# OMRON PLC Based Vibration Signature Analysis

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## Abstract

During the manufacturing process, the most important aspect to control is quality. The analysis of vibrations allows for detection of decreasing quality. Workers on the manufacturing floor are on the front lines in terms of quality detection, but they have specific skill sets and may not be able to use complex vibration acquisition technologies. Using basic accelerometers with OMRON programmable logic controllers (PLCs) and accompanying Sysmac Studio software, workers can develop simple standard operating procedures. The overall impact of these new technologies is improved quality control and reduced downtime for manufacturers.

## Introduction

Vibrational patterns can be used for diagnostic purposes in order to determine machine health and perform pass/fail selection in manufactured parts. Once these vibration signals are detected, they undergo a fast-Fourier transformation (FFT). This FFT is completed using coding techniques in the OMRON Sysmac Studio. The FFT plots of different parts or machines are compared, and pass/fail criteria are developed based on differences in frequencies and amplitudes between good and bad parts or machines.

## Methods and Materials

The proposed system uses a single axis piezoelectric accelerometer to collect vibration signals fro m machines and, with the addition of an impact hammer, vibrational patterns can be induced and measured in manufactured parts. The vibration patterns are sent to OMRON PLCs (NXHAD402) and undergo FFT.

PCB 621C40 Accelerometer

OMRON NXHAD402 Analog Input Device

## Results

*A. Amplitude Comparisons, Individual Signals.*

| Trial | Input Amp. | Input Freq. | Sample Array Freqs. | Sample Array Amp |
|---|---|---|---|---|
| 1 | 1 | 100 | 50 | 0.5290 (split) |
| 2 | 1 | 1333 | 650 | 0.7220 (split) |
| 3 | 1 | 2546 | 1240 | 0.5170 (split) |
| 4 | 1 | 3000 | 1465 | 0.6667 |
| 5 | 0.5 | 3000 | 1465 | 0.8181 |
| 6 | 1 | 3871 | 1890 | 0.5815 |
| 7 | 1 | 5000 | 2440 | 0.8416 |

The table in A. shows the values recorded by the PLC when the function generator was used to create single sine wave inputs. (split) indicated the signal was split into 2 or more signals over 3-25 Hz.

*B. Amplitude Comparisons, Combined Signals*

| Trial | Input Amp. | Sample Array Freqs. | Sample Array Amp |
|---|---|---|---|
| 1 | 1 | 100 | 0.2710 |
| 2 | 1 | 1333 | 0.2490 |
| 3 | 1 | 2546 | 0.1155 (split) |
| 4 | 0.5 | 3000 | 0.5474 (split) |
| 5 | 1 | 3871 | 0.4729 |
| 6 | 1 | 5000 | 0.1406 |

The table in B. shows the values recorded by the PLC when the function generator was used to create a signal of the sum of the sin waves in part A (excepting trial 4). (split) indicates the signal was split into 2 or more signals over 5-25 Hz

## Discussion

Comparing the results in A to the results in B. shows that with a variety of signals of comparable amplitudes, our program cannot yet consistently distinguish small changes in amplitudes from signals. The frequencies displayed in the PLC sample array are not always consistent with the input frequencies, but they are consistent with how they are measured (i.e. during the test the sample array frequency of 650 was always associated with the actual input frequency of 1333). It is suggested for future research to create a running average of the sample array amplitudes as they could vary by 1 or more order of magnitude per reading.

## Conclusions

The program's ability to separate frequencies in signals in the frequency spectrum where the wearing of motorized parts can be detected make it suitable for pursuing further research in developing a program capable of automating this process. Before this process is finalized, a consistent way of measuring the amplitude in the sample array must be developed.

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