

What's up with Bump Testing ?

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VIBRATION ANALYSIS HARDWARE

What is a bump test ?

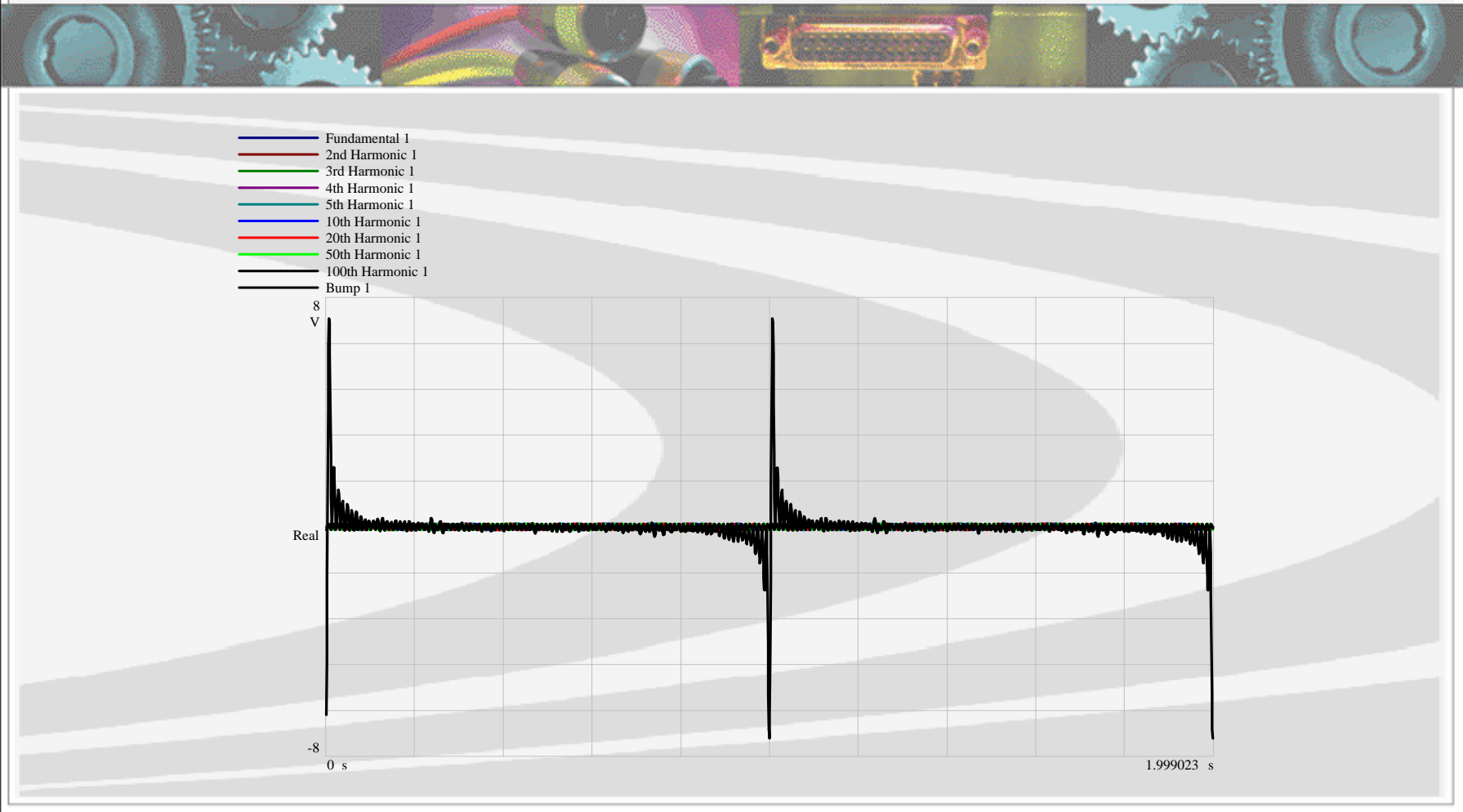
- A bump test is the measured response of an impact to an object.
- The force of the impact is not controlled or measured.
- The response of the object is not controlled, **BUT IS MEASURED.**
- A single channel response measurement.

Why do a bump test ?

- To excite and measure the natural frequency(s) of an object.
 - ✓ To identify a resonance
 - ✓ To understand a change in mass
 - ✓ To understand a change in stiffness
 - ✓ To understand a change in damping

Bump Testing

How does it work ?



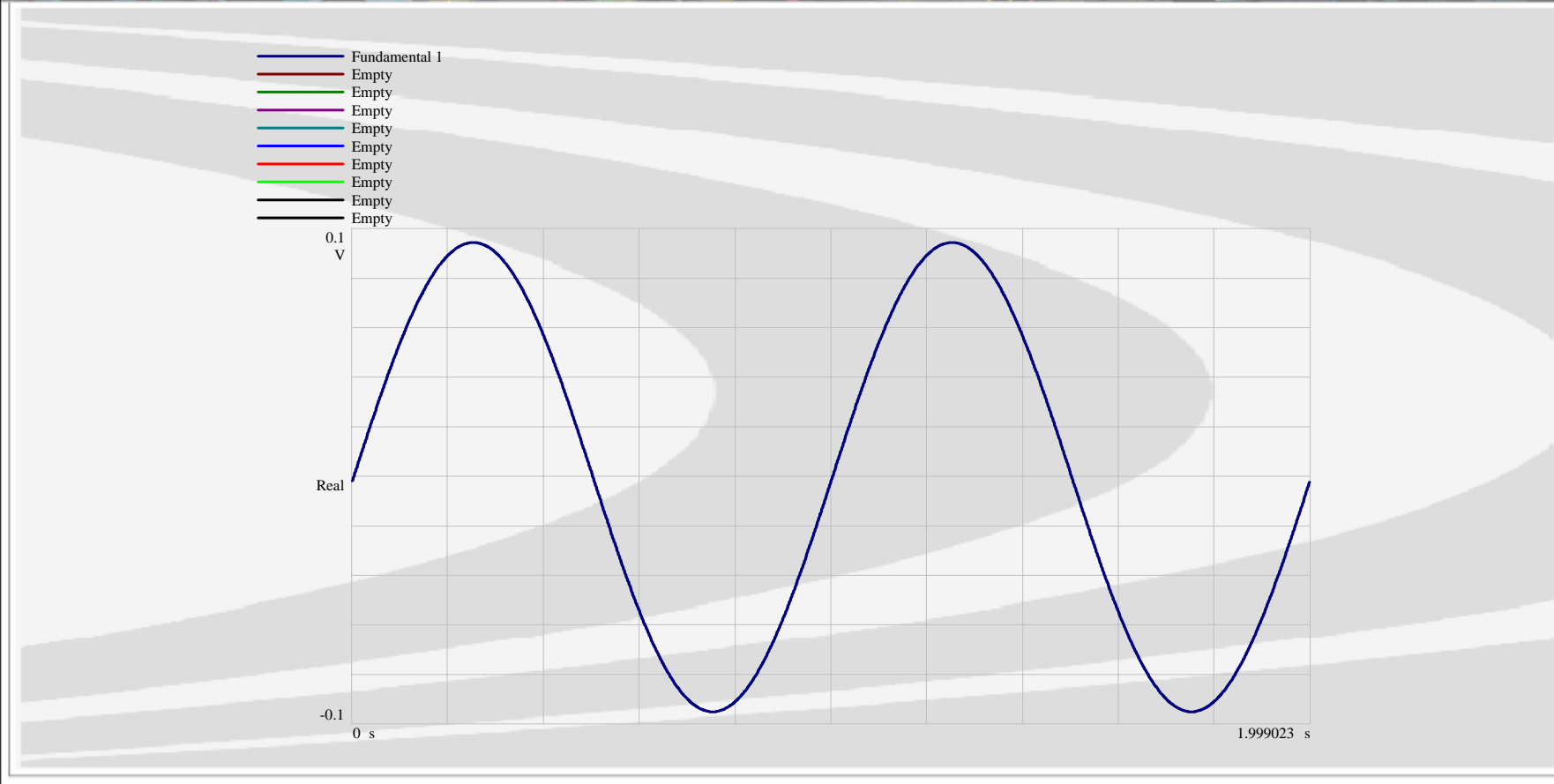
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Bump Testing

Sine Waves ?



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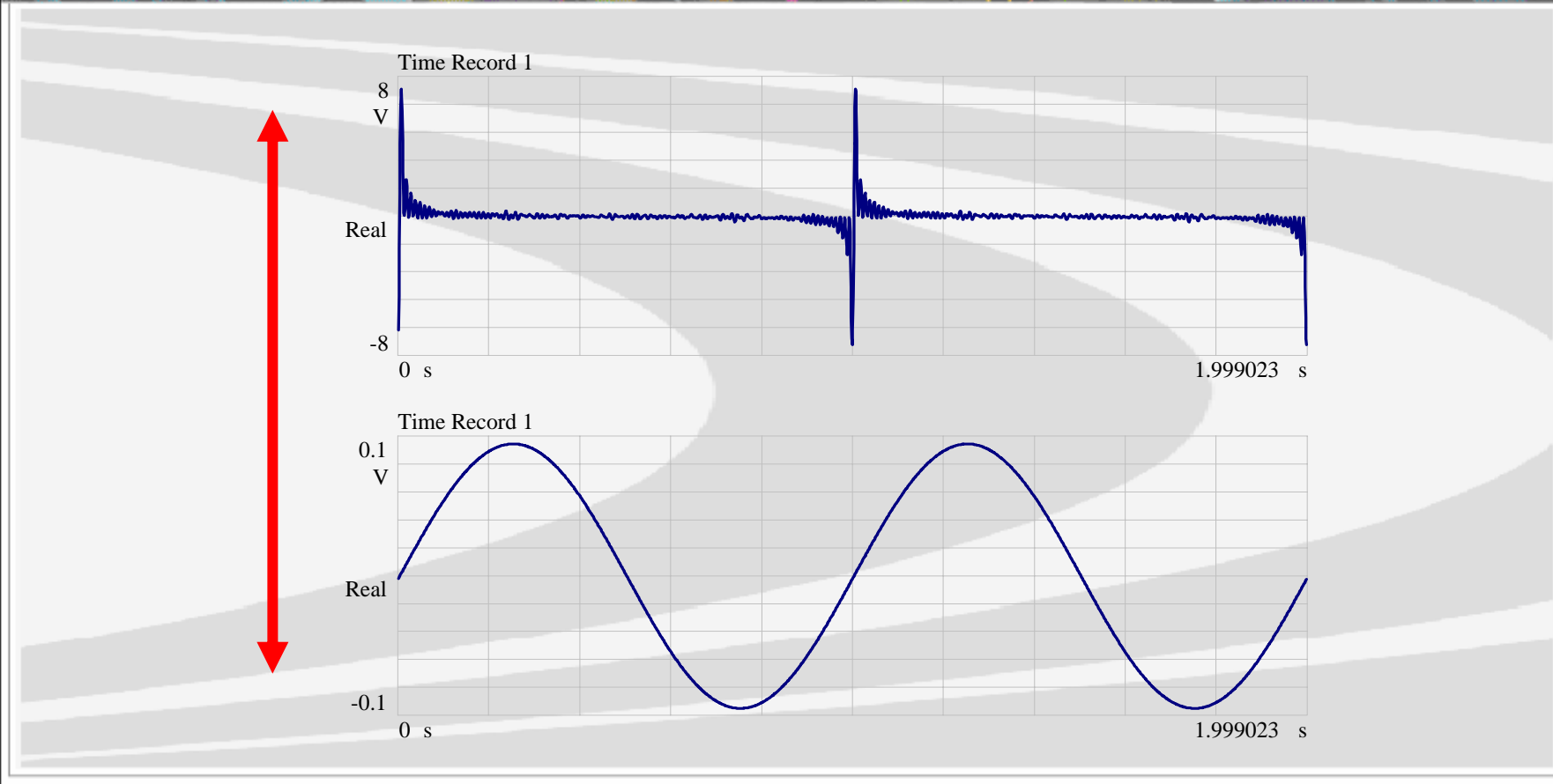
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Bump Testing

Bumps from Sine Waves ?



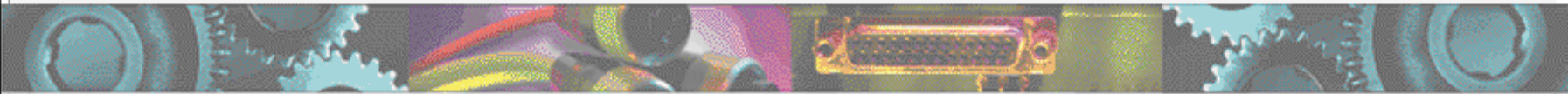
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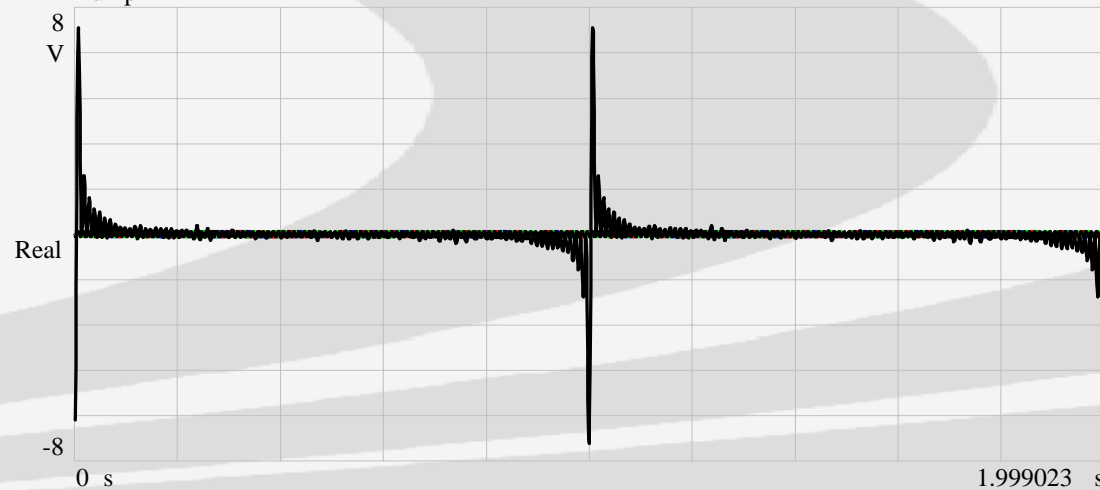


Bump Testing

100th Harmonic



- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- 20th Harmonic 1
- 50th Harmonic 1
- 100th Harmonic 1
- Bump 1



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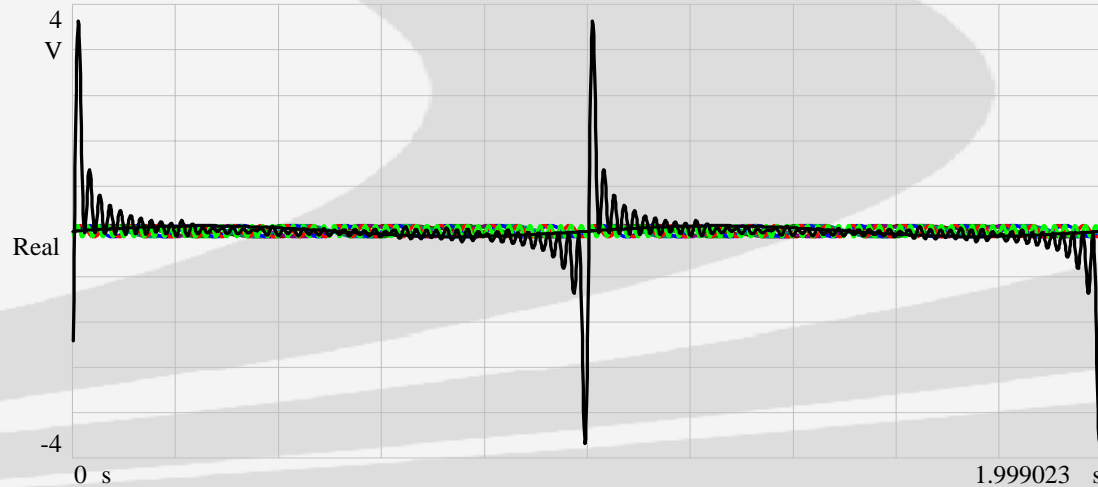


VIBRATION ANALYSIS HARDWARE

Bump Testing

50th Harmonic

- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- 20th Harmonic 1
- 50th Harmonic 1
- Bump 1
- Fundamental 1



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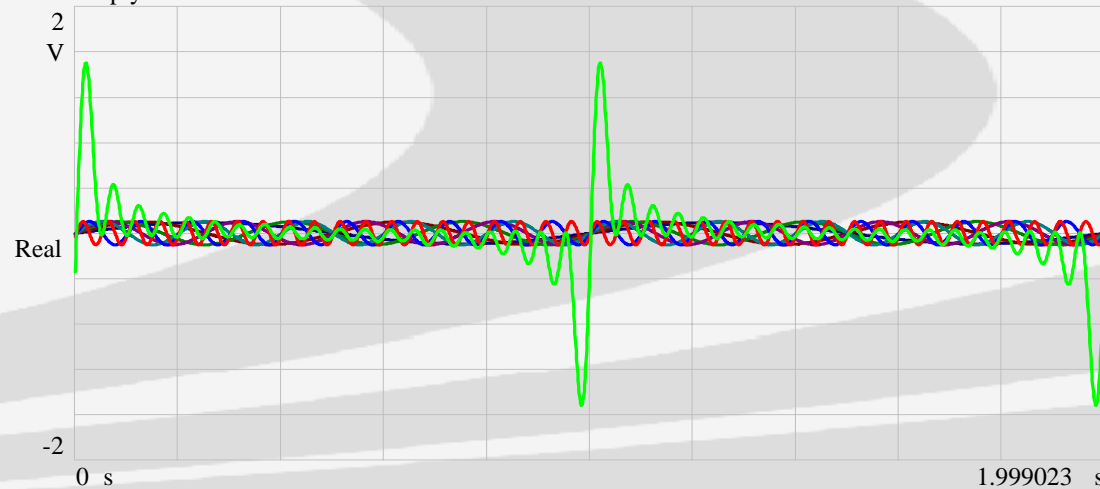


VIBRATION ANALYSIS HARDWARE

Bump Testing

20th Harmonic

- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- 20th Harmonic 1
- Bump 1
- Empty
- Empty



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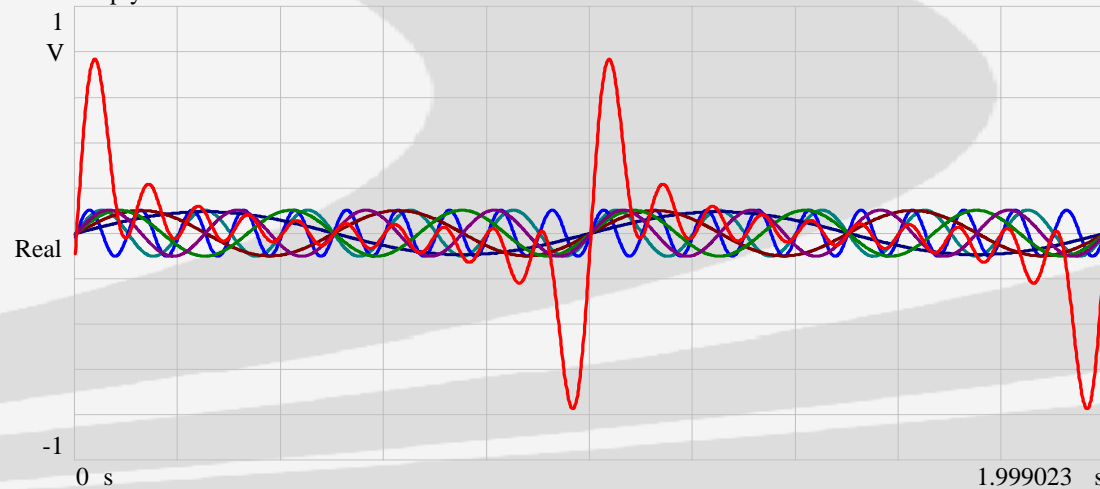


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Bump Testing

10th Harmonic

- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- Bump 1
- Empty
- Empty
- Empty



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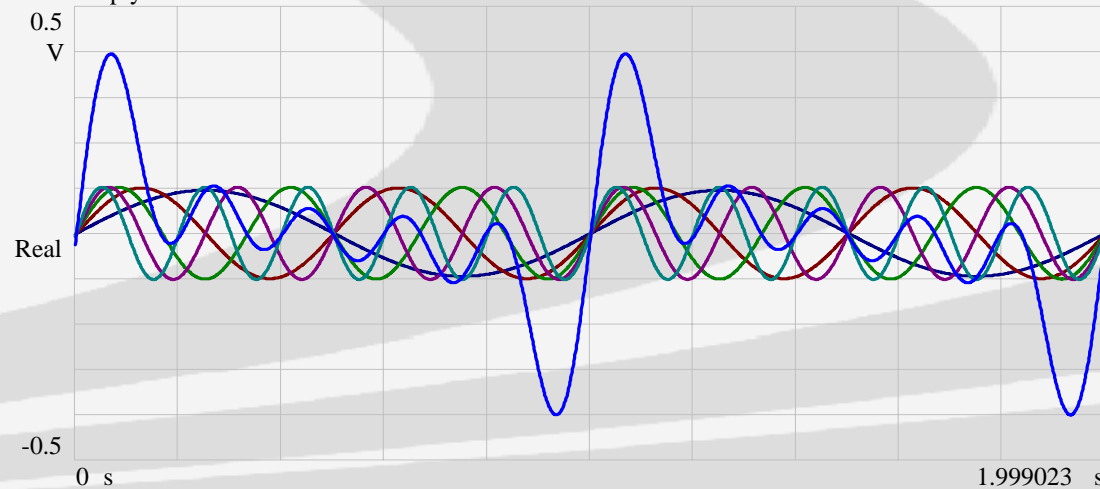


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Bump Testing

5th Harmonic

- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- Bump 1
- Empty
- Empty
- Empty
- Empty



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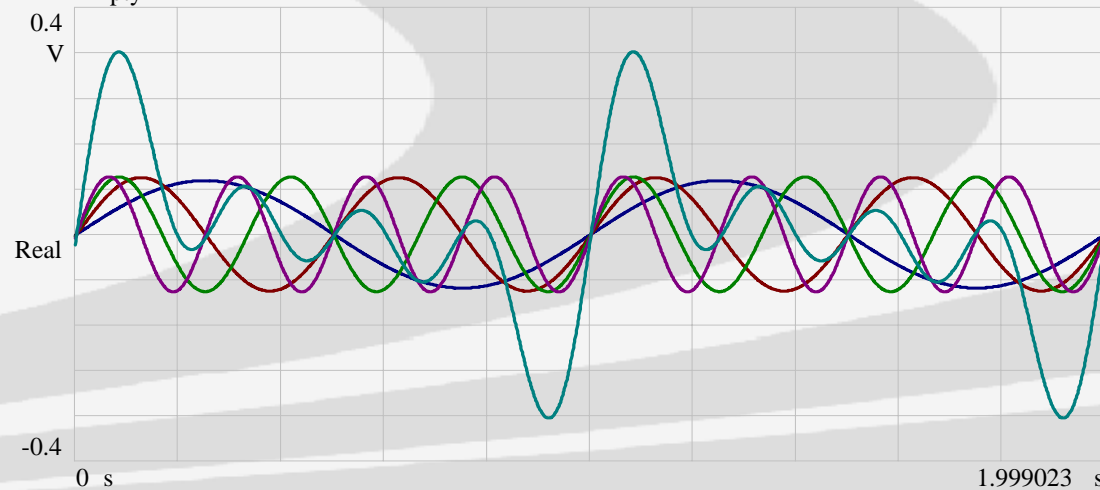


VIBRATION ANALYSIS HARDWARE

Bump Testing

4th Harmonic

- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- Bump 1
- Empty
- Empty
- Empty
- Empty
- Empty



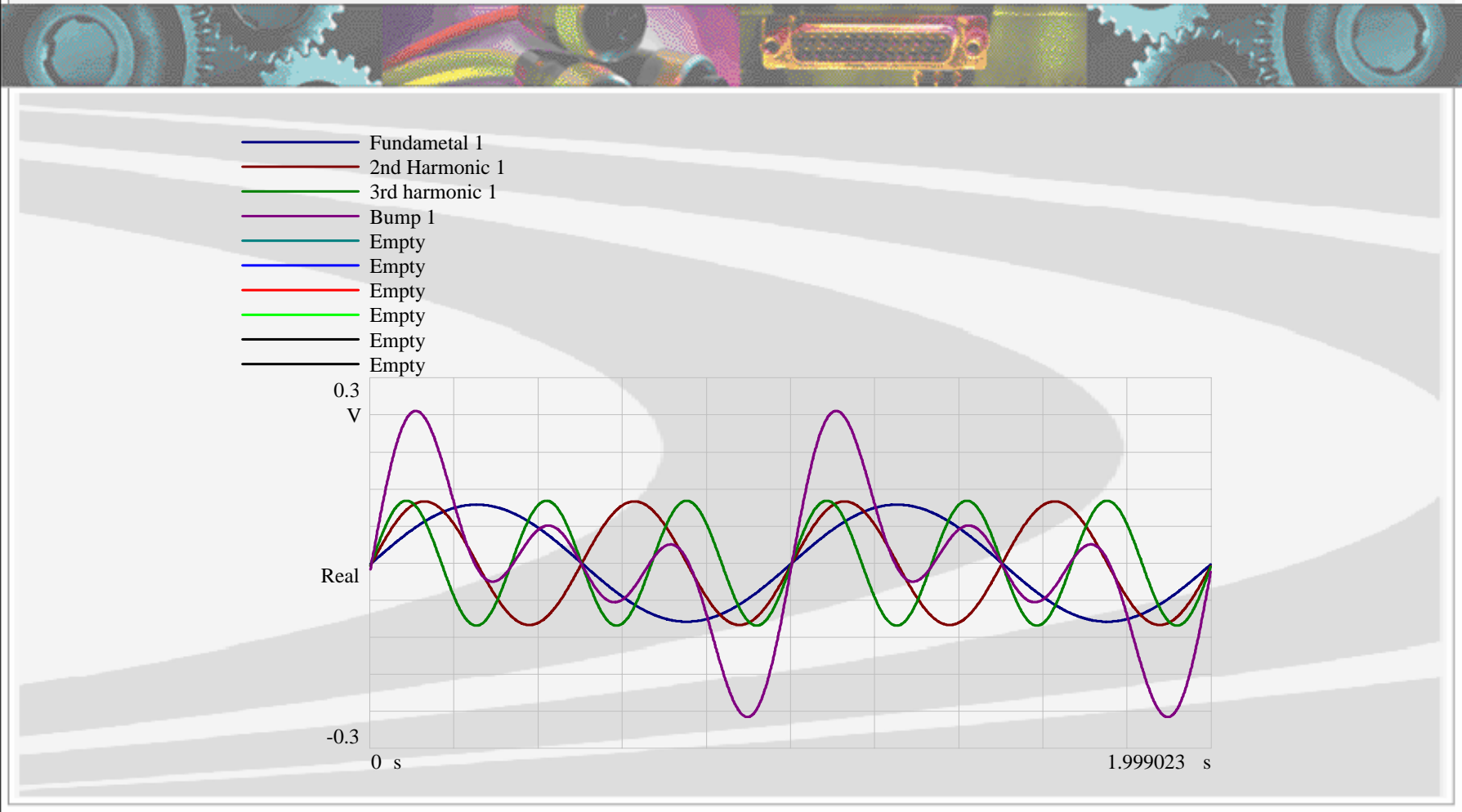
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Bump Testing

3rd Harmonic



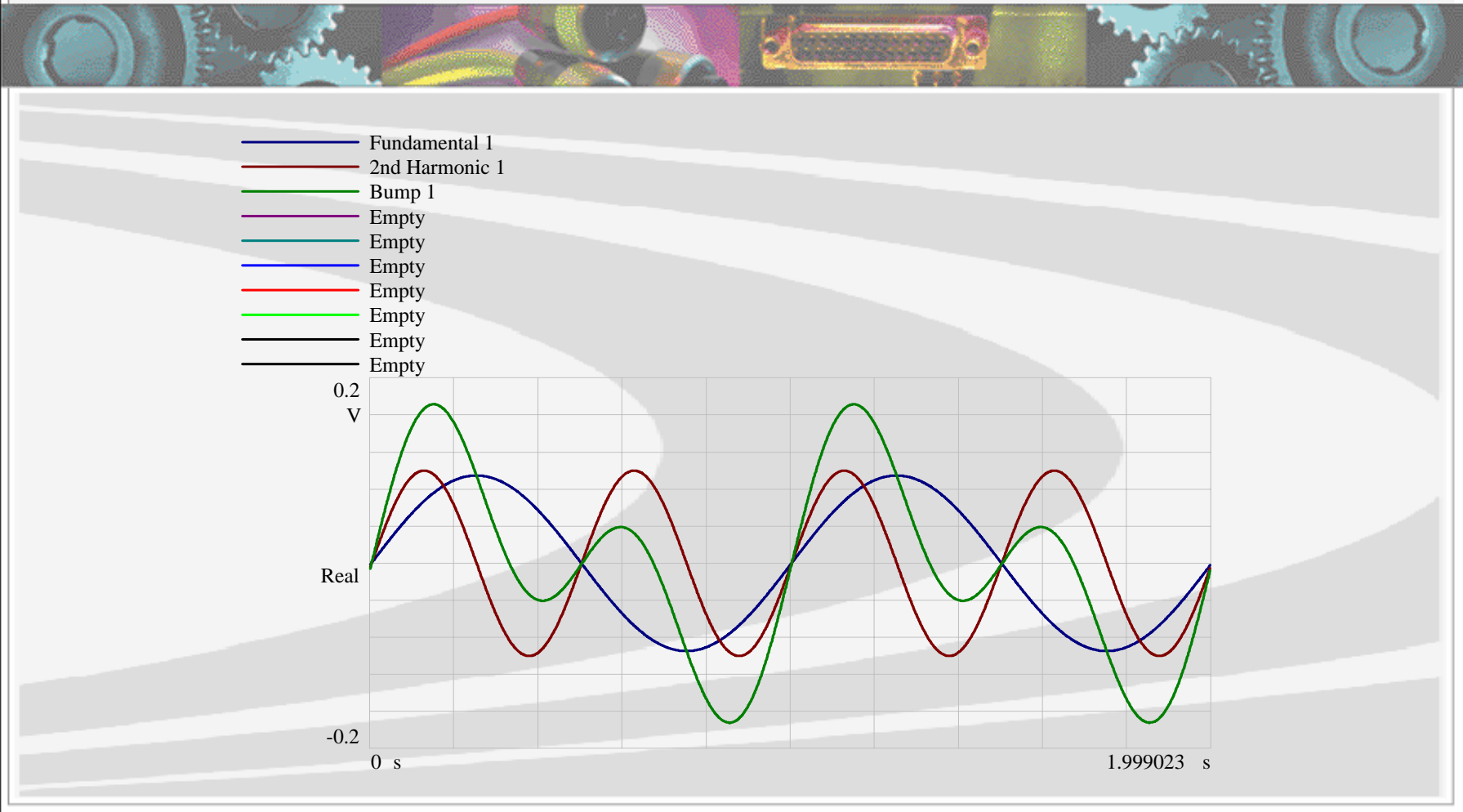
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Bump Testing

2nd Harmonic



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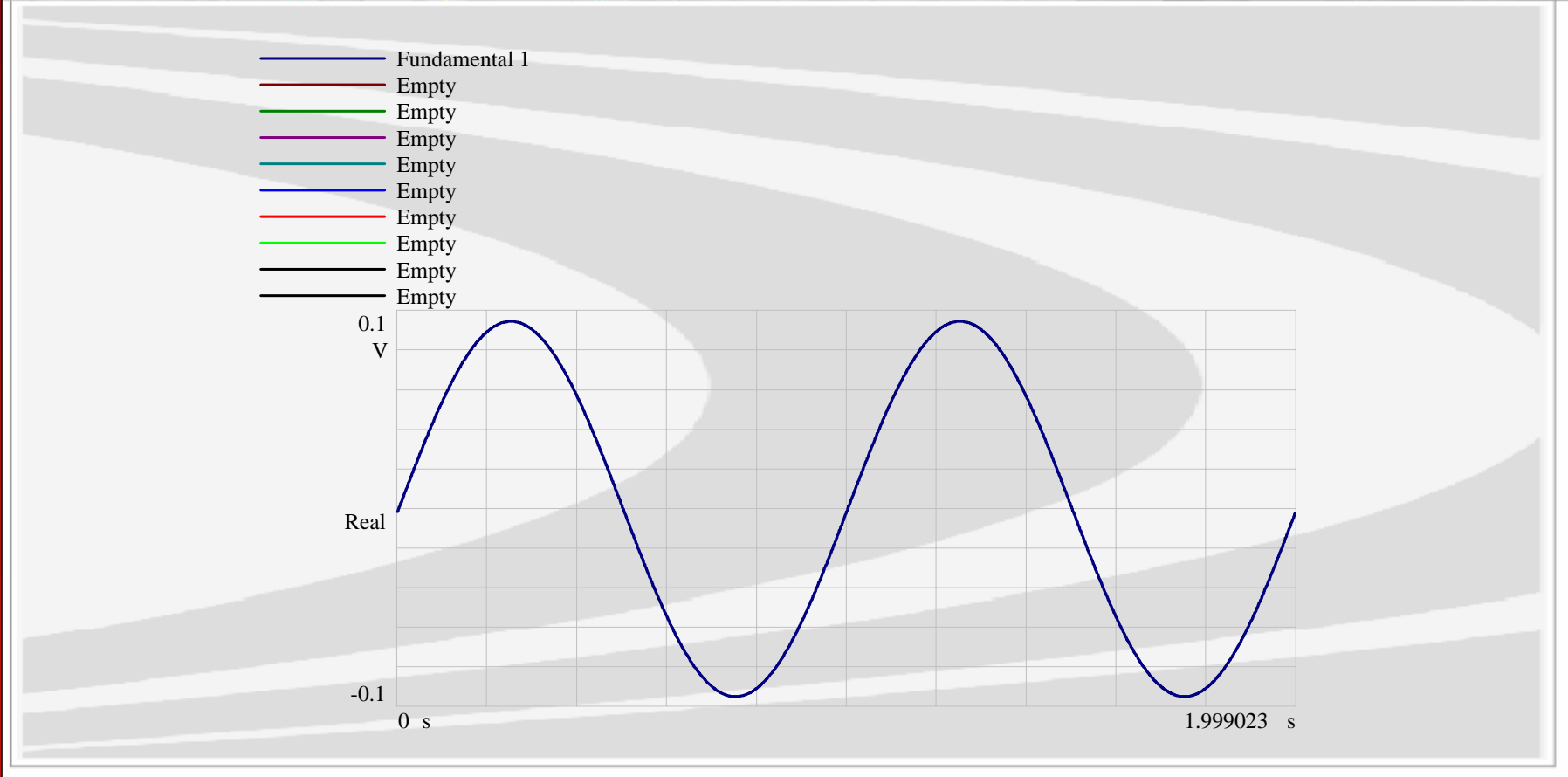
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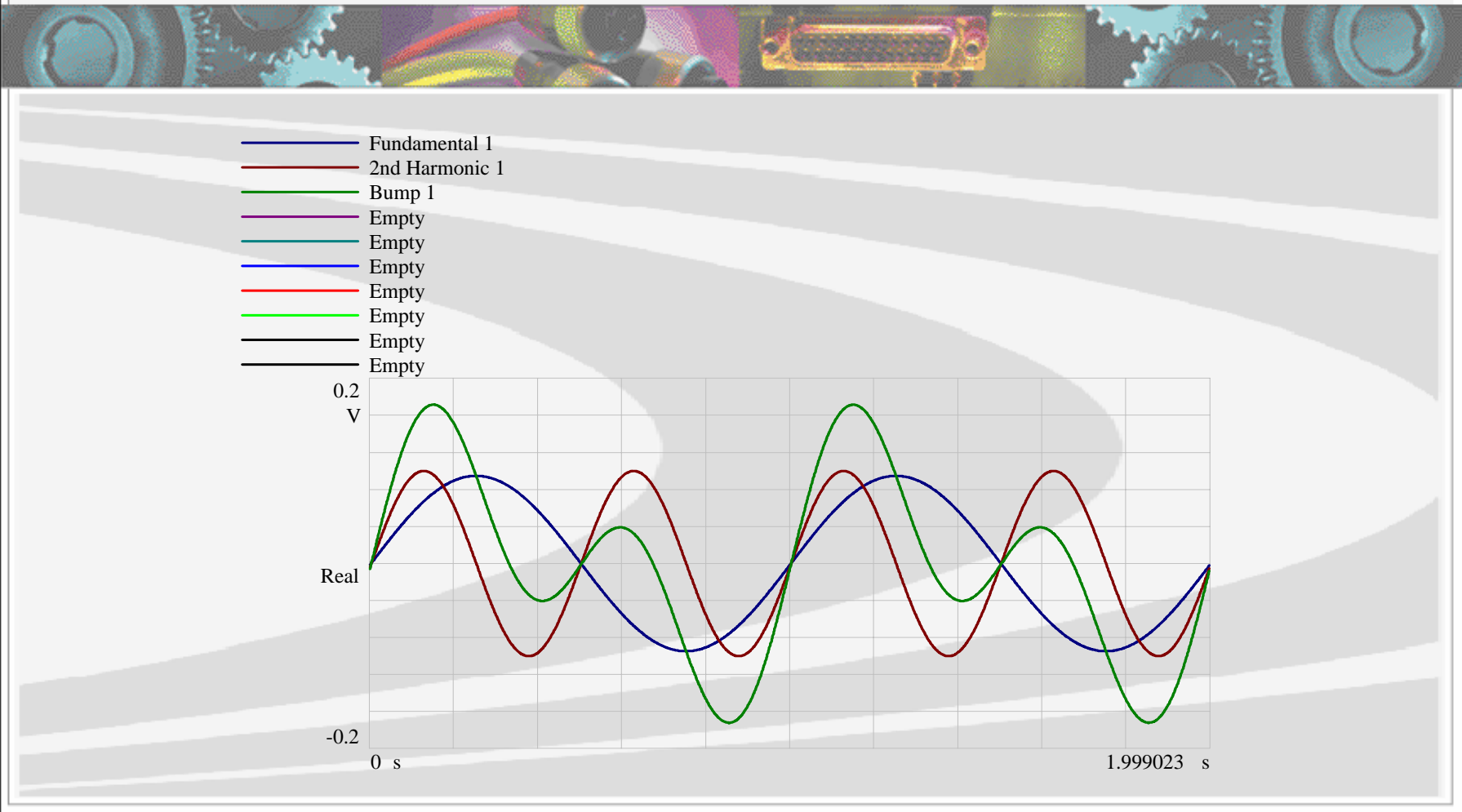
VIBRATION ANALYSIS HARDWARE

Fundamental



Bump Testing

2nd Harmonic



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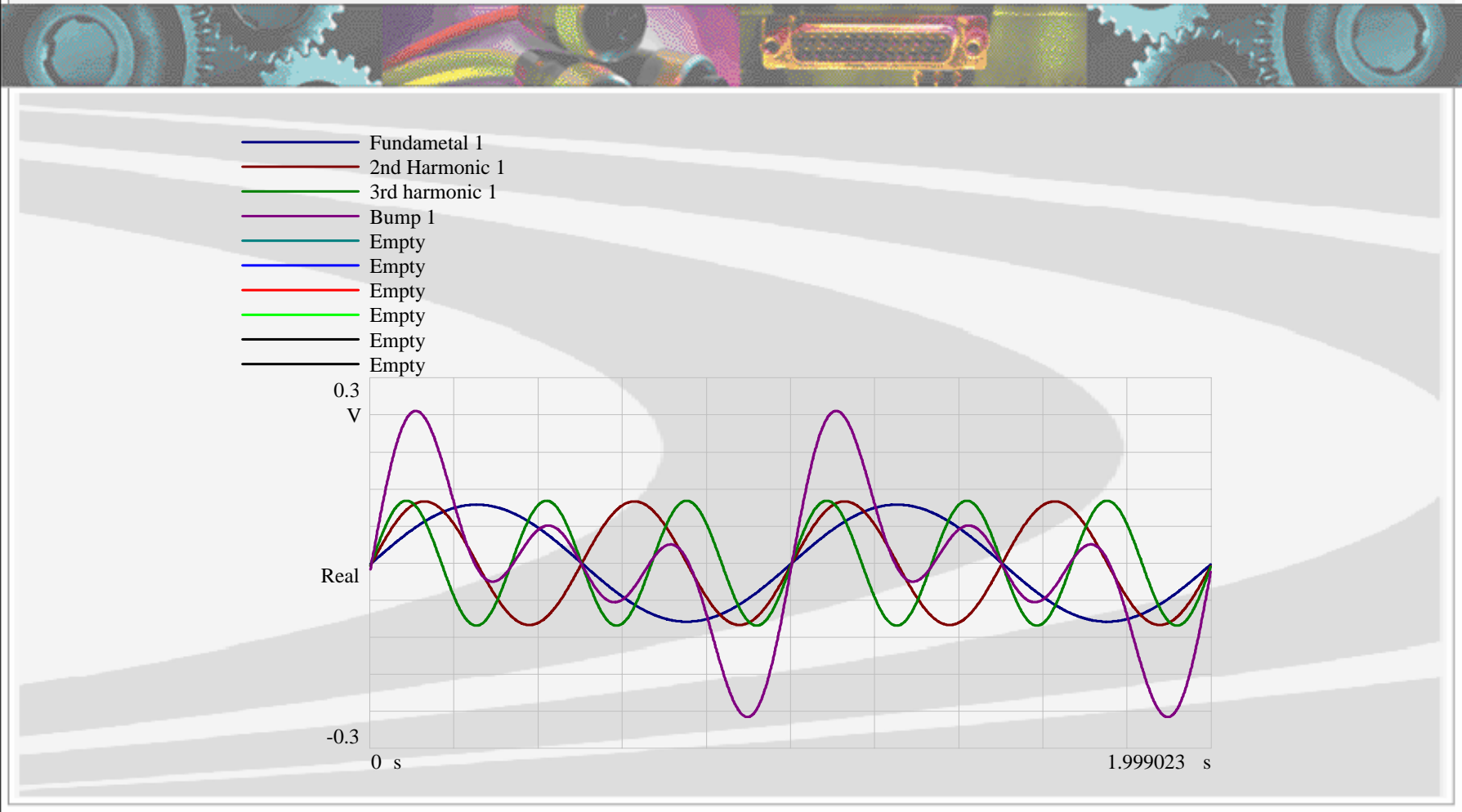
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Bump Testing

3rd Harmonic



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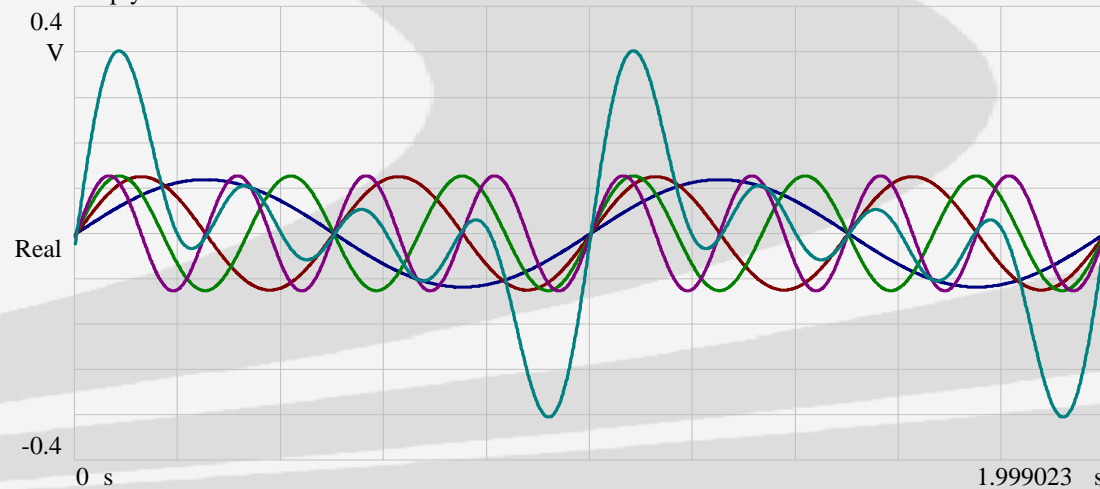


VIBRATION ANALYSIS HARDWARE

Bump Testing

4th Harmonic

- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- Bump 1
- Empty
- Empty
- Empty
- Empty
- Empty



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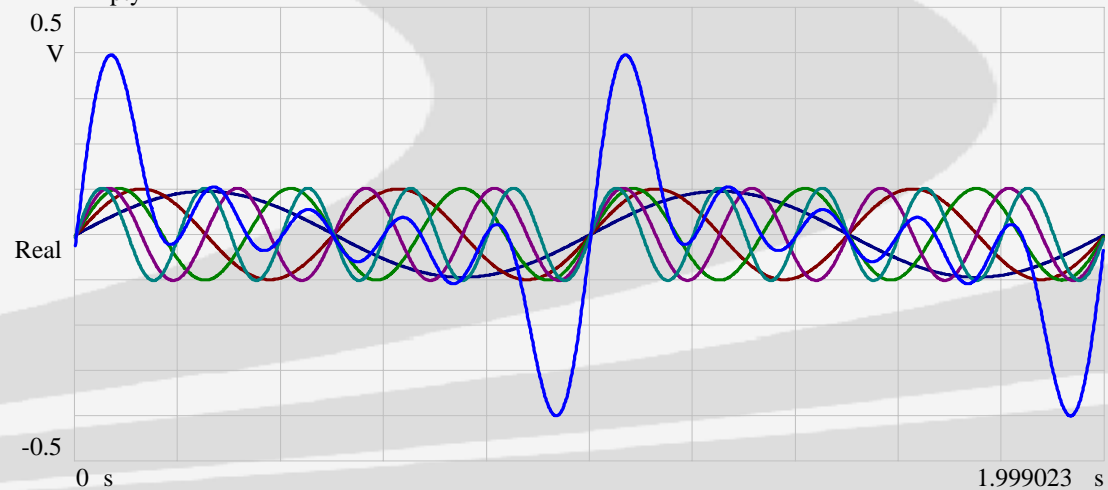


VIBRATION ANALYSIS HARDWARE

Bump Testing

5th Harmonic

- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- Bump 1
- Empty
- Empty
- Empty
- Empty



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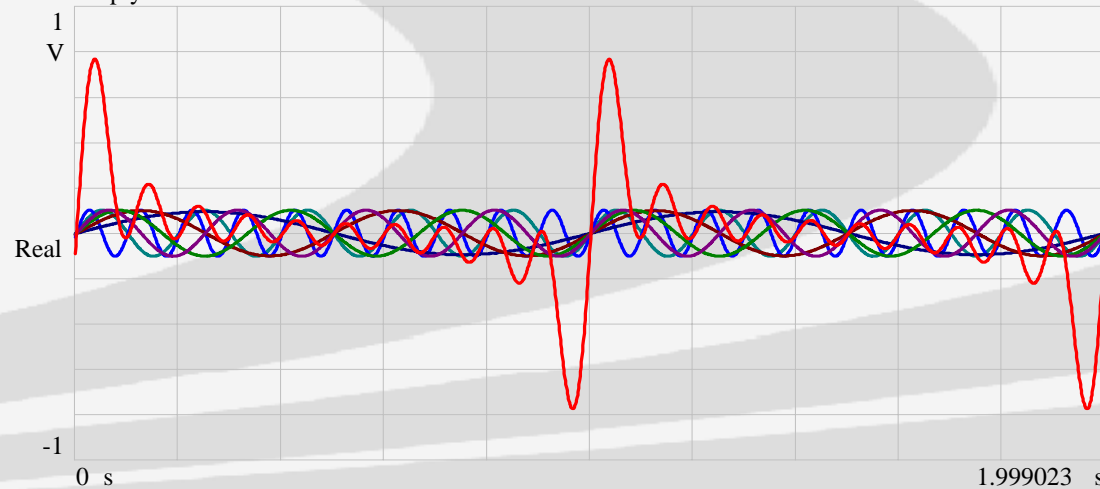


VIBRATION ANALYSIS HARDWARE

Bump Testing

10th Harmonic

- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- Bump 1
- Empty
- Empty
- Empty



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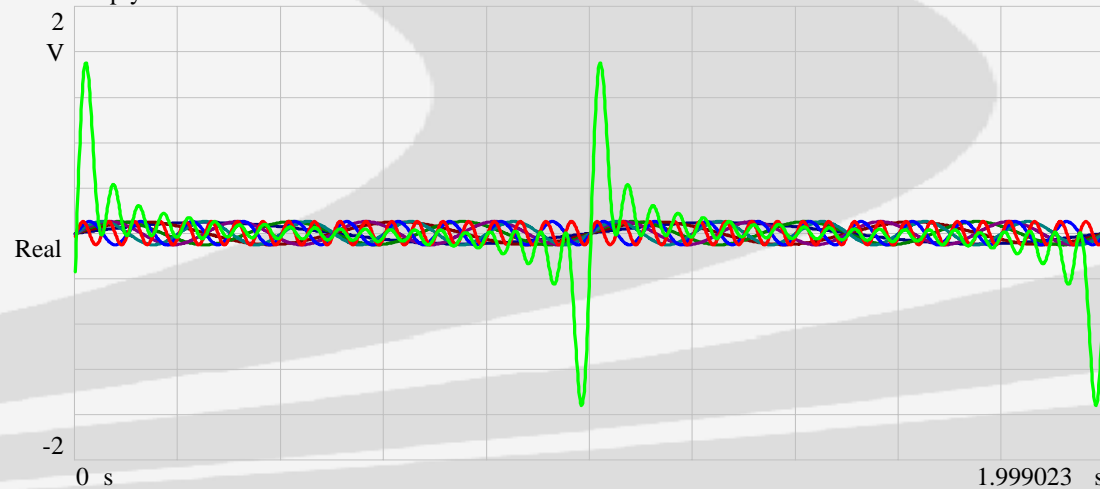


VIBRATION ANALYSIS HARDWARE

Bump Testing

20th Harmonic

- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- 20th Harmonic 1
- Bump 1
- Empty
- Empty



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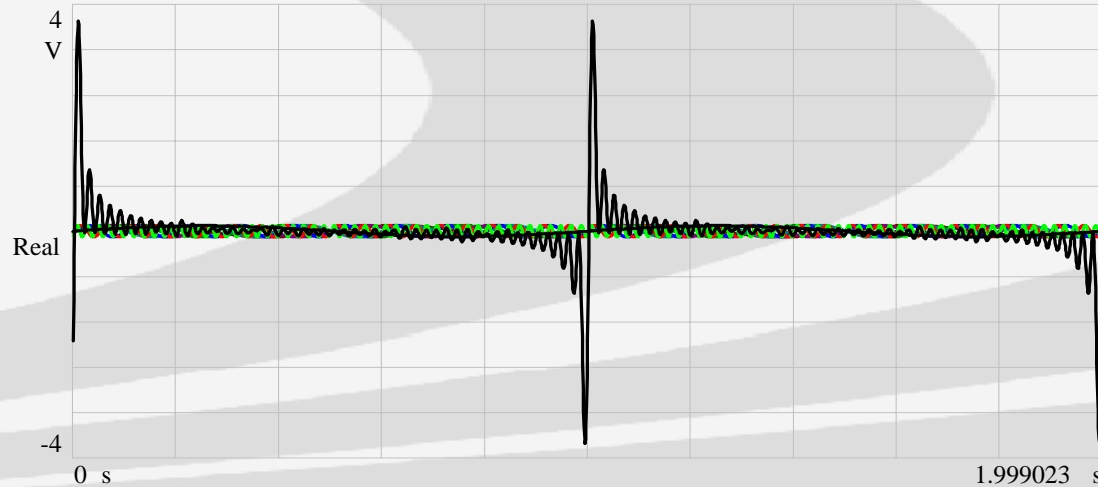


Bump Testing

50th Harmonic



- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- 20th Harmonic 1
- 50th Harmonic 1
- Bump 1
- Fundamental 1



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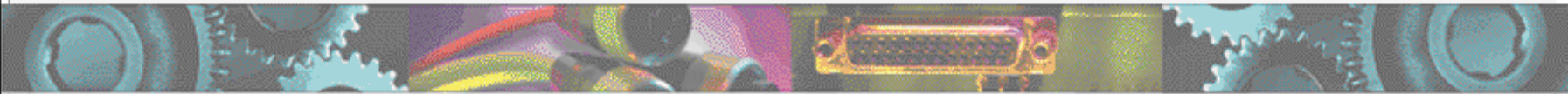
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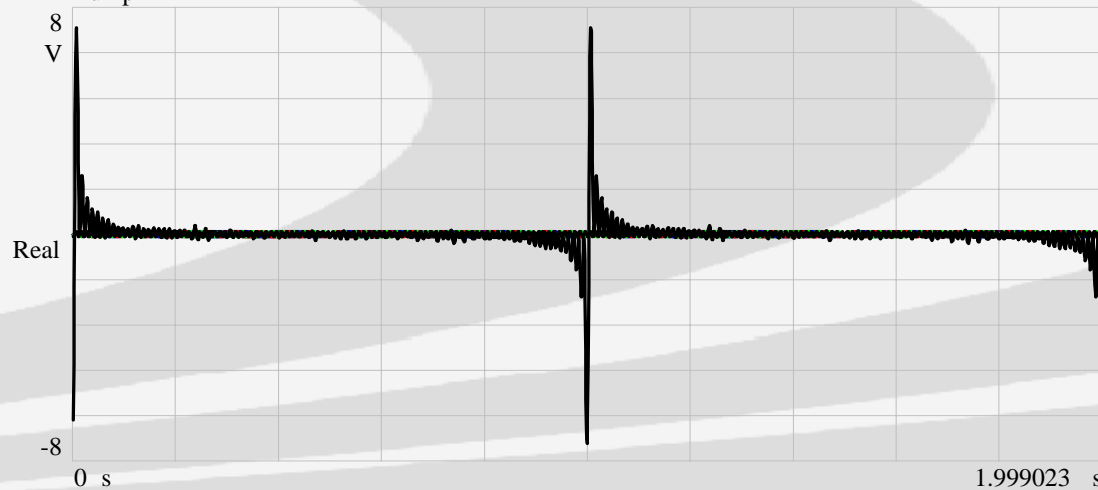
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Bump Testing

100th Harmonic



- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- 20th Harmonic 1
- 50th Harmonic 1
- 100th Harmonic 1
- Bump 1



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VIBRATION ANALYSIS HARDWARE

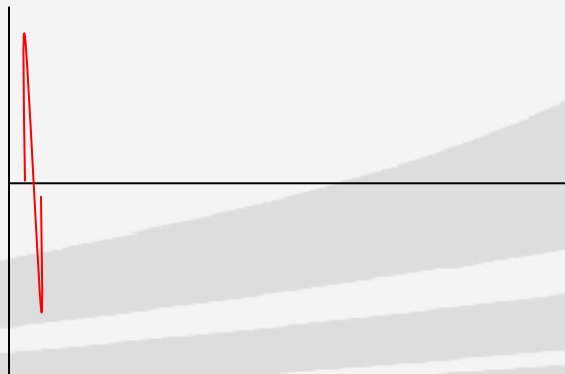
How does it work ?

- Bump testing or impact testing works because the bump or impact contains all of the individual frequencies or sign waves.
- When you bump or impact the object under test, you will excite all of the natural frequencies of that object.

What do you impact with ?

➤ Pin Drops !

- ✓ High frequency content
- ✓ Low energy value



➤ Cow Plops !

- ✓ Low frequency content
- ✓ High energy value



Energy Value vs. Frequency

- The item used to deliver the impact to the object under test will determine the energy that is delivered to the object.
 - ✓ Large objects with considerable mass should be impacted with rubber or wood. This will generate high energy low frequency responses. (cow plops)
 - ✓ Small objects with considerable stiffness should be impacted with metal or hard plastics. This will generate low energy high frequency responses. (pin drops)

Set-up

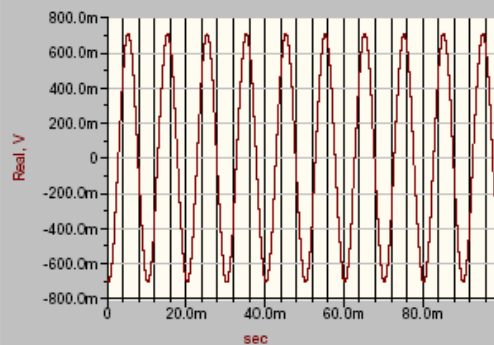
➤ UNIFORM WINDOW

- Take your time – Bump around
- Do not over range or clip the input signal
- 800 – 1600 lines of resolution
- Try some different frequency spans
- Only 1 bump for each time record
- About 4 averages (depends on noise)

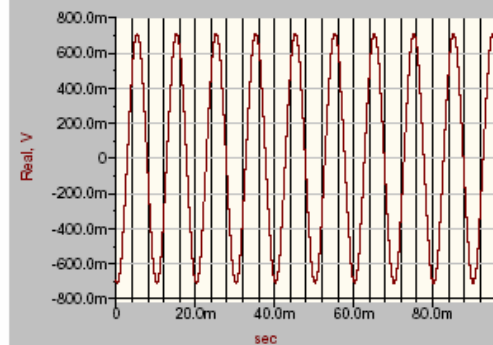
Bump Testing

Why the Uniform Window ?

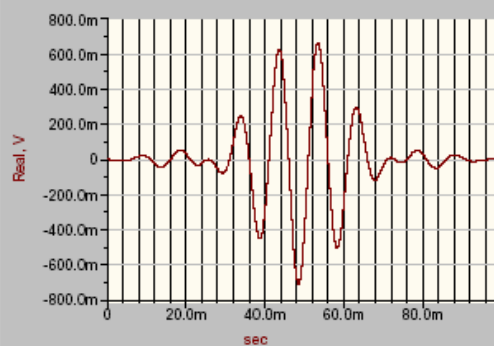
Run00008 Real Time



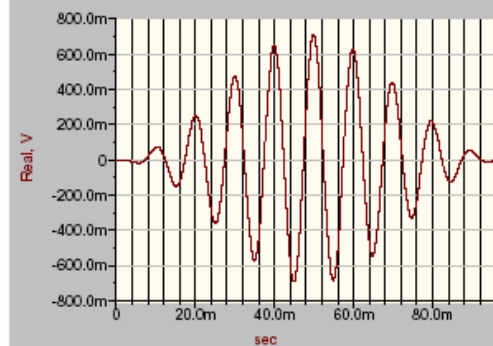
Run00008 Uniform



Run00010 Flat Top



Run00009 Hanning



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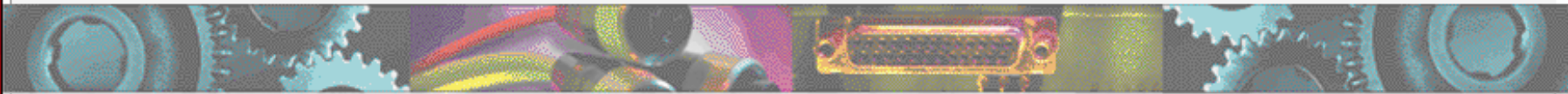
What to Bump ?

- 1" diameter steel round stock
- 36" length
- Clamped in "V" blocks at each end
- CTC AC140 accelerometer stud mounted on center (100 mV/g)

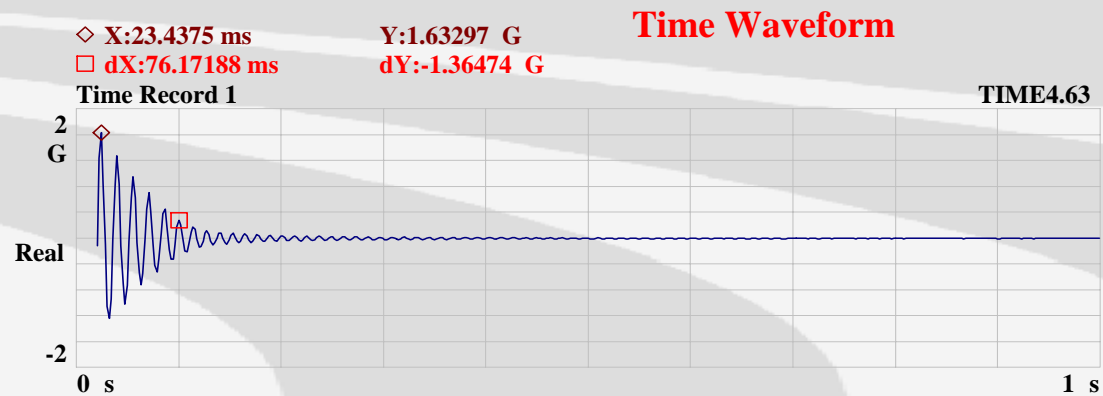


Bump Testing

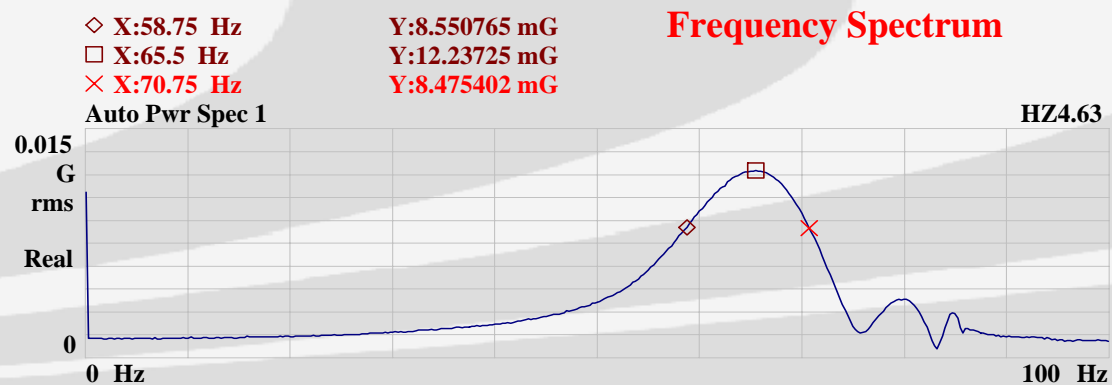
Bump It ! Two Responses !



TIME



FREQUENCY

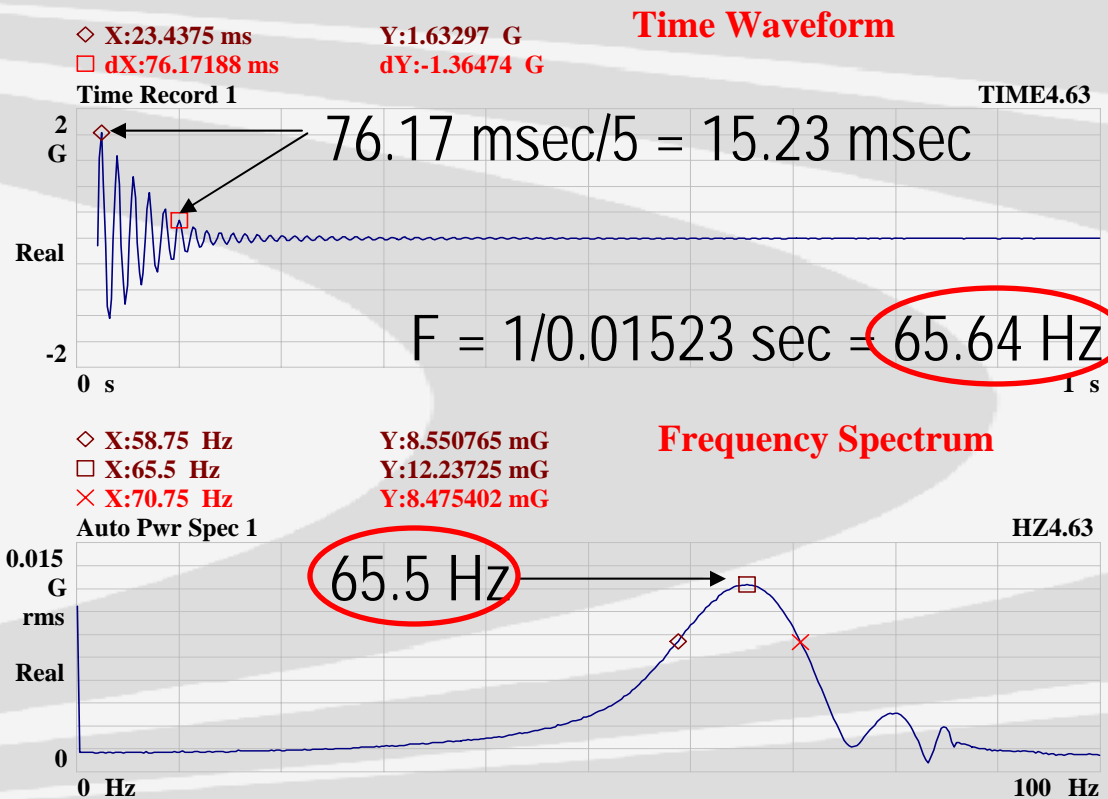


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Mental Health Check !



CASE HISTORY



Bumps in the Road !



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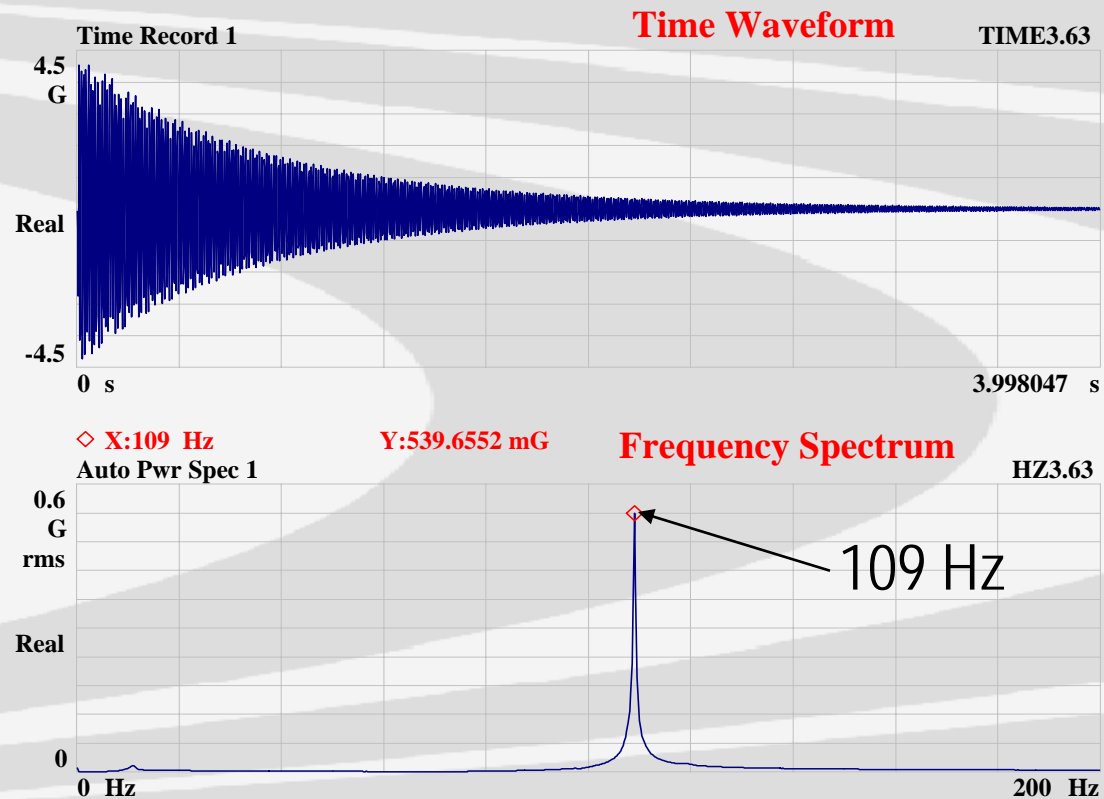
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Case History

So Easy !!!!!



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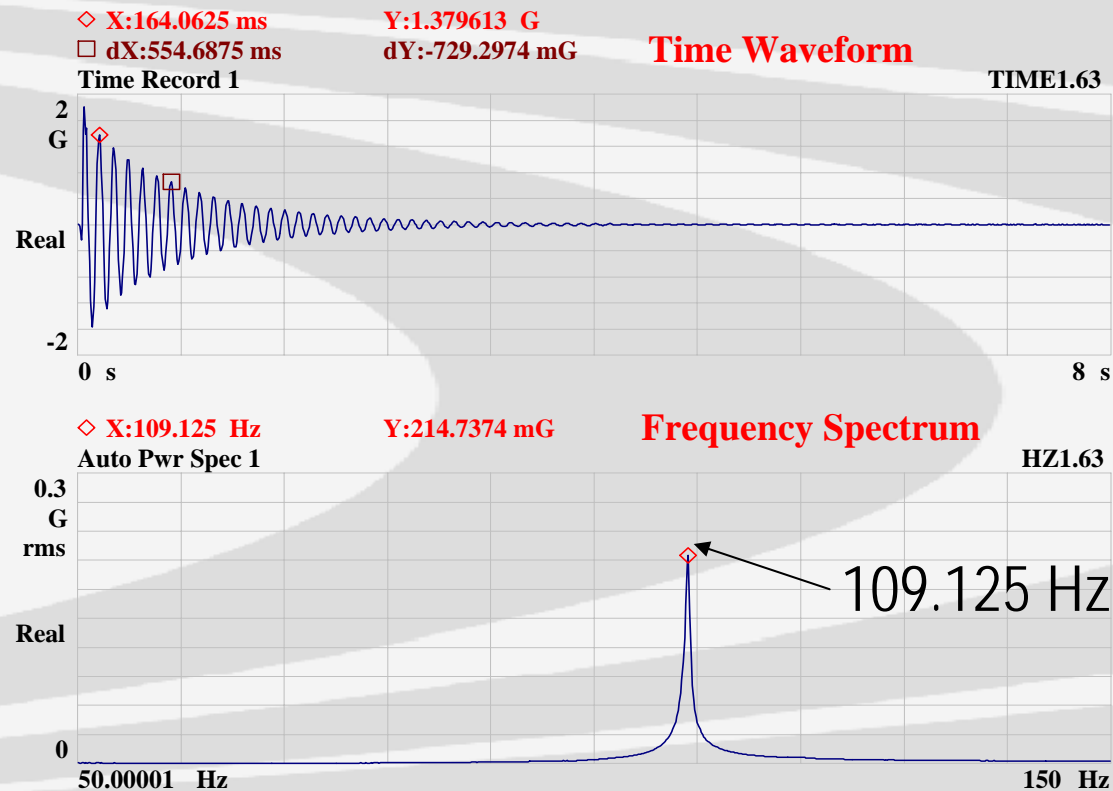
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Case History

Zoom



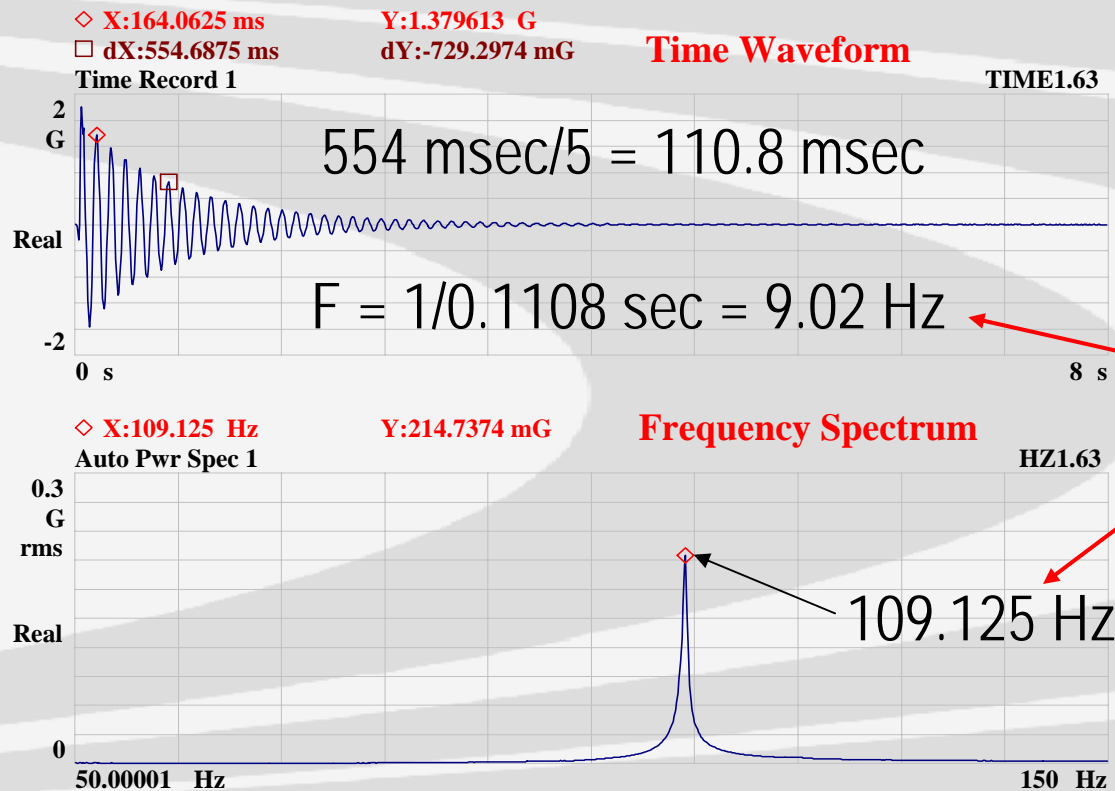
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Case History

Zoom & Mental Health Check



What
the
He__!



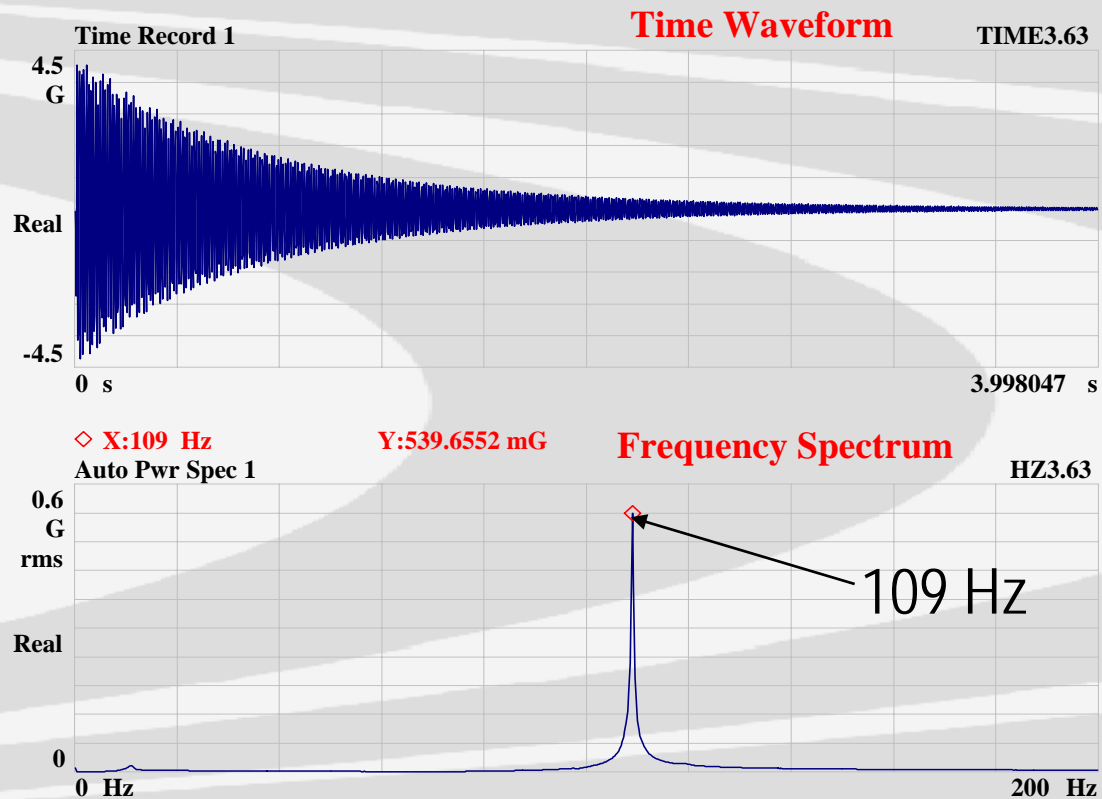
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Case History

So Easy ???????



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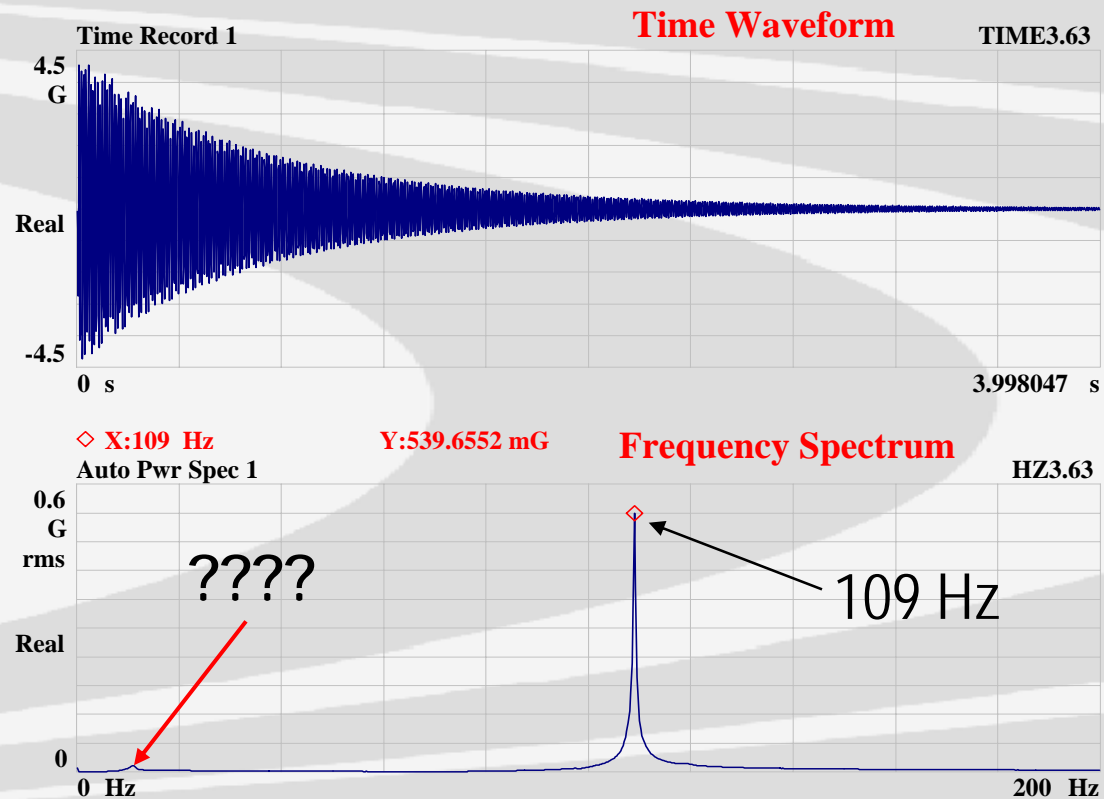
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Case History

What's This ?



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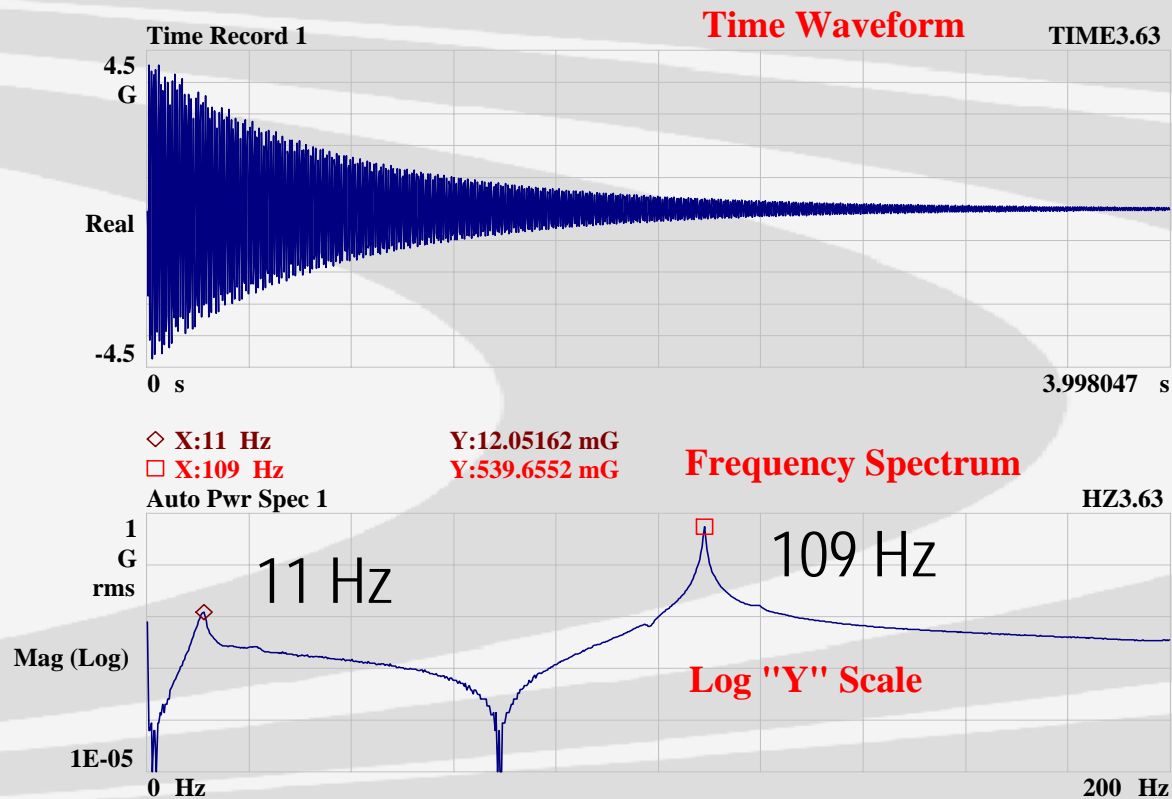
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VIBRATION ANALYSIS HARDWARE

Case History

Log – Can't Live With It, Can't Live Without It !



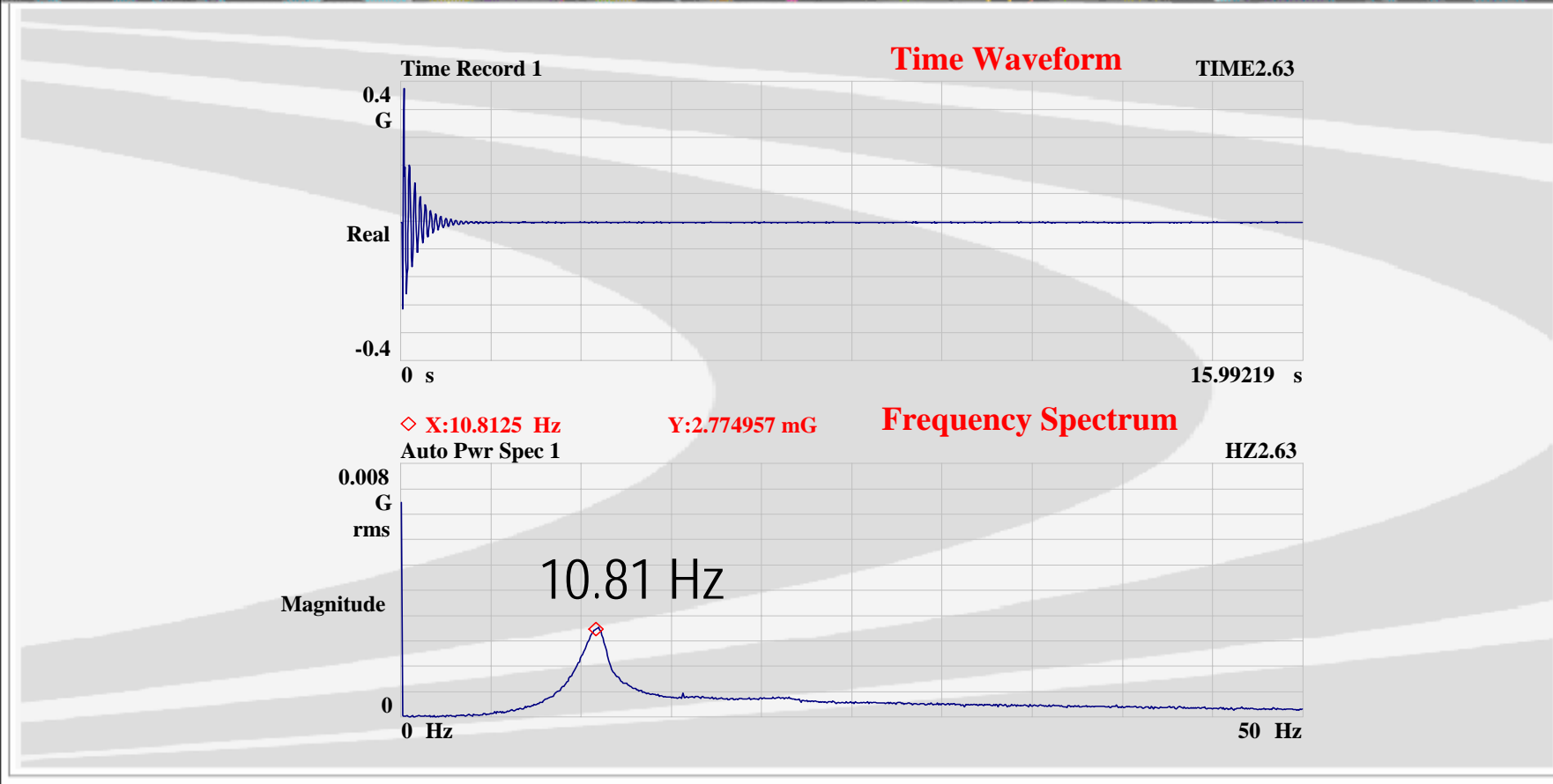
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Case History

0 – 50 Hz Span



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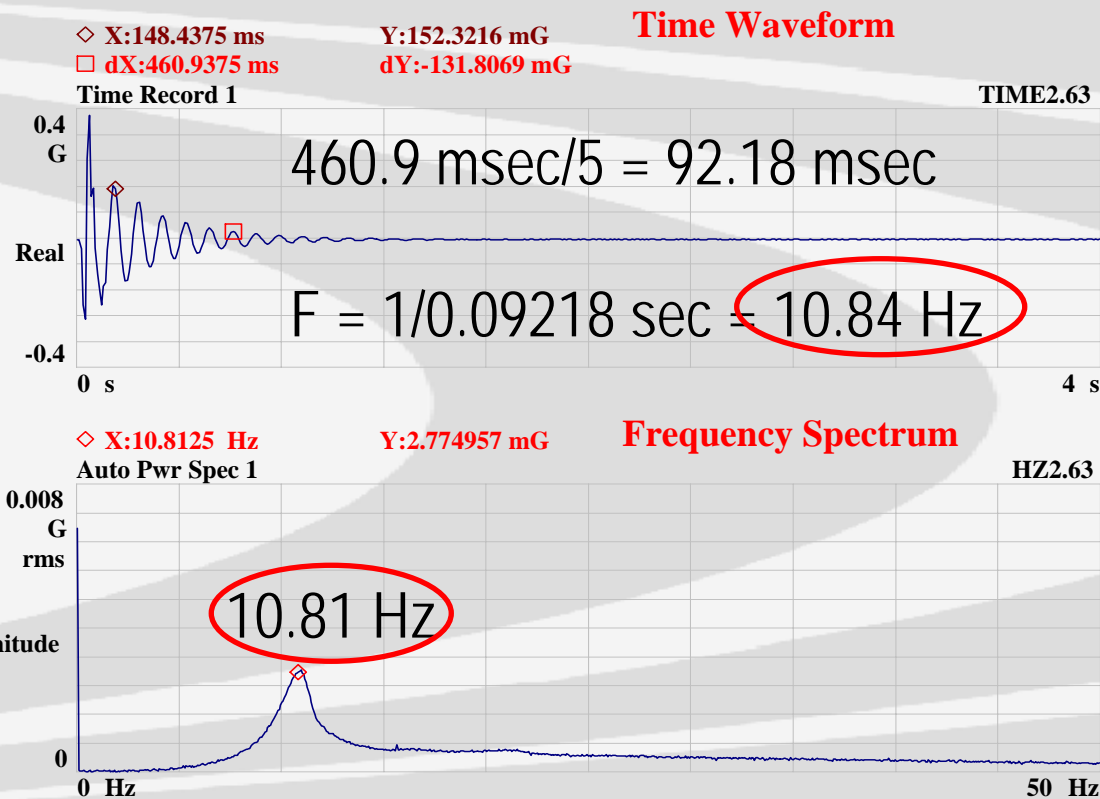
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VIBRATION ANALYSIS HARDWARE

Case History

0 - 50 Hz (expanded "x" scale)

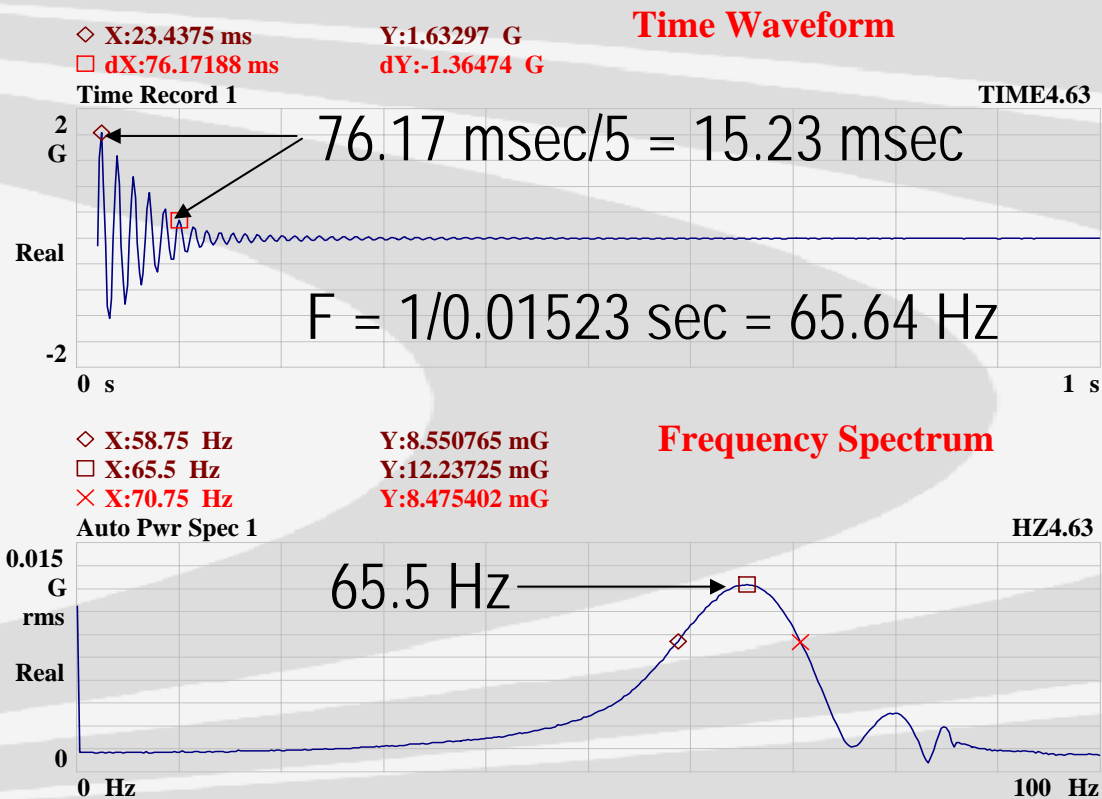


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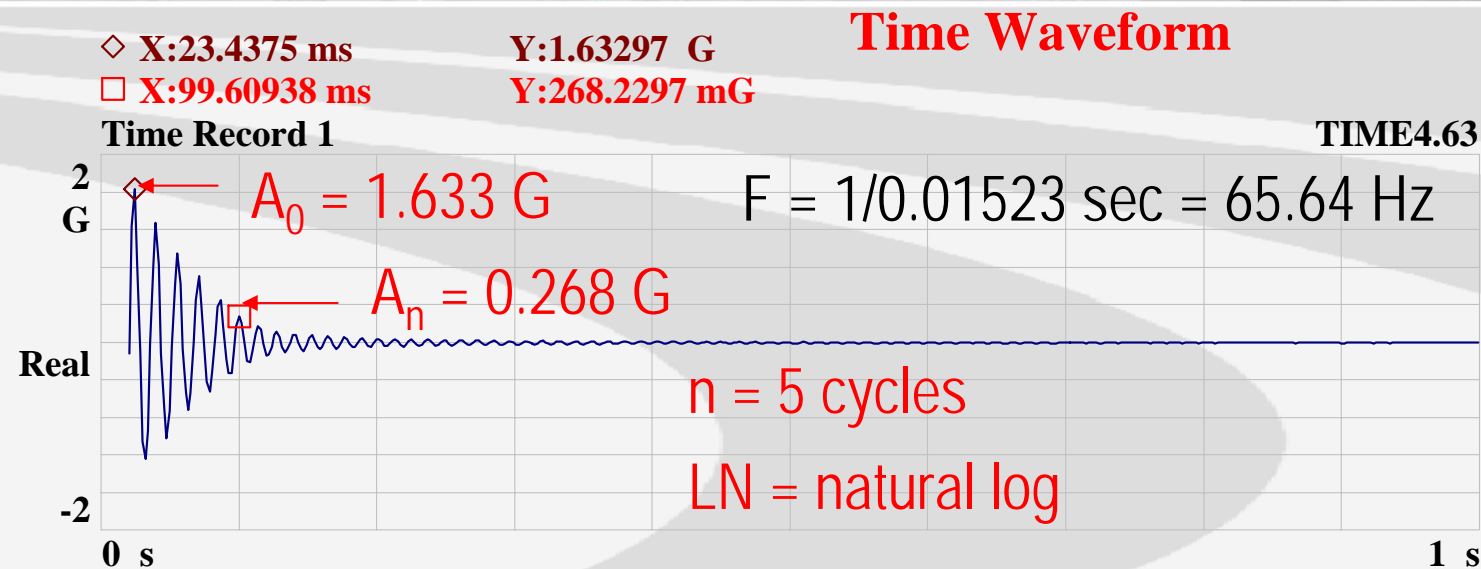
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Back to Bump Testing



Using the Time Waveform



$$\text{Log decrement} = [1/n[\text{LN}(A_0/A_n)]] = [1/5[\text{LN}(1.633/0.268)]] = 0.36$$

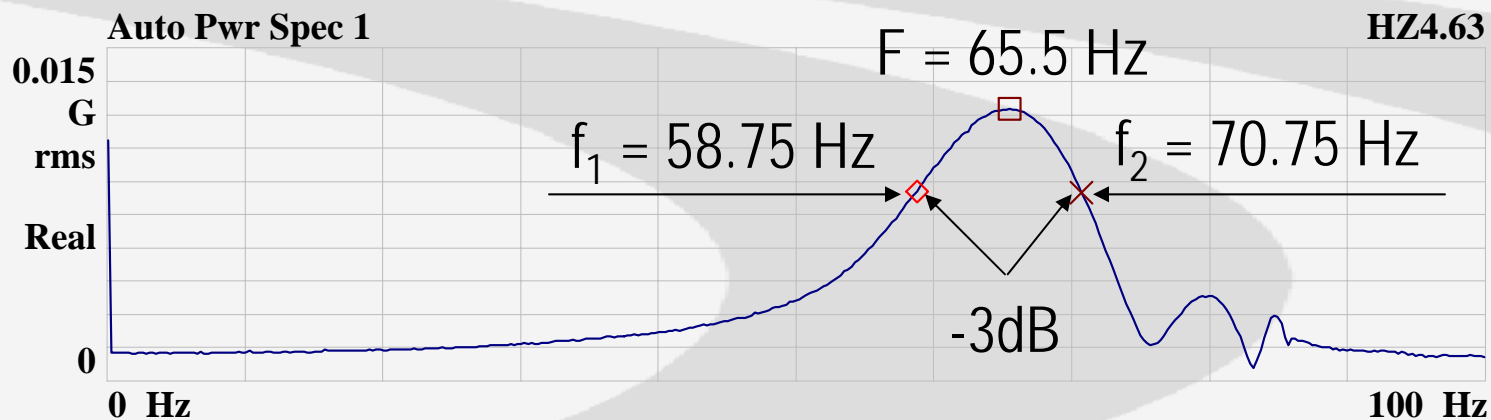
$$\text{Damping ratio} = \text{Log dec}/2\text{Pi} = 0.36/2\text{Pi} = 0.36/6.28 = 0.057$$

$$\text{Amplification factor} = 1/(2*\text{Damping}) = 1/(2*0.057) = 8.68$$

Using the Spectrum

- ◇ X:58.75 Hz Y:8.550765 mG
- X:65.5 Hz Y:12.23725 mG
- × X:70.75 Hz Y:8.475402 mG

Frequency Spectrum



Find the -3dB points = $A_F * .707 = 12.24 \text{ mG} * .707 = 8.65 \text{ mG}$

Find the frequencies at the -3dB points (f_1 and f_2)

Amplification factor = $F / (f_2 - f_1) = 65.5 / (70.75 - 58.75) = 5.46$

Mass & Stiffness

$$F_n = 1/2\pi\sqrt{k/m}$$

▲ INCREASE the stiffness (k)

▲ INCREASE the frequency (F)

▲ INCREASE the mass (m)

▼ DECREASE the frequency (F)



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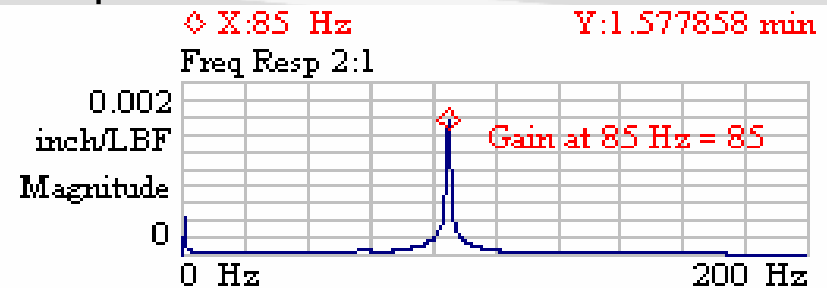
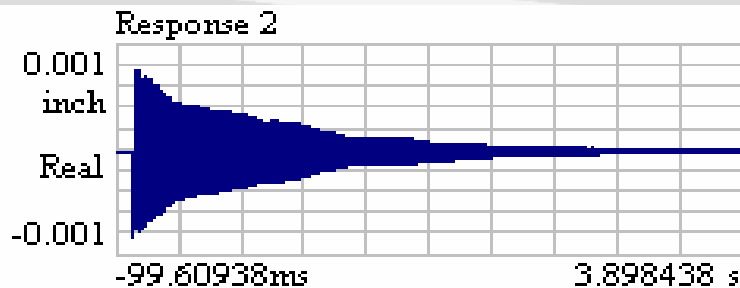


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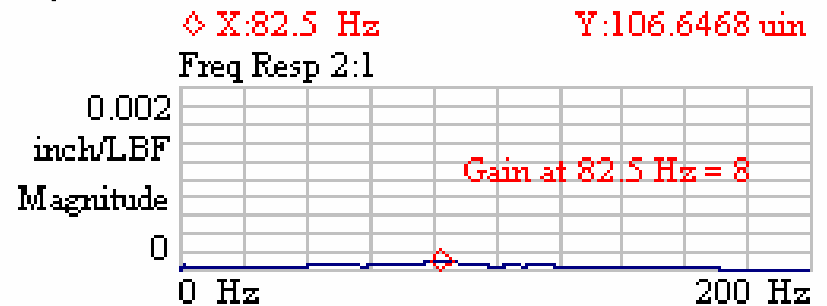
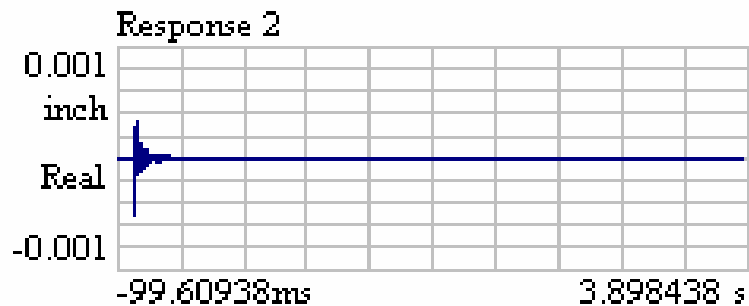
Damping

Control the Response

Un-Damped



Damped



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Summary

- Take your time
- Choose your weapon
- Bump around
- Uniform Window
- Look at the time waveform
- Look at the frequency spectrum
- Do a mental health check
- Calculate the amplification factor
- Change the mass
- Change the stiffness
- Add damping
- Bump around

Thank You !

Thank You !

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this and other subjects at
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in the “*Technical
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