LICD 27 dated 18-09-2018

Topics Covered: Design of Square wave generator using opamp (with LT Spice simulation and verification of the design), concept of Voltage limiting in square wave generator and triangular waveform generator circuit (with LT Spice simulation of the circuit), Use of clock in digital system, Revisited 3 opamp Instrumentation amplifier and its formula + LT Spice simulation, Disadvantages of 3 opamp IA of using 7 external resistors, Necessity of Instrumentation amplifier Monolithic IC AD620 (Single gain Programmable Instrumentation amplifier + with LT Spice simulation of the circuit)

Design a square-wave oscillator for $f_o = 1KHz$ with $\pm V_{sat} = 10V$ 01 12/9/18

Solution:- $T = 2RC \ln\left[\frac{1+\beta}{1-\beta}\right]$ --- for Astable Multivibrator

$$\beta = \frac{R_2}{R_1 + R_2}$$

let $R_1 = R_2 = 10K\Omega, \frac{1}{4}W$

ie $\beta = \frac{1}{2}$

ie $T = 2RC \ln\left[\frac{1.5}{0.5}\right]$

$\therefore T = 2RC \times (1.0986)$

$T = 2.197\,RC$

$f_o = 1KHz$ --- given

$f_o = \frac{1}{T}$

ie $1KHz = \frac{1}{2.197\,RC}$

$RC = 0.455 \times 10^{-3}$

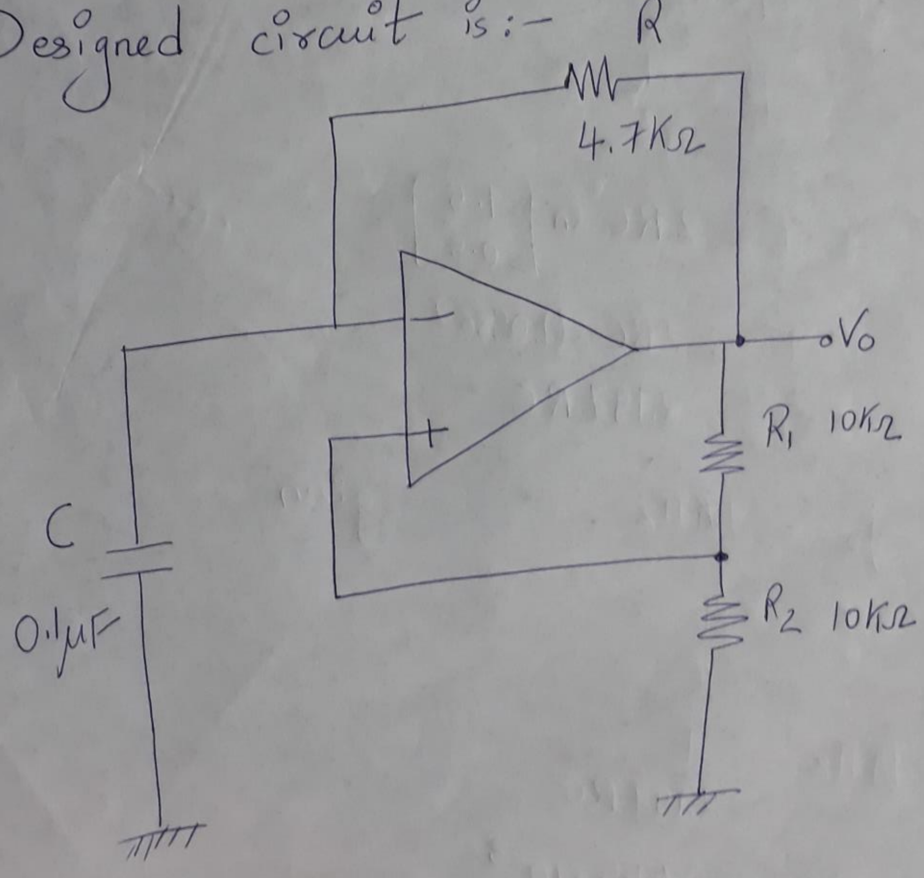
Let $C = 0.1\mu F$

i.e. $R = \dfrac{0.455 \times 10^{-3}}{0.1 \times 10^{-6}}$

$$\boxed{R = 4.55 K\Omega}$$

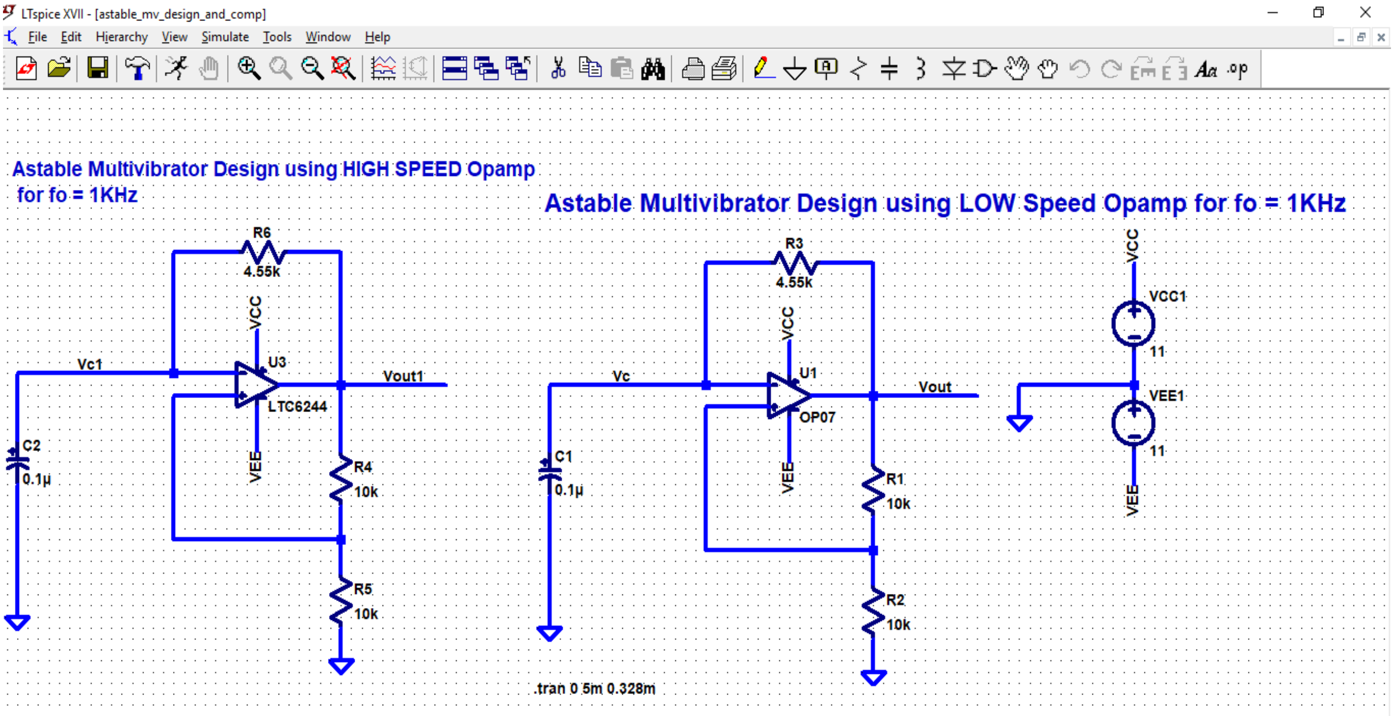
Select $\underline{R = 4.7K\Omega, 1/4W}$

→ Designed circuit is:-

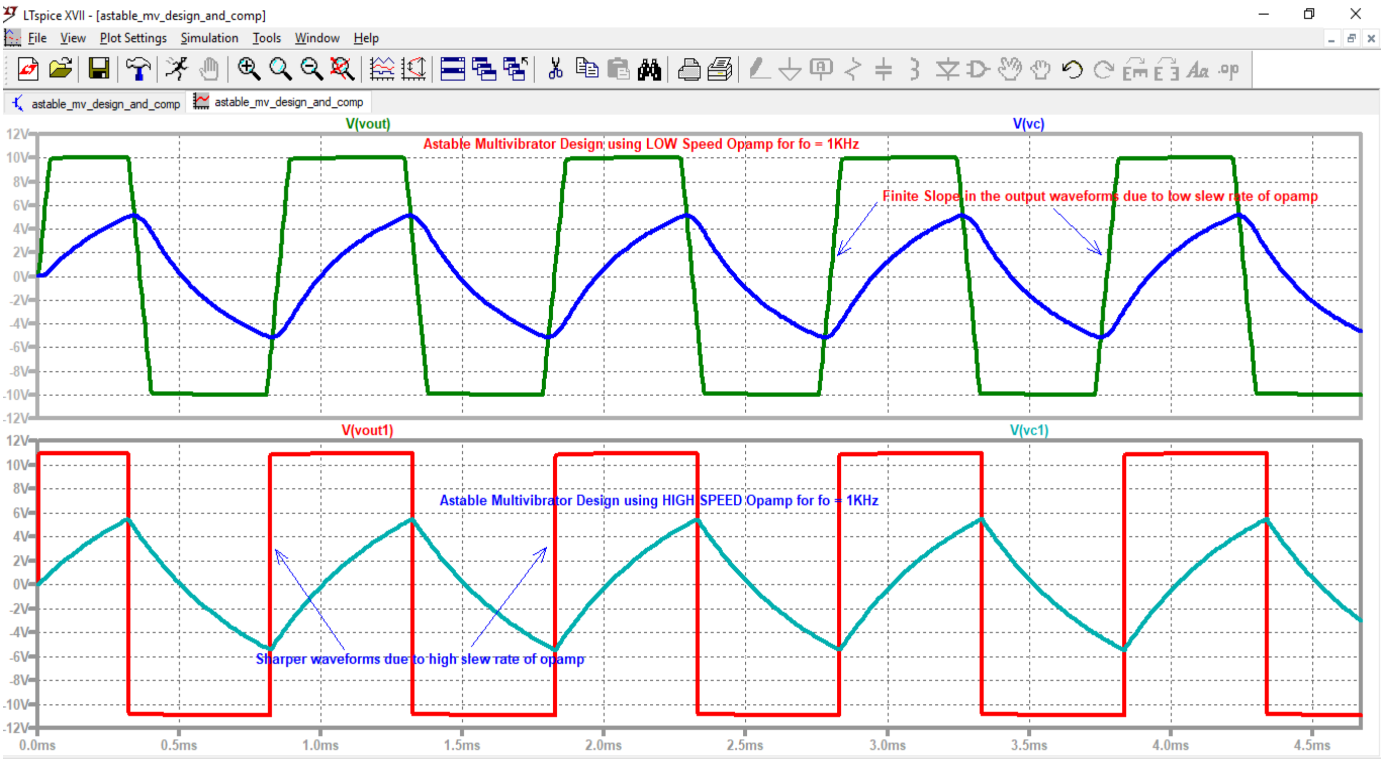


Simulation was carried out in LT Spice and simulation results were discussed in class

Topics: Designed Circuit for Square waveform generator/ Astable Multivibrator

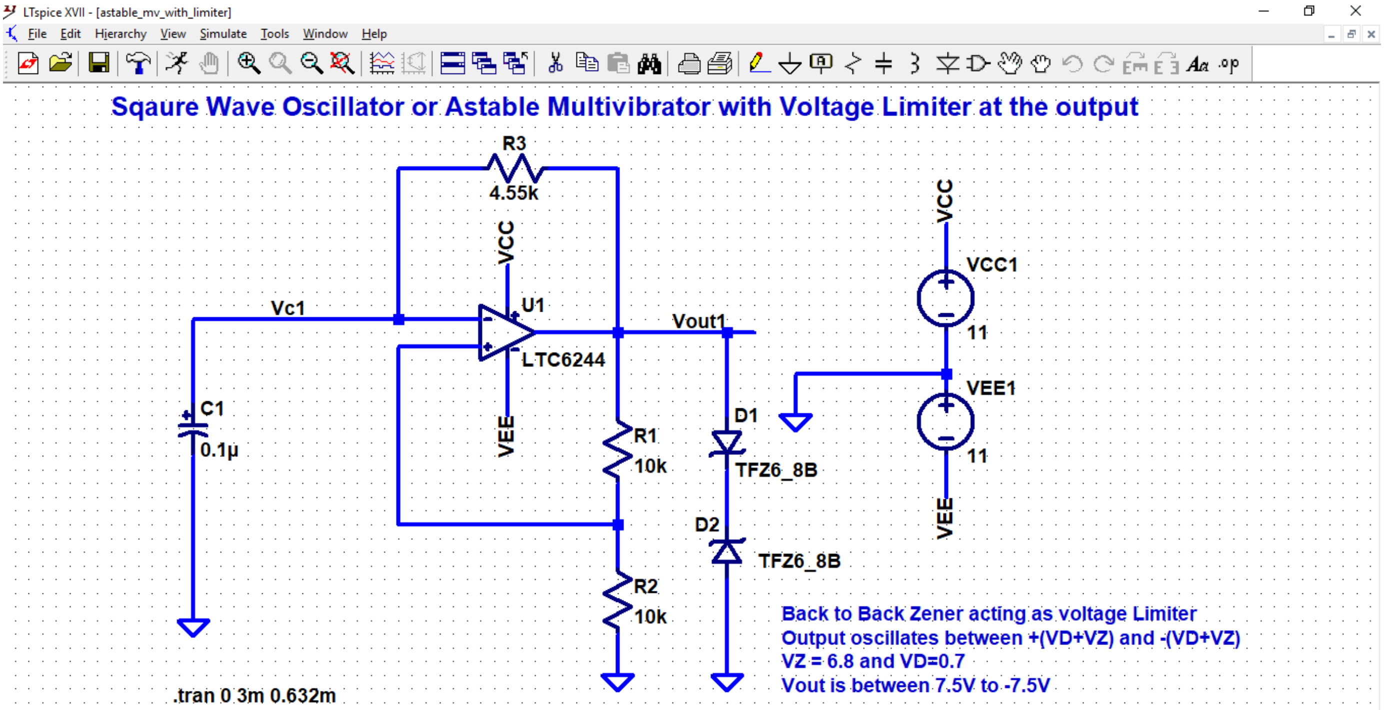


Output Square waveforms (Very Sharp waveforms for High Speed Opamp)

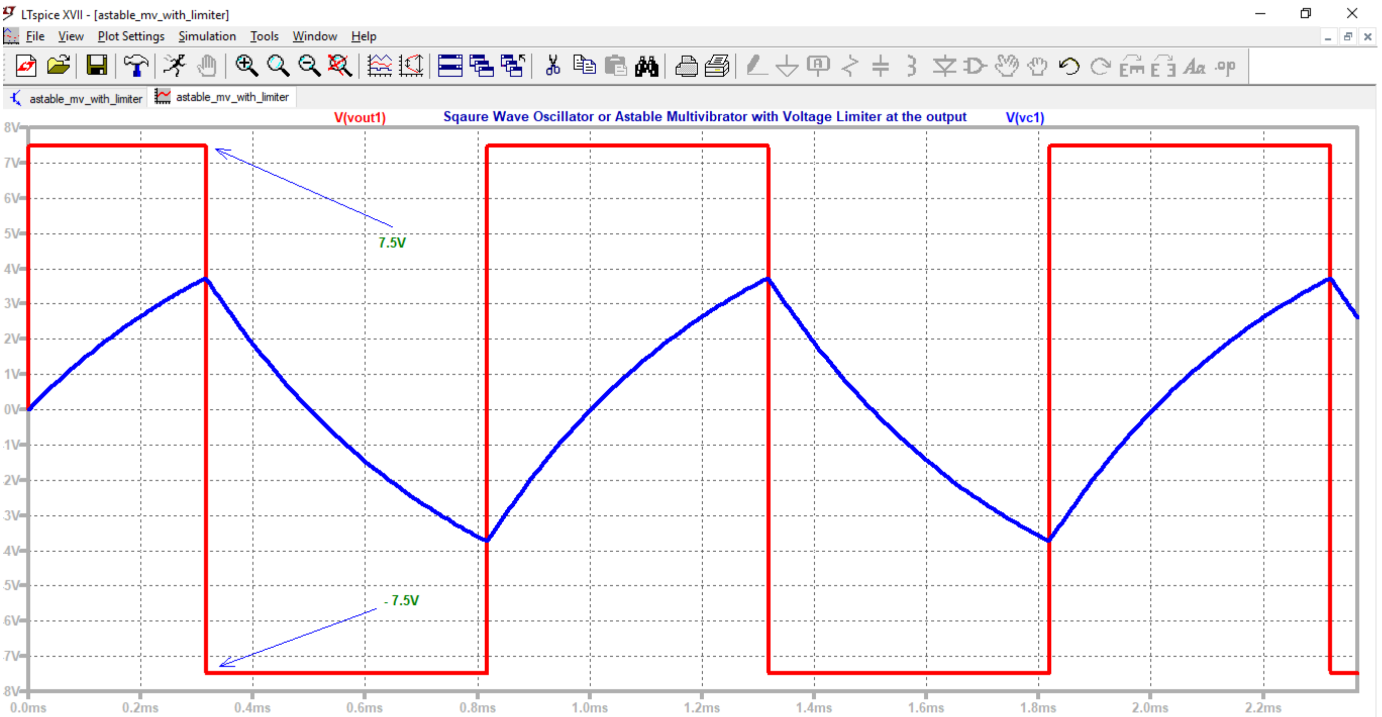


Simulation was carried out in LT Spice and simulation results were discussed in class

Topics: Square waveform generator/ Astable Multivibrator circuit with Voltage Limiter

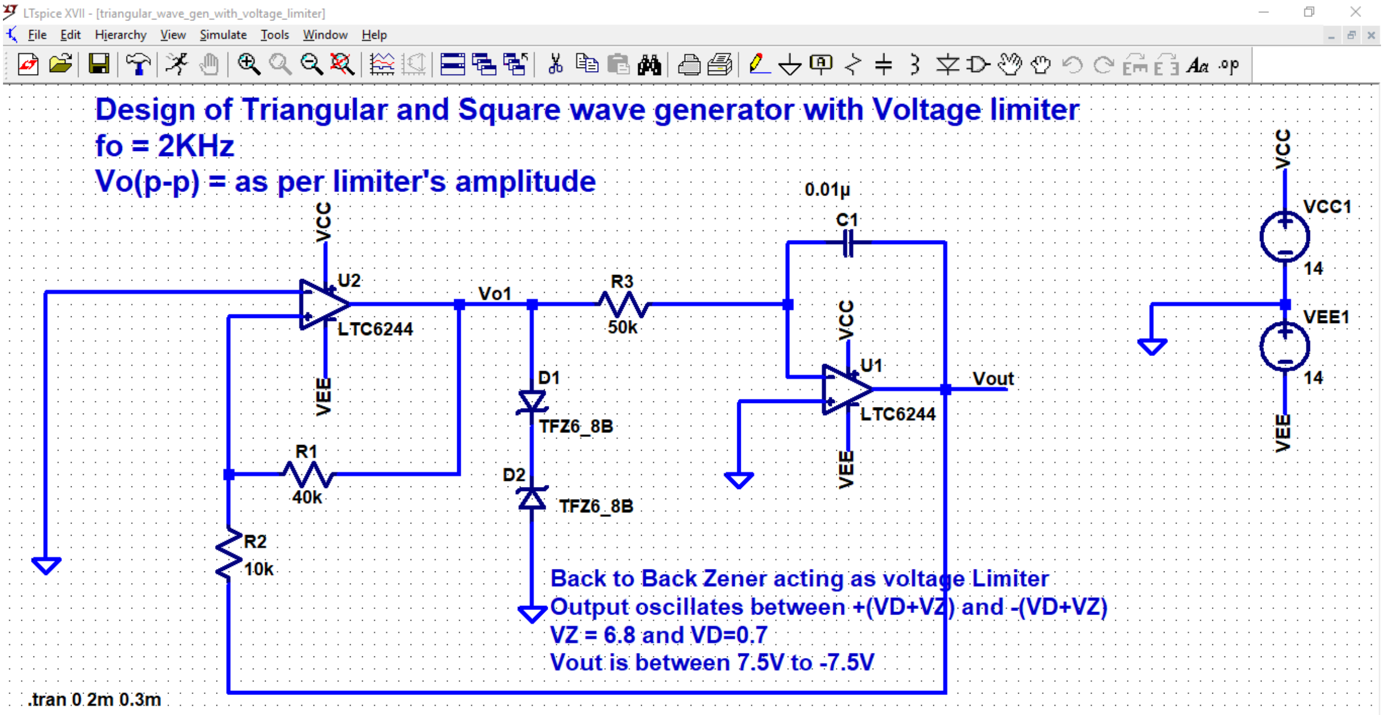


Output Square waveforms with voltage Limiter

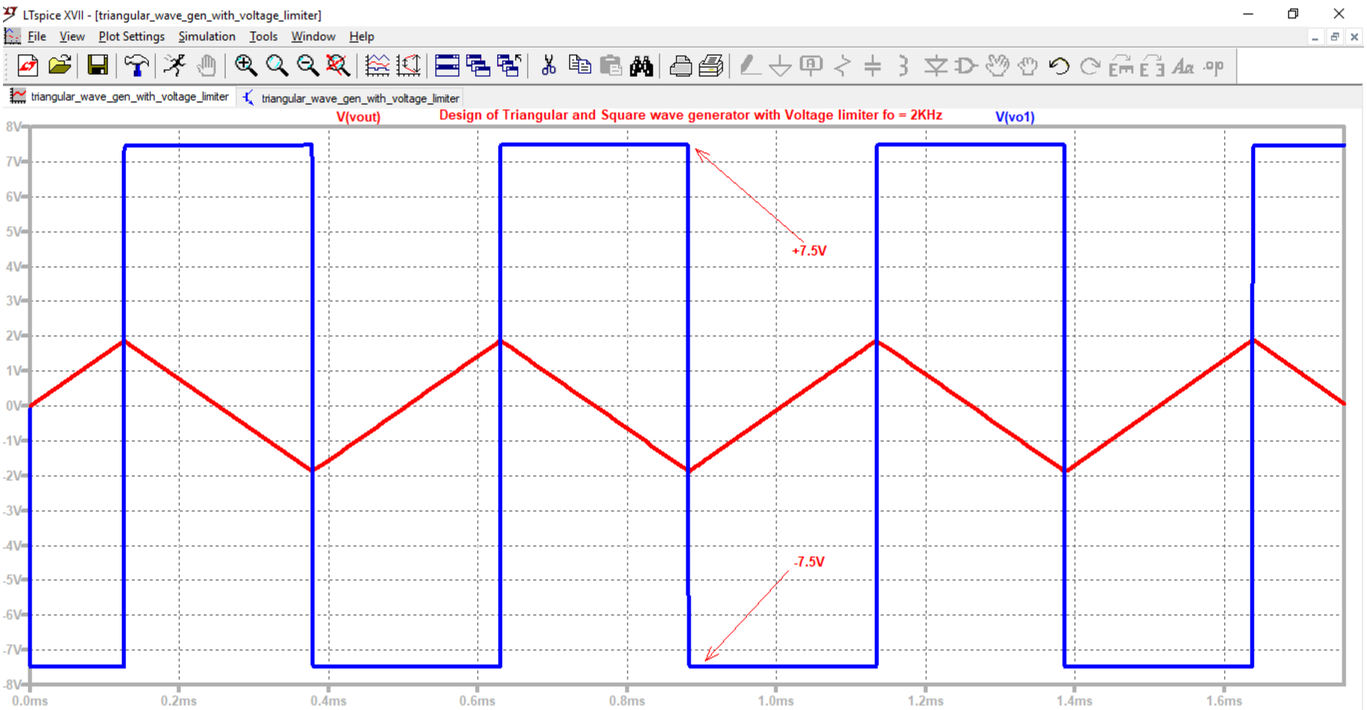


Simulation was carried out in LT Spice and simulation results were discussed in class

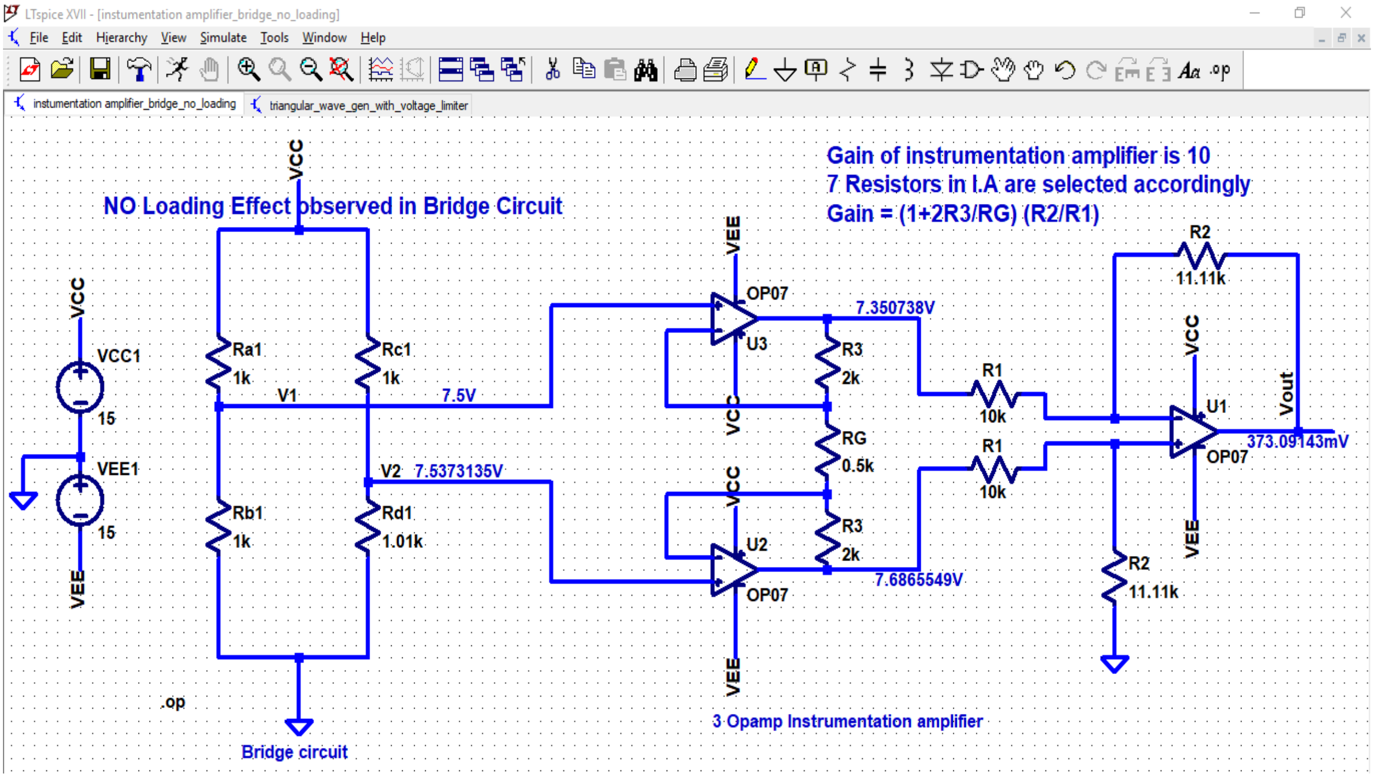
Topics: Triangular and Square waveform generator circuit with Voltage Limiter



Output Triangular and Square waveforms with voltage Limiter



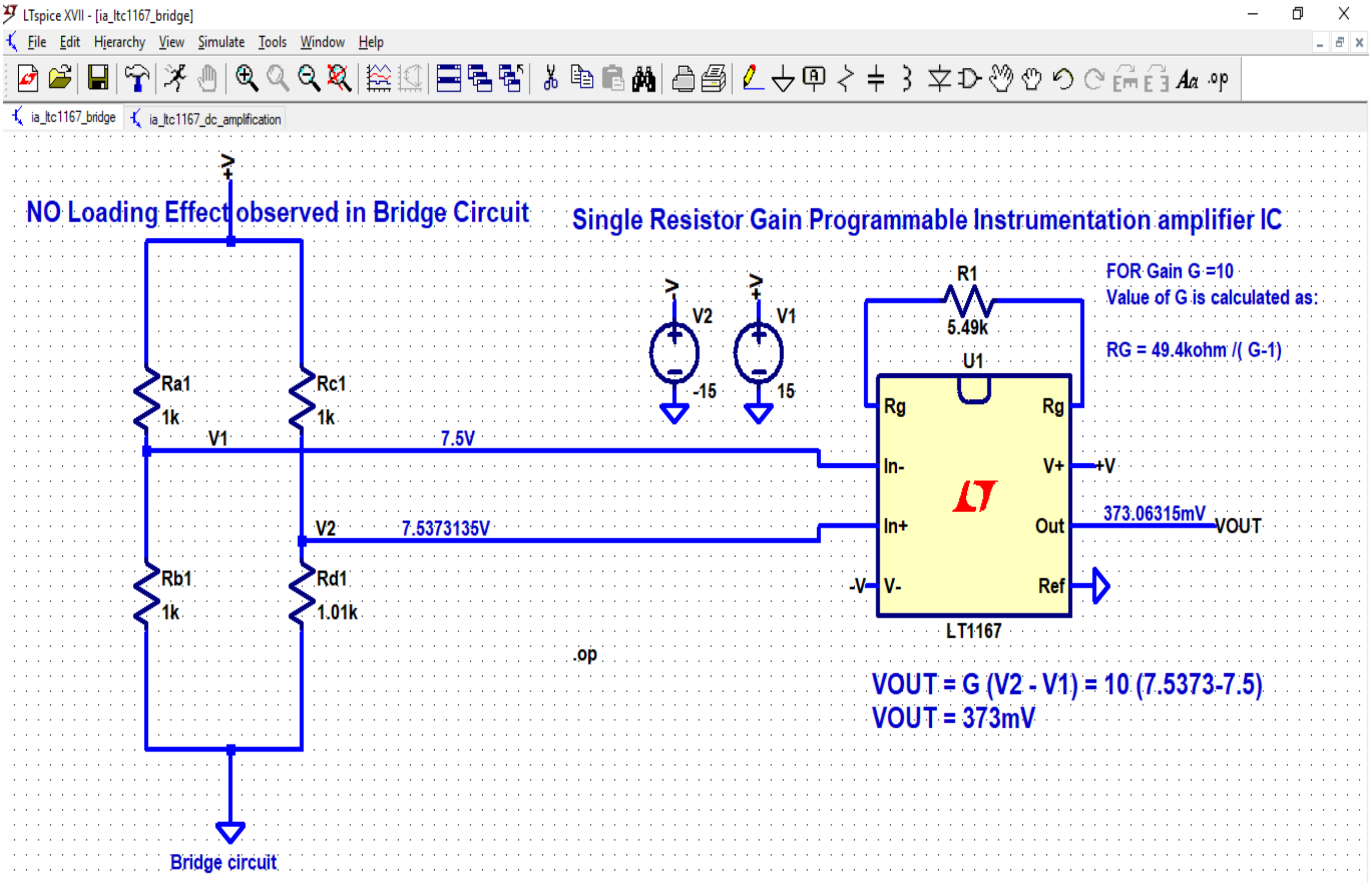
NEED OF Monolithic Instrumentation IC AD620



In the above circuit, we learn that ….. → To set a fixed precise gain in 3 opamp Instrumentation amplifier, we need 7 external resistors of closely matched and accurate values (which is never practically realizable.... That's why we go for Instrumentation amplifier IC)

There are other advantage of Instrumentation Amplifier in IC form, which we will see shortly.

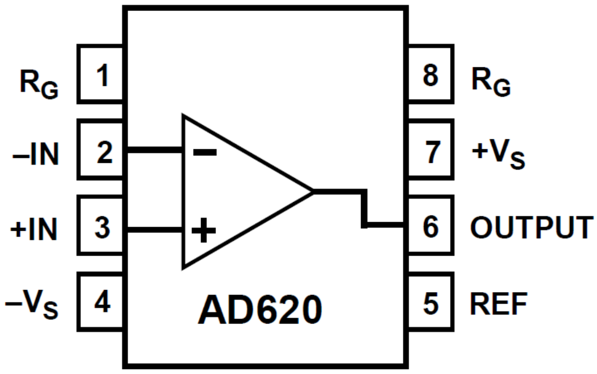
In contrast to above Circuit of 3 opamp Instrumentation amplifier where 7 resistors were used to set Gain of 10….. NOW with Instrumentation amplifier IC we can easily and precisely set the Gain of 10 using ONLY single external resistor RG



INSTRUMENTATION AMPLIFIER AD620

(This topic can be a contender for Short note type question in exams)

CONNECTION DIAGRAM

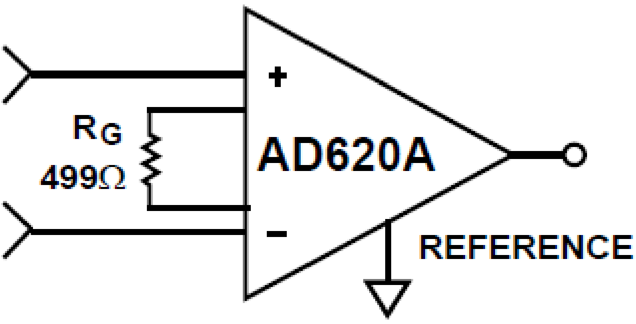


TOP VIEW

Description:

The AD620 is a low cost, high accuracy instrumentation amplifier that requires only one external resistor to set gains of 1 to 10,000.

The AD620 is a monolithic instrumentation amplifier based on a modification of the classic three op amp approach. Monolithic construction and laser wafer trimming allow the tight matching and tracking of circuit components, thus ensuring the high level of performance.



AD620A MONOLITHIC INSTRUMENTATION AMPLIFIER, G = 100

SUPPLY CURRENT = 1.3mA MAX

GAIN SELECTION

The AD620 gain is resistor-programmed by R_G, or more precisely, by whatever impedance appears between Pins 1 and 8. The AD620 is designed to offer accurate gains using 0.1% to 1% resistors. Table 5 shows required values of R_G for various gains. Note that for G = 1, the R_G pins are unconnected ($R_G = \infty$). For any arbitrary gain, R_G can be calculated by using the formula:

$$R_G = \frac{49.4\,k\Omega}{G-1}$$

Table 5. Required Values of Gain Resistors

1% Std Table Value of R_G(Ω)	Calculated Gain	0.1% Std Table Value of R_G(Ω)	Calculated Gain
49.9 k	1.990	49.3 k	2.002
12.4 k	4.984	12.4 k	4.984
5.49 k	9.998	5.49 k	9.998
2.61 k	19.93	2.61 k	19.93
1.00 k	50.40	1.01 k	49.91
499	100.0	499	100.0
249	199.4	249	199.4
100	495.0	98.8	501.0
49.9	991.0	49.3	1,003.0

Furthermore, the AD620 features 8-lead SOIC and DIP packaging that is smaller than discrete designs and offers lower power (only 1.3 mA max supply current), making it a good fit for battery-powered, portable (or remote) applications.

The AD620, with its high accuracy of 40 ppm maximum nonlinearity, low offset voltage of 50 µV max, and offset drift of 0.6 µV/°C max, is ideal for use in precision data acquisition systems, such as weigh scales and transducer interfaces.

Furthermore, the low noise, low input bias current, and low power of the AD620 make it well suited for medical applications, such as ECG and non-invasive blood pressure monitors.

Features of AD 620

1. **Easy to use**
   a) **Gain set with one external resistor**
   b) **(Gain range 1 to 10,000)**

2. **Wide power supply range (±2.3 V to ±18 V)**

3. **Higher performance than 3 op amp IA designs**

4. **Available in 8-lead DIP and SOIC packaging**

5. **Low power, 1.3 mA max supply current**

6. **Excellent dc performance (B grade)**

   a) **50 μV max, input offset voltage**

   b) **0.6 μV/°C max, input offset drift**

   c) **1.0 nA max, input bias current**

   d) **100 dB min common-mode rejection ratio (G = 10)**

7. **Excellent ac specifications**

   a) **120 kHz bandwidth (G = 100)**

APPLICATIONS OF AD620

1. **Weigh scales**
2. **ECG and medical instrumentation**
3. **Transducer interface**
4. **Data acquisition systems**
5. **Industrial process controls**
6. **Battery-powered and portable equipment**