<<IERG3820>><<Communications Laboratory>>

Report on Experiment<<1>>

Frequency Synthesis of Signals

Group: C 4

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Submission Date:

Disclaimer

I declare that the assignment here submitted is original except for source material explicitly acknowledged, and that the same or related material has not been previously submitted for another course. I also acknowledge that I am aware of University policy and regulations on honesty in academic work, and of the disciplinary guidelines and procedures applicable to breaches of such policy and regulations, as contained in the website http://www.cuhk.edu.hk/policy/academichonesty/



Tam Yi Ki 29/01/2020

Signature Name Date

Choi Man Hin 29/01/2020

Signature Name Date

1. **Objectives**

* Measure and characterize the signal waveform in time-domain as well as the signal spectrum in frequency domain.
* Synthesis various common signals using different frequency components.

1. **Data Analysis**

TP5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel | Frequency  (KHz) | Peak-to-peak  (V) | Fundamental signal amplitude  (dBV) | Max harmonic  (different between fundamental to harmonic, -dB) |
| 1 | 0.993 | 9.6 | 10 | 49 |
| 2 | 1.994 | 11.3 | 11 | 51 |
| 3 | 2.988 | 8.3 | 8.9 | 51 |
| 4 | 3.971 | 14.9 | 13.9 | 50.43 |
| 5 | 4.960 | 9.6 | 10.2 | 52.8 |
| 6 | 5.935 | 15.0 | 13.9 | 54.86 |
| 7 | 6.94 | 14.0 | 13.4 | 50.33 |
| 8 | 7.91 | 5.9 | 14.2 | 51.05 |
| 9 | 8.93 | 3.75 | 1.9 | 51.05 |
| 10 | 9.82 | 2.02 | -4.5 | 51.22 |

Square

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Channel | Frequency  (KHz) | Peak-to-peak  (V) | Max. amplitude (dBV) | Max harmonic  (-dB) | Phase shift degree |
| 1 | 0.992 | 15.9 | 14.7 | 49.375 | 0 |
| 2 | - | - | - | - | - |
| 3 | 2.967 | 4.8 | 4.1 | 56.875 | 0 |
| 4 | - | - | - | - | - |
| 5 | 4.949 | 2.93 | -200m | 54.375 | 0 |
| 6 | - | - | - | - | - |
| 7 | 6.951 | 2.15 | -3.0 | 55.0 | 0 |
| 8 | - | - | - | - | - |
| 9 | 8.910 | 1.64 | -5.7 | 55.0 | 0 |
| 10 | - | - | - | - | - |

一張含有 室內, 地板 的圖片

自動產生的描述

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自動產生的描述

Triangle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Channel | Frequency  (KHz) | Peak-to-peak  (V) | Max. amplitude (dBV) | Max harmonic  (-dB) | Phase shift degree |
| 1 | 0.992 | 14.1 | 14.7 | 49.375 | 0 |
| 2 | - | - | - | - | - |
| 3 | 2.978 | 1.52 | 4.1 | 56.125 | 61.6 |
| 4 | - | - | - | - | - |
| 5 | 4.951 | 610m | -400m | 46.250 | 0 |
| 6 | - | - | - | - | - |
| 7 | 6.96 | 290m | -24.5 | 41.250 | 28.2 |
| 8 | - | - | - | - | - |
| 9 | 8.87 | 190m | -34.6 | 42.500 | 0 |
| 10 | - | - | - | - | - |

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自動產生的描述

Sawtooth

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Channel | Frequency  (KHz) | Peak-to-peak  (V) | Max. amplitude (dBV) | Max harmonic  (-dB) | Phase shift degree |
| 1 | 0.992 | 14.1 | 14.7 | 49.375 | 0 |
| 2 | 1.981 | 6.9 | 7.2 | 37.500 | 0 |
| 3 | 2.967 | 4.5 | 3.2 | 62.500 | 64.7 |
| 4 | 3.971 | 3.60 | 1.7 | 38.125 | 0 |
| 5 | 4.970 | 2.80 | -600 | 46.875 | 34.2 |
| 6 | 5.95 | 2.32 | -2.3 | 56.250 | 2.34 |
| 7 | 6.94 | 1.99 | -3.7 | 51.875 | 23.4 |
| 8 | 7.90 | 1.76 | -4.8 | 62.500 | -2.62 |
| 9 | 8.90 | 1.52 | -6.3 | 40.000 | 19.3 |
| 10 | 9.90 | 1.37 | -70.7 | 61.250 | 0 |

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自動產生的描述

Rectangle (33:67)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Channel | Frequency  (KHz) | Peak-to-peak  (V) | Max. amplitude (dBV) | Max harmonic  (-dB) | Phase shift degree |
| 1 | 0.992 | 14.1 | 14.7 | 49.375 | 0 |
| 2 | 1.977 | 7.0 | 7.5 | 36.250 | 43.23 |
| 3 | - | - | - | - | - |
| 4 | 3.940 | 3.4 | 400m | 38.750 | 57.83 |
| 5 | 4.970 | 2.8 | -1.7 | 44.375 | 71.81 |
| 6 | - | - | - | - | - |
| 7 | 6.983 | 2.0 | -54.2 | 51.250 | 72.07 |
| 8 | 7.868 | 1.74 | -54.0 | 48.310 | 78.45 |
| 9 | - | - | - | - | - |
| 10 | 9.990 | 1.41 | -57.3 | 48.750 | 81.06 |

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自動產生的描述

1. **Discussion**
2. What are the effects of the odd harmonics and the even harmonics to synthesize?

Answer:

Odd harmonics can be rotated 180 degrees about the origin, like the square signal and the triangle signal. Even harmonics can be reflected across the Y axis.

In signal synthesis, odd harmonics are harmonics with frequencies 3f, 5f, 7f, etc, and even harmonics are harmonics with frequencies 2f, 4f, 6f, etc, with f being the fundamental frequency.

When more odd harmonics are added, the resulting signal become more distinct. When more even harmonics are added, they cancel out with the fundamental frequency, so they are less effective.

1. What are the impacts to the signal if the harmonics are positive or negative?

Answer:

Positive harmonics:

Positive harmonics produce magnetic fields and currents that rotate in the same direction as the fundamental frequency. Positive harmonics add extra waveforms that are rotating in the same direction as the fundamental frequency to the summing signal. Assuming the fundamental signal is a sine wave, positive harmonics add extra sine waves to the summing signal.

Negative harmonics:

Negative harmonics produce magnetic fields and currents that rotate in the opposite direction as the fundamental frequency. Negative harmonics add extra waveforms that are rotating in the opposite direction as the fundamental frequency to the summing signal. Assuming the fundamental signal is a sine wave, negative harmonics add extra cosine waves to the summing signal, which are sine waves that have phase shift of .

1. **Summary**

In this lab experiment, we attempt to synthesize different signals, like a triangle wave and a pulse. By summing up combinations of signals with different frequencies, changing their phases and amplitudes, we have successfully synthesis the required signals. We have also learned about the harmonics of the summing signal, and how they being odd or even, and positive or negative, affect the synthesis of signals.

1. **References**

<https://www.ecmweb.com/power-quality-reliability/article/20897053/effects-of-harmonics-on-power-systems>