Achieving System Cost Reduction and Performance Optimization using *RocketMEMS*® Semi-Custom Pressure Sensors

Charles Chung, Ph.D.

AMFITZGERALD
& ASSOCIATES

Recent Articles on *RocketMEMS®*

- **"Achieving System Cost Reduction and Performance Optimization through Semi-Custom MEMS Pressure Sensors."**
  - **Sensors Magazine, January 16, 2015**
- **"Choosing MEMS Pressure Sensors for Medical Device Applications."**
  - **Medical Design Briefs, November 1, 2014**
- **"Tailored MEMS Sensors for Customers Seeking Business Opportunities in the Long Tail Marketplace"**
  - **CMM Magazine, November, 2014**
- **Link to more articles and more information:**
  - **http://www.amfitzgerald.com/publications.html**

Overview

- **What are Semi-custom Pressure Sensors?**
- **System Level Benefits of Semi-custom**
  - **Increase system performance**
  - **Decrease system cost**
  - **Improve system reliability**
- **Scalable Production Volumes**
- **Moving Forward and Next Steps**
- **Questions & Answers**

What are Semi-Custom Pressure Sensors?

- **Semi-custom pressure sensors are devices based on existing reference designs that were developed for an established, production-proven fabrication process**

- **Semi-custom pressure sensors have a degree of customization with less risk and cost compared to a fully custom device**

	Sensor Specification	Fabrication Process	Development Time	Development Cost (Order of Magnitude)
Off-the-Shelf MEMS	Fixed	Fixed	None	0
Semi-Custom MEMS AMFitzgerald RocketMEMS®	Custom	Fixed	Months	$ 100K+
Custom MEMS	Custom	Custom	Years	$ 1M+

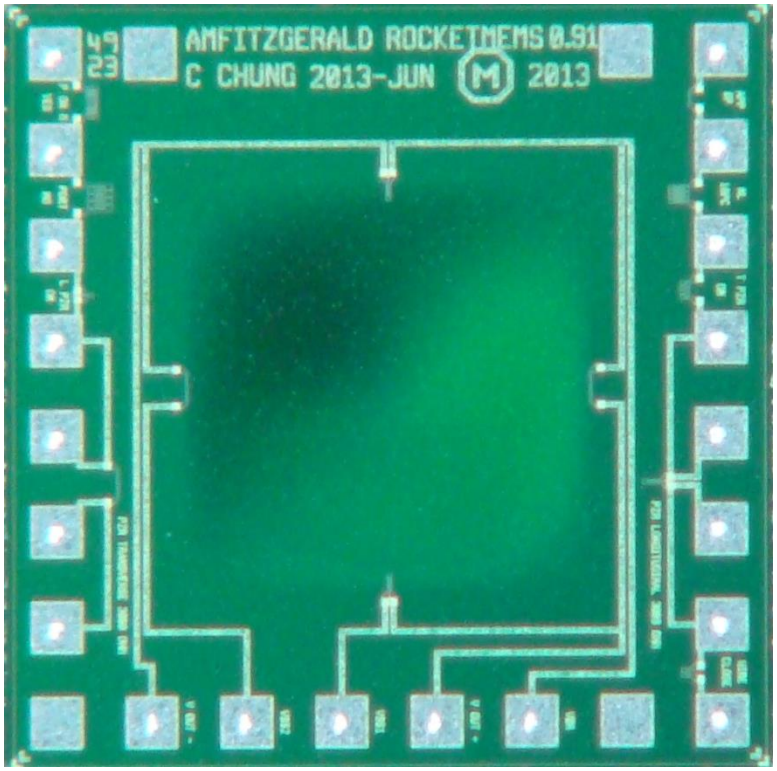
- **Many pressure sensor applications' needs may be met with the *RocketMEMS*® semi-custom approach**

How Does Semi-custom Work?

- **Semi-custom devices start with a established, stable, in-production process**

- **Side View:**
- **The cross section of the device is defined by the fabrication process**
- **Development of the fabrication process is the expensive, time consuming, and risky part of semiconductor chip development**

- **Top View:**
- **The lateral features are defined by the masks**
- **Lateral features are easier and less risky to change**

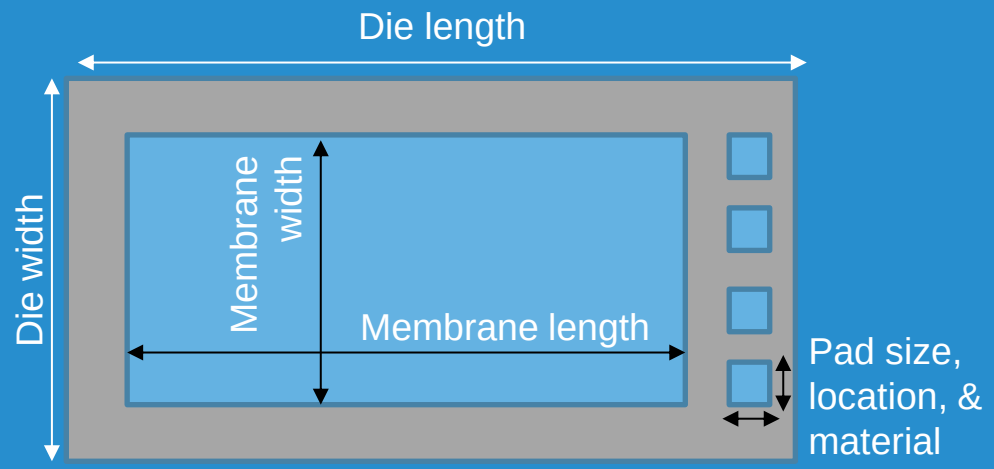


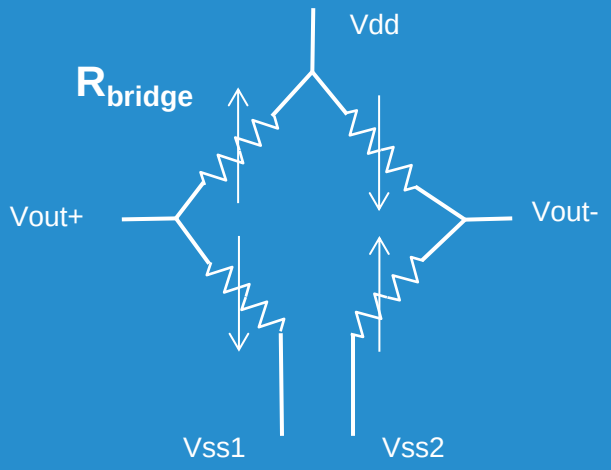
Top View

Photo of a RocketMEMS Pressure Sensor

Side View

RocketMEMS®: Customizable Parameters





Mechanical Parameters

Die length, width, and thickness
Membrane length, width, thickness
Pad location, size, number, and material
Burst Pressure

Electrical Parameters

Bridge resistance
Offset voltage, Power draw
Full bridge or Half bridge

Electromechanical Parameters

Pressure range, Pressure sensitivity

Ranges of Customizable Parameters

	Medical	Consumer Electronics	Industrial or Aerospace
Chip length (mm)	0.3 – 2		
Thickness (mm)	0.3 - 1		
Bridge Resistance (KΩ)	1 – 10		
Pressure range, absolute (atm)	0.5 - 1.5 (380-1140 mmHg)	0.2 – 2	0.2 – 10 (3-150 psi)
Example Applications	**Blood pressure Flow Monitors**	**Altimeter (altitude) Barometers (weather)**	**Fuel Gauges Hydraulic Systems**

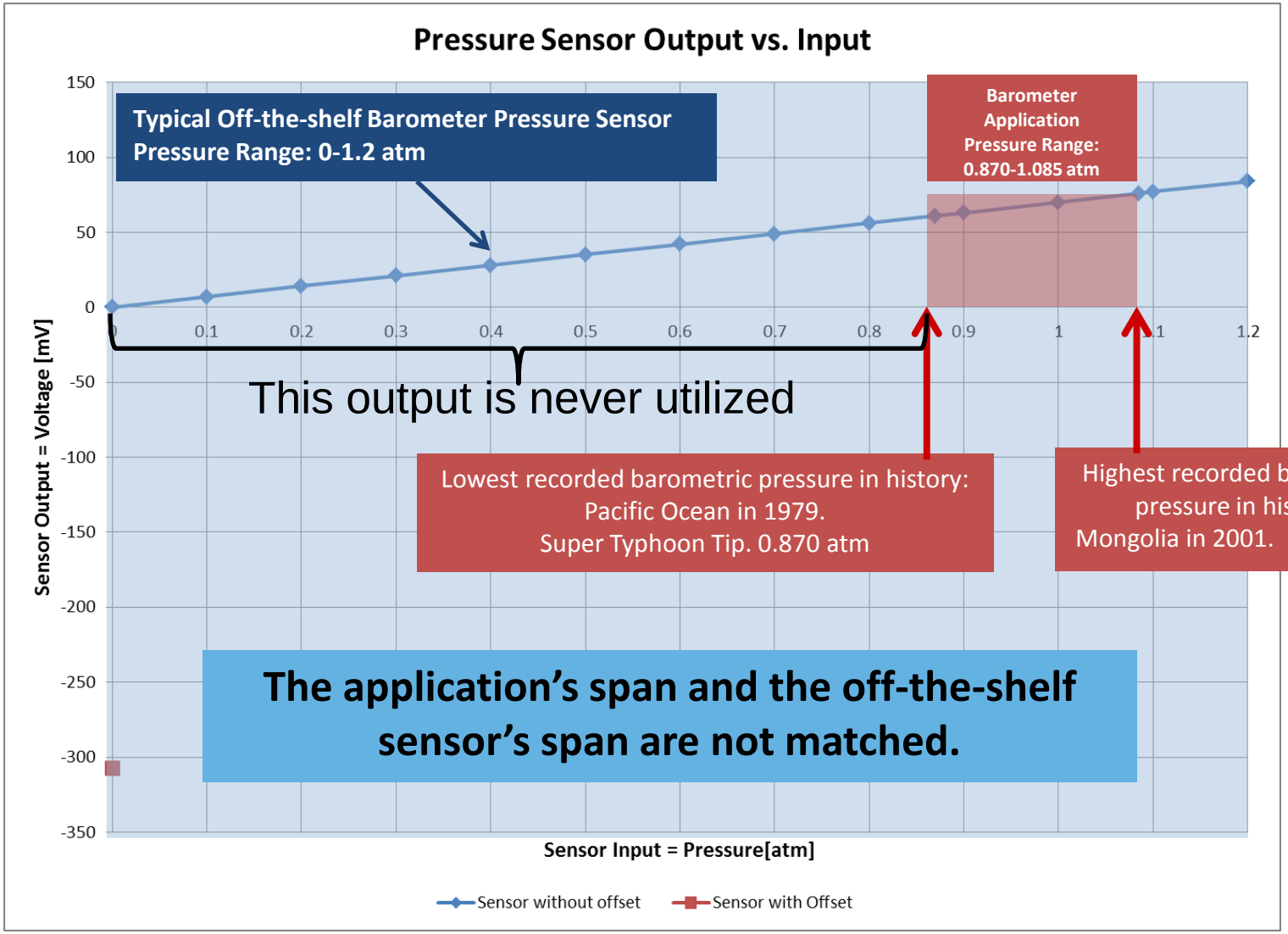
<u>Please note</u>:

These are example specifications for these example applications. These are not the boundaries of the *RocketMEMS*® process.

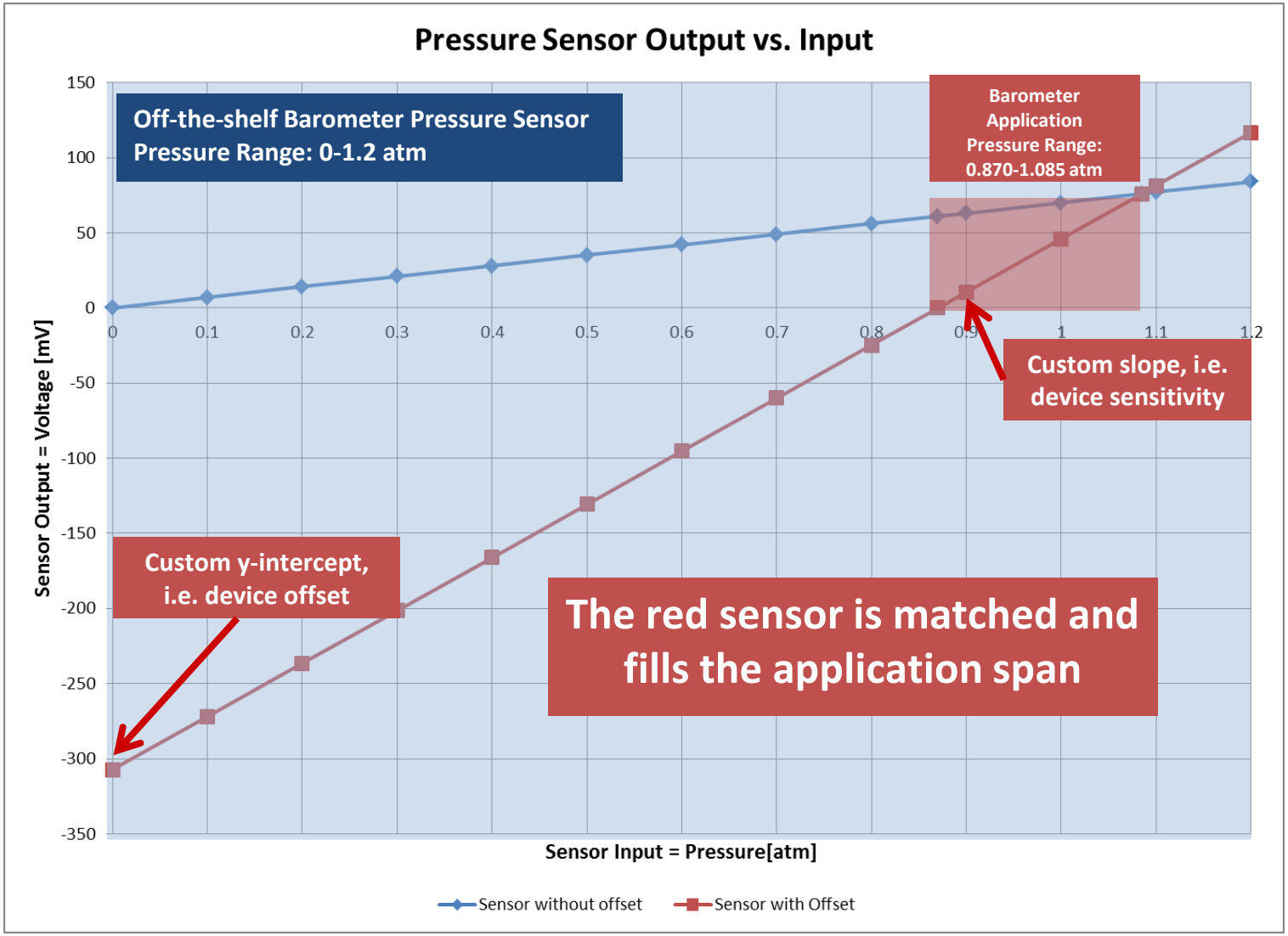
How Can Semi-Custom Devices Benefit Your System?

- **Increase system performance**
- **Reduce system cost**
- **Improve system reliability**

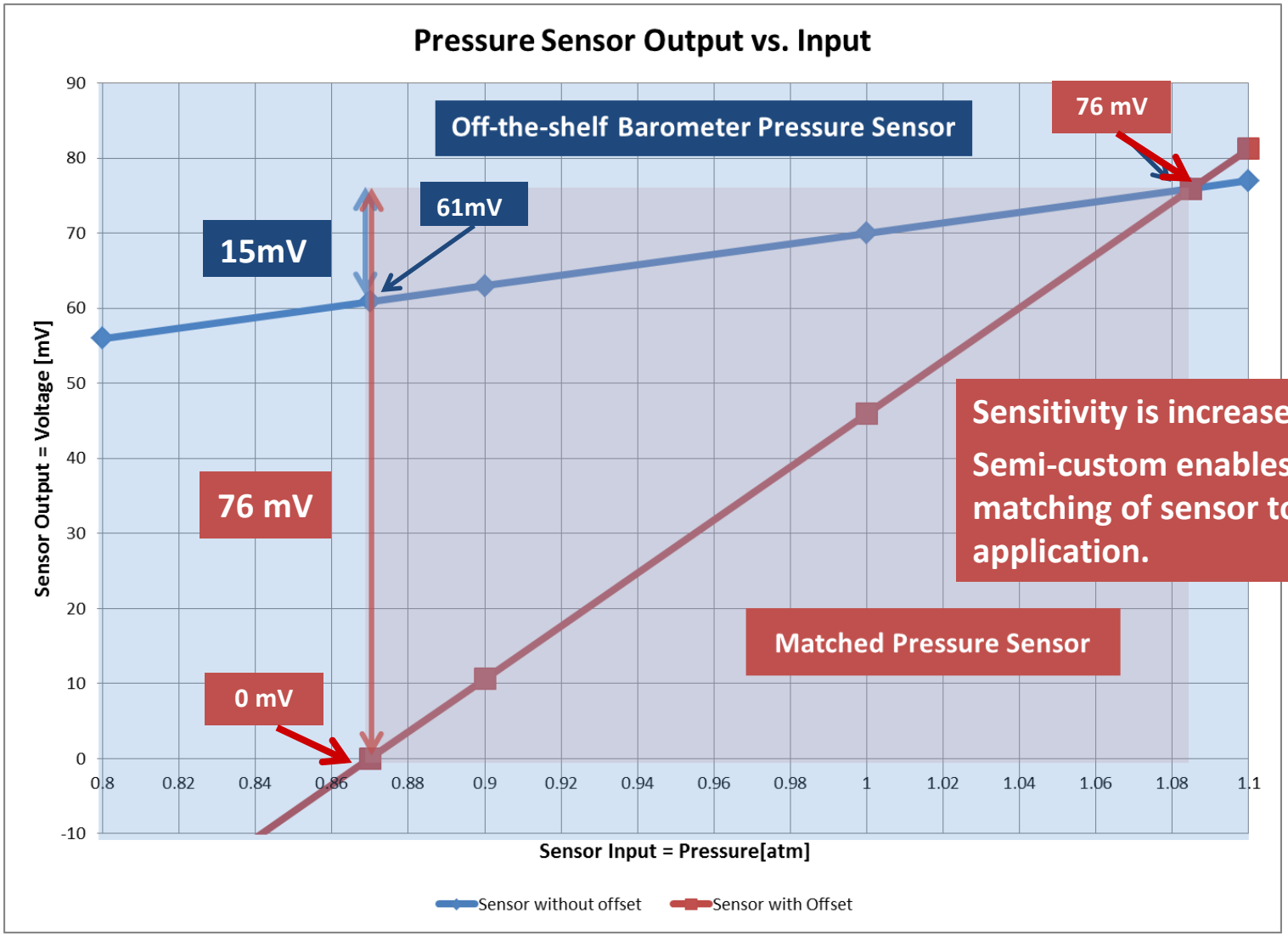
Matching Application and Sensor Spans: Off-the-Shelf



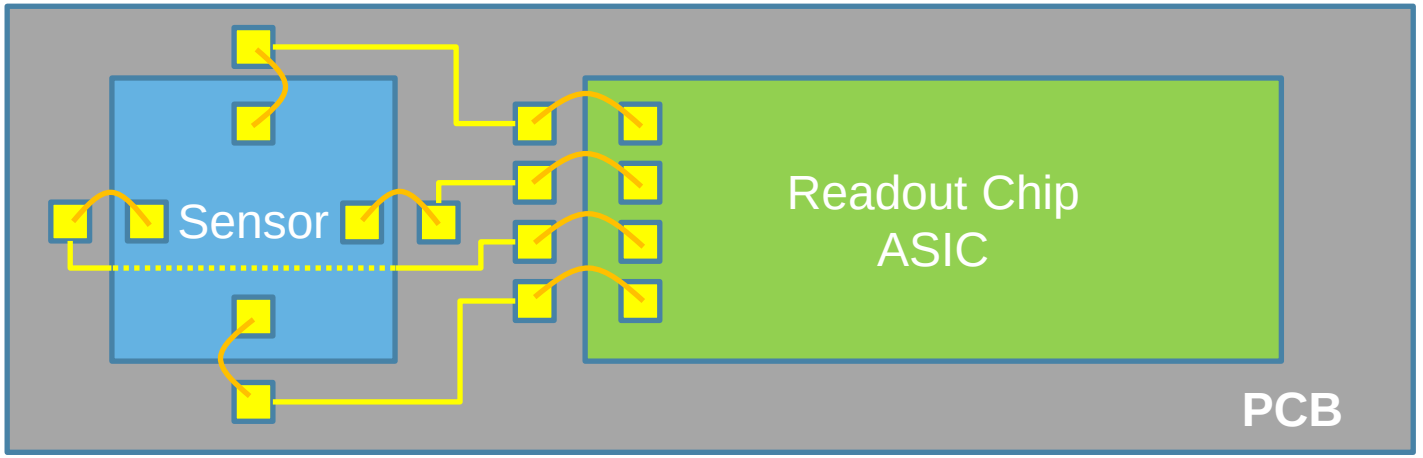
Matching Application and Sensor Spans: Semi-Custom



Zoom of Application Space



Semi-Custom: System Cost Reduction & Reliability Improvement



Case A: Bond pads positioned optimally for each individual chip

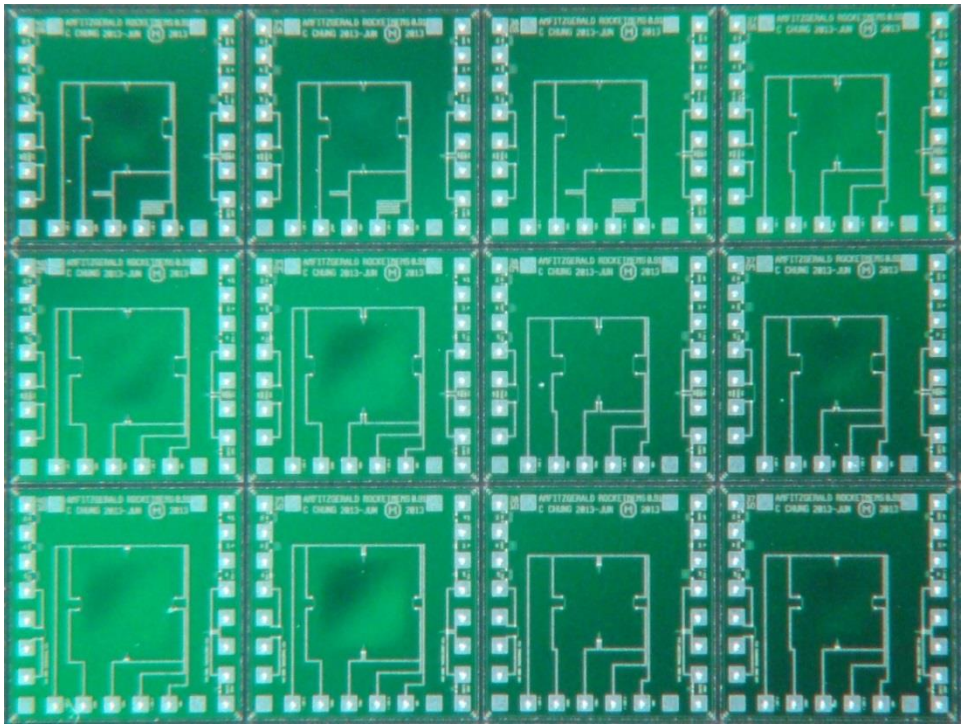
Case B: Bond pads positioned optimally for overall system

Remove 1 component (PCB) and 4 wirebonds.

Reduce costs, increase reliability (wirebonds are a typical point of failure), and decrease system size.

Scaling Die Volume: Prototyping to Production

- ***RocketMEMS®* die volumes scale with your needs**
- **Multiple designs on a run**
- **Scalable production volumes:**
  - **Rapid prototyping**
    - **500+ devices**
  - **Low volume production**
    - **1000's to 10,000's devices/year**
  - **High volume production**
    - **Millions of devices/year**



Multi-Project Wafer: Many different chip designs are processed on the same wafer

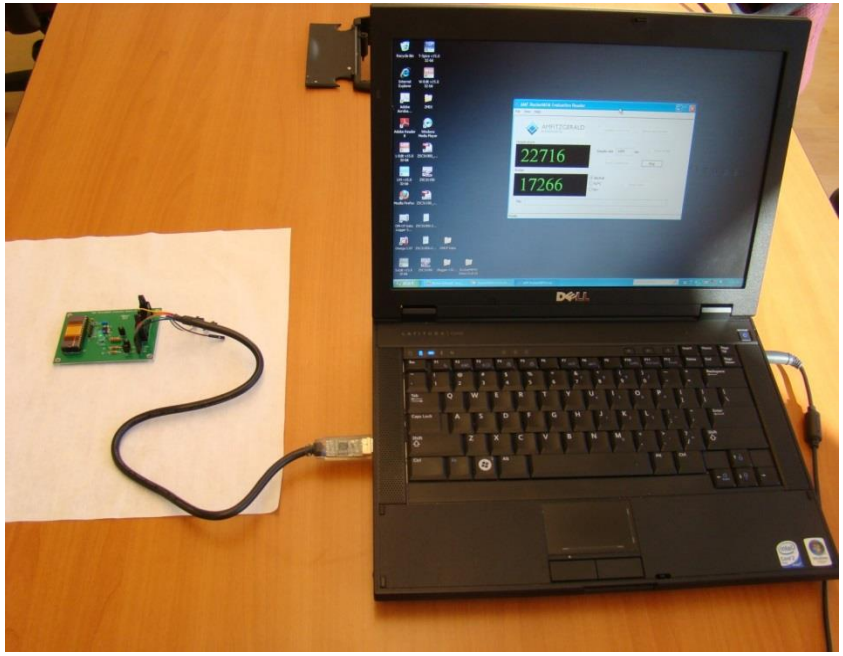
RocketMEMS®: Specification to Device

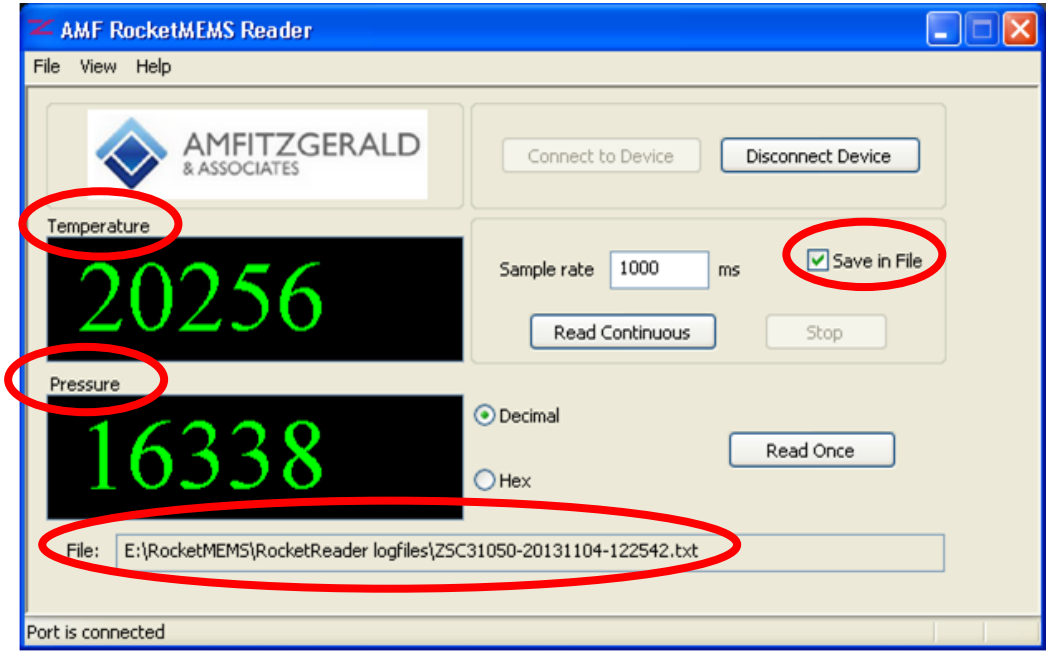
- **Customer provides specification**
- **AMFitzgerald designs pressure sensors**
- **Silex Microsystems fabricates the chips**
- **Customer receives bare pressure sensor die in 4-5 months**

- **All die are 100% tested**
  - **All known-good die**
  - **This is unique to *RocketMEMS***

- **Options: Readout electronics, ASIC, Packaging:**
  - **We can offer support and recommendations**

Plug and Play Evaluation Kit with ZMDI ASIC





Kits include:

***RocketMEMS®* Pressure sensor Readout with ZMDI ASIC and Board**

Board-to-PC USB Cable

Software and Manual

Monitor Pressure

Monitor Temperature

Store data in log file

Pressure & temperature outputs are in raw digital counts.
No compensation or calibration algorithm is applied.
This allows a transparent view for evaluation of sensor performance.

To request an evaluation kit, please contact us at: rocketmems@amfitzgerald.com

Silex: the world leader in MEMS Manufacture

Accelerometers

Gyros

Pressure Sensors

Cantilevers

Touch Membranes

Flow Sensors

Filter Structures

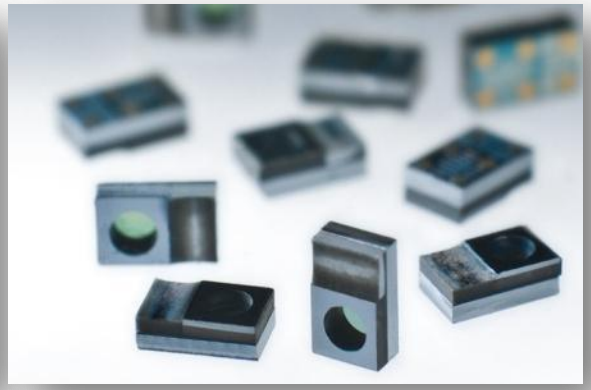
CMOS Interposers

Needles

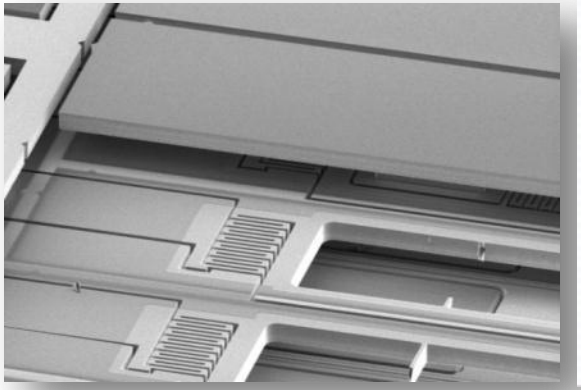
uBatteries

IR Sensors

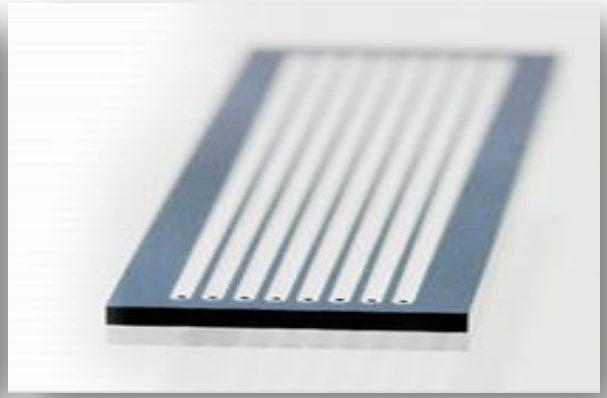
Pressure sensors for measuring blood pressure in coronary arteries



Microphones for mobile telephones



Mirrors for optical switching



Lab-on-chip for DNA analysis

Cell/DNA Analysis

Microphones

RF Switches

Lab-on-Chips

Print Heads

Drug Delivery Devices

Mirrors

Optical Benches

Oscillators

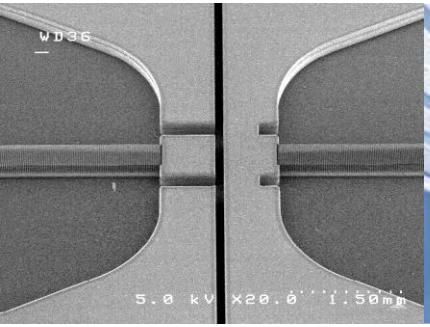
Silex Microsystems

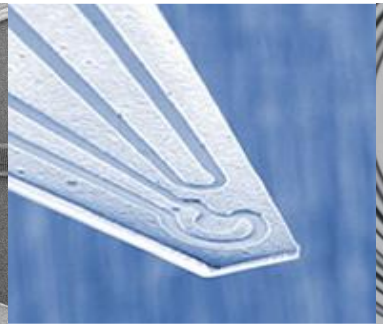
- Dedicated MEMS foundry with 12 years of volume MEMS production experience
  - Over 350 projects
  - Over 100 international customers
  - Work with over 50% of world's top 30 MEMS companies
- Bringing Innovation in Technology
  - Sil-Via® TSVs in consumer applications since 2006
  - Silicon interposers for all-silicon 2.5G packaging since 2006
  - Advanced wafer level packaging
  - Met-Via® Thick wafer metal TSVs since 2010
- Custom process integration to support the needs of MEMS innovators worldwide

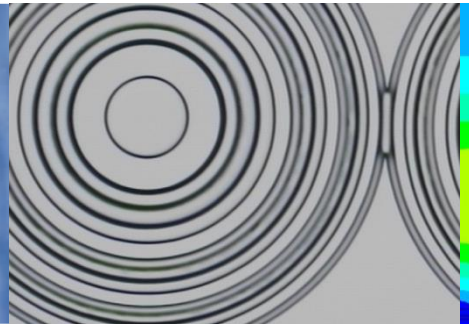
AMFitzgerald Company Information

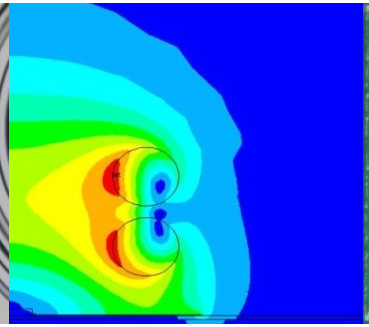
- **MEMS product development firm**
  - **Global clientele**
  - **Over 125 clients served to date**
  - **Startups to Fortune 100 companies**
- **Headquarters in Burlingame, California**
  - **Silicon Valley, near SFO airport**
- **Consistent growth since founding**
  - **Founded in 2003**
- **Active member of the MEMS Industry Group**

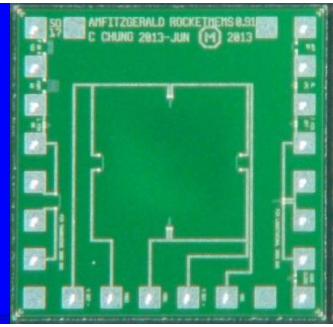
Headquarters in Burlingame, CA





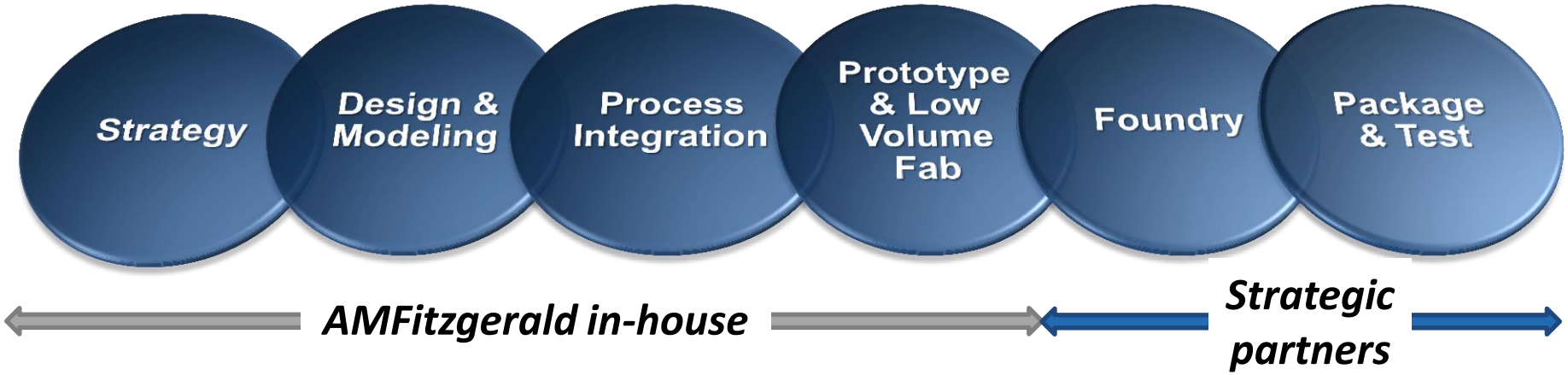






AMFitzgerald: Your Partner in MEMS Product Development

A complete supply chain from concept to production



- **MEMS development from start to finish**
- **Multi-disciplinary, expert engineering team**
- **Design and process integration for volume production**
- **In-house prototype fabrication, easy transition to production partners**

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RocketMEMS®:

Semi-custom Pressure Sensors

- **Increase system performance**
- **Decrease system cost**
- **Improve system reliability**
- **With reduced development costs, times, and risk**

For Information, Inquiries, Die Samples, Evaluation Kits

Webpage: www.amfitzgerald.com/rocketmems.html
Articles: www.amfitzgerald.com/publications.html
Email: rocketmems@amfitzgerald.com

Company Headquarters
700 Airport Blvd. Suite 210
Burlingame, CA 94010 USA
Phone: +1 (650) 347 MEMS
Fax: +1 (650) 347 6366
www.amfitzgerald.com

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& ASSOCIATES