MÜHENDİSLİK FAKÜLTESİ
FACULTY OF ENGINEERING
ELEKTRİK-ELEKTRONİK MÜHENDİSLİĞİ BÖLÜMÜ
DEPARTMENT OF ELECTRICAL AND
ELECTRONICS ENGINEERING

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 23 02
F: +90 312 210 23 04
ee@metu.edu.tr
www.eee.metu.edu.tr

EXPERIMENT 3. SIGNAL GENERATION, FILTERING, CROSS CORRELATION, A/D, D/A, DMA
PART 1
LABORATORY REPORT

Student 1: S. Emre Can-2093524
Student 2: Yekta Demirci-2093607

Task 1

1) Generate a **sine wave without frequency hopping** where the waveform parameters are as follows. **Sampling rate** is **50000 Samples/s**, waveform **frequency** is **100 Hz**, **Phase offset** is **0 degree**, **Vpp** is **5 V** and **Offset** is **0 V**. **Observe the output waveform** both in the **oscilloscope and front panel**. Now, increase the frequency of sine wave **from 500 Hz until 3 kHz in 500 Hz steps**. **Comment on the change** in the waveforms.

Sampling frequency is 50kHz. When it is scaled to 2*pi, low frequencies like 100, 500 fall into very left of the graph. Therefore, they are hard to track. The conversion is as follows (100/50K)*(2*pi). As we increase the frequency of the sine peaks goes to middle points and become more easy to track. In the time domain sine wave frequency is obviously increased.

2) Keep the **frequency of sine wave** at **3 kHz** and increase the sample rate **from 50000 Samples/s to 500000 Samples/s in 50000 Samples/s steps**. **Comment on the change**.

As we increase the sampling frequency, 2*pi interval is mapped to a more precise interval in FFT domain. Likewise the upper case, ((Freq of Sine)/(Sampling Freq))*2*pi conversion is done. Scale of X axis is changed. As we increase the sampling rate the FFT peaks move to outer area. Also as we increase sampling rate, we also observe more periods of the sine waves in time domain, in other words more samples but their frequency is the same.

3) Set the **frequency of sine wave** to **100 Hz** and decrease the sample rate **from 45000 Samples/s to 5000 Samples/s in 10000 Samples/s steps. Comment on the change.**

We expect no aliasing. This case is also similar to previous 2 cases. When we map sampling to 2*pi, the resolution is decreased.

4) Now, set the frequency of sine wave and sample rate to **1 kHz** and **50000 Samples/s. Turn on Frequency Hopping** option and adjust the **frequency deviation** to **50 Hz. Observe** the waveforms. Increase the frequency deviation **from 100 Hz until 500 Hz in 100 Hz steps. Observe the changes** in the waveforms **and comment on the results.**

As we increase the noise deviation, the waveform started to have more significant frequency chance. We also observed that with the increasing frequency deviation, FFT plot resulted a certain amount of noise

5) Repeat the steps 1, 2, 3 and 4 for square wave.

5)1) In this case, square wave has odd frequency harmonics. Therefore, in the FFT interval there are several peaks occur. Magnitude of the odd harmonics converges to 0 as the harmonic no increases. When we increase the frequency, harmonics start to overlap when their magnitude does not converge to 0. When aliasing occurs we observe low quality square waves, it starts to distort. However, since low level harmonics overlap it does not affect the square wave much.

5)2)
Likewise, the question 2 case the mapping done into a higher interval as we increase the sampling rate. Harmonics tend to move to 0 and 2*pi.

5)3)

Sampling rate is decreased, as a result we get low resolution in 0-2pi interval. Harmonics start to overlap. When overlapping occurs in other words aliasing, square wave starts to distort.

5)4)

When frequency distortion occurs, square wave is affected more than sine wave. Because square wave has many sinusoidal harmonics and each harmonic is affected by the distortion. As a result, there is a stacked distortion. As we increase the distortion rate signal distorts more as expected. There are many noisy impulses in the FFT plot. For the time plot square start to distort.

6) Generate a **sine wave without frequency hopping** with sampling rate **100 Samples/s.** Set the **number of elements read from FIFO_output** to **100.** Adjust the **frequency of sine wave** to **101 Hz. What do you observe in the Front Panel? What is the frequency of observed signal? Comment** on the result.

When frequency is set as 100 due to aliasing we cannot observe the signal. When the frequency is increased to 101, overlapping impulses passes the sampling frequency in the FFT domain and 1Hz signal is observed. It can be thought in the other way. Number of elements is 100. Sampling rate is also 100. It means the time domain plot shows 1second interval. When 101 is given the whole interval shows a single period sine wave. It means the frequency is 1.

7) Now**, increase the frequency to 105 Hz in 1 Hz steps. Comment on the frequencies** of the waveforms.

As we expect from the part 6, as we increase the frequency 1 by 1, the number of sine waves we observe in the time domain increases. Due to extreme overlapping we observe 1Hz wave for 101Hz signal, 2Hz wave for 102Hz signal etc.

8) Increase the frequency of sine wave **from 1001 Hz to 1005 Hz in 1 Hz steps** while **sample rate is still 100 Samples/s.** Are the results **similar** to the ones in part 7? **Why?**

The results are similar. Since the sampling rate is 100Hz. 0-2pi interval is proportional to this. Therefore input frequency is observed like mod(100)Hz. As we pass 100Hz it goes back to 0Hz since 2*pi radiance is reached and since it is periodic it goes back to 0 radiance in FFT domain.