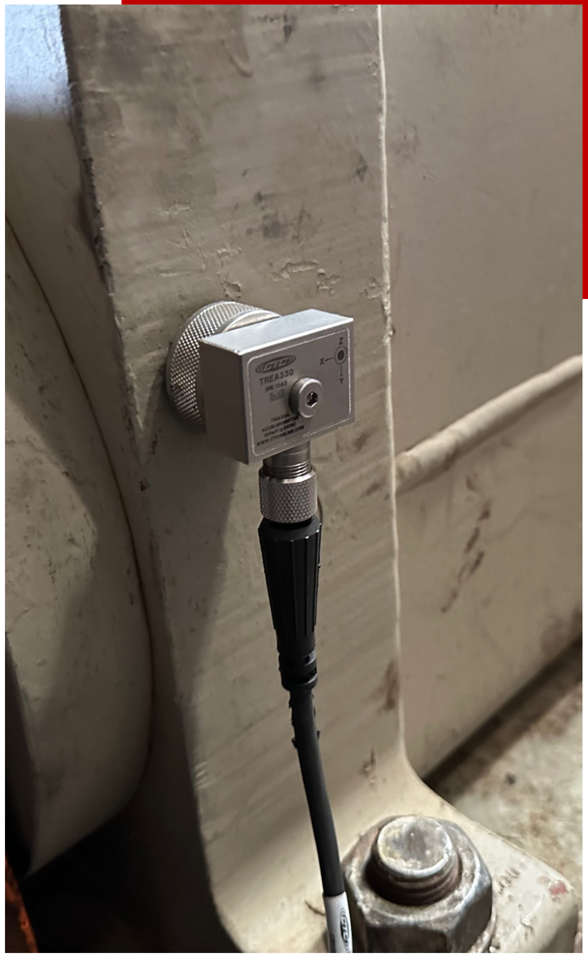
CTC UNIVERSITY

LEVEL 3, LESSON 2

ALL ABOUT BUMP TESTING

Introduction



Welcome to **Level 3, Lesson 2 – All About Bump Testing**, part of CTC's free online vibration analysis training series.

We hope you enjoyed and benefitted from the previous course and will continue to build your vibration analysis knowledge as you progress through Level 3.

Training Objectives

Upon completion of this lesson, you will understand the basics of bump testing, including:

1. *What is a bump test?*
2. *Why do a bump test?*
3. *How do bump tests work?*

Bump Testing – 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

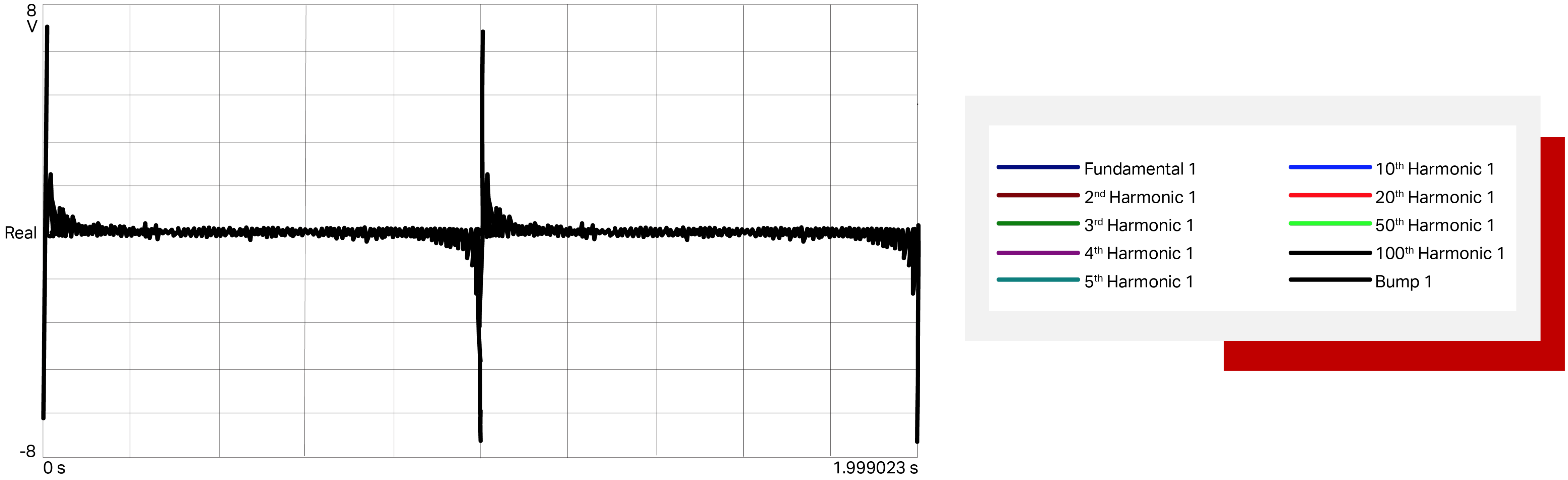
Bump Testing –
Why Do A Bump Test?

Bump testing is done to excite and measure the natural frequency(s) of an object.

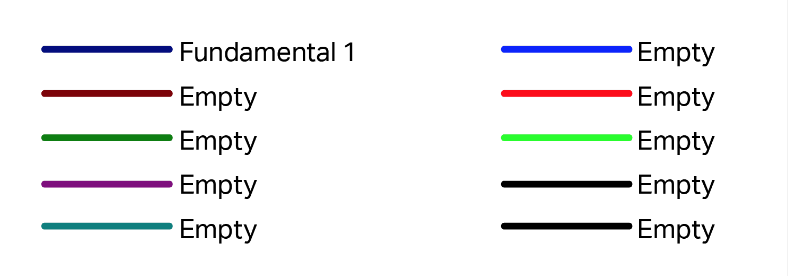
When bump testing is done, you will:

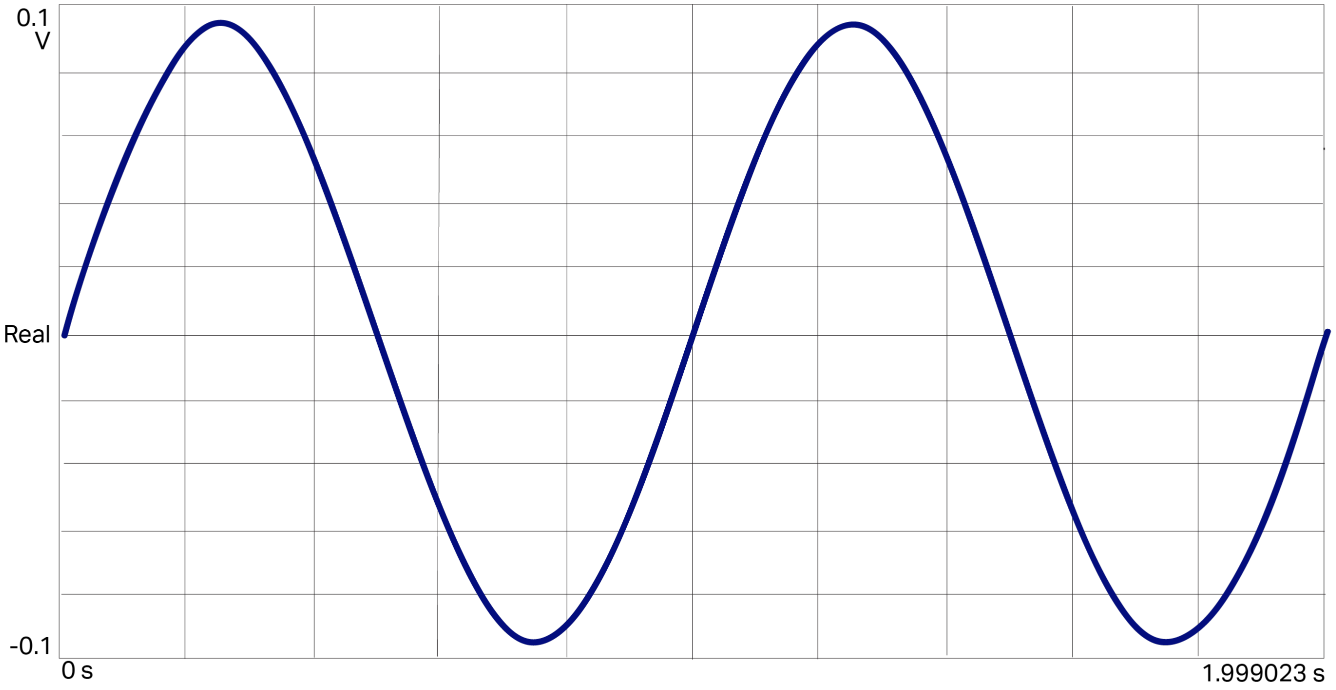
- Identify a resonance
- Understand a change in mass
- Understand a change in stiffness
- Understand a change in damping

Bump Testing – How Does It Work?

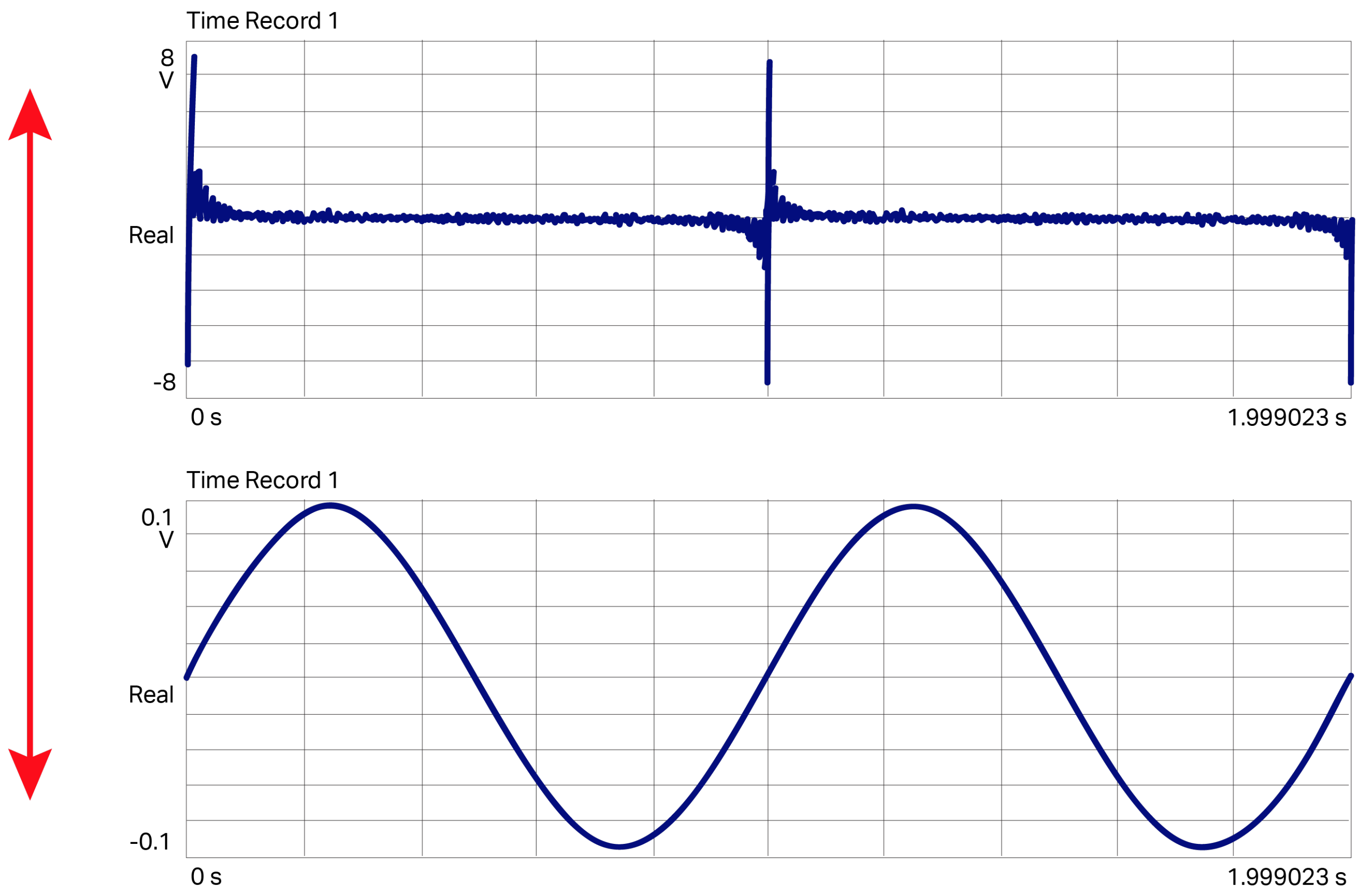


Bump Testing – Sine Waves?

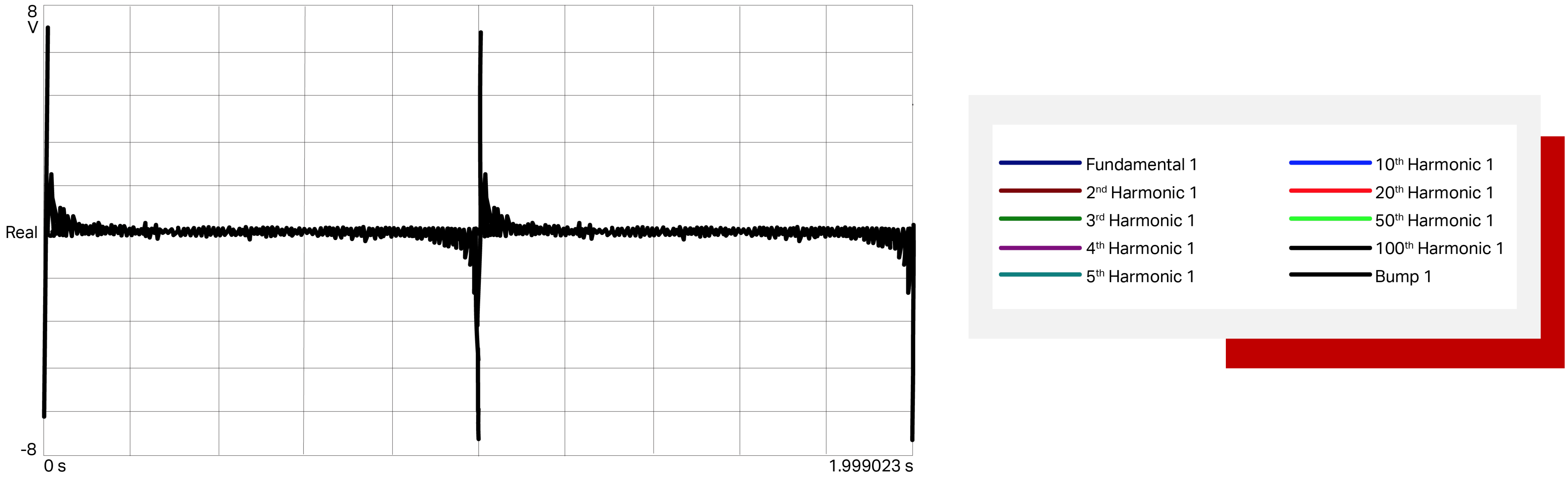




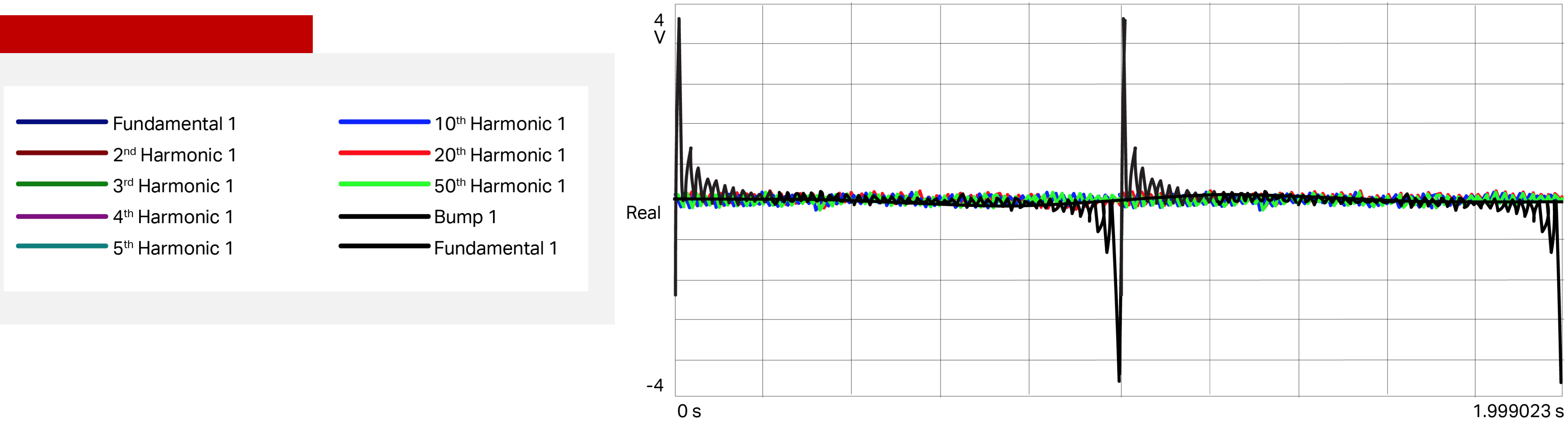
Bump Testing –
Bumps From Sine Waves?



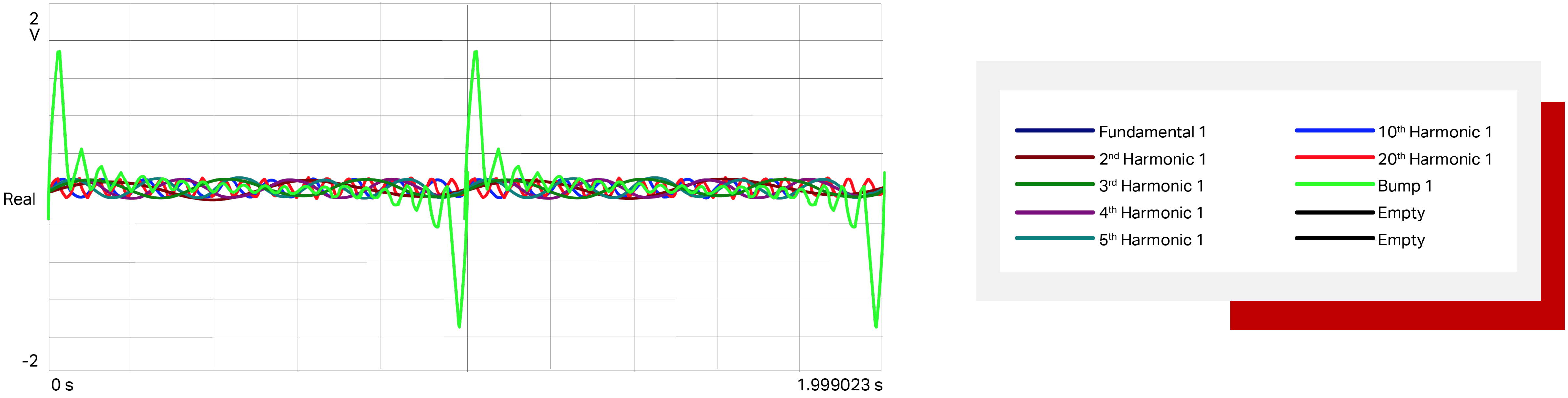
Bump Testing – 100^{th} Harmonic



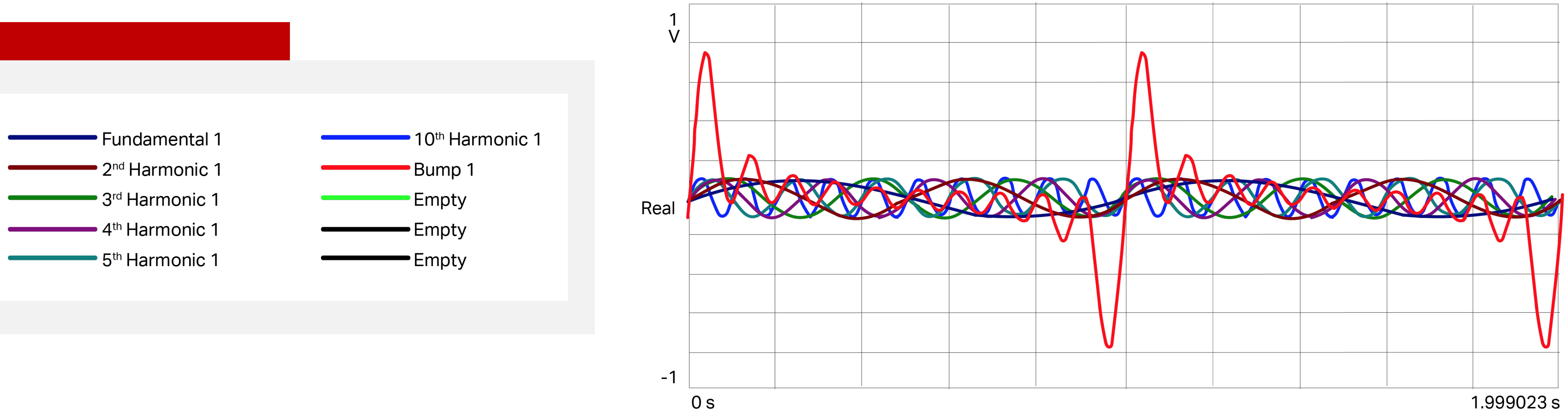
Bump Testing – 50th Harmonic



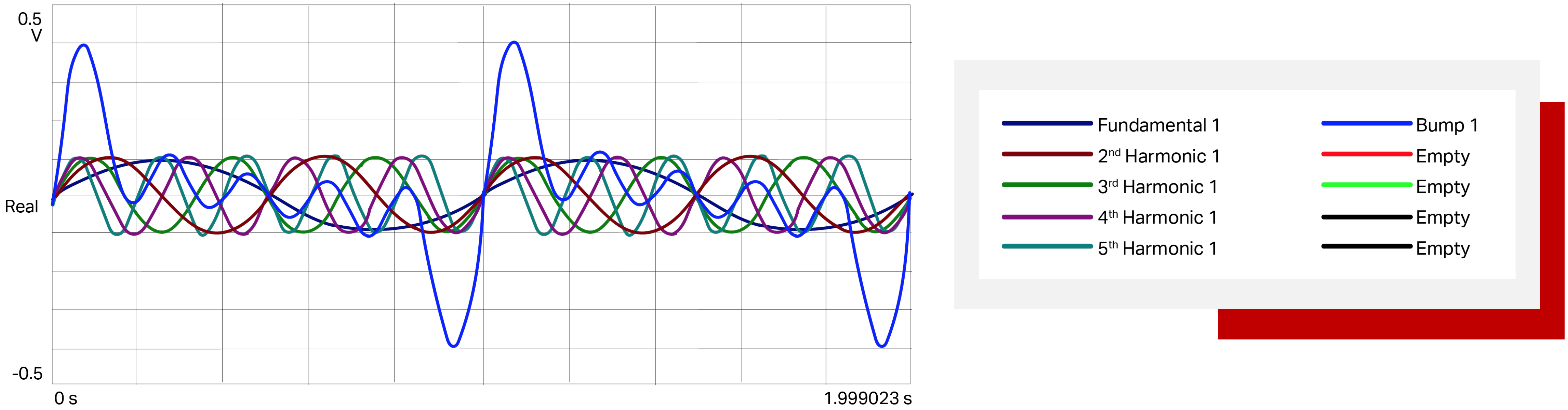
Bump Testing – 20th Harmonic



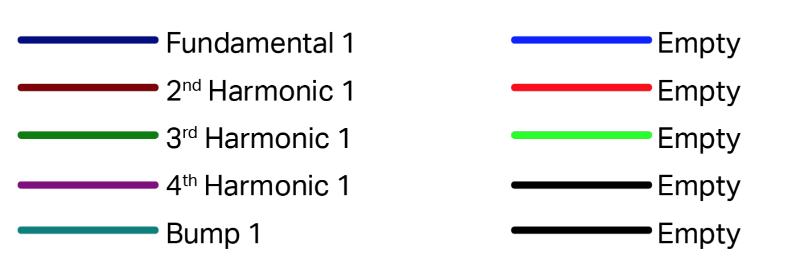
Bump Testing – 10th Harmonic

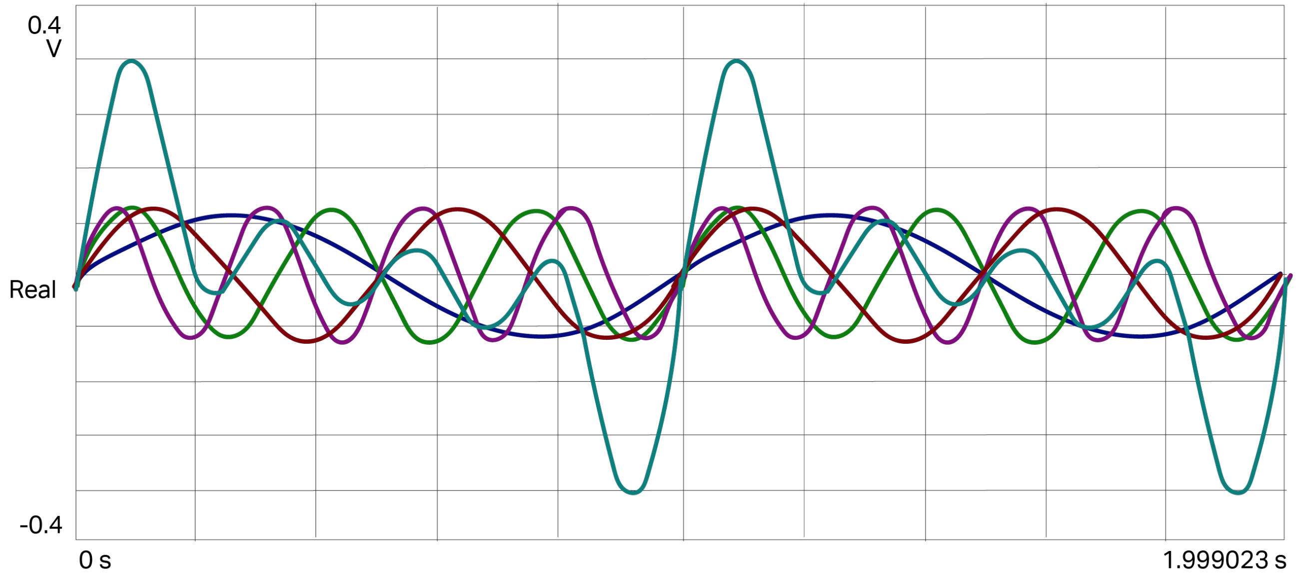


Bump Testing – 5th Harmonic

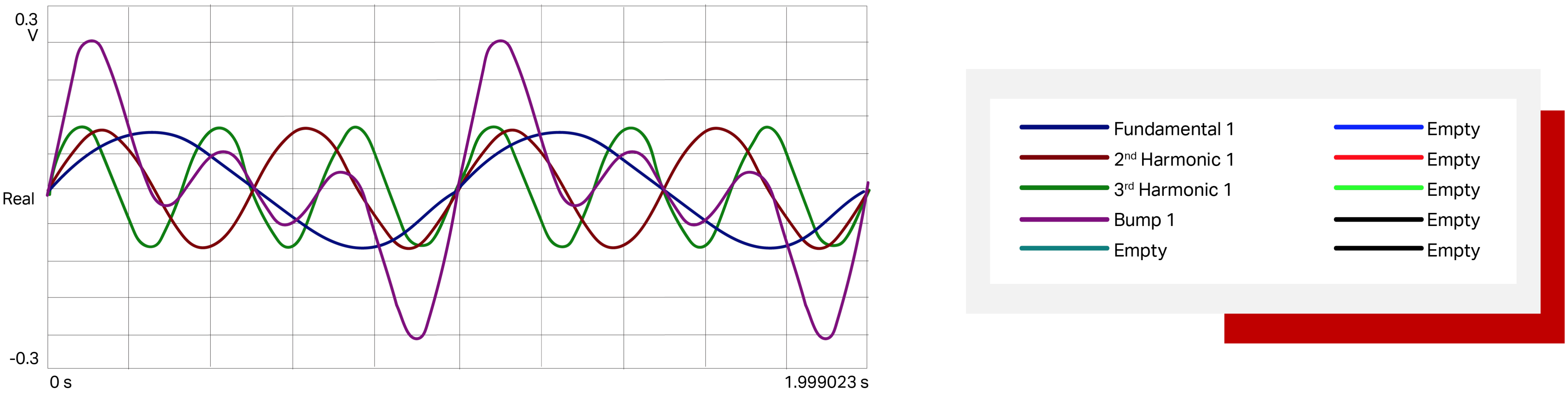


Bump Testing – 4th Harmonic

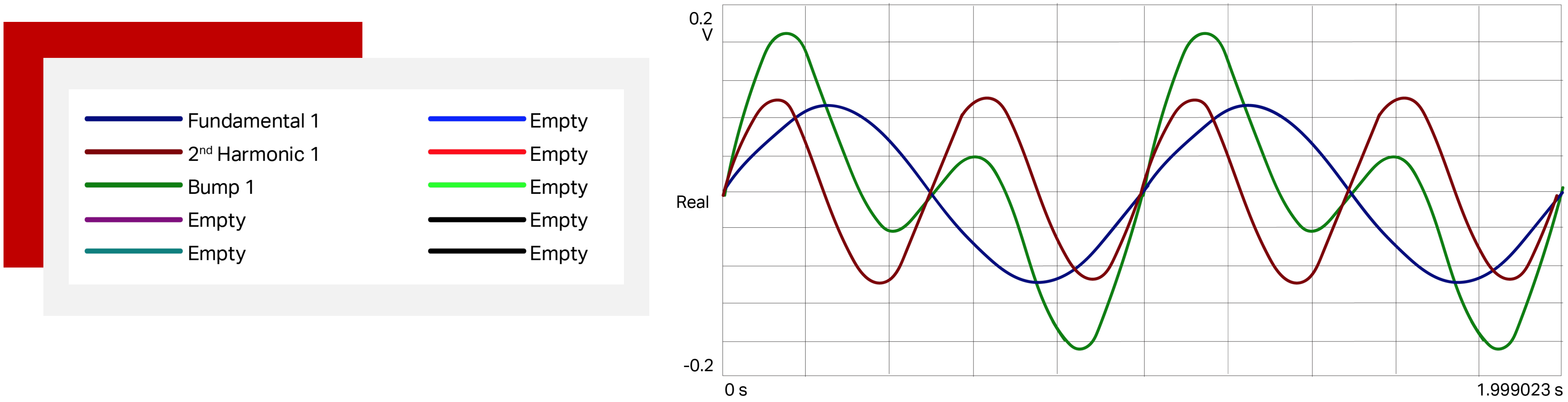




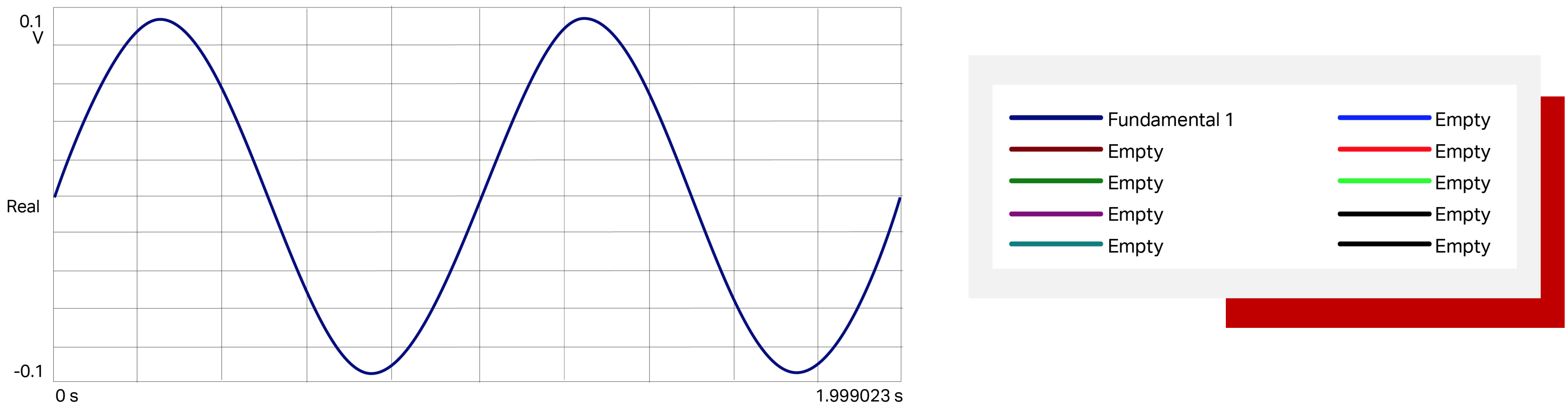
Bump Testing – 3rd Harmonic



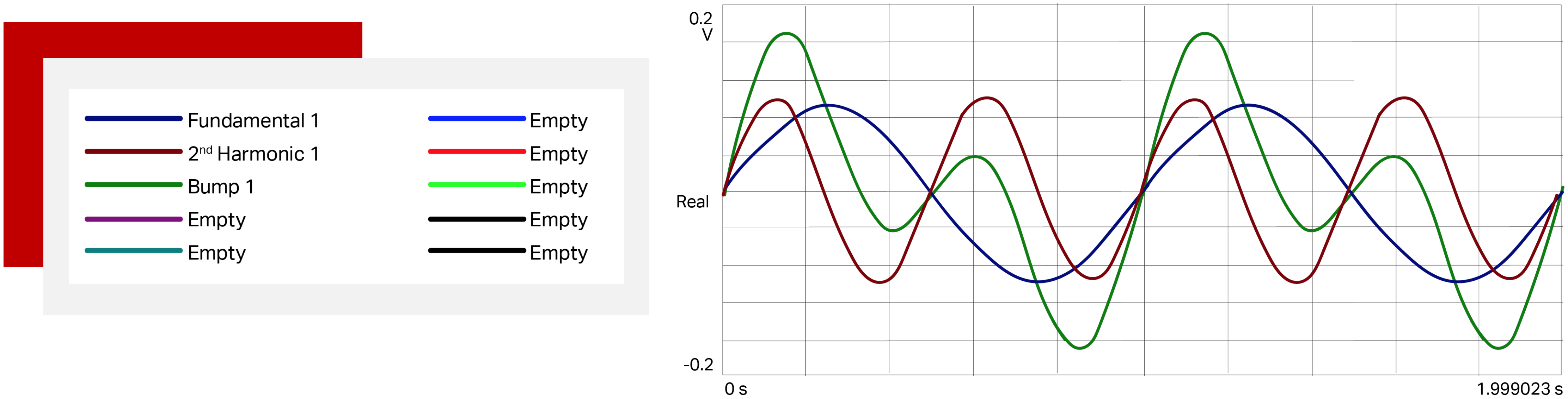
Bump Testing – 2nd Harmonic



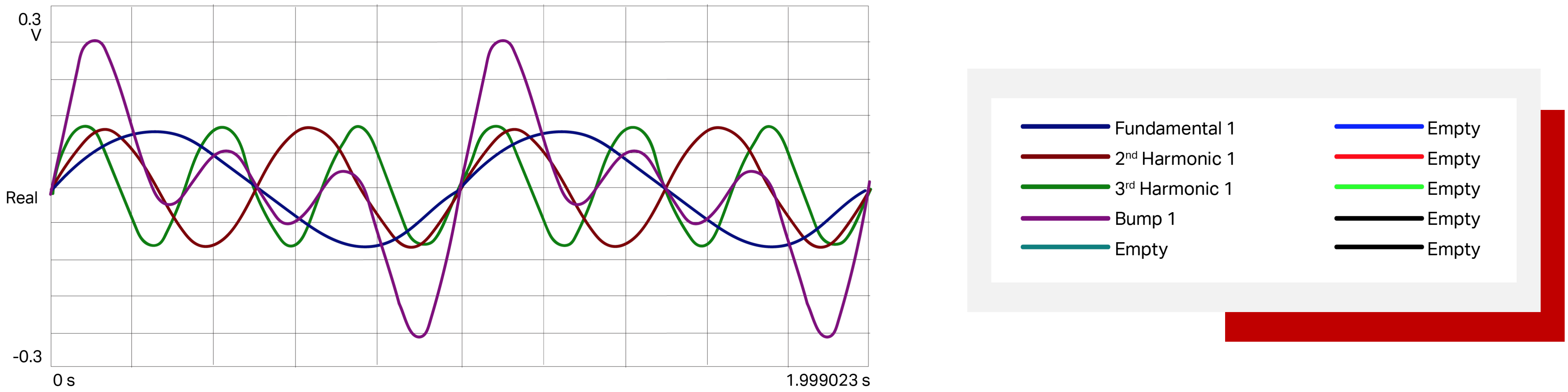
Bump Testing – Fundamental



Bump Testing – 2^{nd} Harmonic

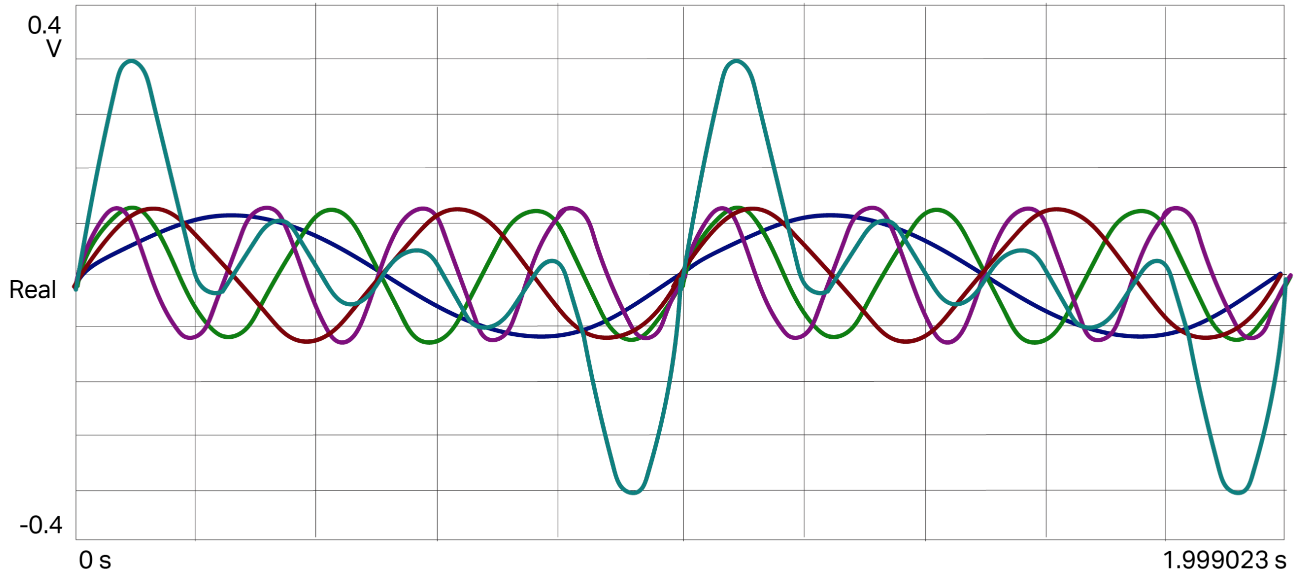


Bump Testing – 3rd Harmonic

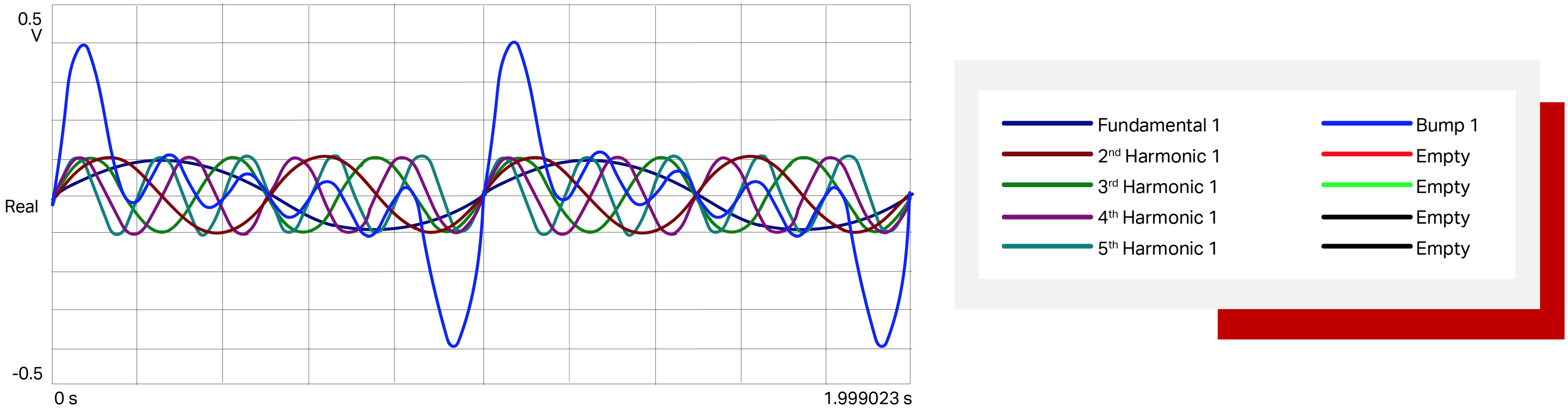


Bump Testing – 4th Harmonic

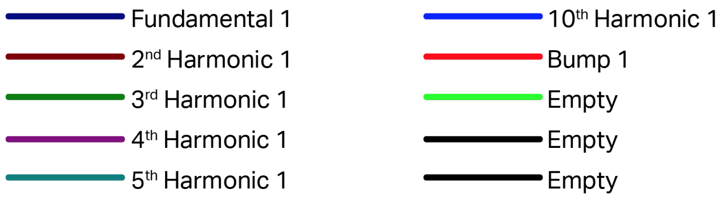
- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- Bump 1
- Empty
- Empty
- Empty
- Empty
- Empty

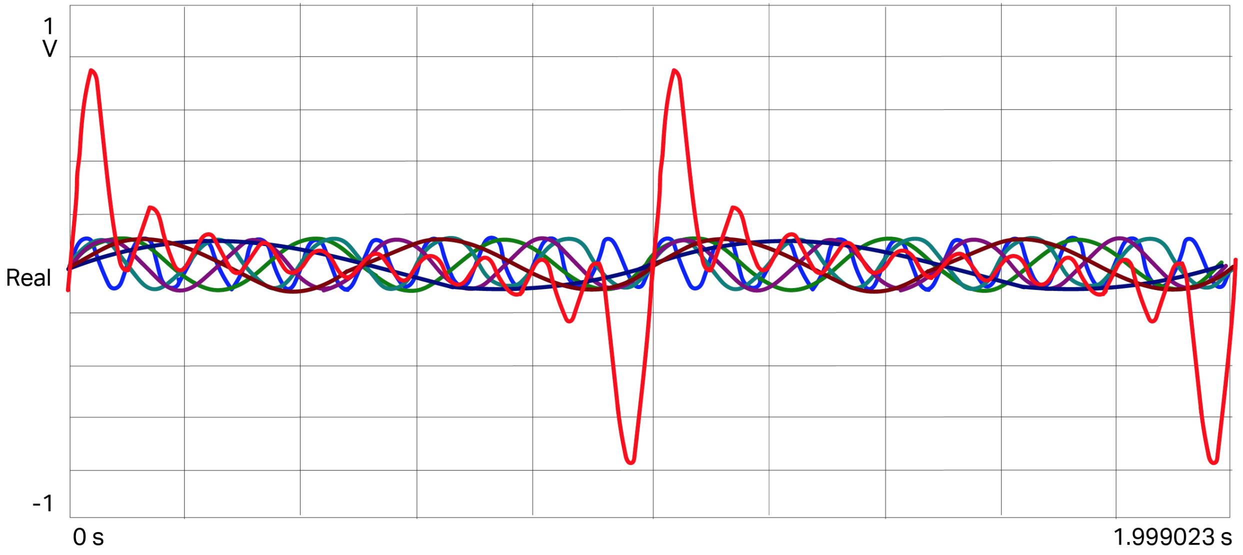


Bump Testing – 5^{th} Harmonic

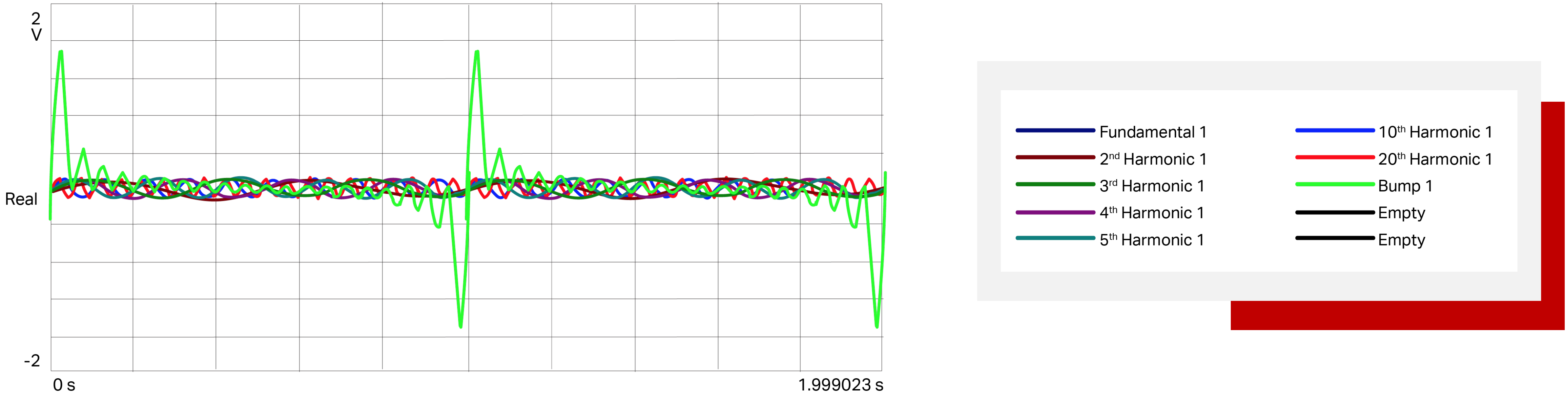


Bump Testing – 10th Harmonic



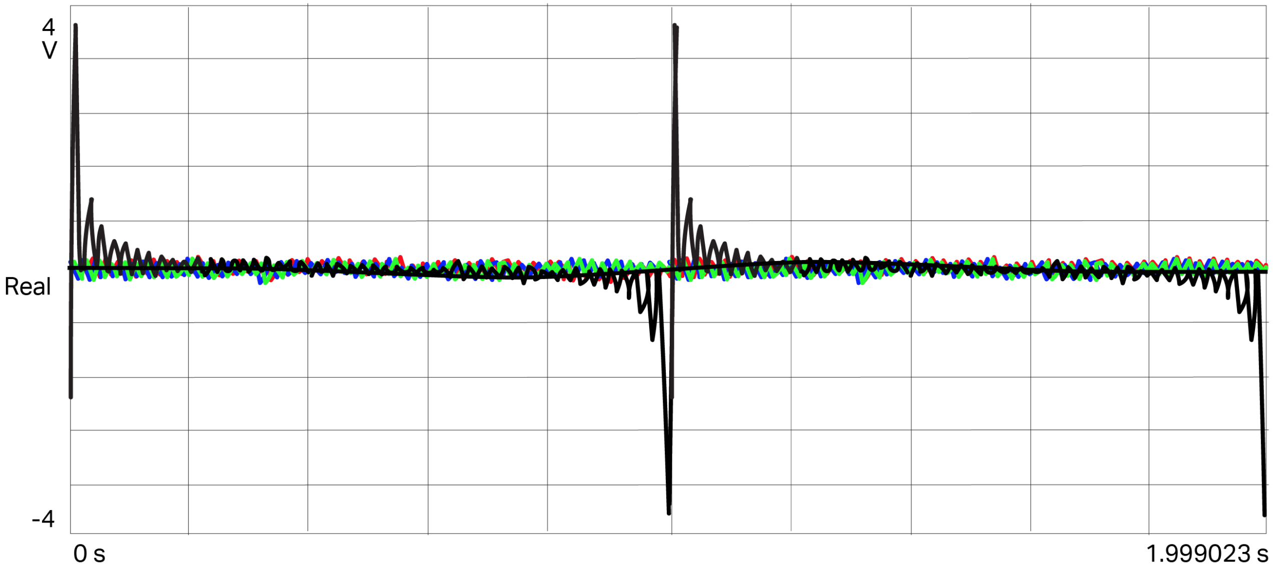


Bump Testing – 20th Harmonic

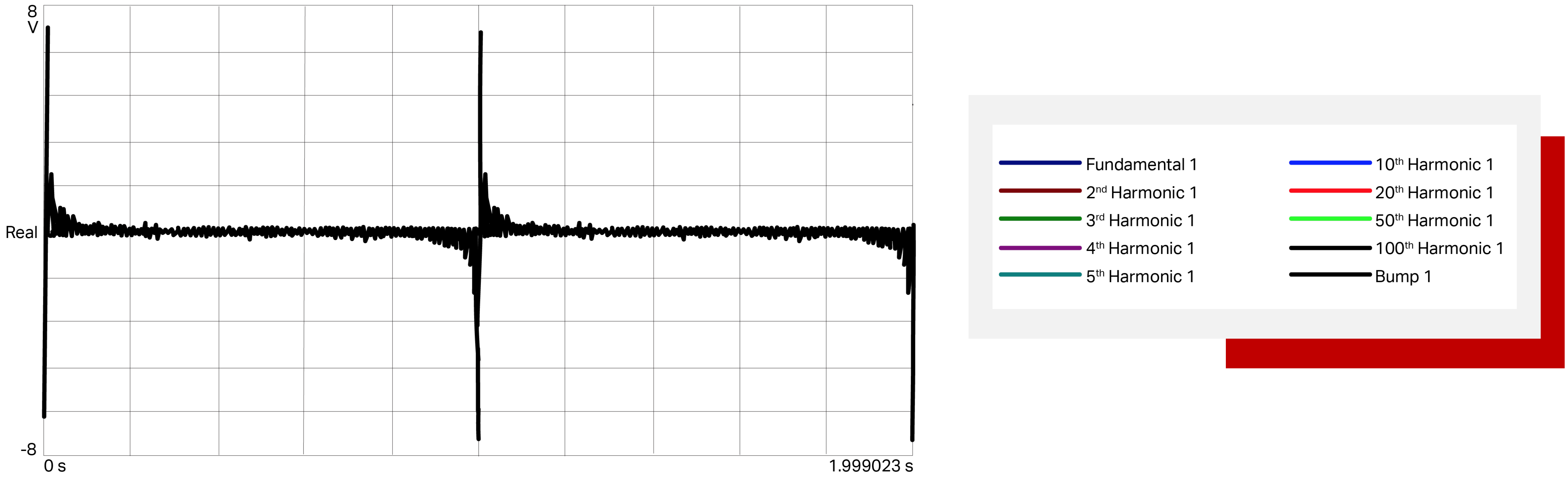


Bump Testing – 50th Harmonic

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



Bump Testing – 100th Harmonic



How Does Bump Testing Work?

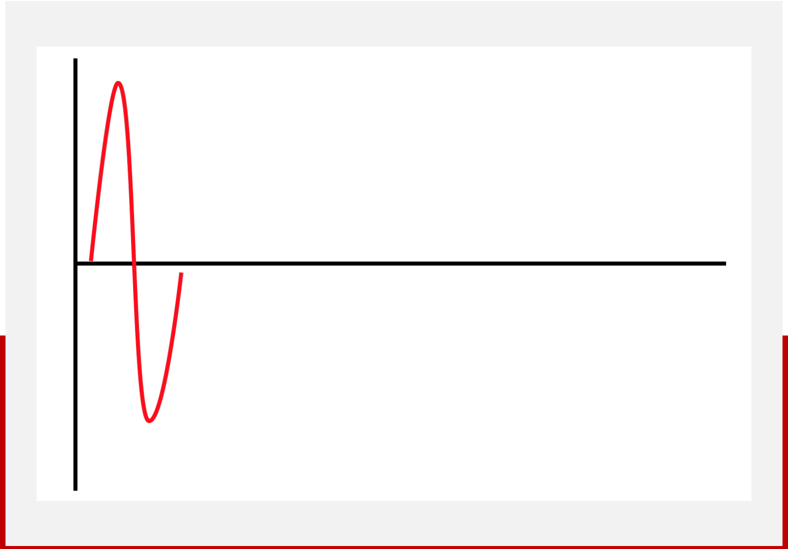
Bump testing (or impact testing) works because the bump or impact contains all the individual frequencies or sign waves

When you bump or impact the object under test, you will excite all the natural frequencies of that object

Bump Testing –
What Do You Impact With?

Pin Drops

high frequency content | low energy value



Cow Plops

low frequency content | high energy value

Bump Testing – 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.

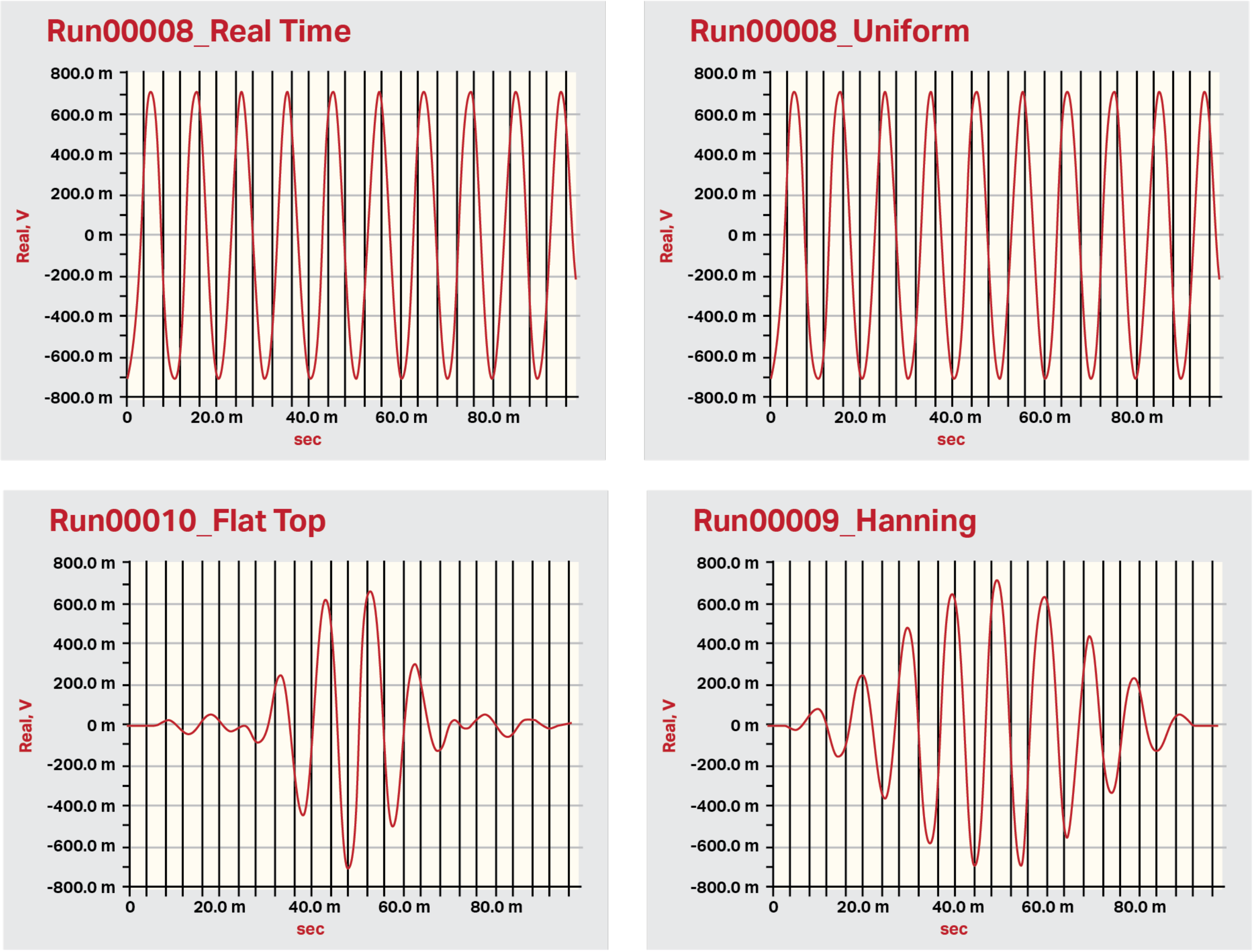
This will generate low energy, high frequency responses (pin drops).

Bump Testing – Set Up

Uniform Window

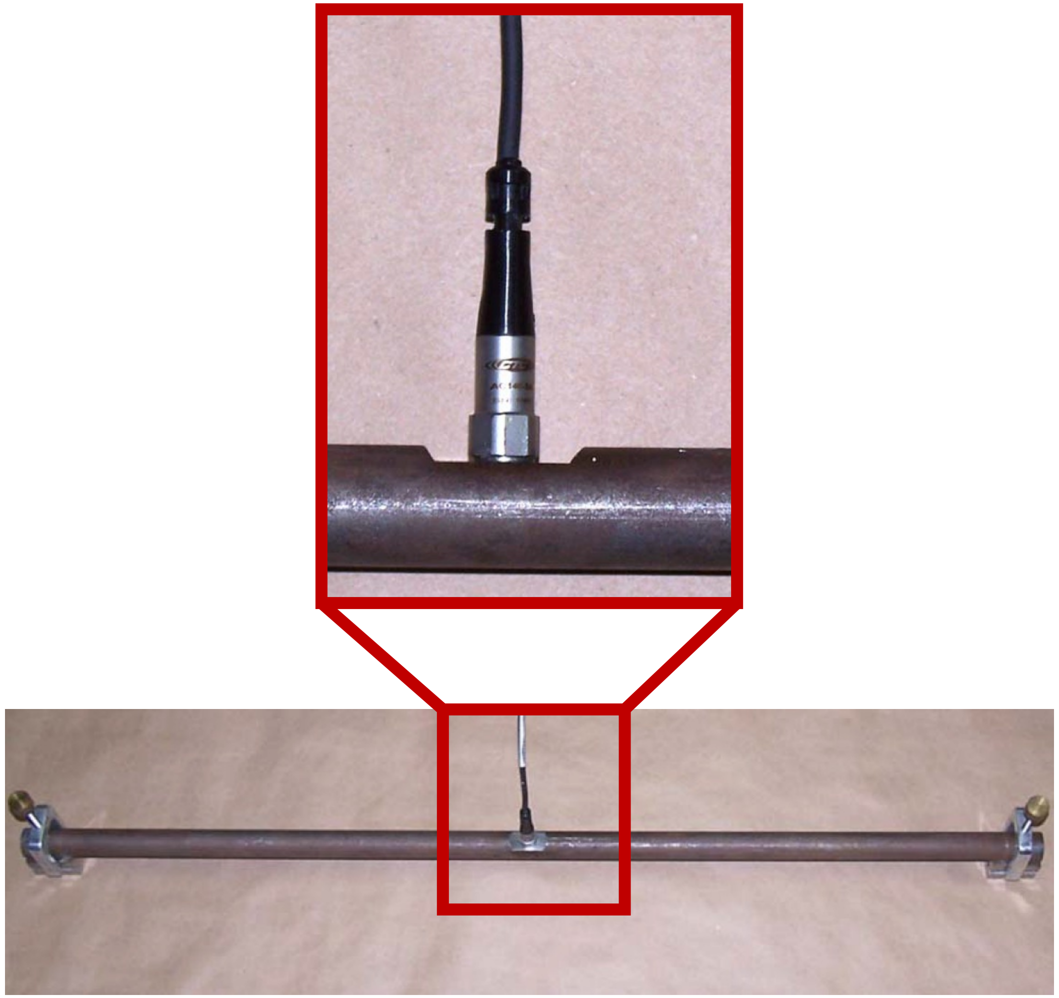
- Take your time – bump around
- Do not over range or clip the input signal
- 800 – 1,600 lines of resolution
- Try some different frequency spans
- Only one bump for each time record
- About four averages (depends on noise)

Bump Testing –
Why The Uniform Window?



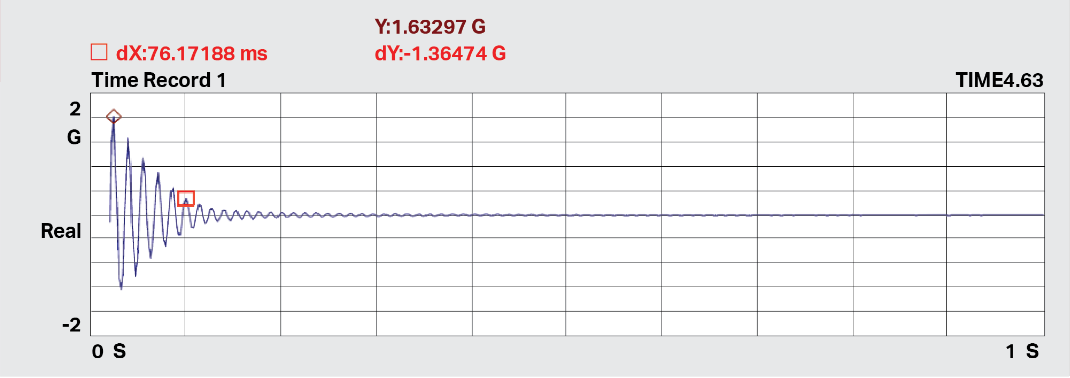
Bump Testing – What To Bump?

- 1 in. (25.4 mm) diameter steel round stock
- 36 in. (914.4 mm) length
- Clamped in "V" blocks at each end
- CTC's 100 mV/g AC140 accelerometer stud mounted on the center

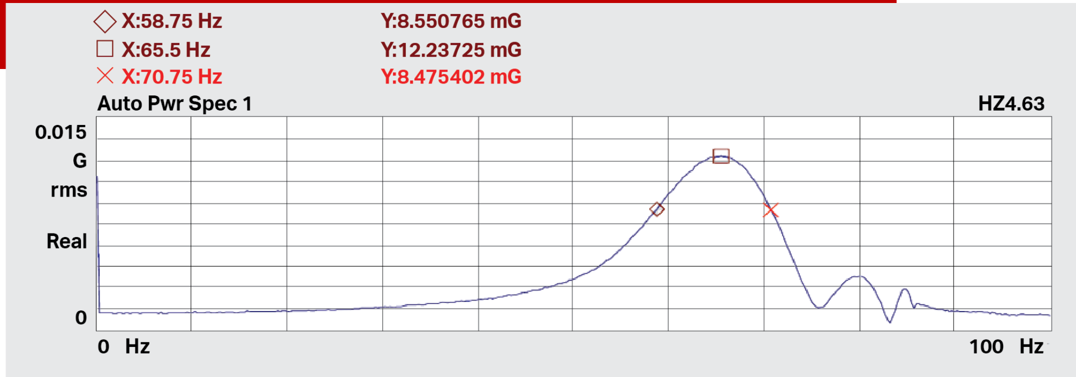


Bump Testing –
Bump It! Two Responses!

Time Waveform

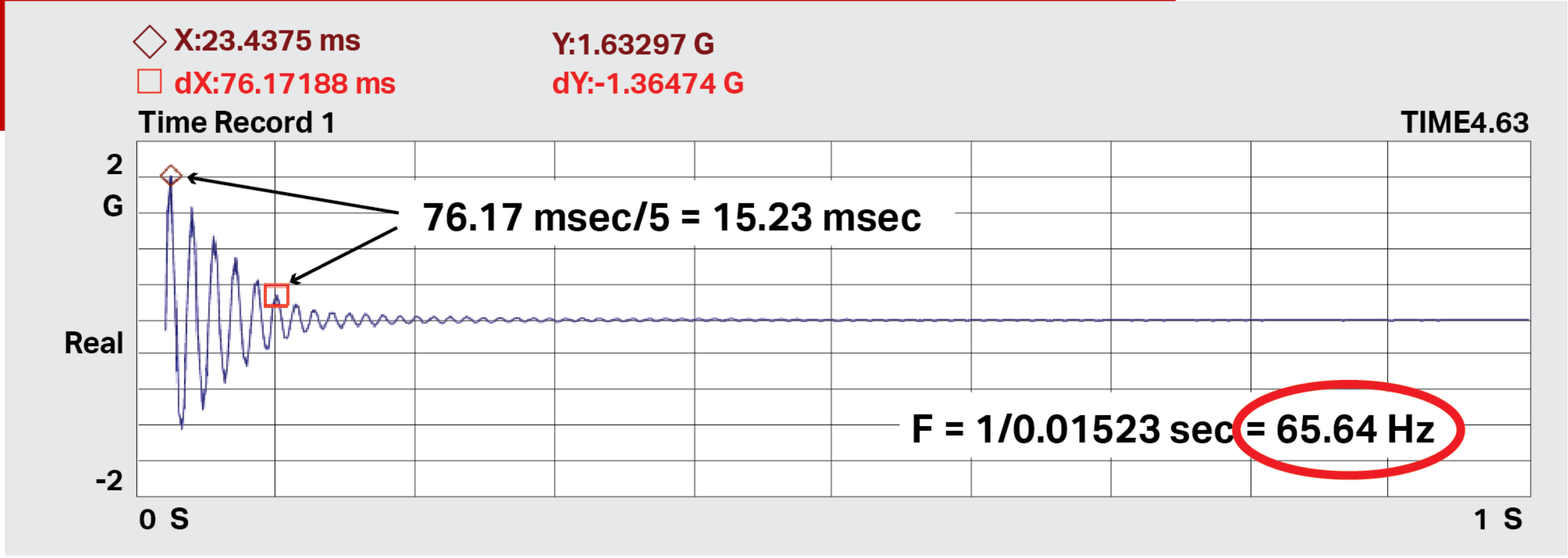


Frequency Spectrum



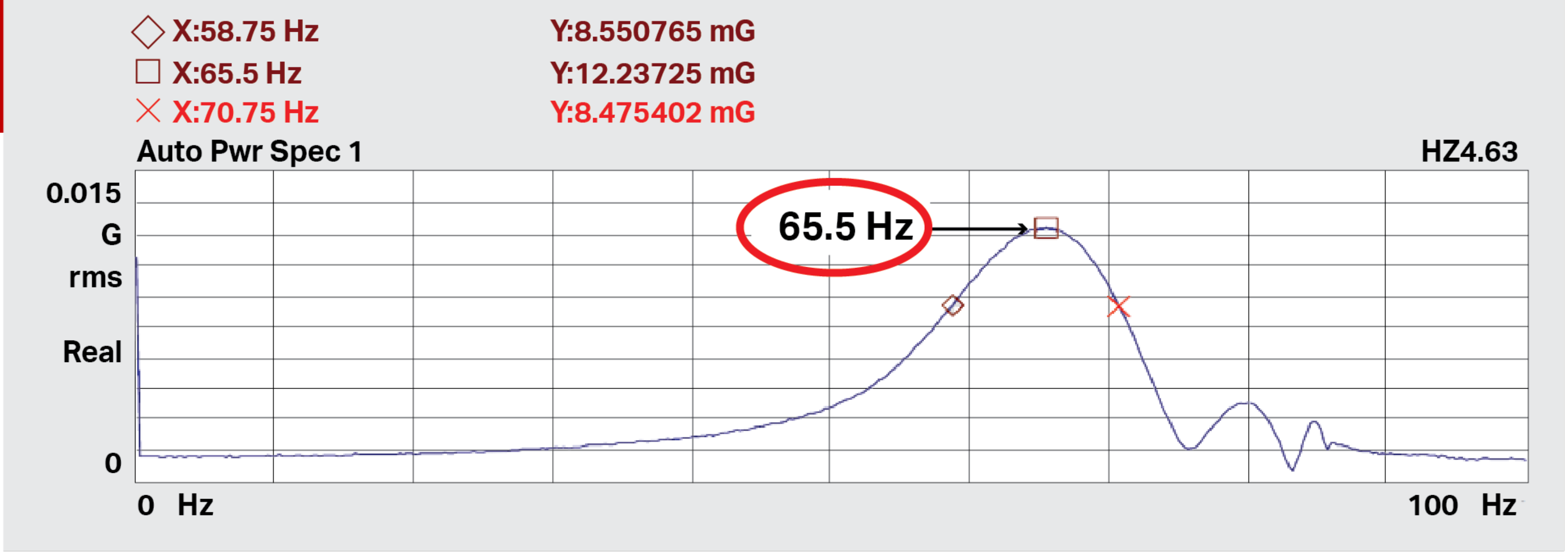
Bump Testing –
Mental Health Check!

Time Waveform



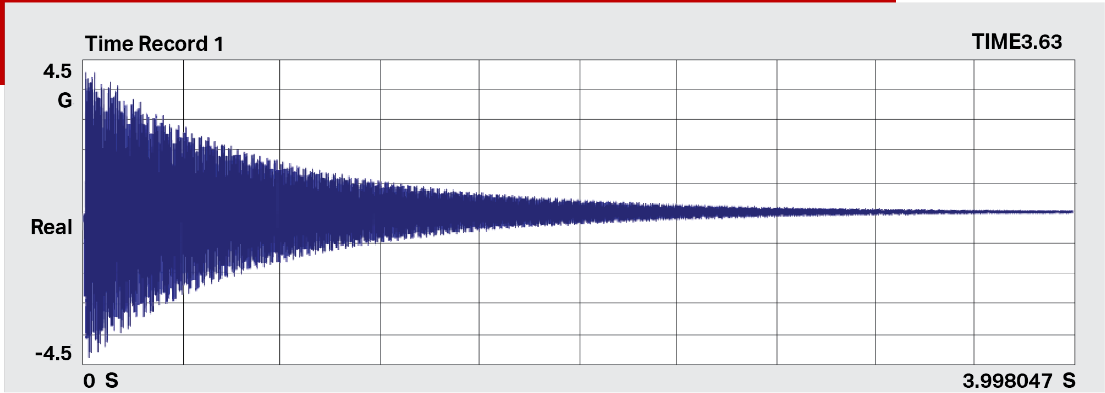
Bump Testing – Mental Health Check!

Frequency Spectrum

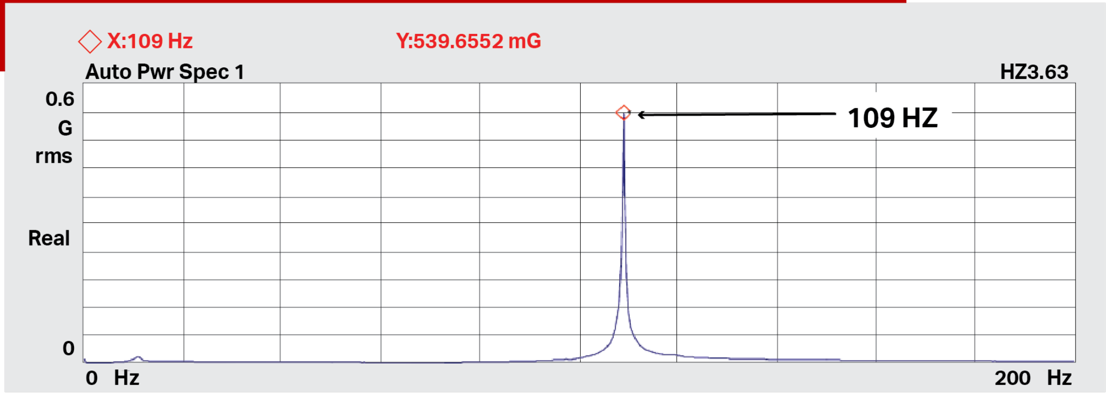


Case History – So Easy!

Time Waveform

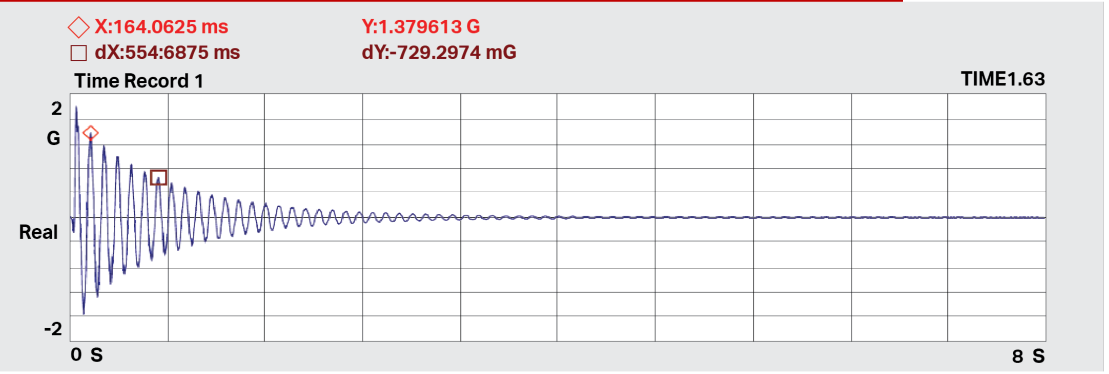


Frequency Spectrum

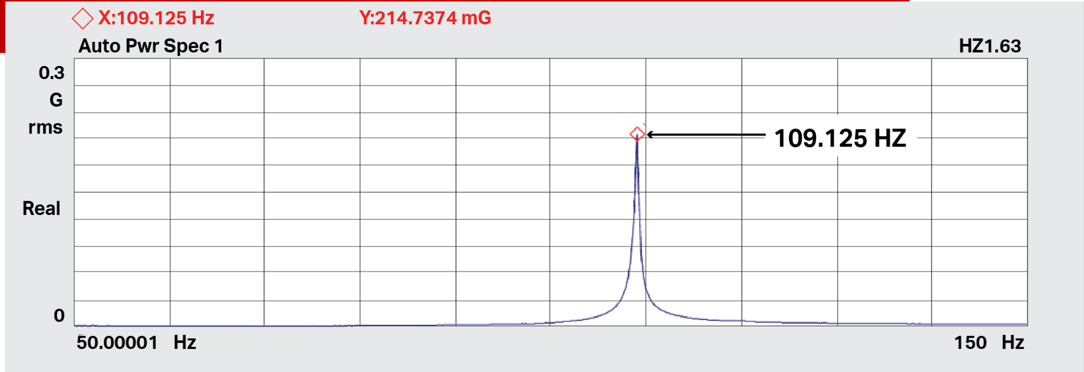


Case History – Zoom

Time Waveform

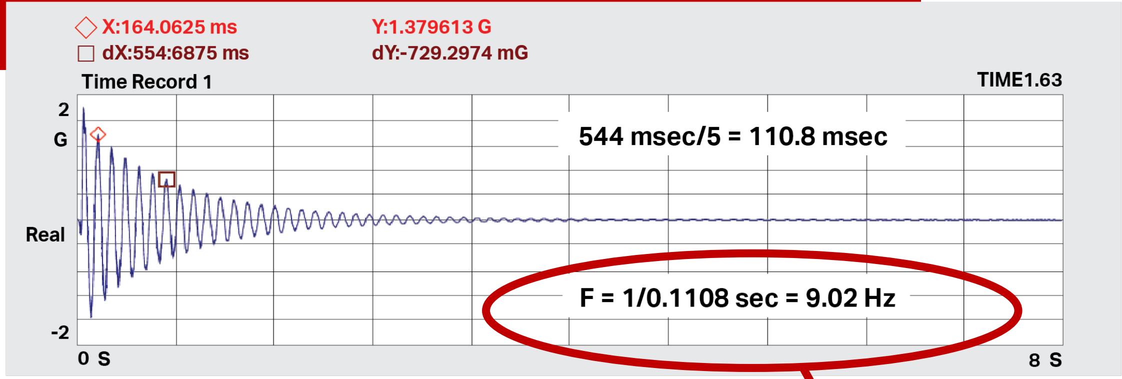


Frequency Spectrum

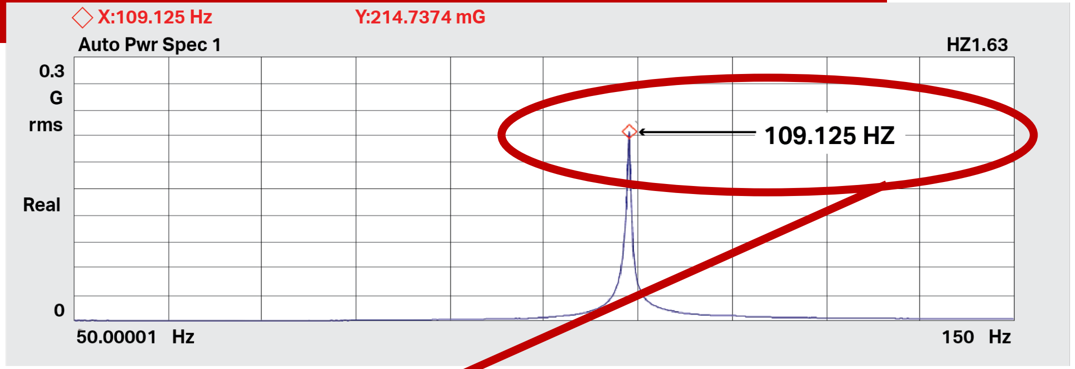


Case History –
Zoom & Mental Health Check

Time Waveform



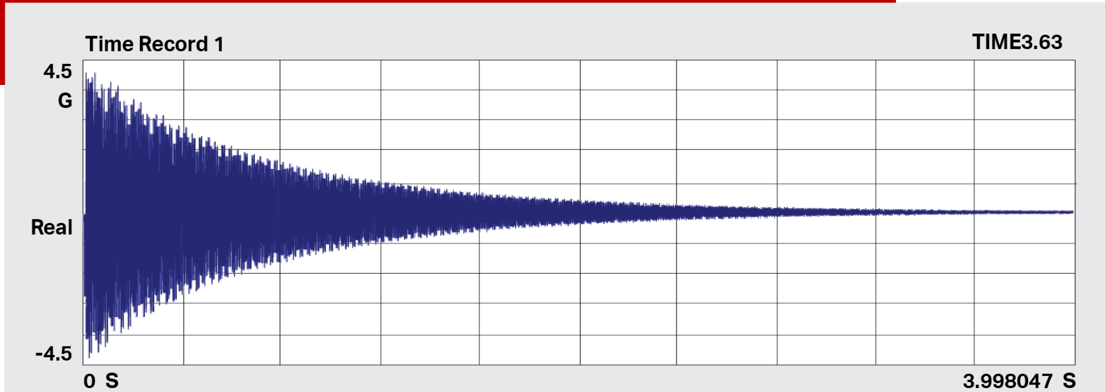
Frequency Spectrum



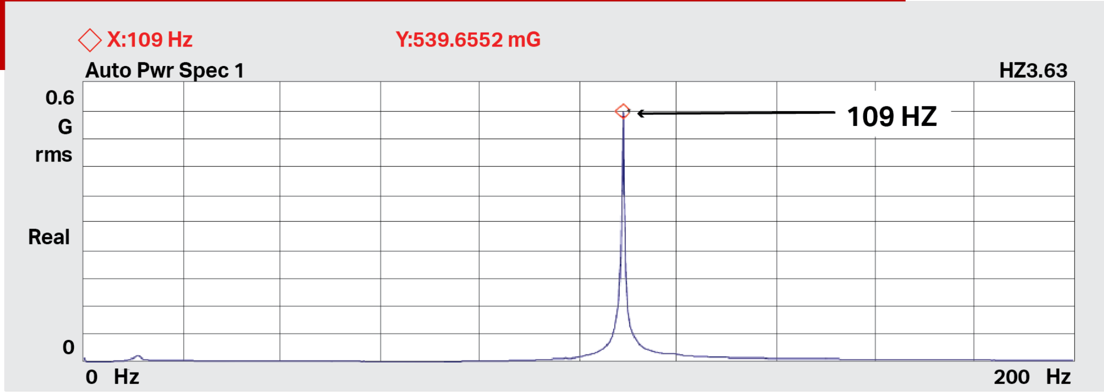
What the…?!

Case History – So Easy?

Time Waveform

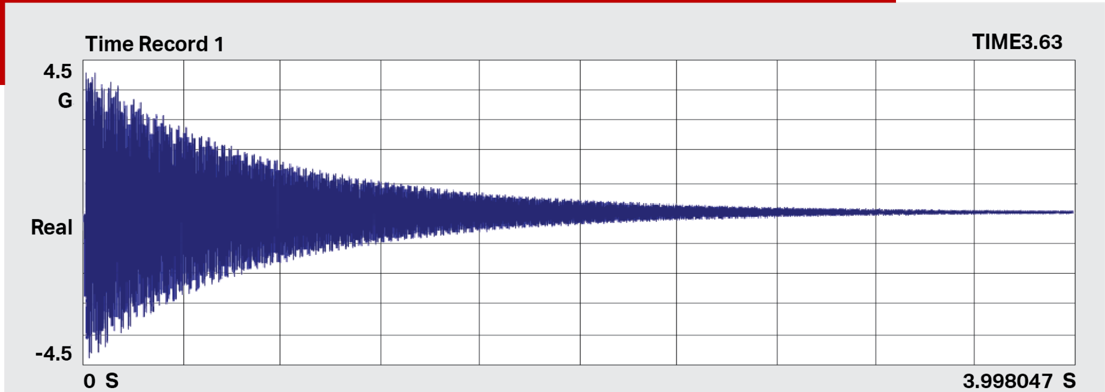


Frequency Spectrum

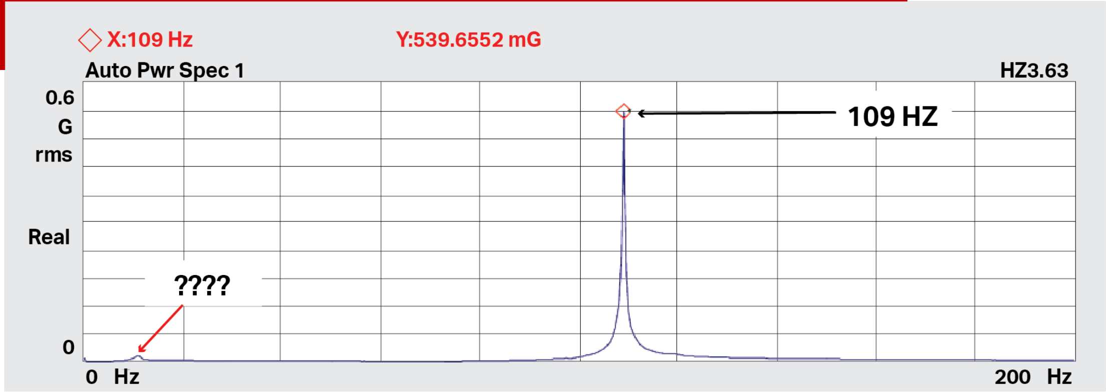


Case History – What Is This?

Time Waveform

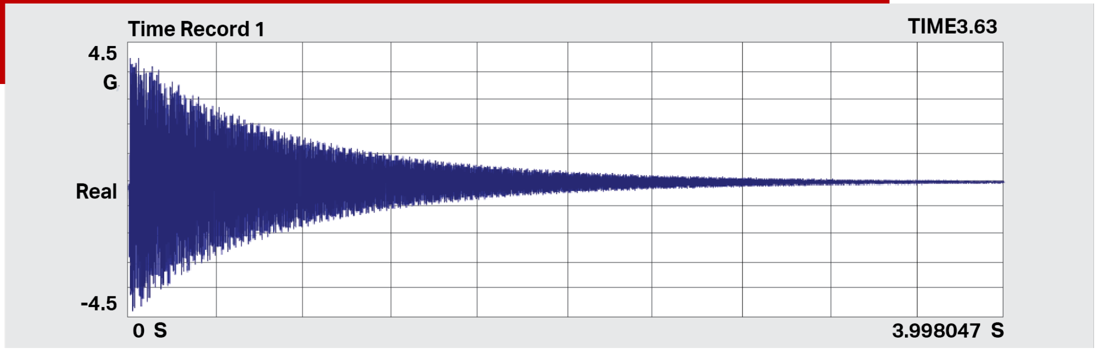


Frequency Spectrum

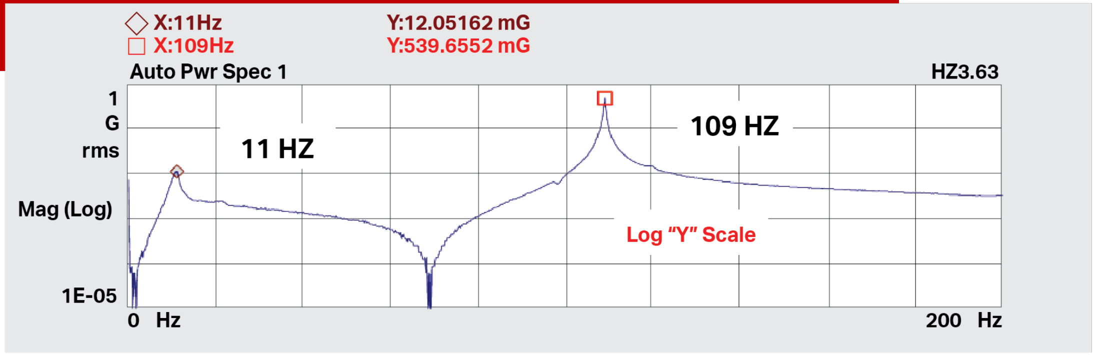


Case History –
Log: Can't Live With It, Can't Live Without It!

Time Waveform

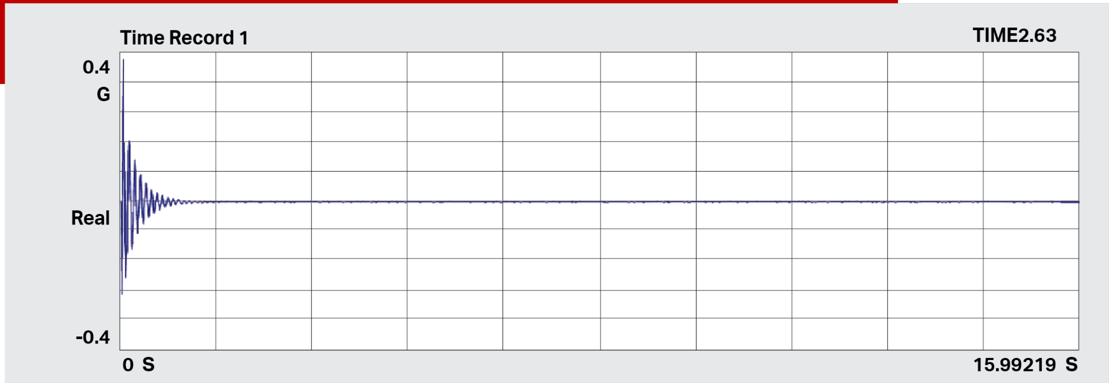


Frequency Spectrum

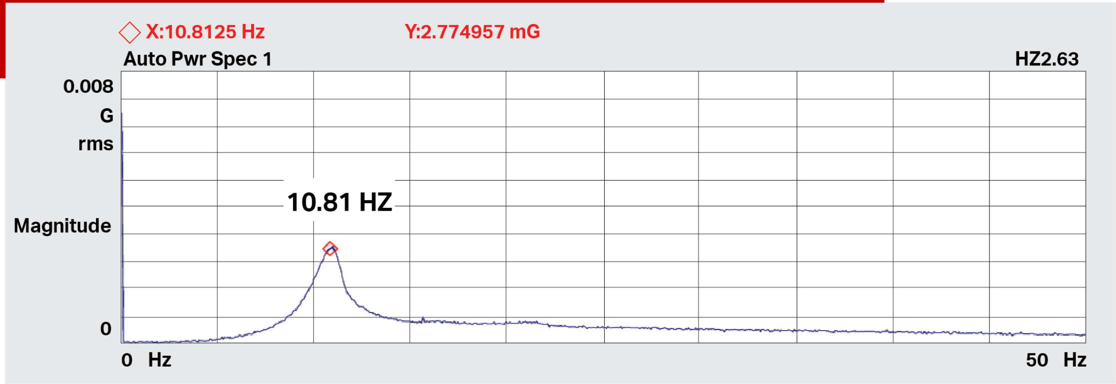


Case History – 0-50 Hz Span

Time Waveform

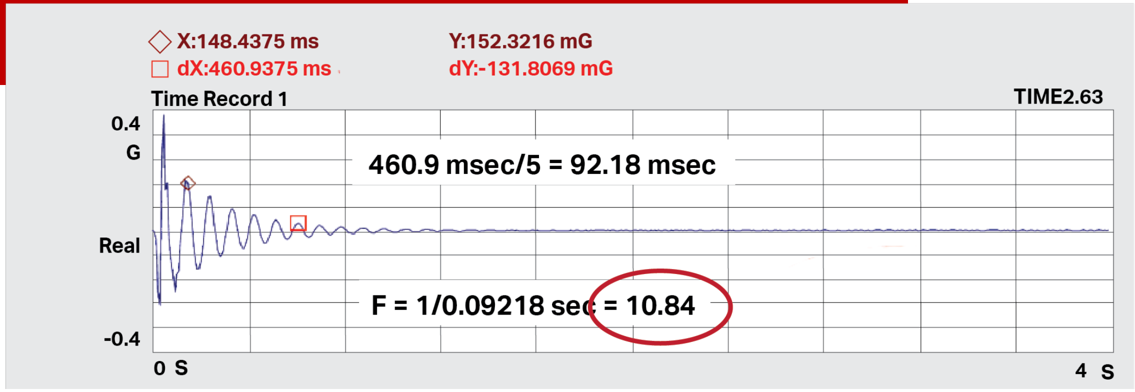


Frequency Spectrum

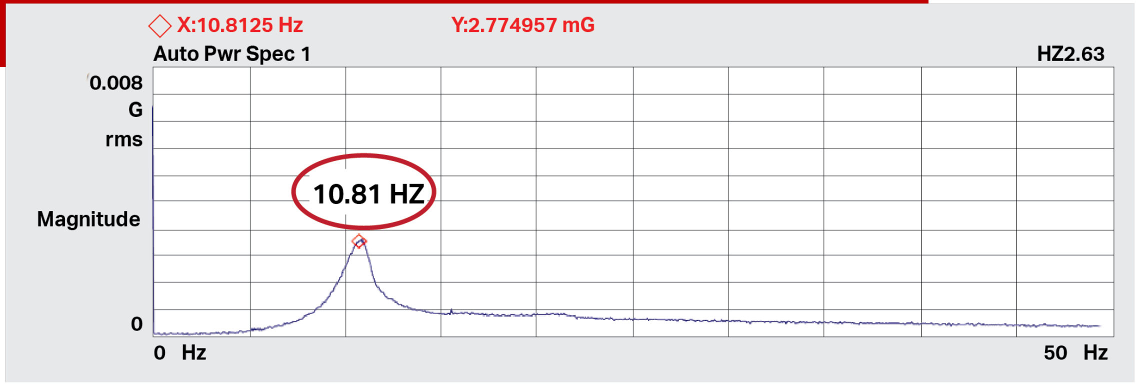


Case History –
0-50 Hz (Expanded "X" Scale)

Time Waveform

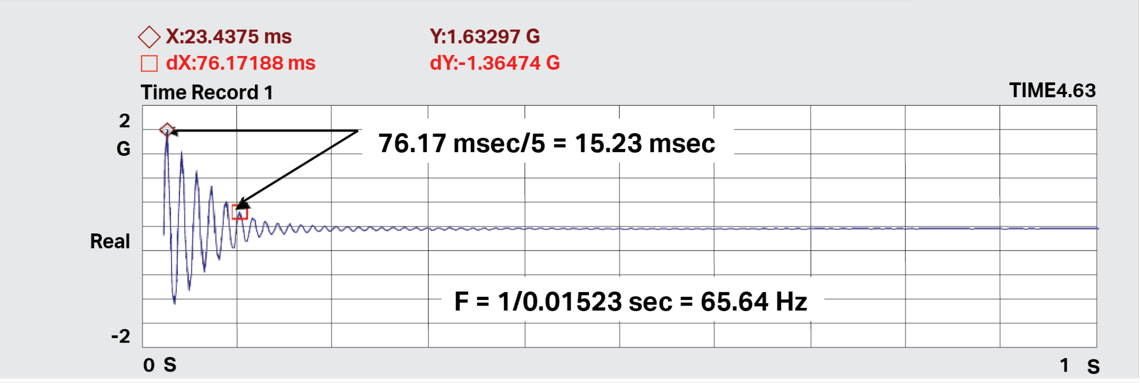


Frequency Spectrum

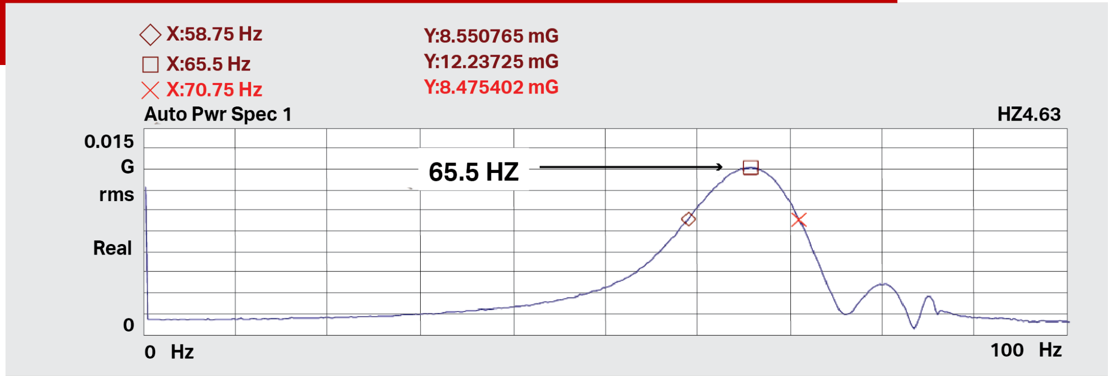


Case History –
Back To Bump Testing

Time Waveform

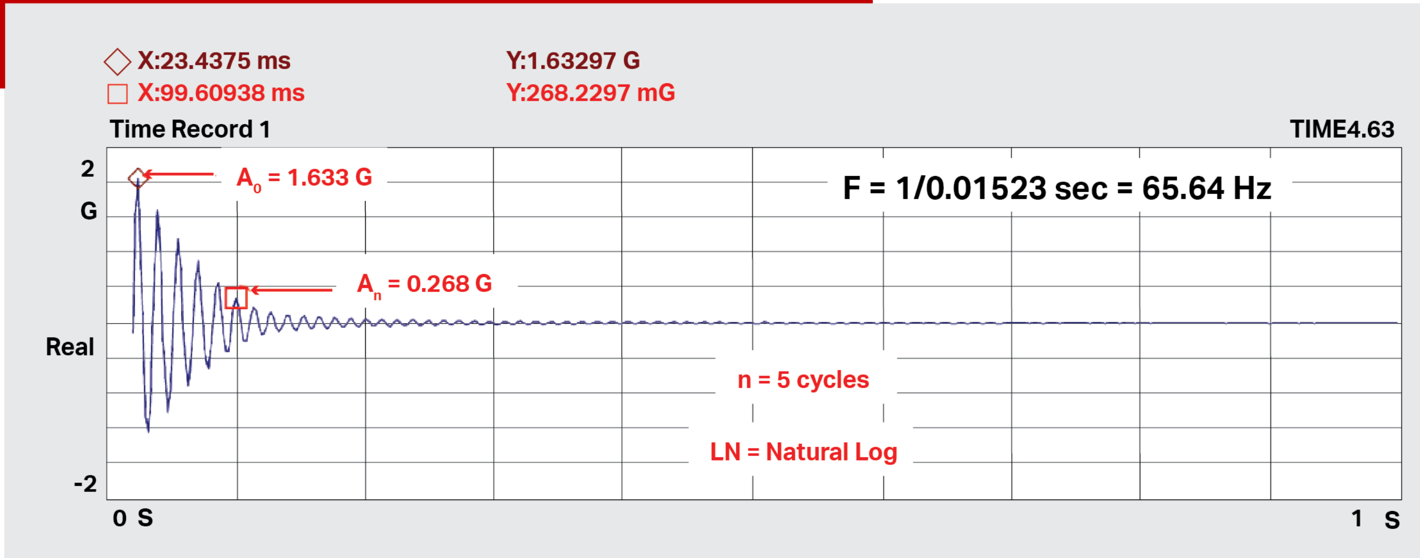


Frequency Spectrum



Case History – Back To Bump Testing

Time Waveform



Log Decrement = $[1/n[LN(A_0/A_n)]]$ = [1/5[LN(1.633/0.268)]] = 0.36

Damping Ratio = Log dec/2Pi = 0.36/2Pi = 0.36/6.28 = 0.057

Amplification Factor = 1/(2*Damping) = 1/(2*0.057) = 8.68

Amplification Factor – Using The Spectrum

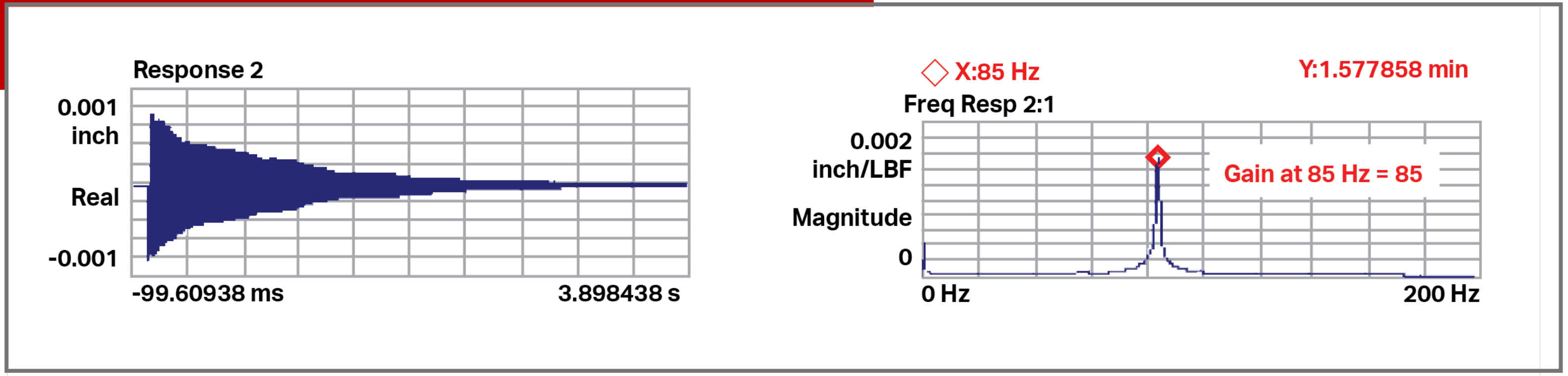
$$F_n = 1/2Pi\sqrt{k/m}$$

- Increase the stiffness (k)
- Increase the frequency (F)

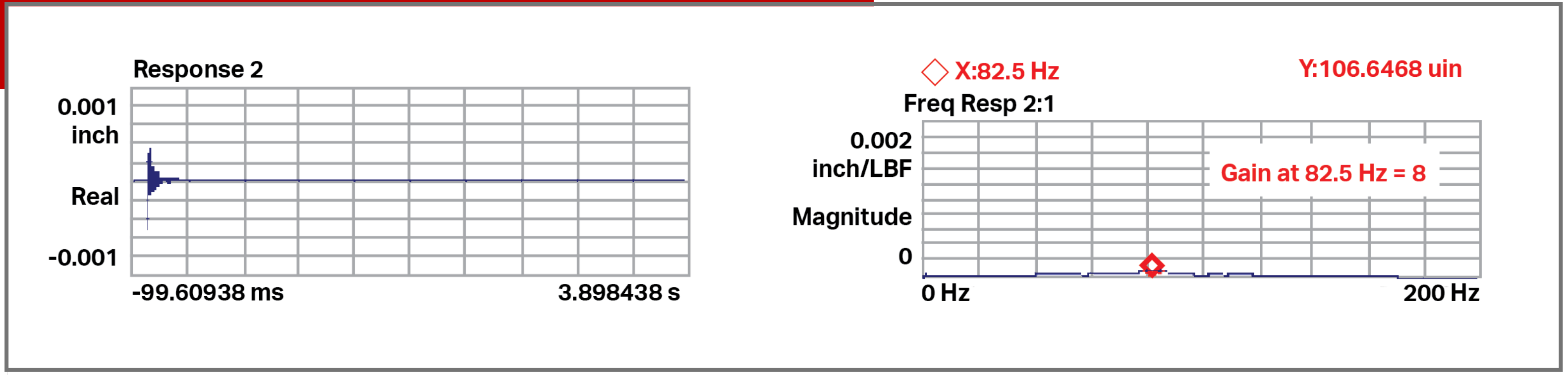
- Increase the mass (m)
- Decrease the frequency (F)

Damping – Control The Response

Un-Damped



Damped



CTC

Conclusion

- 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

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