Part V: Integrating MEMS Technology Into Systems

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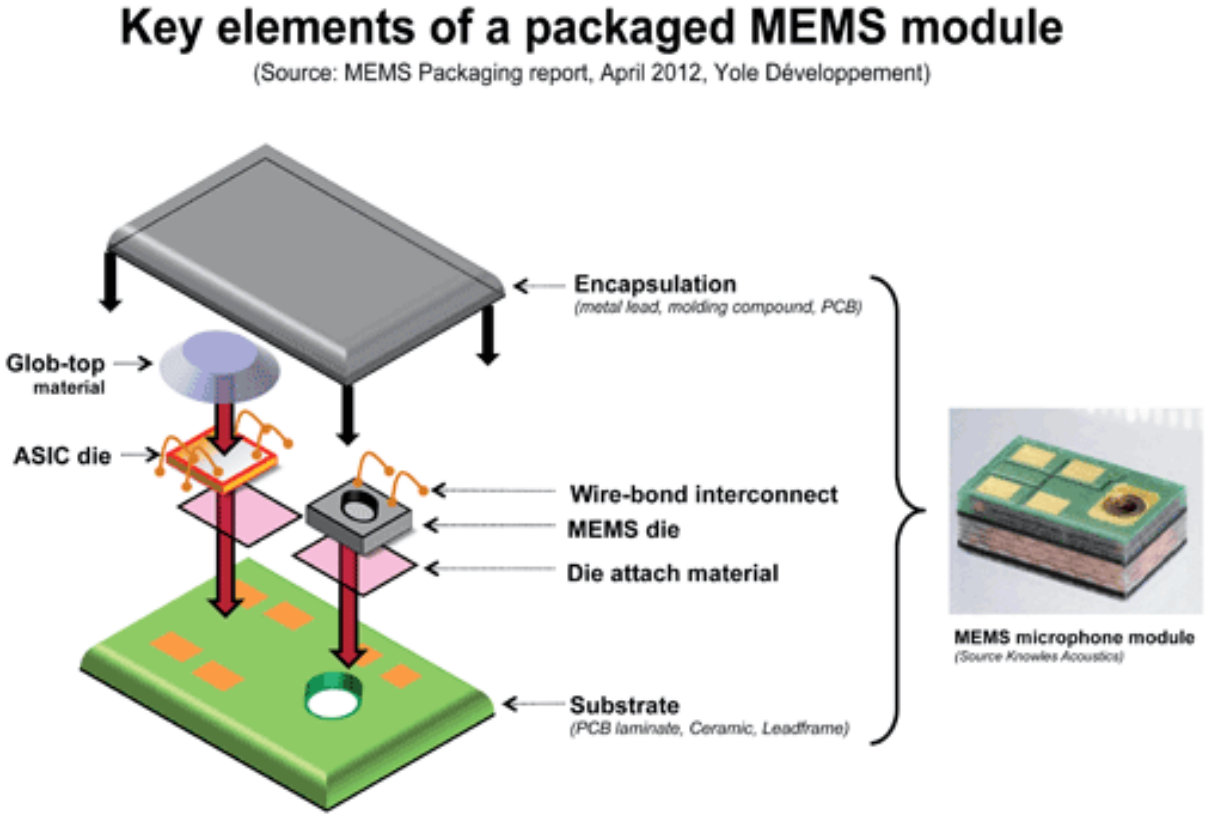
DesignNews

System Integration

- Packaging of MEMS chips
- Choosing MEMS
- System interface

MEMS package overview



Packaging MEMS chips is tricky

- All MEMS sensors also sense temperature and strain
  - Die attach, wire bonding critical
- Package and test are ~ 70% of finished unit cost
- Buy finished parts (not bare die) unless you know what you are doing!

Package types

Sealed, hermetic MEMS

- Accelerometers
- Gyroscopes
- Oscillators
- Imagers

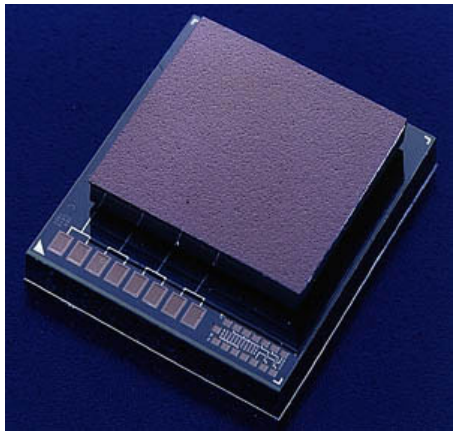
MEMS exposed to environment

- Pressure sensors
- Microphones
- Gas sensors
- Flow sensors

- Can be mounted like standard IC chips
- Board/case mounting requires access to outside world

Mounting

- Socket
- Surface mount to PCB
- Surface mount to flex circuit
- Flip chip
- Chip to wafer bonding



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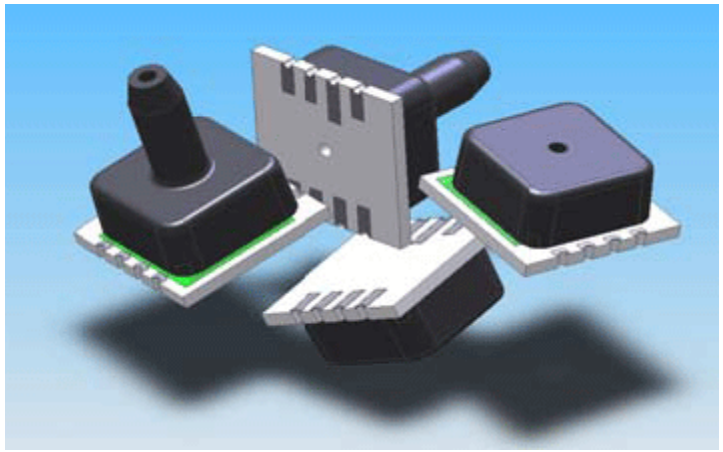


Special concerns for motion sensors

- Chip must be properly aligned with package axes
- Make sure mechanical mount won't filter out your signal!
  - Flexible structure is a low pass filter

Selecting MEMS sensors

Example: Motion sensors

Application

- Human or machine motion?
- Number of axes?
- Angular or linear acceleration, or both?
- Sensing range?

Selection Tables (ADI)

MEMS Inertial Sensors

Accelerometers

	Part Number	Range (*g*)	Output Type	Sensing Axes	BW Typ (kHz)	Sensitivity	Noise (mg/√Hz)	Voltage Supply (V)	Supply Current (mA)	Temperature Range (°C)	Package
MEMS Accelerometers	*Analog Accelerometers*										
	ADXL103	±1.7, ±18	Analog	1	2.5	100 mV/*g* to 1000 mV/*g*	0.11	3.0 to 6.0	0.7	−40 to +125	5 mm × 5 mm × 2 mm LCC
	ADXL203	±1.7, ±5, ±18	Analog	2	2.5	100 mV/*g* to 1000 mV/*g*	0.11	3.0 to 6.0	0.7	−40 to +125	5 mm × 5 mm × 2 mm LCC
	ADXL335	±3	Analog	3	1.6	300 mV/*g*	0.15	1.8 to 3.6	0.35	−40 to +85	4 mm × 4 mm × 1.45 mm LFCSP
	ADXL326	±16	Analog	3	1.6	57 mV/*g*	0.3	1.8 to 3.6	0.35	−40 to +85	4 mm × 4 mm × 1.45 mm LFCSP
	ADXL337	±3	Analog	3	1.6	300 mV/*g*	0.175	1.8 to 3.6	0.3	−40 to +85	3 mm × 3 mm × 1.45 mm LFCSP
	ADXL206	±5	Analog	2	2.5	312 mV/*g*	0.11	4.75 to 5.25	0.7	−40 to +175	13 mm × 8 mm × 2 mm SBDIP
	ADXL325	±5	Analog	3	1.6	174 mV/*g*	0.25	1.8 to 3.6	0.35	−40 to +85	4 mm × 4 mm × 1.45 mm LFCSP
	ADXL327	±2	Analog	3	1.6	440 mV/*g*	0.25	1.8 to 3.6	0.35	−40 to +85	4 mm × 4 mm × 1.45 mm LFCSP
	ADXL278	±35, ±50, ±70	Analog	2	0.4	27 mV/*g* to 55 mV/*g*	1.1	4.75 to 5.25	2.2	−40 to +105	5 mm × 5 mm × 2 mm LCC
	ADXL78	±35, ±50, ±70	Analog	1	0.4	27 mV/*g* to 55 mV/*g*	1.1	4.75 to 5.25	2.2	−40 to +105	5 mm × 5 mm × 2 mm LCC
	ADXL001	±70, ±250, ±500	Analog	1	22	2.2 mV/*g* to 16 mV/*g*	3.3	3.135 to 6	2.5	−40 to +125	5 mm × 5 mm × 2 mm LCC
	Digital Accelerometers										
	ADXL312	±1.5, ±3, ±6, ±12	Digital	3	1.6	2.9 mg/LSB	0.34	2.0 to 3.6	0.17	−40 to +105	5 mm × 5 mm × 1.45 mm LFCSP
	ADXL345	±2, ±4, ±8, ±16	Digital	3	1.6	3.9 mg/LSB	0.24	2.0 to 3.6	0.03 to 0.14	−40 to +85	3 mm × 5 mm × 1 mm LGA
	ADXL346	±2, ±4, ±8, ±16	Digital	3	1.6	3.9 mg/LSB	0.34	1.7 to 2.75	0.03 to 0.14	−40 to +85	3 mm × 3 mm × 1 mm LGA
	PWM Accelerometers										
	ADXL213	±1.2	PWM	2	0.25	30%/*g*	0.16	3.0 to 6.0	0.7	−40 to +85	5 mm × 5 mm × 2 mm LCC
	ADXL212	±2	PWM	2	0.5	12.5 %/*g*	0.5	3.0 to 5.25	0.7	−40 to +85	5 mm × 5 mm × 2 mm LCC
iSensor® MEMS Accelerometer Subsystems	*Digital Accelerometers*										
	ADIS16003	1.7	Digital	2	5.5	—	0.11	5	1.5	−40 to +125	7 mm × 7 mm LGA
	ADIS16006	5	Digital	2	2.2	—	0.2	5	1.5	−40 to +125	7 mm × 7 mm LGA
	Inclinometers										
	ADIS16209	±1.7; ±180°	Digital	2	0.05	0.025°/LSB	0.19	3.3	11 (normal); 0.14 (sleep)	−40 to +125	9 mm × 9 mm LGA
	ADIS16201	±1.7; ±90°	Digital	2	2.25	0.1°/LSB	—	3.3	11 (normal); 0.5 (sleep)	−40 to +125	9 mm × 9 mm LGA
	ADIS16203	±1.7; ±180°	Digital	1	2.25	0.025°/LSB	—	3.3	11 (normal); 0.5 (sleep)	−40 to +125	9 mm × 9 mm LGA
	ADIS16210	±1.7; ±180°	Digital	3	0.05	—	—	3.3	18 (normal); 0.23 (sleep)	−40 to +125	15 mm × 24 mm × 15 mm module
	Impact Sensors										
	ADIS16240	±19	Digital	3	1.6	51.4 mg/LSB	0.48	3	1 (normal); 0.1 (sleep)	−40 to +85	12 mm × 12 mm BGA
	ADIS16204	±70	Digital	2	0.4	8.407 mg/LSB	1.8	3.3	12 (normal); 0.15 (sleep)	−40 to +105	9 mm × 9 mm LGA
	Vibration Sensors										
	ADIS16228	±18	Digital	3	5	0.3052 mg/LSB	0.248	3.3	40 (normal); 0.23 (sleep)	−40 to +125	15 mm × 24 mm × 15 mm module
	ADIS16223	±70	Digital	3	22	4.768 mg/LSB	3.3	3.3	43 (normal); 0.23 (sleep)	−40 to +125	15 mm × 15 mm × 15 mm module
	ADIS16227	±70	Digital	3	22	1.192 mg/LSB	3.3	3.3	43 (normal); 0.23 (sleep)	−40 to +125	15 mm × 15 mm × 15 mm module

Selecting MEMS sensors

Power Consumption

- uA, mA
- Sleep mode

Interface

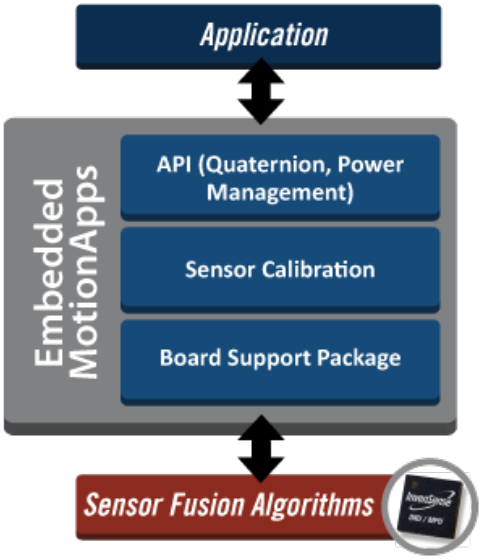
- Digital
- Analog

Selecting MEMS sensors

- Temperature Stability
  - Operating temperature range
  - ppm/degC
- Sensitivity
- Bandwidth
- Noise
- Read spec sheets and app notes carefully!

IDM system integration solutions

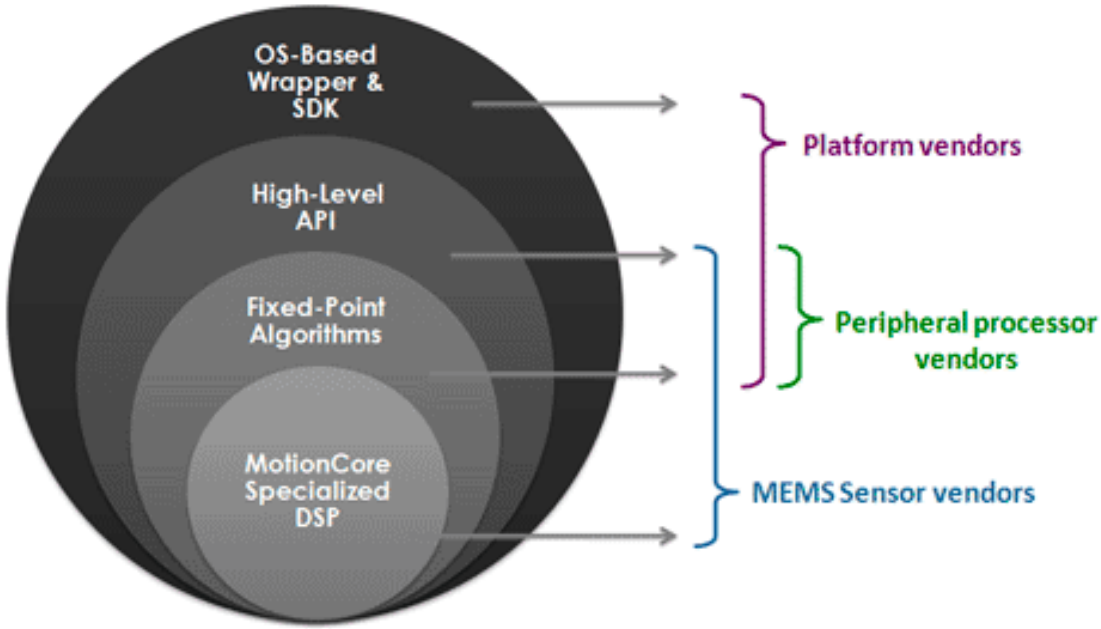
- InvenSense MotionApps™



- STMicro iNEMO

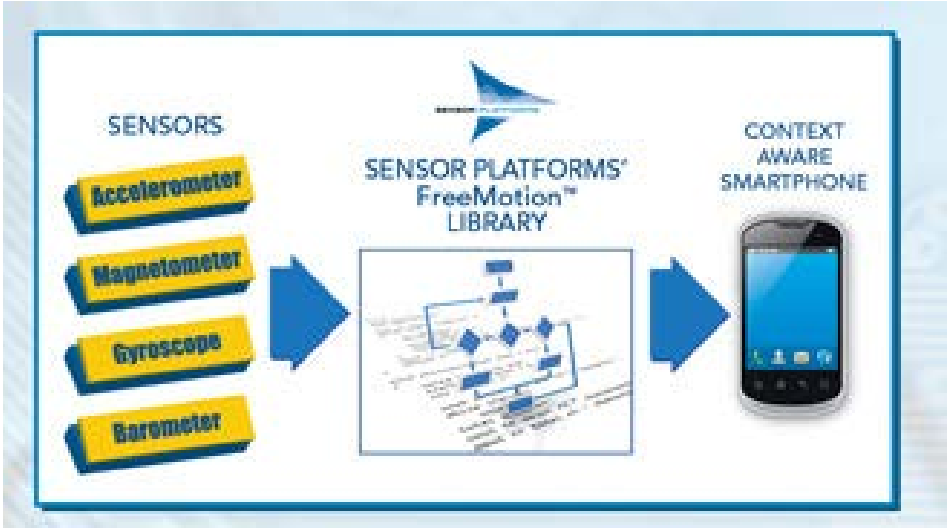
3rd party system solutions: Movea

- MotionCore™
- Sensor agnostic



3rd party system solutions: Sensor Platforms

- FreeMotion™ Library



Summary

- Lots of exciting applications for MEMS
- System integration solutions available
- Get busy and have fun!

- Thanks for listening!
- www.amfitzgerald.com