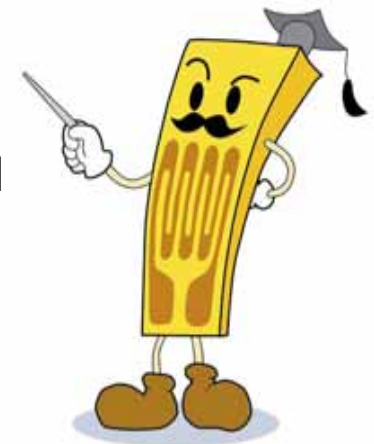


# Miniature Damped Accelerometer Series offers Wide Range of Applications

developed & manufactured by  
**Kyowa Electronic Instruments Co. Ltd.,**

Presented by  
KYOWA Electronic Instruments Co. Ltd & ZSE GmbH  
Mitsutaka Kanehira, chief engineer

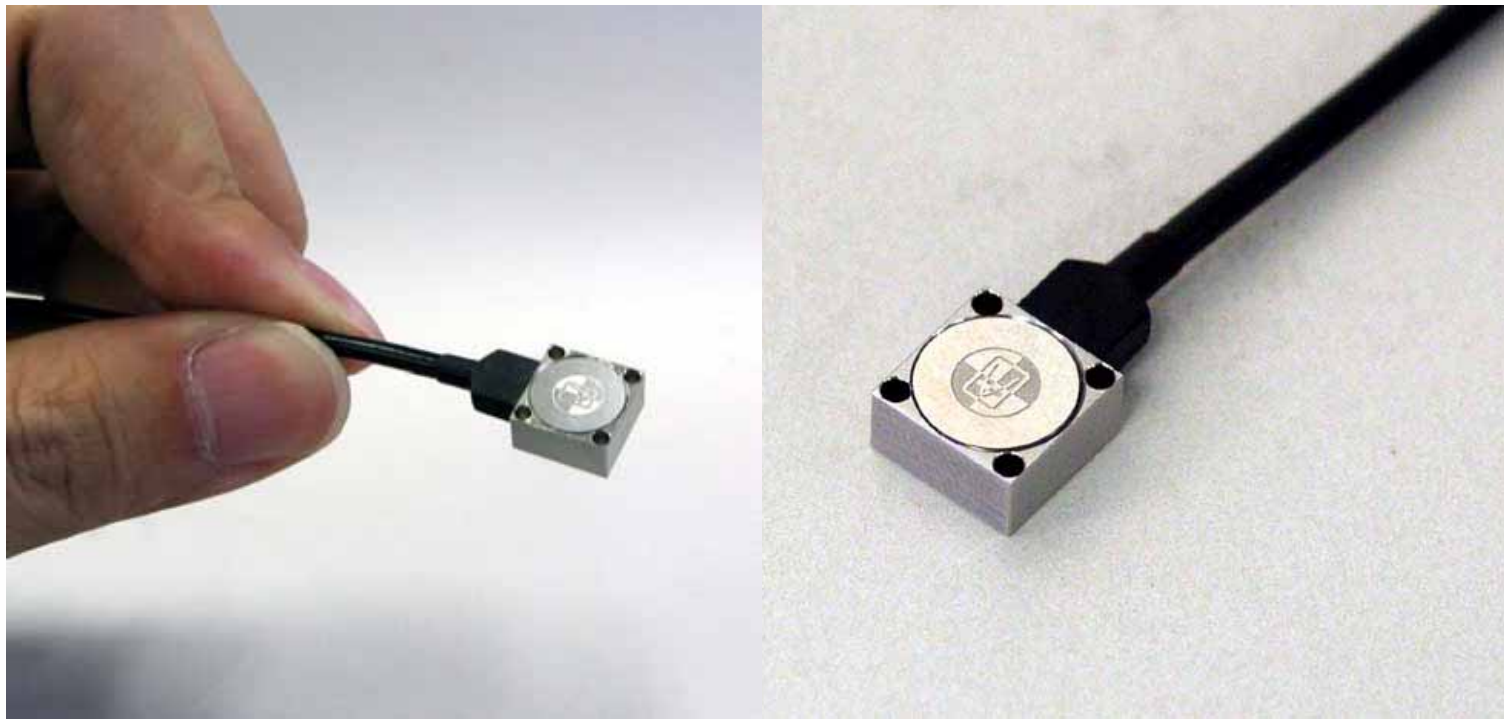
Tuesday 31 May, 2005



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# New Damped Accelerometer ASE-A Series



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# Introduction

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## Accelerometers

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Accelerometers are used to detect & measure acceleration of a mass such as a vehicle and its components.

When connected to the appropriate Data Acquisition System, they accurately quantify:

- Amplitude of vibration
- Frequency spectrum
- Velocity
- Displacement



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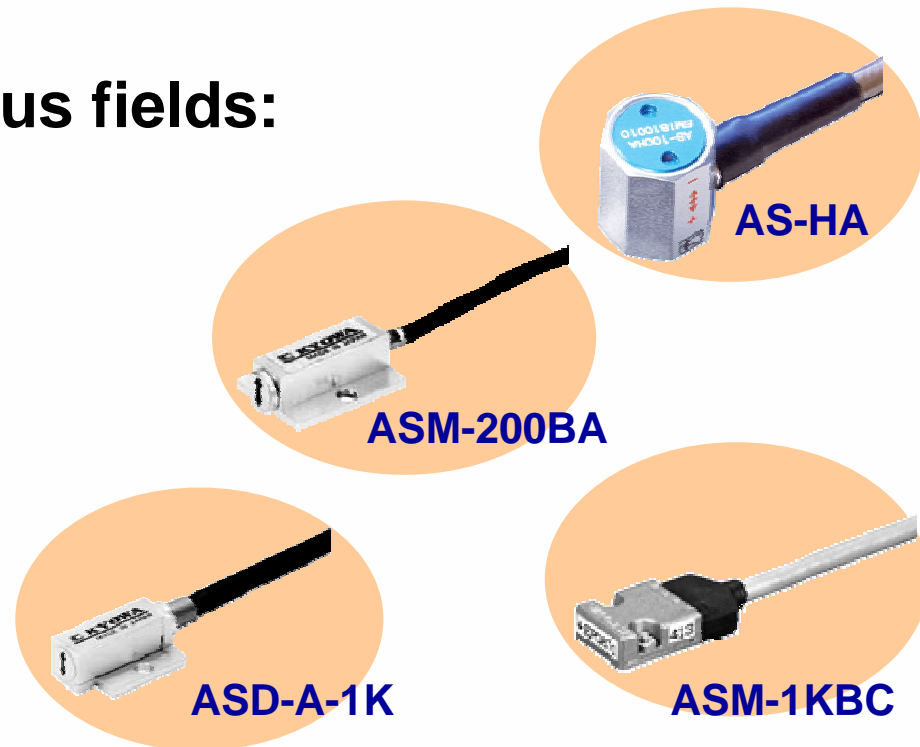
# Introduction

## Accelerometers

Accelerometers are an essential sensor for automobile development and evaluation, experimental measurement, and analysis.

### ■ Widely utilized in various fields:

- ◆ Power train
- ◆ Controllability
- ◆ Drive train
- ◆ Strength, Reliability
- ◆ Car Crash Testing
- ◆ Product Line



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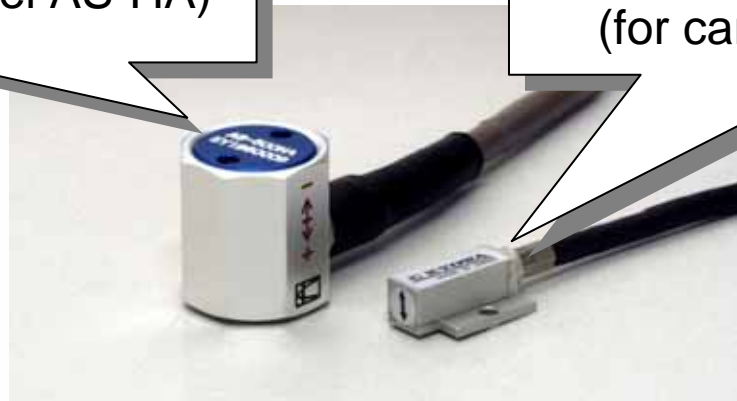
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## Comparison of Damped and Undamped Accelerometers

**Specific differences between damped and undamped Accelerometers are Size and Frequency characteristics**

**Damped Accelerometer**  
(Kyowa's current model AS-HA)

**Undamped Accelerometer**  
(for car crash testing ASD-A)



### ■ Size

Until now, Kyowa damped accelerometers were larger than undamped types because of the complicated internal structure needed for damping ratio design.

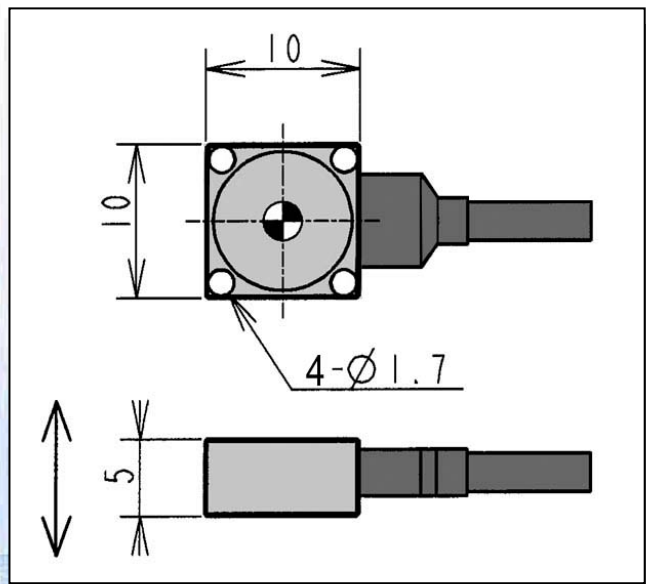


## New Damped Accelerometer ASE-A Series

### Small, Light Weight Design

Utilizing sputtering technology, size and weight are minimized

- **Dimensions: 10 x 10 x 5mm (0.4 x 0.4 x 0.2inch)**
- **Weight: Approx. 3grams (0.1oz)**

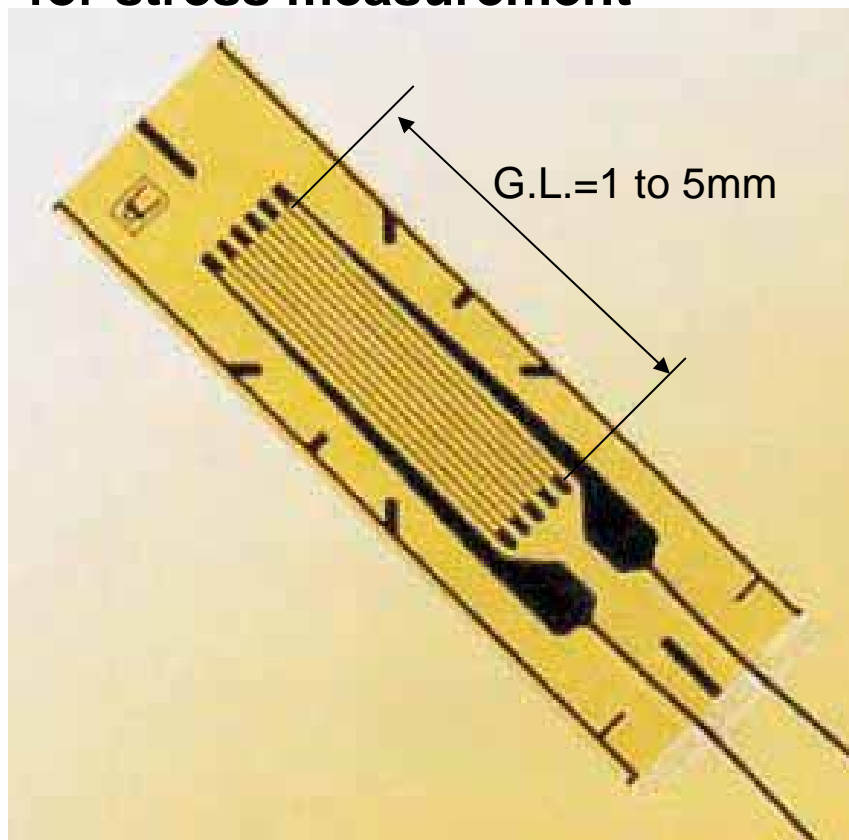


- Minimal impact on the vibration mode of the object under measurement
- Ideal for space limited applications

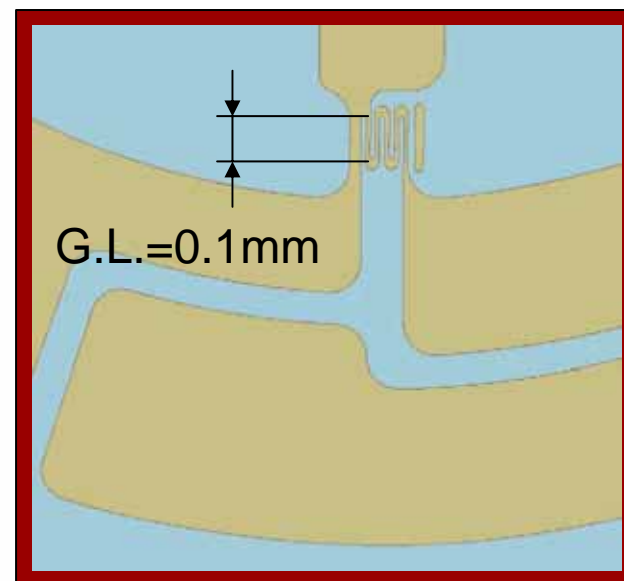
# New Damped Accelerometer ASE-A Series

## ASE-A Accelerometer Technical Features

- Typical Strain gage for stress measurement



- New Accelerometer gage pattern using sputtering techniques



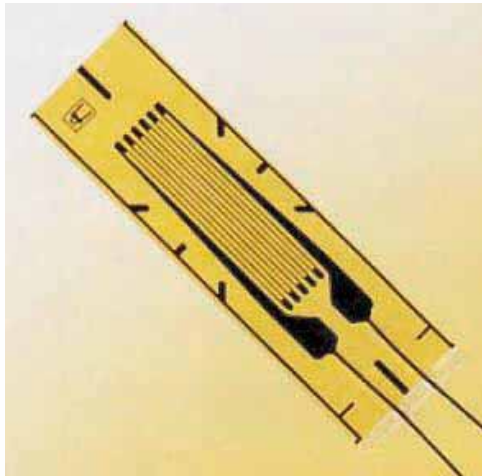
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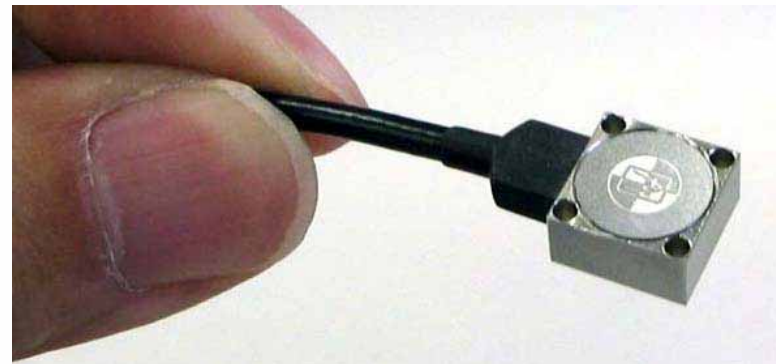
# New Damped Accelerometer ASE-A Series

## Kyowa Strain Gage Technology

KYOWA commercialized the first Japanese-made strain gages in 1951.



Based on the abundant experience and technologies accumulated over 50 years, KYOWA now manufactures many kinds of high-performance Strain Gages and Strain gage based Transducers.



ASE-A using sputtering techniques to form micro-size strain gage and install without any adhesive.



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## New Damped Accelerometer ASE-A Series

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### Optimized Damping

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Achieving the Optimized Damping Ratio  
Prevents Transducer Resonance

ASE-A Damping Ratio: Approx. 0.7



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## Advantages of Using Damped Accelerometers

**Choosing the proper damping is an effective way to prevent transducer resonance output that exceeds the input amplifier accurate measurement range**

### ■ What is “Optimized Damping”?

In order to respond faithfully to the input waveform, the delay time of the accelerometer output should remain constant throughout the frequency spectrum of the input waveform.

When the damping ratio is approximately 0.7, signals shift on the time axis in the amount of the delay time, but the original waveform of the signal itself is maintained.



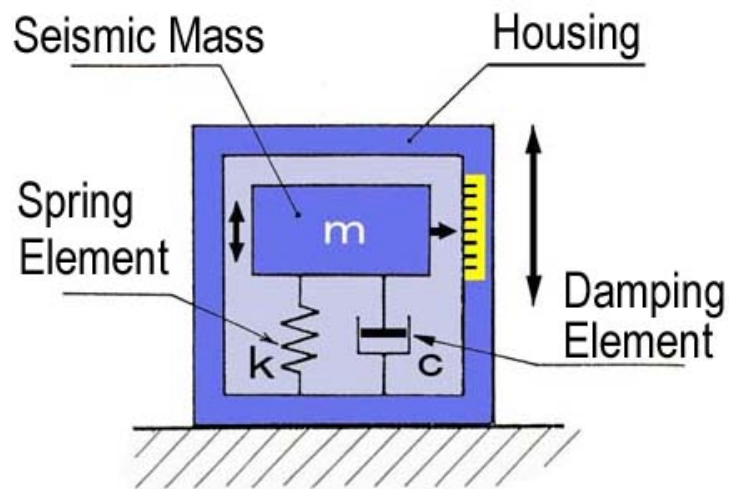
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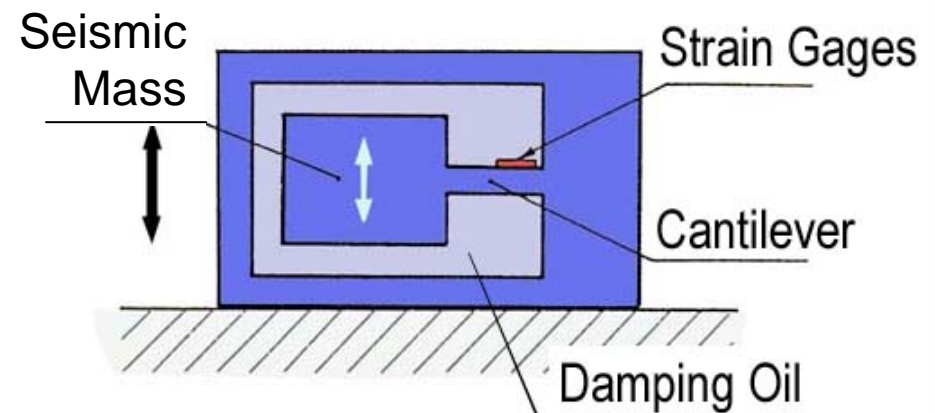
# Fundamental Structure of Accelerometers

Common accelerometer structure consists of seismic mass, spring, and damping element.

## Conceptualization

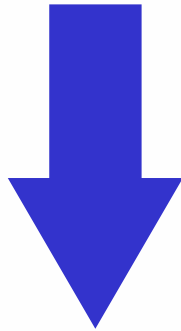


## Example of Structure

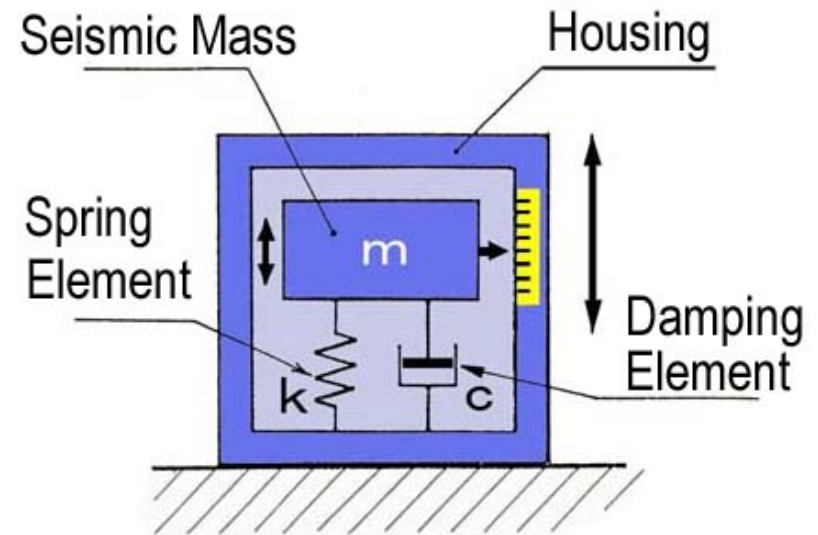


## Fundamental Structure of Accelerometers

Relative displacement between housing and seismic mass are in proportion to the input acceleration within a frequency response range.



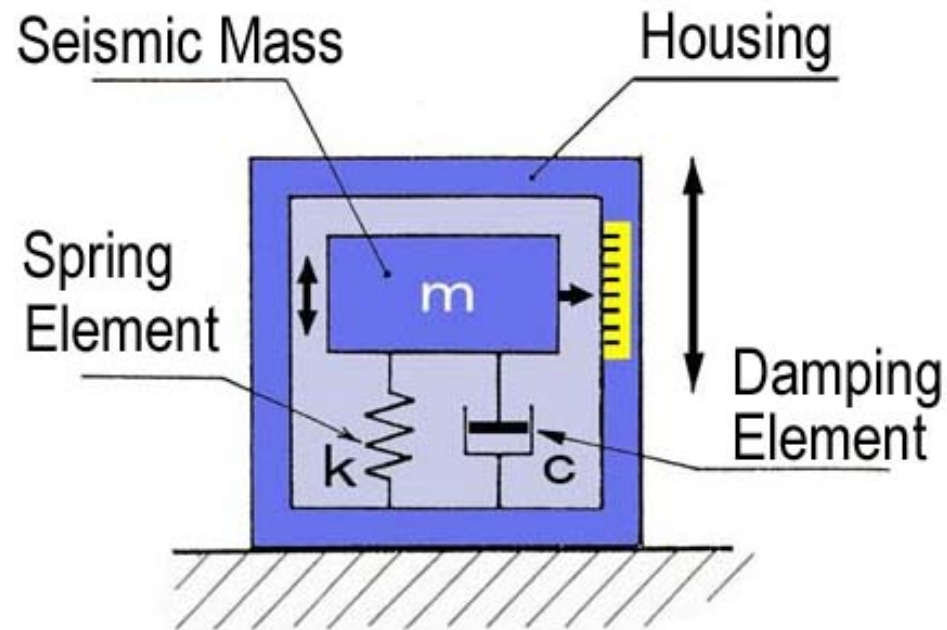
Acceleration is measured by detecting the relative seismic mass displacement .



# Fundamental Structure of Accelerometers

## What is damping?

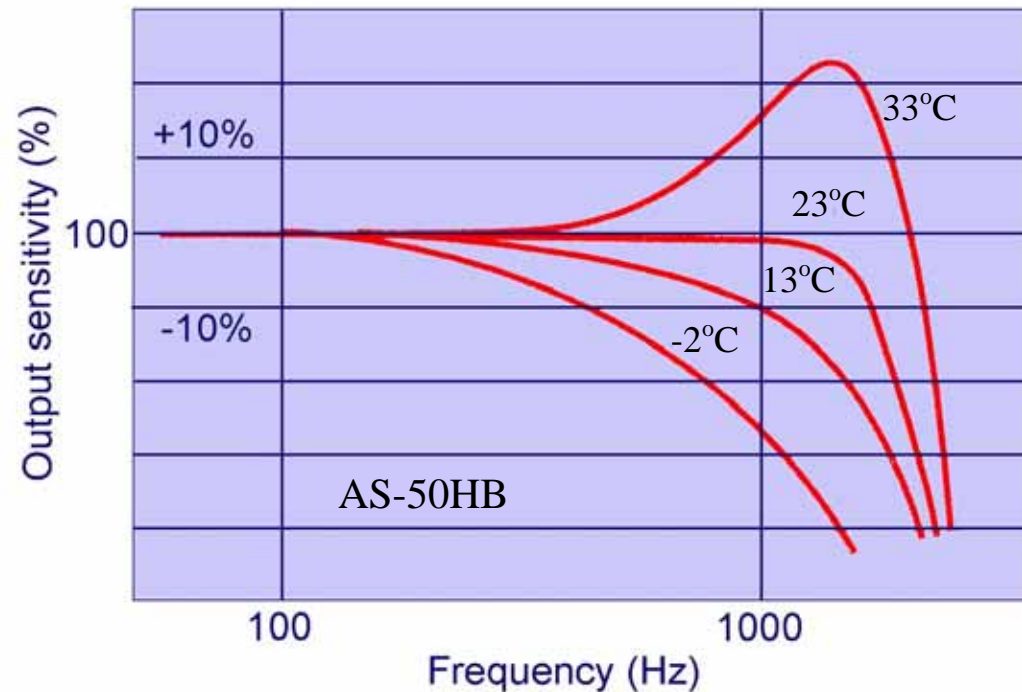
### Fundamental Conceptualization of Accelerometer



## Temperature Effect for Frequency Response

The viscosity of the damping oil is adjusted to the frequency response optimized at 23°C.

Changes in viscosity due to temperature changes affect the frequency response and Phase characteristics. The frequency response characteristics of our typical damped accelerometer are affected by Temperatures as shown in the figure below.

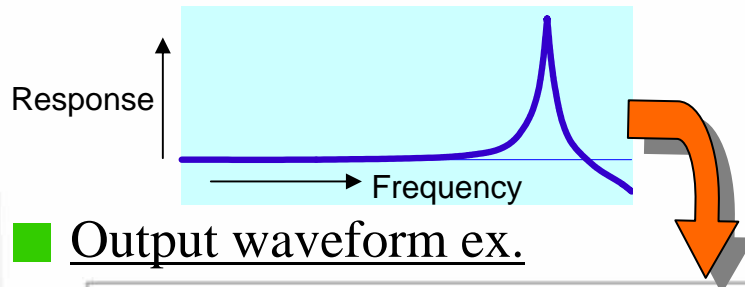


# Comparison between Damped and Undamped Accelerometers

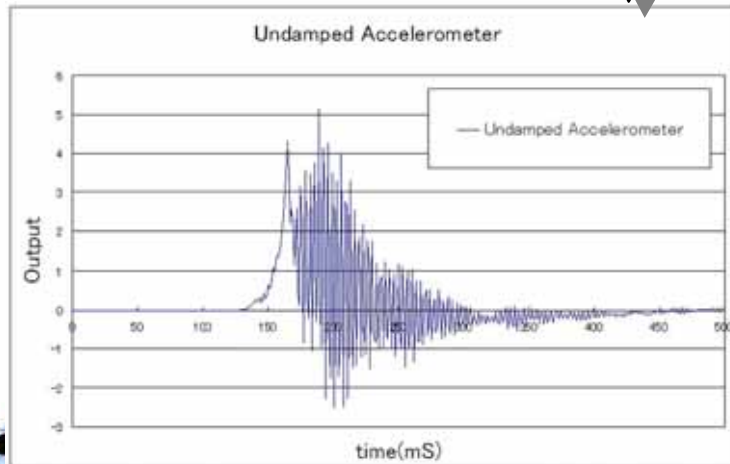
## Undamped Type

Small in size. Has a resonance peak in the frequency characteristic.

### Frequency characteristics



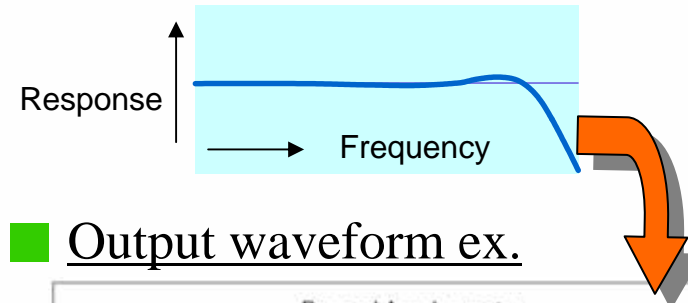
### Output waveform ex.



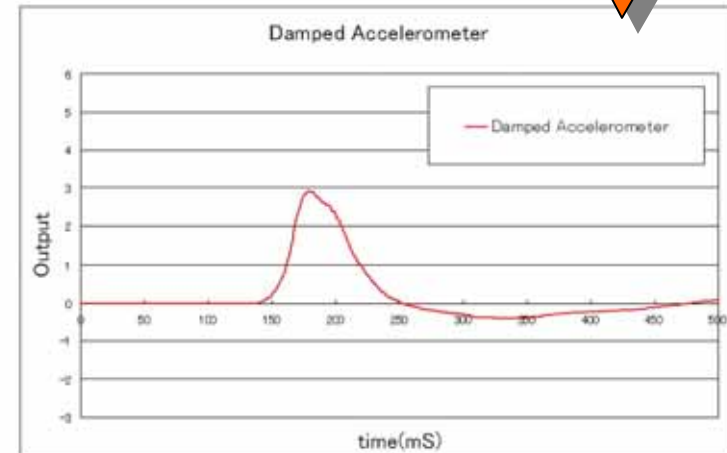
## Damped Type

Larger size. No resonance peak in the frequency characteristic.

### Frequency characteristics



### Output waveform ex.

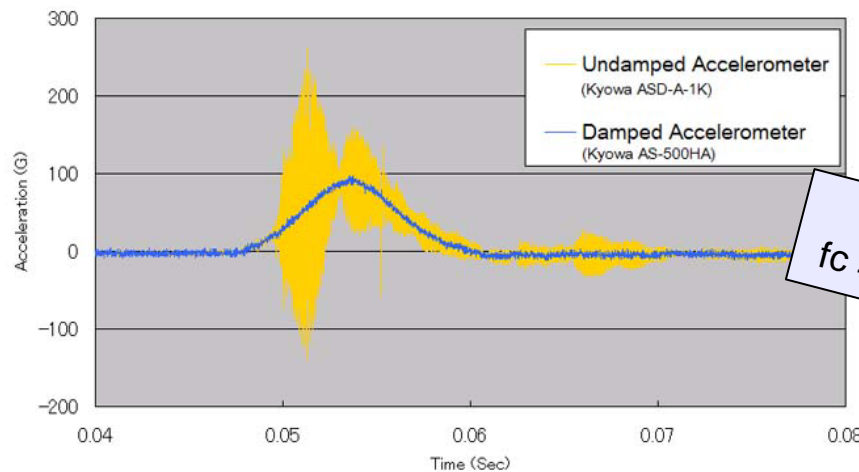


# Undamped Accelerometer Measurement Problems

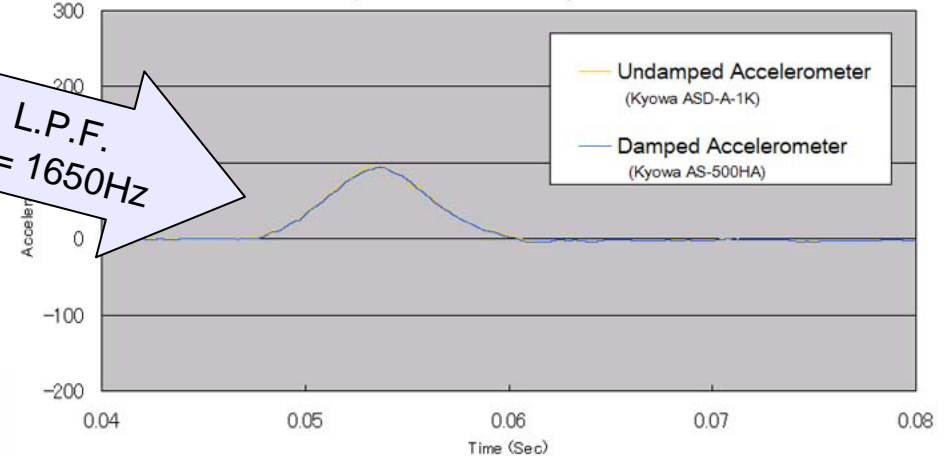
## Undamped Accelerometer Measurement Problems

If a waveform contains a spectrum of frequencies that are near the resonance frequency of the accelerometer, a resonance vibration occurs. This introduces the possibility of resonant waveform signals that exceed the range of the input amplifier (saturates the amplifier).

Response waveform  
by Damped and Undamped accelerometer



Response waveform  
by Damped and Undamped Accelerometer  
(L.P.F:  $f_c=1650\text{Hz}$ )



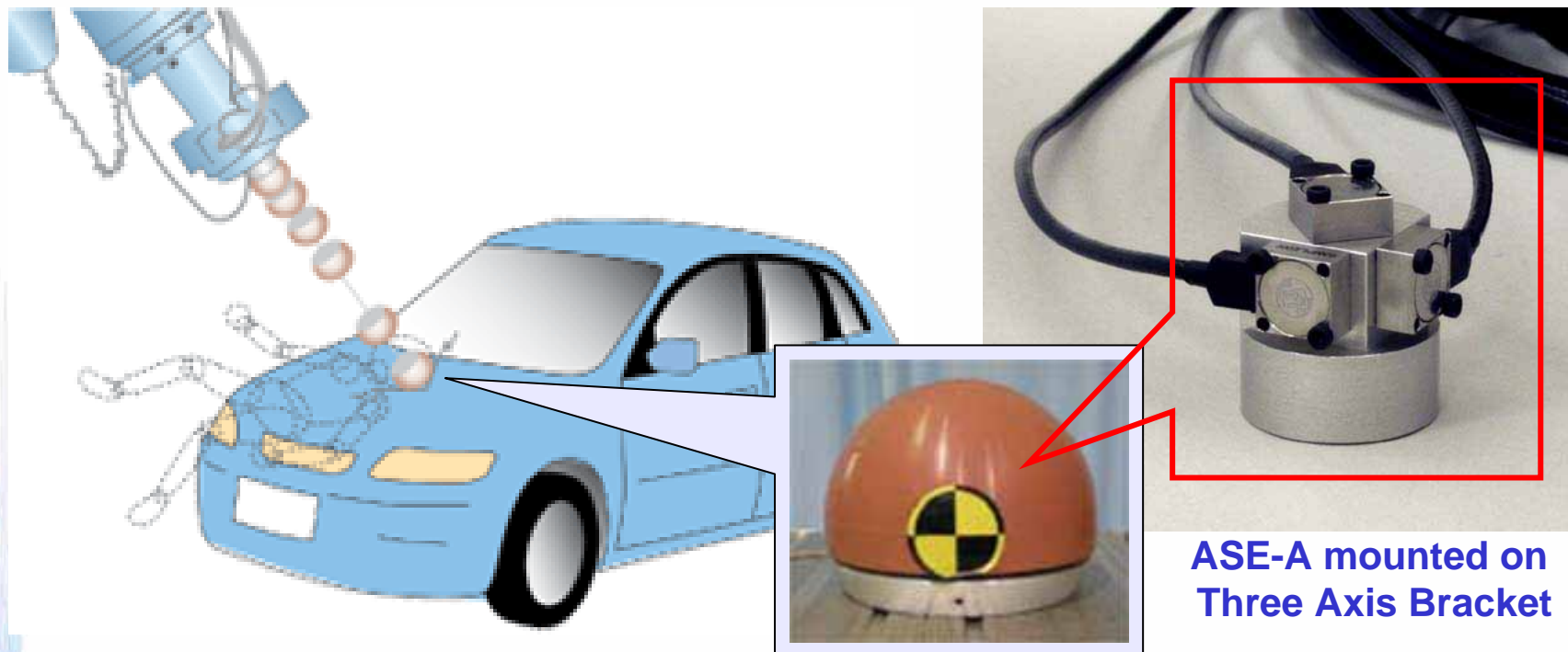
L.P.F.  
 $f_c = 1650\text{Hz}$



# New Damped Accelerometer ASE-A Series

## Application Example of New Damped Accelerometer ASE-A

### ■ Application Example for Pedestrian Head Protection Performance Tests



*Photo by courtesy of  
National Organization for Automotive Safety & Victims' Aid*



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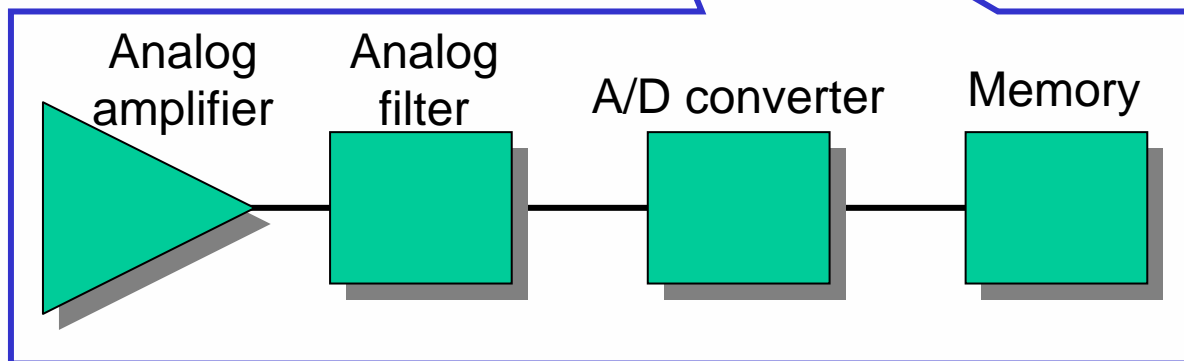
# New Damped Accelerometer ASE-A Series

## Application Example of New Damped Accelerometer ASE-A

### ■ Application Example for Pedestrian Head Protection Performance Tests

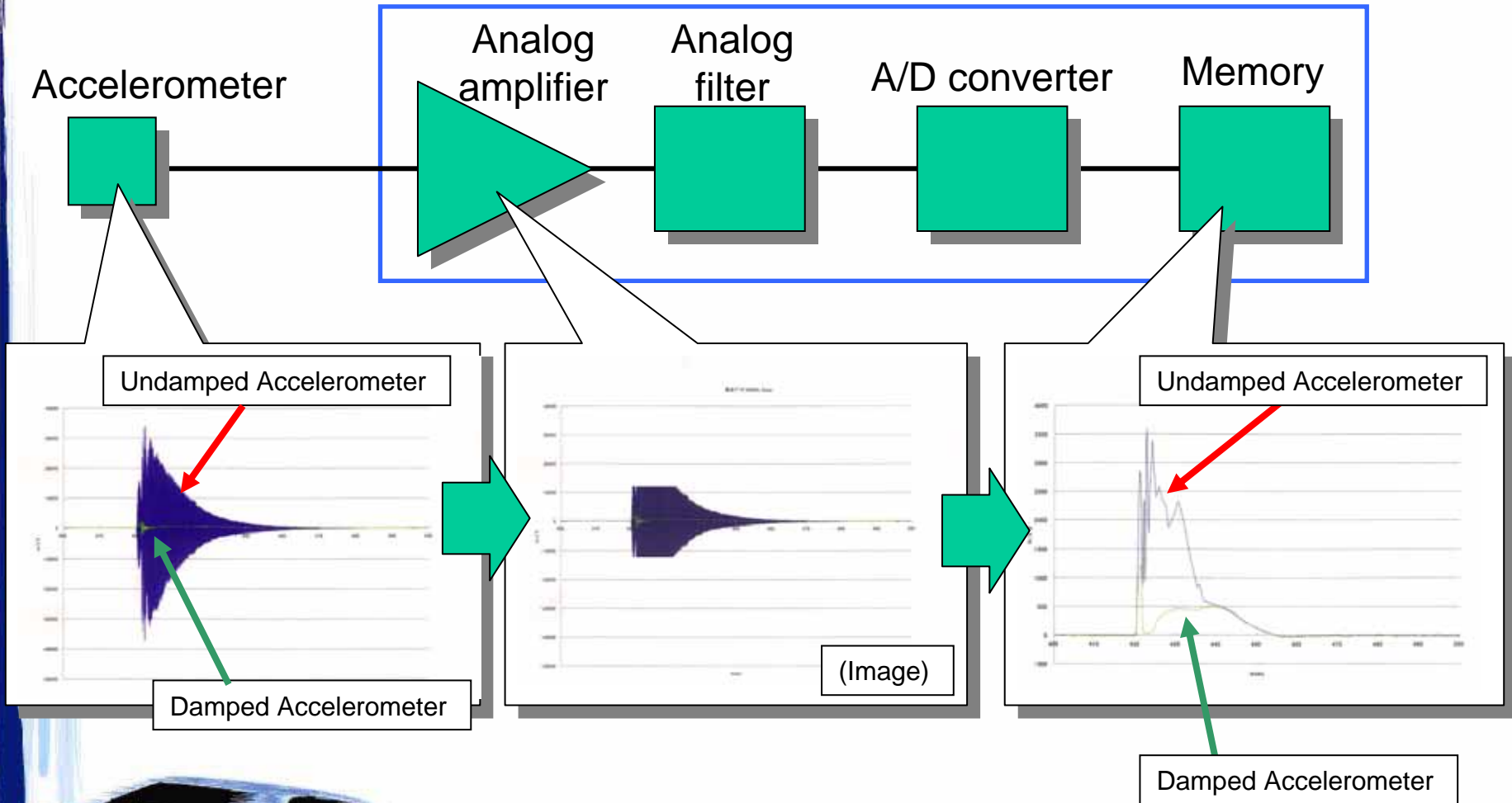


Data Acquisition Unit  
DIS-3000B



# Undamped Accelerometer Measurement Problems

If resonance output signal appears...

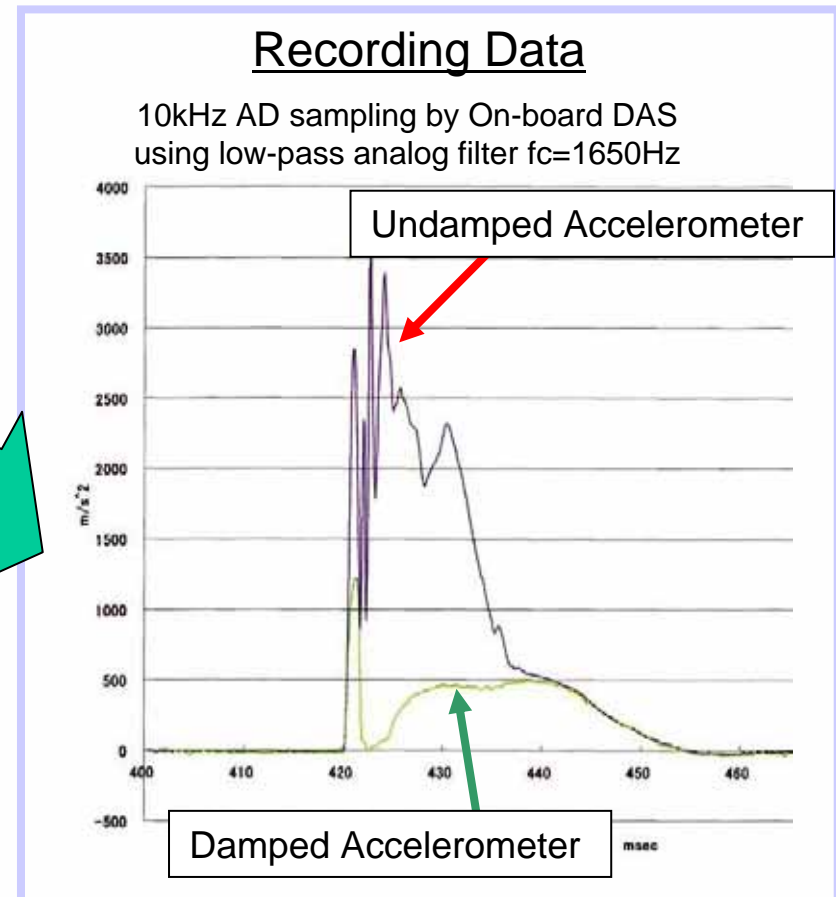
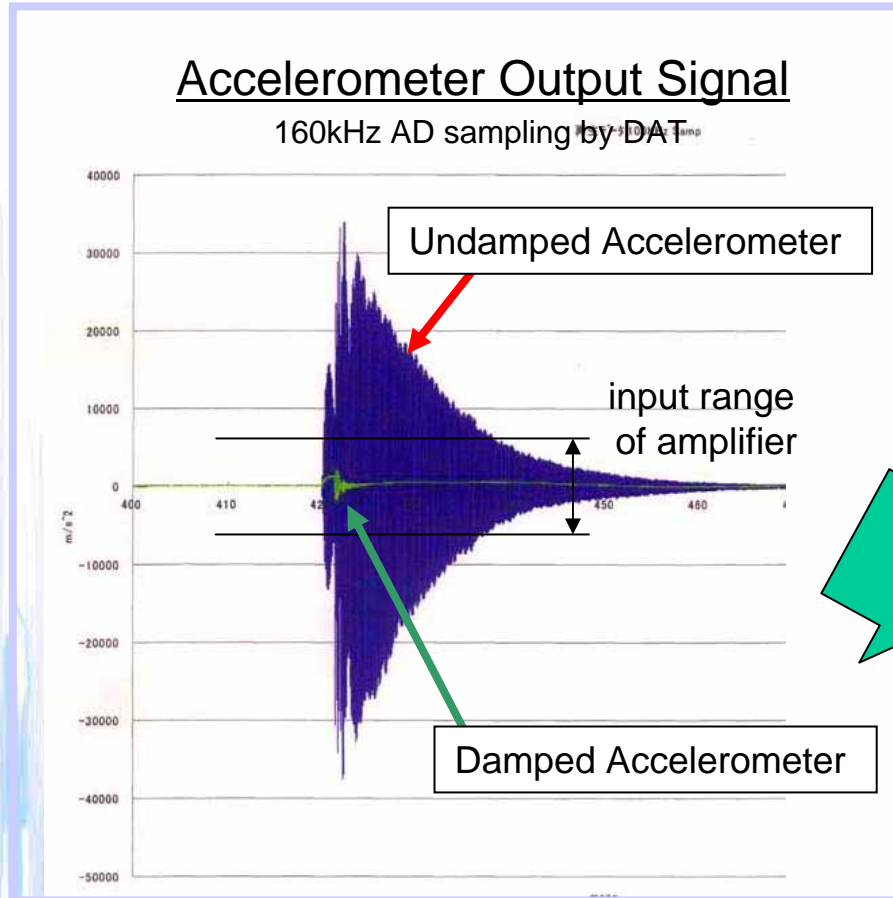


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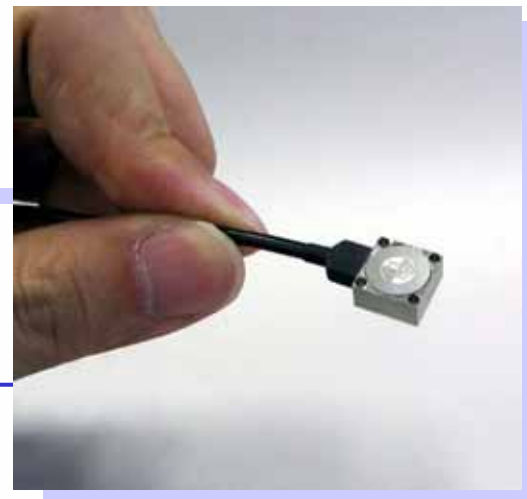
# Undamped Accelerometer Measurement Problems

If the resonant waveform signals exceed input range of amplifier...



## New Damped Accelerometer ASE-A Series

### Feature



- Miniature size

Dimensions: 10 x 10 x 5mm  
(0.4 x 0.4 x 0.2inch)

- Optimized damping

Damping ratio: Approx. 0.7



## New Damped Accelerometer ASE-A Series

### Characteristics of ASE-A

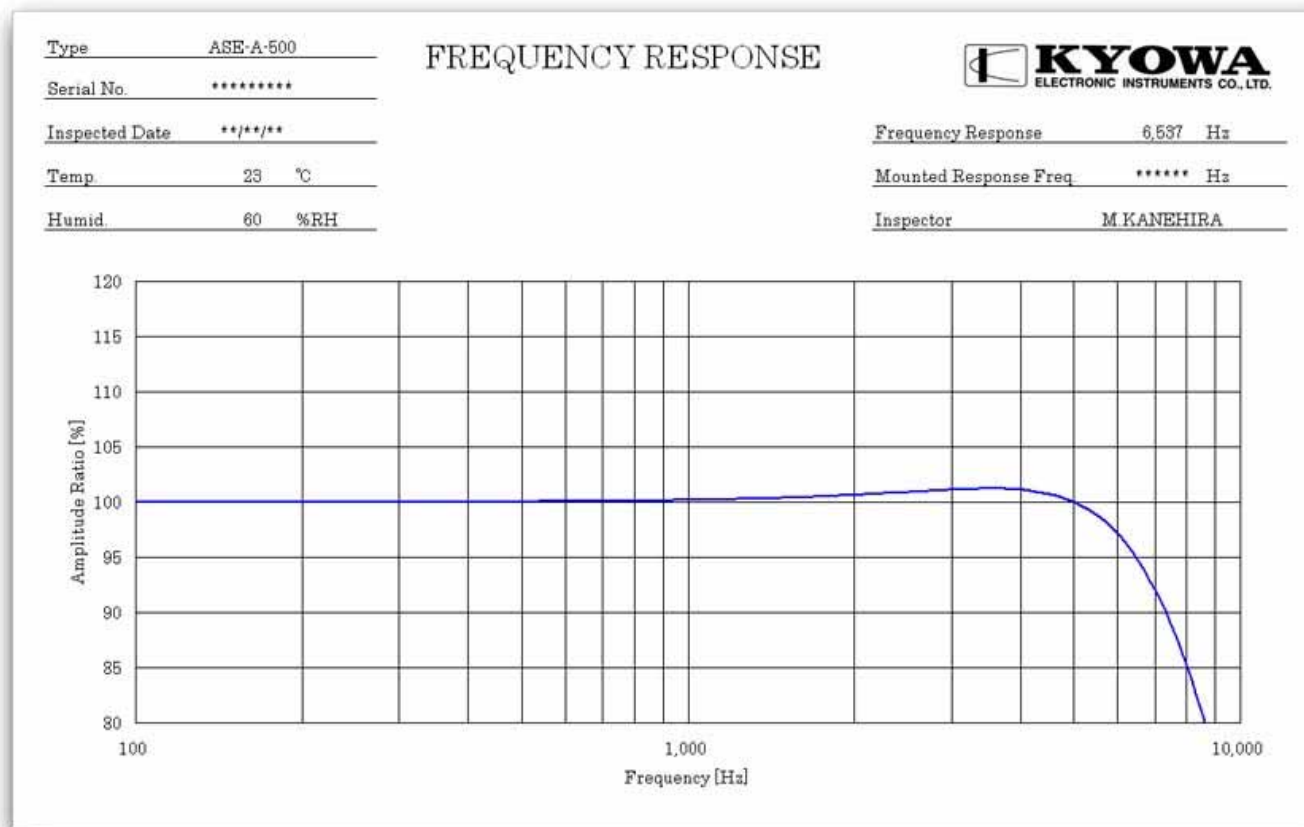
#### ■ Specifications of New Accelerometer (500g range version)

- Model: ASE-A-500
- Dimensions: 10 x 10 x 5mm
- Rated Output: 1mV/V min.
- Freq. Response(at 23C): 0 to 5kHz, +/-5%
- Damping Ratio: Approx. 0.7
- Non-linearity: +/-1%RO max.
- Acceleration Limits: 2,000g
- Excitation Voltage: 1 to 10V AC or DC



# New Damped Accelerometer ASE-A Series

## Frequency Response of ASE-A



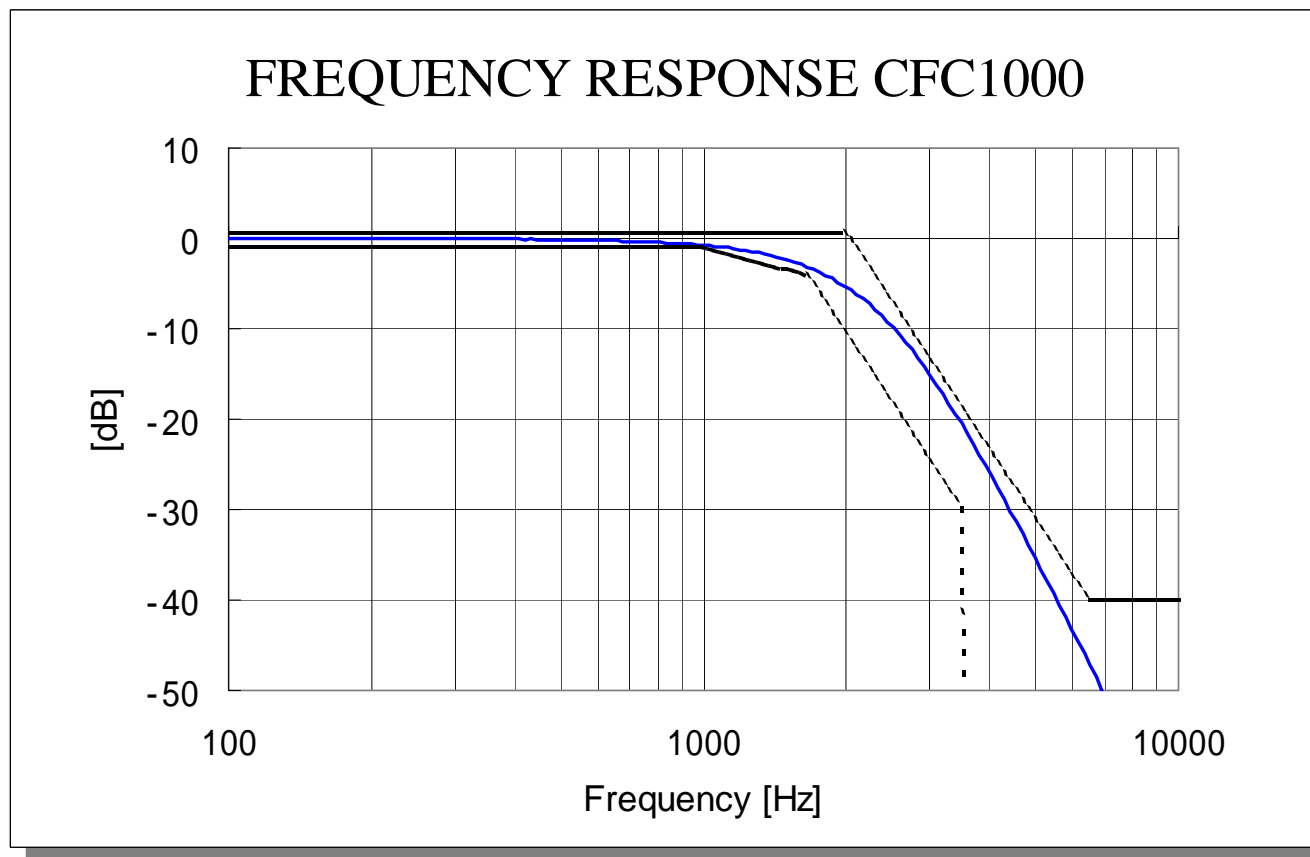
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# New Damped Accelerometer ASE-A Series

## Frequency Response of ASE-A

with Kyowa's on-board DAS, DIS-3000B



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## New Damped Accelerometer ASE-A Series

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### ASE-A Series Offers Many Ranges

Model	Range
<b>ASE-A-2</b>	<b>+/- 19.61 m/s<sup>2</sup> (+/- 2 g)</b>
<b>ASE-A-5</b>	<b>+/- 49.03 m/s<sup>2</sup> (+/- 5 g)</b>
<b>ASE-A-10</b>	<b>+/- 98.07 m/s<sup>2</sup> (+/- 10 g)</b>
<b>ASE-A-20</b>	<b>+/- 196.1 m/s<sup>2</sup> (+/- 20 g)</b>
<b>ASE-A-50</b>	<b>+/- 490.3 m/s<sup>2</sup> (+/- 50 g)</b>
<b>ASE-A-100</b>	<b>+/- 980.7 m/s<sup>2</sup> (+/- 100 g)</b>
<b>ASE-A-200</b>	<b>+/- 1961 m/s<sup>2</sup> (+/- 200 g)</b>
<b>ASE-A-500</b>	<b>+/- 4903 m/s<sup>2</sup> (+/- 500 g)</b>
<b>ASE-A-1K</b>	<b>+/- 9807 m/s<sup>2</sup> (+/- 1000 g)</b>



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# New Damped Accelerometer ASE-A Series

## New Model ASE-A Series Damped Accelerometer Applications

### ■ Side Impact Tests



Photo by courtesy of  
National Organization for Automotive Safety & Victims' Aid



ASE-A



Kyowa On-board  
Data Acquisition Unit  
Model DIS-3000B

### ■ Frontal Impact Tests



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# New Damped Accelerometer ASE-A Series

## ASE-A Series Damped Accelerometer Applications



Memory Recorder/Analyzer  
EDX-2000A



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# New Damped Accelerometer ASE-A Series

## Summary

Kyowa's New Damped Accelerometer Series

### ■ Size benefits

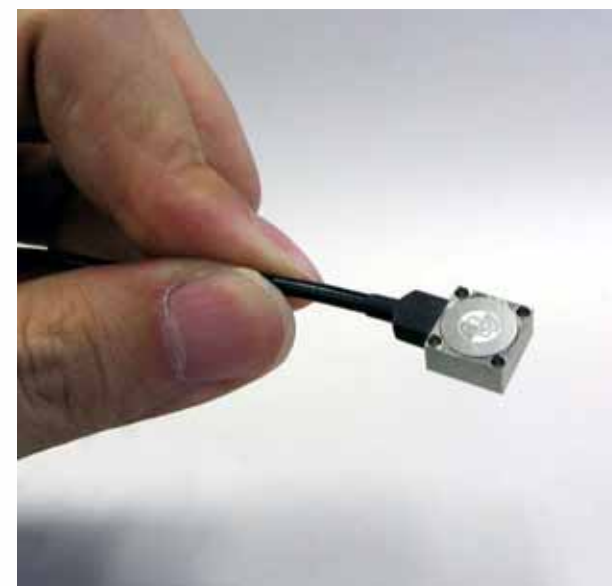
- ◆ Easy handling
- ◆ Miniaturization expands uses

### ■ Prevents resonance by optimized damping

- ◆ Improved measuring reliability & results

### ■ Immediate application benefits

- ◆ Pedestrian head protection performance tests
- ◆ Car body deformation measurements in car crash testing
- ◆ Car performance tests



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automotive  
**testing** expo 2005  
europe

Find out more today!  
View these new Model ASE-A  
Accelerometers  
at ZSE Booth 5540.

Thank You!



**ZSE GmbH**

Germany Sales/Service/Support  
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