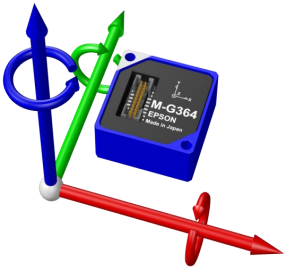


# EPSON Motion Sensor Products

March 2022



**CONFIDENTIAL**



# Content

- **QMEMS Technology**
- **Industrial IMUs**
- **Low Noise Accelerometer / Vibration Sensors**

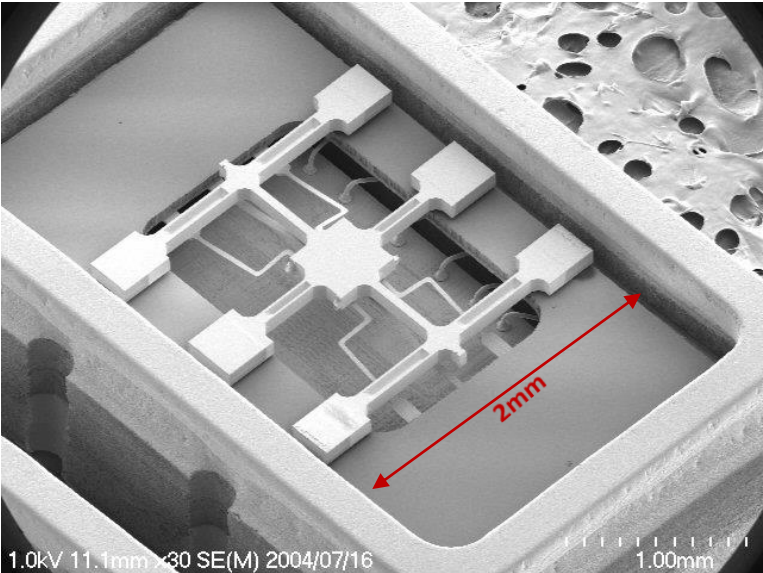


# QMEMS Technology

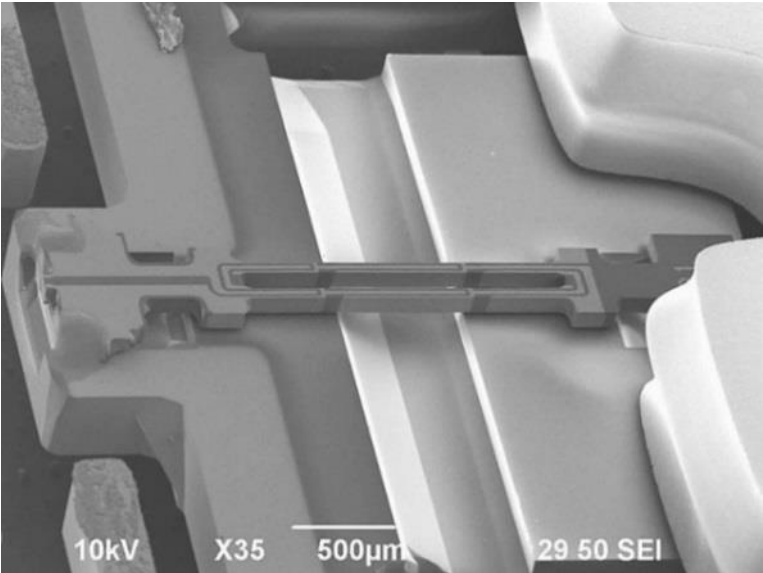


# Proprietary Epson QMEMS Technology

### Gyro-Element



### Accelerometer-Element



**QUARTZ** + **MEMS** = **QMEMS**



# Advantages of QMEMS

- **Proprietary Epson QMEMS structure**
  - High signal to noise ratio
  - High stability & precision
  - High sensitivity
  - Low zero-point drift
  - Low sensitivity against mechanical shock and vibration (gyro)



# Epson Motion Sensor Module Division

**QMEMS  
Technology**

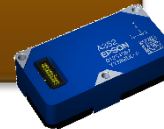
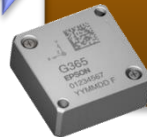
**Semiconductor  
Technology**

**All Key Components  
are produced by Epson**

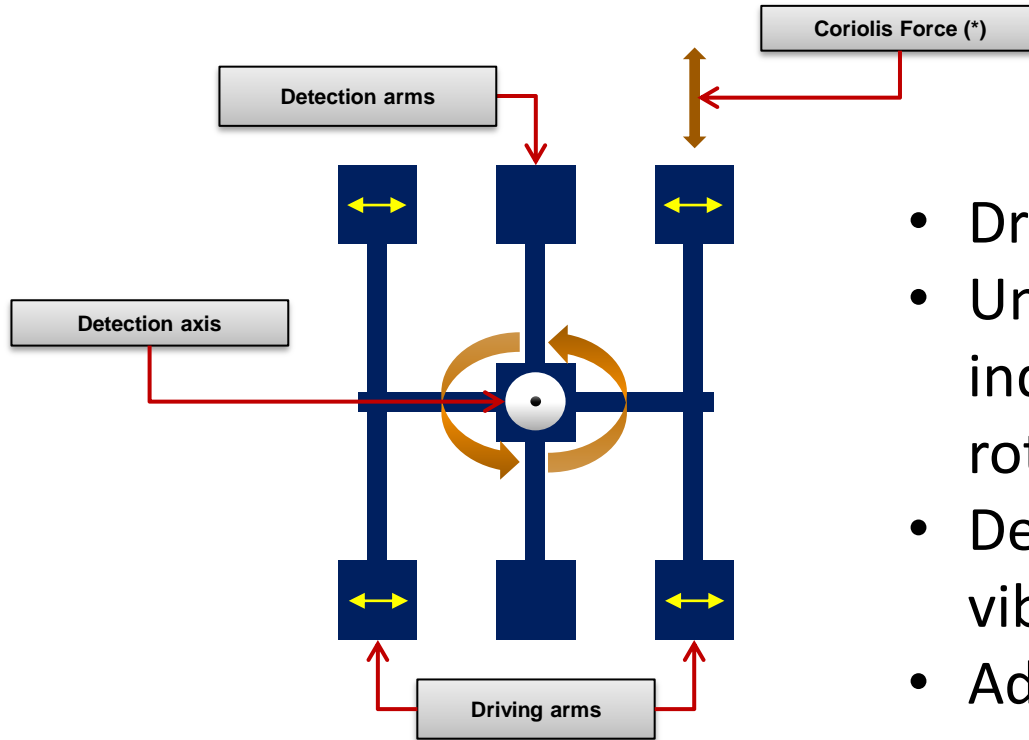
**High signal to noise ratio  
High stability & precision  
High sensitivity  
Low zero point drift**

**Low power  
High Integration  
Compact size  
Own Technology**

**IMU  
Accelerometer**



# QMEMS Gyro Element



- Driving arms vibrate constantly
- Under rotation, coriolis force induces a vibration around the rotation axis
- Detection arms follow this vibration
- Advantage: symmetric structure

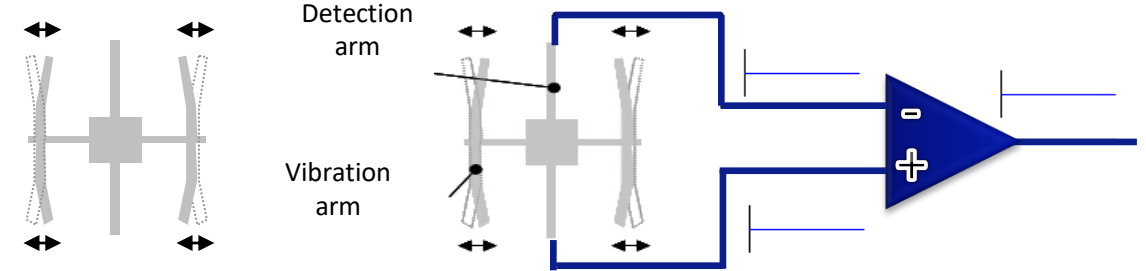
(\*) Coriolis Force:  $F_c = -2m\bar{\Omega} \times \bar{v}$

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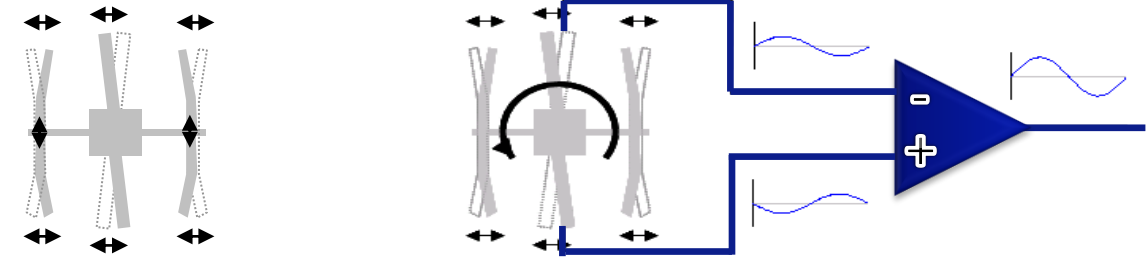


# Epson Gyro – Shock Resistance

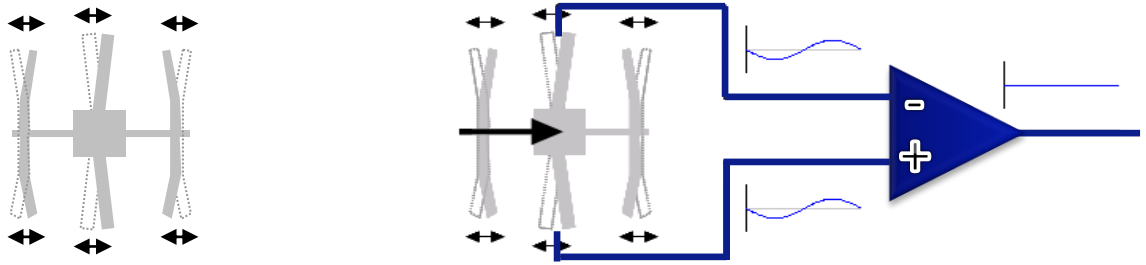
No rotation



Under rotation



Under shock or acceleration



**Differential amplifier cancels out signals caused by acceleration/shock**





# Industrial IMUs



# IMU - Definition

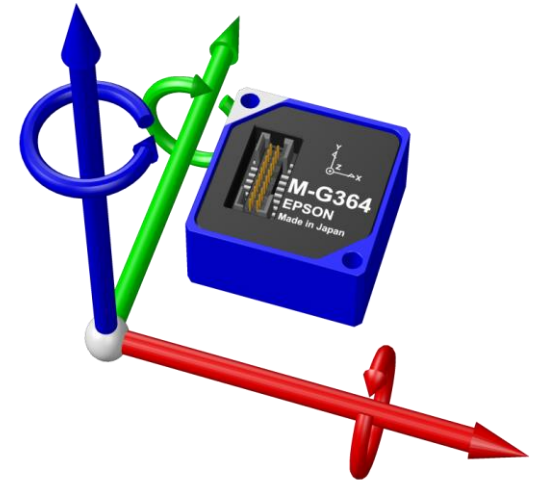
**IMU = Inertial Measurement Unit**

## Contains:

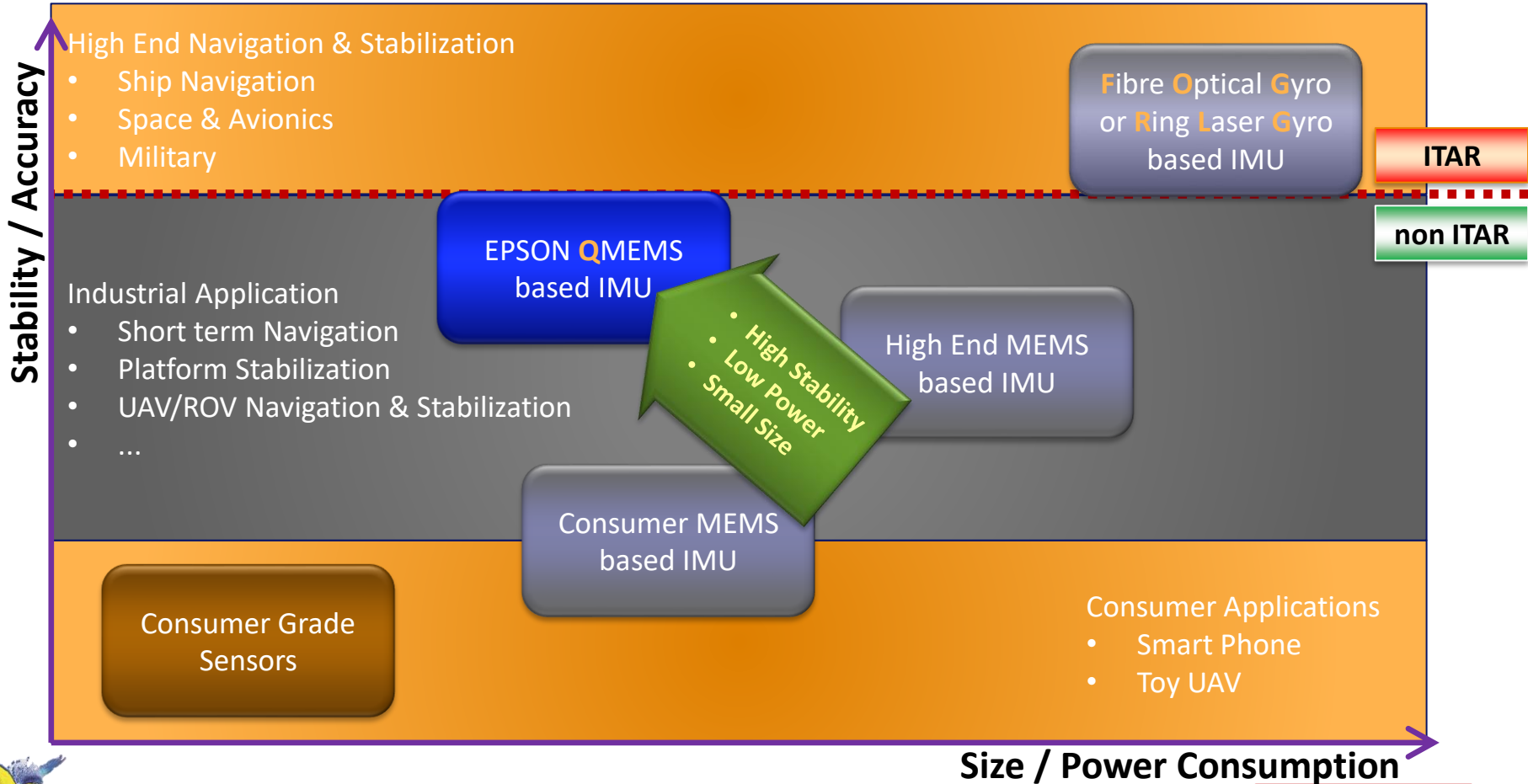
- 3x orthogonal gyro sensors (rotation speed)
- 3x orthogonal acceleration sensor

## Measures:

- Any change of state of motion
- Independent from external references



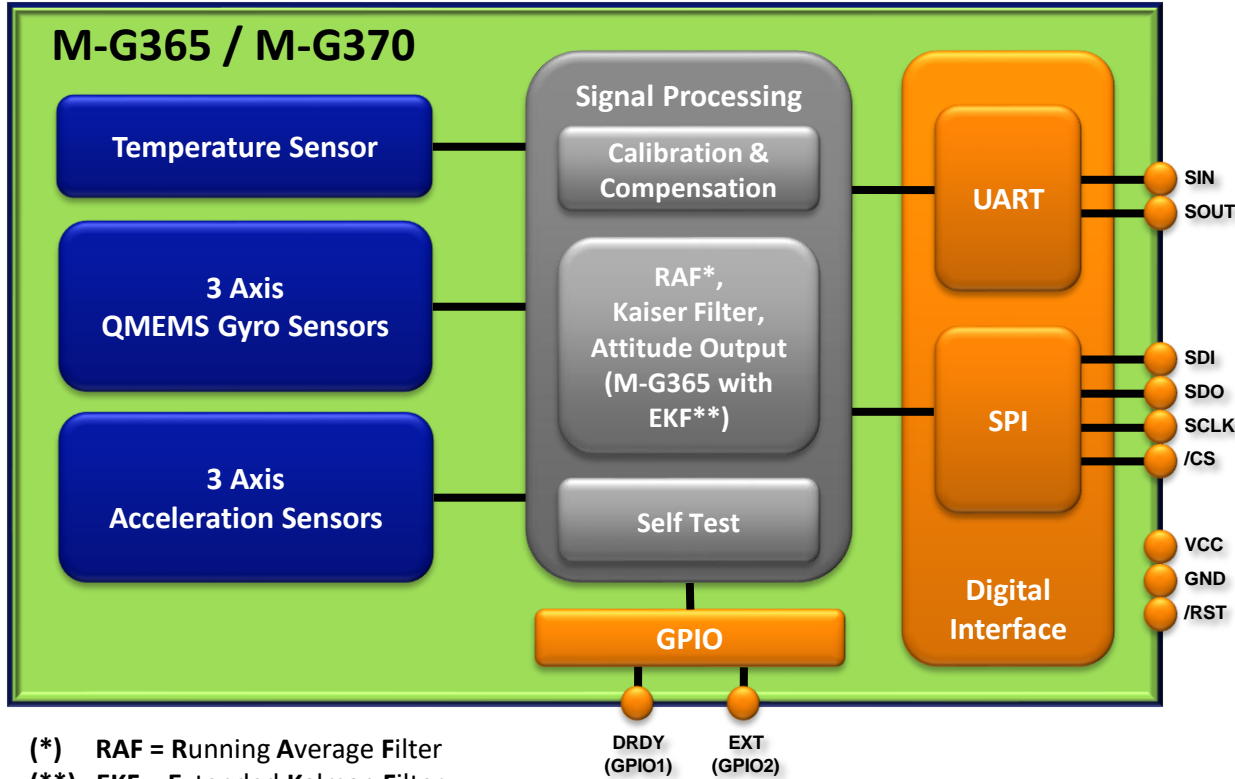
# Epson IMU Market Position



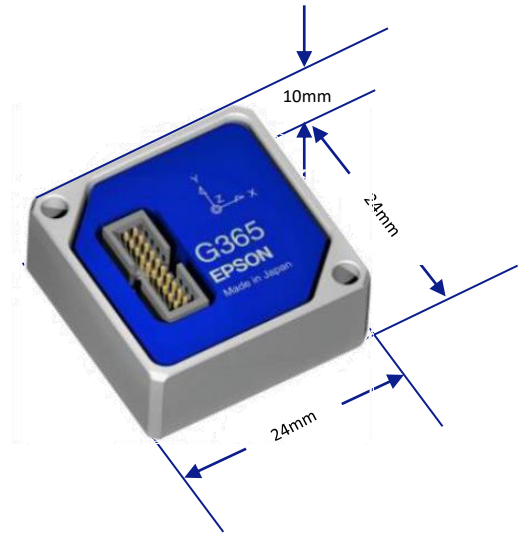
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# EPSON IMU Block Diagramm






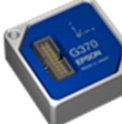

(\*) RAF = Running Average Filter  
(\*\*) EKF = Extended Kalman Filter



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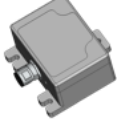
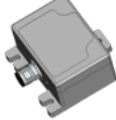



# EPSON IMU Lineup – Regular Versions

P/N	M-G364		M-G354	M-G365		M-G370	M-G370
P/N addition	PDC0	PDCA	PDH0	PDC1	PDF1	PDF1	PDS0
							
Status	M/P		M/P	M/P		M/P	M/P 2022
Gyro [dps]	±200	±100	±450	±450		±450	±200
Initial Bias Error [deg/sec,σ]	0.1		0.1	0.1		0.1	0.1
In-Run Bias Stability [deg/hr]	2.2		3	1.2		0.8	0.8
ARW [deg/√hr]	0.09		0.2	0.08		0.06	0.03
Noise [deg/sec/√Hz]	0.002		0.002	0.002		0.0013	0.0007
BW [Hz]	200		200	472		189	189
Accl [g]	±3		±5	±4	±10	±10	±10
Bias Error [mg,1σ]	5		5	3	3	2	2
BIS [μg]	50		70	8	14	12	12
VRW [m/s/√hr]	0.025		0.030	0.022	0.040	0.025	0.025
Noise [μg/√Hz]	60		60	48	80	60	60
BW [Hz]	200		200	167	167	167	167
Data output	16bit ≤ 2ksps or 32bit ≤ 1ksps						→
Max. Sample Rate	2ksps						→
Attitude Output	(N/A)			Embedded EKF		(N/A)	→
Interface	UART/SPI (20-pin connector)						→
PKG Size	24x24x10mm <sup>3</sup>						→
Operation Temp. [°C]	-40 to +85						→
Power (typ.)	3.3V, 18mA, 60mW			3.3V, 16mA, 53mW			→



# EPSON IMU Lineup – Rugged Versions

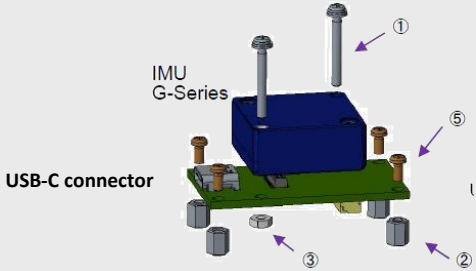
	Under Development			
P/N	M-G550	M-G552		M-G57x(**)
P/N addition	PC20	Px10	Px70	
				
Status	M/P	M/P	M/P	Development
Build in IMU	M-G320	M-G365PDF1	M-G370PDF1	
Gyro	±150dps	±450	±450	±450
Initial Bias Error [deg/sec,σ]	0.5	0.1	0.1	0.1
In-Run Bias Stability [deg/hr]	3.5	1.2	0.8	0.5
ARW [deg/√hr]	0.1	0.08	0.06	0.04
Noise [deg/sec/√Hz]	0.002	0.002	0.0013	0.0008
BW [Hz]	200	472	189	189
Accl	±5G	±10G	±10G	±10G
Bias Error [mG,σ]	15	3	2	2
In-Run-Bias Stability [μG]	100	14	10	6
VRW [m/s/√hr]	0.05	0.04	0.025	0.015
Noise [μG/√Hz]	100	80	60	35
BW [Hz]	200	167	167	167
Attitude Output	No	Yes	No	No
Interface	PC: CANopen	PC: CANopen PJ: CAN - SAE J1939 PR: RS422	PC: CANopen PJ: CAN - SAE J1939 PR: RS422	RS422
Max. Sample Rate [sps] (With attitude output)	1000 (N/A)	PC/PJ:1000 ; PR:2000 (200)	PC/PJ:1000 ; PR:2000 (N/A)	2000 (N/A)
Operation Temp. [°C]	-25 to +70	-30 to +80	-30 to +80	-30 to +70
PKG Size [mm³]	52x52x26	65x60x30	65x60x30	65x60x30
Environmental spec.	IP67	IP67	IP67	IP67
Power (typ.)	9-30V, 26.5mA@12V	9-30V, 550mW	9-30V, 550mW	9-30V, 550mW

(\*\*) under development, specification subject to change without further notice

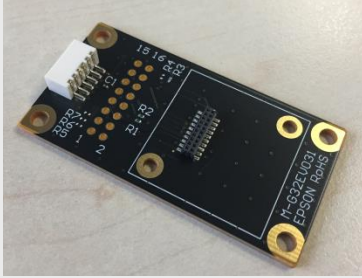


# IMU Evaluation Tools & Software

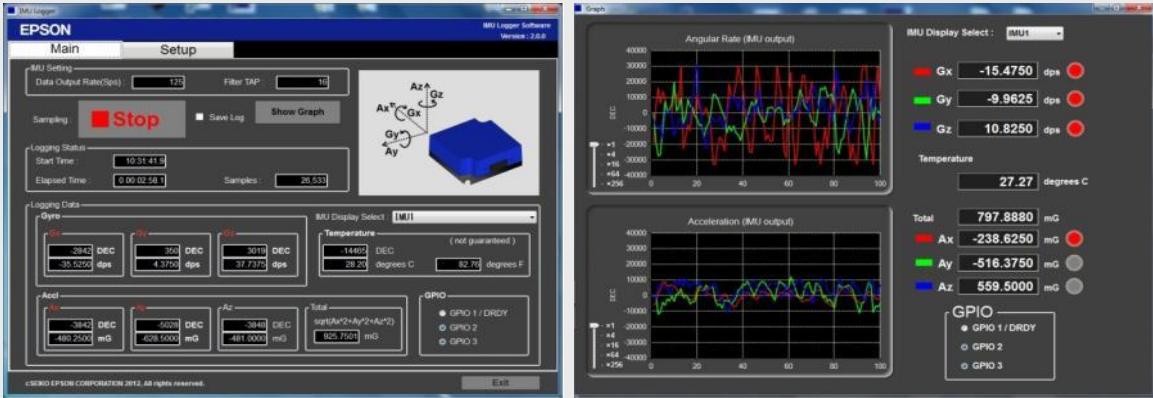
## USB connector board (M-G3EV041)



## Connector Board G-Series (M-G32EV031)



## Logger Software

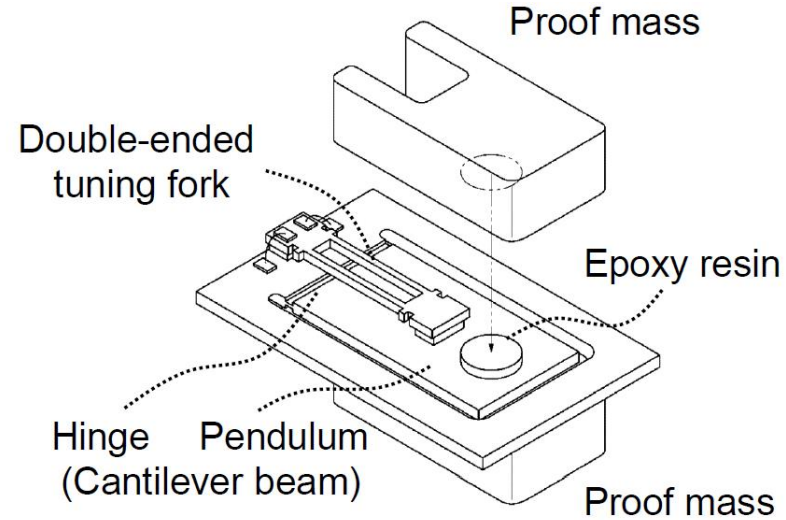
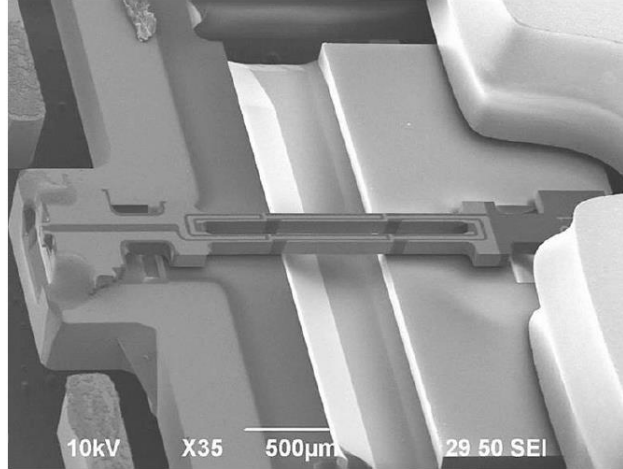


# Low Noise Accelerometer / Vibration Sensors

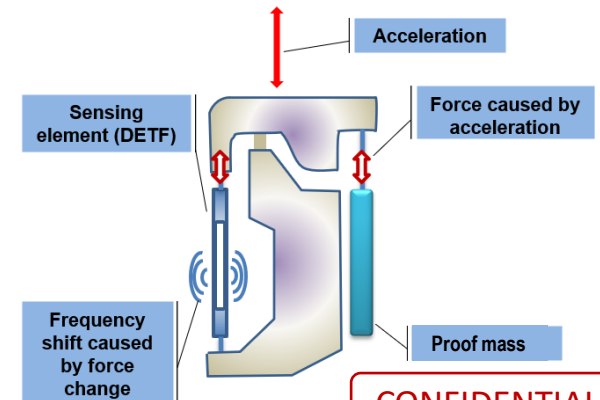




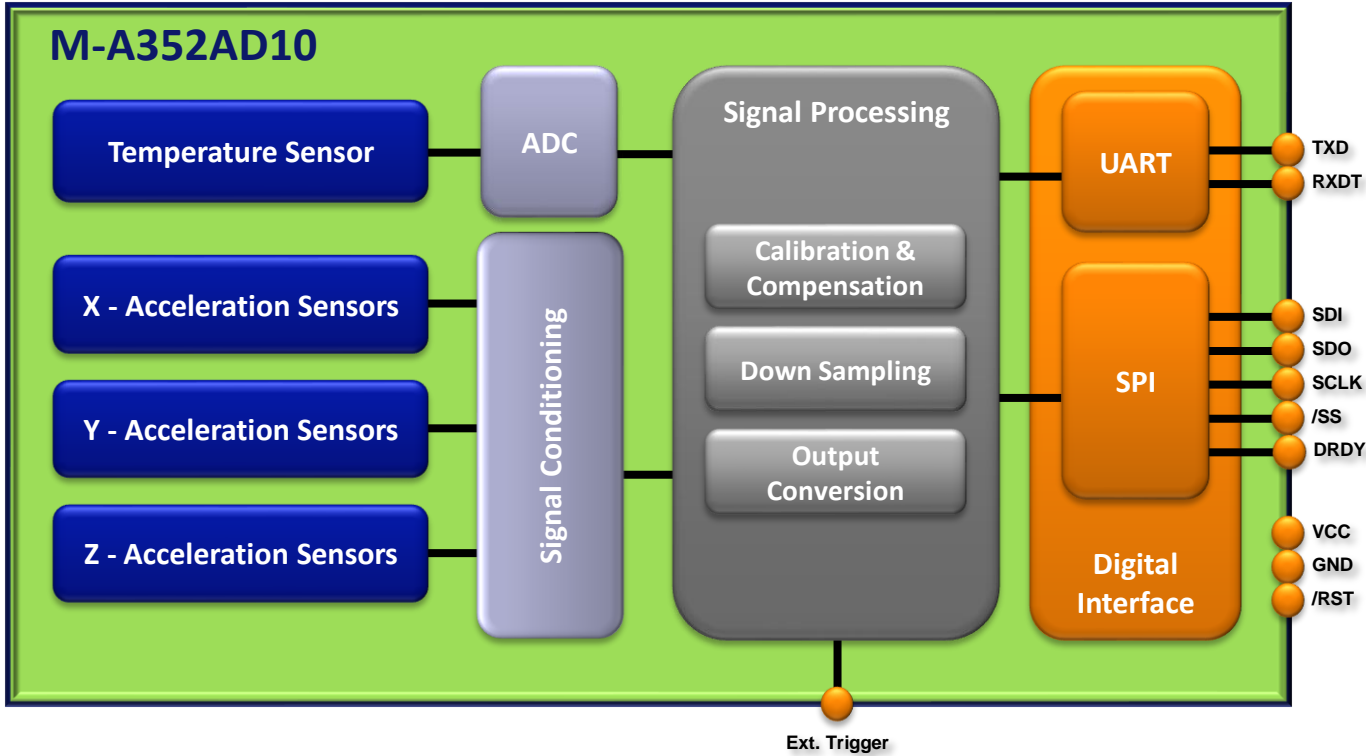
# QMEMS Acceleration Sensor Principal






- Resonance frequency changes with the force applied
- Force applied is proportional to acceleration of inertial mass
- Direct digital output => no additional noise by A/D converter



# EPSON Accelerometer Block Diagram



# Accelerometer Line Up

P/N	M-A352AD10	M-A552AC10	M-A552AR10
			
Status	M/P	M/P	M/P
<b>GENERAL DESCRIPTION</b>			
Dimensions [mm]	50x24x16	65x60x30	65x60x30
Housing	Al	IP67 conform	IP67 conform
Output Interface	UART & SPI	CAN	RS422
Number of Axes	3	3	3
Acceleration/Shock [G]	1,000	1,000	1,000
Operation Temp. [C]	-30 to 85	-30 to 70	-30 to 70
Operating Voltage [V]	3.3	9 - 32	9 - 32
Operating Current [mA]	20 typ @ 3.3V	35 typ @ 12V	40 typ @ 12V
<b>Accelerometer</b>			
Dynamic Range [G]		±15max	
Scale Factor [μG/LSB]		0.06	
Nonlinearity [% FS]		±0.03	
Misalignment [°]		0.1	
Initial Bias Error [mG]		±2 max	
Bias Repeatability [mG]		3	
Temperature sensitivity [mG/°C]		±0.1 typ	
Noise Density [μG/√Hz, rms]		0.2	
Bandwidth (-6dB) [Hz]		Up to 460 selectable	



# Specification: M-A542VR10,M-A342VD10

- ❖ Output physical quantity, output format, frequency range meet ISO10816/20816.
- ❖ There are 2 types of accelerometer. One is IP 67 dust- and water-protected RS422 interface unit. The other is built-in type accelerometer.

Item	Condition	Specification	Unit	ISO compliant
Detection axis		XYZ 3axis		Compliant
Output physical quantity		Velocity / displacement (switchable)		Compliant (Velocity output)
Output format		Raw / RMS / p-p (Switchable)		Compliant (RMS output)
Frequency range	Velocity -3dB at 25°C	10~1,000	Hz	Compliant
	Displacement -3dB at 25°C	1~100	Hz	
Dynamic range	Velocity	±100	mm/s	
	Displacement	0.2	m	
Noise density	Velocity	$2 \times 10^{-4}$	mm/s/ $\sqrt{\text{Hz}}$	
Dust-and water-protected	Unit	IP67		
Operating temperature range	Unit	-30~85 °C		



IP67 dust-and water-protected RS422 interface unit M-A542VR10



Built-in type Vibration sensor M-A342VD10

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# Summary: Feature of EPSON Vibration sensor

- **EPSON vibration sensor complies with floodgate of dam monitoring guideline, ISO10816/ 20816**

It can also output velocity and displacement.

- **Wide dynamic range**

There is no need to adjust for measurement range in accordance with intensity of vibration in the site.

- **No need to care about magnetic field**

Since quartz crystal is diamagnetic material, it is hard to be influenced by magnetic field.

Therefore, it can measure motor with magnetic field precisely.

- **Resistant to noise**

Digital output

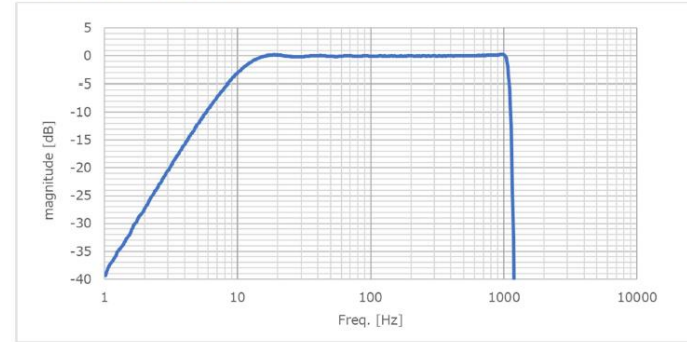
- **Simple measurement environment**

Peripheral like charge amplifier and AD converter is not needed

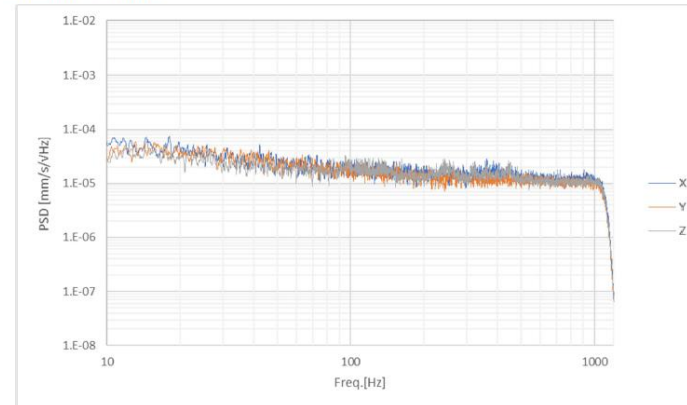
- **High reliability**

MTBF : 87,600 hours

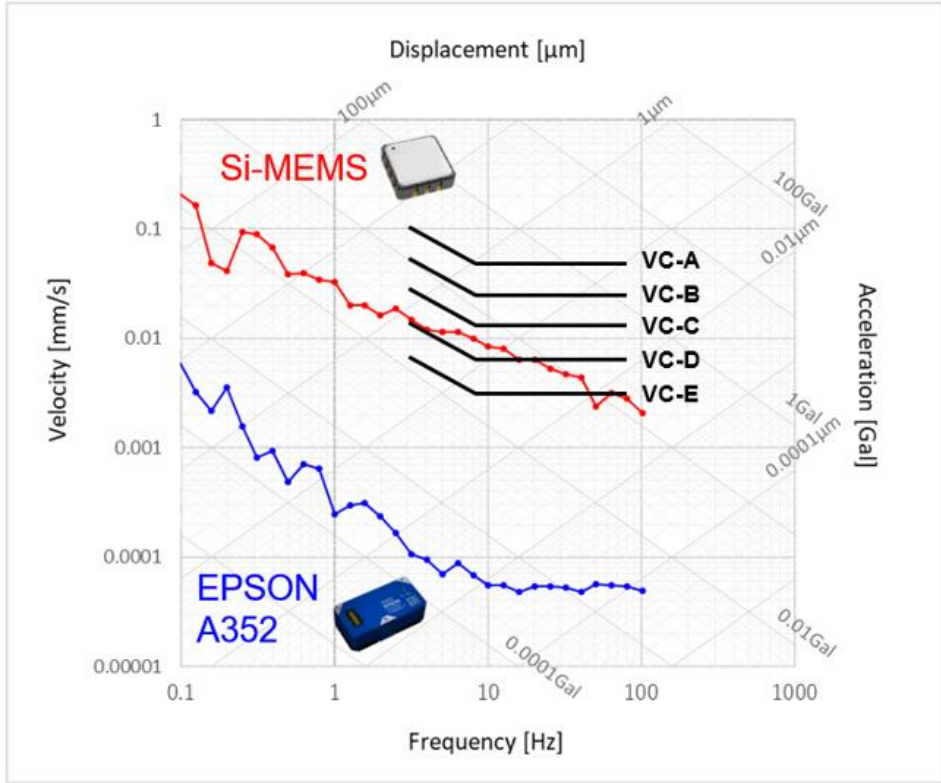
■ FREQUENCY RESPONSE



■ NOISE DENSITY



# M-A352 Low Noise Density



- To see the real noise performance of Epson A352, we must go underground.
- Epson A352 can be used to identify all environmental vibration criteria (VC-A to VC-E).



Measurement location image (Not actual location)





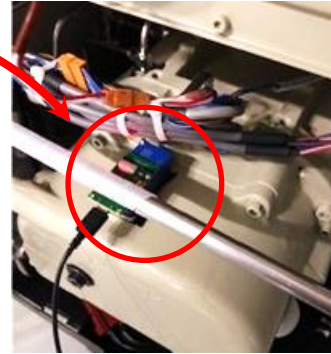
# MHM - Predictive Maintenance of Motors/Fans

- One of our target applications is to manage manufacturing plants.
- Abnormalities can be prevented by observing changes in the vibrations over time and changes over the years.

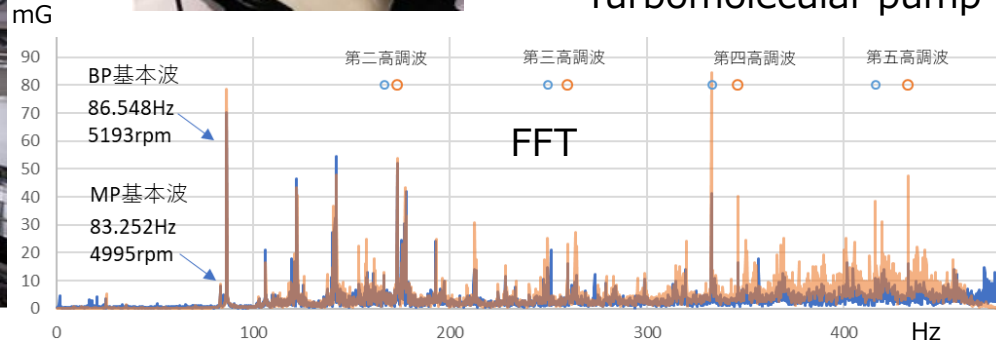
Quartz accelerometer / IMU



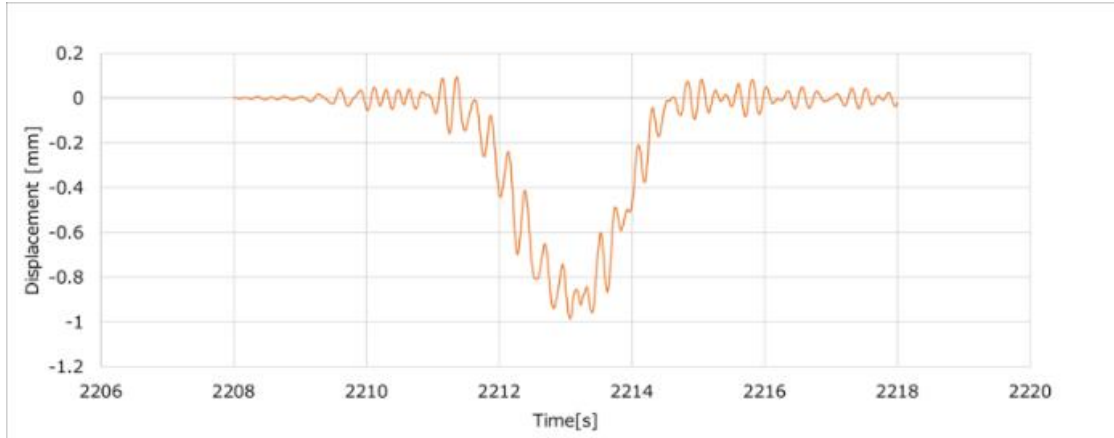
Semiconductor fabrication plant



Turbomolecular pump



# Accel. Appl. – Other: Weight in Motion (WIM)



Example of deformation by a vehicle passing.

Two signals are visible with the M-A352:

1. Resonance frequency of the bridge:
  - +/- 0.1mm amplitude of 4Hz cycles
2. Deformation of the bridge:
  - -1mm amplitude of 0.2Hz cycle
  - Can be used to calculate weight of vehicle (WIM or Weight in Motion)



Measurement location image (Not actual location)





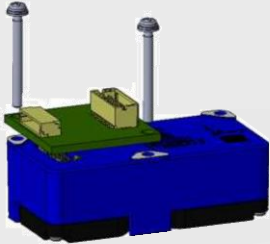
# Target Application

- Building & Structural Health Monitoring
- Seismic Measurements
- Earthquake Detection
- Vibration Control and Stabilization
- Motion Analysis and Control
- Weight in Motion
- Machine Health Monitoring

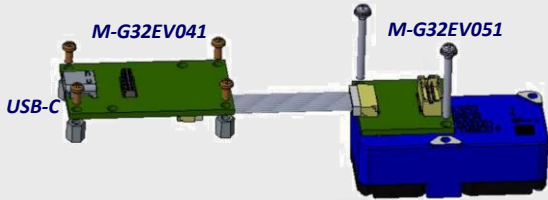


# Accelerometer M-A352 – Eval. Tools & Software

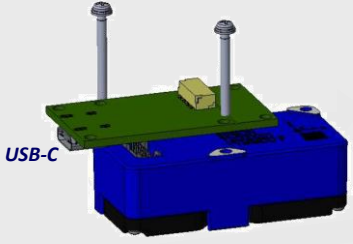
## Connector Board (M-G32EV051)



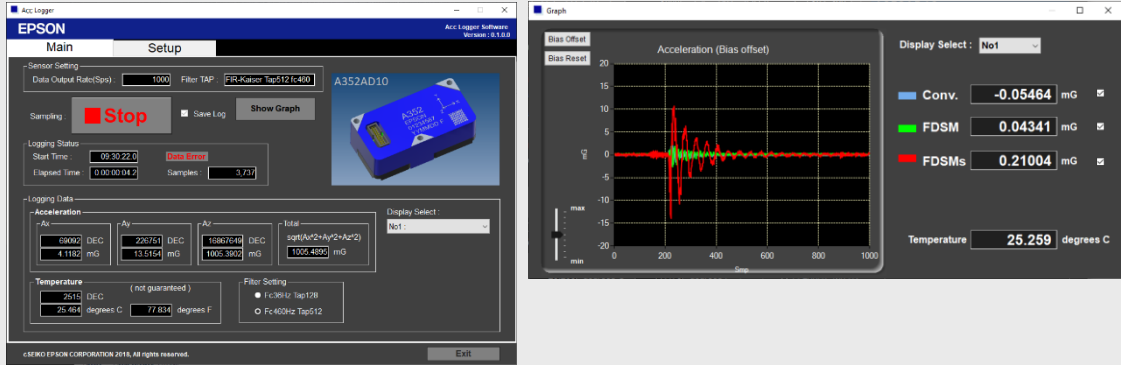
## Flex. USB Connection (M-G32EV041 & M-G32EV051)



## USB Board (M-G32EV041)



## Logger Software



# EPSON

EXCEED YOUR VISION

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