LMV822,LMV932

A Quick Sine Wave Generator

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Technology Edge

A Quick Sine Wave Generator

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In various design and test situations, a sine wave signal with an arbitrary frequency may be needed. The following design, and accompanying Excel spreadsheet implement a sine wave generator that can be quickly assembled with a dual op amp and small number of resistors and capacitors. Figure 1 shows the schematic for the quick sine wave generator:

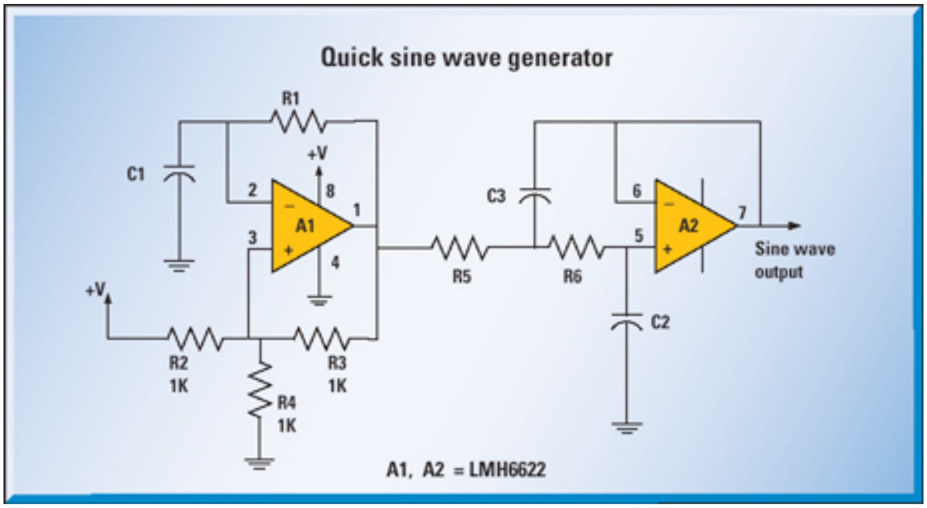

Figure 1

This circuit generates a sine wave by first generating a square wave, at the required frequency, with amplifier A1 that is configured as an astable oscillator with the frequency determined by R1 and C1. The two-pole low pass filter, using A2, filters the square wave output from A1. The filter is a unity gain Sallen-Keys filter with its cut off frequency equal to the square wave frequency from A1. The square wave is made up of the fundamental frequency and the odd harmonics of the fundamental frequency. The filter removes most of the harmonic frequencies and the fundamental frequency remains at the output of A2. The fundamental frequency component of a square wave is about 1.27 times the peak amplitude of the square wave and the amplitude of the sine wave output will be approximately 87 percent of the peak of the square wave. The peak of the square wave will depend on the amplifier’s supply voltage and the output swing specification of the amplifier. Additionally, the peak of the square and the sine wave will track changes in the amplifier’s supply voltage.

In this design, the frequency is specified along with the value of C1 and based on these values, the values of R1, C2, C3, R4, and R5 are calculated. The values of R2, R3 and R4 are 1K Ohms and should be matched in value to help minimize errors in the actual frequency of operation compared to the calculated frequency of operation.

The equations for the component selection follow. The frequency, F, is the required sine wave frequency. The value for C1 is selected arbitrarily, with a value of 0.001 µfd being a good initial value for 1 MHz. The other component values are calculated as follows:

$$C2 = C1$$
$$C3 = 2C1$$
$$R1 = \frac{\frac{1}{2} F}{.693 \cdot C1}$$
$$R6 = R5$$
$$R5 = \frac{1}{8.8856 \cdot F \cdot C1}$$

An Excel speed sheet is available online that will calculate the component values given the frequency and C1. The spreadsheet will also give the nearest 1% resistor values to the calculated resistor values. Given that the required frequency is 1 MHz and C1 is 0.001 µfd, the following is an example of the spreadsheet results:

Frequency =	1000000		Calculated value	Nearest 1% resistor value
C1 =	0.001			
		R1 =	721.5	715
		C3 =	0.002	
		R5 = R6 =	112.5	113

$$F = 1\ \text{MHz}$$
$$C1 = 0.001\ \mu\text{fd}$$
$$C2 = 0.001\ \mu\text{fd}$$
$$C3 = 0.002\ \mu\text{fd}$$
$$R1 = 715\Omega$$
$$R5 = 113\Omega$$
$$R6 = 113\Omega$$

The accuracy of the actual frequency of operation, compared to the calculations, will be dependent on the tolerance of the components used around amplifier A1. The tolerance of the component value used around A2 will affect the filter's pole locations and will affect the amplitude of the filtered sine wave.

The Excel spreadsheet will calculate component values given the frequency required and the value of C1 and is easy to use. Enter the frequency, in Hz, in cell B2 and enter the capacitance of C1 in µfd, in cell B4. The other component will be calculated with the resistance in Ohms and the capacitance in µfd.

The characteristics of the amplifier selected will also affect the range of component values selected. In the example, a high-speed amplifier is being used and the resistor values should be kept low (below about 15 K W) to minimize the effects of the input bias currents of this type of amplifier. High–bandwidth amplifiers will need power supply bypass capacitors and component layout may affect performance. If a lower frequency oscillator is required, a lower bandwidth amplifier such as the LMV822 or LMV932 could be used. The lower input bias currents of these devices will work with a wider range of resistor values and component placement is not as critical. The bandwidth of the amplifier should be at least 10 times the frequency of oscillation. Assembling the circuit using the calculated component values has the following performance, see Figure 2:

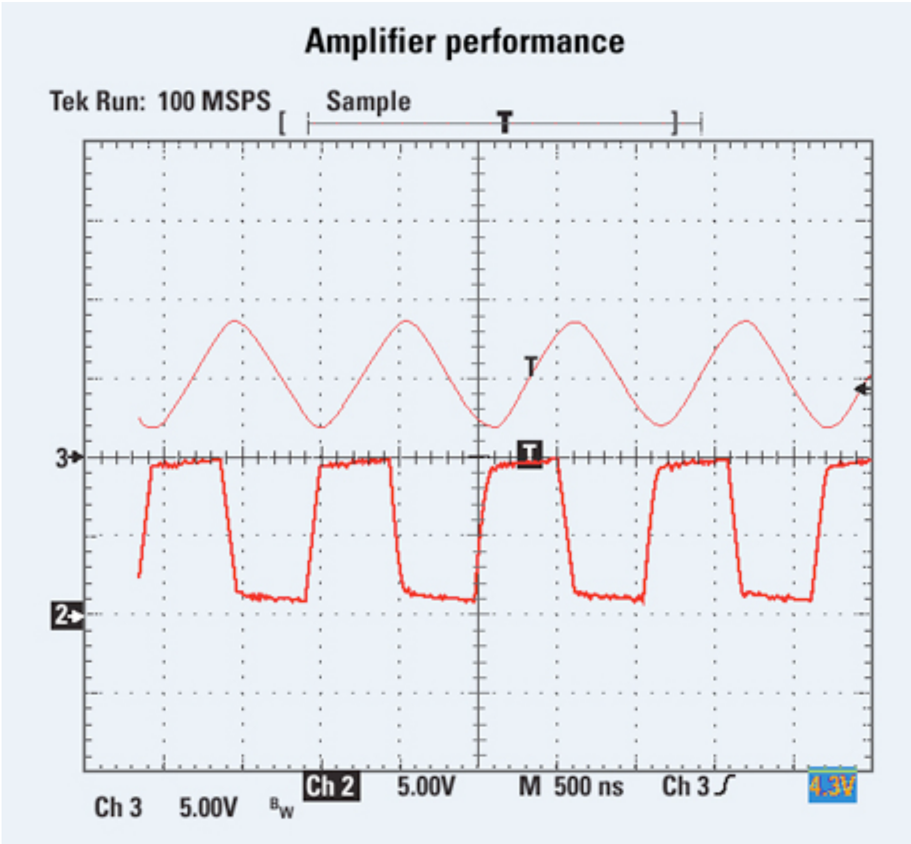

Figure 2
Oscillator Output (Pin1) and Sine Wave Output (Pin7) Waveforms

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