Antonio ATA Cooled Feed
Feed Tip Vibration Measurements Various Dampers
2018-12-14, Minex Engineering, Matt Fleming

Version	Date	Comment	Initials
Version 0	2018-12-07	Preliminary.	Matt Fleming
Version 1	2019-01-10	For meeting.	MCF

Contents:
None prepared.

Summary:
This document collects some preliminary measurement of vibration for the Sunpower GT Cryocoler with a passive damper and an active damper. The expectation was that the active damper would be significantly better but preliminary measurements are unclear. In general an Active Damper does better than most of the Passive Dampers we tested with one important exception. We have concluded that a Passive Damper can do just as well if properly designed and tuned. We do not know how difficult this is and it may be the reason people ofen choose and Active Damper. We do know the Active system applied to our application will have a hardware cost and be challenging to integrate the electronic control boards.

Discussion:
The table below is a summary of 6 sets of data taken. The table shows the Feed Serial Number, the mounting arrangement for the Cryo Cooler, the type of mounting for the Accelerometer, the type of Damper, and the results. The label "Axis" is for accelerations along the axis of the cooler where the motor is producing the source vibration. Page 2 shows some images of the configurations. Pages 3 to 8 show plots for each testing, one page for each test. It is interesting to note that most Dampers that perform poorly are vibrating at 120 Hz.

Item	Feed Num	Cooler Mount	Accel Mount	Damper Type	Axis (g)	Axis FFT (g)	Horz (g)	Horz FFT (g)	Vert (g)	Vert FFT (g)
1	018	Bellows	A	P	0.10	0,020 120Hz	0.38	0.031 280Hz	0.38	0.026 280Hz
2	019	Bellows	A	P	0.80	0.200 120Hz	2.00	0.470 120Hz	0.70	0.200 120Hz
3	016	Bellows	B	P	0.36	0.082 120Hz	0.92	0.340 120Hz	0.48	0.164 120Hz
4	016	Bellows	B	A	0.34	0.036 120Hz	0.36	0.096 120Hz	0.40	0.130 120Hz
5	016	Rigid	B	P	0.90	0.220 120Hz	0.46	0.160 120Hz	0.96	0.310 120Hz
6	016	Rigid	B	A	0.64	0.274 60Hz	0.18	0.021 60Hz	0.20	0.028 180Hz

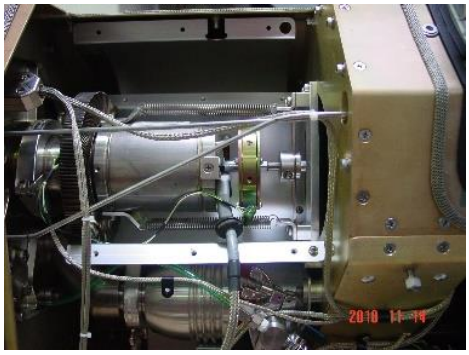
Item 1 on Feed 018, Has the very lowest measured vibration. It has a Bellows mounted Cooler and a perfect Passive Damper. It is even better than various attempts to use the Active Damper. When this feed is running one can barely feel any vibration at the Base Plate. The fft shows almost nothing at 60 or 120 Hz. This suggests that a Passive Damper can work very well if properly tuned.

Item 2 has the very worst measured vibration we have seen. It has same setup as Item 1, but it is interesting to note that acceleration along the cooler axis is 10 times higher than item 1, but more interesting is the horizontal direction has very high amplitude at 2.00 g which is 5.3 times item 1. Horizontal and vertical side movements are a function of the spring plates used. Poorly made spring plates can cause a sort of figure 8 motion of the Damper creating the side accelerations. One reason the Active Damper does well is because it has better quality and a better arrangement of the springs. They are also separated by a longer distance axially making the assembly more stable.

For Items 3 & 4, with a bellows mounted Cooler, we compare an average performance Passive Damper to the Active unit. Along the cooler axis the Active is 95% of Passive, and on horizontal 39% of Passive, and on vertical 83%.

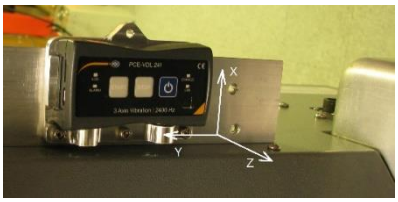
For Items 5 & 6, with Rigid Cooler mounting, we compare Passive and Active Dampers. Along the Cooler axis, the Active is 71% of Passive, and on horizontal 41% of Passive, and on vertical 21%. We know a properly designed spring systems should result in low side accelerations for Passive or Active.

For Items 4 & 6, with an Active Damper, we compare a Bellows Cooler to a Rigid mounted Cooler. Along the Cooler axis it Bellows is about 53% of Rigid, so 2:1 on that. We investigated a rigid mount because the bellows is a source of additional cost and vacuum failures due to fatigue. If we can consistently produce a Damper as good as Item 1, it might work quite well at 0.20 g with a rigid mounting.



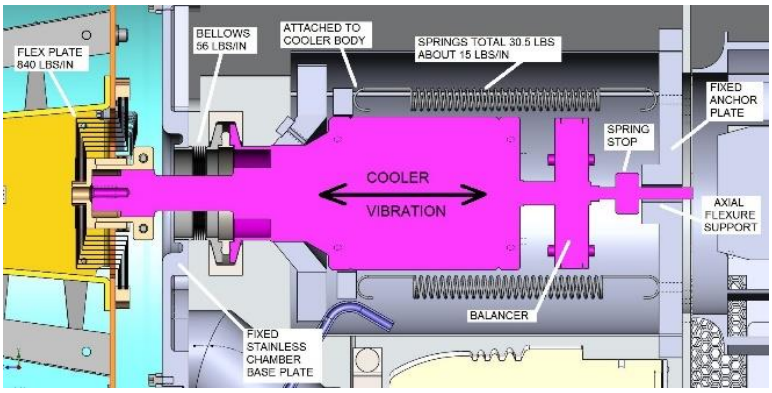
Passive Damper

Active Damper



Accelerometer Mounting A on external side of housing.

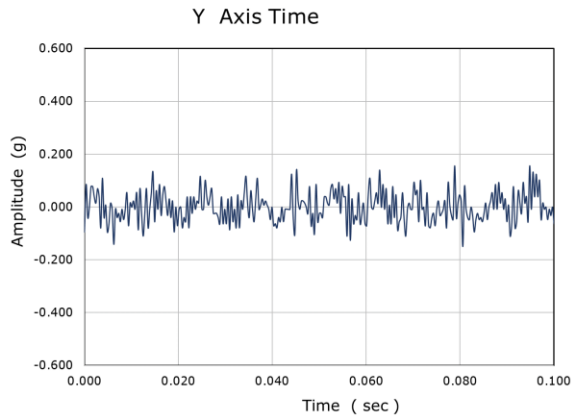
Mounting B on back of Dewar Base Plate



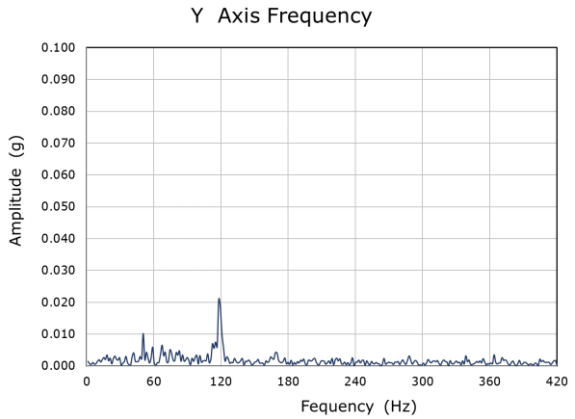
The Rigid Mounting was the original design with a solid tube between the Cooler and Dewar Base Plate. This provides good Cooler support, however axial vibration is able to move directly into the Base.

The bellows mounting isolates the cooller axis vibration.

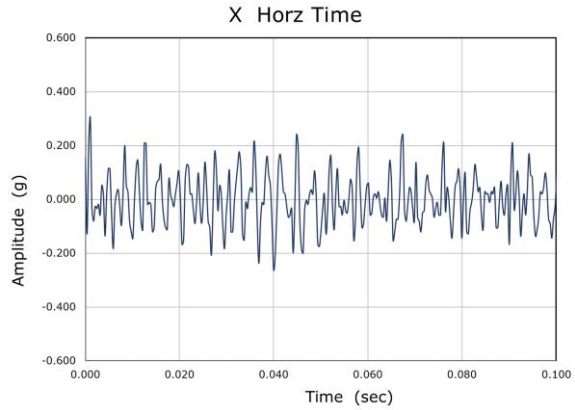
Bellows Mount Passive Dampener, Accelerometer mounting A. (very quiet, best ever to date)
Filename: 2018-12-06 13-36 018 BFD1TCP240w quiet.



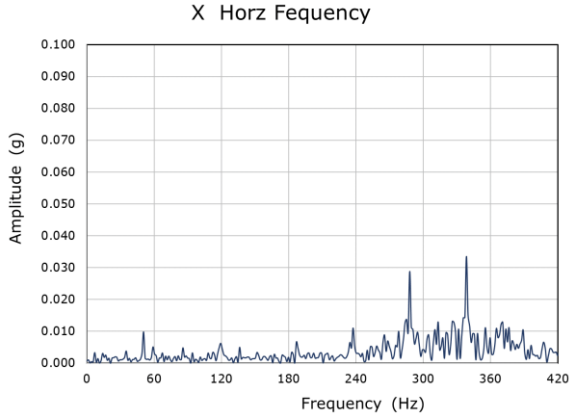
0.10 peak to peak



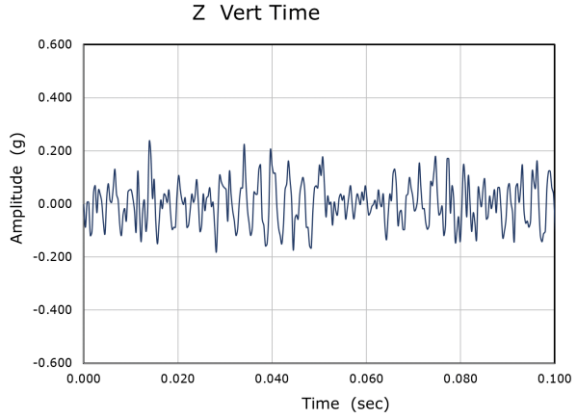
0.020 max at 120



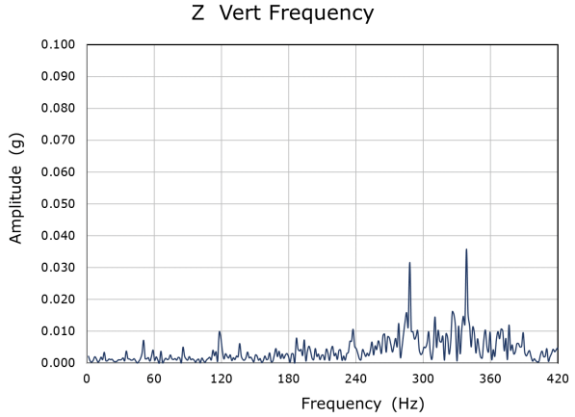
0.38 peak to peak



0.031 max at above 280

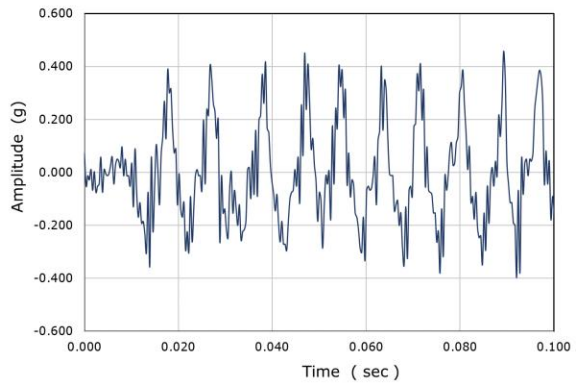


0.38 peak to peak

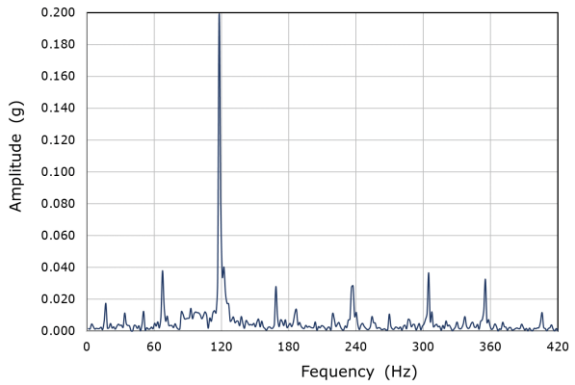


0.036 max at 280

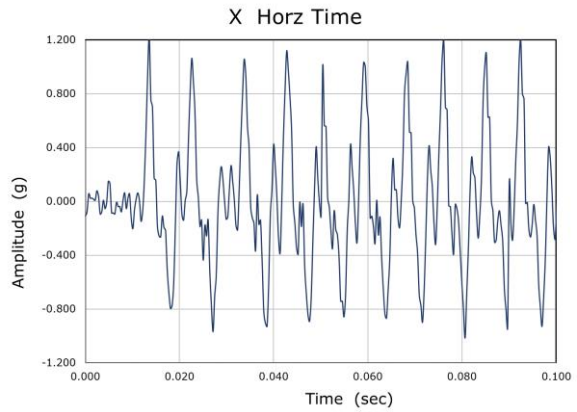
Bellows Mount Passive Dampener, Accelerometer mounting A. (very loud, heavy vibration)
Filename: 2018-12-06 13-50 019 BFD1TCP240w loud.



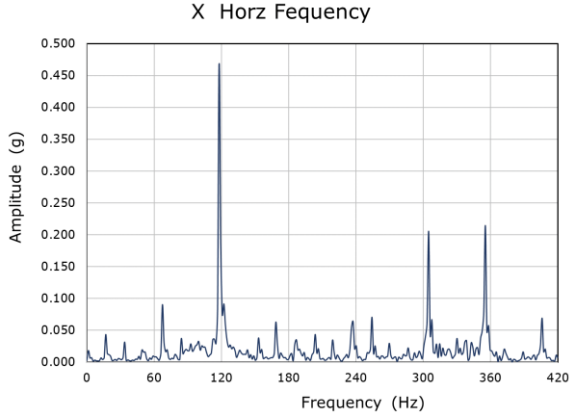
0.80 peak to peak



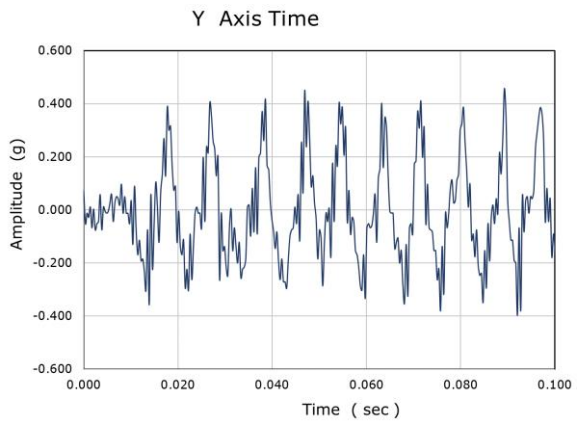
0.200 max at 120



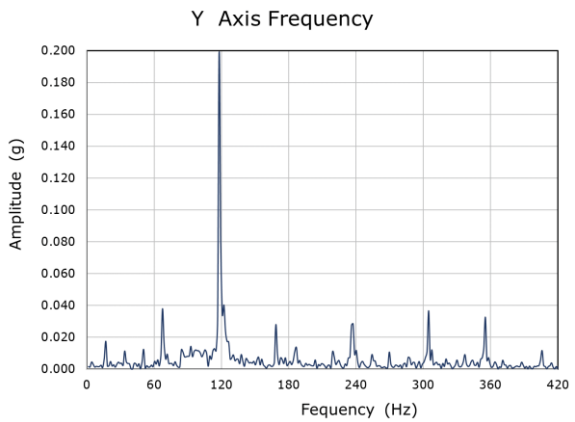
2.00 peak to peak



0.470 max at 120



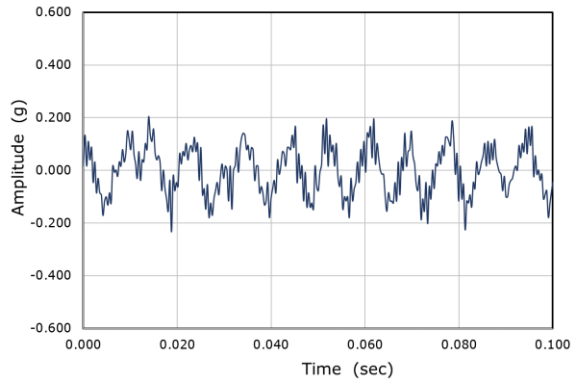
0.70 peak to peak



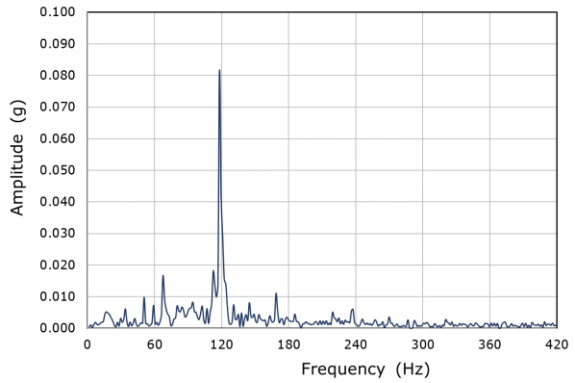
0.200 max at 120

Bellows Mount, Passive Damper, Feed 016, Accelerometer mounting B on Base Plate. (bellows passive)

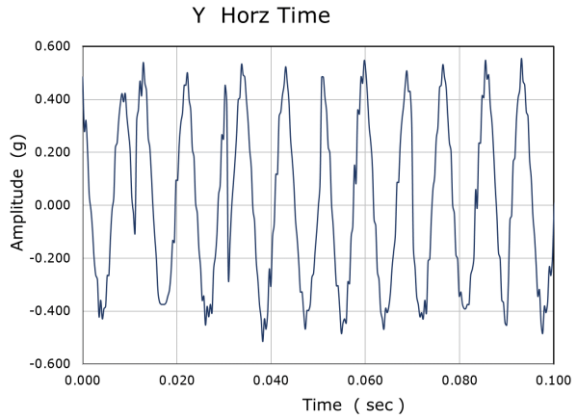
Bellows Mount Passive Dampener, Accelerometer mounting A. (very loud, heavy vibration)
Filename: 2018-12-07 16-09 SN-016 BFD1TCP200w



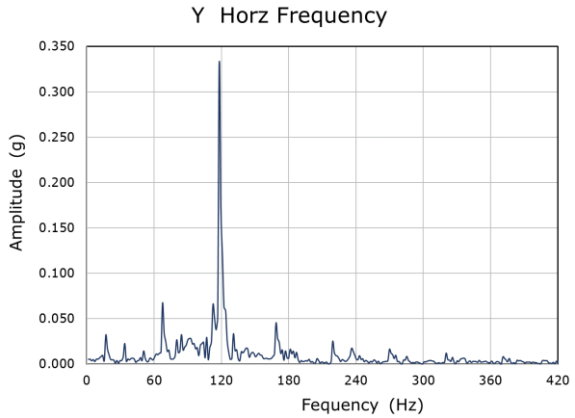
0.36 peak to peak



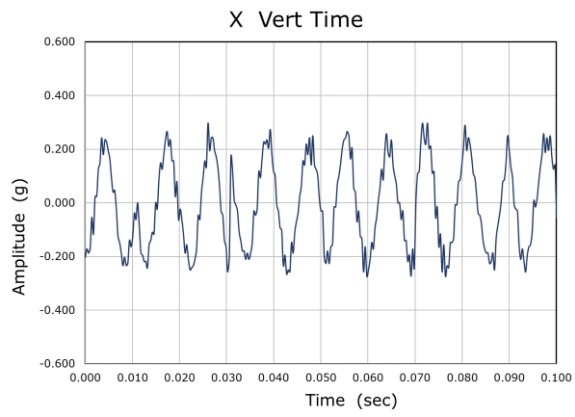
0.082 max at 120



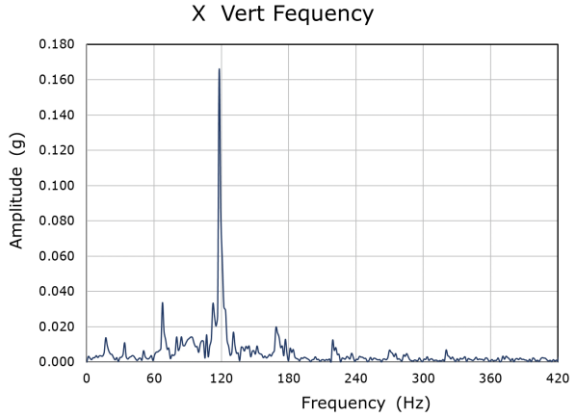
0.92 peak to peak



0.340 max at 120

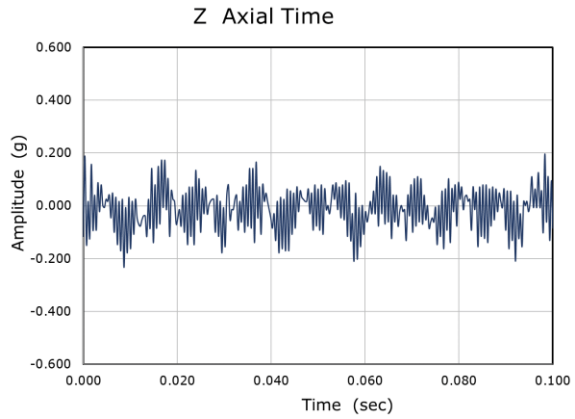


0.48 peak to peak

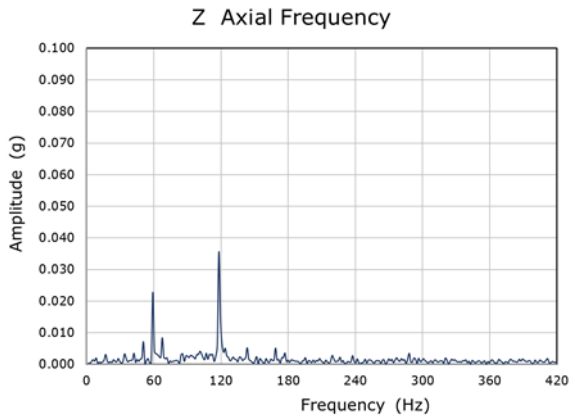


0.164 max at 120

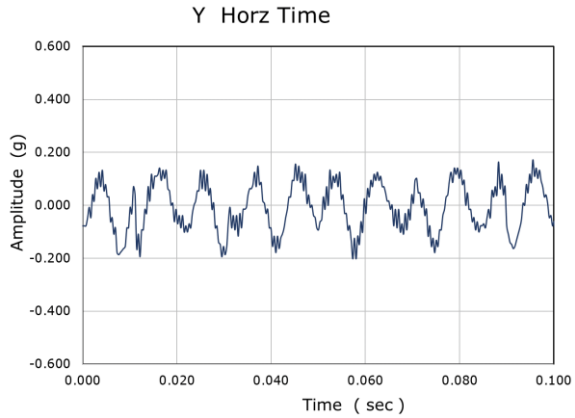
Bellows Mount, Active Damper, Feed 016, Accelerometer mounting B on Base Plate. (bellows active setup)
Filename: 2018-12-11 13-46 Feed 016 BFD1TCA250w calcs.xlsx



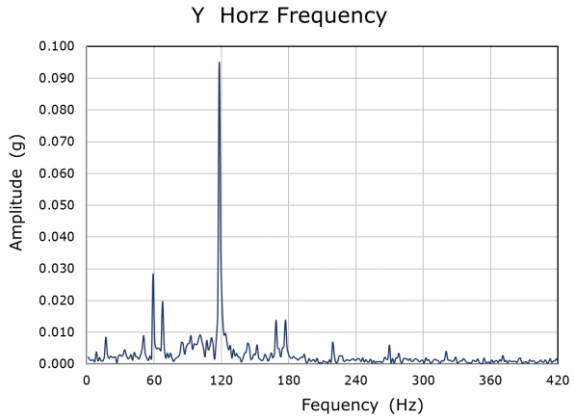
0.34 peak to peak



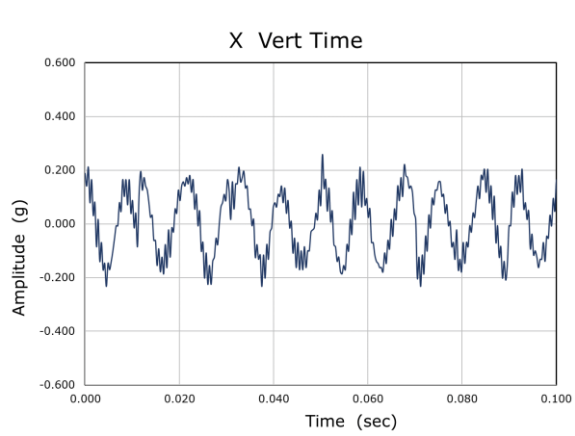
0.036 max at 120



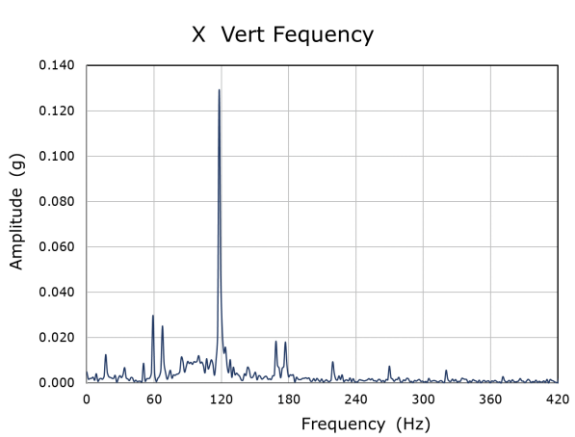
0.36 peak to peak



0.096 max at 120

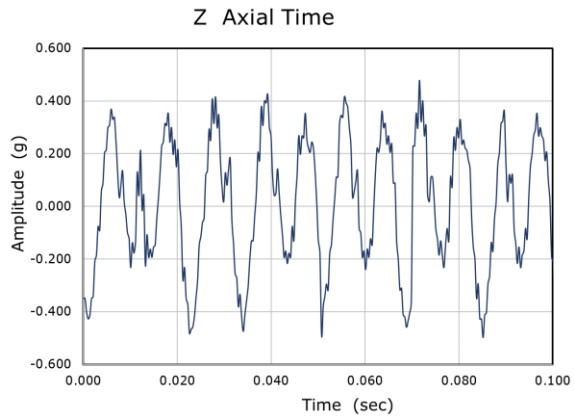


0.40 peak to peak

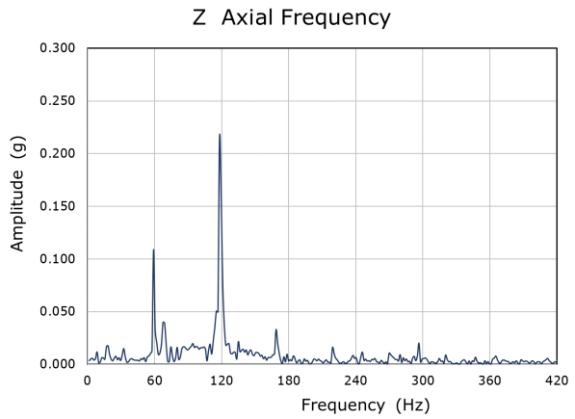


0.130 max at 120

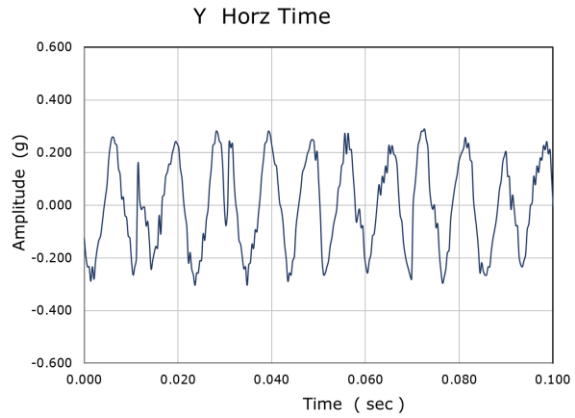
Rigid Mount, Passive Damper, Feed 016, Accelerometer mounting B on Base Plate. (rigid passive)
Filename: 2018-12-12 17-11 Feed 016 RFD1TCP238w calcs.xlsx



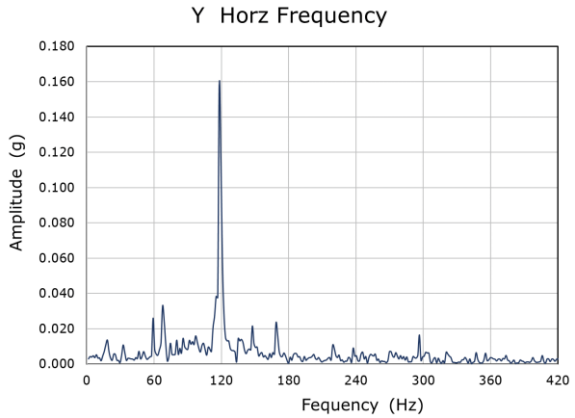
0.90 peak to peak



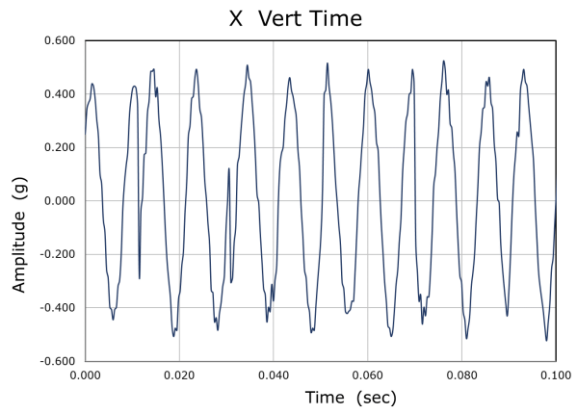
0.220 max at 120



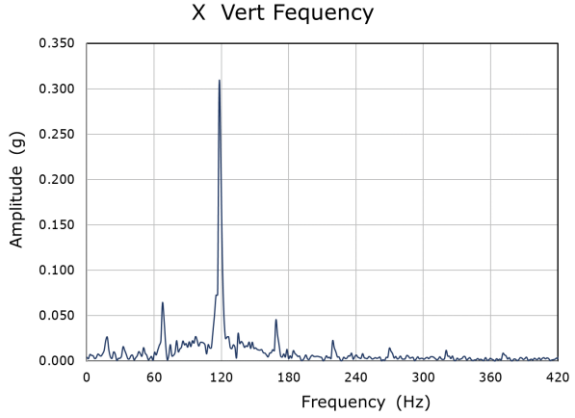
0.46 peak to peak



0.16 max at 120

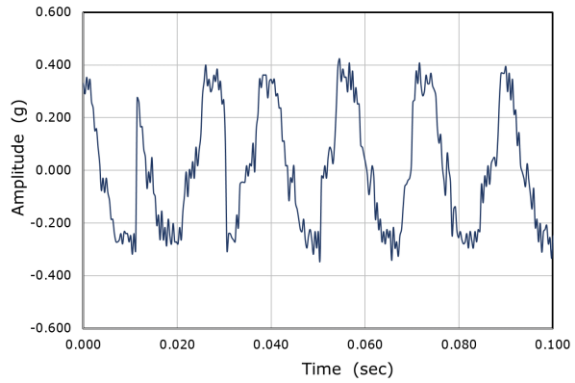


0.96 peak to peak

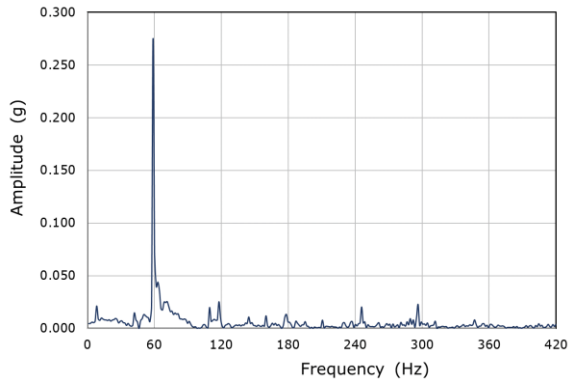


0.310 max at 120

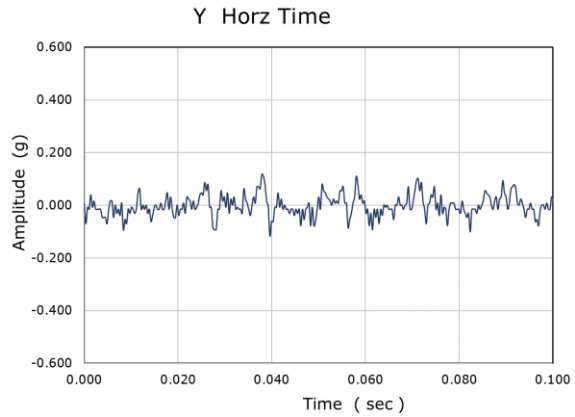
Rigid Mount, Active Damper, Feed 016, Accelerometer mounting B on Base Plate. (rigid active)
Filename: 2018-12-14 11-16 Feed 016 RFD1TCA238w calcs.xlsx



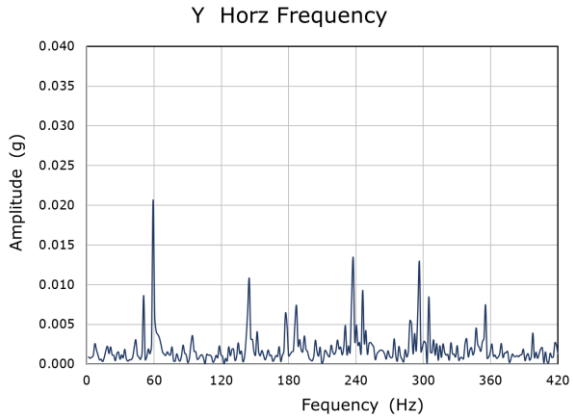
0.64 peak to peak



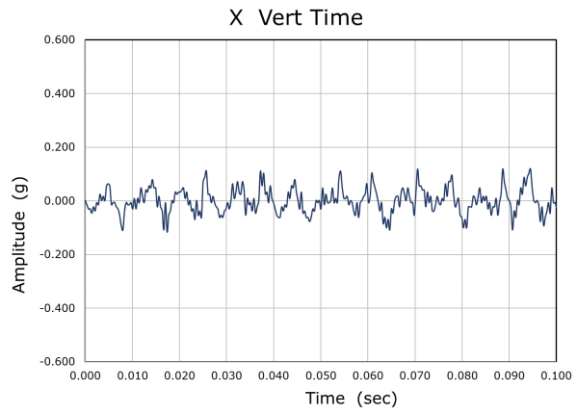
0.274 max at 60



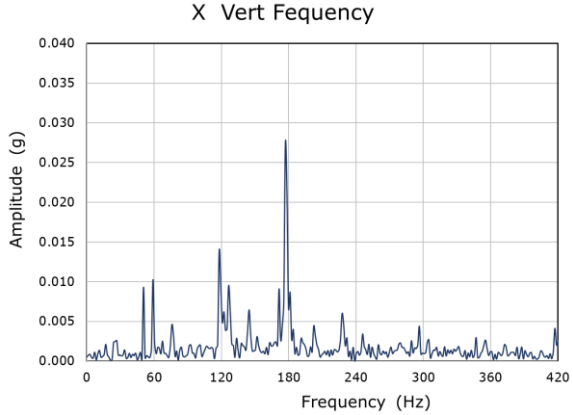
0.18 peak to peak



0.021 max at 60



0.20 peak to peak



0.028 max at 180