

# Power-line measurements in 116 Prospect House, Princeton University

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## 1 Purpose

Purpose of the document is to find how good/bad is a power-line of a normal house. It visually compares measurements to measurements from power-line in E-quad lab.

The measurements are from a house with no inhabitants and hence there were no appliances or devices to be turned on for test measurements.

## 2 Conclusion

1. It is not convincing(at present) that one location is sufficient to detect the state of all the appliances(in the current experiments –light bulbs) in the house
2. The noise in home looks considerably lower than from E-quad

## 3 Measurement

**Data Captures.** Two traces each for a duration of 30 minutes were captured from ground floor and top (2nd) floor of the house. These are for analysis, but at present not clear how helpful this would be. There are shorter traces of 3 minutes that were captured which are presented below.

**Experiment Design.** There was a laptop and a raspberry Pi that were plugged into the wall-port near the measurement apparatus. Apart from it the lighting lamps on different floors were turned on and off at approximately 16 seconds interval to see observable differences in the spectrograms.

Events	Time (On)	Time(Off)
Laptop	16 sec	192
Ground Floor first room light panel	32	176
Ground Floor bulb(1)	48	160
Ground Floor light panel	64	144
Middle stairs bulbs(3)	72	128
Top Floor Stair light bulbs(2)	96	112

Table 1: Table showing list of Events generated and time(in seconds) when the measurements are done on ground floor(First room) of the house, corresponding to Figure 1

## 4 Results

### 4.1 Ground Floor measurements

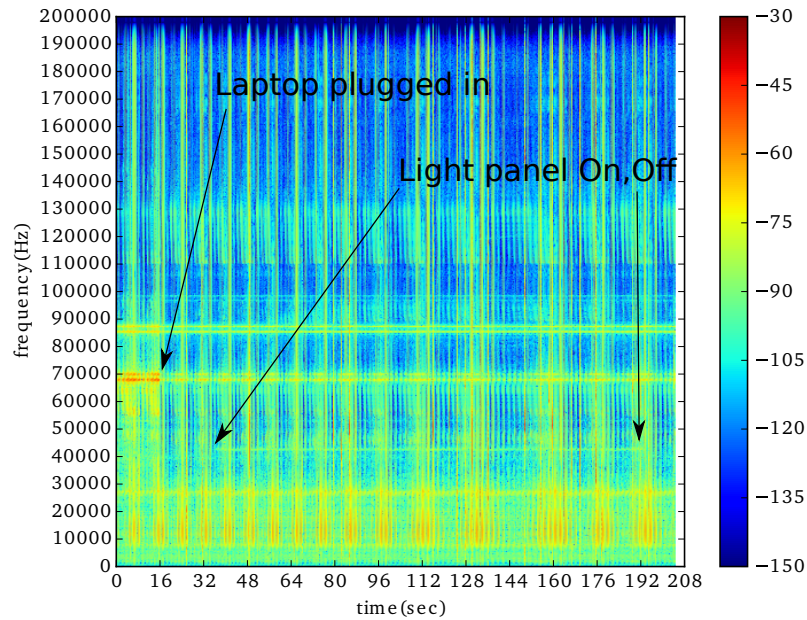


Figure 1: Events generated when the measurements are conducted from First room on the ground floor given by Table 4.1

Comments on Figure 1:

1. There seems to be (destructive) interference in the frequencies for laptop which I had not thought about. I would expect certain frequency to show

up instead of a band of frequencies getting lighter in intensity as in the spectrogram

2. Light panel switch is in the first room and powers the light in the room. The EMI generated is the only one that is visibly noticeable in the spectrogram
3. The rest of the events in the table 4.1 are not noticed in the spectrogram

## 4.2 Top Floor Experiment

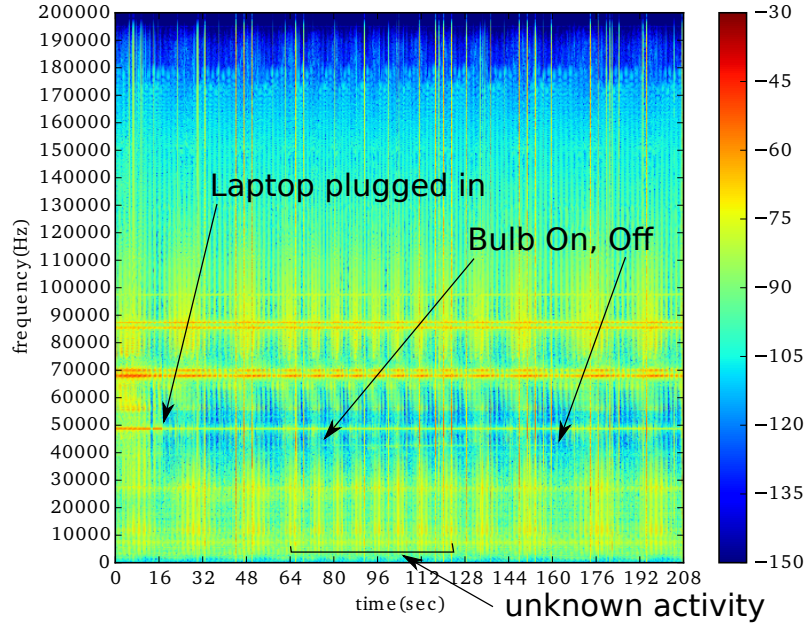


Figure 2: Events generated when the measurements are conducted from First room on the ground floor given by Table 4.2

Comments on Figure 2:

1. There is change in the EMI pattern when a lamp on ground floor is turned on
2. There is no observable change in EMI when other light switches are turned on/off.
3. There is change in time period of the cyclic EMI pattern labelled "unknown" in the spectrogram, as we do not know what caused it

Events	Time (On)	Time (Off)
Laptop	16 sec	192
Top floor Stair light bulbs(2)	32	176
Middle stairs bulbs(3)	48	160
Ground Floor light panel	64	144
Ground Floor bulb(1)	80	128
Ground Floor first room light panel	96	112

Table 2: Table showing list of events generated and time(in seconds) when the measurements are done on the top floor of the house, corresponding to Figure 2. Bracketed number represents the number of bulbs turned on by single switch.

4. The dB scale is the same on all the spectrograms so they can be compared easily

### 4.3 Lab Experiment

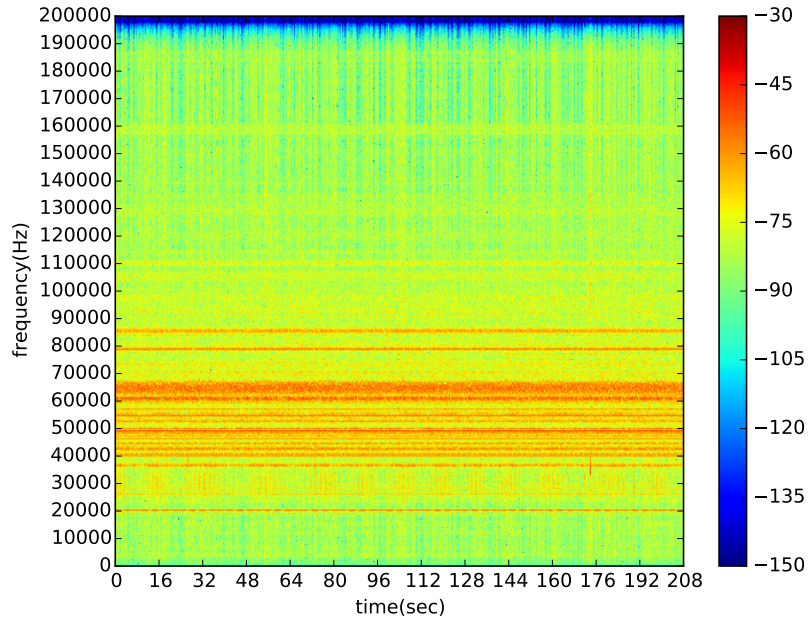


Figure 3: Power-line spectrum in E-Quad lab of first 200 KHz frequency band

1. The noise floor of the entire spectrum in E-Quad is higher than noise floor of home. No devices were turned on/off while experiment was conducted.

2. The dominant frequency around 85KHz is present in both home and E-Quad
3. The frequency band of 40 KHz to 70 KHz is cluttered. This might be because most of the devices have switching frequencies in the range and there are many high power consuming devices on the power-line

## 5 File Sizes for data collection

Keeping logs for the size of data collection in case researchers at Princeton are interested in long term data captures.

1. For a sample rate of 400 KHz (real sampling), a file of float data type is saved.
2. 30 minute of data collection, the generated around 2.8 GB file. Similar file sizes for collection from top, ground floor of the house.
3. File size grows depending on the amount of data captured instead of time period of capture. For example, for same time period of 200 seconds the file generated in 200 secs at home PL is 95 MB, while in E-Quad EE dept, it is 385 MB.

## 6 Hardware Used

The Power-line Coupler used is : Echelon Power-line Coupling Circuit. MODEL 78200R Echelon Corporation San Jose, California. PL-20 L-E 120V

## 7 References