FLOW INDUCED VIBRATION LAB

PURPOSE: The main purpose of this lab is to measure the critical flow speeds of two cantilever tubes in water and to compare the measured speeds with theoretical speeds.

PROCEDURE: An accelerometer is used to detect the tip motion of each tube. Attach this to the round tube. Install the tube on the wave tank towing carriage frame. Connect the accelerometer and carriage speed indicator to an oscilloscope. Use a ramp run up the tank to record the main features of the tube vibration. Use constant speed runs to focus in on the motion at specific speeds. Attach rope in a spiral pattern to the tube and repeat the ramp run. Repeat all of the tests for the box tube.

REPORT: Calculate the critical speeds for the two tubes. Compare the theoretical speeds to the measured speeds. Also compare the theoretical periods of vibration to the measured periods. Comment on the results. Discuss sources of error.

The critical speed U for resonance:

$$U = D/[S\,\mathbf{T}]$$

Circle	$S=0.20$
Square	$S=0.15$

The critical speed U for galloping is:

$$U = U_{\circ}\ M/M_{\circ}\ \zeta\ \mathbf{a}$$

$$U_{\circ} = D/\mathbf{T} \qquad M_{\circ} = \rho D^2$$

Circle	$\mathbf{a}=\infty$
Square	$\mathbf{a}=8$

The natural periods **T** of a cantilever tube are:

$$\mathbf{T}_n = 2\pi/K_n\ \sqrt{[[ML^4]/[EI]]}$$

$$K_1=3.52 \qquad K_2=22.0 \qquad K_3=61.7 \qquad K_4=120.9$$

The second moment of area I is:

Circle	$I = \pi/64\ (OD^4 - ID^4)$
Square	$I = 1/12\ (OD^4 - ID^4)$


8 10:28 AM


8 11:21AM


8 10:25

STI Vibration Monitoring Inc.

Vibration Monitoring and Machine Protection Systems
1010 East Main Street, League City, TX 77573 Phone:281.334.0766 Fax: 281.334.4255
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Condition Monitoring Custom Products

CMCP1100 Series
General Purpose Industrial Accelerometer

Features

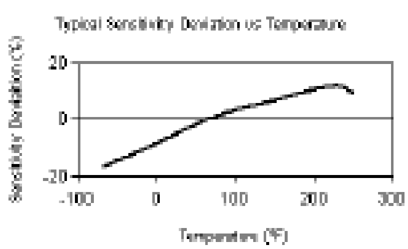
- Small Size Case, 1/2" x 1.05",
- Small Footprint, 1/2"
- Integral Cable (5, 10 or 20 Meters)
- 100 mV/g Sensitivity
- 0.32 Hz to 10 KHz Frequency Range (± 3 dB)
- Waterproof
- LOW COST

Standard

Side-Exit

High Temperature

DYNAMIC PERFORMANCE	ENGLISH	SI
Sensitivity (±10%)	100 mV/g	10.2 mV/(m/s²)
Measurement Range	±50 g	±490 m/s²
Frequency Range: (±3 dB)	20 – 600k cpm	0.32 – 10k Hz
Mounted Resonant Freq.	1320k cpm	22k Hz
Amplitude Linearity	±1%	±1%
Transverse Sensitivity	≤7%	≤7%
ENVIRONMENTAL		
Shock Limit	5,000 g pk	49k m/s² pk
Temperature Range (STD)	-65 to +185° F	-54 to 85° C
Temperature Range (HT)	-65 to 250° F	-54 to 120° C
ELECTRICAL		
Settling Time	≤2 sec	≤2 sec
Excitation Voltage	18 to 30 VDC	18 to 30 VDC
Excitation Constant Current	2 to 20 mA	2 to 20 mA
Output Impedance	<150 ohms	<150 ohms
Output Bias Voltage	8 to 12 VDC	8 to 12 VDC
Electrical Case Isolation	>10^8 ohms	>10^8 ohms
Electrical Protection	RFI/ESD	RFI/ESD
Integral Cable	22 AWG, 221° F	22 AWG, 105° C
MECHANICAL		
Size	0.5 x 1.05"	12.7 x 26.67 mm
Weight (including 5 M cable)	2.5 oz	70.7 g
Mounting Thread	1/4-28 UNF-2B	1/4-28 UNF-2B
Mounting Torque	2 to 5 ft-lb	2.7 to 6.8 N-m
Sensing Element	Ceramic/Shear	Ceramic/Shear
Case Material	Stainless Steel	Stainless Steel
Sealing	Potted	Potted
Wrench Flats	7/16"	7/16"



Ordering Information:

Part No.	-XX	-XX	Description
CMCP1100			Low Cost Industrial Accelerometer
CMCP1100HT			High Temperature
CMCP1100S			Side Exit
	05		5 Meter Integral Cable (16.5 feet)
	10		10 Meter Integral Cable (33 feet)
	20		20 Meter Integral Cable (66 feet)
	XX		Specify Length
		-00	Blunt Cut
		-01	Female BNC Connector

Spectral Noise:

10 Hz:	8 µg / √Hz	78.5 (mm/s²) / √Hz
100 Hz:	5 µg / √Hz	49.1 (mm/s²) / √Hz
1000 Hz	4 µg / √Hz	39.2 (mm/s²) / √Hz

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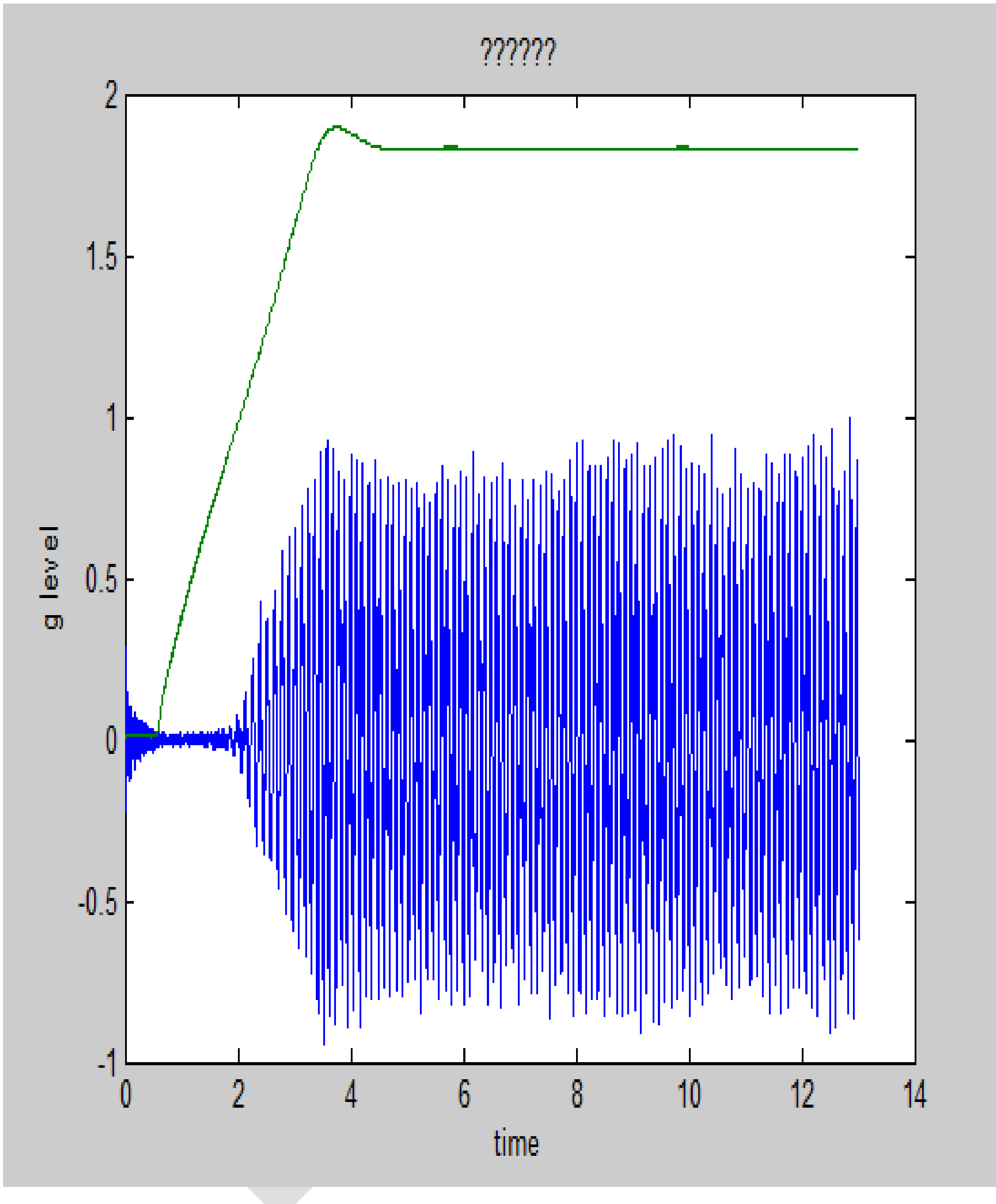
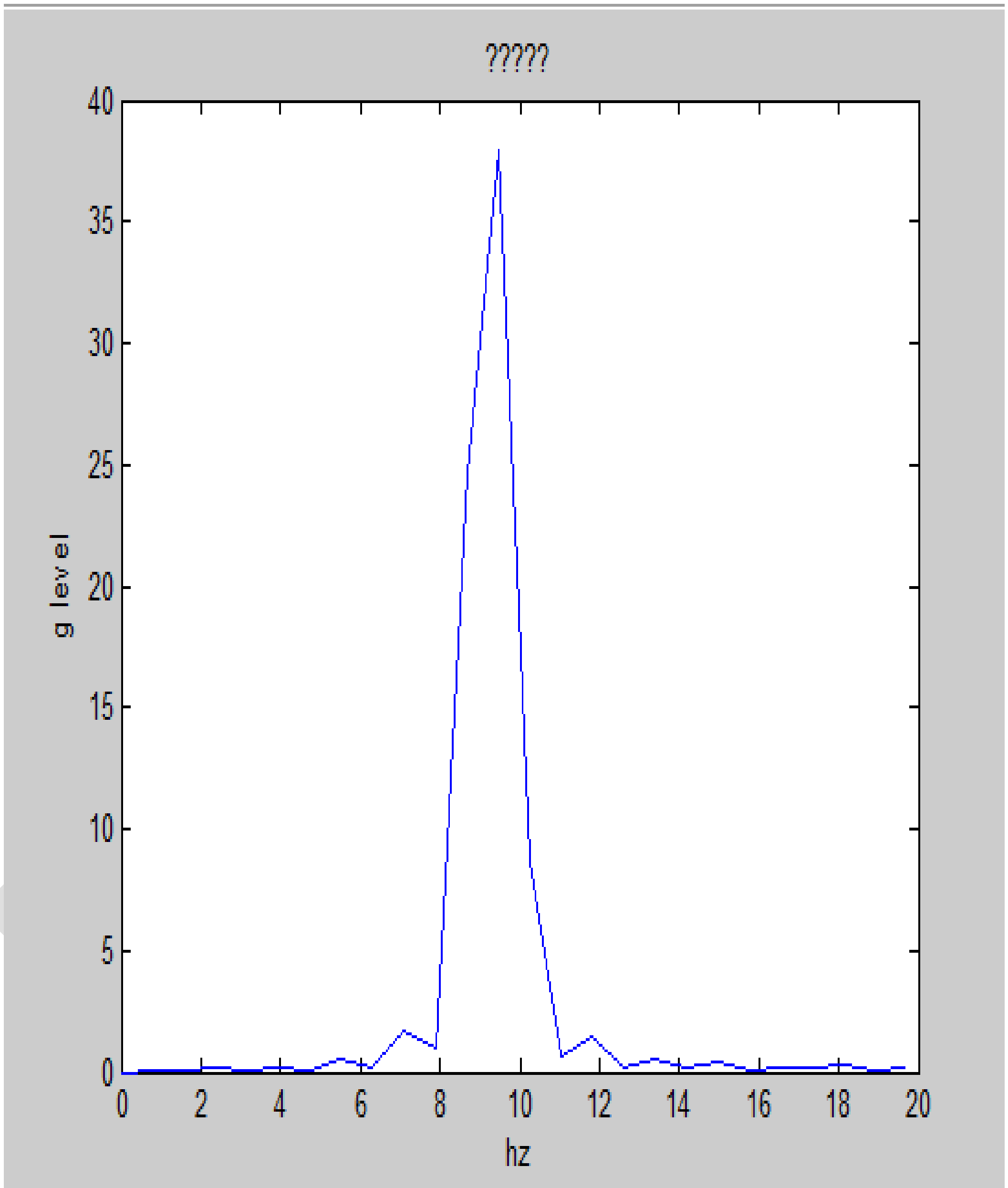
www.stiwebstore.com

```
%
% MUN DATA
%
clear all
name='data.txt';
S=load(name);
nit=21000;
for it=1:nit
 time(it)=S(it,1);
 shake(it)=S(it,2);
 speed(it)=S(it,3);
end
plot(time,shake,time,speed)
xlabel('time')
ylabel('g level')
title('???????')
```


??????
g level
time
2
1.5
1
0.5
0
-0.5
-1
0
2
4
6
8
10
12
14

```
%
% FLOW INDUCED VIBRATION
%
% FAST FOURIER TRANSFORM
%
% CANTILEVER TUBE DATA
%
clear all
name='data.txt';
S=load(name);
total=0.0;
pad=15000;
nit=1023;
jit=nit+1;
bit=jit/40;
mit=2*nit;
for it=1:nit
 kit=it+pad;
 shake(it)=S(kit,2);
 total=total+S(kit,2);
end
average=total/nit;
shake=shake-average;
z=fft(shake,mit);
p=z.*conj(z)/mit;
f=1613*(0:bit)/mit;
plot(f,p(1:bit+1))
xlabel('hz')
ylabel('g level')
title('?????')
```


?????
g level
hz
0
5
10
15
20
25
30
35
40
0
2
4
6
8
10
12
14
16
18
20