

TECHNICAL NOTE

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Document Title STIM300 Random Vibration "High Performance Aircraft"			

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1 Summary

The Vibration Rectification Coefficient (VRC) of STIM300 (8 units, 10g version) has been characterized using random vibrations in accordance to MIL-STD 810E 514.4-8 "High Performance Aircraft". The results are in accordance to the STIM300 datasheet TS1524 rev.24.



2 Objective

Measure the vibration rectification coefficient (VRC) of STIM300 gyro and accelerometers when exposed to random vibrations.

3 Method

Perform the following sequence is performed on 8 STIM300:

- Mount STIM300 on shaker-table, oriented so that acceleration (Grms=14.83) will be applied in X, Y, Z-direction
- No vibration applied: 15min
- Vibration: 15min
- No vibration applied: 15min
- Vibration: 15min
- No vibration applied: 15min
- Calculate average of the individual test sections
- Calculate VRC according to equation 1

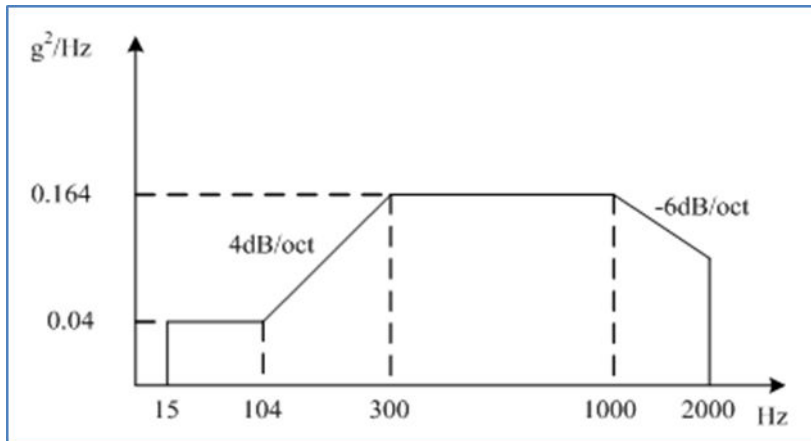


Figure 1: Random vibration spectrum: MIL-STD 810E 514.4-8 "High Performance Aircraft"

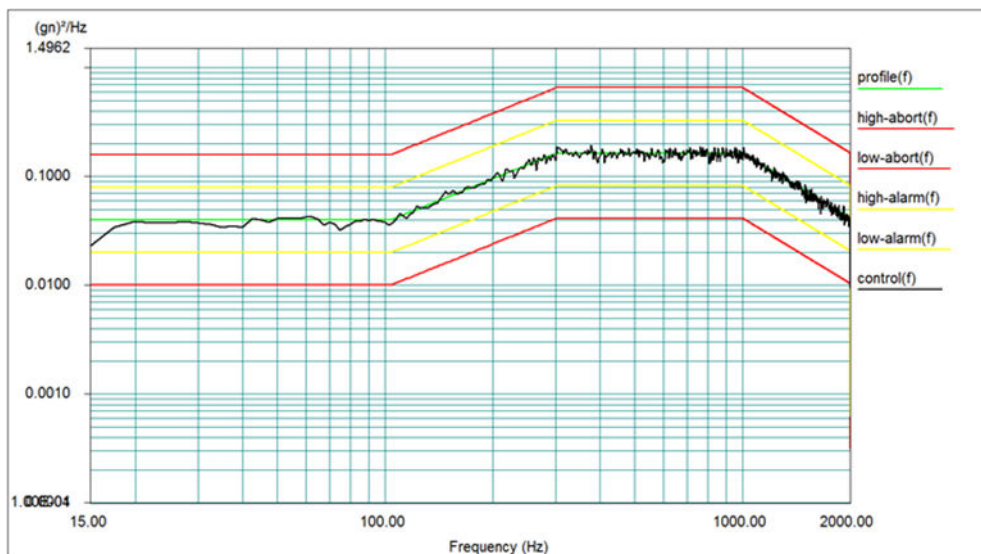


Figure 2: Spectrum during test

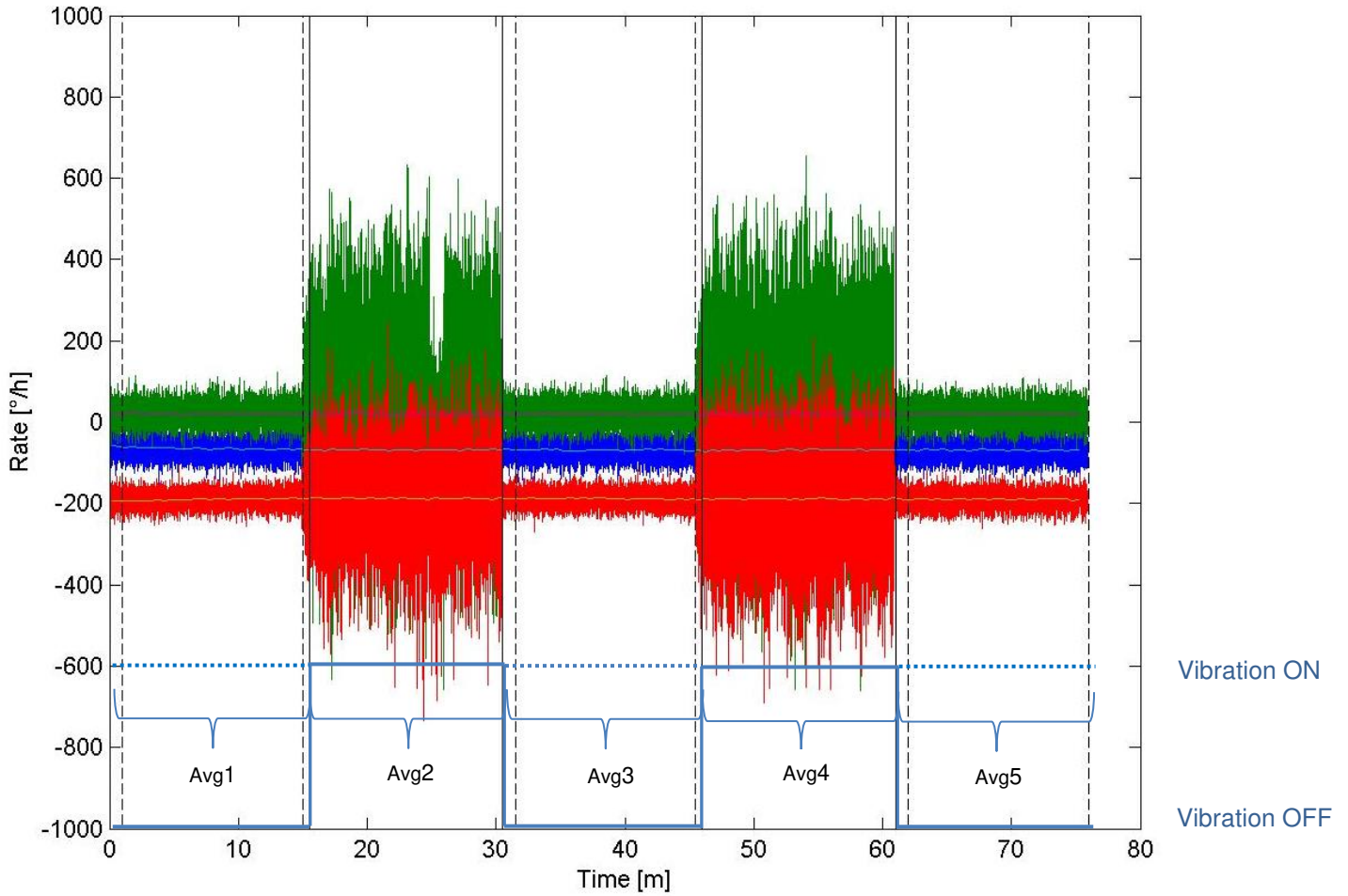


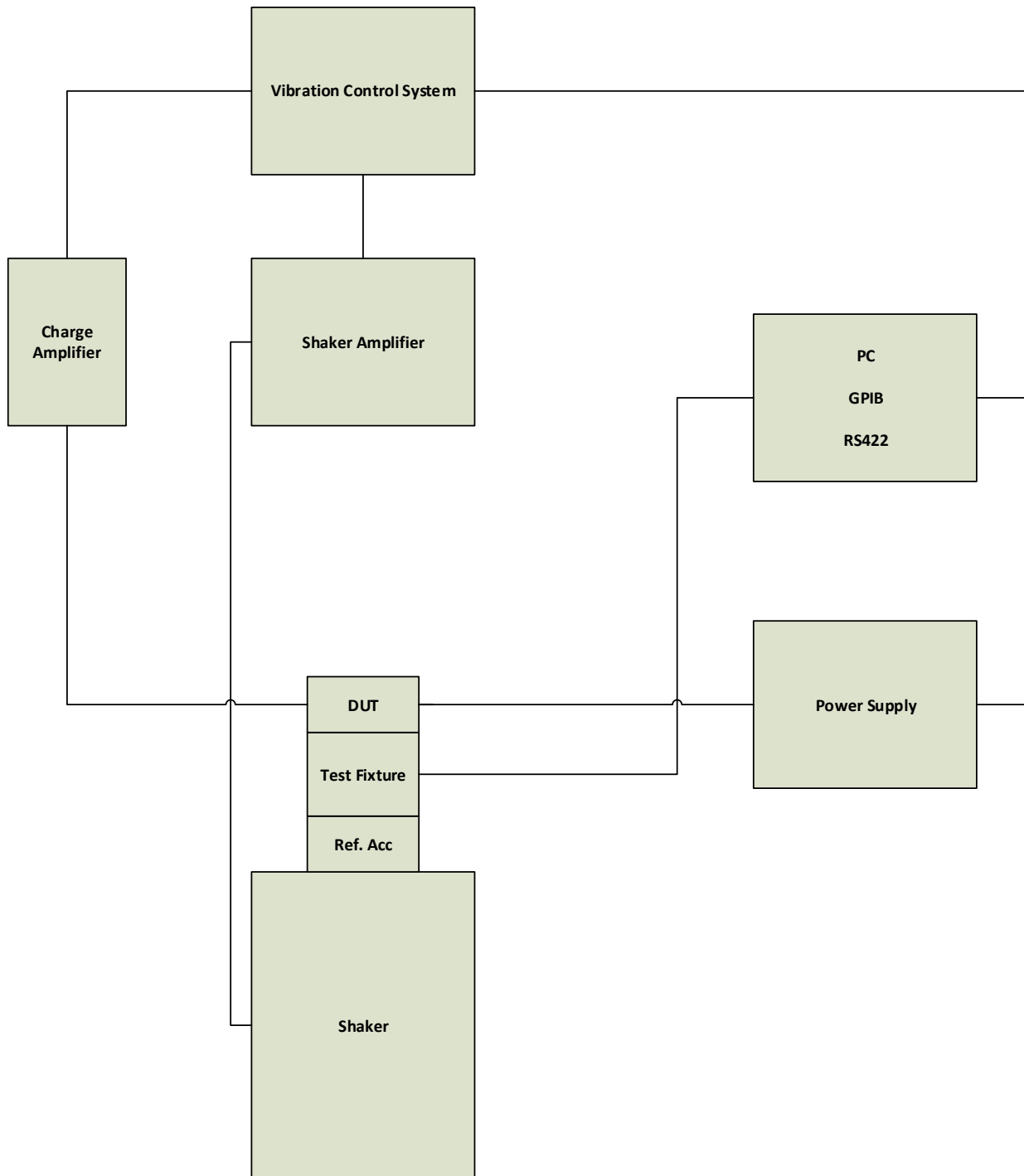
Figure 3: Example of random vibration test sequence (gyro)

Equation 1: Calculation of VRC

$$VRC = ABS \left[\frac{(Avg2 - Avg1) + (Avg2 - Avg3) + (Avg4 - Avg3) + (Avg4 - Avg5)}{4} \right] \cdot g_{2rms} \quad [^{\circ}/h/g_{2rms}]$$



4 Test setup



4.1 Test equipment

Equipment	Description	SEN No
LDS V725	Shaker	420529
LDS DPA4	Shaker amplifier	420008
LDS Dactron Comet	Vibration control system	420719
Bruel & Kjør	Conditioning amplifier	420478
HP	PC	51671
Agilent E3631A	Power Supply	420568



5 Material

The following STIM300 -10g were measured:

- N25581707828426
- N25581647653616
- N25581647653599
- N25581647653622
- N25581710876797
- N25581707829519
- N25581710876769
- N25581710876772

6 Results

6.1 Gyro results

The gyros are sensitive to acceleration-forces in its z-direction:

- X- and Y-gyros have their highest sensitivity to vibrations in z-direction
- Z-gyro has its highest sensitivity to vibrations in y-direction

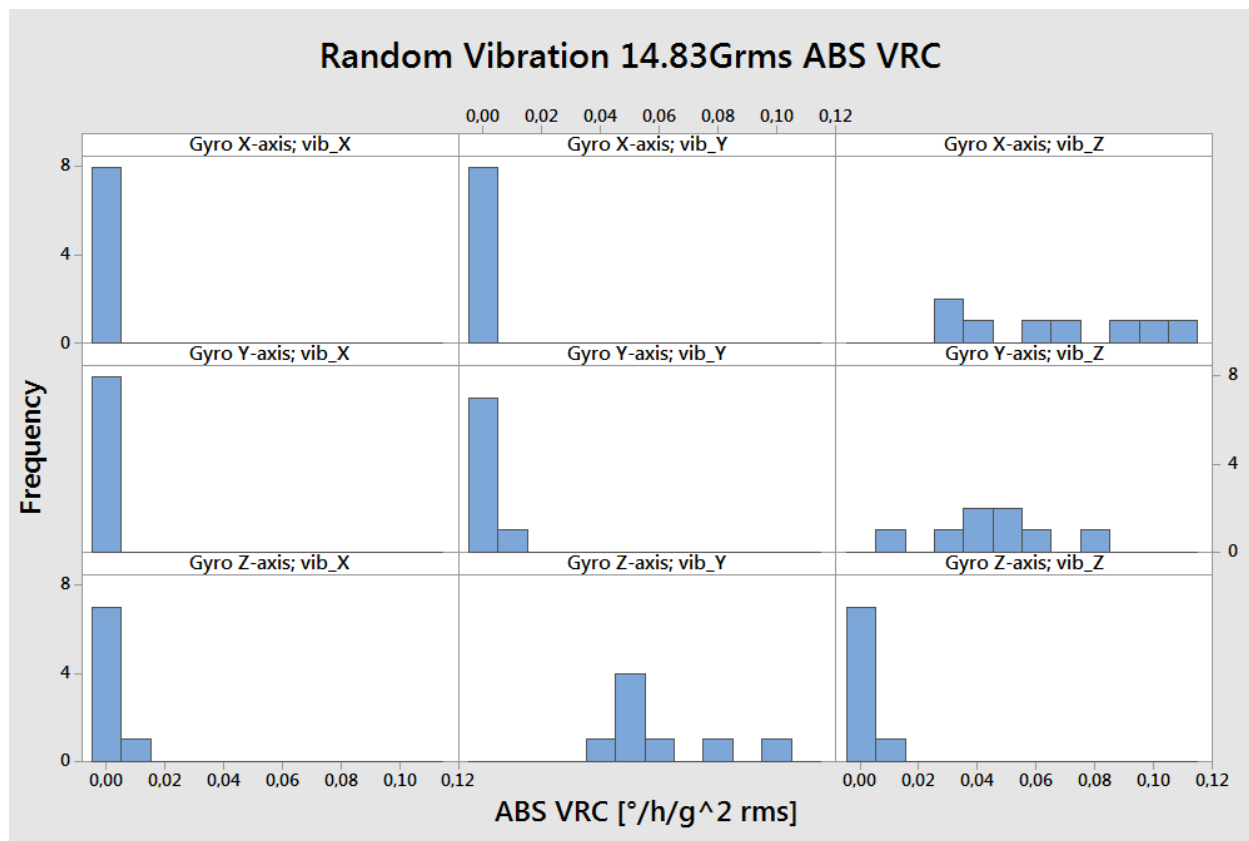


Figure 4: VRC results of STIM300 gyro



Direction of vibration	X-Gyro avg VRC [$^{\circ}/h/g^2rms$]	Y-Gyro avg VRC [$^{\circ}/h/g^2rms$]	Z-Gyro avg VRC [$^{\circ}/h/g^2rms$]
X	0.001	0.001	0.002
Y	0.002	0.002	0.059
Z	0.066	0.047	0.002

Table 1: Gyro VRC results

6.2 Accelerometer results

The accelerometers have their highest sensitivity to acceleration-forces in their own direction as shown in figure 5.

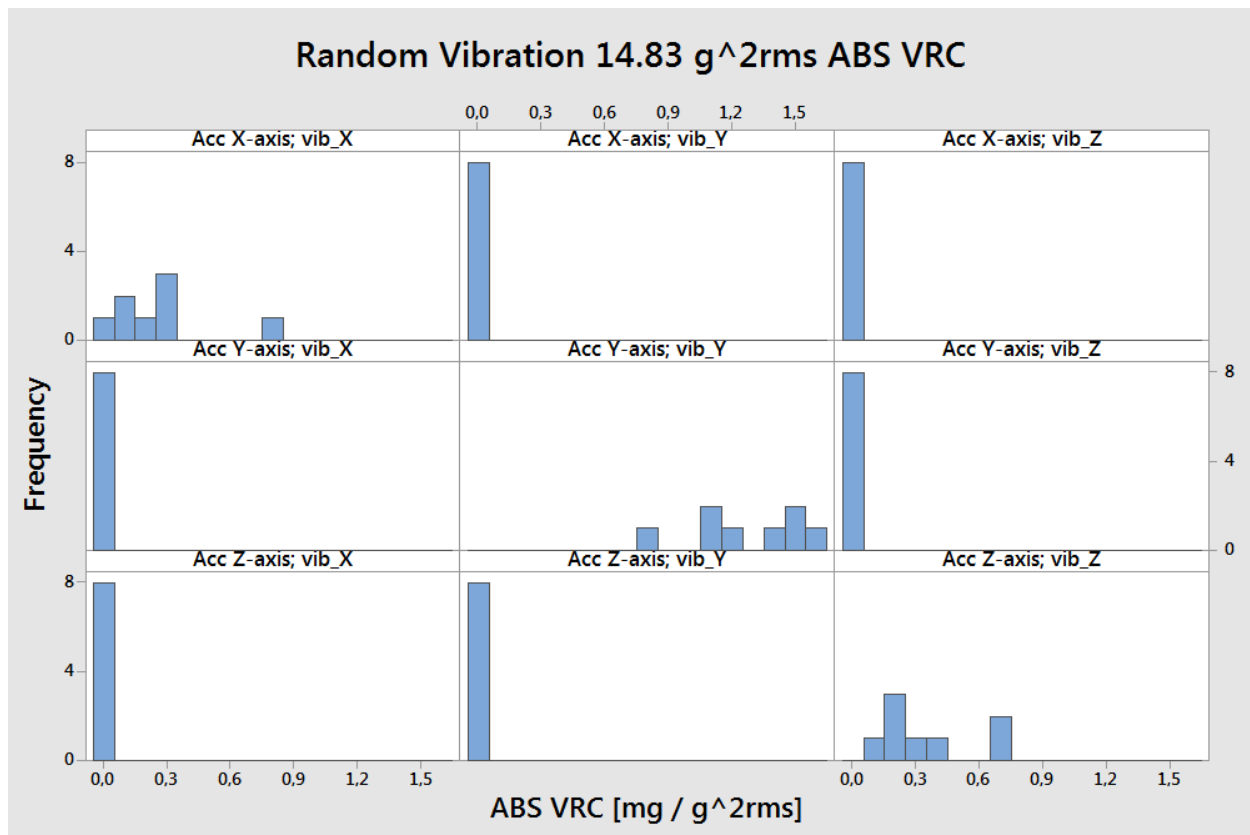


Figure 5: VRC results of STIM300 Accelerometer

Direction of vibration	X-Acc avg VRC mg/g ² rms]	Y-Acc avg VRC mg/g ² rms]	Z-Acc avg VRC mg/g ² rms]
X	0.279	0.002	0.003
Y	0.007	1.273	0.003
Z	0.004	0.002	0.347

Table 2: Acc VRC results



6.3 Discussion of results

Applying the "High Performance Aircraft" random vibration profile resulted in a VRC of $0.066^\circ/\text{h}/\text{g}^2\text{rms}$. This profile is dominated by frequencies in the range 300-1000Hz range. The results match well with the VRC (@5g sinusoidal) specification in STIM300 datasheet TS1524 rev.24 ($0.06^\circ/\text{h}/\text{g}^2\text{rms}$ @ 1000Hz). The VRC increases with increasing frequency and is constant in the g-range of 5-20g).

As indicated the accelerometers have their largest VRC in their own direction, ref. figure 5. The VRC of $1.27 \text{ mg}/\text{g}^2 \text{ rms}$ match well with the VRC specification in the datasheet, $0.5 \text{ mg}/\text{g}^2 \text{ rms}$ @ 1000Hz and $1.4 \text{ mg}/\text{g}^2 \text{ rms}$ @ 2000Hz (@ 10g sinusoidal).

7 Conclusion

The results are in accordance to the expectation based on the datasheet TS1524 rev.24. Measurements show that the gyro sensing element is sensitive to vibrations only in its z-direction, ref. table 1. As a result of how the three gyros are mounted in the IMU, all gyros will be insensitive to vibrations in the x-direction of the IMU.

The accelerometers have their largest VRC to acceleration-forces in their own direction, ref table 2.