Report of Project 0

【Group Members】

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【Experimental Objectives】

1. **Understand the process of signal acquisition;**
2. **Master the basic functions and usage of usb-4704;**
3. **Master the basic functions and usage of ELVIS II+;**
4. **Master the basic functions and usage of DAQNavi.**

【Experimental Apparatus】

1. **USB-4704；**
2. **DAQNavi；**
3. **DAQNavi Driver for USB-4704；**
4. **ELVIS II+；**

【Experimental Procedures】

Part 1. Test USB-4704 analog input/output, digital input/output, and counter functions.

1. **Connect the analog input and analog output through a wire, set the waveform of the output signal in DAQNavi, check the waveform displayed in the analog input and record the results under different setting parameters;**
2. **The effect of sampling rate in simulation input should be illustrated with different results;**
3. **Connect the digital input terminal and the analog output terminal through a wire, set the analog output level in DAQNavi, check the level at the digital input terminal and record the results under different setting parameters;**
4. **Determine the voltage range of high and low levels in digital input and output and attempt to indicate the purpose of such setting;**
5. **Connect the counter end to the analog output end or digital output end, set duty cycle parameters, check the waveform of the input end and record the results under different setting parameters.**

Part 2. Test functions of ELVIS II+ oscilloscope, signal generator and digital multimeter.

1. **Connect the usb-4704 analog output terminal to an oscilloscope through a wire, set the waveform of the output signal in DAQNavi, check the waveform displayed in the oscilloscope terminal and record the results under different setting parameters;**
2. **Connect the signal generator with the oscilloscope through a wire, set the waveform of the output signal at the control of the signal generator, check the waveform displayed at the oscilloscope and record the results under different setting parameters;**
3. **Connect the USB-4704 analog output terminal to the digital multimeter through a wire, set the analog output level in DAQNavi, and record the results under different setting parameters at the digital multimeter terminal;**
4. **Connect the USB-4704 digital output terminal to the digital multimeter through a wire, set the high/low level output in DAQNavi respectively, and record the results at different levels in the digital multimeter terminal.**

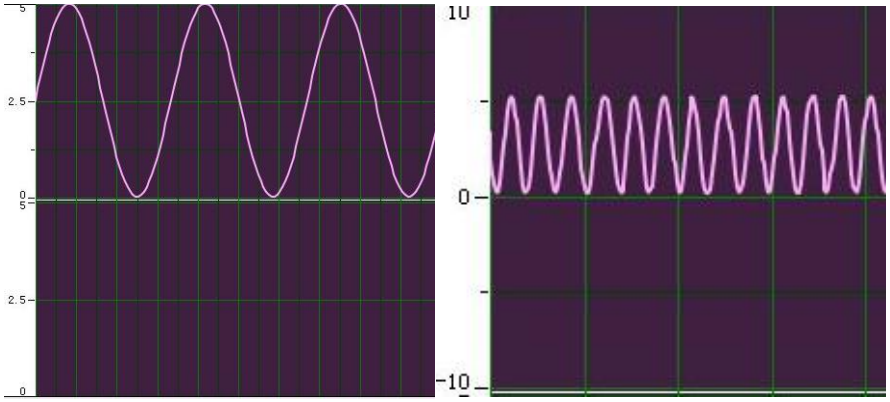
【Results and discussion】

Part 1. Test USB-4704 analog input/output, digital input/output, and counter functions.

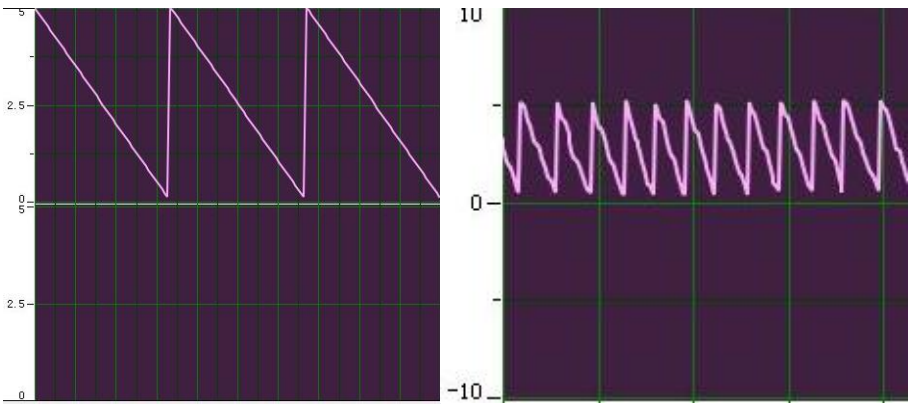
1. Results under different parameters.

Different waveforms: frequency=10Hz 50 points per period

Static analog sinusoidal output **Instant analog input**

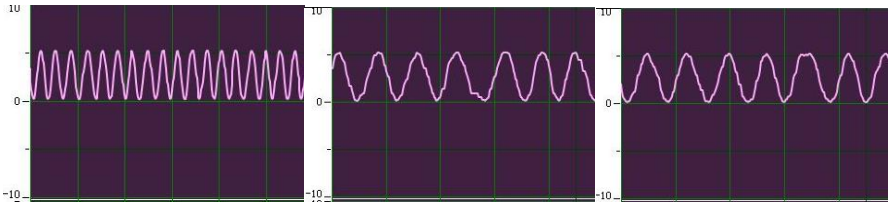


Static analog sawtooth output **Instant analog input**



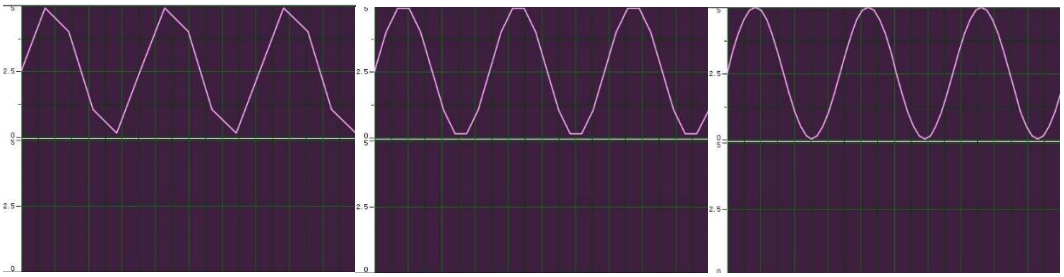
Different frequencies:

Frequency 10 Hz **Frequency 20 Hz** **Frequency 50 Hz**



Different number of points per period: Sinusoidal signal frequency=10 Hz

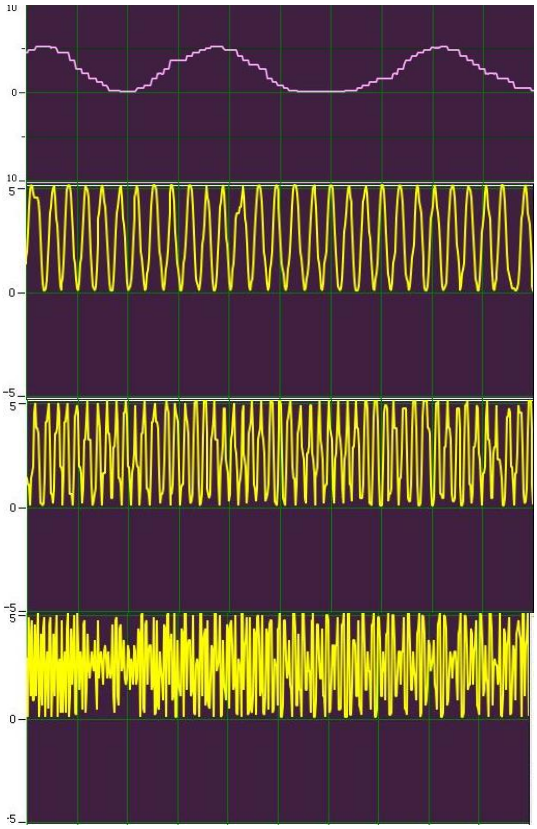
5 10 20



We can see that the analog input and the analog output match well under certain conditions, but when the number of points per period is not enough, the waveform of the analog output is usually not what we want. Besides, if the sampling rate is not appropriate, The waveform we get from the analog input is also somewhat distorted.

2. Verify the sampling theorem.

We use 10 Hz sinusoidal signal as static analog output, and the following pictures show the instant analog input signal under different sample rate. (30 points per period)

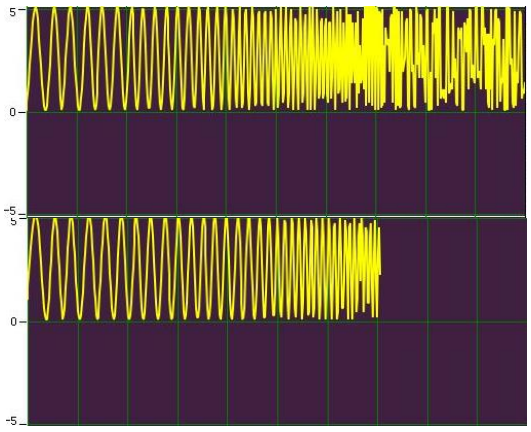


Sample rate: 1000 Hz

Sample rate: 100Hz

Sample rate: 50Hz

Sample rate: 20Hz



Sample rate: 10Hz

Sample rate: 5Hz

In the field of digital signal processing, the sampling theorem is a fundamental bridge between continuous-time signals and discrete-time signals. The theorem set a criteria that if we want to capture all the information from a continuous-time signal of finite bandwidth, the sample rate must be higher than twice of the bandwidth of the continuous-time signal, otherwise aliasing will happen.

When the sample rate is 100 Hz or 50 Hz (higher than twice of 10 Hz), especially when the sampling frequency is more than ten times (higher than twice of 10 Hz) the signal frequency, the sampled signal looks pretty good. While when the sample rate is 20 Hz, the aliasing happens, and the sampled signal exhibits periodic characteristics. When sampling rate is 10 Hz or 5 Hz, there is still the aliasing and the period of the signal increases.

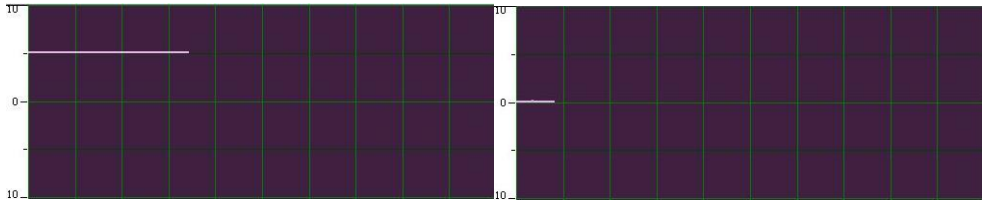
Last but not least, when the sample rate (1000 Hz) is higher than the number of analog output signals (300), analog input signals can also be distorted in the form of steps because the same value can be sampled multiple times.

3. Find the threshold of digital input.

We use analog constant outputs at different levels and observe the signal of digital input, we found that the two thresholds were 1.21V and 1.51V. The interesting thing is that the digital input will remain in its original state when across between 1.21V and 1.51V. After a certain discussion, we think that such design is to prevent interference, to prevent results of the digital input signal due to noise jitter on the results.

4. Find the ranges of digital input.

We use high level digital output and low level digital output, observe the signal of instant analog input.



High level: It looks like the constant signal and the value of signal is about 4.966 V.

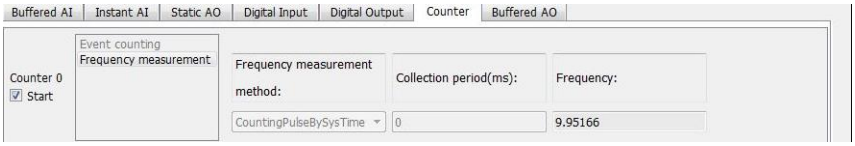
Low level: It looks like the constant signal and the value of signal is about -0.002 V.

5. Verify the function of counter.

We use 10 Hz analog sinusoidal input and start count. The result of counter shows below.

Counting Value:

Frequency:



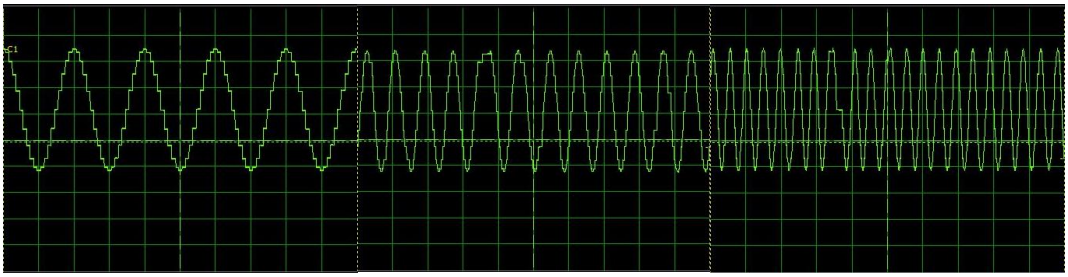
Then we change the duty cycle and found that the results will not change. We think that the function of the counter has nothing to do with the duty cycle, because the counter is to calculate the number of rising or falling edges.

Part 2. Test functions of ELVIS II+ oscilloscope, signal generator and digital multimeter.

1. Results under different parameters

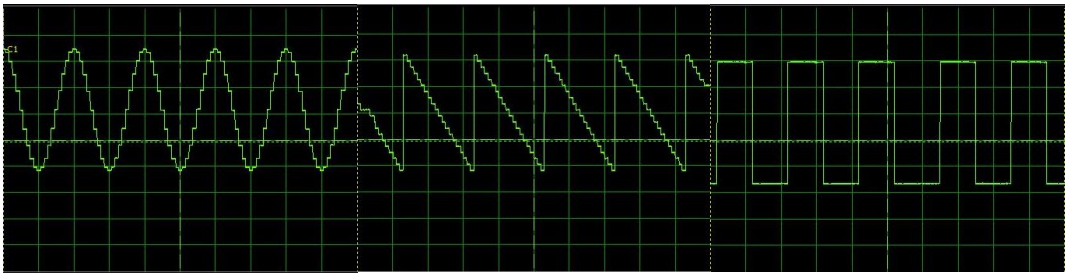
Different frequencies: sinusoidal signal as input

10 Hz **20Hz** **30Hz**



Different waveforms.

Sinusoidal wave **Sawtooth wave** **Square wave:**

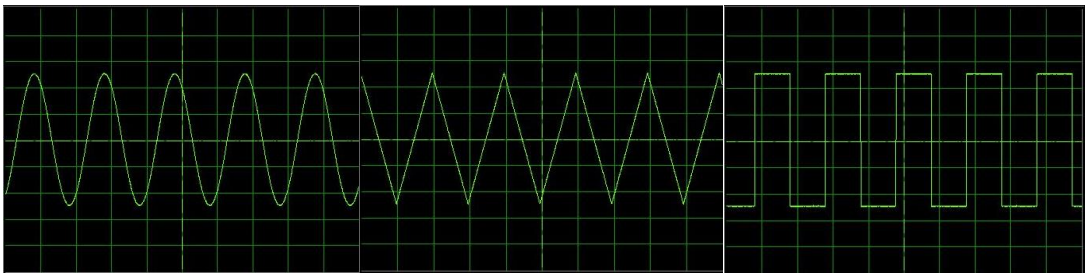


We can see that the oscilloscope and the analog output match well under certain conditions, but if the sampling rate is not appropriate, the waveform we get from the analog input is somewhat distorted.

2. **Test signal generator and oscilloscope.**

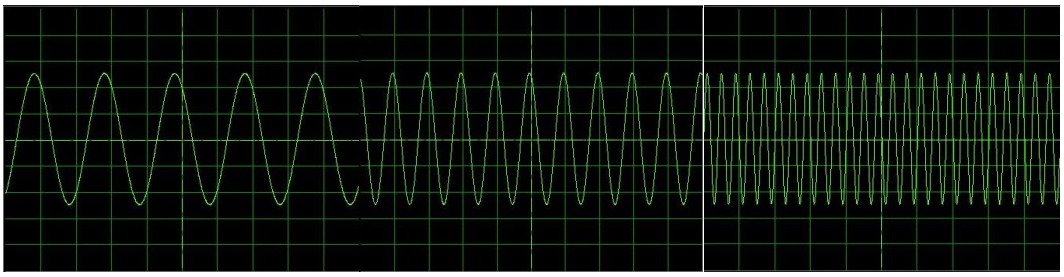
Different waveforms: 10Hz

Sinusoidal signal **Triangular signal** **Square signal**



Different frequencies:

10 Hz **20 Hz** **50 Hz**



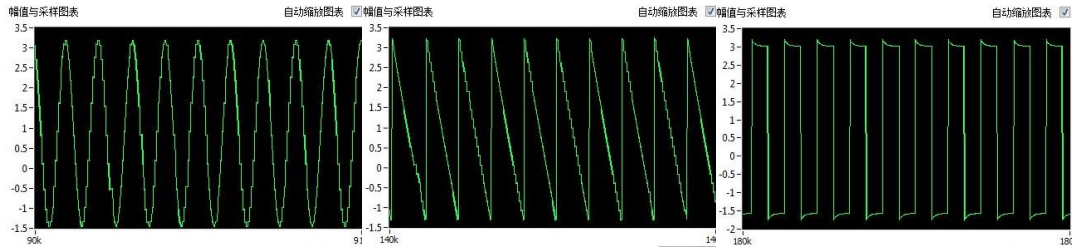
The signal information got by oscilloscope matches well with that of the signal generator.

3. **Test the analog function of digital multimeter.**

Take the USB-4704 as static analog output and NI myDAQ as analog input of digital multimeter.

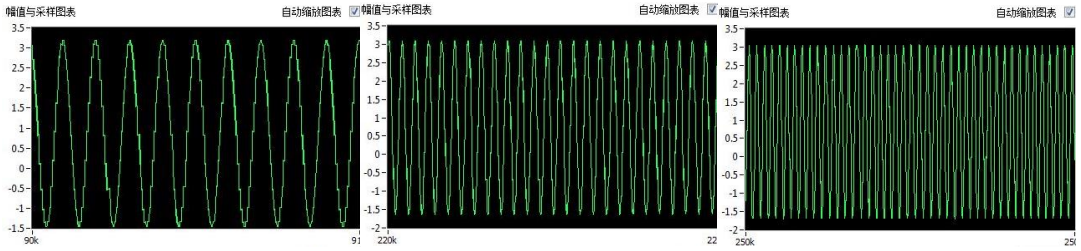
Different waveforms: 10 Hz

Sinusoidal signal **Sawtooth signal** **Square signal**



Different frequencies:

10 Hz **20 Hz** **50 Hz**



4. Test the digital function of digital multimeter.

Take the USB-4704 as digital output and NI myDAQ as digital input of digital multimeter.

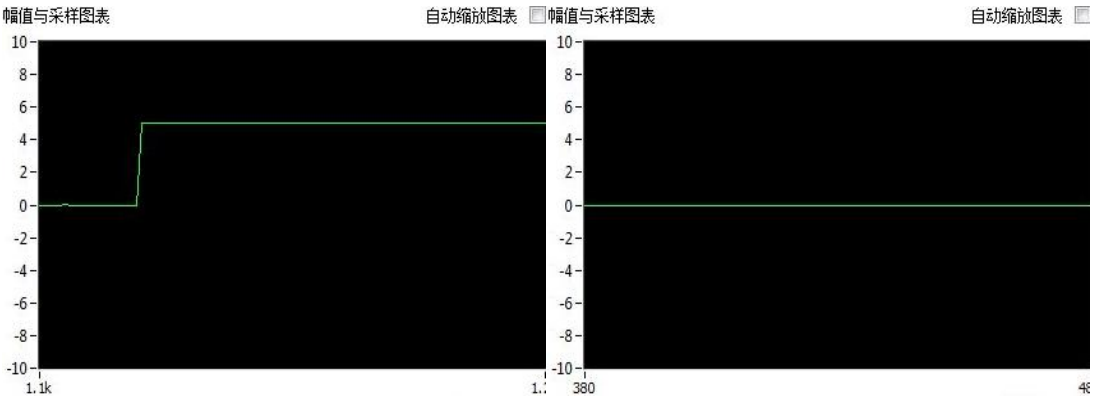
High level:

Low level:

5. Test the high/low level of USB-4704 digital output using digital multimeter

Take the USB-4704 as digital output and NI myDAQ as analogue input of digital multimeter.

High level: ~5 V **Low level: ~0 V**



【Analysis and discussion】

Through this experiment, we have mastered the basic functions of USB-4704 signal acquisition card, ELVIS II+ and the digital multimeter, have been familiar with the operation of the software interface, and mastered the common ground wiring and other basic wiring methods.

Through this experiment, we think there are some points which should be noticed in the process of signal generation and acquisition. We will discuss this in more detail below.

1. If possible, we should try to connect the ground wires while connecting the wires to prevent offset bias interference in later tests.
2. We must know that all the signal is discrete in the process of signal generation and acquisition actually. Besides, we must understand the meanings of some concepts such as frequency, period, the number of points per period, sample rate and so on, So as that we can make sure all the signals are accurate if we choose appropriate parameters.
3. For the digital signal, we must consider the interference of the external environment to the signal. Therefore, we generally have to choose the way to set the potential threshold of "state maintenance" so that the level is accurate when the signal floating up and down in a certain number.