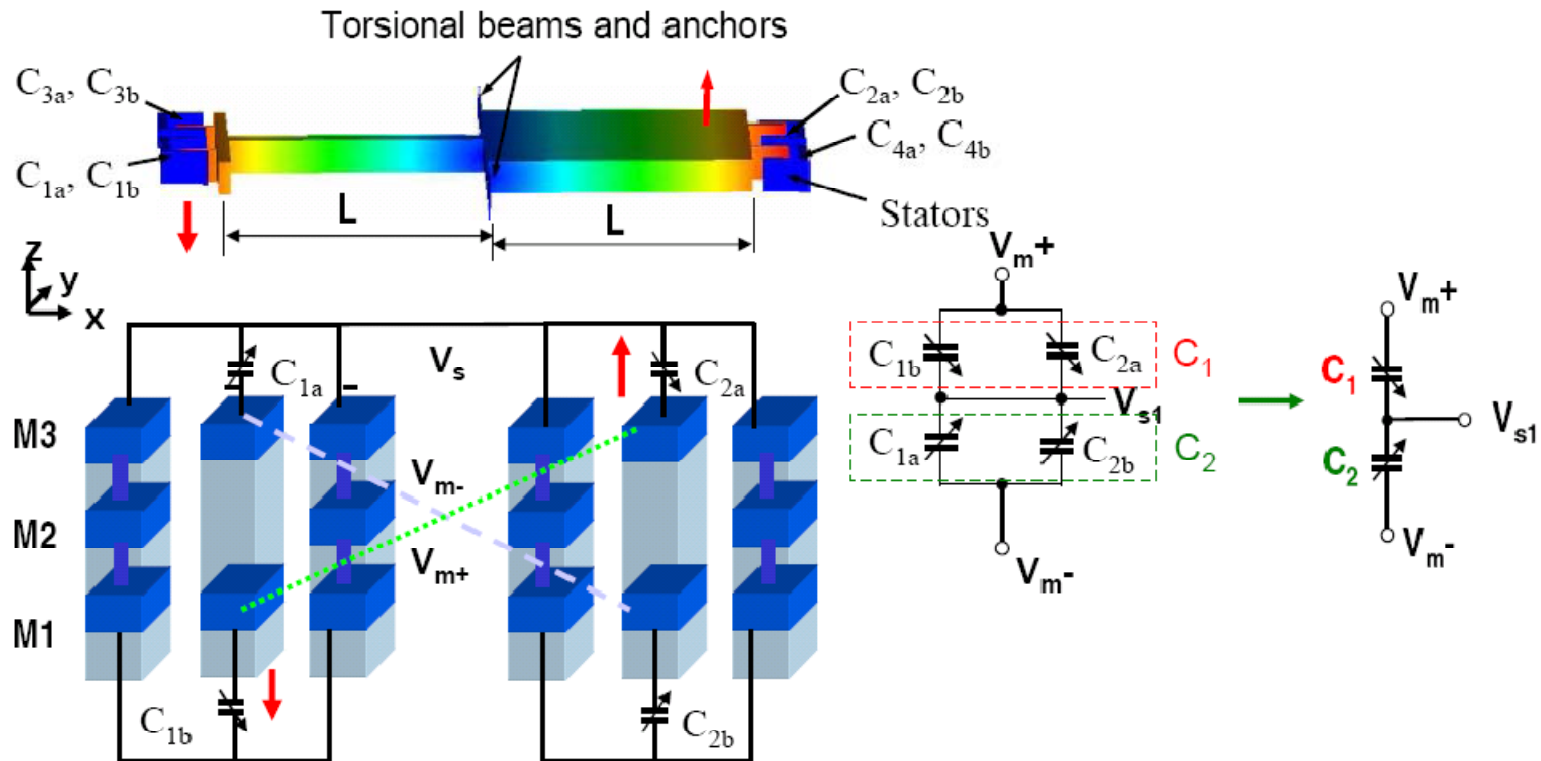
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# Post-CMOS 3-axis Accelerometer (Cont'd)

- Vertical accelerometer



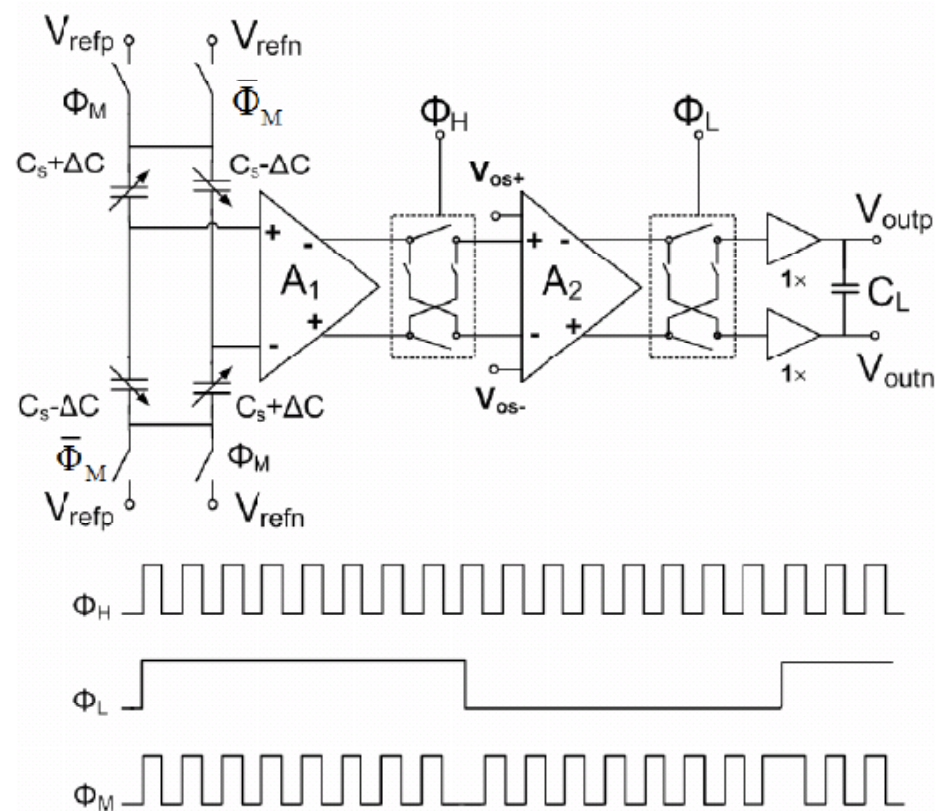
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# Post-CMOS 3-axis Accelerometer (Cont'd)

- Readout electronics



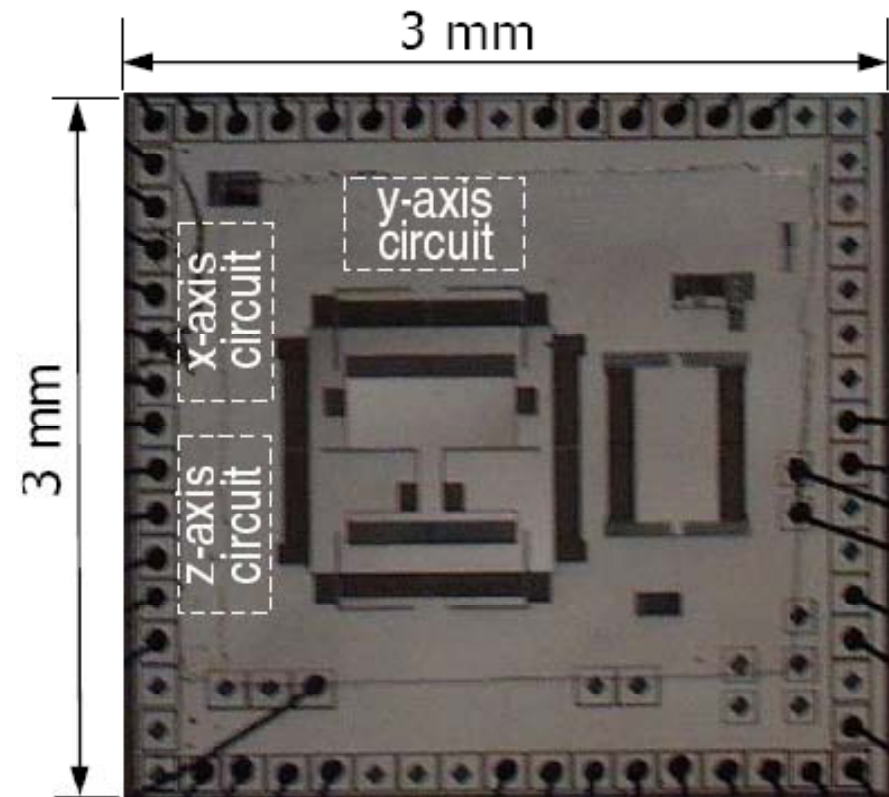
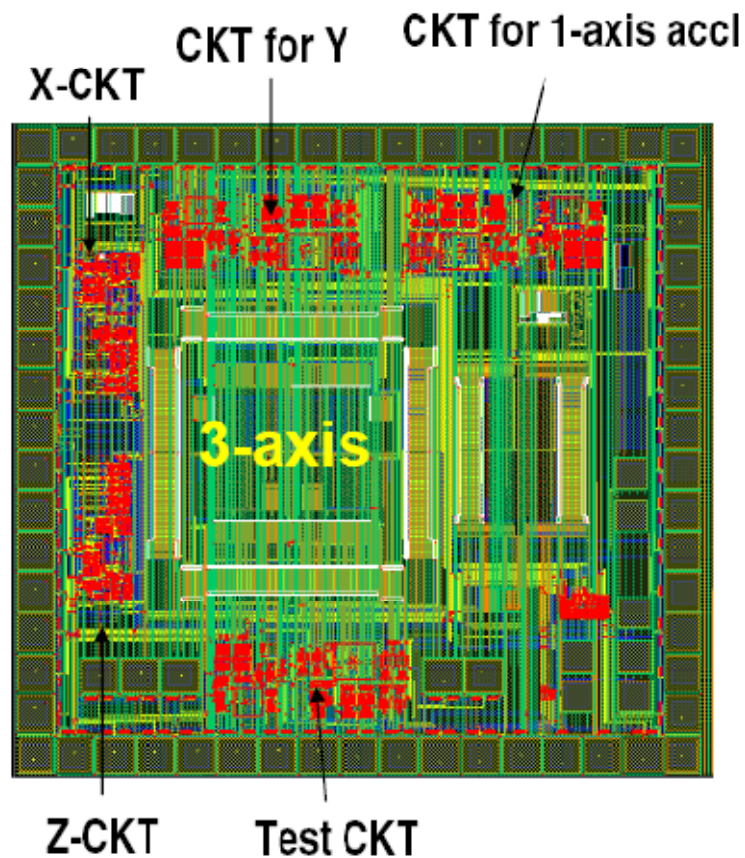
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# Post-CMOS 3-axis Accelerometer (Cont'd)

- Final layout and fabrication results



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# Reference

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- [1] Marc J. Madou, "Fundamentals of MICROFABICATION," 2nd edition
- [2] Analog Devices, ADXL50
- [3] R. C. Jaeger, "Introduction to Microelectronic Fabrication," 2nd edition
- [4] H. Qu, et al, Solid State Sensors Workshop, Hilton Head Island, 2006
- [5] Geen. J, et al, Journal of Solid-state Circuits, 2007

