

# Instrumentation Miniaturization

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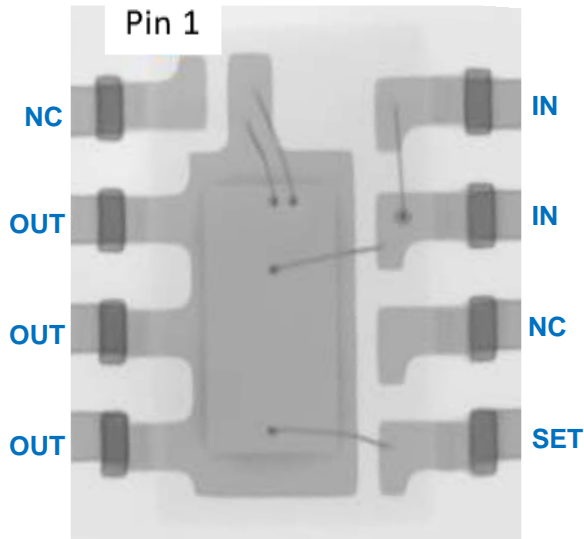
# Topics

- Building Blocks of an Integrated Circuit
- What is a Multi-Chip Module?
- Die Harvesting
- Additional Use-Cases

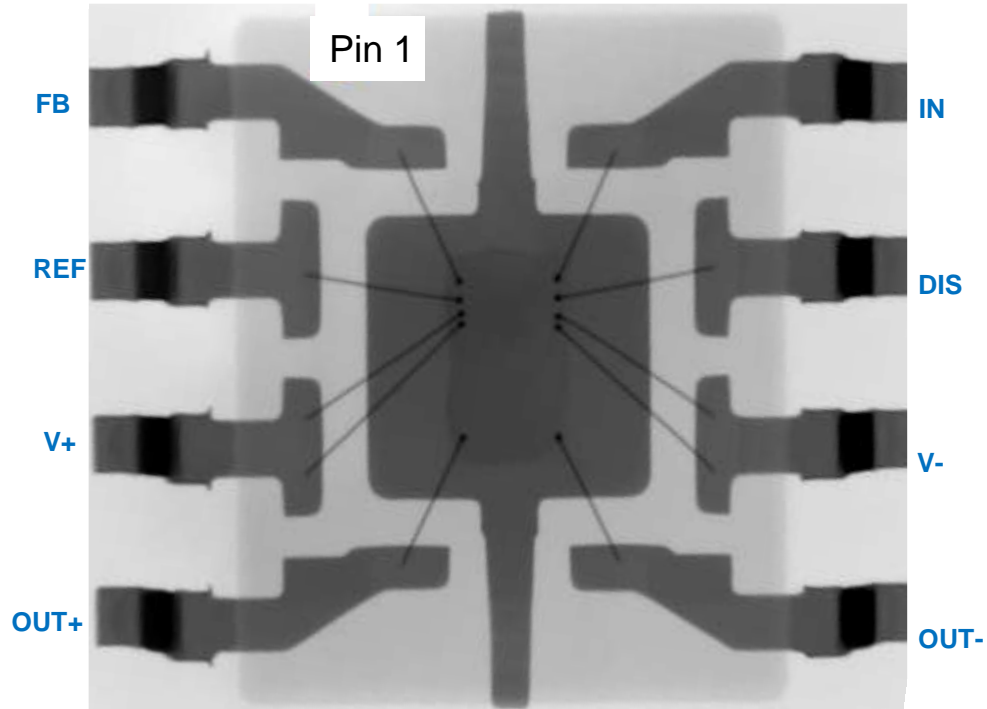




# Building Blocks of an Integrated Circuit ( $\mu$ -Focus X-Ray Images)



Voltage Regulator  
IC Size = 2.8 x 2.9mm  
Die Size = 0.8 x 1.6mm  
≈84% size reduction



Differential Amplifier  
IC Size = 6.0 x 5.0mm  
Die Size = 0.9 x 1.5mm  
≈94% size reduction

Silicon die level design techniques can significantly reduce the size/weight of instrumentation





# Multi-Chip Module (MCM) Overview

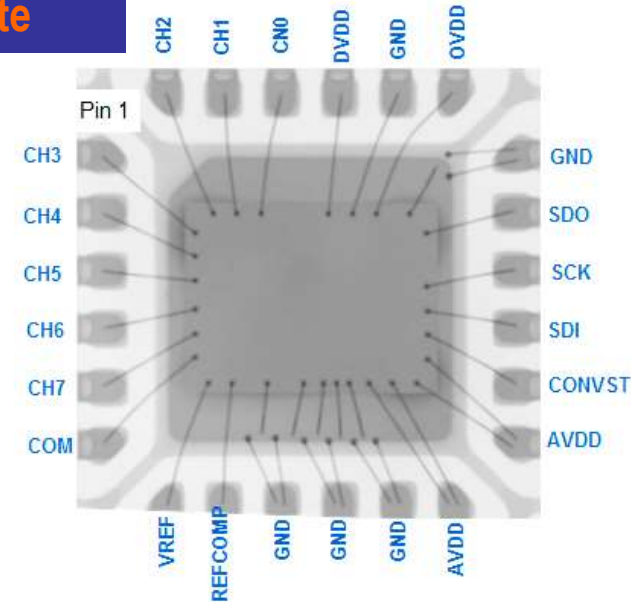
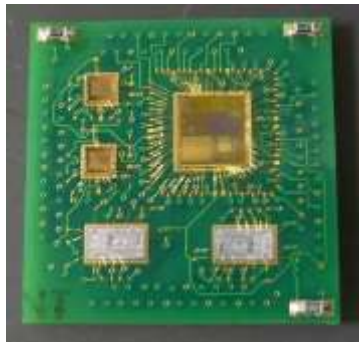
**Definition – The integration of multiple dies onto a single substrate**

## Advantages

- Approx. 50%+ reduction in circuit board size
- Package design can improve operational temperature limits
- Improved signal quality
- Improved EMI/EMC characteristics

## Disadvantages

- Most IC companies require the purchase of a full silicon wafer
- Small reduction in required power



**Analog to Digital Converter**  
 IC Size = 4.0 x 4.0mm  
 Die Size = 2.0 x 1.6mm  
 = 80% size reduction

**This design technique addresses a need/gap in instrumenting payload limited systems**





# Die Harvesting Overview

## Advantages

- Significant reduction in MCM prototype designs cost

## Disadvantages

- Die can be damaged during the scavenging and wire-bond removal process

## Process

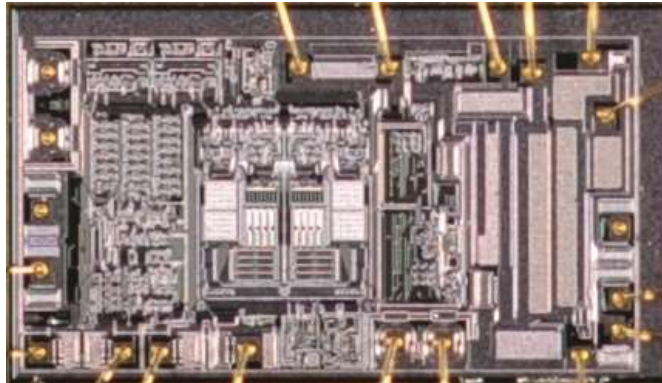
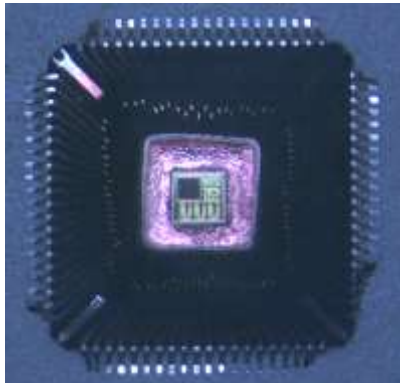
- X-ray component to map wire-bond connections
- Remove plastic encapsulation from existing chips and scavenge the bare dies (Nisene Decapsulator)
- Remove existing wire-bond (IBM Air Jet wire bond remover)



**Nisene Decapsulator**



**IBM Air Jet**





# Die Harvesting / MCM Process (cont.)

## Harvesting Process

- Identify candidate ICs for use in the MCM
- X-ray ICs
- Develop bond pad to IC pin map
- Scavenge the die pieces
- Identify compatible open cavity packages
- Plasma etch cleaning of open cavity packages
- Die-bond die pieces in open cavity packages
- Wire-bond die pieces in open cavity packages
- Encapsulate and cure open cavity packages
- Test/verify components survived the scavenging process

## MCM Design Process

- Design MCM BGA substrate
- Fabricate MCM BGA substrate
- Plasma etch cleaning of substrate
- Die-bond die pieces onto substrate
- Wire-bond die pieces on MCM substrate
- Encapsulate and Cure MCM
- Test/verify MCM components
- Determine cost/unit and production timeline

## Package Integration Equipment



Die Bonder

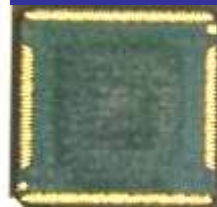


Wire Bonder

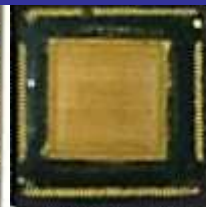


Curing Oven

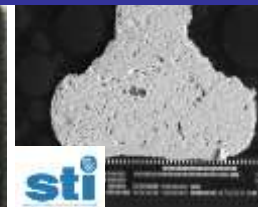
## Package Integration Process



Prepare Substrate



Die Bonding



Wire-Bond (Ball)



Wire-Bond (Wedge)



Encapsulate & Cure





# Additional Use-Cases

Damage to wire-bonds due to vibration or acceleration



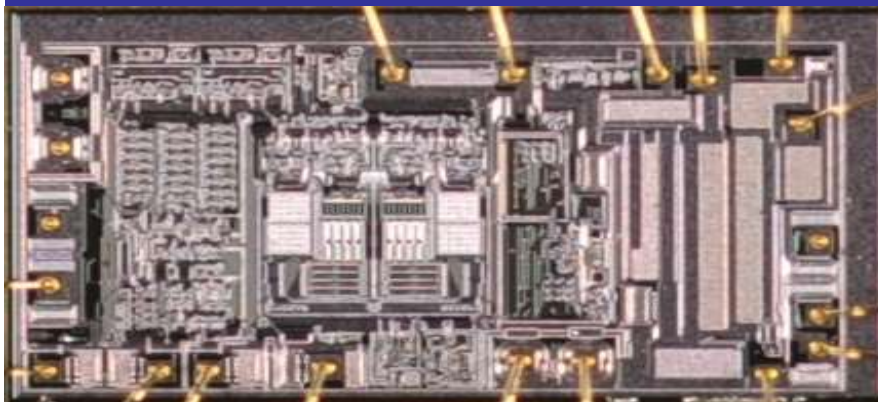
Counterfeit Parts - Die does not match the component markings



Damage to bond wires due to over voltage/current



Die pattern comparison to detect differences and possible malicious circuits





- Questions
- Comments
- Recommendations

