



CONNECTION TECHNOLOGY CENTER, INC.

LEVEL 3 – LESSON 2

WHAT'S UP WITH BUMP TESTING?



INTRODUCTION

Welcome to **Level 3, Lesson 2** of CTC's free online vibration analysis training. We're glad you have taken the time to view this self-paced lesson on bump testing. We hope you enjoy the training and will continue to build your vibration analysis knowledge as you progress through Level 3.

'What's Up With Bump Testing?' is created and presented by CTC for complimentary educational use only. This training presentation may not be edited or used for any other purposes without express written consent from CTC.



OBJECTIVES

Upon completing the following lesson, you will understand the basics of bump testing, including:

- What is a bump test?**
- Why do a bump test?**
- 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?

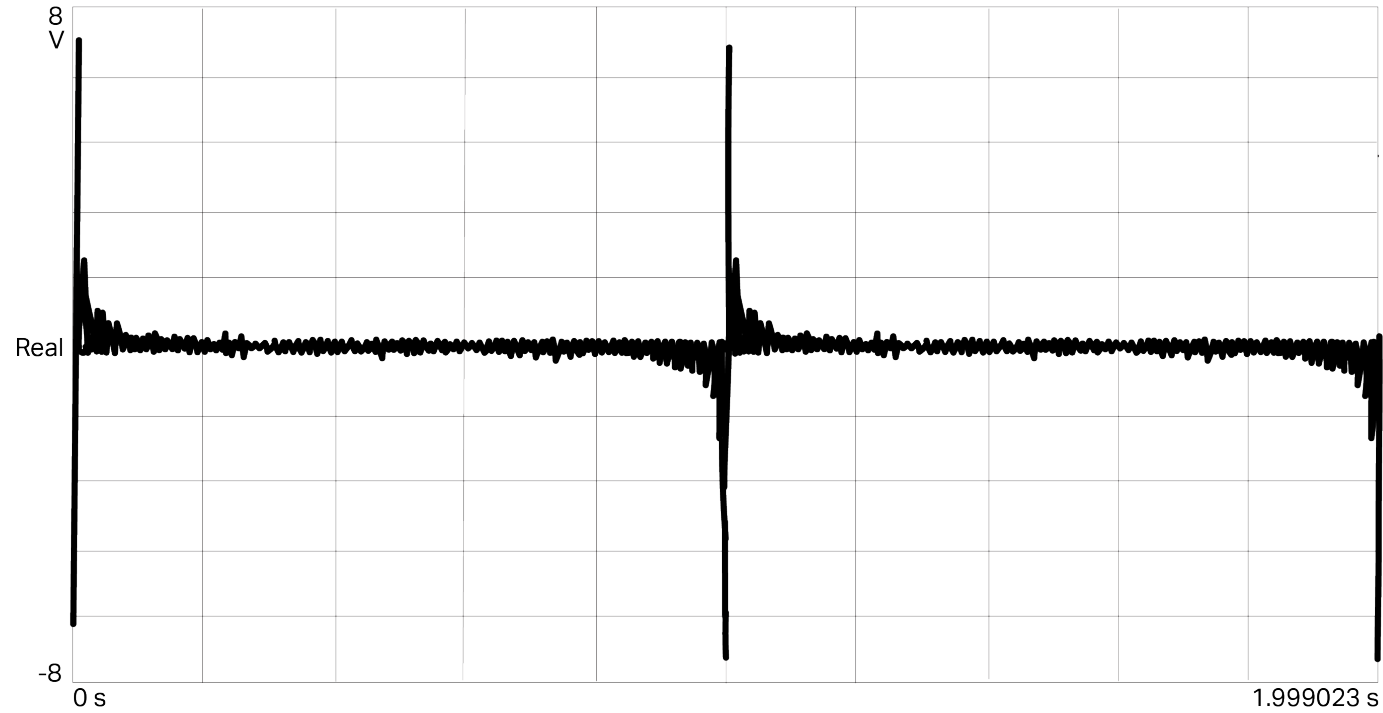
Bump testing is done to **excite and measure the natural frequency(s) of an object**. When bump testing is done, you will:

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

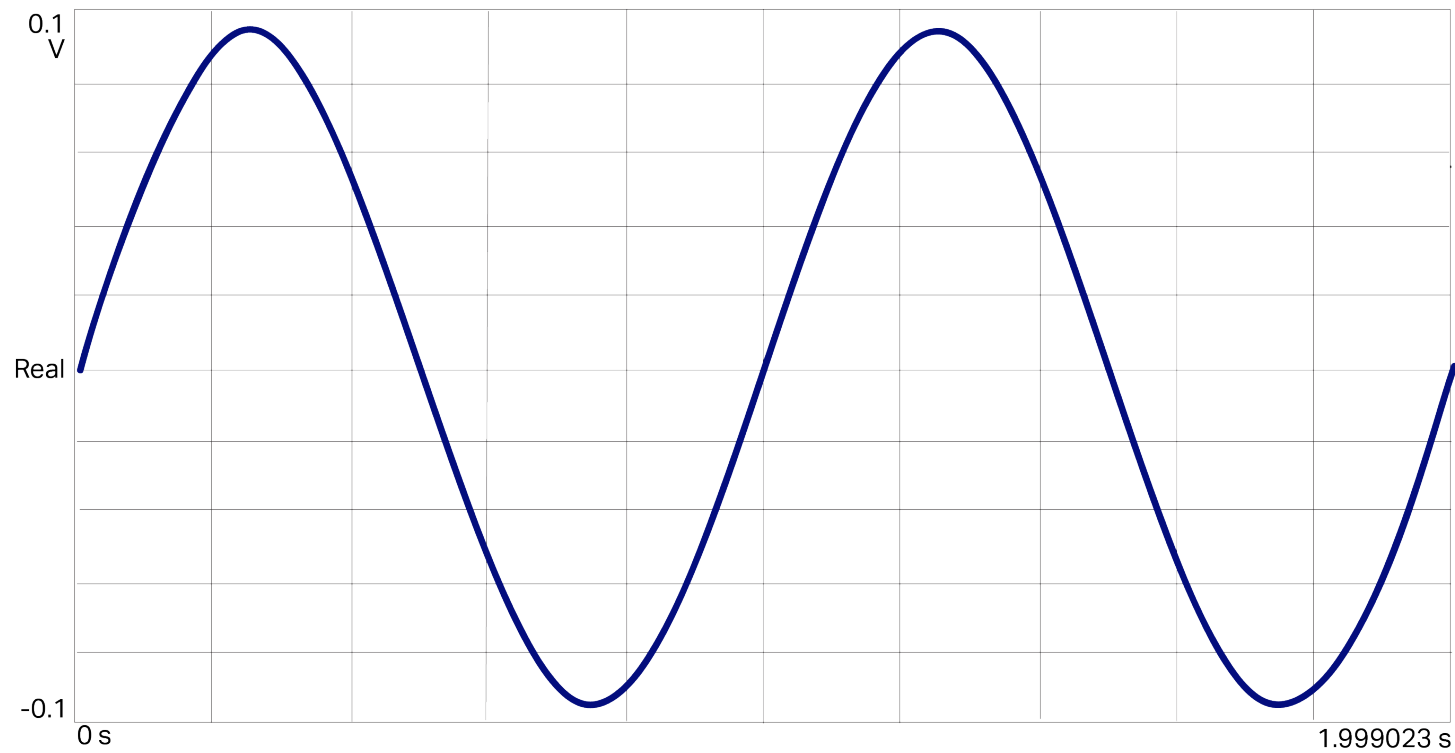
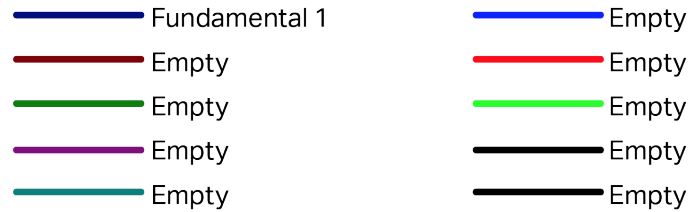


BUMP TESTING – HOW DOES IT WORK?

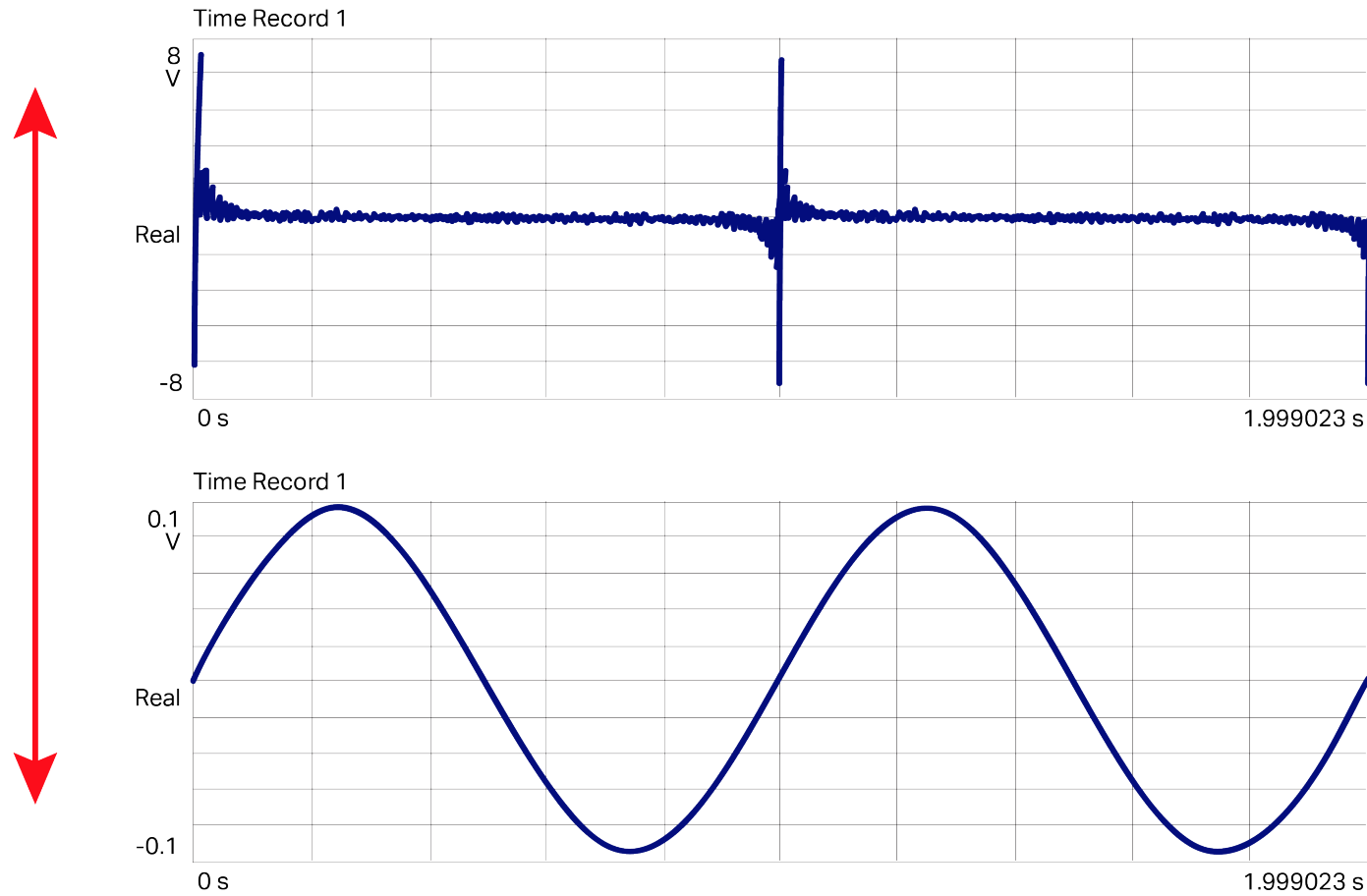
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- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- 20th Harmonic 1
- 50th Harmonic 1
- 100th Harmonic 1
- Bump 1



BUMP TESTING – SINE WAVES?

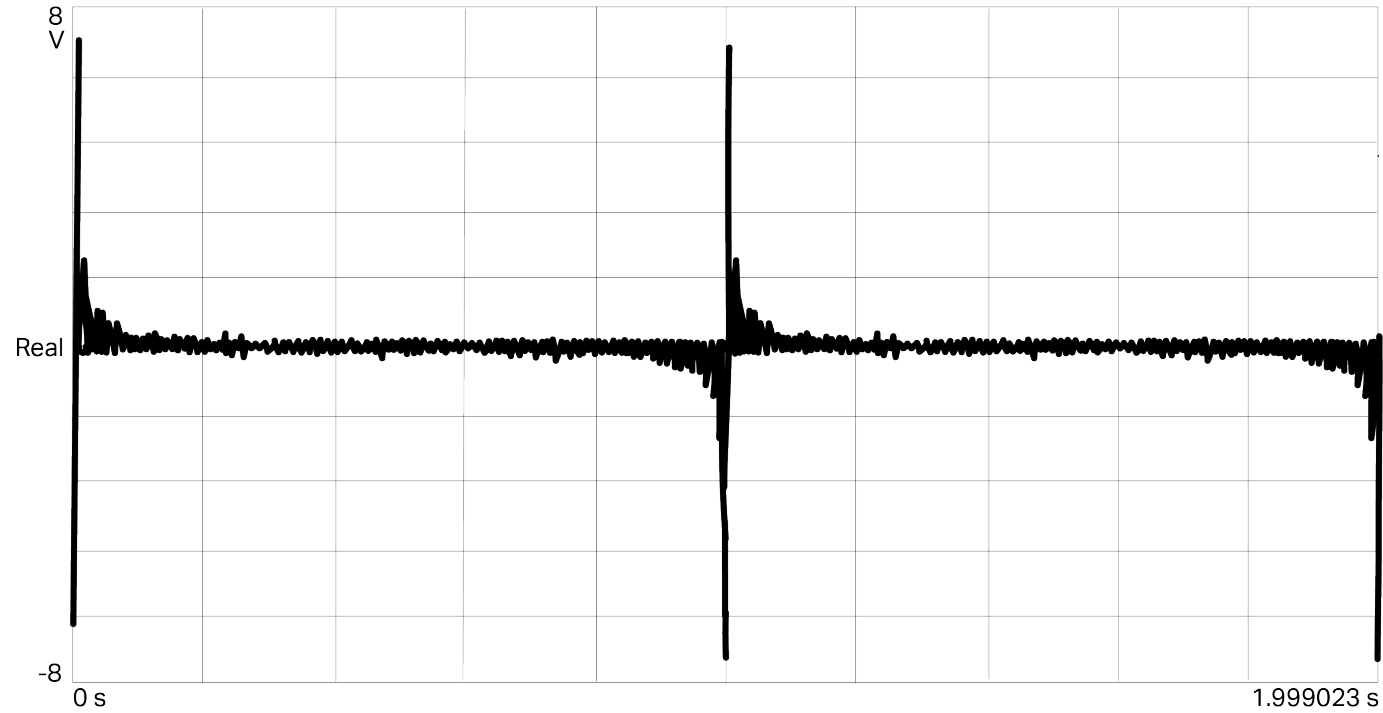


BUMP TESTING – BUMPS FROM SINE WAVES?

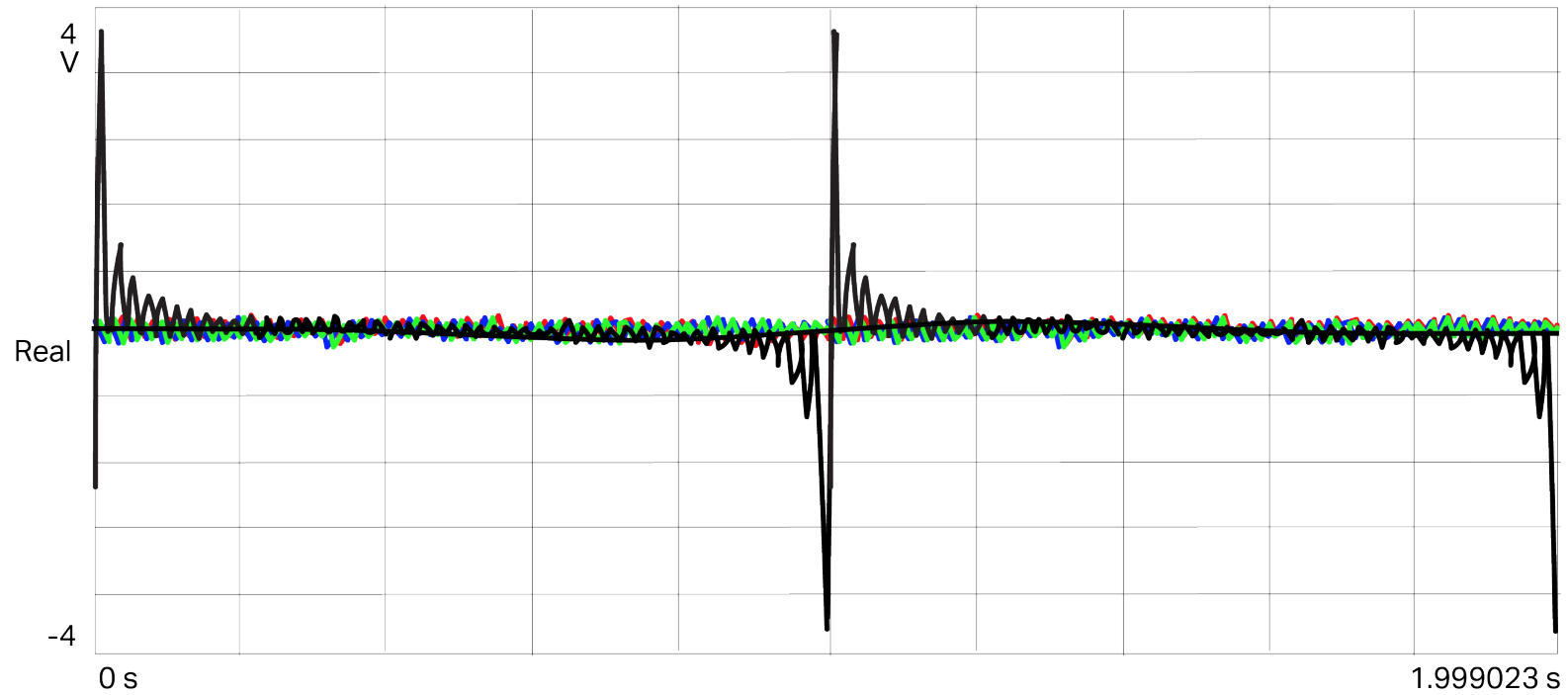
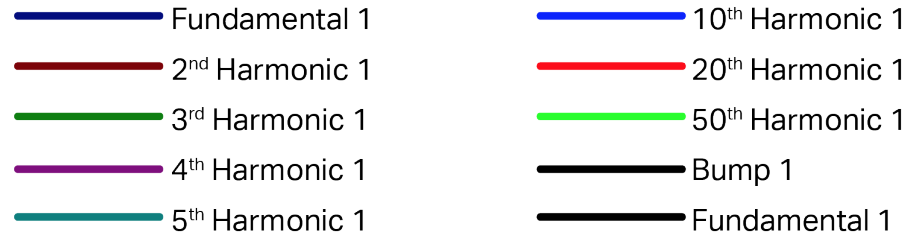


BUMP TESTING – 100TH HARMONIC

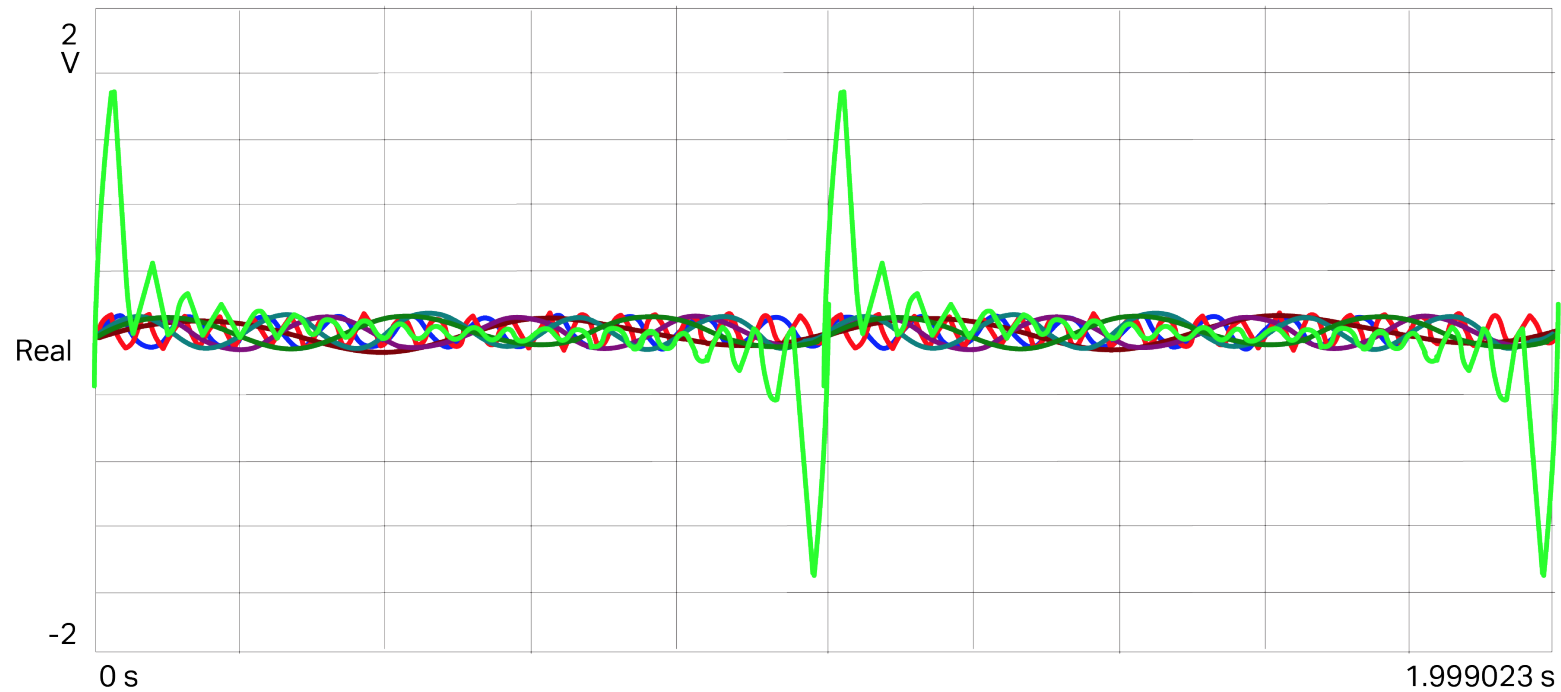
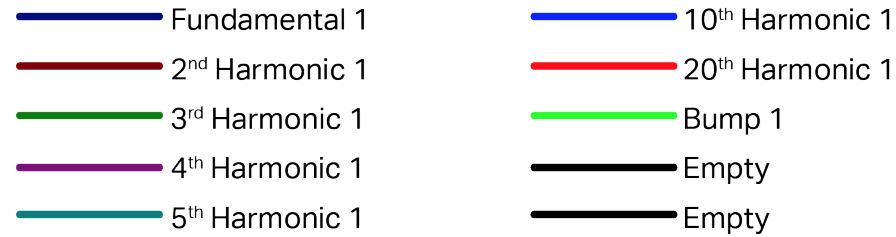
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- 3rd Harmonic 1
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- 50th Harmonic 1
- 100th Harmonic 1
- Bump 1



BUMP TESTING – 50TH HARMONIC

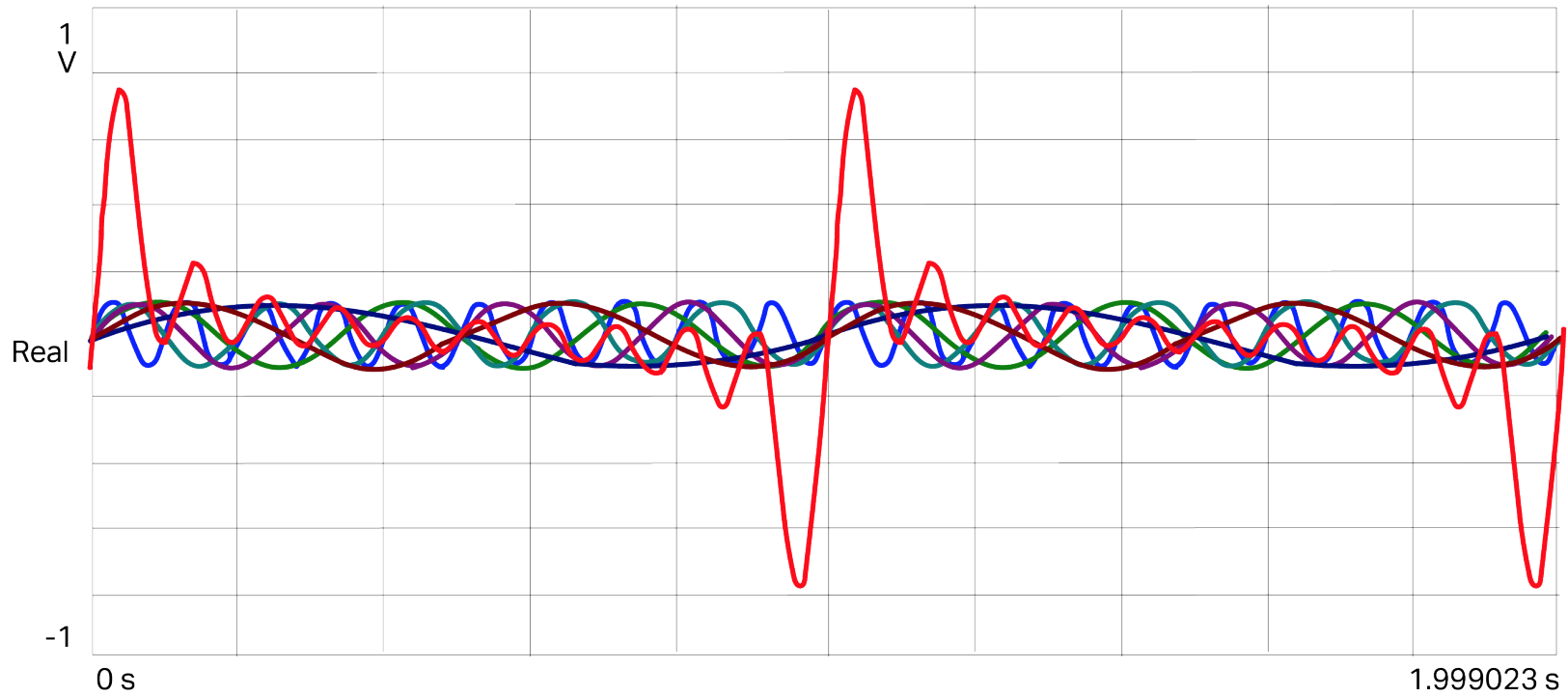


BUMP TESTING – 20TH HARMONIC

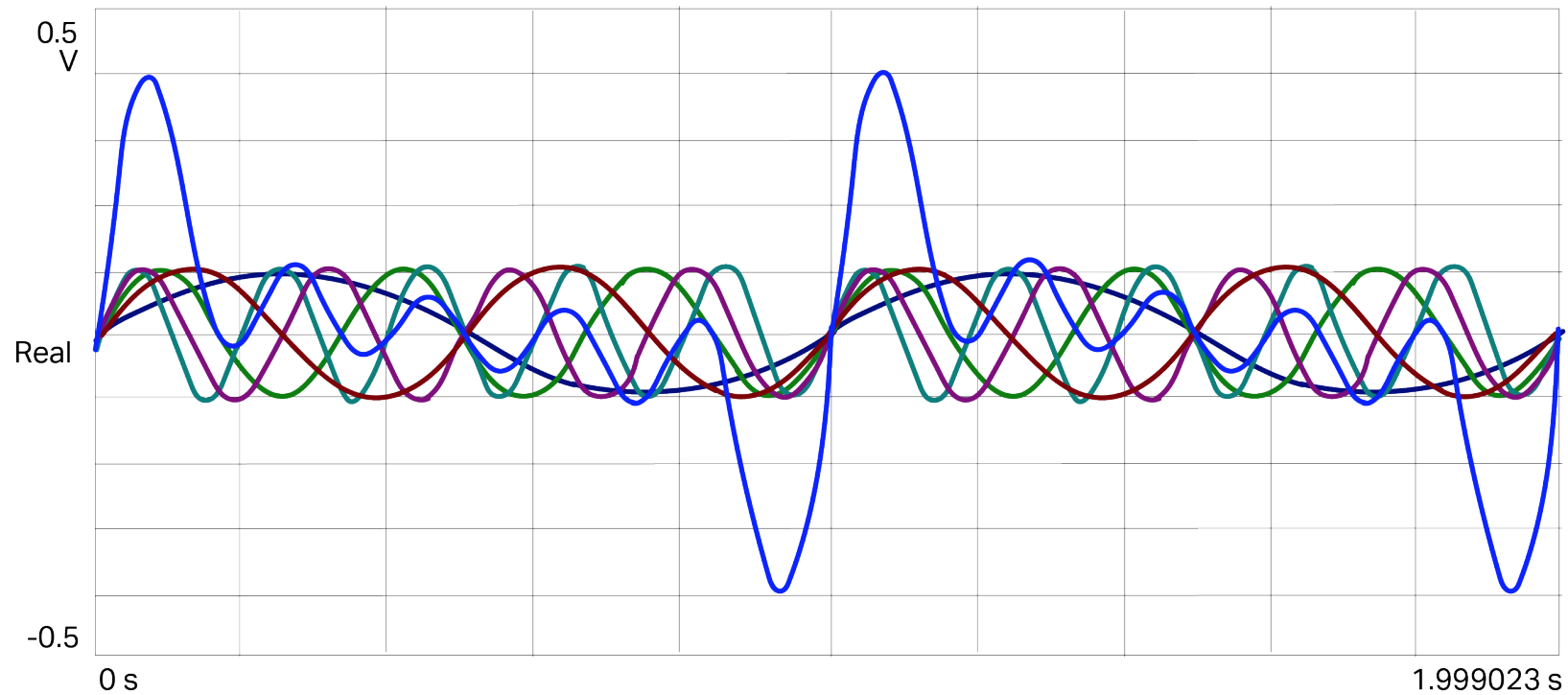
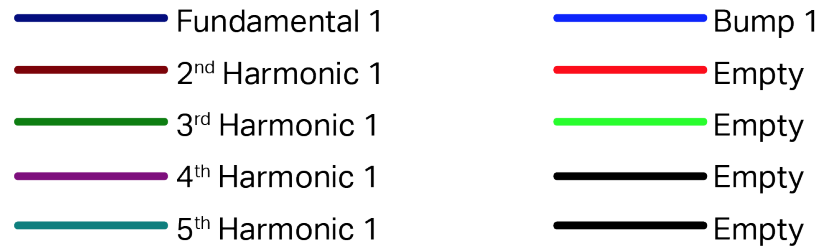


BUMP TESTING – 10TH HARMONIC

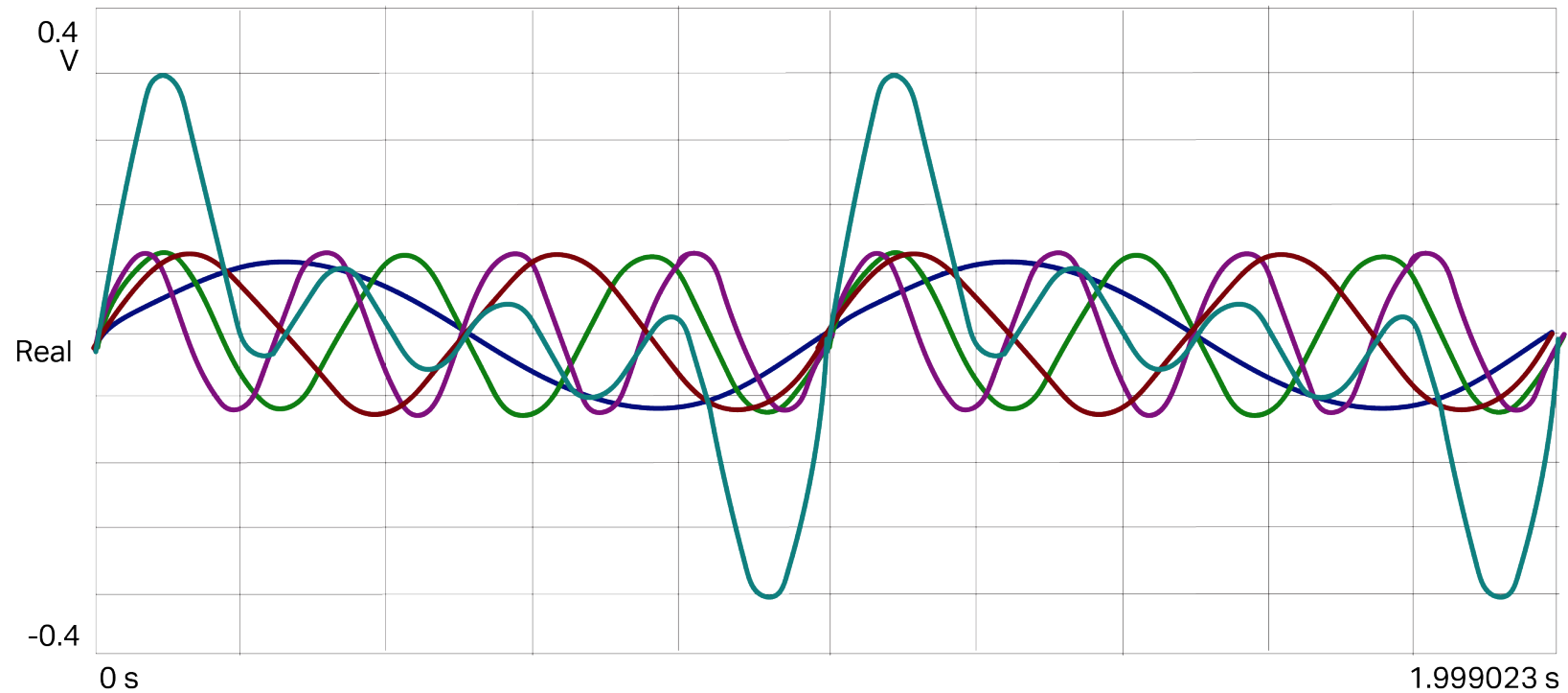
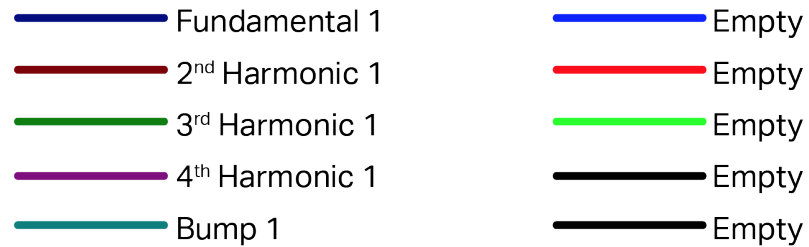
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- 5th Harmonic 1
- 10th Harmonic 1
- Bump 1
- Empty
- Empty
- Empty



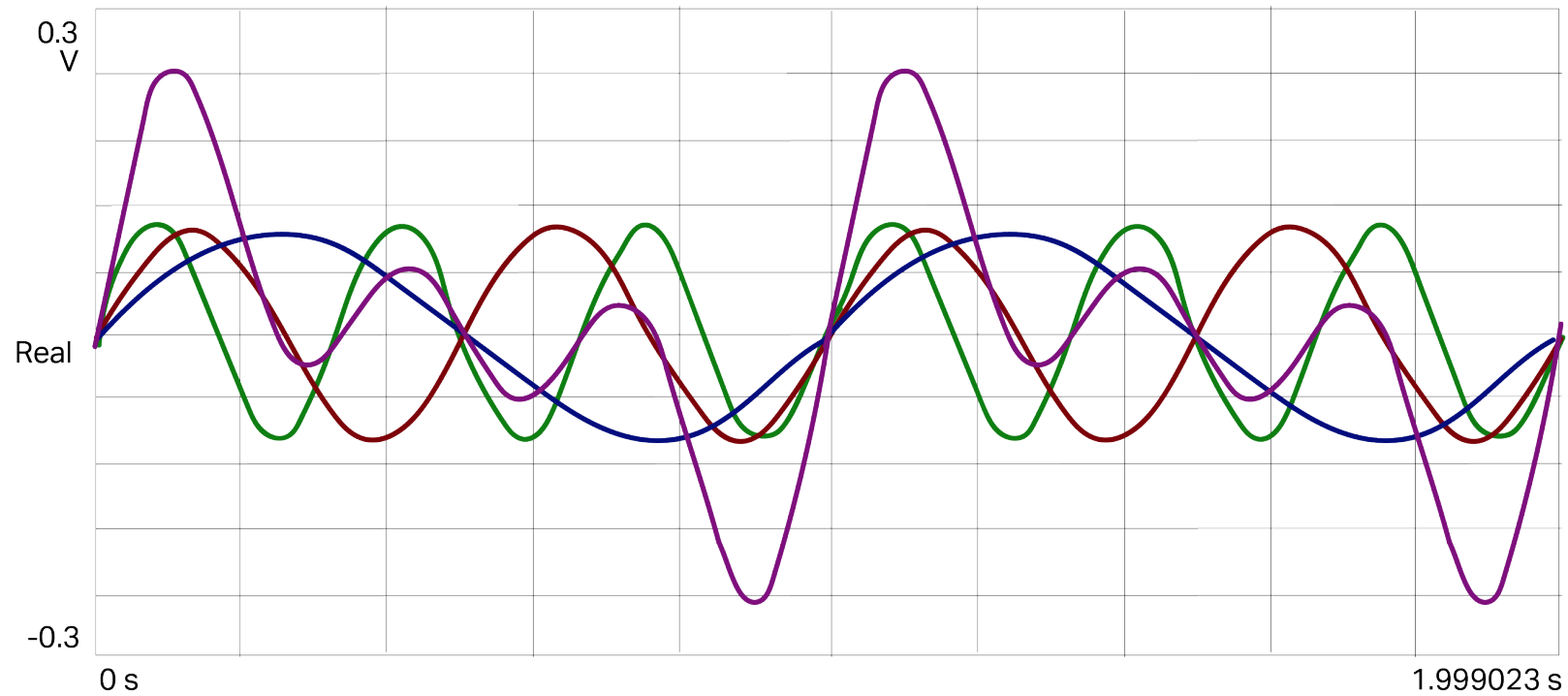
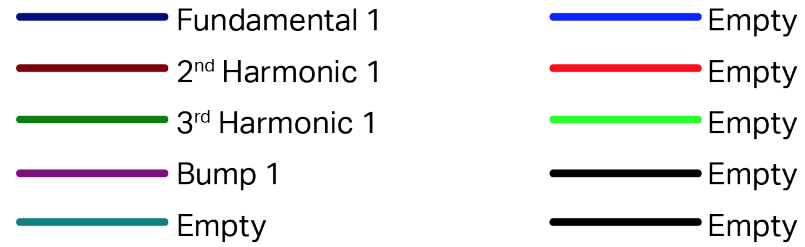
BUMP TESTING – 5TH HARMONIC



BUMP TESTING – 4TH HARMONIC

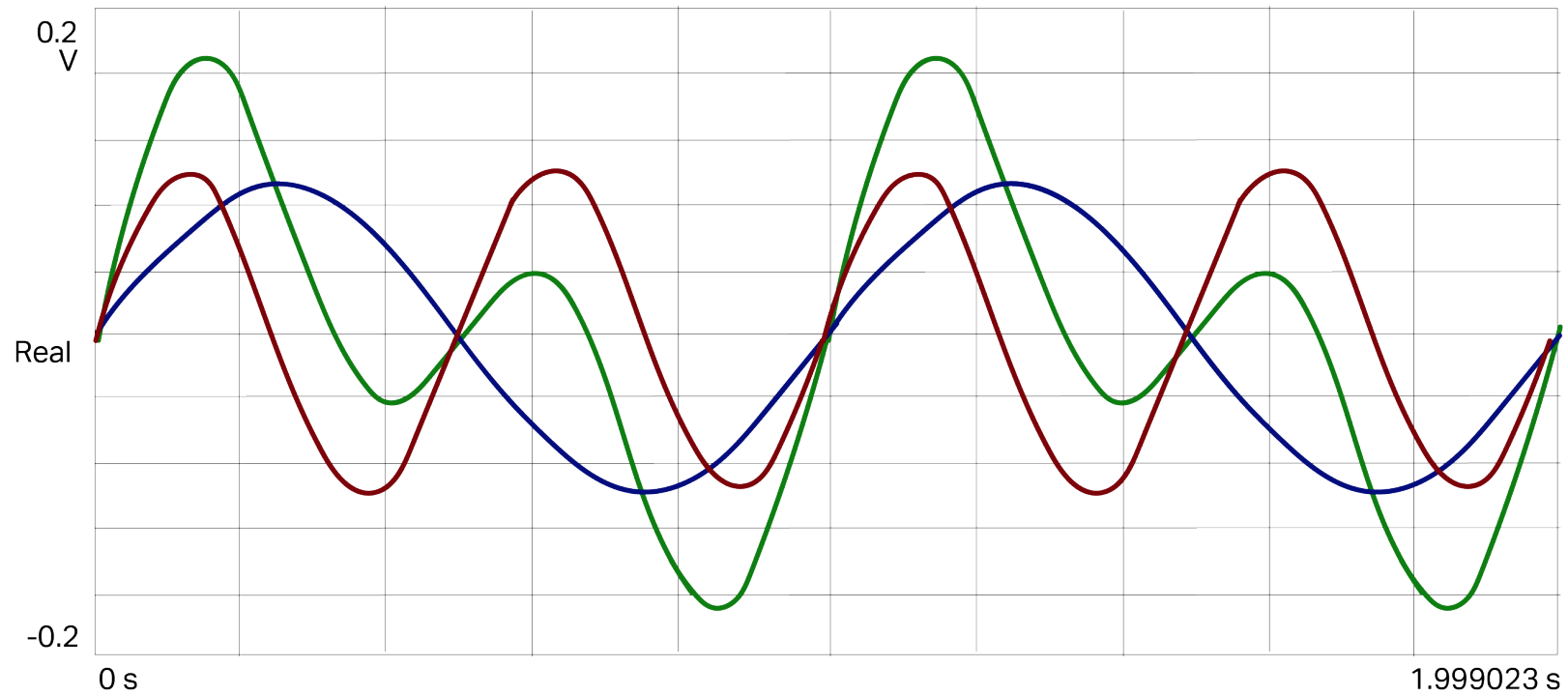


BUMP TESTING – 3RD HARMONIC



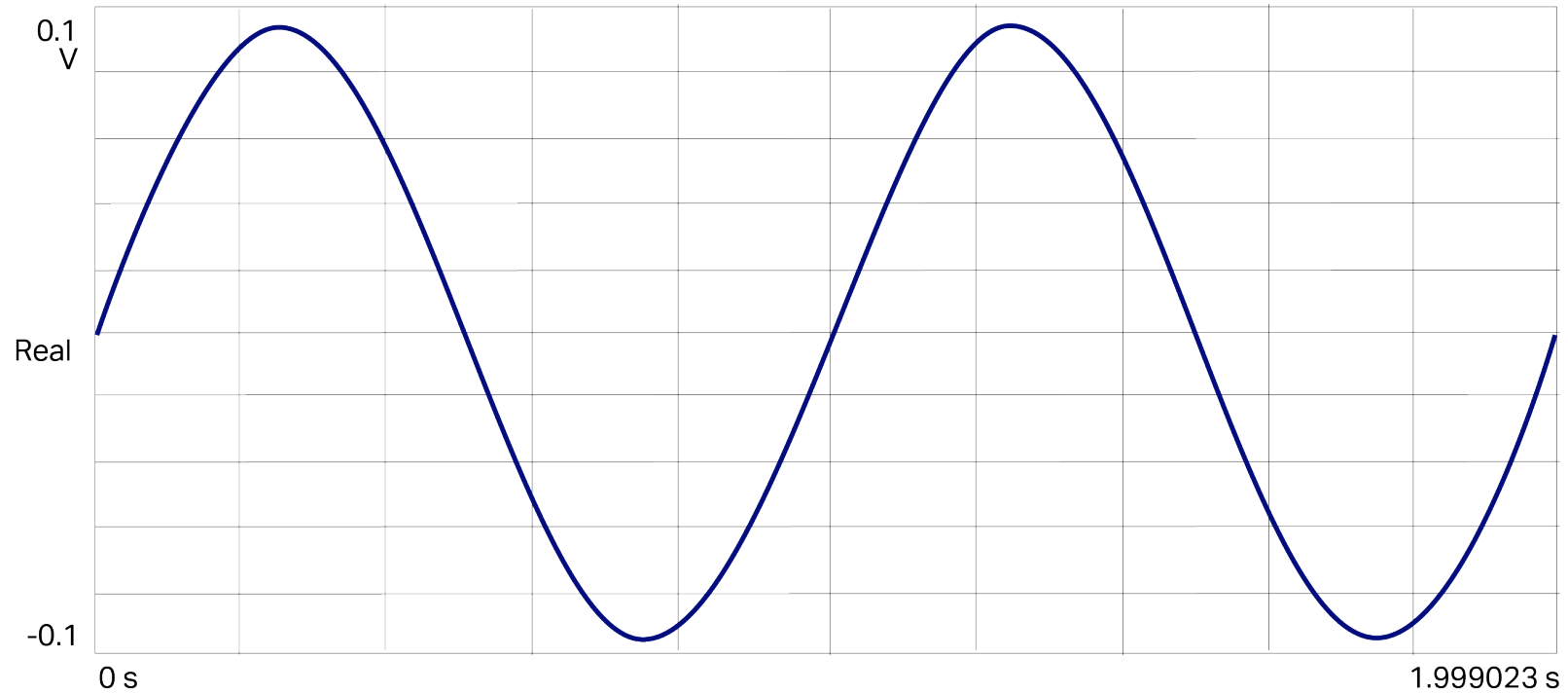
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- Fundamental 1
- 2nd Harmonic 1
- Bump 1
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- Empty
- Empty
- Empty
- Empty
- Empty



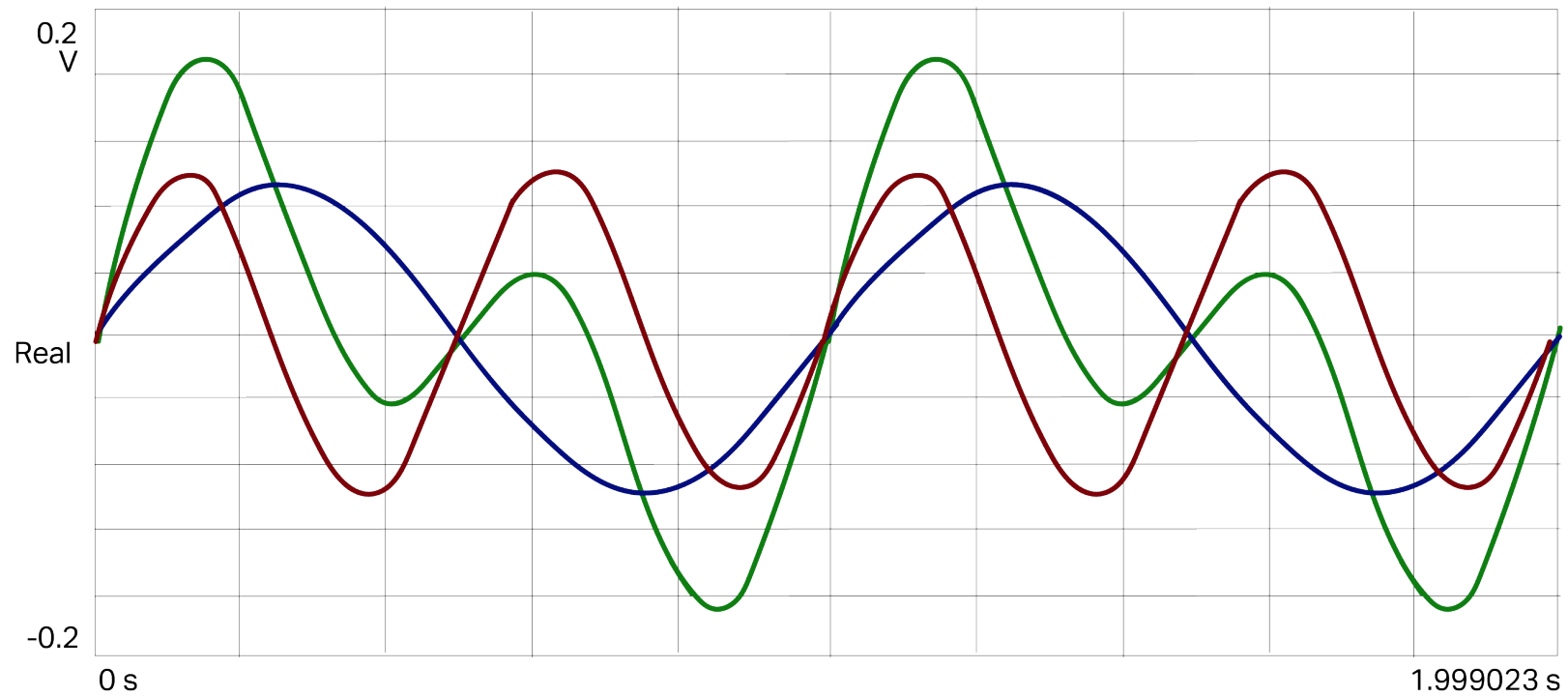
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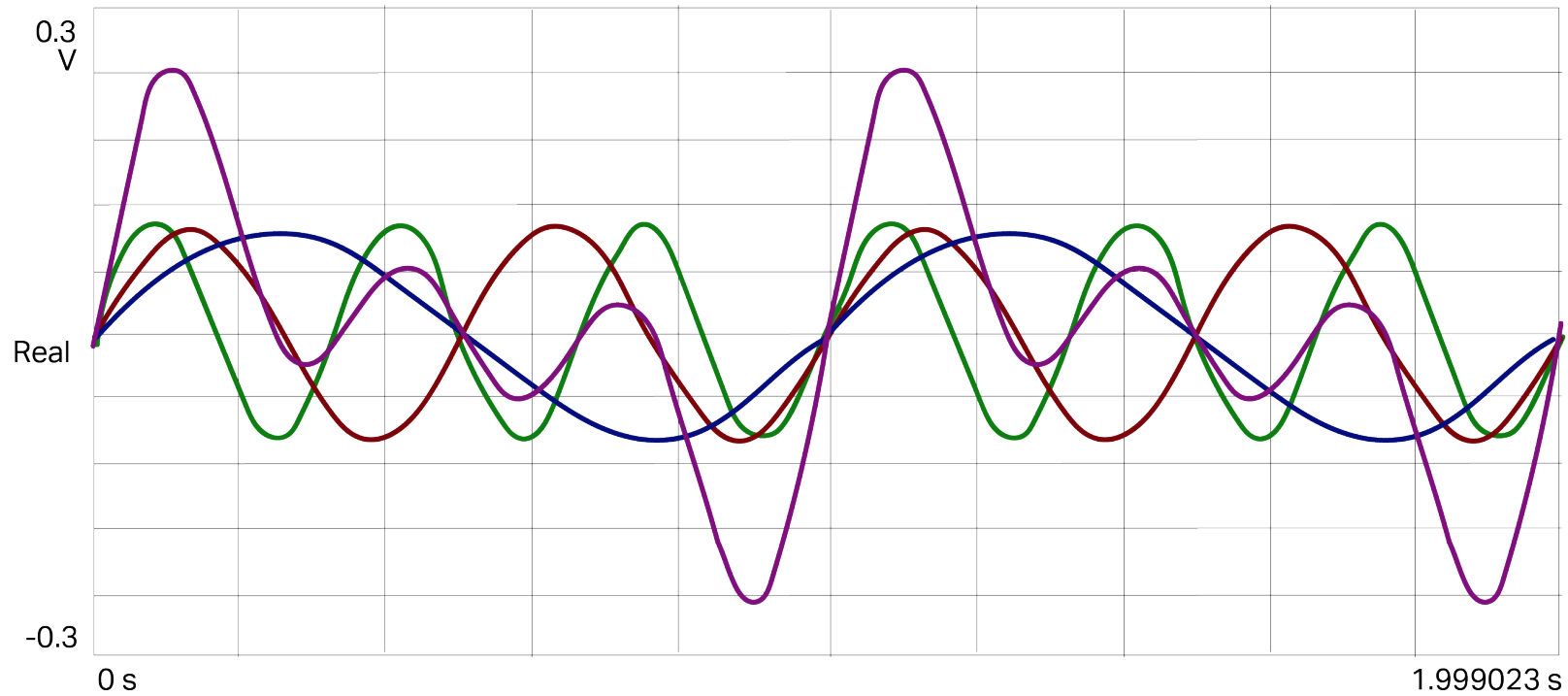
BUMP TESTING – 2ND HARMONIC

- Fundamental 1
- 2nd Harmonic 1
- Bump 1
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- Empty
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- Empty
- Empty
- Empty

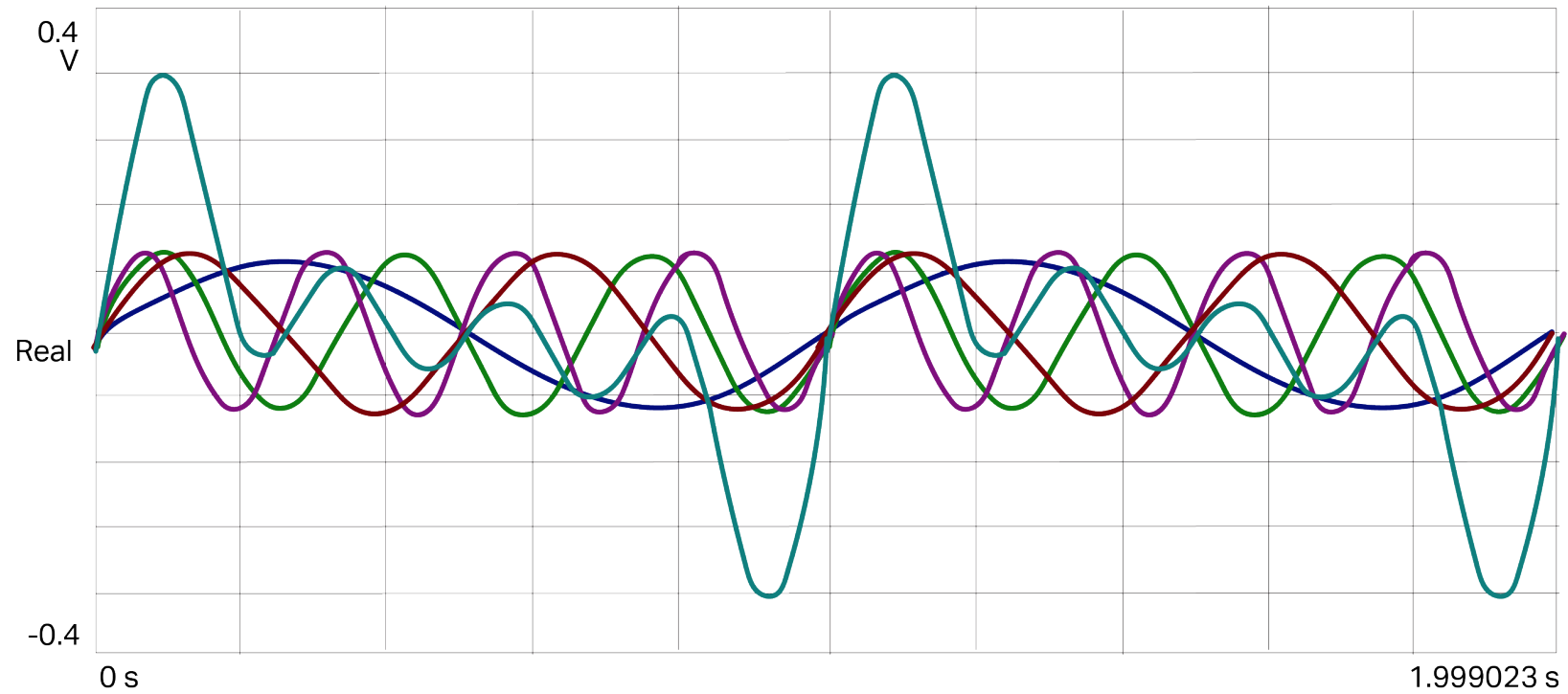
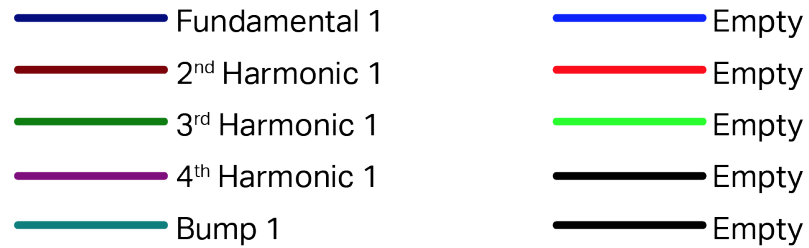


BUMP TESTING – 3RD HARMONIC

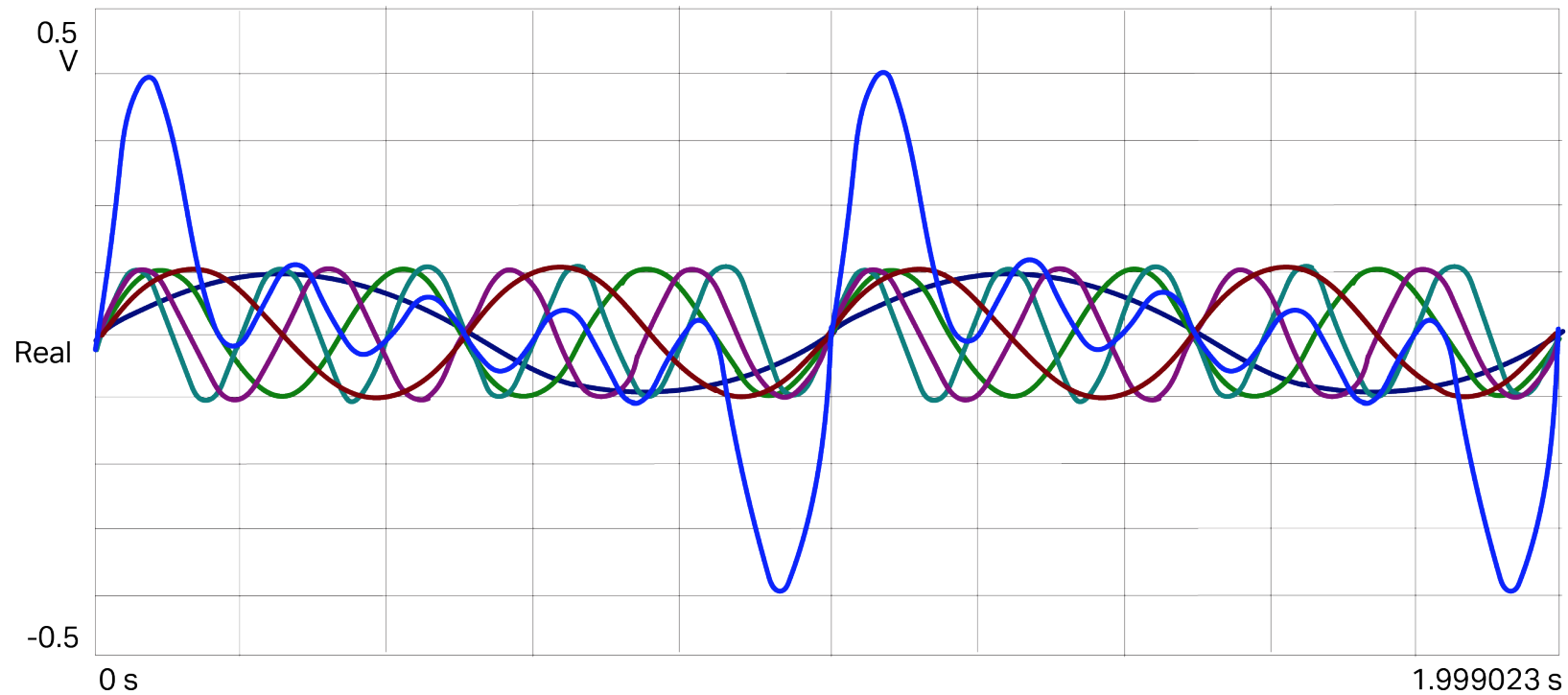
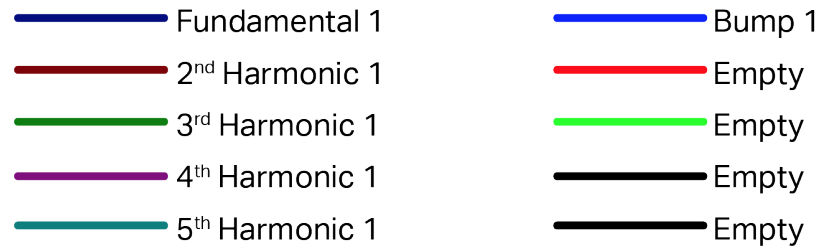
- | | |
|------------------------------|---------|
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| — 2 nd Harmonic 1 | — Empty |
| — 3 rd Harmonic 1 | — Empty |
| — Bump 1 | — Empty |
| — Empty | — Empty |



BUMP TESTING – 4TH HARMONIC

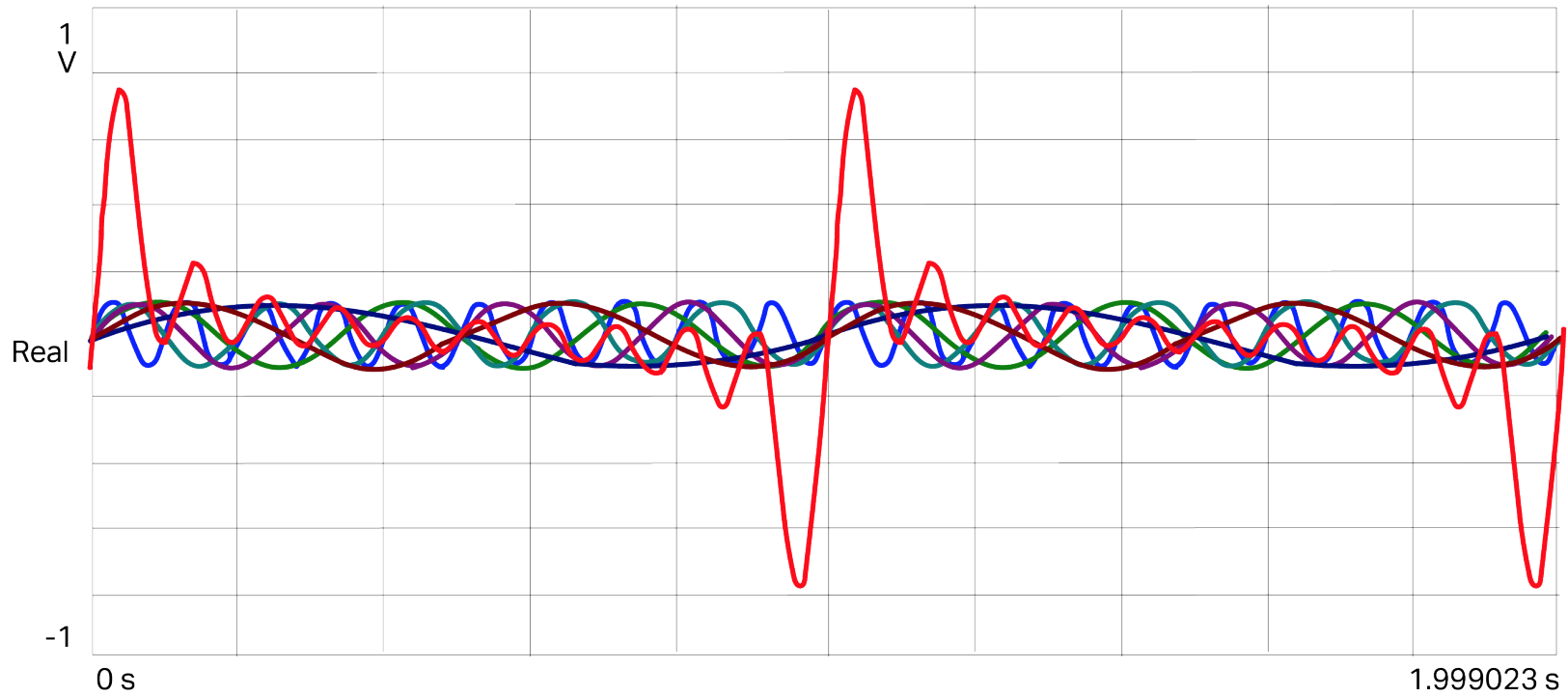


BUMP TESTING – 5TH HARMONIC

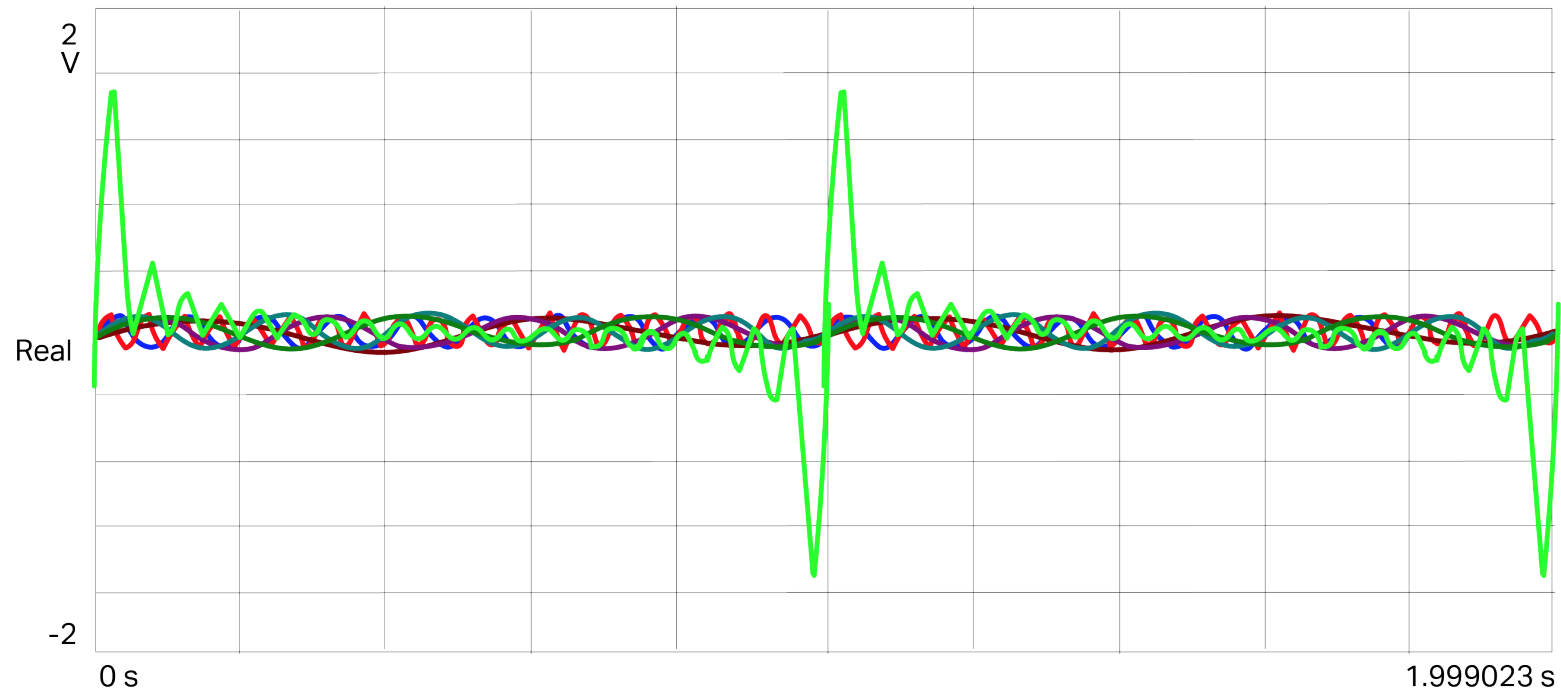
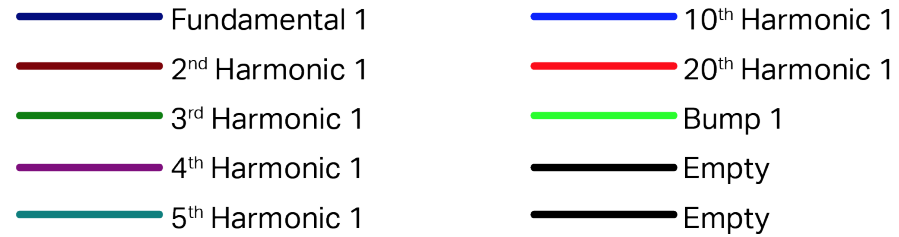


BUMP TESTING – 10TH HARMONIC

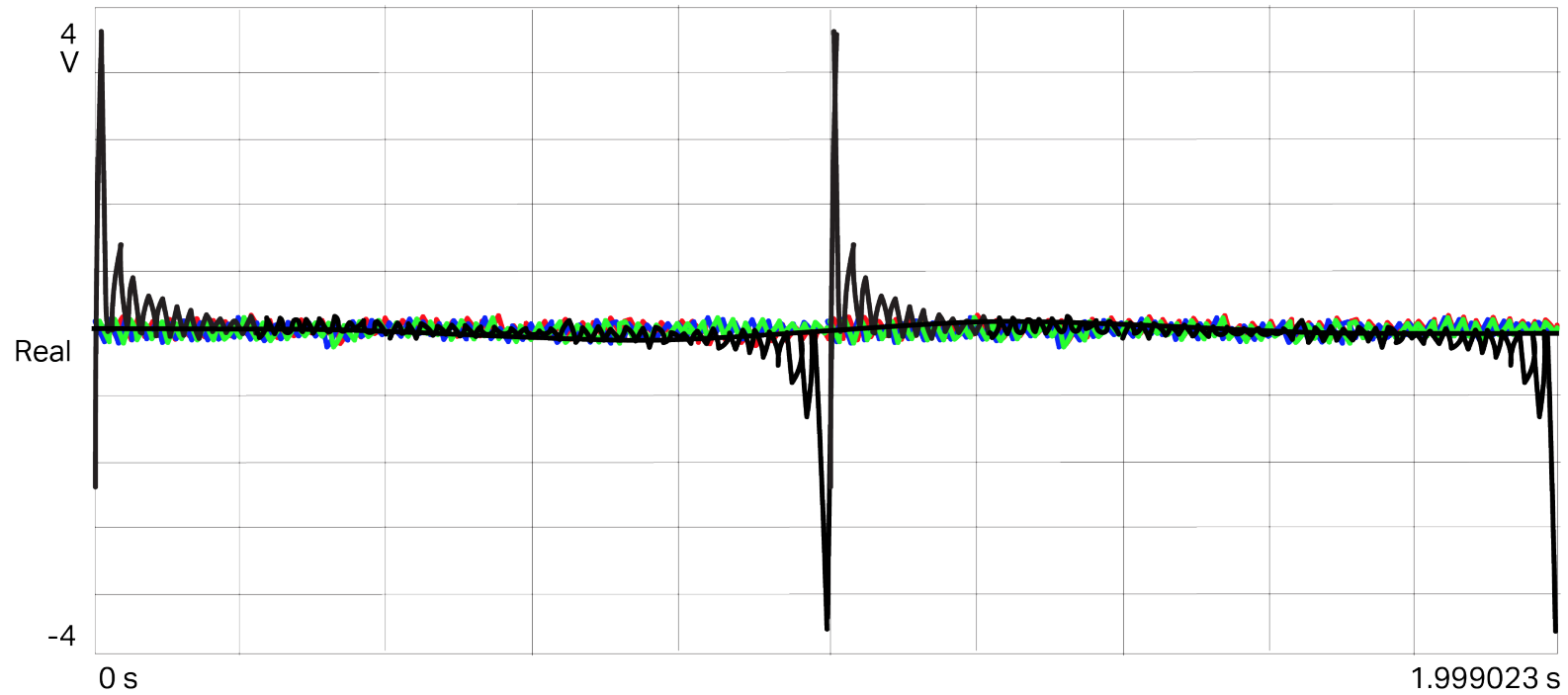
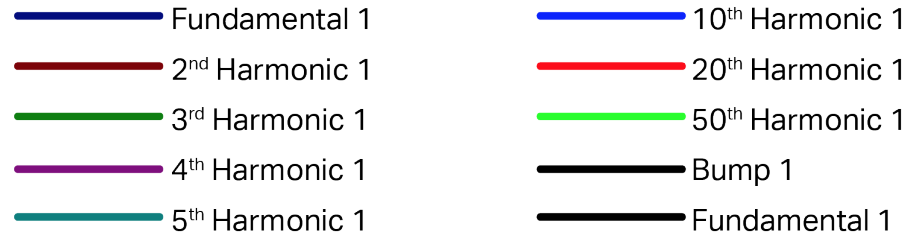
- Fundamental 1
- 2nd Harmonic 1
- 3rd Harmonic 1
- 4th Harmonic 1
- 5th Harmonic 1
- 10th Harmonic 1
- Bump 1
- Empty
- Empty
- Empty



BUMP TESTING – 20TH HARMONIC

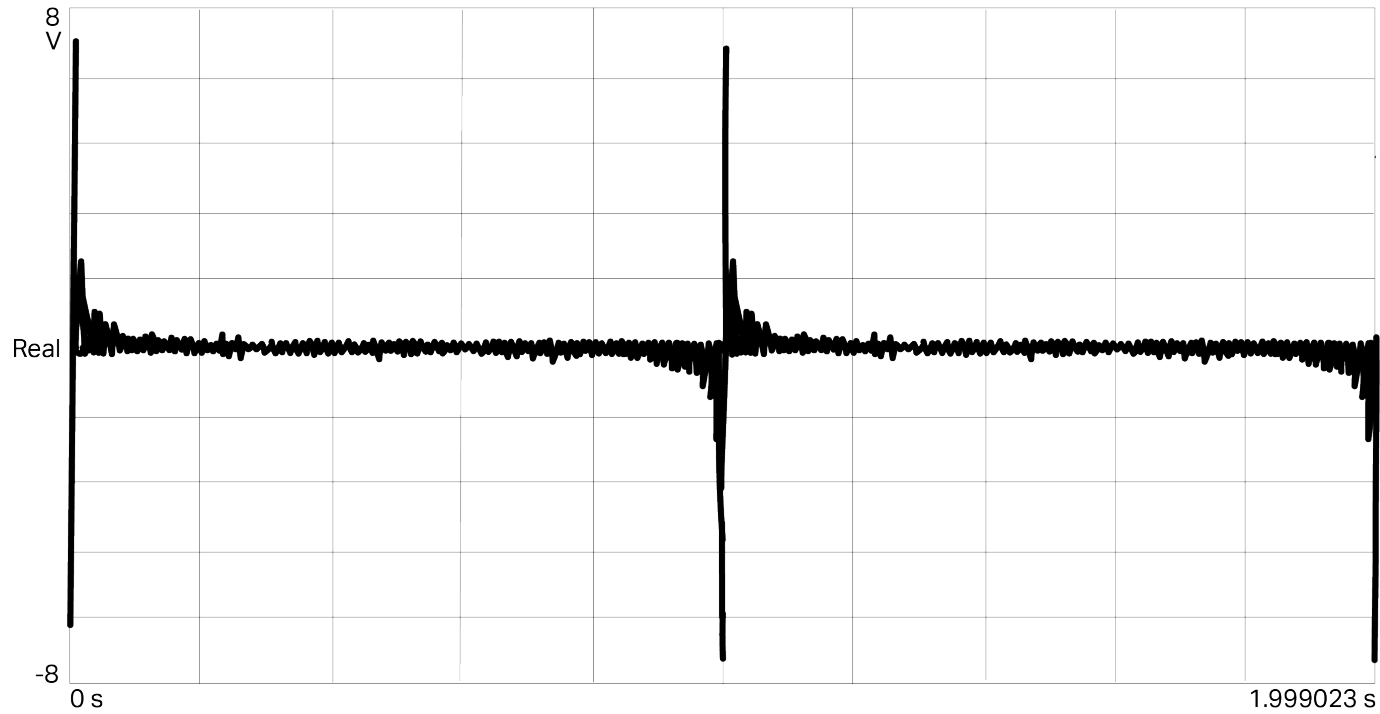


BUMP TESTING – 50TH HARMONIC



BUMP TESTING – 100TH HARMONIC

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



BUMP TESTING – HOW DOES IT WORK?

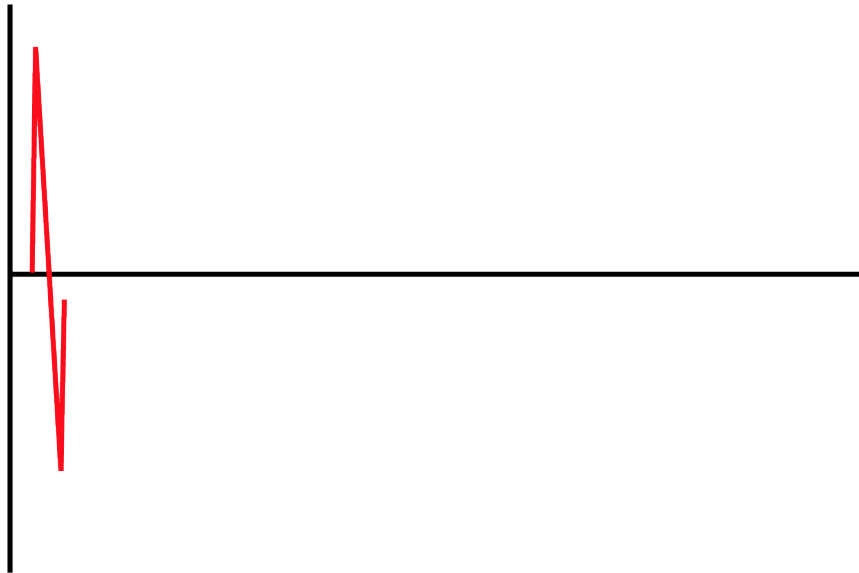
- ❑ Bump testing or impact testing works because **the bump or impact contains all of the individual frequencies or sign waves**
- ❑ When you bump or impact the object under test, you will **excite all of the natural frequencies of that object**



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**).



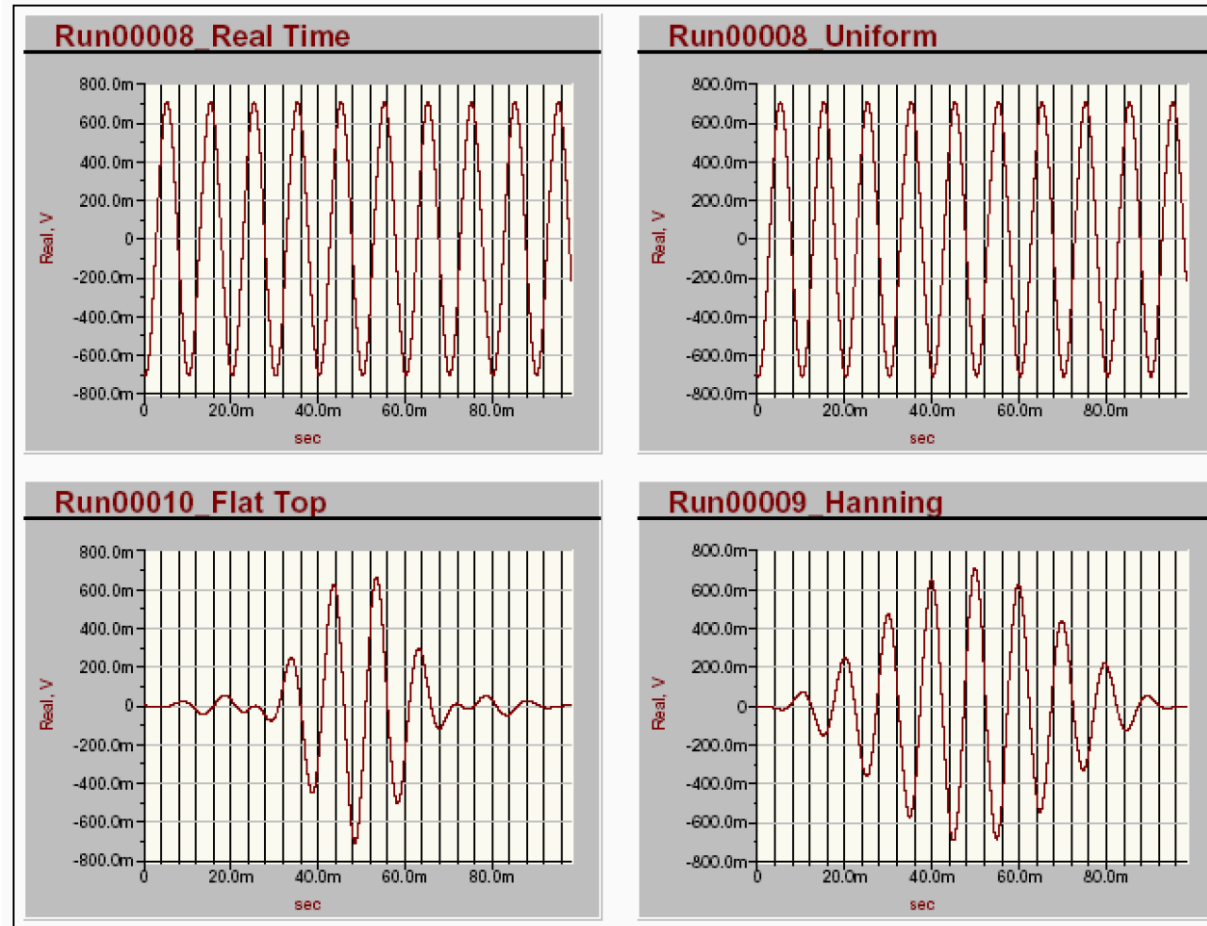
BUMP TESTING – SET UP

UNIFORM WINDOW

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

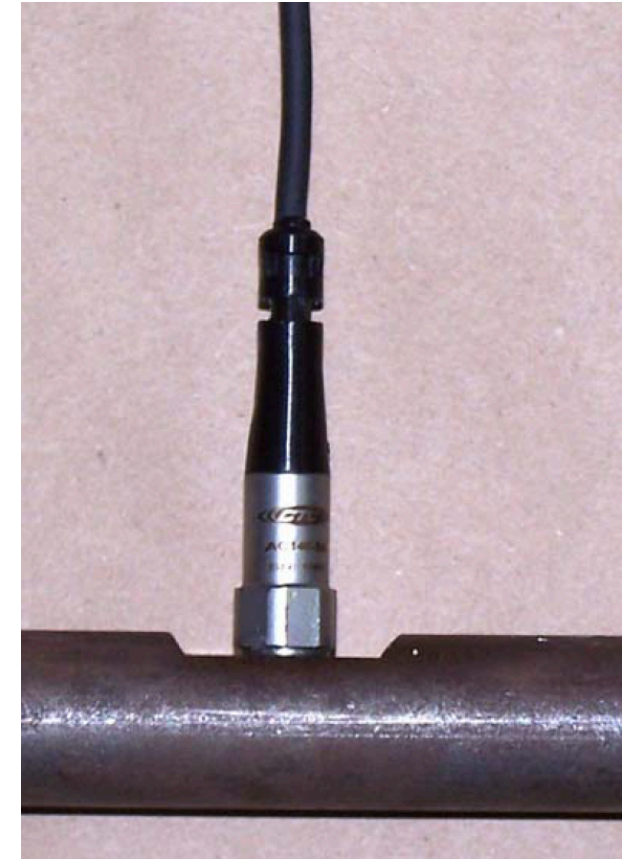


BUMP TESTING – WHY THE UNIFORM WINDOW?



BUMP TESTING – WHAT TO BUMP?

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

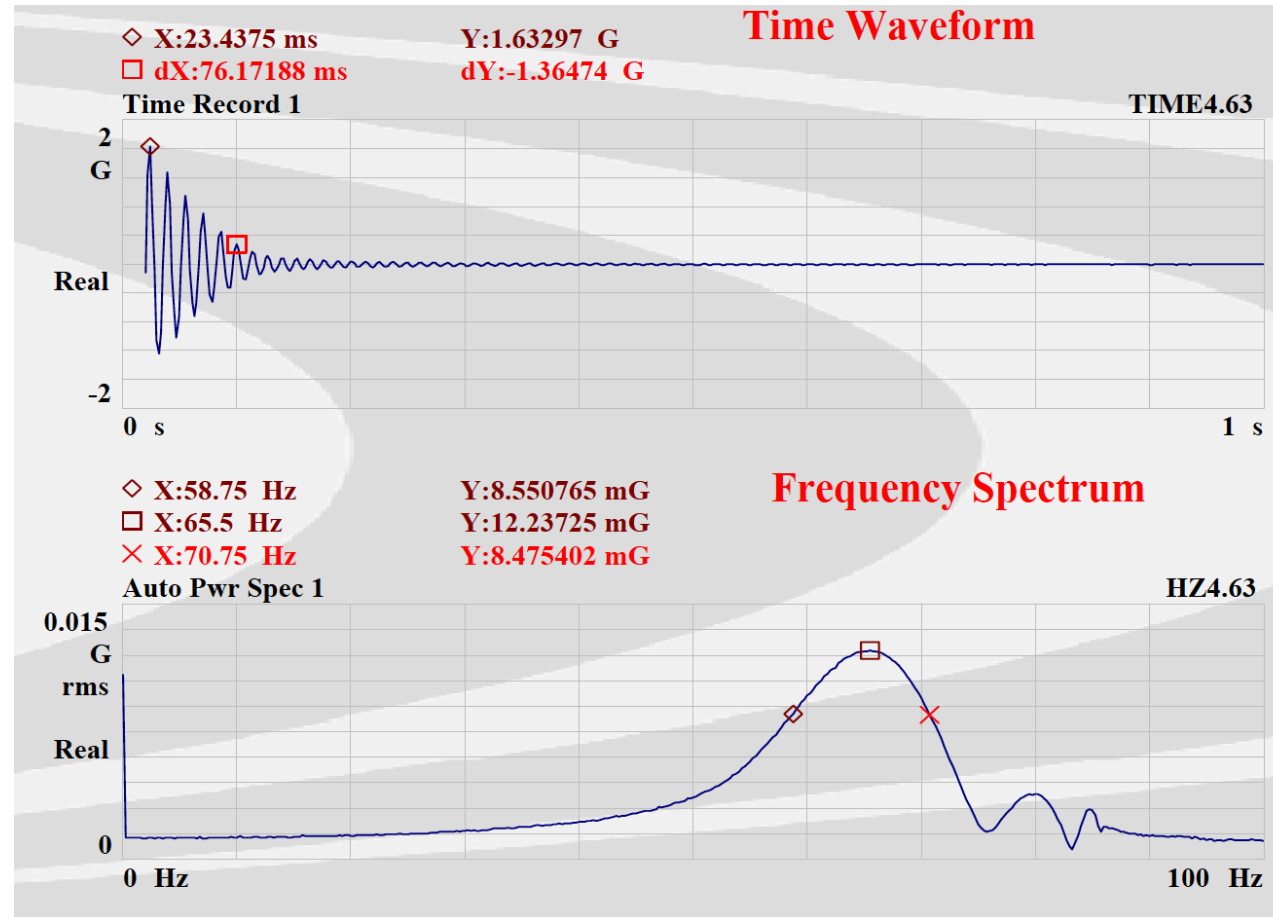


BUMP TESTING – BUMP IT! TWO RESPONSES!

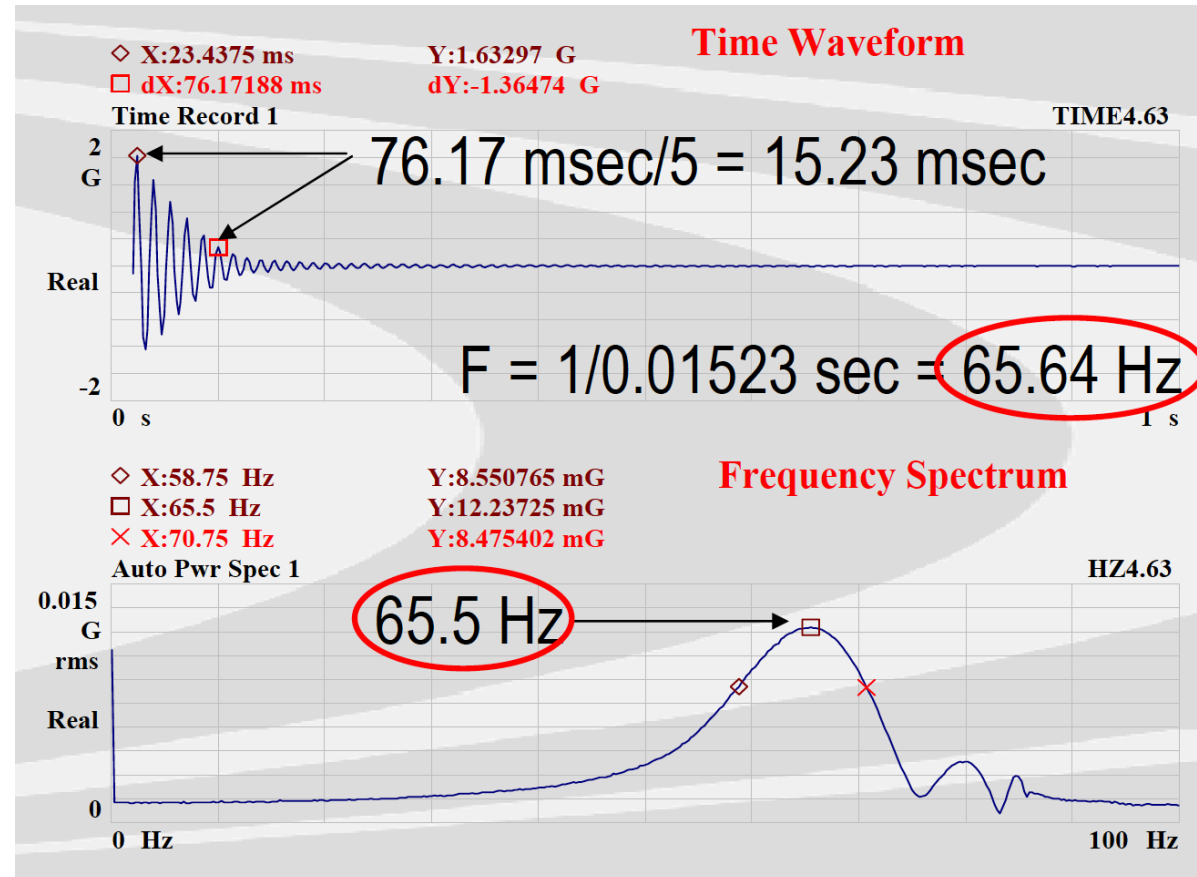
TIME



FREQUENCY



BUMP TESTING – MENTAL HEALTH CHECK!

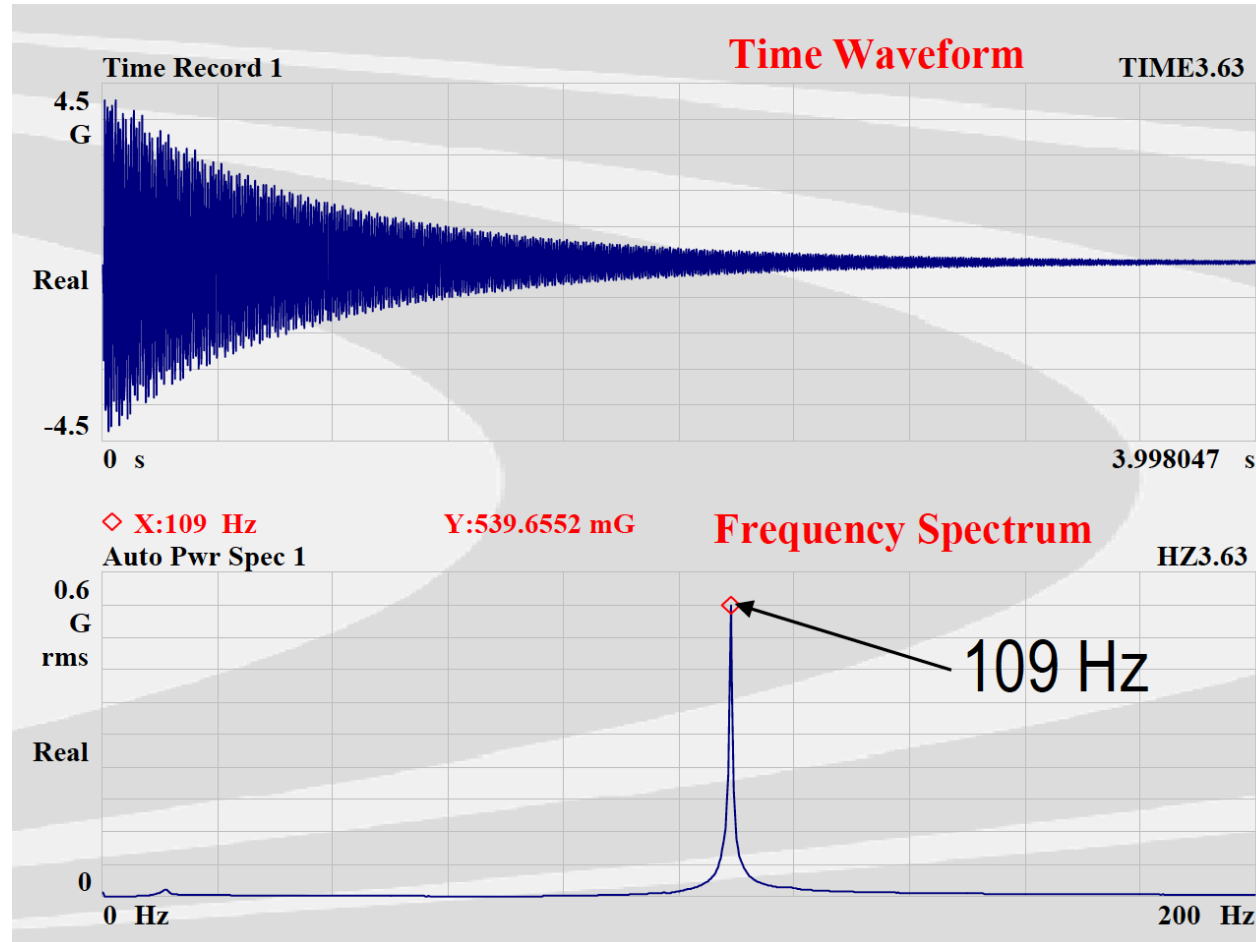


CASE HISTORY

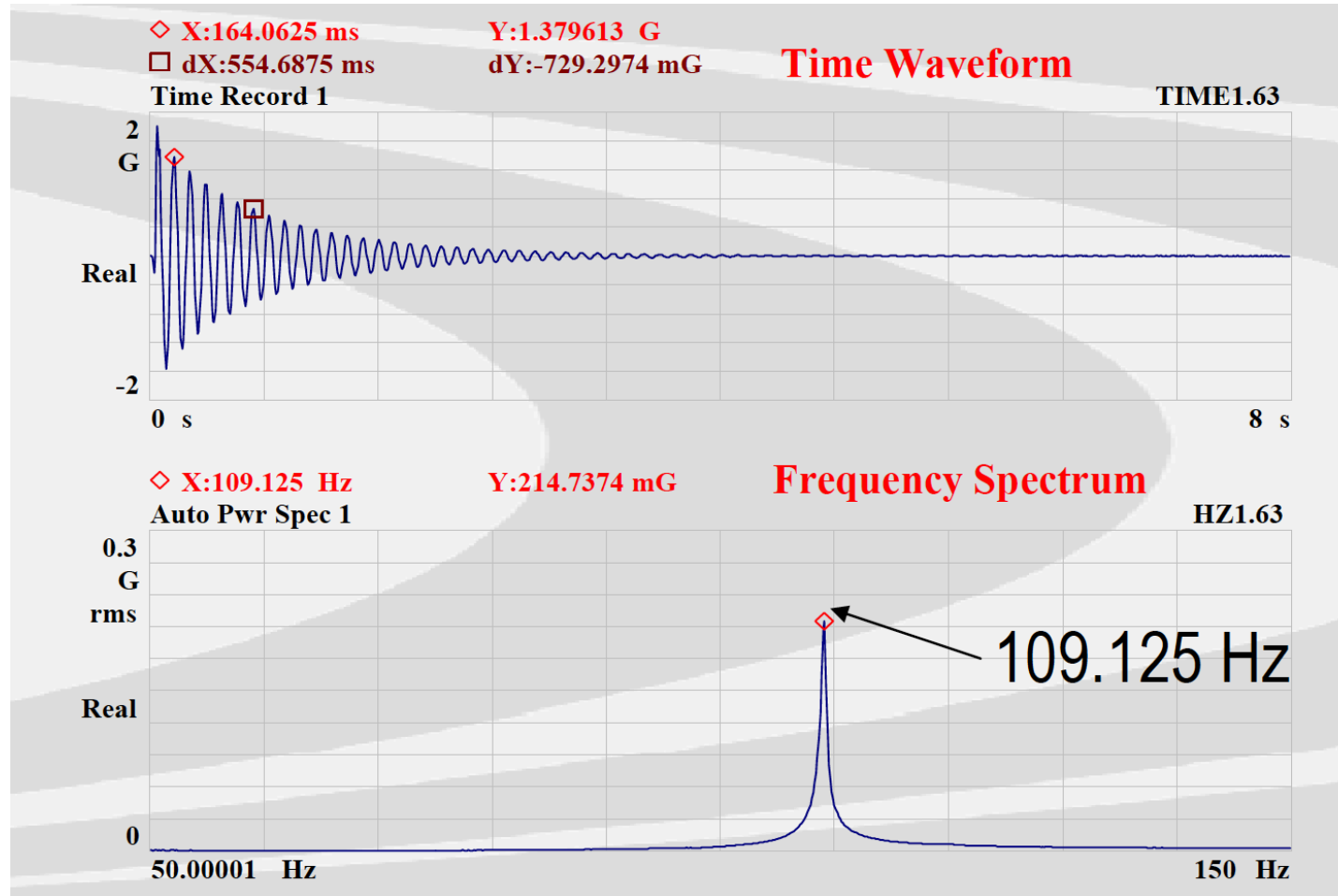
BUMPS IN THE ROAD!



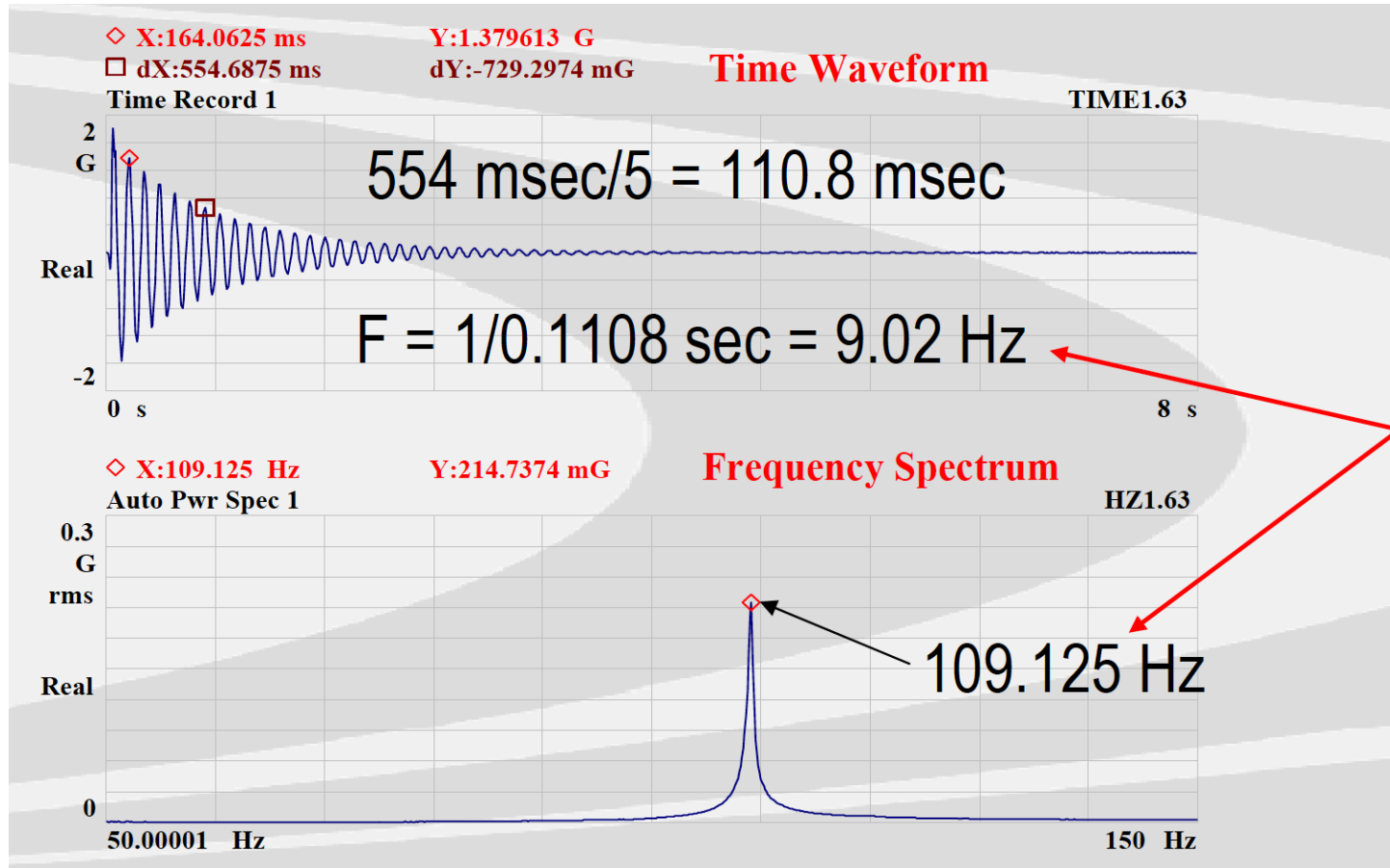
CASE HISTORY – SO EASY!



CASE HISTORY – ZOOM

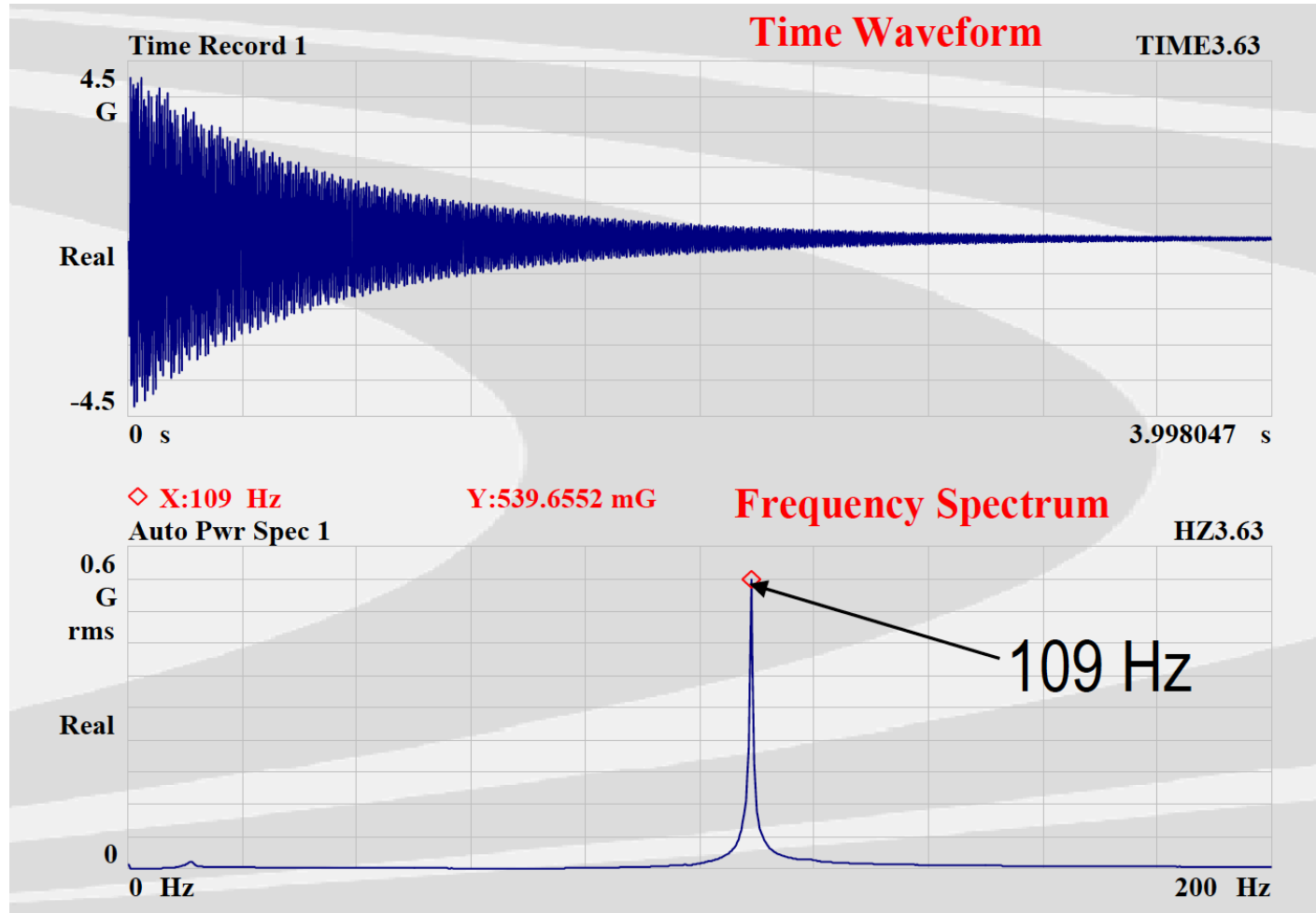


CASE HISTORY – ZOOM & MENTAL HEALTH CHECK

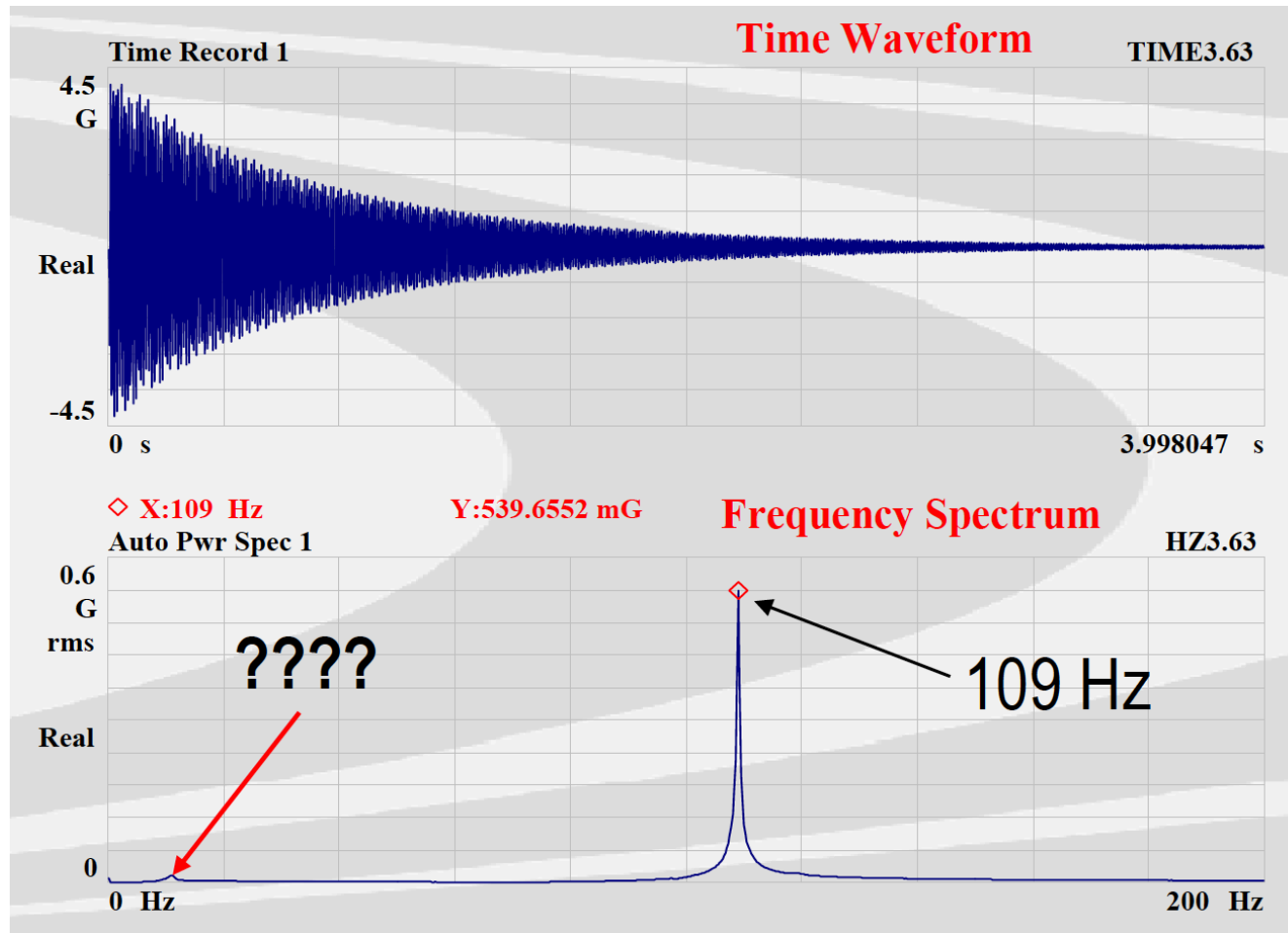


**WHAT
THE...?!**

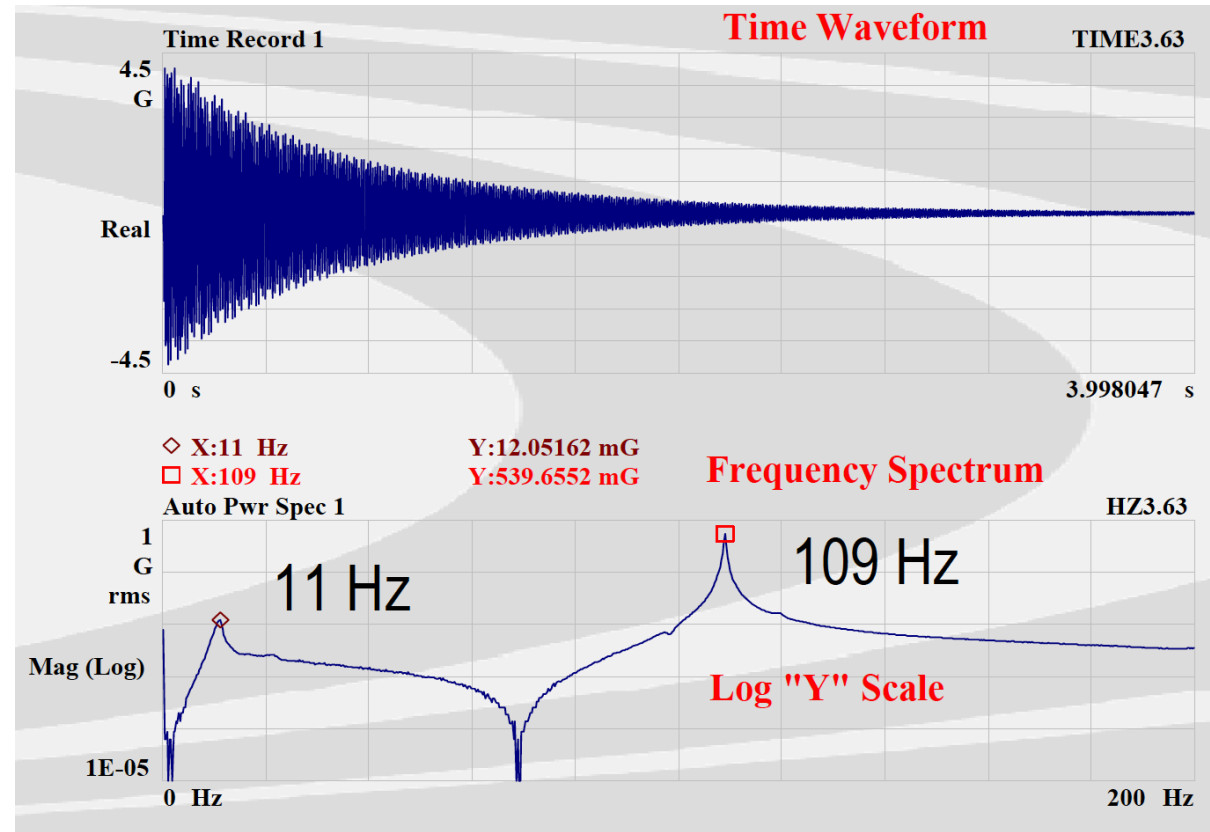
CASE HISTORY – SO EASY?



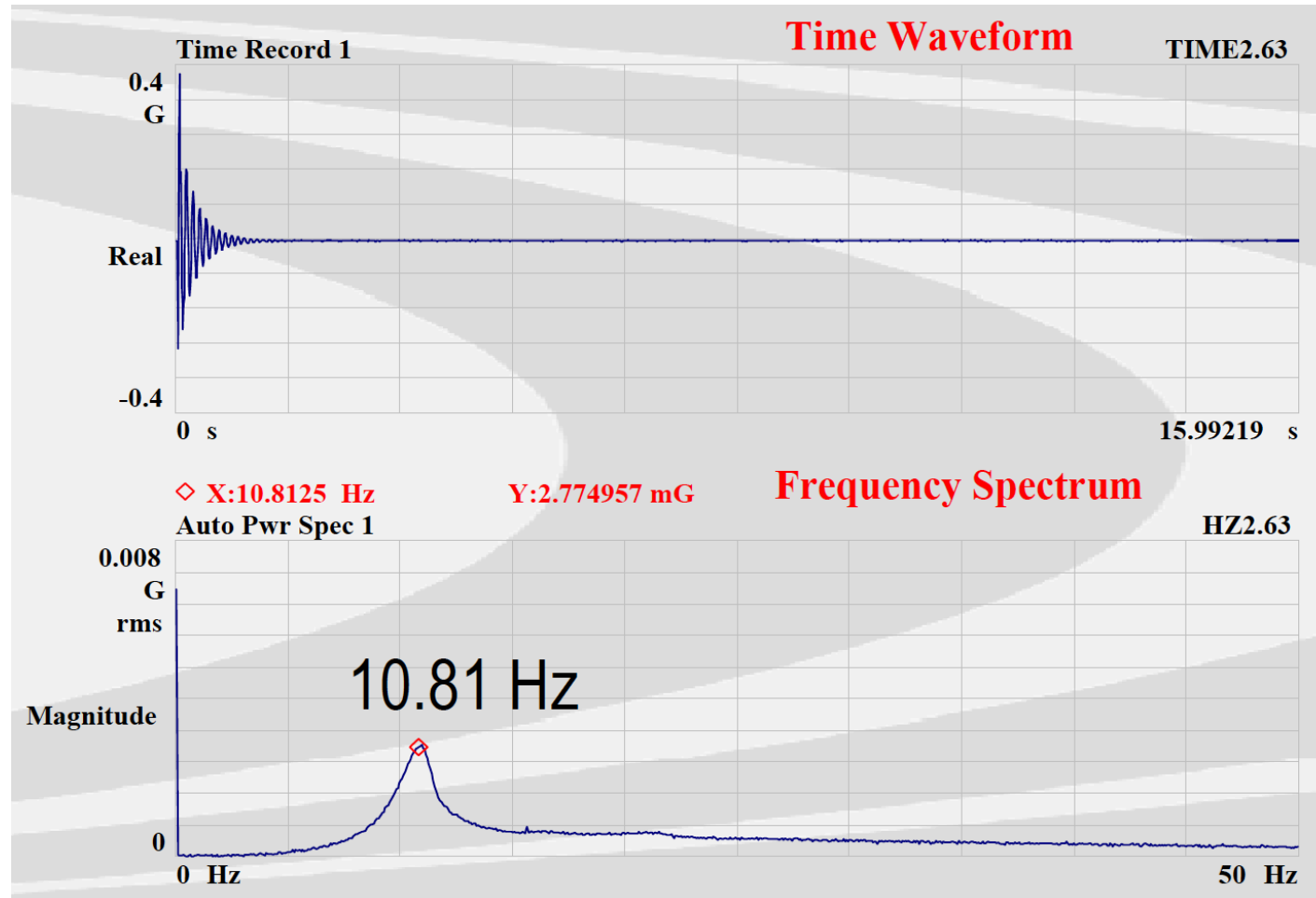
CASE HISTORY – WHAT IS THIS?



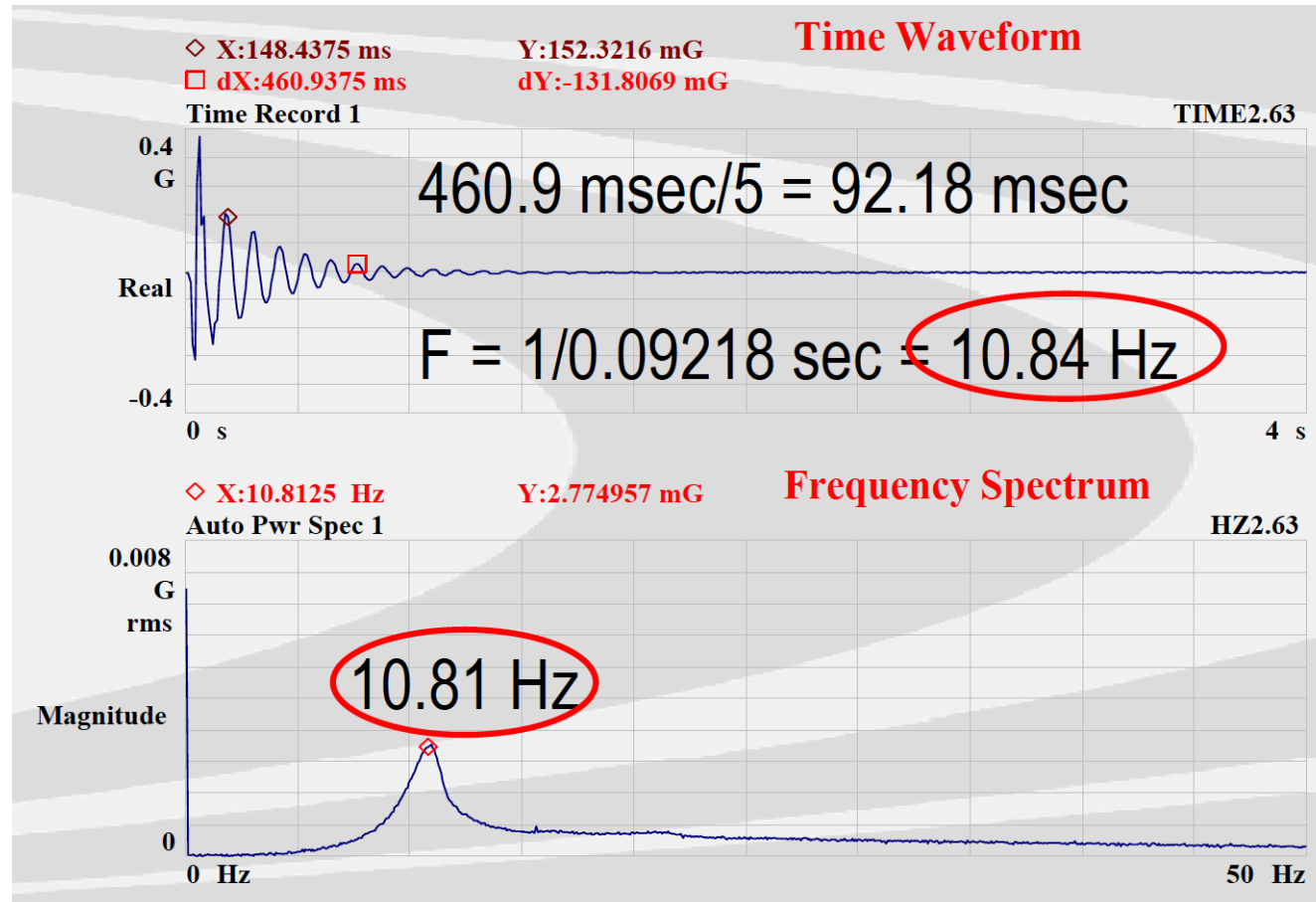
CASE HISTORY – LOG: CAN'T LIVE WITH IT, CAN'T LIVE WITHOUT IT!



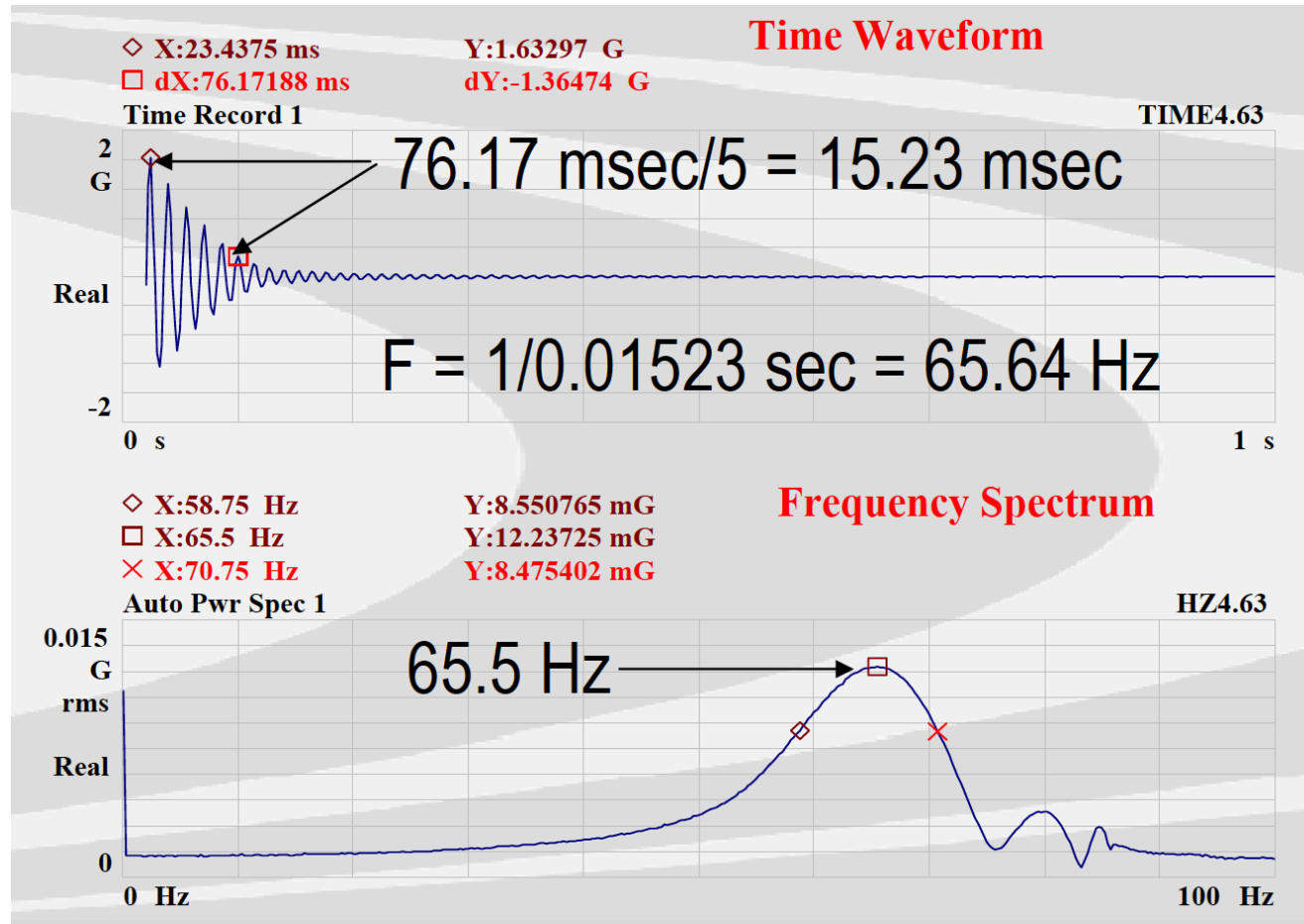
CASE HISTORY – 0–50 Hz SPAN



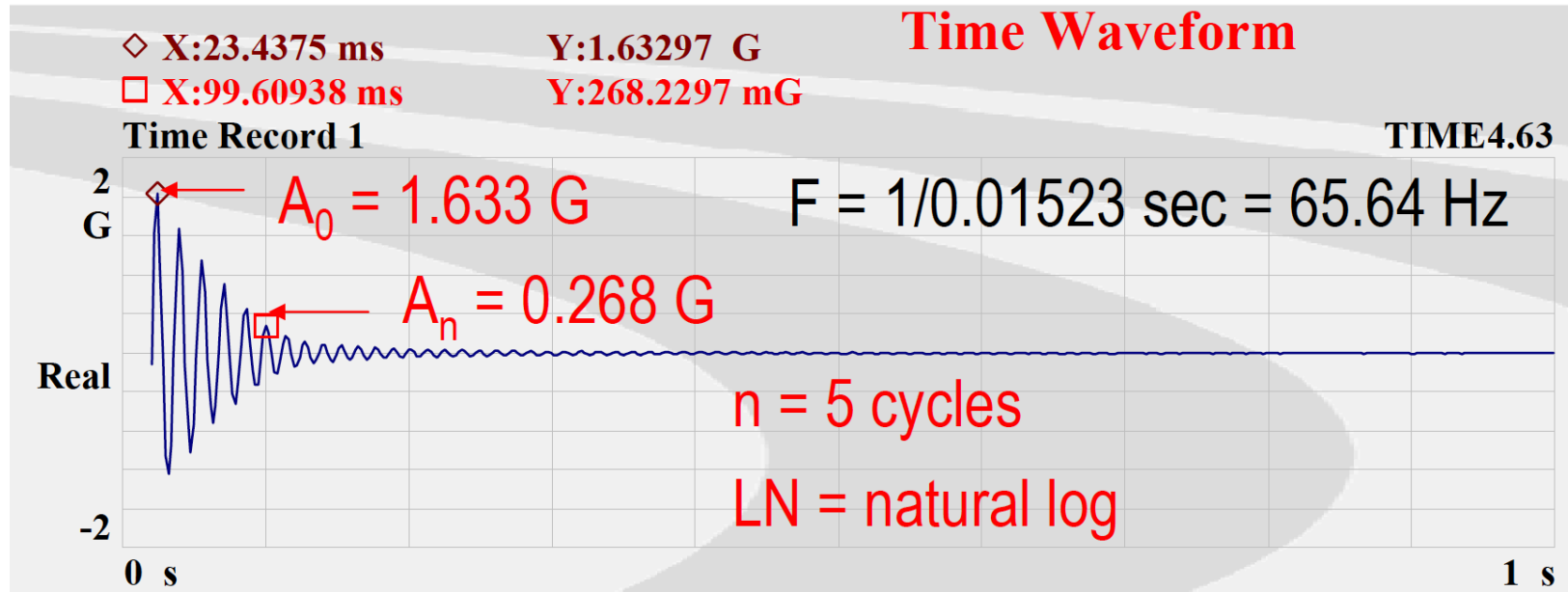
CASE HISTORY – 0–50 Hz (EXPANDED “X” SCALE)



BUMP TESTING – BACK TO BUMP TESTING



AMPLIFICATION FACTOR – USING THE TIME WAVEFORM



- ❑ **Log decrement** = $[1/n[\text{LN}(A_0/A_n)]] = [1/5[\text{LN}(1.633/0.268)]] = 0.36$
- ❑ **Damping ratio** = $\text{Log dec}/2\text{Pi} = 0.36/2\text{Pi} = 0.36/6.28 = 0.057$
- ❑ **Amplification factor** = $1/(2*\text{Damping}) = 1/(2*0.057) = 8.68$

AMPLIFICATION FACTOR – USING THE SPECTRUM

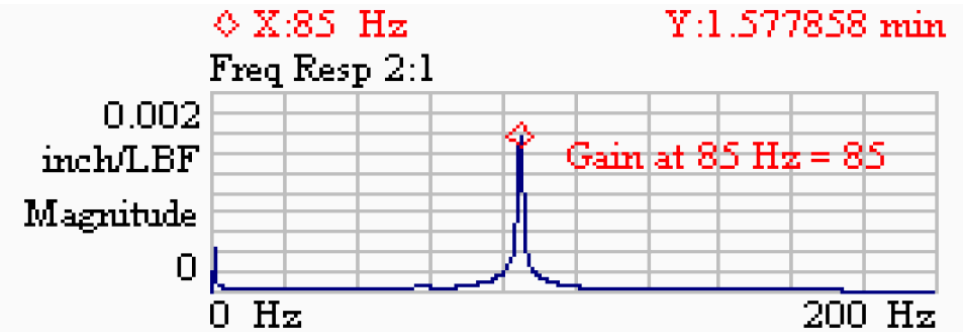
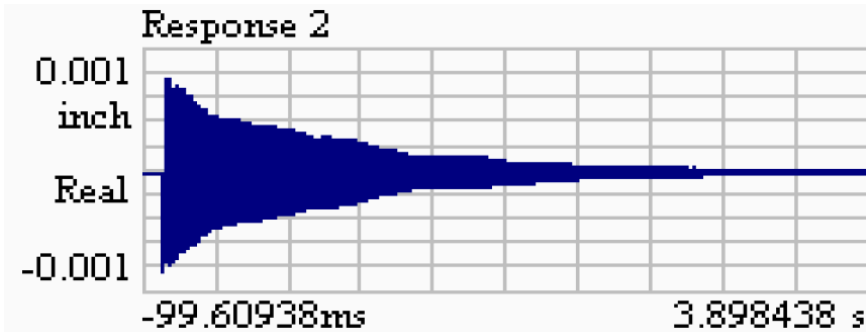
$$F_N = 1/2\pi \sqrt{k/m}$$

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

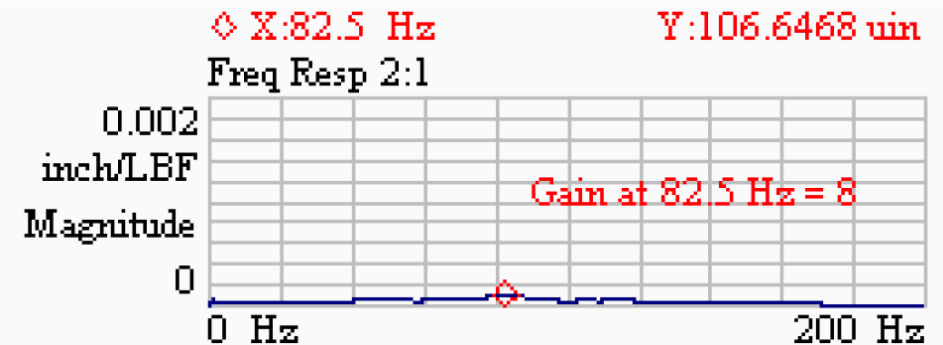
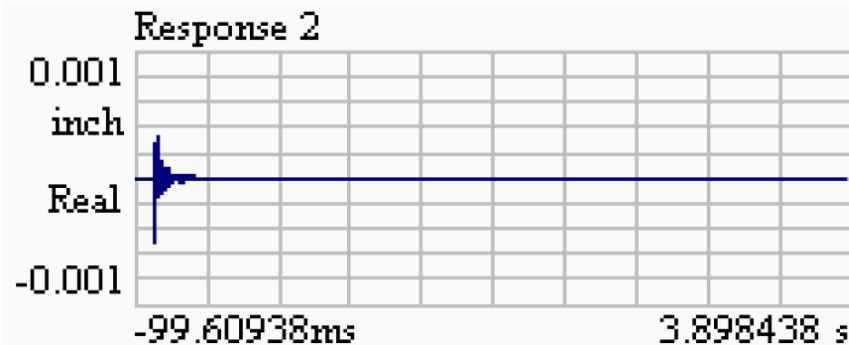
- Increase** the mass (m)
- Decrease** the frequency (F)

DAMPING – CONTROL THE RESPONSE

UN-DAMPED



DAMPED



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



SUMMARY

Thank you for taking the time to review this training lesson.

CTC prides itself on the industry's best customer service and technical support. CTC is proud to employ Vibration Institute Certified Analysts as part of our commitment to providing the industry's best service and support.

For more technical information, additional white papers, and training materials, we invite you to visit our website at www.ctconline.com.



SUMMARY

CTC offers a full range of vibration analysis hardware and process and protection instruments for industrial use. Our customers choose us time and time again based on:

- ❑ **Superior durability**
- ❑ **Accuracy and performance**
- ❑ **Quick service (shipping most orders in 3 days)**
- ❑ **Knowledgeable support staff**
- ❑ **Industry's only UNCONDITIONAL LIFETIME WARRANTY
on all CTC Line products**

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