Name : (1)**Saisao Kham** (2)**Haoru Xie**
Assignment: Experiment 6 (Report)
Lab session: Friday
Instructor: Dr. Liu
Due Date 10/30/2016(Sunday) (Extended to Nov 6 2016)

"This report is prepared by **Saisao Kham(EE312)**, who is the first author and prepared the original draft of the report, and **Haoru Xie(EE352)**, who is the second author and revised the report."

Cover and Score Sheet

Experiment 6 - LabVIEW Data Acquisition and Analysis

Author: SAISAO KHAM (50168989) Partner: HAORU XIE

Score

Item	Credit	Score
Data	4	
Basic A/D D/A Measurements		
Waveform Digitization at High Sampling Rate		
Waveform Digitization at Low Sampling		
Two I-V Plots of BJT		
h-Parameters		
Conclusion	1	
Total	**5**	

TA Signature: Zheng Zheng Date: 12/2/16

Cover and Score Sheet

Experiment 6 - LabVIEW Data Acquisition and Analysis

Author: Haoru Xie Partner: _____

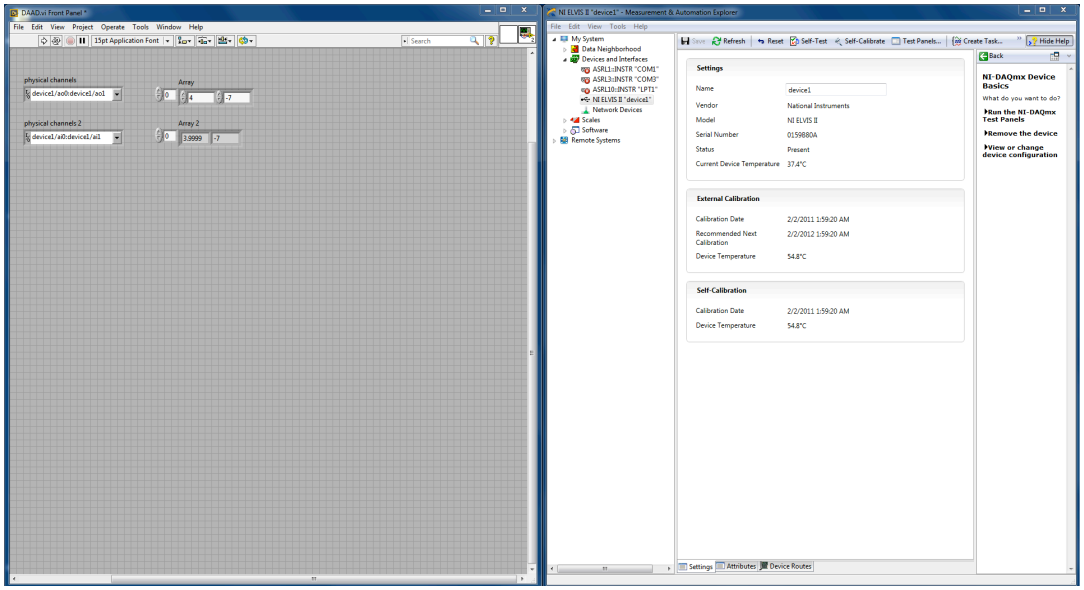
Score

Item	Credit	Score
Data	3	
Basic A/D D/A Measurements	✓	
Waveform Digitization at High Sampling Rate	✓	
Waveform Digitization at Low Sampling	✓	
h-Parameters, V_A	✓	
I-V Plot of MOSFET	✓	
V_P and I_{DSS}	4	
Discussion and Conclusion	1	
Total	**4**	

TA Signature: Zhifeng Zhang Date: 10/21/16

Data

1) Basic A/D D/A measurements



Setting the voltages spreading evenly between -9.95 and 9.95V for both D/A channels. Then record data in an excel file consisting of two columns: D/A output, A/D input. On block of data for channel 0 and another block of data for channel 1. identify the maximum discrepancy.

ch0 input	ch1 input	ch0 output	ch1 output	discrepancy ch0	discrepancy ch1	
-3.99885	-6.99994	4	-7	0.00115	-6E-05	1
-4.99931	-5.99979	5	-6	0.00069	-0.00021	2
-5.4989	-6.50003	5.5	-6.5	0.0011	3E-05	3
-5.99914	-7.50018	6	-7.5	0.00086	0.00018	4
-6.59841	-7.99945	6.5	-8	-0.09841	-0.00055	5
-6.9993	-8.50034	7	-8.5	0.0007	0.00034	6
-7.4989	-9.00059	7.5	-9	0.0011	0.00059	7
7.99947	3.00001	8	3	0.00053	-1E-05	8
-3.00102	5.00028	-3	5	0.00102	-0.00028	9
-7.00123	5.99978	-7	6	0.00123	0.00022	10

For the data we got, the maximum discrepancy for ch0 is 0.00123 when the ch0 output=-7 and ch1 output=6. For the ch1, the maximum discrepancy is0.00059 when the ch0 output=7.5 and the ch1 output=-9.

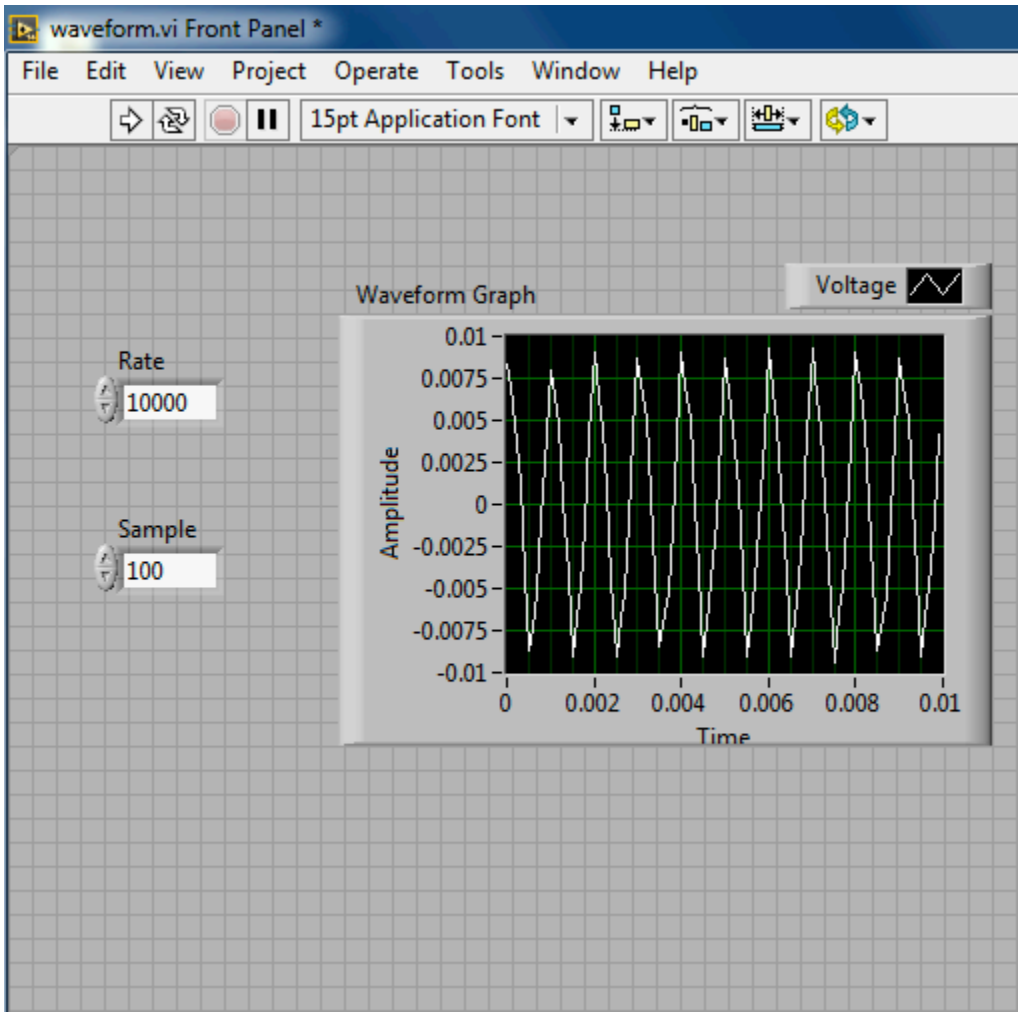
Set D/A0 to 8V. Using 4.7Kohm, 1Kohm, 470ohm and 220ohm between DA/0 and ground. Measuring the output voltage.

R	4.7K	1K	470	220
A/D0	7.99786	7.99077	4.61125	2.23324

2.) Waveform Digitization at High Sampling rate and Low rate

Rate (10000) – Sample (100) (HIGH):

Waveform and data



Data

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Samples	100	
Date	10/21/2016	
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End_of_Header		
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	0.008678	
	0.007711	
	0.00481	
	0.001587	
	-0.003892	
	-0.008727	
	-0.007438	
	-0.004537	
	-0.001636	
	0.003198	
	0.008033	
	0.008033	
	0.004488	
	0.001587	
	-0.00357	

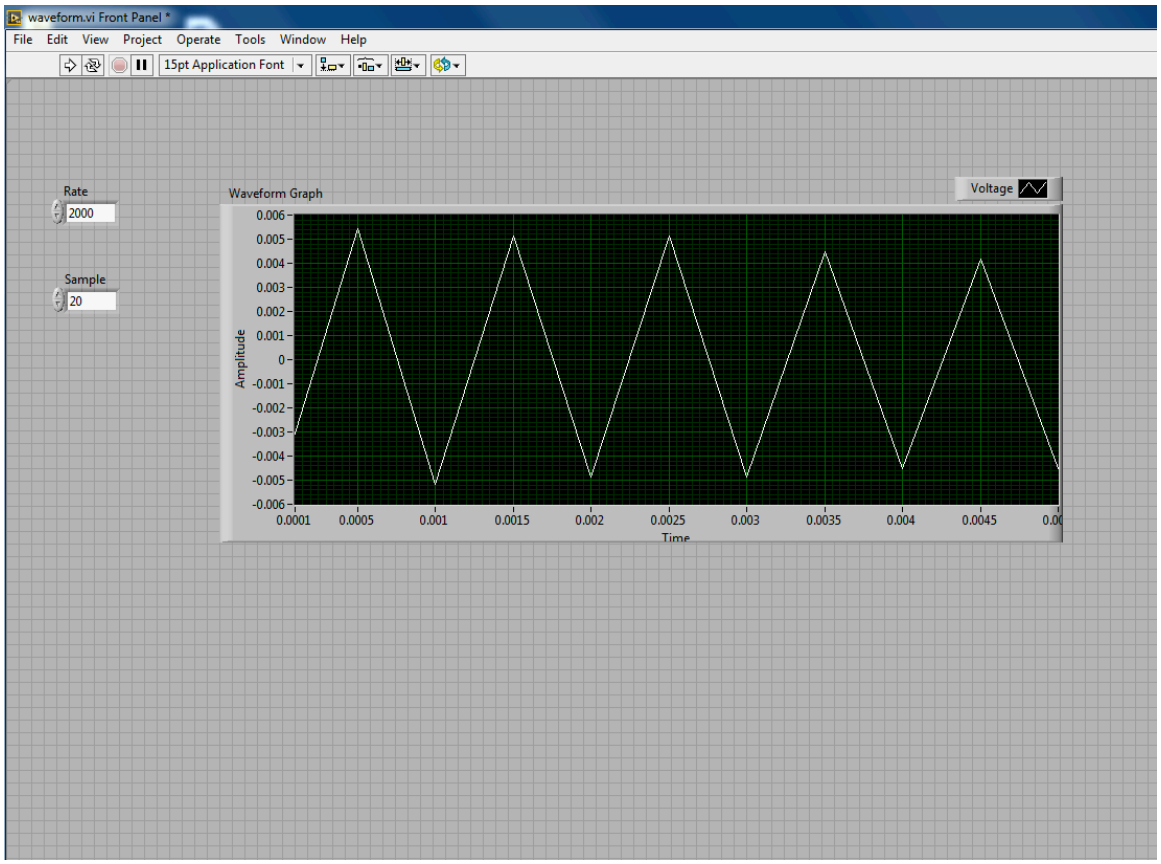
	-0.008727	
	-0.008082	
	-0.005504	
	-0.001636	
	0.003198	
	0.008355	
	0.008033	
	0.00481	
	0.000942	
	-0.00357	
	-0.008727	
	-0.00776	
	-0.005826	
	-0.001314	
	0.003198	
	0.008678	
	0.007388	
	0.00481	
	0.001265	
	-0.00357	
	-0.008405	
	-0.00776	
	-0.005182	
	-0.001636	
	0.003198	
	0.009	
	0.008033	
	0.004488	
	0.001265	
	-0.00357	
	-0.008405	
	-0.00776	
	-0.005182	
	-0.001636	
	0.003521	
	0.008355	
	0.007711	
	0.004488	
	0.000942	
	-0.00357	
	-0.008405	

	-0.00776	
	-0.005182	
	-0.001636	
	0.002876	
	0.007711	
	0.007711	
	0.005132	
	0.001909	
	-0.003892	
	-0.008405	
	-0.00776	
	-0.004859	
	-0.001636	
	0.003198	
	0.008355	
	0.007711	
	0.005777	
	0.000942	
	-0.003892	
	-0.008405	
	-0.007438	
	-0.004859	
	-0.001636	
	0.003843	
	0.008678	
	0.007711	
	0.00481	
	0.001265	
	-0.003892	
	-0.008405	
	-0.00776	
	-0.005182	
	-0.001959	
	0.003843	
	0.008355	
	0.007388	
	0.00481	
	0.001587	
	-0.00357	
	-0.008405	
	-0.00776	

	-0.005182	
	-0.001636	
	0.003521	

Rate (2000) – Sample (20) (LOW):

Data and waveform



Data

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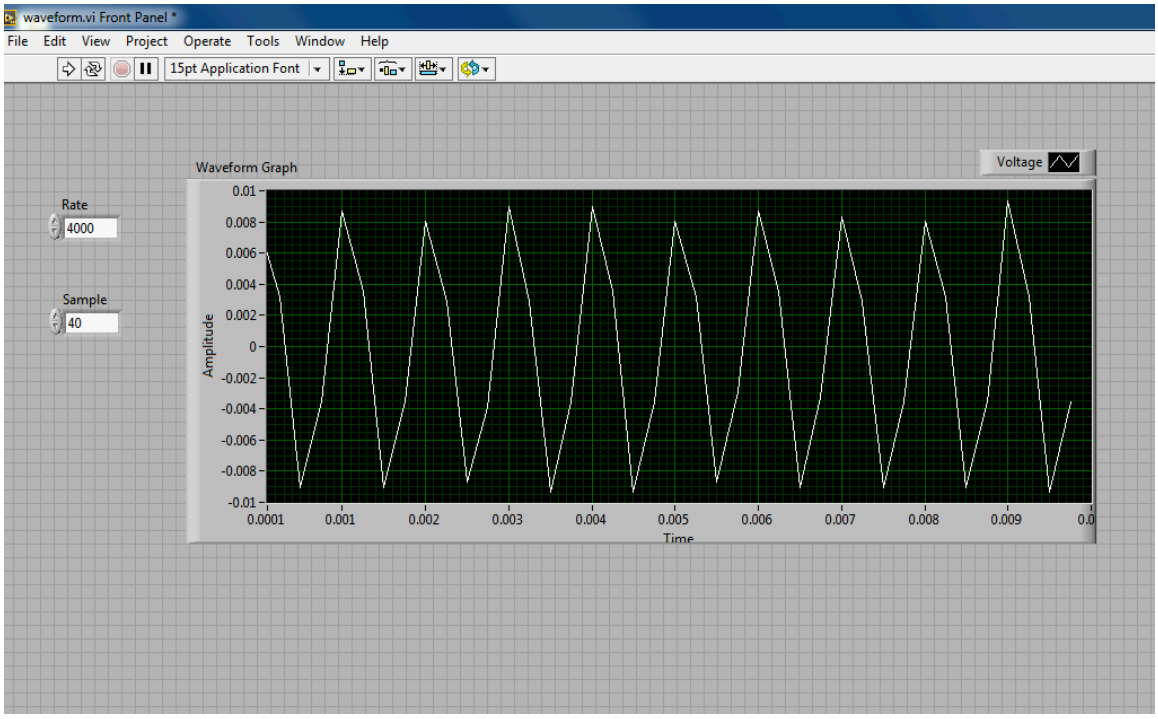
Date	########	
Time	01:30.4	

End_of_Header		
Channels	1	
Samples	20	
Date	########	
Time	01:30.4	
Y_Unit_Label	Volts	
X_Dimension	Time	
X0	0.00E+00	
Delta_X	0.0005	
End_of_Header		
X_Value	Voltage	Comment
	-0.00518	
	0.005454	
	-0.00518	
	0.005132	
	-0.00486	
	0.005132	
	-0.00486	
	0.004488	
	-0.00454	
	0.004165	
	-0.00454	
	0.004488	
	-0.00518	
	0.004165	
	-0.00454	
	0.004165	
	-0.00486	
	0.00481	
	-0.00486	
	0.00481	

Rate (4000) – Sample (40):

Data and waveform



Data

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Decimal_Separator	.	
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X_Columns	No	
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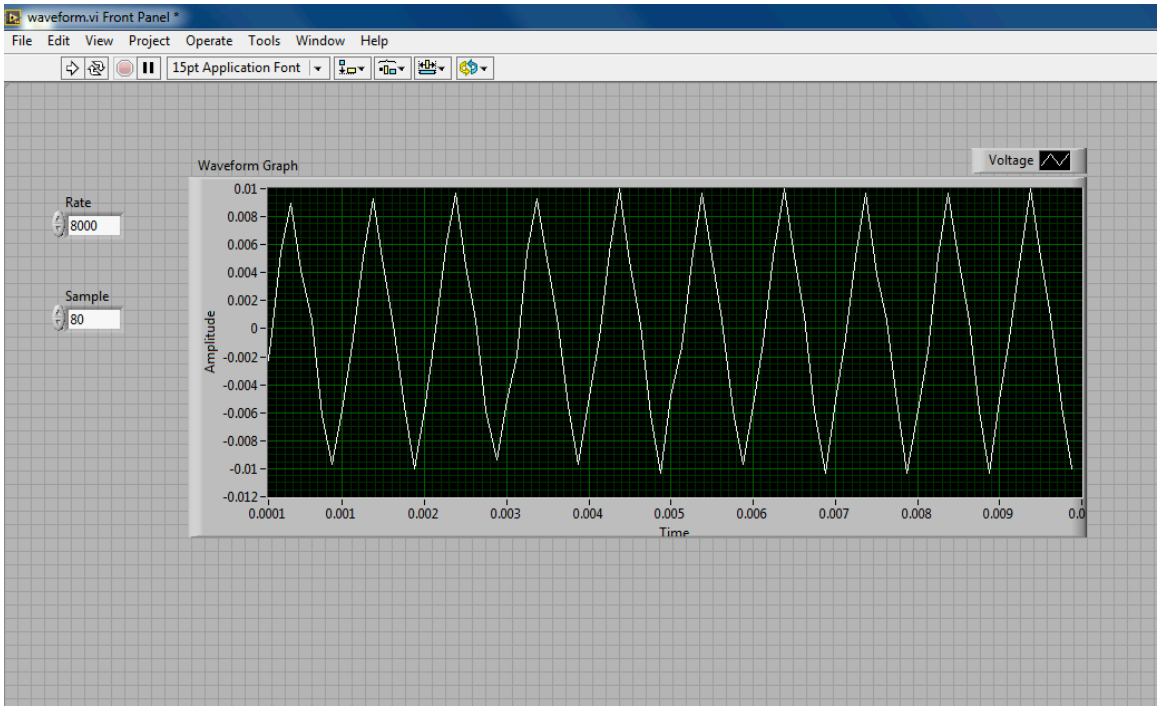
Channels	1	
Samples	40	
Date	########	
Time	57:36.9	
Y_Unit_Label	Volts	

X_Dimension	Time	
X0	0.00E+00	
Delta_X	0.00025	
End_of_Header		
X_Value	Voltage	Comment
	0.007711	
	0.003198	
	-0.00905	
	-0.00357	
	0.008678	
	0.003521	
	-0.00905	
	-0.00357	
	0.008033	
	0.002876	
	-0.00873	
	-0.00389	
	0.009	
	0.002876	
	-0.00937	
	-0.00357	
	0.009	
	0.003521	
	-0.00937	
	-0.00357	
	0.008033	
	0.003198	
	-0.00873	
	-0.00293	
	0.008678	
	0.003521	
	-0.00905	
	-0.00325	
	0.008355	
	0.002876	
	-0.00905	
	-0.00357	
	0.008033	
	0.003198	
	-0.00905	
	-0.00357	

	0.009322	
	0.003198	
	-0.00937	
	-0.00357	

Rate (8000) – Sample (80):

Data and waveform



Data

LabVIEW Measurement		
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Decimal_Separator	.	
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X_Columns	No	
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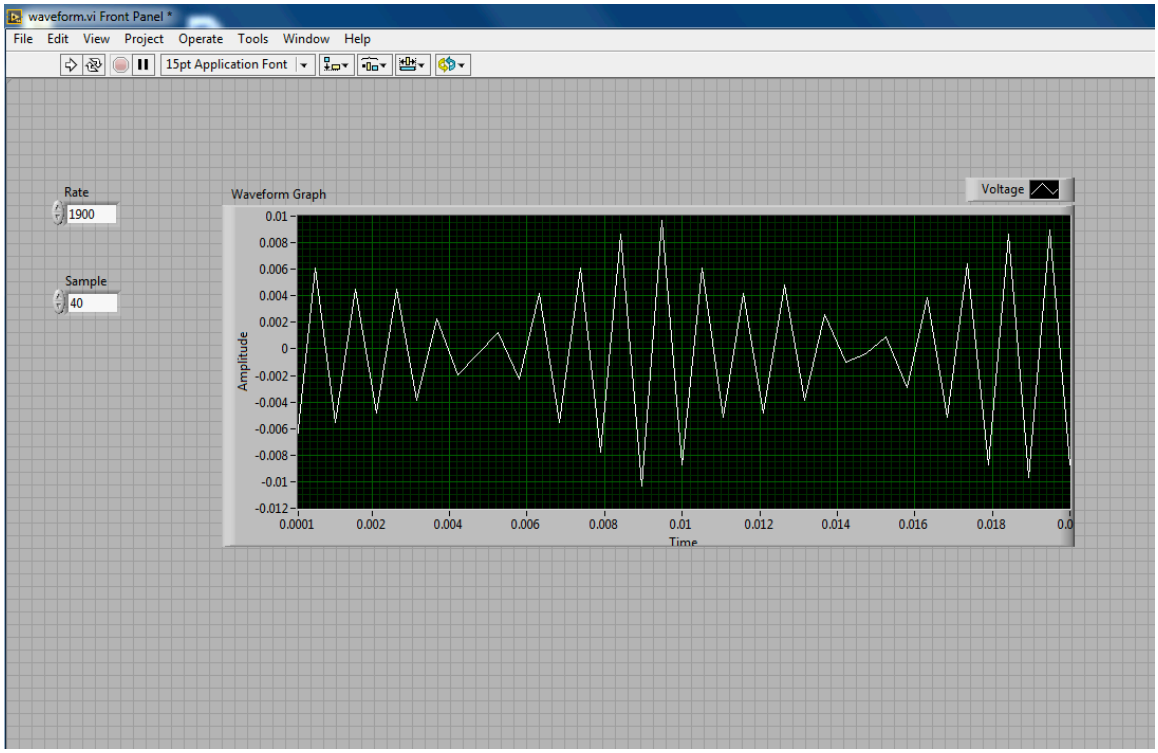
Operator	saisaokh	
Date	########	
Time	55:49.5	

End_of_Header		
Channels	1	
Samples	80	
Date	########	
Time	55:49.5	
Y_Unit_Label	Volts	
X_Dimension	Time	
X0	0.00E+00	
Delta_X	0.000125	
End_of_Header		
X_Value	Voltage	Comment
	-0.00583	
	-0.00099	
	0.005454	
	0.009	
	0.004165	
	0.00062	
	-0.00615	
	-0.00969	
	-0.00583	
	-0.00067	
	0.005132	
	0.009322	
	0.004488	
	0.000298	
	-0.0055	
	-0.01002	
	-0.00583	
	-0.00067	
	0.005777	
	0.009644	
	0.004488	
	0.00062	
	-0.00583	
	-0.00937	
	-0.00518	
	-0.00196	
	0.005454	
	0.009322	
	0.004488	

	0.000298	
	-0.0055	
	-0.00969	
	-0.00486	
	-0.00067	
	0.005454	
	0.009967	
	0.00481	
	0.000298	
	-0.00615	
	-0.01034	
	-0.00486	
	-0.00131	
	0.00481	
	0.009644	
	0.005132	
	0.00062	
	-0.00583	
	-0.00969	
	-0.0055	
	-0.00099	
	0.005132	
	0.009967	
	0.005132	
	0.000942	
	-0.00583	
	-0.01034	
	-0.00518	
	-0.00067	
	0.005132	
	0.009644	
	0.003843	
	0.00062	
	-0.00518	
	-0.01034	
	-0.00583	
	-0.00164	
	0.005132	
	0.009644	
	0.005132	
	0.00062	

	-0.00583	
	-0.01034	
	-0.00518	
	-0.00067	
	0.005132	
	0.009967	
	0.005132	
	0.000942	
	-0.0055	
	-0.01002	

Try it with rate of 1900 and sample =40



Data

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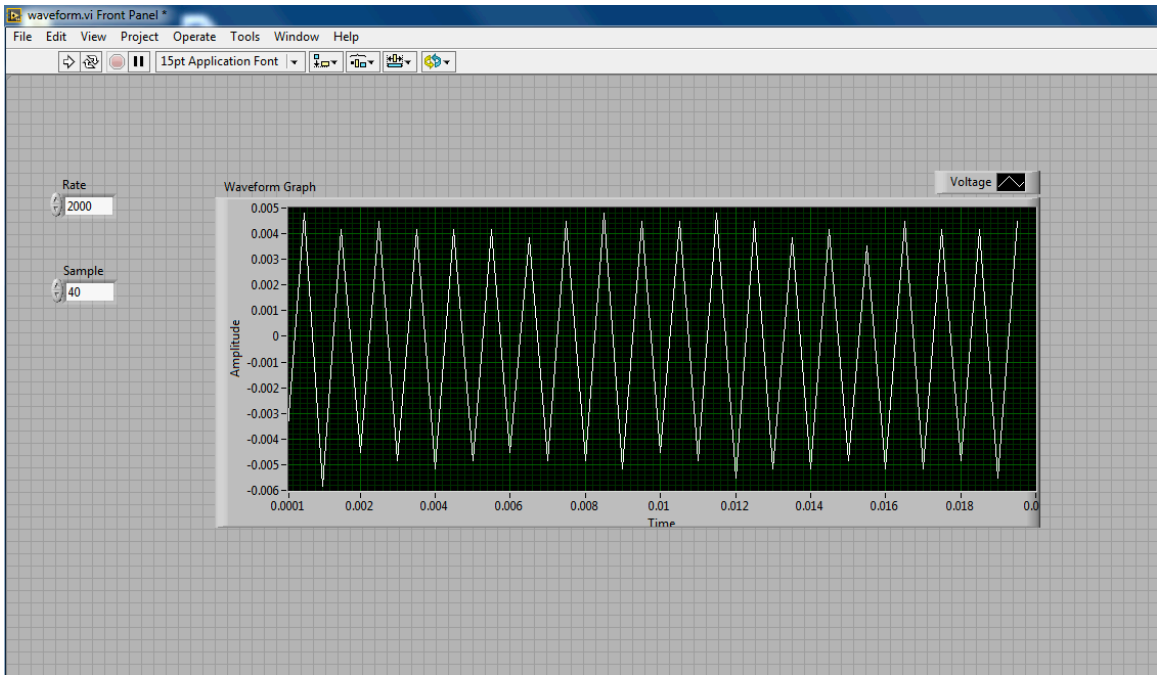
X_Columns	No	

Time_Pref	Absolute	
Operator	saisaokh	
Date	########	
Time	08:10.1	
End_of_Header		
Channels	1	
Samples	40	
Date	########	
Time	08:10.1	
Y_Unit_Label	Volts	
X_Dimension	Time	
X0	0.00E+00	
Delta_X	0.000526	
End_of_Header		
X_Value	Voltage	Comment
	-0.00905	
	0.006099	
	-0.0055	
	0.004488	
	-0.00486	
	0.004488	
	-0.00389	
	0.002231	
	-0.00196	
	-0.00035	
	0.001265	
	-0.00228	
	0.004165	
	-0.0055	
	0.006099	
	-0.00776	
	0.008678	
	-0.01034	
	0.009644	
	-0.00873	
	0.006099	
	-0.00518	
	0.004165	
	-0.00486	
	0.00481	

	-0.00389	
	0.002554	
	-0.00099	
	-0.00035	
	0.000942	
	-0.00293	
	0.003843	
	-0.00518	
	0.006421	
	-0.00873	
	0.008678	
	-0.00969	
	0.009	
	-0.00873	
	0.005777	

It is no long a sine wave. Try with other rate: 2000



Almost sine wave

LabVIEW Measurement		
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X_Columns	No	
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Operator	saisaokh	
Date	########	
Time	10:09.4	
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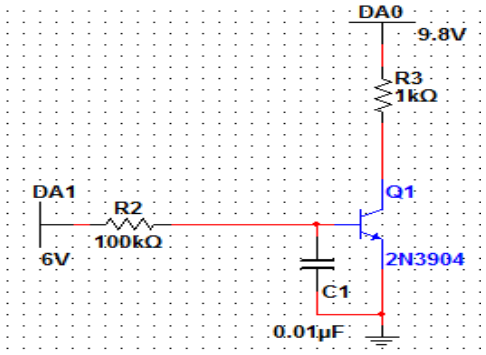
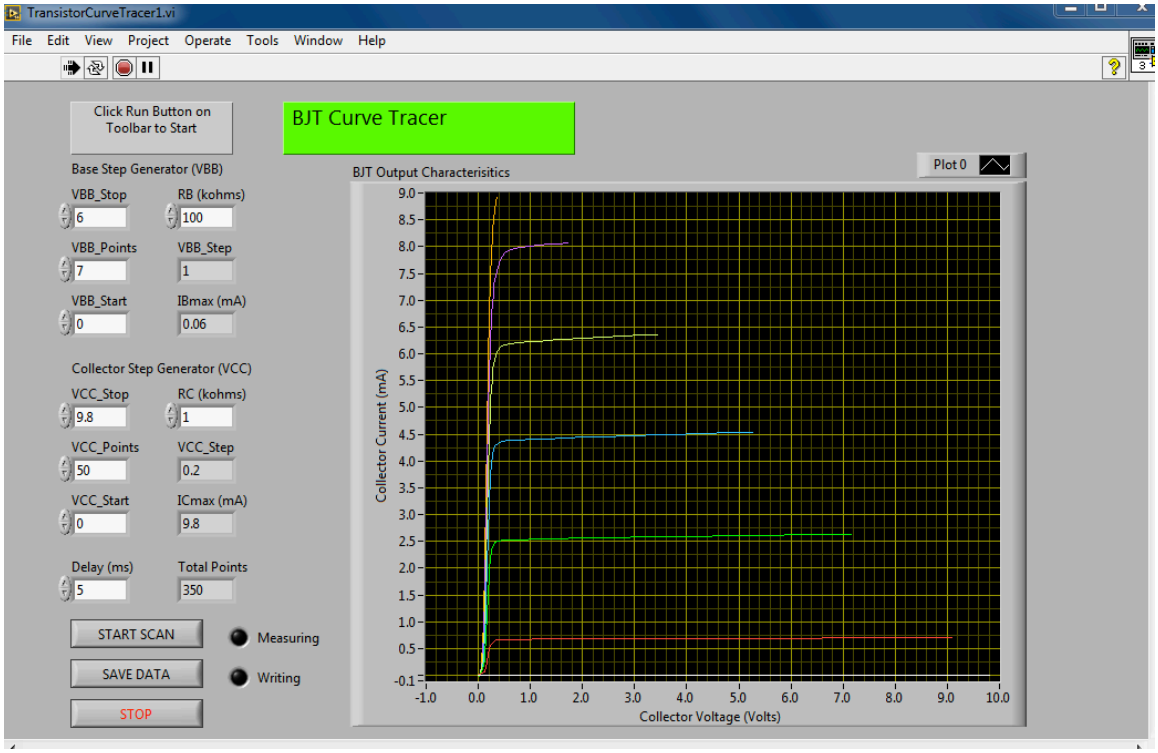
Channels	1	
Samples	40	
Date	########	
Time	10:09.4	
Y_Unit_Label	Volts	
X_Dimension	Time	
X0	0.00E+00	
Delta_X	0.0005	
End_of_Header		
X_Value	Voltage	Comment
	-0.00518	
	0.00481	
	-0.00583	
	0.004165	
	-0.00454	
	0.004488	
	-0.00486	
	0.004165	
	-0.00518	
	0.004165	
	-0.00486	
	0.004165	
	-0.00454	
	0.003843	
	-0.00486	
	0.004488	
	-0.00486	
	0.00481	
	-0.00518	
	0.004488	
	-0.00454	
	0.004488	
	-0.00486	

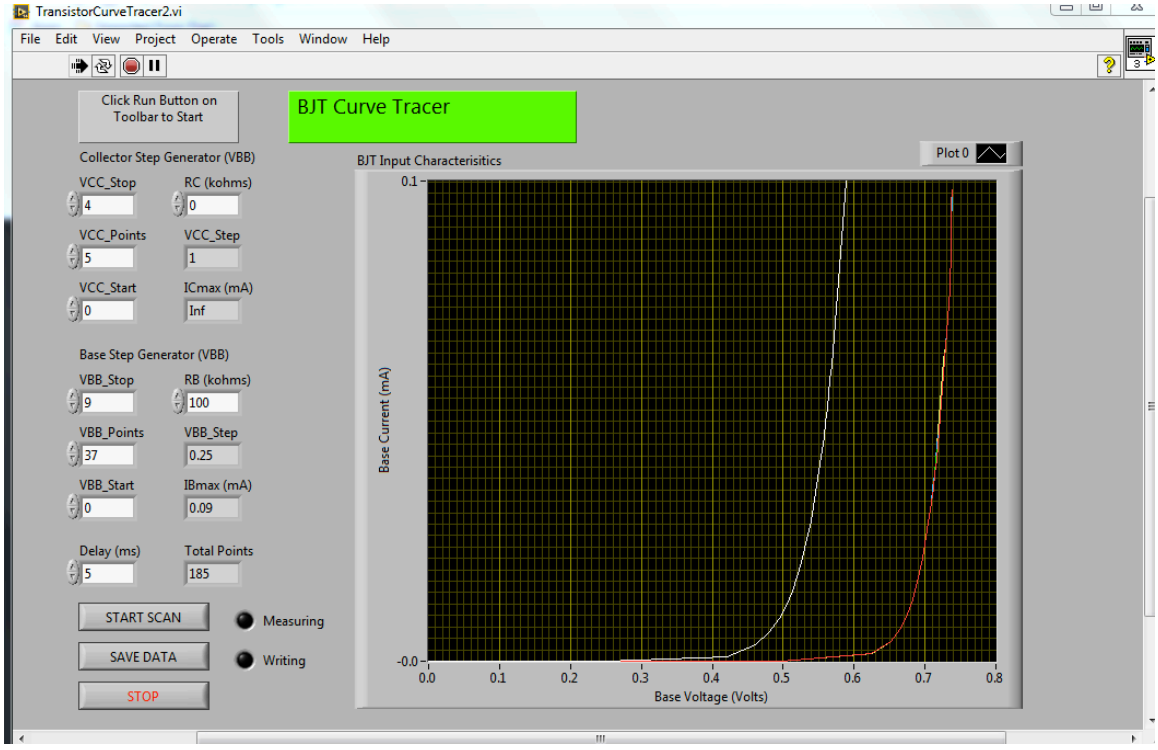
	0.00481	
	-0.0055	
	0.004488	
	-0.00518	
	0.003843	
	-0.00518	
	0.004165	
	-0.00486	
	0.003521	
	-0.00518	
	0.004488	
	-0.00518	
	0.004165	
	-0.00486	
	0.004165	
	-0.0055	
	0.004488	

I-V Plot of Diode



I-V Plots of BJT





The data file for BJT input characteristics. The data in the file are recoded in ix columns corresponding to power supply voltage, collector current, and bas current. Unit of current is mA

h-Parameters, V_A

Only show some of the data

V_{CE} (V)	I_C (mA)	V_{BE}	I_B (mA)
0.498	2.598	0.627	0.011
0.698	2.598	0.635	0.014
0.894	2.607	0.64	0.016
1.094	2.607	0.645	0.019
1.279	2.627	0.649	0.021
1.479	2.627	0.654	0.023
1.68	2.627	0.659	0.026
1.875	2.637	0.664	0.028
2.075	2.637	0.667	0.031
2.271	2.646	0.669	0.033
2.471	2.646	0.674	0.036
2.666	2.656	0.676	0.038
2.866	2.646	0.679	0.041
3.066	2.646	0.681	0.043
3.257	2.666	0.684	0.046
3.462	2.656	0.686	0.048
3.652	2.676	0.688	0.051
3.857	2.666	0.691	0.053
4.053	2.676	0.693	0.056
4.253	2.676	0.696	0.058
4.453	2.676	0.698	0.061

$$h_{IE} = \frac{\Delta V_{BE}}{\Delta I_B} \qquad V_{CE}\text{=constant}$$

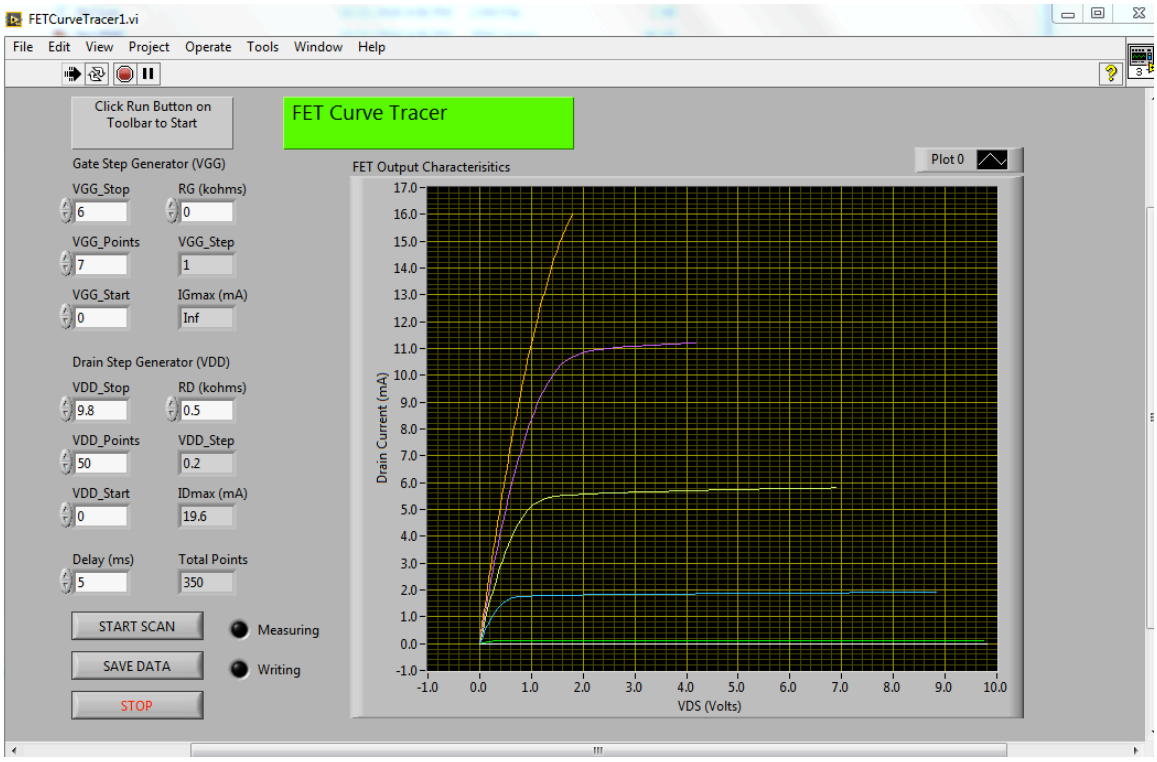
$$h_{FE} = \frac{\Delta I_C}{\Delta I_B} \qquad V_{CE}\text{=constant}$$

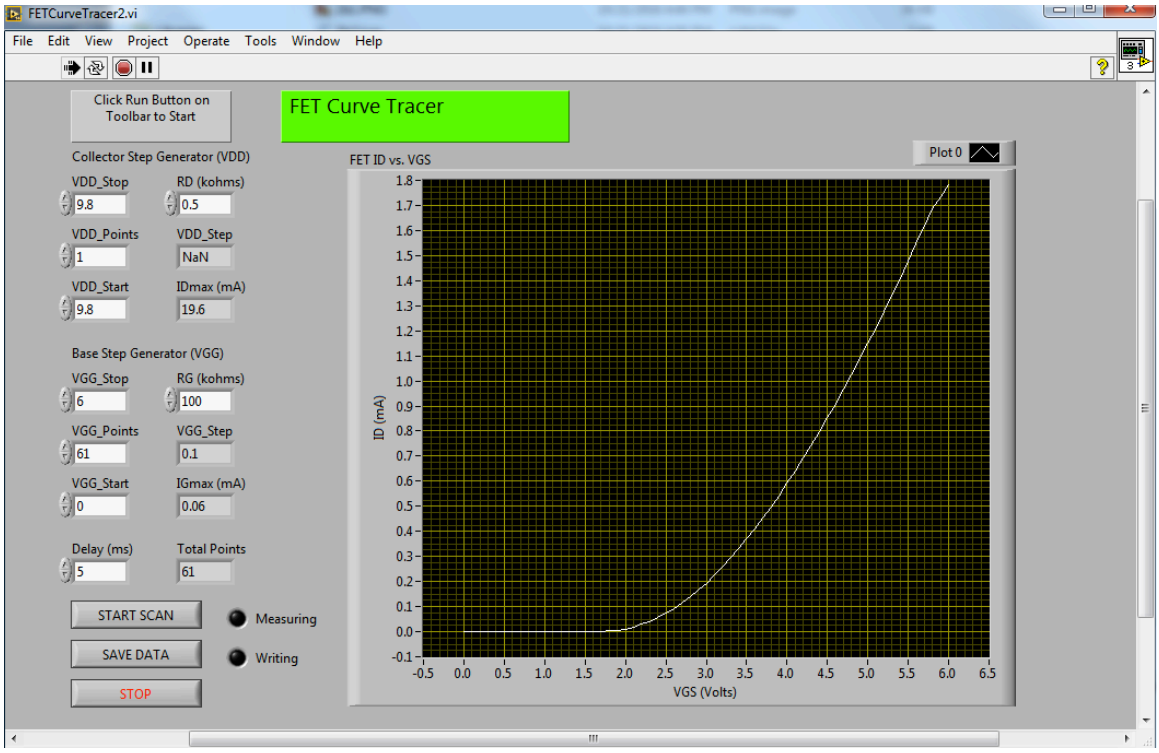
$$h_{OE} = \frac{\Delta I_C}{\Delta V_{CE}} \qquad I_B\text{=constant}$$

We also obtain the h-parameters:

h_{OE}	h_{FE}	h_{RE}	h_{IE}
0.020	1.601	0.015	1.235

I-V Plot of MOSFET





Vp and Idss

When V_{GS} is below the pinch-off voltage, V_P, there is no current. I_D versus V_{GS} curve above pinch off can be fitted with the following parabolic equation:

$$I_D = \frac{I_{DSS}}{V_P^2} \cdot (V_{GS} - V_P)^2$$

Discussion and Conclusion

Sampling rate determines the sound frequency range (corresponding to pitch) which can be represented in the digital waveform. The range of frequencies represented in a waveform is often called its bandwidth. Waveforms sampled at a high sampling rate can represent a broad range of frequencies and hence have broad bandwidth. In fact, the maximum bandwidth of a sampled waveform is determined exactly by its sampling rate; the maximum frequency representable in a sampled waveform is termed its Nyquist frequency, and is equal to one half the sampling rate. Thus, for example, a waveform sampled at 16,000 Hz can represent all frequencies up to its Nyquist frequency of 8,000 Hz.

A problem called aliasing occurs when a signal to be sampled contains energy at frequencies above the sampling Nyquist frequency. The figure above illustrates how aliasing would occur when the sampling rate is much too low for the frequency of an input signal. The solid curve represents the analog signal at a comparatively high frequency. Some samples were taken at a relatively low sampling rate. The dotted line illustrates the apparent frequency of the sampled waveform, completing about two cycles in the period that the original signal completed 20 cycles.

Obviously, aliasing has the effect of producing sounds of lower frequency from sounds that are higher in frequency than the Nyquist frequency. Once aliasing has occurred, it is absolutely impossible to distinguish a component generated by aliasing from one that was actually present in the input signal. This effect is one of the most common sources of distortion in digitized waveforms. Fortunately, most modern computer hardware for digitizing sound has builtin filters which are tuned to remove

sound energy at frequencies beyond the Nyquist frequency for whatever sampling rate is being used.