Monolithic Integrated Circuit Function Generator Lab Procedure

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Abstract

This laboratory exercise will use the XR2206 monolithic IC function generator. The approach will place emphasis on the evaluation of specifications from Exar's data sheets in comparison to laboratory measured data. The exercise will explore the parameters for setting frequency, amplitude, and waveform shape. The use of the function generator to produce amplitude modulation and frequency modulation signals will also be demonstrated. A complete schematic of a circuit suitable for construction will be provided.

Introduction

The objective of the development of the circuit for this laboratory exercise was to exploit the XR2206 wide sweep range of 2000:1 to produce an audio function generator capable of frequencies from 20 Hz to 20kHz with only one range selection. Students are required to use the manufacturer's data sheet to analyze the requirements to set the frequency, amplitude and waveform shape of the output. Using the generator to drive a speaker provides the opportunity to examine the effect of the 600Ω output impedance on a 4Ω or 8Ω speaker. This can initiate a discussion of how to decrease the output impedance using operational amplifiers and voltage followers. The amplitude and frequency modulation features usually will increase the students' natural curiosity. The frequency modulation (FM) can produce some very interesting audio effects. Students should be encouraged and motivated to explore changing frequencies using the frequency shift keying (FSK) feature. The amplitude modulation (AM) feature can be demonstrated in an exciting fashion by changing the timing capacitance value to produce an approximate 600kHz signal in the AM broadcast frequency band. The modulation frequency can be heard on a standard AM radio receiver positioned close to the circuit. The positive and negative nine volts for the power supply was chosen for simplicity. The use of two nine volt batteries with the circuit provided for construction will result in a totally functional audio signal generator project. The author would like to encourage you to implement the use of the following laboratory exercise in the education of students.

Integrated Circuit Function Generator Laboratory Exercise

I. Activities to be completed before completing this lab exercise:

A. Read the XR2206 data sheets at http://www.exar.com/products/xr2206.html.
B. Complete all calculations and record all expected values in all tables.
C. Construct the circuit in Figure 1 and Figure 3 as shown below

II. Objectives:

A. You will be able to use manufacturer's data sheets obtained from the worldwide web.
B. You will be able to utilize the information obtained from data sheets to predict the operation of XR2206 circuit.

III. Procedure – Amplitude and Frequency Adjustments:

A. Examine the waveform at pin 2 with an oscilloscope and a digital meter (DMM).
B. Adjust the 100kΩ to 25kΩ and the 1MΩ pot to the minimum resistance.
C. Draw the triangle waveform on Figure 2 using a dashed line.
D. Close the sine/triangle switch.
E. Draw the sine waveform on Figure 2 using a solid line.
F. Observe the waveform at pin 11 (Ch2) in preparation for the analysis activity.
G. Measure and record the values for the quantities in Table 1.
H. Adjust the output for an 8 volts peak to peak sine wave at a frequency of 1000Hz.
I. Measure and record the value of resistance of the 100kΩ pot for the previous output.

IV. Procedure – Amplitude Modulation (AM):

A. Connect V_{IN} Figure 3 to common and adjust the 1kΩ pot for 0V Vout.
B. Connect Vout to pin1 of the XR2206.
C. Observe the amplitude at pin2 as the 1kΩ pot is varied for a Vout of +4V to –4V. Make a mental note for the analysis activity by comparing the effect to the expected.
D. Remove V_{IN} from common. Then connect V_{IN} to a 1Vpp 1 Hz sine wave from the lab function generator. Observe the effect on the output at pin 2 while changing the waveform from sine to triangle to square and back to a sine wave.
E. Change the 0.047µF capacitor to a 220pF capacitor and change V_{IN} to 1Vpp @1kHz.
F. Draw the waveform at pin 2 on Figure 4 of the amplitude-modulated output.

V. Procedure – Frequency Modulation (FM):

A. Connect Vout of the circuit in Figure 5 to pin 7 of the XR2206 with setup in III-H.
B. Observe the waveform at pin 2 while changing V_{IN} from sine to triangle to square and back to a sine wave. Then, vary the frequency of V_{IN}. Make a mental note for the analysis activity by comparing the observed to the expected effect.

Data:

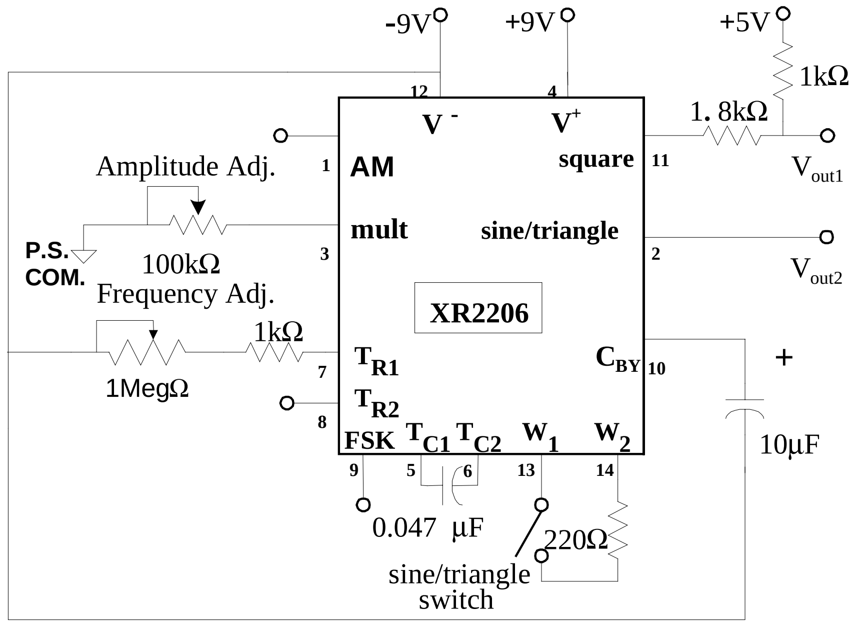

Figure 1: Dual ± 9 volt supply wiring diagram

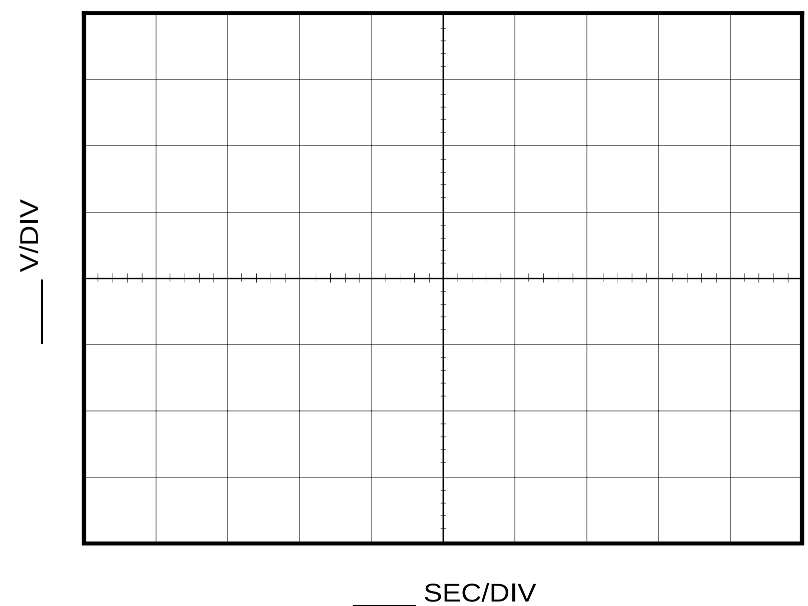

Figure 2. Pin 2 output with a solid line for the sine wave and a dashed line for the triangle wave

Quantity	Vout2 p-p Tri. @25k	Vout2 p-p Sine @25k	Freq. out maximum	Freq. out minimum	R_{1Meg} @1kHz	R_{100k} 8Vpp	V_{DC} @pin 2	V_{DC} @pin 3	V_{DC} @pin 7
Expected									
Measured									
% Error									

Table 1. Frequency and Amplitude Adjustment Measurements

Data Continued: Amplitude Modulation

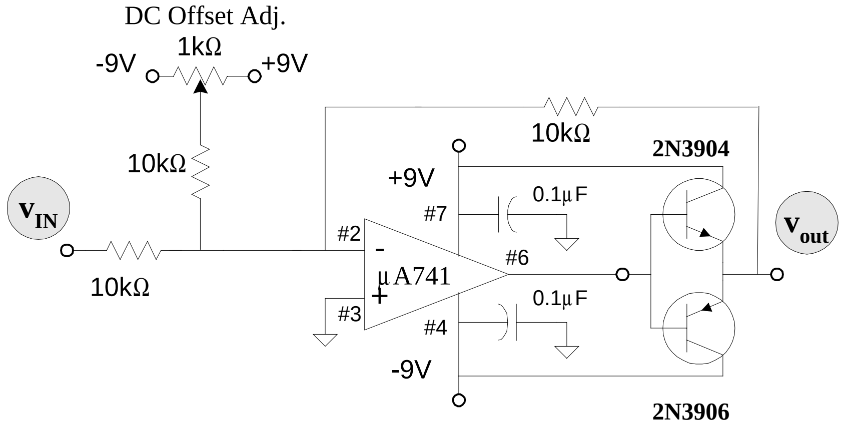

Figure 3. Inverting Summer Signal Conditioning Amplifier for Amplitude Modulation

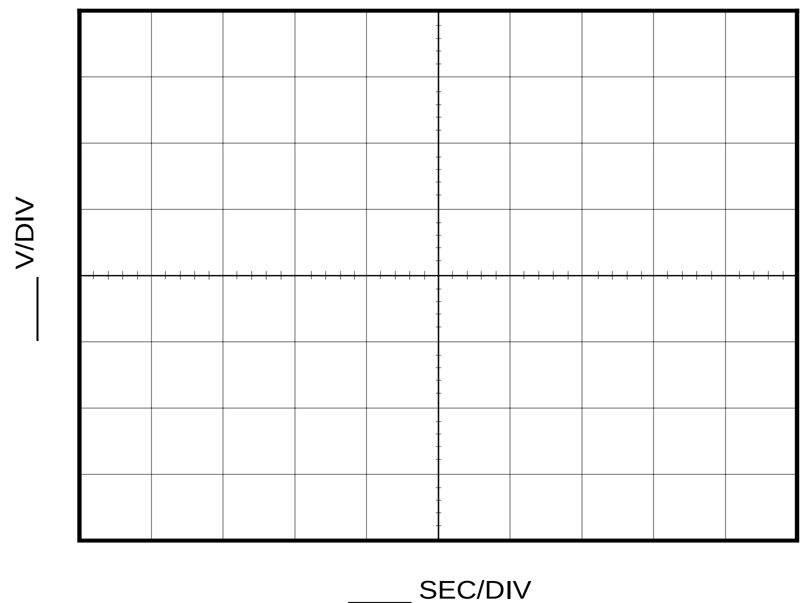

Figure 4. Amplitude Modulated waveform at pin 2

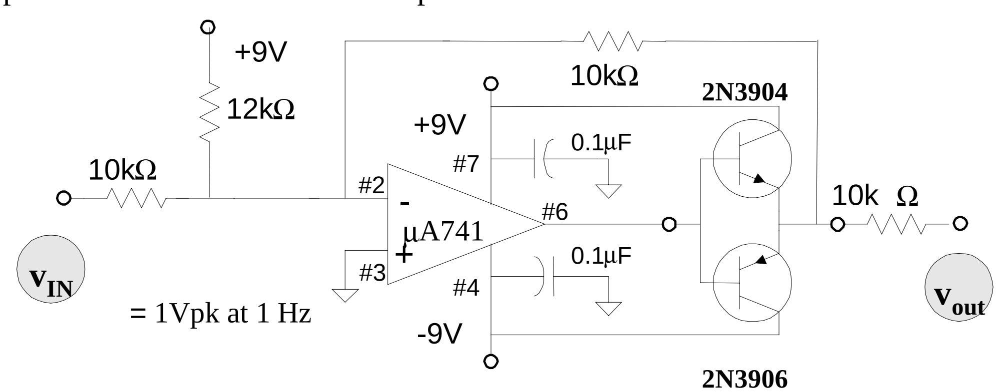

Figure 5. Inverting Summer Signal Conditioning Amplifier for Frequency Modulation

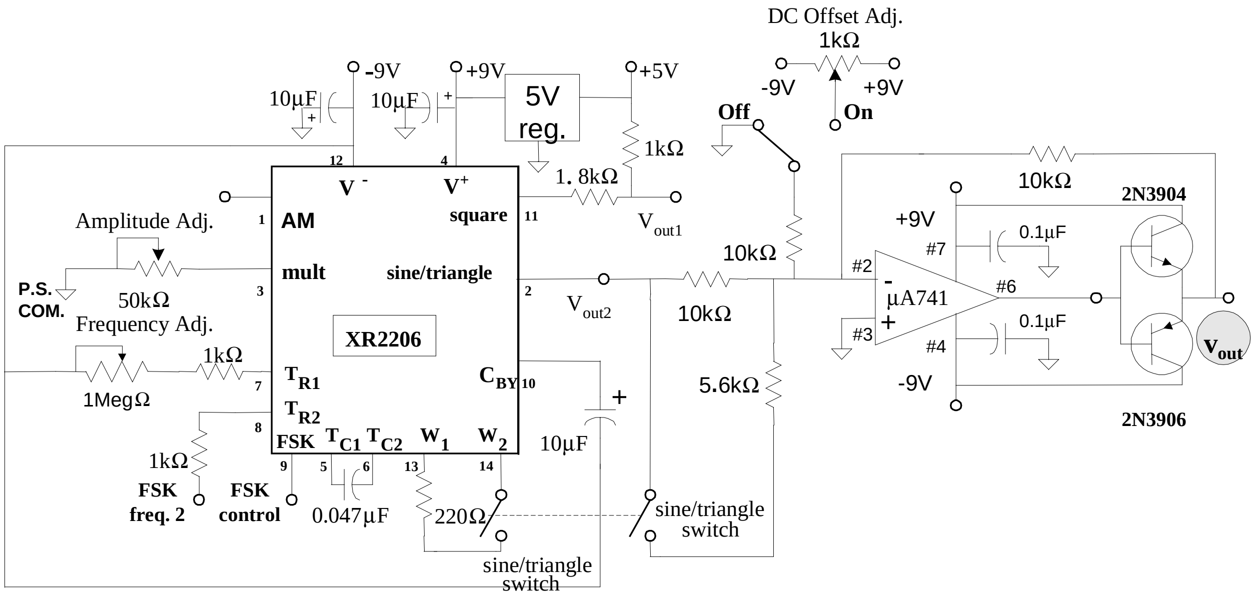

Figure 6. Complete Connection Diagram for the Audio Sine/Triangle/TTL Function Generator

Conclusion

There are obvious rewards from early exposure to using the world wide web to examine data sheets of integrated circuits. The students' heightened awareness of what resources are available is increased. This provided a valuable and rewarding "surfing" experience increasing student knowledge of the technical support resources that are easily accessible. The increased awareness and knowledge of amplitude and frequency modulation will prove beneficial in several advanced topics in future courses. Completing the construction of the audio generator project should serve to motivate students toward continued exploration of several related topics.

Bibliography

1. Exar Integrated Systems, *XR2206 Monolithic Function Generator Data Sheet*, Exar, Sunnyvale, Calif.

2. Fahlsing, Theodore E. 1999. Introducing Applications Design into a First Year Electronics Devices Course. American Society for Engineering Education

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