



# Perfecting the Sine Test Module

*Today's Presenter: Jade Vande Kamp*

*We will begin shortly!*



# Meet VR



# Sine Testing

- General Overview
  - Key Parameters
  - Test Types
- Creating and Running Tests
  - Creating a Quick Test
  - Creating an Advanced Test
  - Key Graphs
- Additional Features



# Sine Testing - General

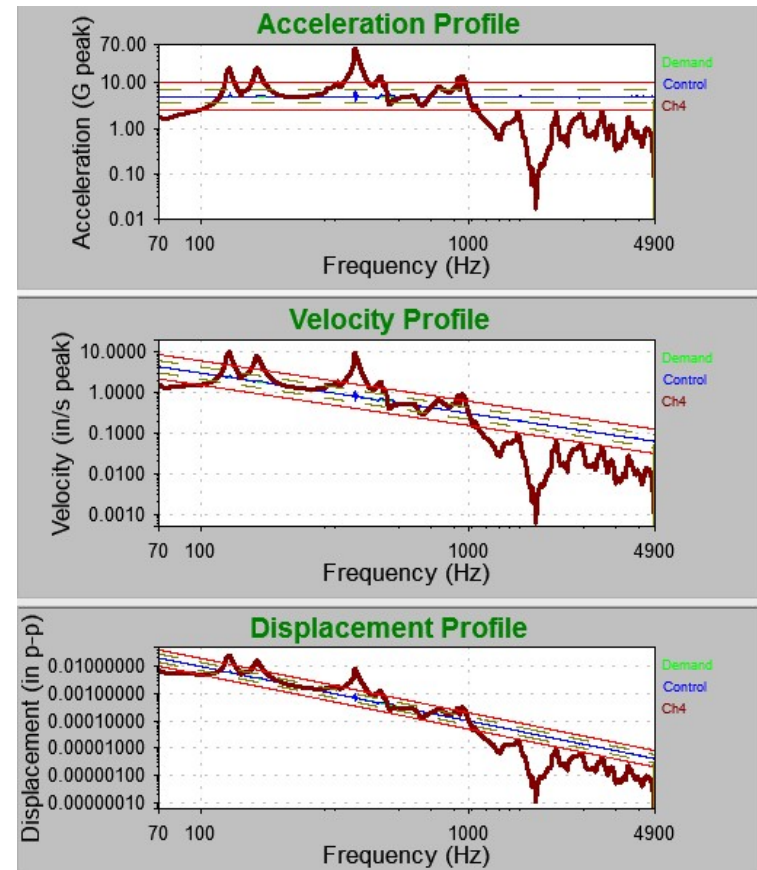
- What is a Sine Test?
  - Caution! Non Real World Vibration
- Use Cases
  - Engineering Evaluation
    - Find and Target Structural Resonances
    - Validate Finite Element Models
    - Product Performance and design
    - Fatigue Testing at Resonance
  - Production Testing
    - Pass/Fail – Based on a test specification

# Sine Testing - General

- Basic Sine Testing
  - Goal: Hold a constant G level and sweep through a range of frequencies
  - Observe the product response in multiple locations
  - Note any damage or resonance
- Limitations
  - Single Frequency Excitation
  - Difficult to correlate to end-use environment

# Sine Testing - Parameters

- Sine Testing Parameters
  - Acceleration
    - G's
  - Velocity
    - in/s or mm/s
  - Displacement
    - in or mm (pk to pk)
  - Frequency
    - Hz



# Sine Testing - Parameters

- If 2 of the parameters are known, the others can be calculated

- Acceleration (A)
- Velocity (V)
- Displacement (D)
- Frequency (F)

$$D = \frac{V}{\pi F} = \frac{GA}{2\pi^2 F^2} = \frac{2V^2}{GA}$$

$$V = \pi F D = \frac{GA}{2\pi F} = \sqrt{\frac{GAD}{2}}$$

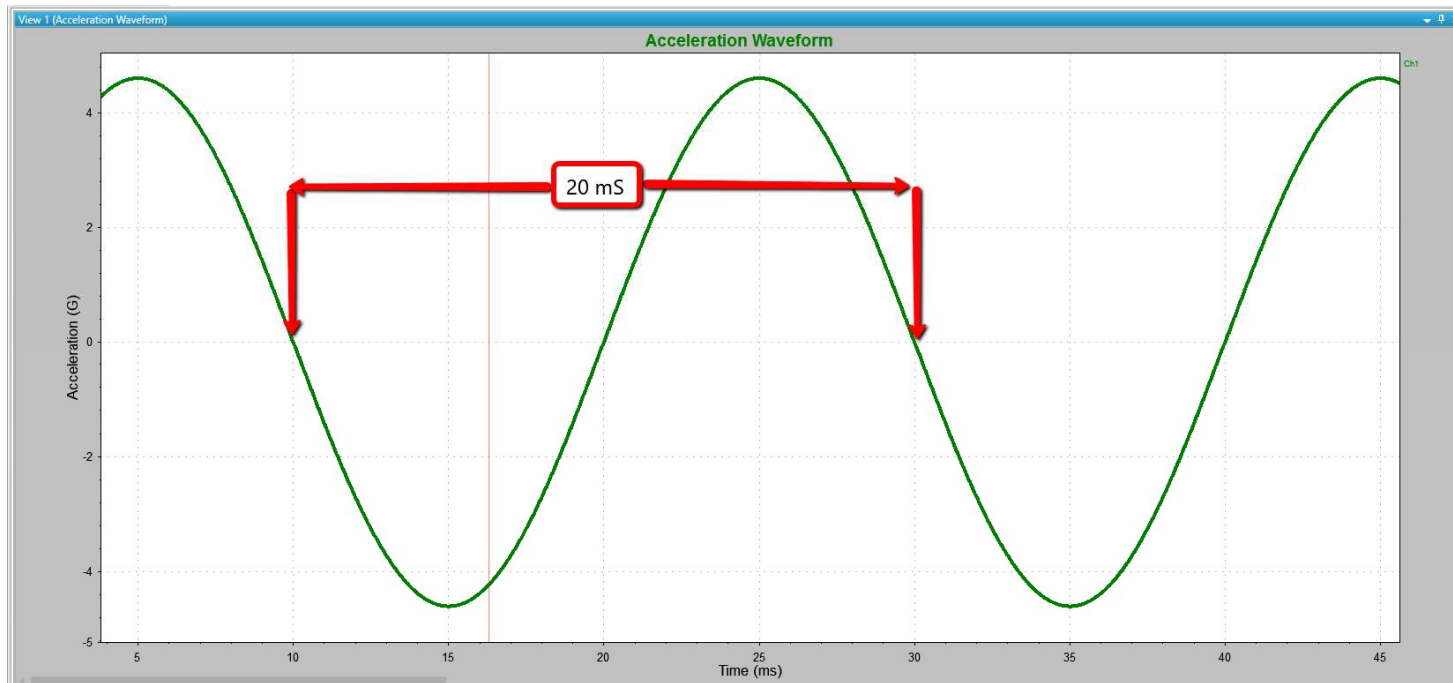
$$A = \frac{2\pi^2 F^2 D}{G} = \frac{2\pi F V}{G} = \frac{2V^2}{GD}$$

$$F = \sqrt{\frac{GA}{2\pi^2 D}} = \frac{V}{\pi D} = \frac{GA}{2\pi V}$$

- All parameters are related, a change will result in a proportional change in the remaining parameters.

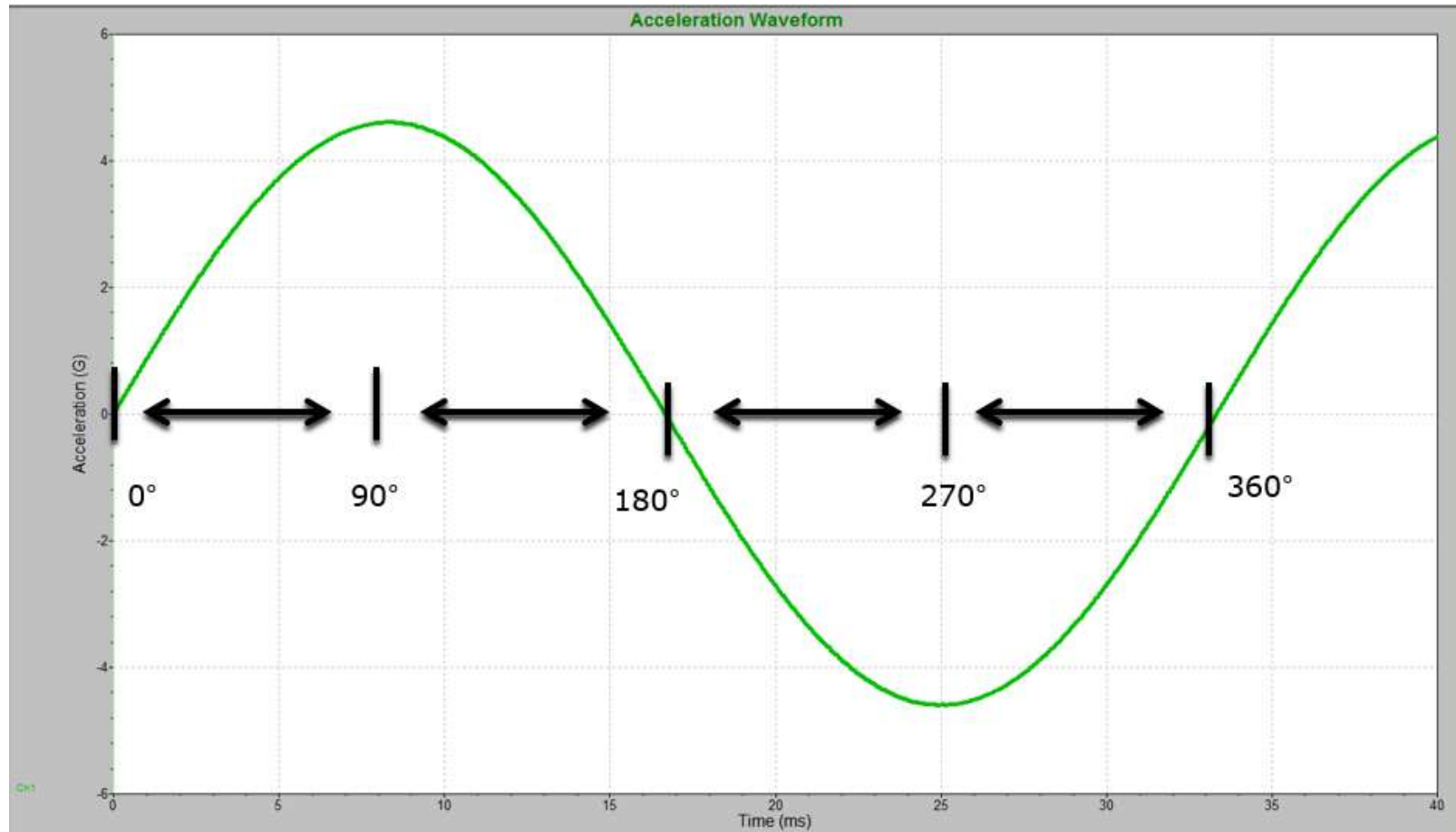
# Sine Testing – Cycle Calculation

- Frequency of a sine wave is calculated by dividing 1 second by the time of the cycle

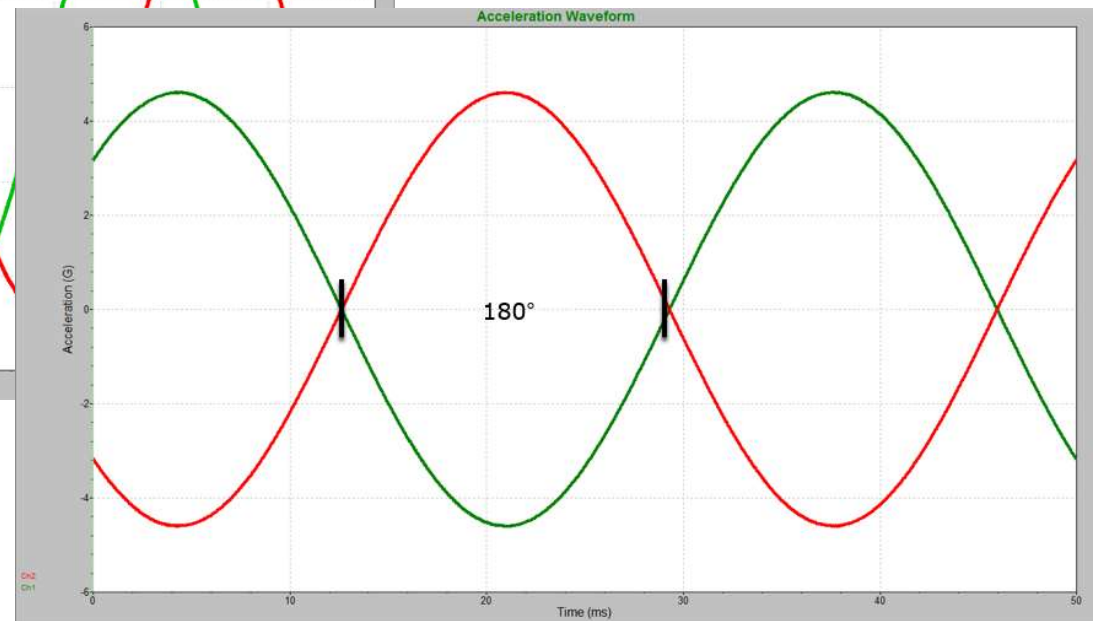
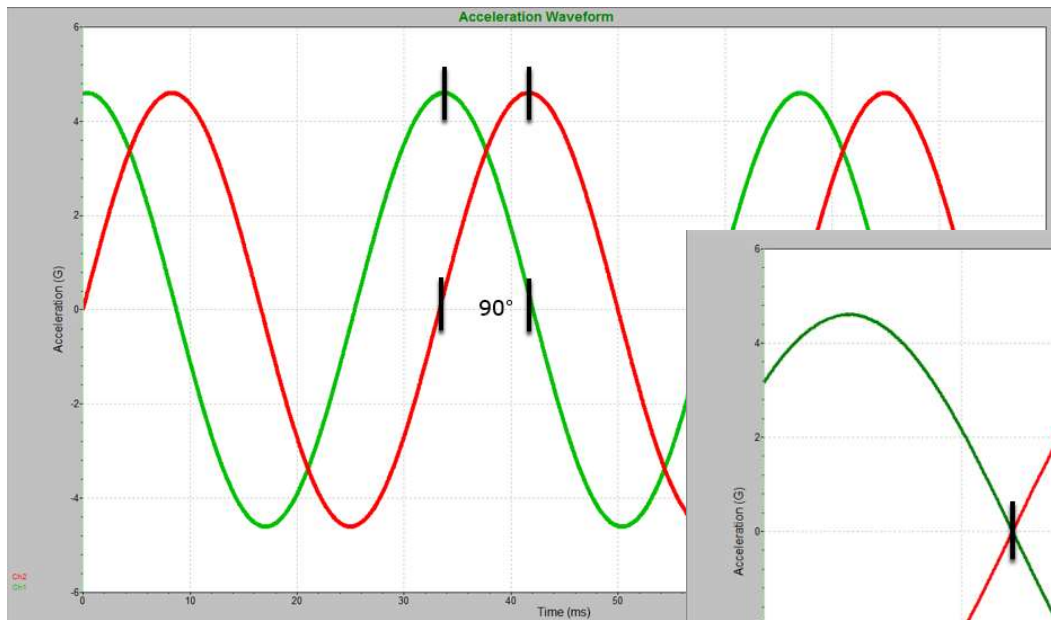




# Sine Testing – Phase



# Sine Testing – Phase Relationship



# Sine Testing – Types of Tests

- Fixed Frequency (Dwell)
  - Constant Frequency and G, held for a specified amount of time or cycles
- Swept Frequency
  - Constant G level moving at a given sweep rate between frequencies for a specified number of sweeps or time
- Stepped Frequency
  - Constant G Level at differing fixed frequencies

# Sine Testing – Quick Test

- Quick Test Setup
  - New Test → Sine

Quick Test

Frequency  Hz to  Hz

Displacement  in

Acceleration  G

Sweep rate  Oct/min (logarithmic)

Duration  Sweeps

Control Channel

Sine Resonance Tracked Dwell (SRTD)

Report

Accel:  G peak      Vel:  in/s peak      Disp:  in pk-pk

Start frequency of sweep.

# Sine Testing – Quick Test

- Quick Test Parameters
  - Frequency – Enter the Frequency value
  - Displacement AND/OR Acceleration must be entered
  - Sweep Rate
  - Duration
  - Control Channel
  - SRTD
  - Report

# Sine Testing – Battery Spec

- Parameters provided by specification
  - The vibration shall be a sinusoidal waveform with a logarithmic sweep between 7 Hz and 2000 Hz and back to 7 Hz traversed in 15 min
  - This cycle shall be repeated 12 times for a total of 3 hours for each of three mutually perpendicular mounting positions of the DUT. One of the directions of vibration must be perpendicular to the terminal face
  - The logarithmic frequency sweep is as follows: from 7 Hz a peak acceleration of 1 G is maintained until 18 Hz is reached. The amplitude is then maintained at 0.8 mm (1.6 mm total excursion) and the frequency increased until a peak acceleration of 8G occurs (approximately 50 Hz). A peak acceleration of 8G is then maintained until the frequency is increased to 2000 Hz.

# Sine Testing – Advanced Test

- Advanced Test Setup
  - New Test → Sine → Advanced

Analyzer				Notching			Step Test				
Profile	Schedule	Sweep	Parameters	Limits	Pre-Test	Channels	Data	Tables	Calc	Resonance	
Start Amplitude		Start Frequency		End Amplitude		End Frequency					
» 1	1	G peak ▾	at	30	Hz	to	1	G	at	100	Hz
Insert		Delete		Control Units							
				G ▾							
				Velocity Units							
				in/s ▾							
				Displacement Units							
				in ▾							
Maximum A,V,D requirements over the defined test frequency range:											
Accel:		1 G peak		Vel:		2.04826 in/s peak		Disp:		0.0217328 in pk-pk	
Starting Acceleration, Velocity, or Displacement of segment.											

# Sine Testing – Advanced Test

- Profile Tab

	Start Amplitude		Start Frequency		End Amplitude		End Frequency
1	<input type="text" value="1"/>	G peak ▾ at	<input type="text" value="30"/> Hz	to	<input type="text" value="1"/> G at		<input type="text" value="100"/> Hz
2	<input type="text" value="1"/>	G peak ▾ at	100 Hz	to	<input type="text" value="1"/> G at		<input type="text" value="200"/> Hz
3	<input type="text" value="1"/>	G peak ▾ at	200 Hz	to	<input type="text" value="1"/> G at		<input type="text" value="500"/> Hz
» 4	<input type="text" value="1"/>	G peak ▾ at	500 Hz	to	<input type="text" value="1"/> G at		<input type="text" value="1000"/> Hz

Maximum A,V,D requirements over the defined test frequency range:

Accel:  G peak

Vel:  in/s peak

Disp:  in pk-pk

Control Units

▾

Velocity Units

▾

Displacement Units

▾





# Sine Testing – Advanced Test

- Schedule Tab

Level start	Duration							Control Channel	Digital outputs:						
									0	1	2	3	4	5	
1	Enter Form	Pre-Test.html							Browse	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Sweep up from	30	Hz	1	Sweeps	100	%	Default	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3	Hold at	250	Hz	0:10:00	hh:mm:ss	100	%	Default	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4	Enter Form	Post-Test.html							Browse	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
» 5	View Report	Form Report.rtf							Browse	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Show digital outputs

Total Time at Level 0:11:41

Insert

Delete

Show or hide the auxiliary remote input configuration controls.



# Sine Testing – Advanced Test

- Sweep Tab

	Sweep rate	Tolerance		Abort		
		(+ dB)	(- dB)	(+ dB)	(- dB) ▾	
30 Hz	>--> 3	Oct/min (logarithmic) ▾	3	3	6	6
100 Hz	>--> 3	Oct/min (logarithmic) ▾	3	3	6	6
200 Hz	>--> 3	Oct/min (logarithmic) ▾	3	3	6	6
500 Hz	>--> 3	Oct/min (logarithmic) ▾	3	3	6	6
1000 Hz	>--> 3	Oct/min (logarithmic) ▾	3	3	6	6

Enable individual sweep rate settings for each segment

Enable individual tolerance and abort values for each segment

Total Time at Level

0:11:41



# Sine Testing – Advanced Test

- Parameters Tab

Startup Parameters		Adaptive feedback	Disabled
Time	10	seconds	
Running Parameters			
Response time	20	ms	
Min response time	2	cycles	
Increasing rate	20	dB/sec	
Decreasing rate	20	dB/sec	
Input Filter Parameters			
Fractional bandwidth	20	%	
Maximum bandwidth	5	Hz	
General Parameters		Auto	
Sample rate	65536	Hz	<input checked="" type="checkbox"/>
Graph resolution	2000	per Sweep	
Shutdown rate	40	dB/sec	

Time to reach startup drive limit output (Typical 10 seconds).

# Sine Testing – Advanced Test

- Limits Tab

**Control Limits**  
 Define limits on Sweep tab instead

Plus Abort (+)	<input type="text" value="6"/>	<input type="text" value="dB"/>	<input type="text" value="v"/>
Plus Tol (+)	<input type="text" value="3"/>	<input type="text" value="dB"/>	
Minus Tol (--)	<input type="text" value="3"/>	<input type="text" value="dB"/>	
Minus Abort (--)	<input type="text" value="6"/>	<input type="text" value="dB"/>	

Limit drive to Max Output, but don't abort the test

**Startup Drive Limits**

Max System Gain	<input type="text" value="5"/>	<input type="text" value="Volts/G"/>	
Output Threshold	<input type="text" value="0.005"/>	<input type="text" value="Volts"/>	Use System Threshold Setting <input checked="" type="checkbox"/>
Max Output	<input type="text" value="1"/>	<input type="text" value="Volts"/>	
First drive check	<input type="text" value="20"/>	<input type="text" value="%"/>	Use System Drive Check Settings <input checked="" type="checkbox"/>
Second drive check	<input type="text" value="50"/>	<input type="text" value="%"/>	

**Running Drive Limits**

Max System Gain	<input type="text" value="5"/>	<input type="text" value="Volts/G"/>
Max Output	<input type="text" value="1"/>	<input type="text" value="Volts"/>

**Monitored Startup**

Start with Projected Levels  
 Always start using manual control

Initial level	<input type="text" value="-24"/>	<input type="text" value="dB"/>	<input type="text" value="v"/>
Step size	<input type="text" value="6"/>	<input type="text" value="dB"/>	

Allow tolerances and aborts to be set for each frequency segment (Typical NOT checked)

# Sine Testing – Advanced Test

- Channels Tab

Control Channel	Transducer	Tracking Filter	System Limits Apply	Individual Channel Limits			
				Enable	+ Abort	- Abort	
1 <input checked="" type="checkbox"/> Ch1	10 mV/G	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="text" value="6"/>	<input type="text" value="6"/>	dB
2 <input type="checkbox"/> Ch2	10 mV/G	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text" value="6"/>	<input type="text" value="6"/>	dB
3 <input type="checkbox"/> Ch3	10 mV/G	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text" value="6"/>	<input type="text" value="6"/>	dB
4 <input type="checkbox"/> Ch4	10 mV/G	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text" value="6"/>	<input type="text" value="6"/>	dB

Combine control channels using  System Limits:  
Accel=40 G  
Vel=89 in/s  
Disp=1 in

Disable lower control abort limit while notching is active  
 Load this Input Configuration with the test

Channels used to close the control loop.

# Sine Testing – Advanced Test

- Data Tab

Data storage directory	<input type="text" value="C:\VibrationVIEW\Data\2015-09"/>	<input type="button" value="Browse"/>	Data file name	<input type="text" value="2015Sep23-1129-0001"/>	<input type="button" value="Copy from test name"/>
<input type="checkbox"/> Save reports in Data storage directory	<input type="text" value="C:\VibrationVIEW\Reports\2015-09"/>	<input type="button" value="Browse"/>	<input checked="" type="checkbox"/> Use Data file name for report	<input type="text" value="2015Sep23-1129-0001"/>	
Save data to disk					
<input type="checkbox"/> every <input type="text" value="1"/> sweeps	<input type="checkbox"/> Prompt for Run Name and Annotation Lines when starting the test				
<input type="checkbox"/> every <input type="text" value="10"/> minutes	<input type="checkbox"/> Clear Hi/Lo data after auto-save				
<input type="checkbox"/> every <input type="text" value="20000"/> cycles	<input type="checkbox"/> Use this graph layout				
<input type="checkbox"/> at end of each level	<input type="text"/>				
<input checked="" type="checkbox"/> at end of test	<input type="button" value="Browse"/>				
Graph annotation lines					
Prompts	Graph annotation lines (shown in data bottom and in reports)				
<input type="text" value="Note 1"/>	<input type="text"/>				
<input type="text" value="Note 2"/>	<input type="text"/>				
<input type="text" value="Note 3"/>	<input type="text"/>				

Prompt for save directory and annotation lines immediately after starting the test.

# Sine Testing – Advanced Test

- Notching Tab

Channel	Minimum (lower) limits				Maximum (upper) limits			
	Mode	Level relative to control		Mode	Level relative to control			
1	Boost to	2	G	Notch at		G		
2	Boost (Table)	Edit		Notch (dB)		dB		
3	Abort at	3	G	Abort at		G		
4	Abort (dB)	4	dB	Abort (Table)	Edit			

Disable lower control abort limit while notching is active

Hide the breakpoint table entry.

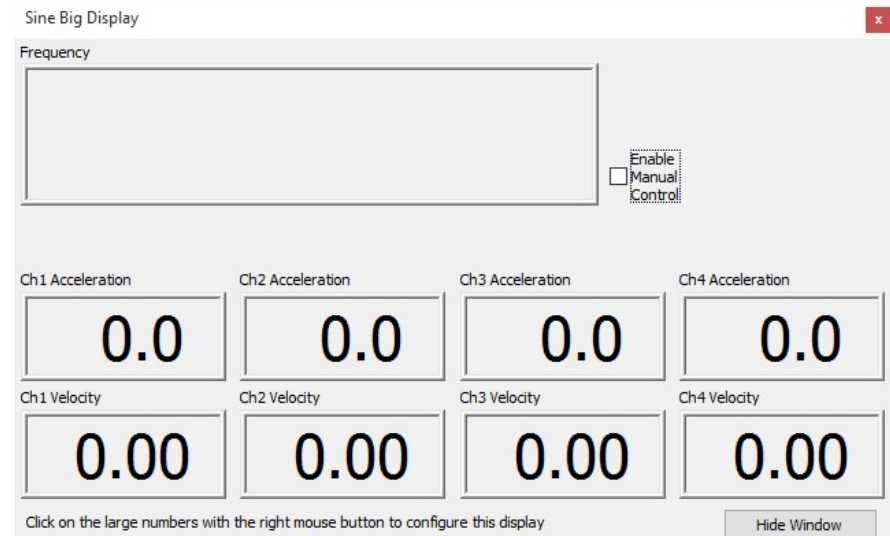
# Sine Testing – Graphs

- Key Graphs:
  - Acceleration vs. Frequency
  - Velocity vs. Frequency
  - Displacement vs. Frequency
  - Output Drive vs. Frequency
  - Transmissibility
  - Time History Plots
  - Drive vs. Input



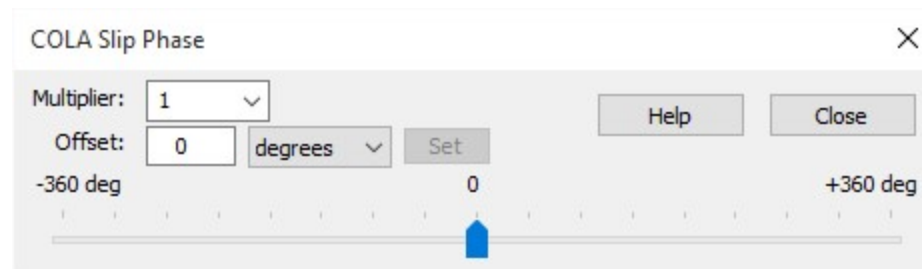
# Sine Testing – Big Display

- Click on the View Tab → Select Sine Big Display
  - Enable manual control
  - After clicking on G-Level or Sweep Rate use the scroll wheel to adjust the rate
  - Right clicking on the bottom displays allow for selection of channels and functions



# Sine Testing – Strobe Light

- View → Sine COLA Slip
  - COLA output gives a ref sine wave at 1V pk (user configurable) to synchronize your strobe signal.



# Sine Testing – Conclusion

- Introduction to Sine Testing
- Creating Tests
  - Quick Test Setup
  - Advanced Test Setup (Battery Specification)
  - Key Graphs
  - Notching
- Sine Big Display
- Using a Strobe Light

# Thank You for Attending!

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