EUROPEAN UNION
European Regional Development Fund

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Project Name:

Sunset LED Specification test sheet

Test Case ID: BDCSUNSET02VIB

Test Title: Operating Vibration range evaluation

Description: Testing Sunset prototype LEDs to evaluate it works consistently under constant vibration Between 10Hz and 50Hz

Test Designed by: Adenowo Gbadebo

Test Designed date: 11 Feb 2019

Test Executed by: Adenowo Gbadebo

Test Execution date: 18 Mar – 22 Mar 2019

Test Conditions and parameters:

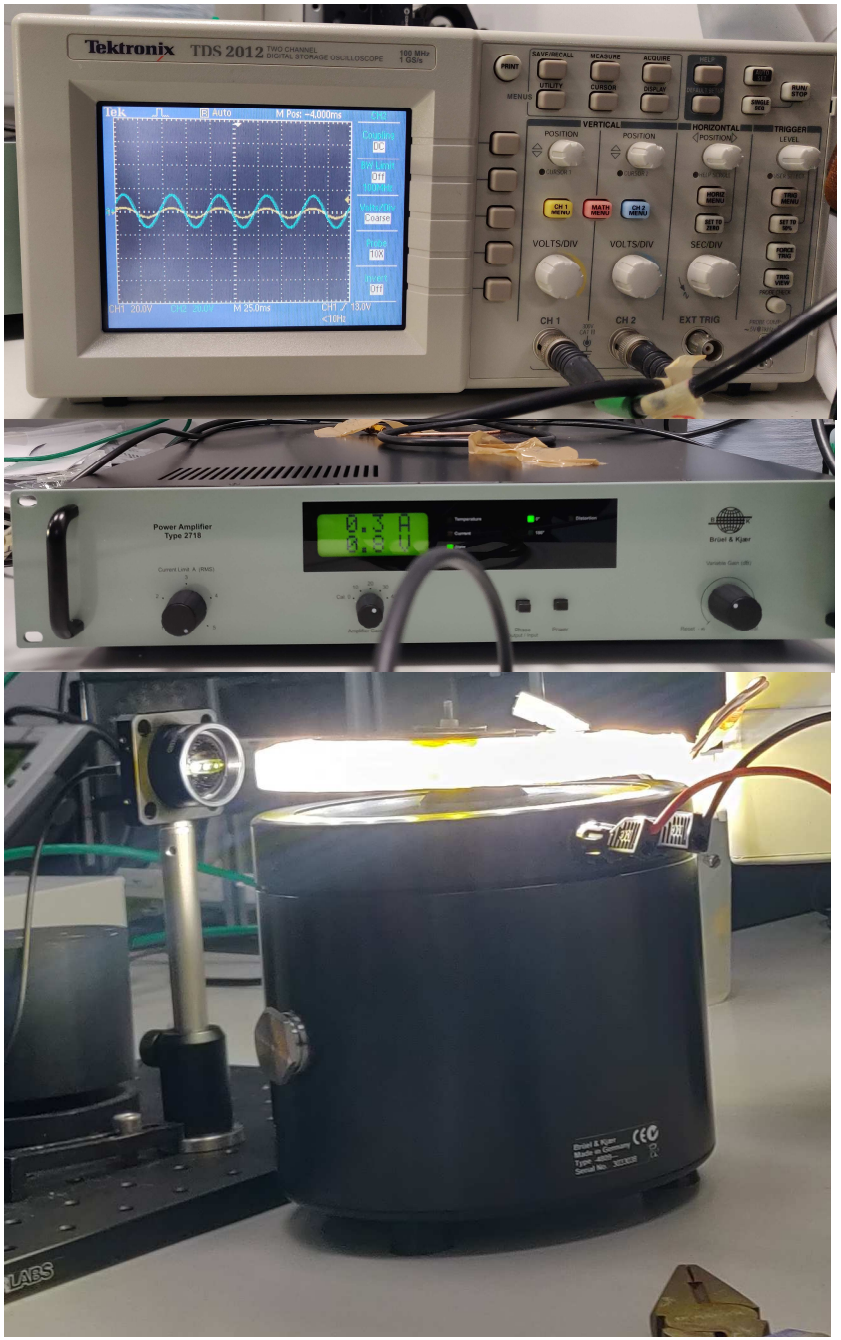
- The LED was exposed to frequencies between 10 and 50Hz at different intensities matching the prominent vibration frequencies generated by trains when they pass a point on a rail track.
- The time was gradually increased from 5 mins to 1 day (overnight experiments were not run for health and safety reasons).
- The LED was measured during vibration.
- Due to the vibration of the entire setup some random frequencies were observed in the data measured.
- The measurements were then plotted on a color map that make fluctuations in parameter obvious from inspection
- The data's Fourier transform was plotted as color maps
- Measurements were taken every 10 ms
- To reduce the criticality of alignment across experiments that data is normalized
- The quantity is the velocity of the vibration in mm/s or the velocity level in dB reference 1 nm/s. The perception level of the equipment to vibration is across a wide range. Nearly feasible vibrations which lies around 0.1 mm/s of the floor where the equipment is attached is most important as this are the quantities that apply the most physical stress on the equipment. Vibrations in the magnitude of 0.01 to 0.03 mm/s (velocity levels of 80 - 90 dB) lie just below this level [1].
- The frequency range between 10 Hz and 50 Hz are the most dominant frequencies generated on a rail track [1] and for non-continuous vibrations a 3 (0.3nm/s) to 10 (10 nm/s) dB higher transfer factor is a conservative assumption for vibrations of passing trains.
- The assumptions and parameters tested are listed below
    - Magnitudes measured - 3/4/7/10dB
    - Frequencies measured - 10/20/30/40/50Hz
    - Length of train assumed - 4.2Km of train
    - Speed if train assumed - 140km/h (38m/s)

1. Leeuwen HJA Van, Zwienen AC Van. The determination of railway vibrations levels in practice. *Internoise 2016*. 2016:2110-2118.

Step	Test Steps	Expected Result	Actual Result	Status (Pass/Fail)	Notes
1	LED mounted on Vibration table	No variation in LED performance when LED experiencing vibration	No variation in LED performance when LED vibrated	Pass	There is increased vibration of the environment as the frequency reduces which then vibrates the photo diode and introduces slight errors to the measurements
2	LED measured before during and after vibration	No variation in LED performance	No variation in LED performance	Pass	The color maps show the frequencies extracted from analyzing the captured data. This is a match with set vibration frequency. It also shows no effect on the intensity of the light.
3	Captured data was analysed using FFT	The frequencies observed in the FFT should match the vibration frequencies set during experiments	The frequencies observed in the FFT should match the vibration frequencies set during experiments	Pass	The capture rate was at about 48Hz which introduced an error to data captured at 50Hz. Due to a slight jitter in data capture the average measured capture rate was used. This introduced a slight drift to some measurements

Post-conditions:

- The frequency extracted from analyzing the captured data is a match with set vibration frequency. It also shows no effect on the intensity of the light.
- Measurements were taken every 10 ms
- Measurements were saved on a computer using a photodiode, amplifier and Arduino



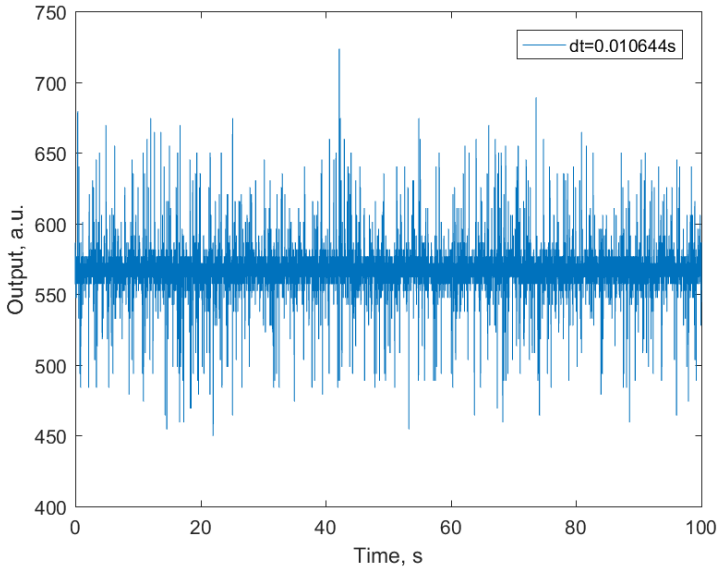


Figure 1 100s sample of data captured vibrating at 10Hz and 3,4,7,10 dB (1 hour each) captured every 10ms (avg.)

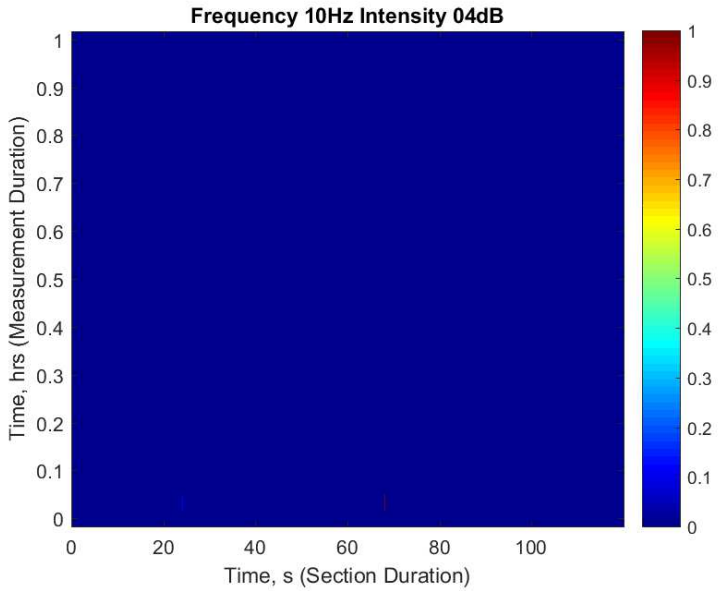


Figure 2 vibrating at 10Hz and 4dB LED intensity (1 hour): Single blue color indicates constant output of LED

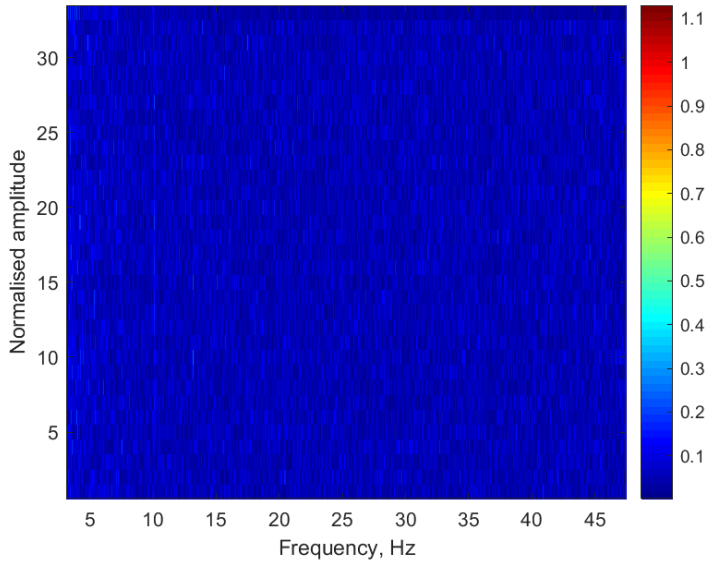


Figure 3 vibrating at 10Hz and 3,4,7,10 dB (1 hour each): A faint line can be seen at 10Hz

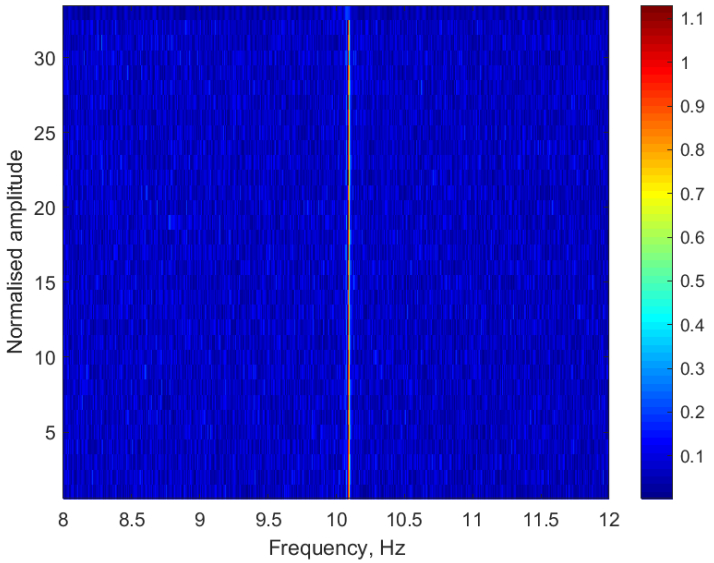


Figure 4 vibrating at 10Hz and 3,4,7,10 dB (1 hour each): zoomed in to 10Hz

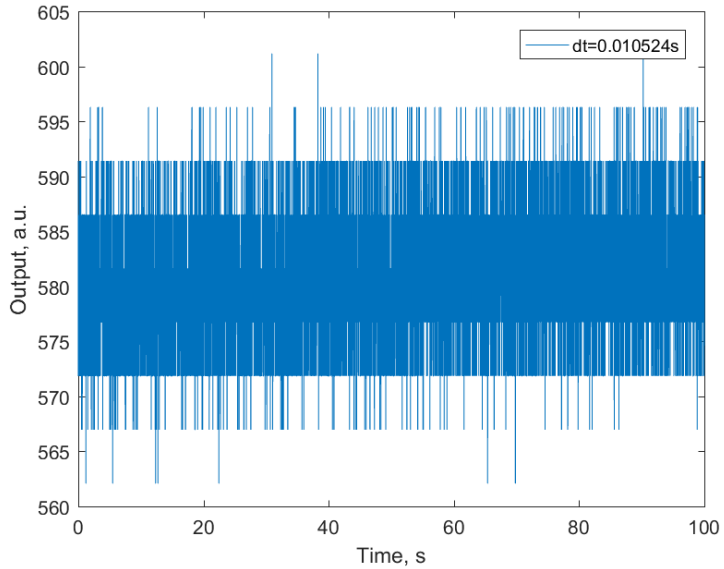


Figure 5 100s sample of data captured vibrating at 20Hz and 3,4,7,10 dB (1 hour each) captured every 10ms (avg.)

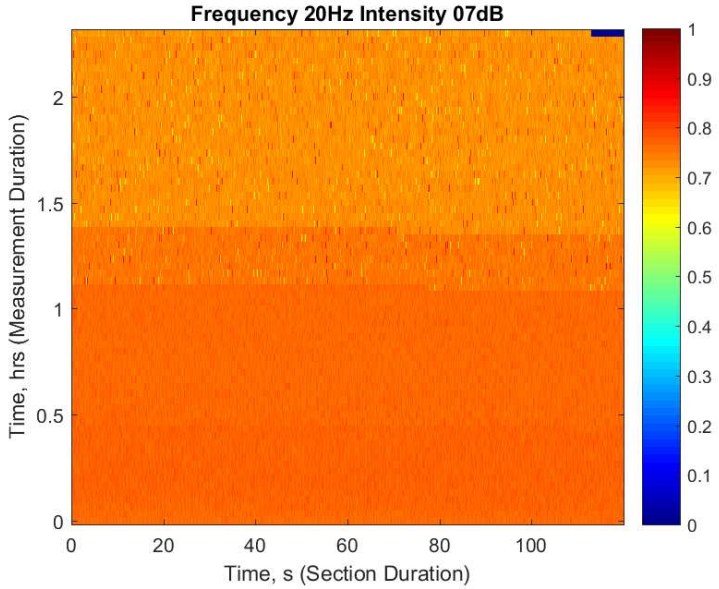


Figure 6 vibrating at 20Hz and 7 dB LED intensity (1 hour): Layers of orange due to a change in parameter during data capture

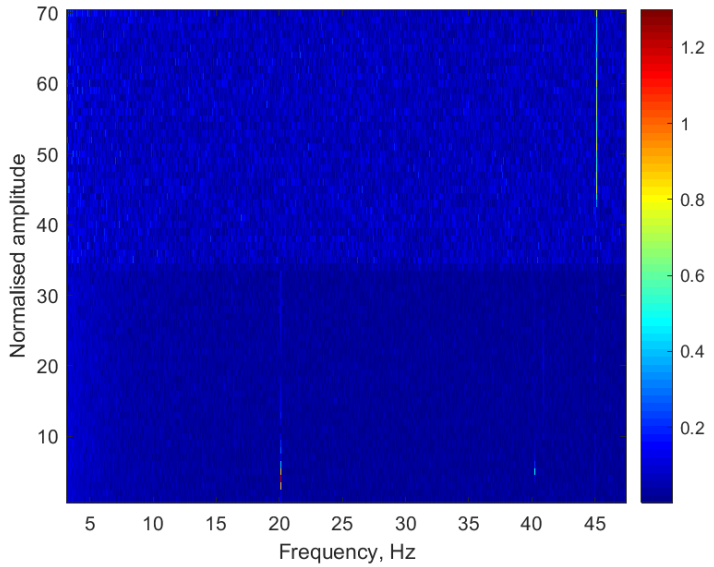


Figure 7 vibrating at 20Hz and 3,4,7,10 dB (1 hour each): A faint line can be seen at 20Hz

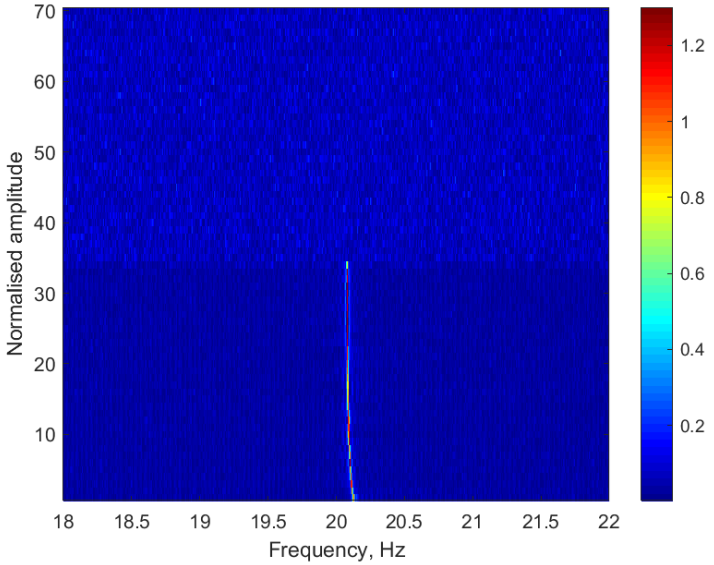


Figure 8 vibrating at 20Hz and 3,4,7,10 dB (1 hour each): zoomed in to 10Hz

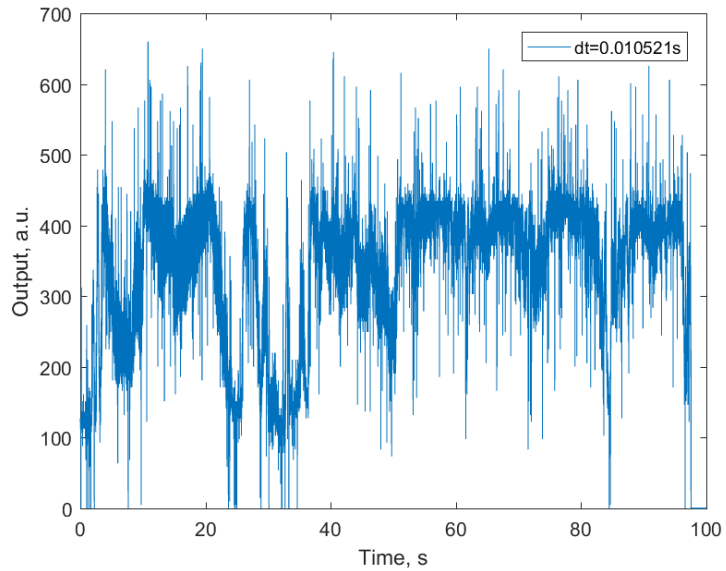


Figure 9 100s sample of data captured vibrating at 30Hz and 3,4,7,10 dB (1 hour each) captured every 10ms (avg.)

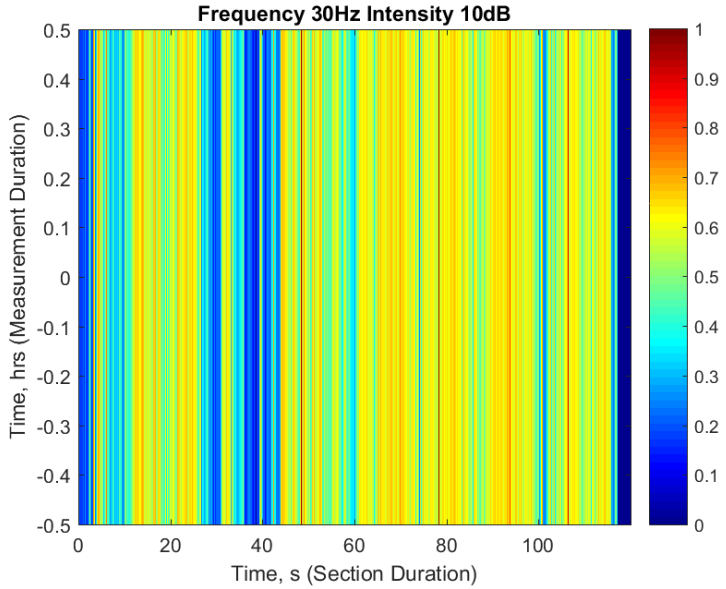


Figure 10 vibrating at 30Hz and 10 dB LED intensity (1 hour): Multiple vertical colors shows a consistent fluctuation in intensity due to magnitude (speed) of vibration

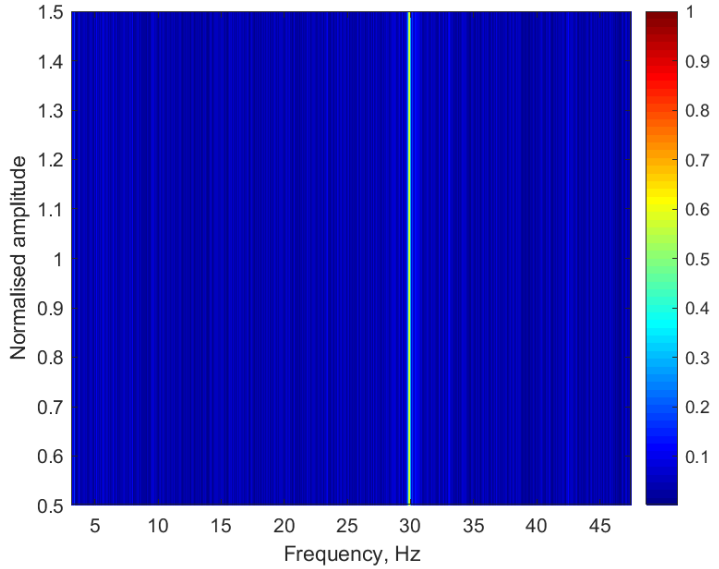


Figure 11 vibrating at 30Hz and 10 (3,4,7) dB (1 hour each): A line can be seen at 30Hz

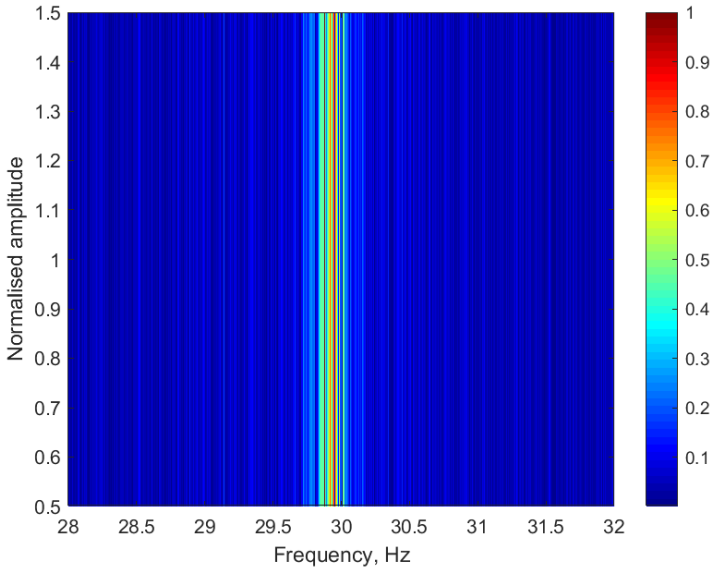


Figure 12 vibrating at 30Hz and 10 (3,4,7) dB (1 hour each): zoomed in to 30Hz

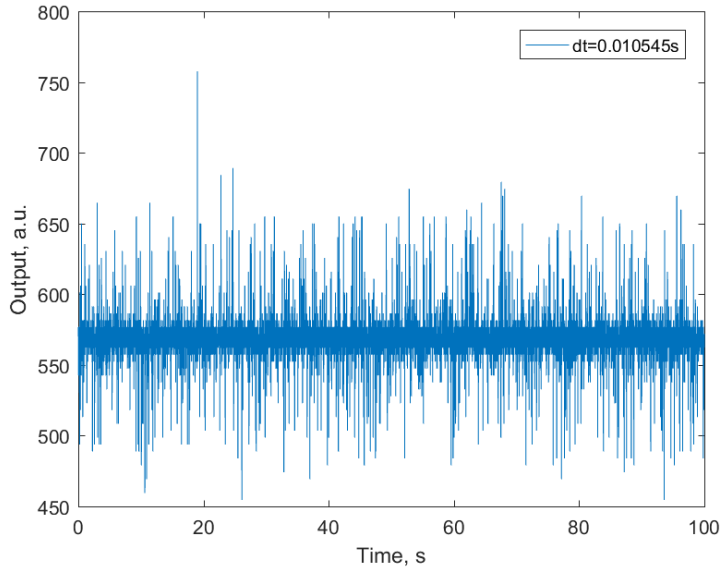


Figure 13 100s sample of data captured vibrating at 40Hz and 3,4,7,10 dB (1 hour each) captured every 10ms (avg.)

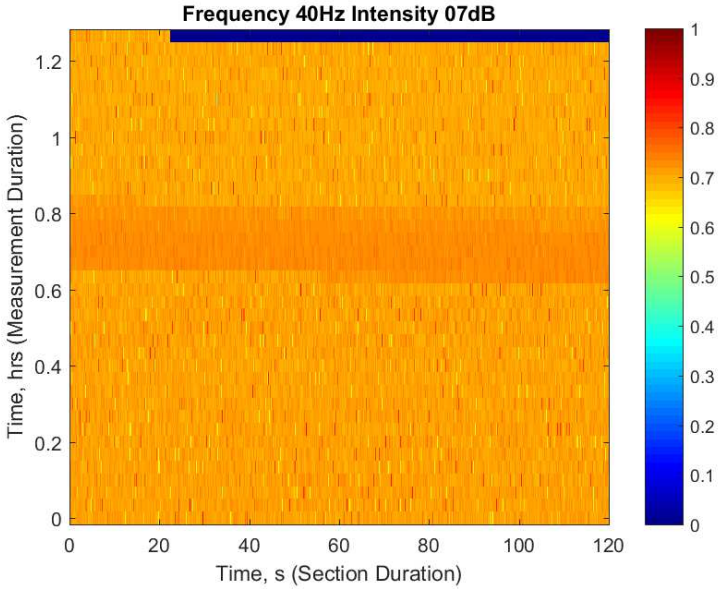


Figure 14 vibrating at 40Hz and 7 dB LED intensity (1 hour): Uniform orange color due to constant intensity. Blue patch is 0 padding with no data

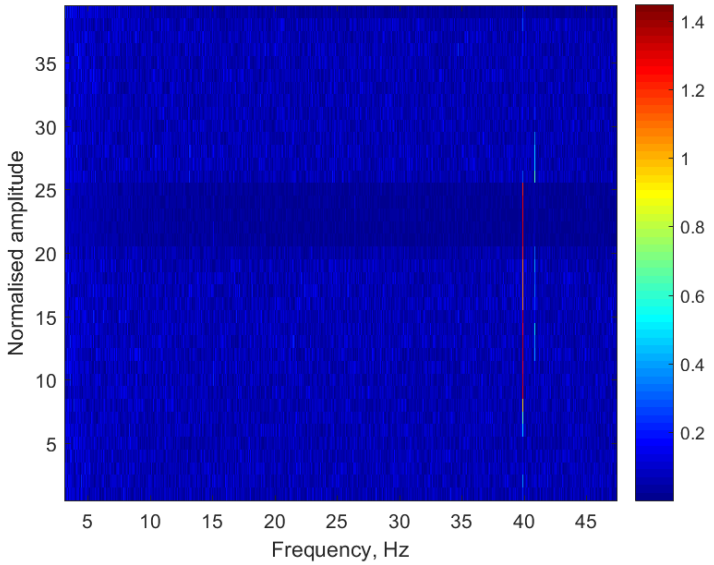


Figure 15 vibrating at 40Hz and 7 (3,4,10) dB (1 hour each): A line can be seen at 40Hz

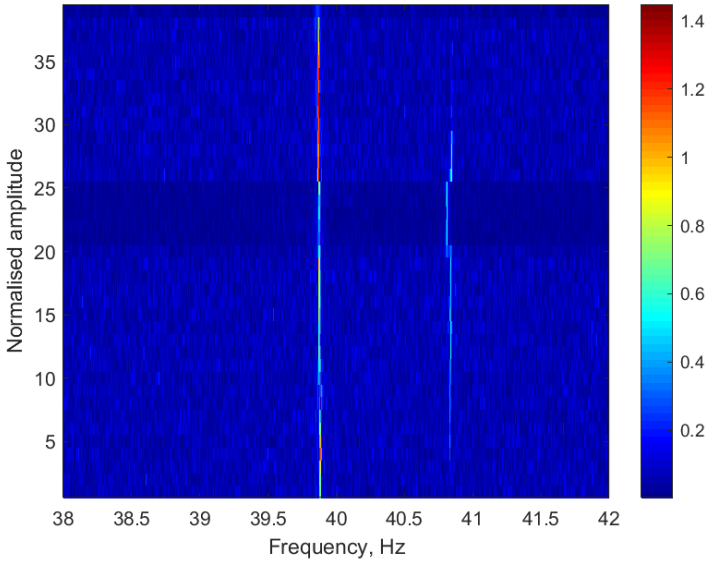


Figure 16 vibrating at 40Hz and 7 (3,4,10) dB (1 hour each): zoomed in to 40Hz

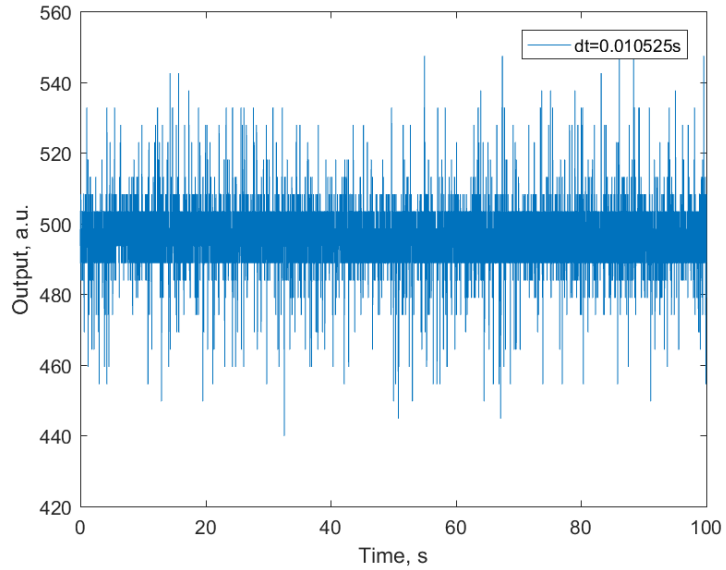


Figure 17 100s sample of data captured vibrating at 50Hz and 3,4,7,10 dB (1 hour each) captured every 10ms (avg.)

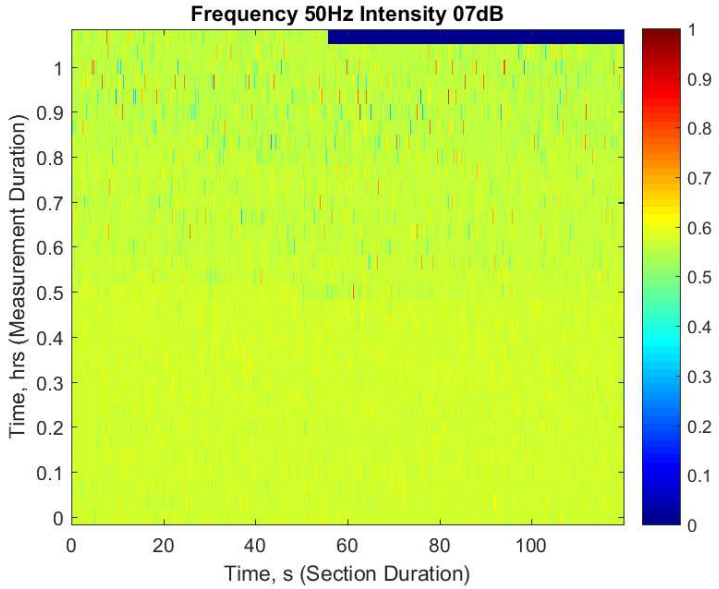


Figure 18 vibrating at 50Hz and 7 dB LED intensity (1 hour): green color due to constant intensity. Blue patch is 0 padding with no data

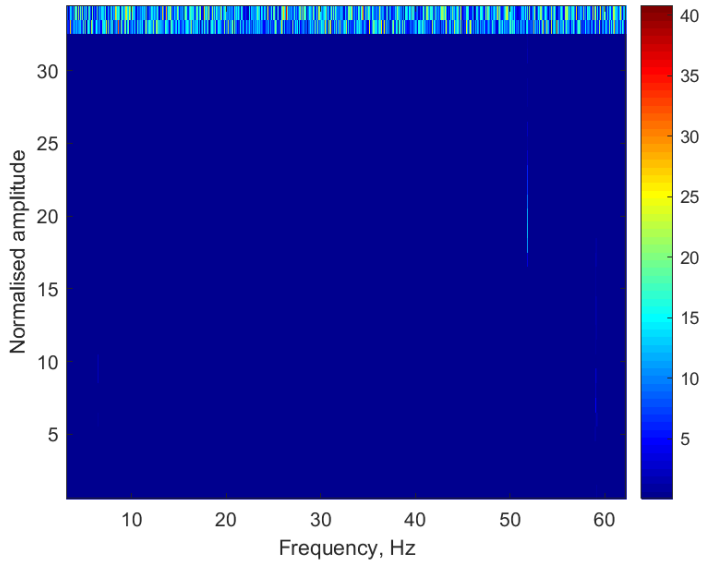


Figure 19 vibrating at 50Hz and 7 (3,4,10) dB (1 hour each): A line can be seen at 50Hz

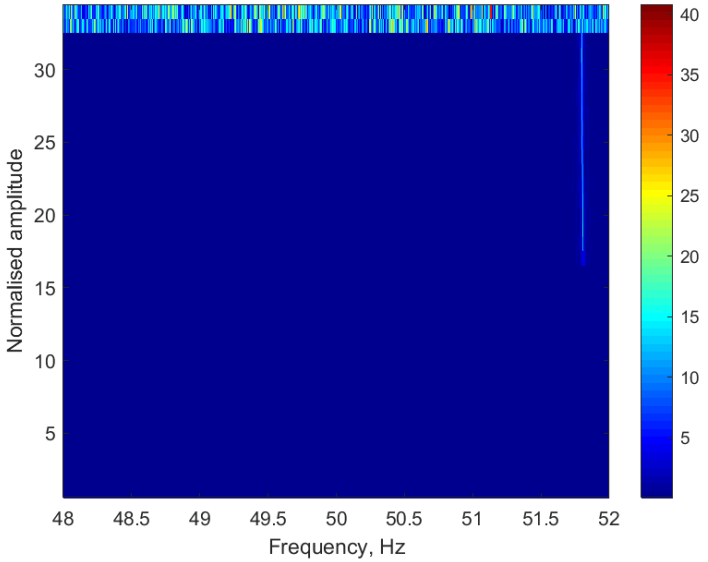


Figure 20 vibrating at 50Hz and 7 (3,4,10) dB (1 hour each): zoomed in to 50Hz