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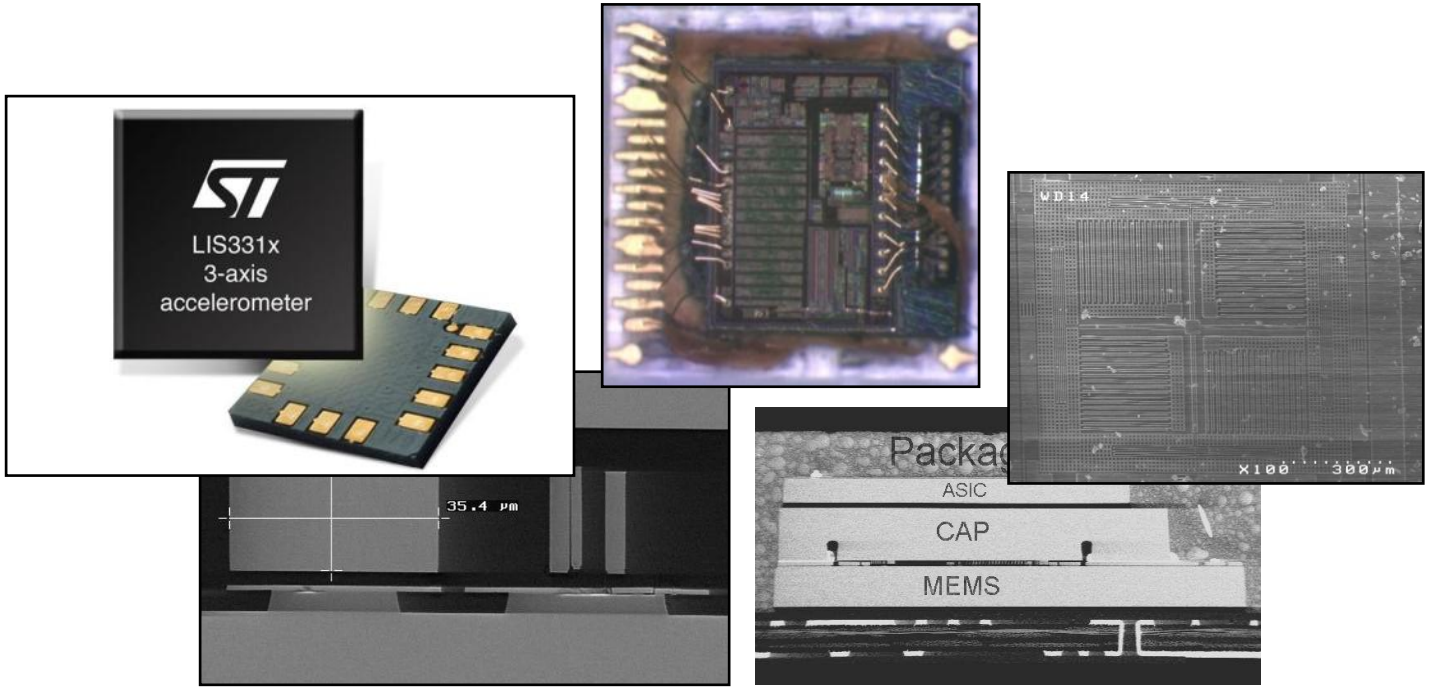
Reverse Costing analysis



STMicroelectronics LIS331DLH
Triple-Axis MEMS Accelerometer

September 2010 - Version 1

Written by: Sylvain HALLEREAU

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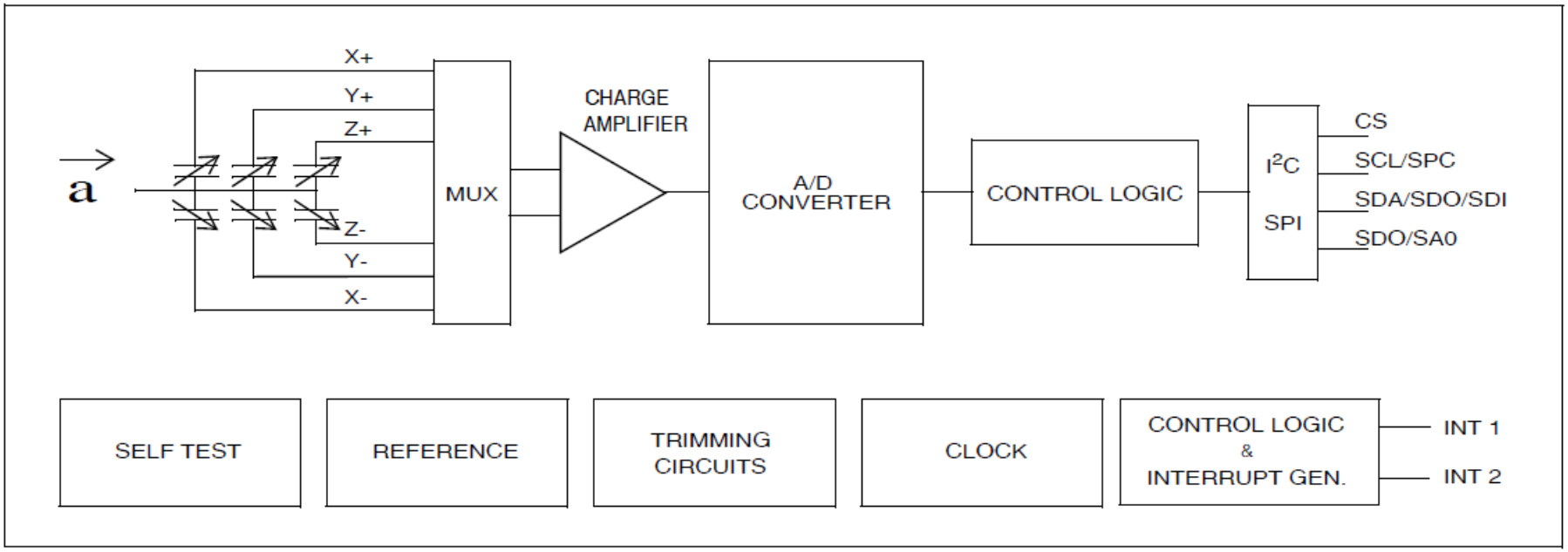
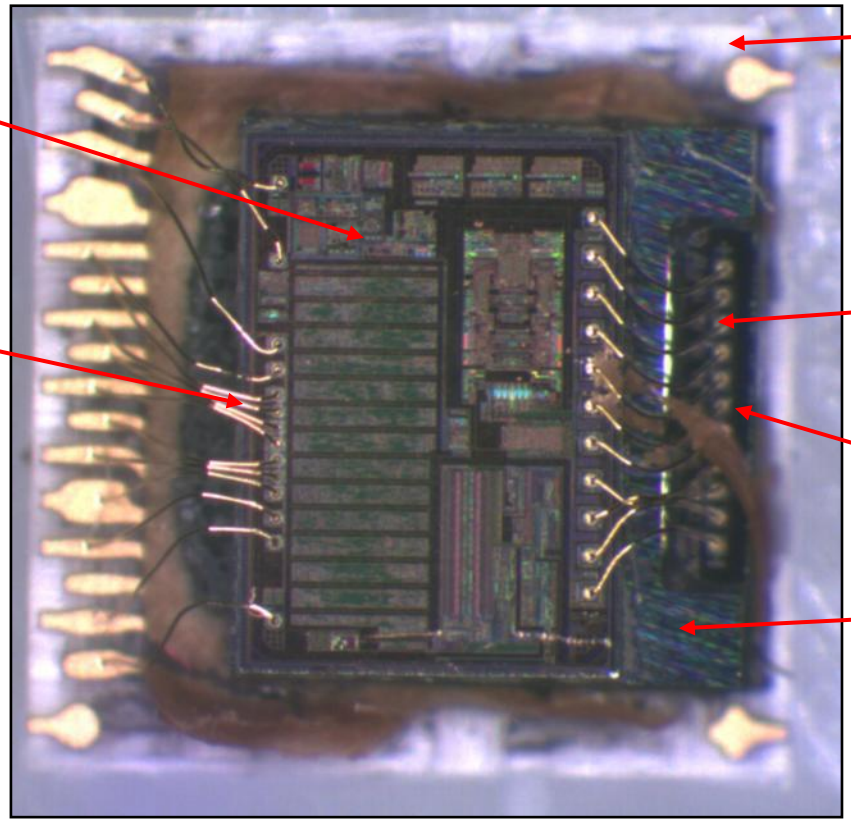
LIS331DLH Specifications

Figure 1. Block diagram



Package Opening – Bonding

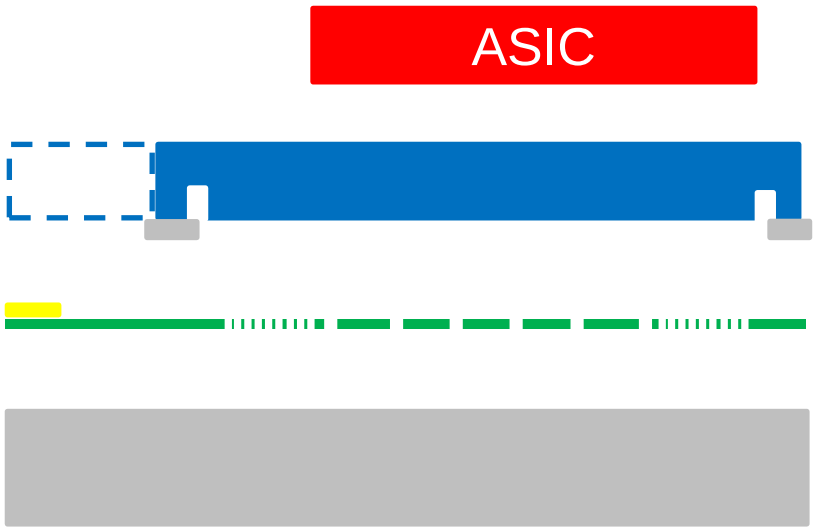


Package Opening

Bonding number : 25
Bonding material : Au (25µm diameter)
Bonding number between ASIC & Package : 14
Bonding number between MEMS & ASIC : 11

Device Structure

- **2 bonded wafers are used to build the LIS331DLH accelerometer MEMS.**



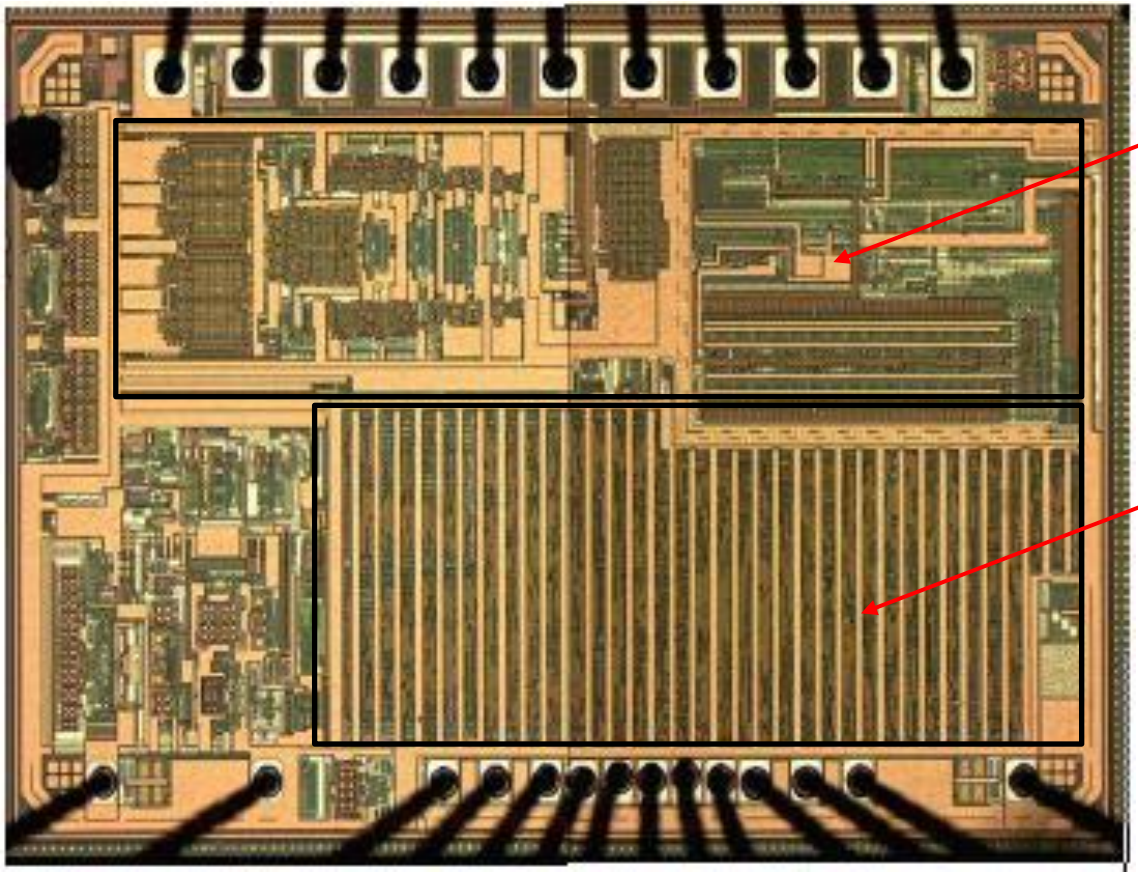
1. The **Cap**
   - Cavity etched by RIE plasma and wet etching
   - Pb Glass Frit deposition

2. The **Surface Micro-Machined**
   - 2 oxide and 2 poly layers deposition
   - Mechanical elements etched by DRIE
   - Mobile elements release

3. The **Silicon substrate**
   - Backgrinding

- **The sensing elements are made in thin poly and oxide layers and are protected by a silicon cap.**
- **The active layers are deposited and patterned.**
- **The sensor is protected and thus can be packaged using a standard assembly process.**
- **The ASIC is using a CMOS 0.Xµm process with SRAM, EEPROM and analog functions.**
- **The ASIC and MEMS are assembled in a LGA16 package stacked.**

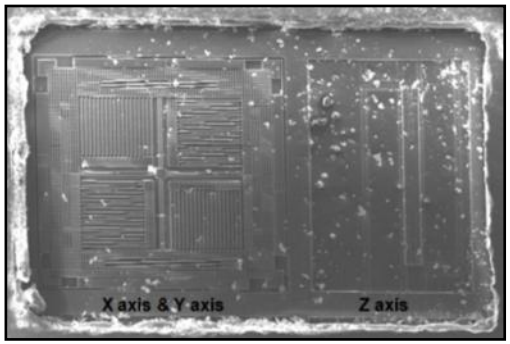
ASIC - Functions



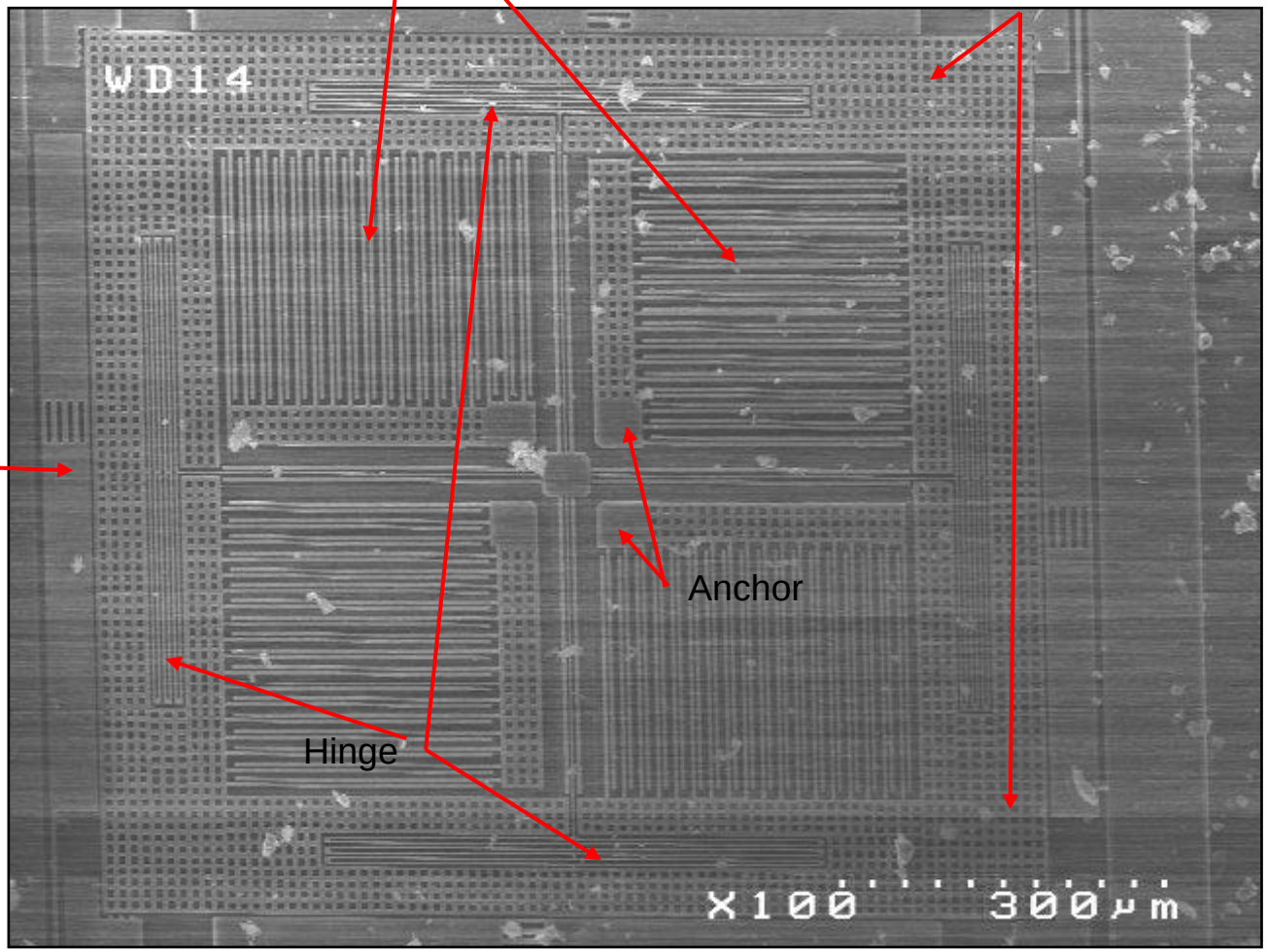
ASIC Die (ST picture)

Memory : No memory block is visible on the picture. But the circuit integrates some registers and Non Volatile Memory (according to datasheet).

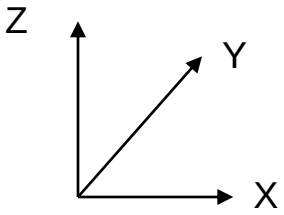
MEMS Sensor – X & Y-Axis SEM Views



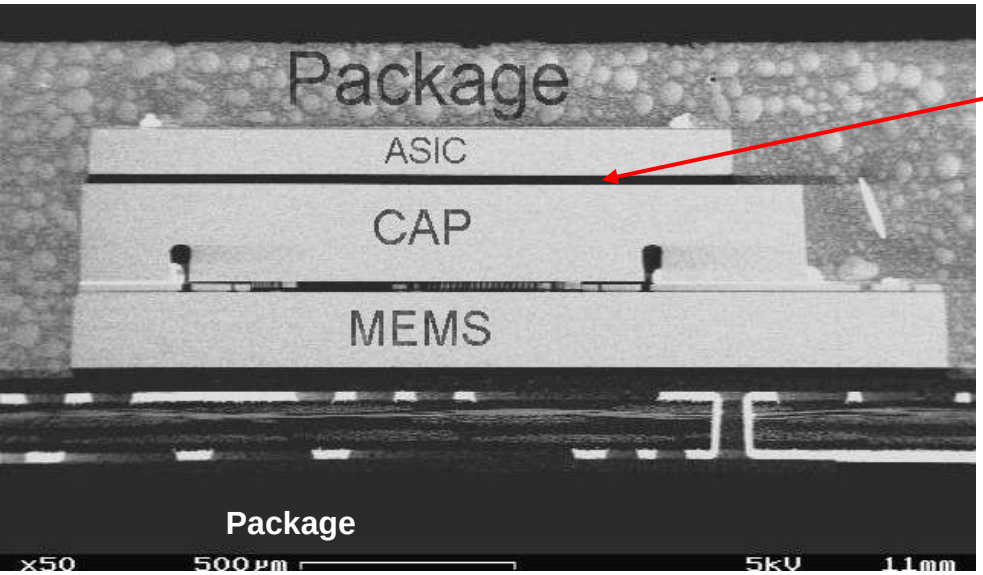
MEMS Sensor Overview



MEMS Sensor SEM View - X-Axis

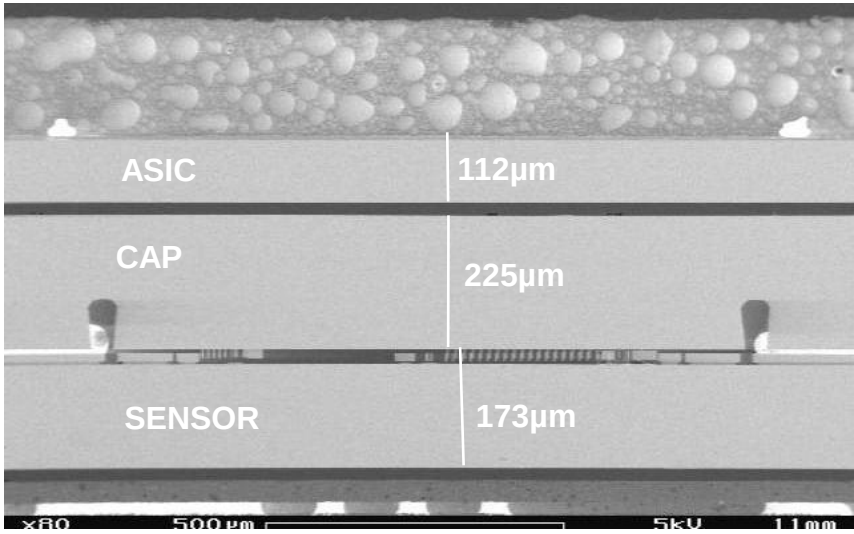


Component Cross-Section

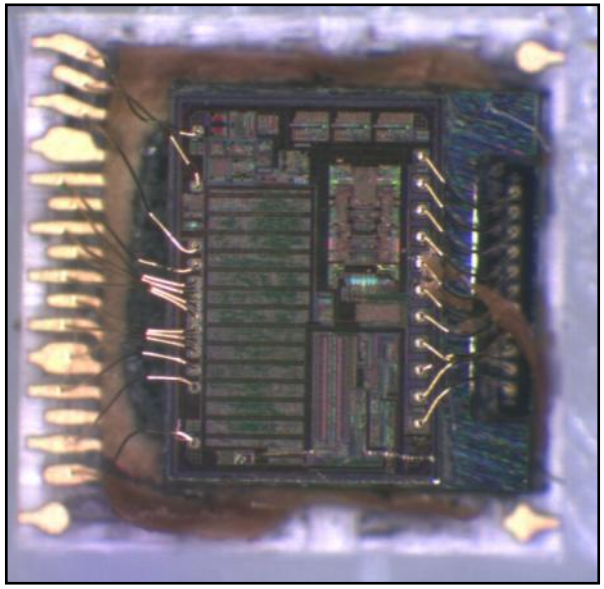


Component Cross Section

The ASIC is glued with epoxy glue on the top of the cap. This configuration reduces the area but increases the thickness of the MEMS.
The 3 wafers are backgrinded in order to decrease the final thickness of the component. The backgrinding step increases the wafer cost and decreases the yield.



MEMS Cross Section



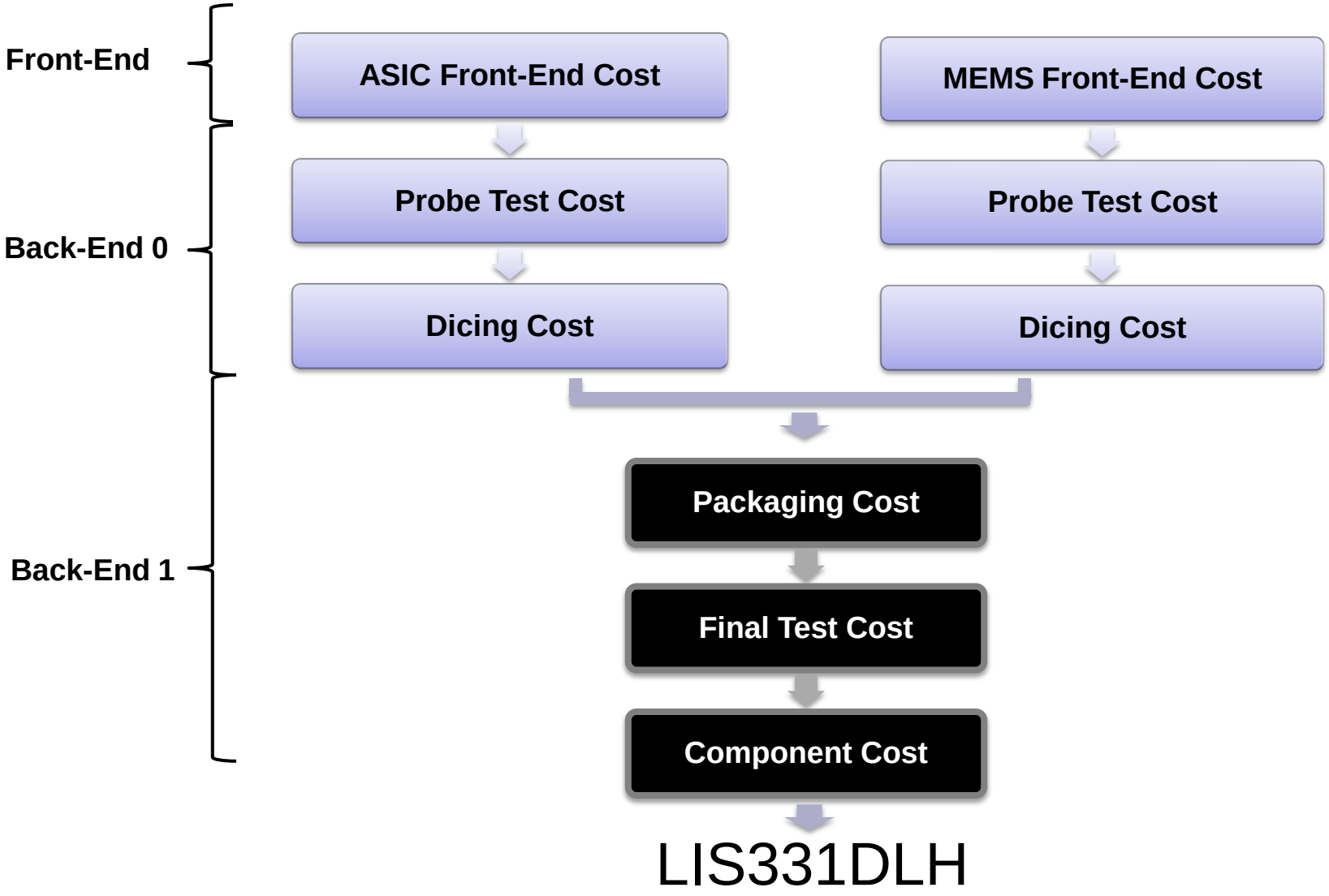
Sensor Process Flow 1/2

Sensor Wafer Process:

•The sensors are manufactured on a standard 200mm wafer. The xxµm of poly-silicon is used for the mechanical elements.

•The manufacturing of the sensor begins with a deposition of the isolation oxide 1 (x.xxµm). A first polysilicon layer (x.xxµm) is then deposited and patterned and I used for electrical interconnects. The sacrificial oxide 2 (x.xxµm) is then deposited, patterned and the anchor and contact holes are etched.

Main steps of economic analysis

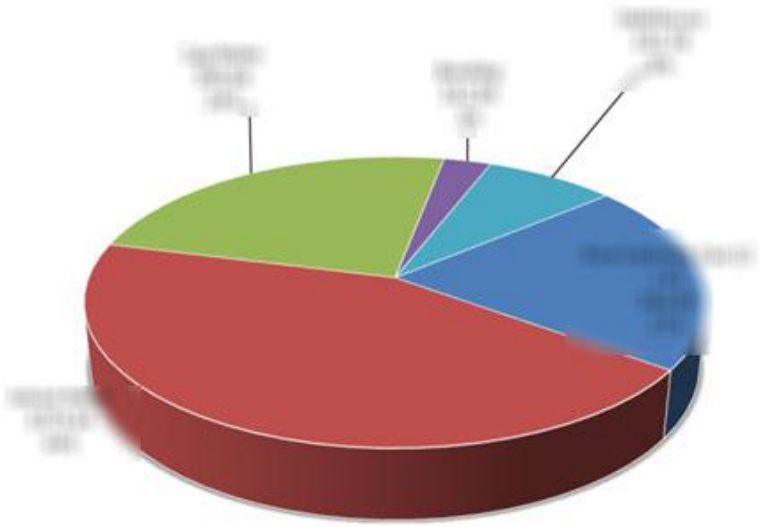


- We perform the economic analysis of the ASIC with the IC Purchaser software.
- We perform the economic analysis of the MEMS and the packaging with the MEMS CoSim+ software.

MEMS Front-End Cost

MEMS Manufacturing	Low Yield		Medium Yield		High Yield	
	Cost	Breakdown	Cost	Breakdown	Cost	Breakdown
Raw Substrate Cost (2 x Si)						
Sensor Wafer						
Cap Wafer						
Bonding						
Yield losses						
MEMS Manufacturing Cost						

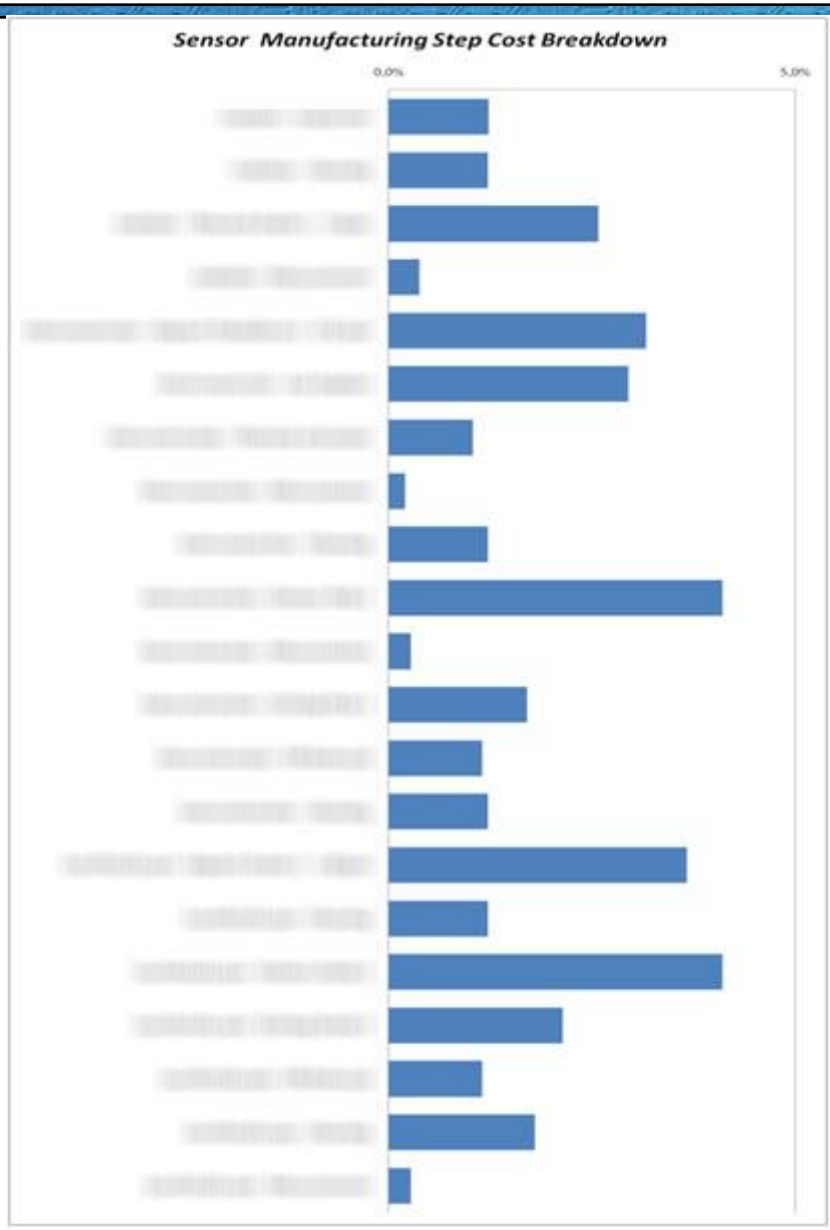
MEMS Manufacturing Cost Breakdown (Middle Yield)



- **The Sensor represents the main part of the manufacturing cost with XX%.**

Sensor FE Cost per Process Steps (1/2)

Sensor Wafer	Cost	Breakdown
[illegible]	[illegible]	[illegible]

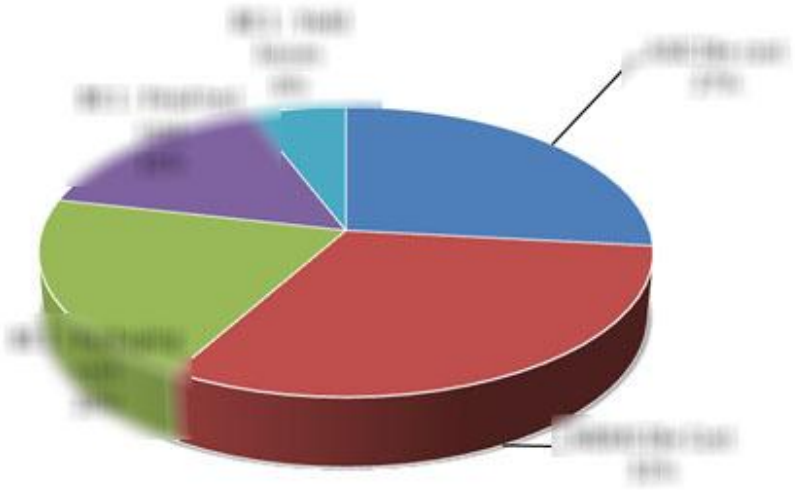


Sensor Manufacturing Steps Cost (Simulated with MEMS CoSim+ Cost Simulation Tool)

LIS331DLH Component Cost (FE + BE 0 + BE 1)

LIS331DLH component cost	Low Yield		Medium Yield		High Yield	
	Cost	Breakdown	Cost	Breakdown	Cost	Breakdown
ASIC Die cost						
MEMS Die Cost						
BE 1 : Packaging cost						
BE 1 : Final test cost						
BE 1 : Yield losses						
component cost						

LIS331DLH Component Cost Breakdown
(Medium Yields)



- The component cost is between $x.xxx and $x.xxx according to yield variations.
- The die (ASIC + MEMS) represents XX% of the total manufacturing cost.
- The packaging cost represents XX% of the total manufacturing cost.
- Final test cost and yield losses (due to packaging and final test) represent XX% of the total manufacturing cost.