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J201

HIGH GAIN N-CH JFET

Linear Systems' products enable customers to build the lowest-noise signal chains possible.

The J201 N-channel JFET is optimized for high gain. The part is particularly suitable for use in low power or high impedance amplifiers.

J201 Benefits:

1. High Input Impedance
2. Low Cutoff Voltage
3. Low Noise

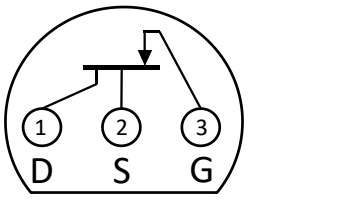
J201 Applications:

1. Battery Powered Amplifiers
2. Anti-polarization Circuit For Sensors
3. Audio Pre-Amplifiers
4. Infra-Red Detector Amplifiers
5. Phase Shift Oscillator
6. Current Limiter
7. Low frequency noise requirements for both low and high source impedance circuits

Package Figure 1.

The J201 is available in the TO-226 (TO-92) plastic package and TO-236 (SOT-23) package. The J series TO-226 package provides low cost, while the SST series, TO-236 (SOT-23) package provides surface-mount capability. Both the J and SST series are available in tape-and-reel for automated assembly and in die form.

TO-92 (3L)
Top View



SOT-23 (3L)
Top View

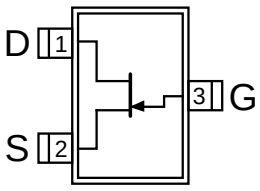


Figure 1.

JFET designs are suitable for battery operated circuits, therefore JFETs are used in guitar, audio and MIC preamps and cable boosters. Some of the designs can be compressed further, eliminating certain components if space is an issue and there is minimal impacts on the behavior of the circuit. The voltage battery is 6 volts as. Since the batteries are small in size, they can easily fit in a small package. Button batteries are not recommended. The circuits are all preamplifiers that do not drive power amplifiers or lines, but for a better signal for the power amplifier. The voltage drain to source is around 4.5V.

Characteristics

N-Channel JFETs have either or both constant voltage or self-bias configurations. The best consistent performance is to have a configuration that uses constant voltage and/or self-bias. The combination of both biasing schemes is the best approach that does not decrease the dynamic range and has low value gain fluctuation.

The J201 Series JFET is an N-Type material sandwiched between two layers of electrically connected P-Type material. The N-Type material is the “GATE” and the P-Type material ends are “Drain” and “Source”. Drain and source ends are interchangeable.

Figure 2. shows the N-Channel JFET Characteristics Curve.

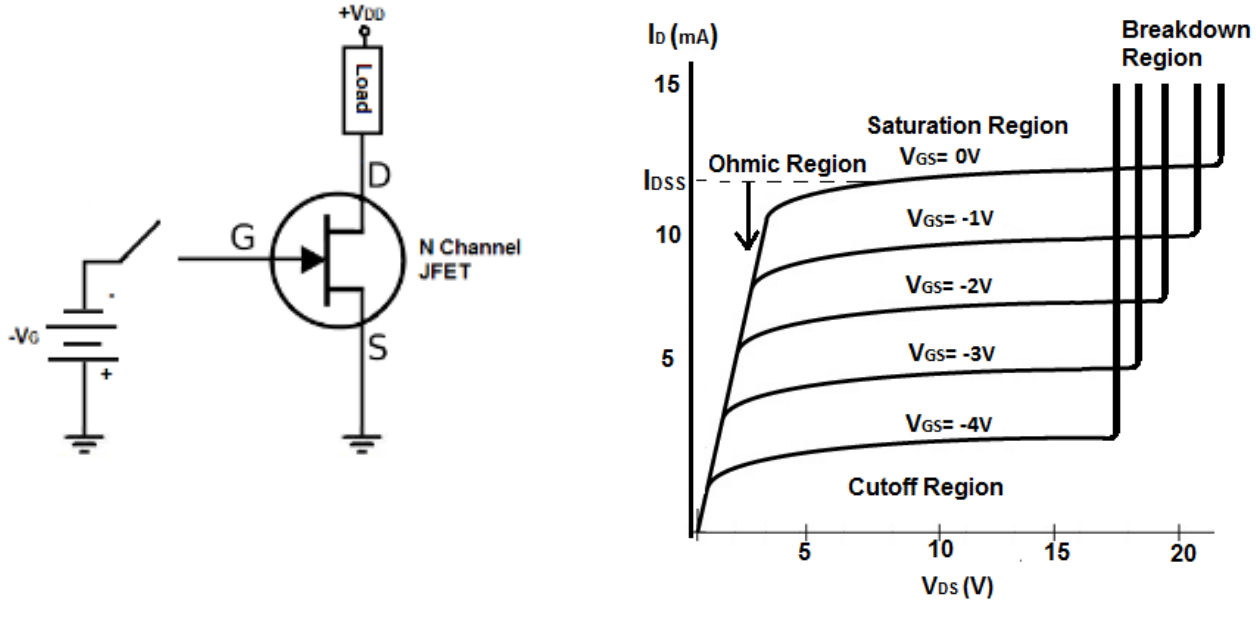


Figure 2.

In order to turn on the N-Channel JFET, a positive voltage +VDD is applied to the drain terminal. The current will flow through the drain-source channel. If the gate voltage, VG, is 0V, the drain current is at its largest value.

If the bias positive voltage, VDD, which powers the drain, is removed then the JFET will turn off. If the bias voltage is not removed, but a negative voltage is applied to the gate, the drain current is reduced. The more the gate voltage, VG, becomes negative, the less the current is until cutoff, which is when the JFET is in the OFF region.

The gain of the JFET decreases as the negative voltage to the gate increases. The current ID output by the transistor, is highest when the voltage fed to the gate terminal is 0V.

Amplification

The J201 Series has very high input impedance and it isolates previous stages from previous stages. The output of the previous stage appears at the input of the next stage because of the low output impedance of the previous stage. Therefore the JFET is used in boosters or amplifications and are capable of driving heavy load or small load resistances.

FETs are low noise devices and are useful component to be used as an amplifier at the receiver front-end as one needs the minimal amount of noise at the final output. Furthermore JFETs are voltage controlled devices and are ideal to be used in Radio Frequency (RF) amplifiers.

The circuit in **Figure 3.** is a pre amp and a buffer. The JFET is biased, and the input signal is AC biased.
If an audio signal is fed in the input "I", the signal at "out" would be a volume.

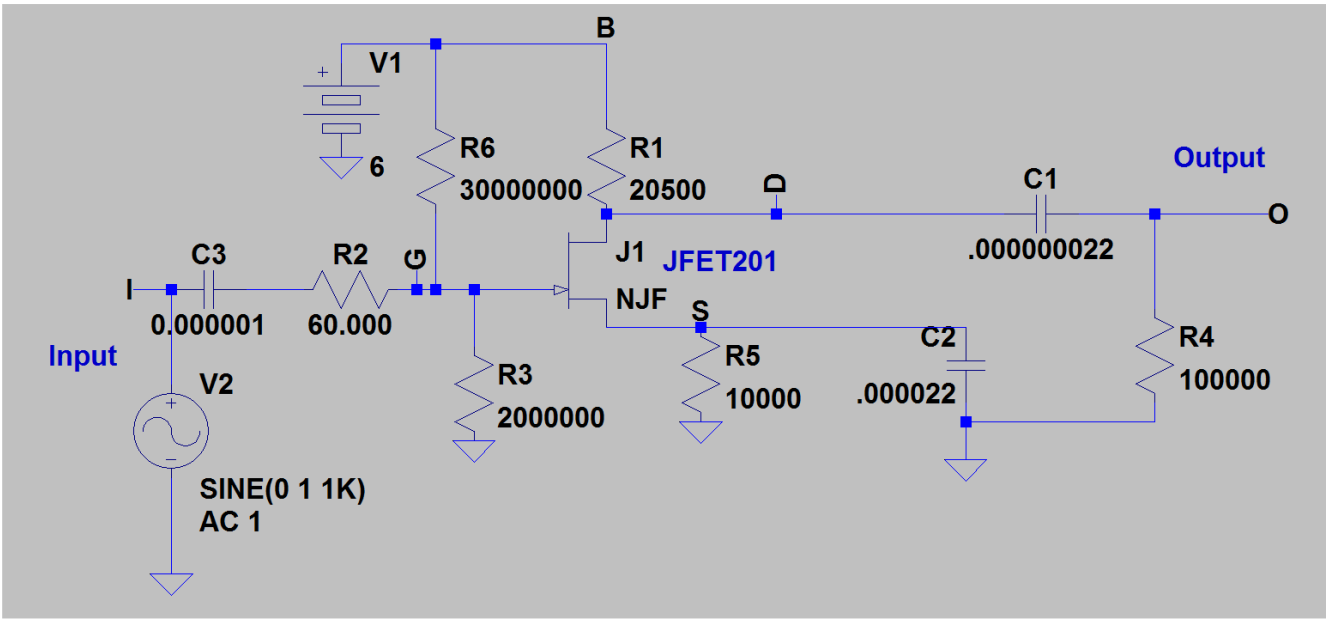


Figure 3.

Figure 4. is the simulation results using a spice software that shows the various waveforms at various points in the circuit including input voltage and current and output voltage waveforms. The input impedance is very high, the combination of R6 and R3.

The circuit in **Figure 5.** is similar to the previous one but the JFET is not biased

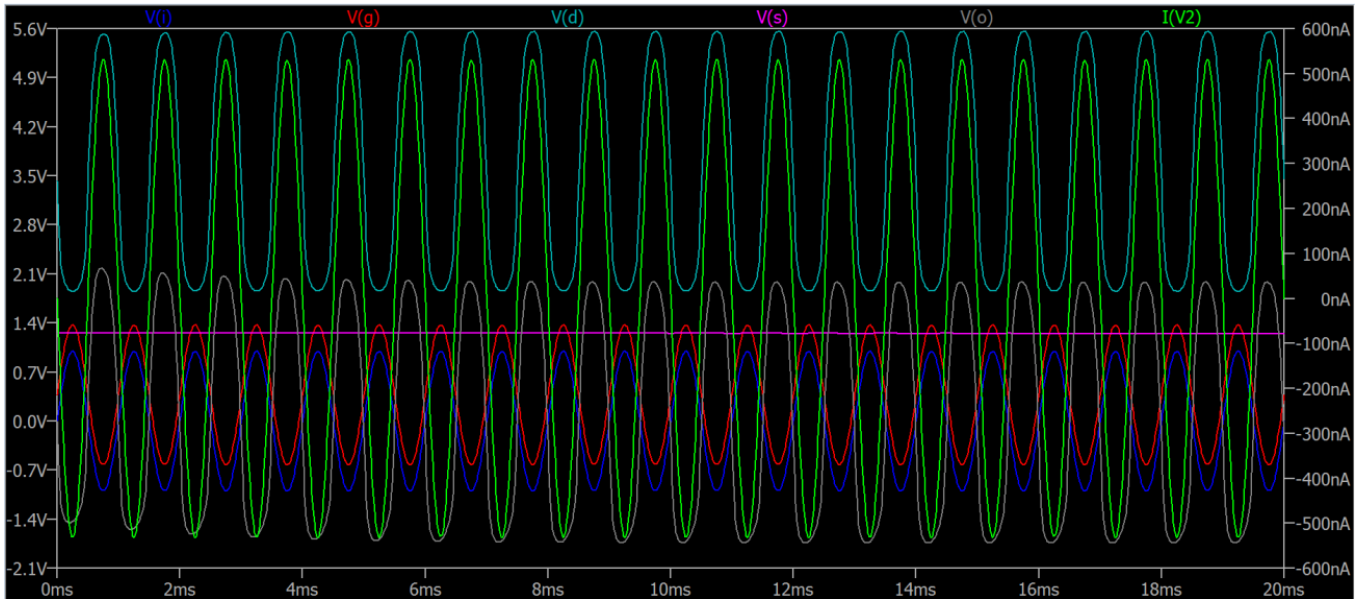


Figure 4.

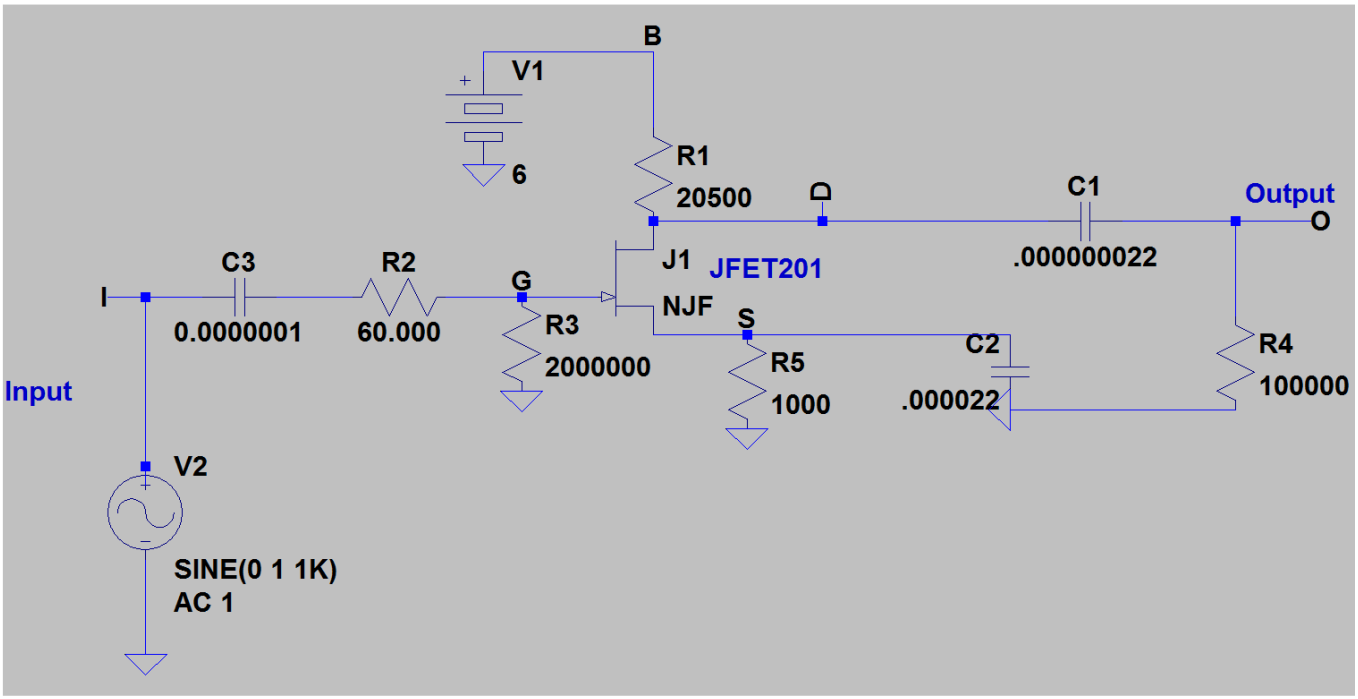


Figure 5.

The simulation waveforms in **Figure 6.** are in the following drawing. In the plot you can notice the waveforms at various points in the circuit including input and output voltage waveforms. The input waveform is a 1V Peak to Peak and I KHz frequency for both circuits. Small signals are even less than that in preamp circuits.

The waveform of the output voltage is similar in both circuits in frequency and voltage. The only difference is the DC offset of the waveform as a result of biasing.

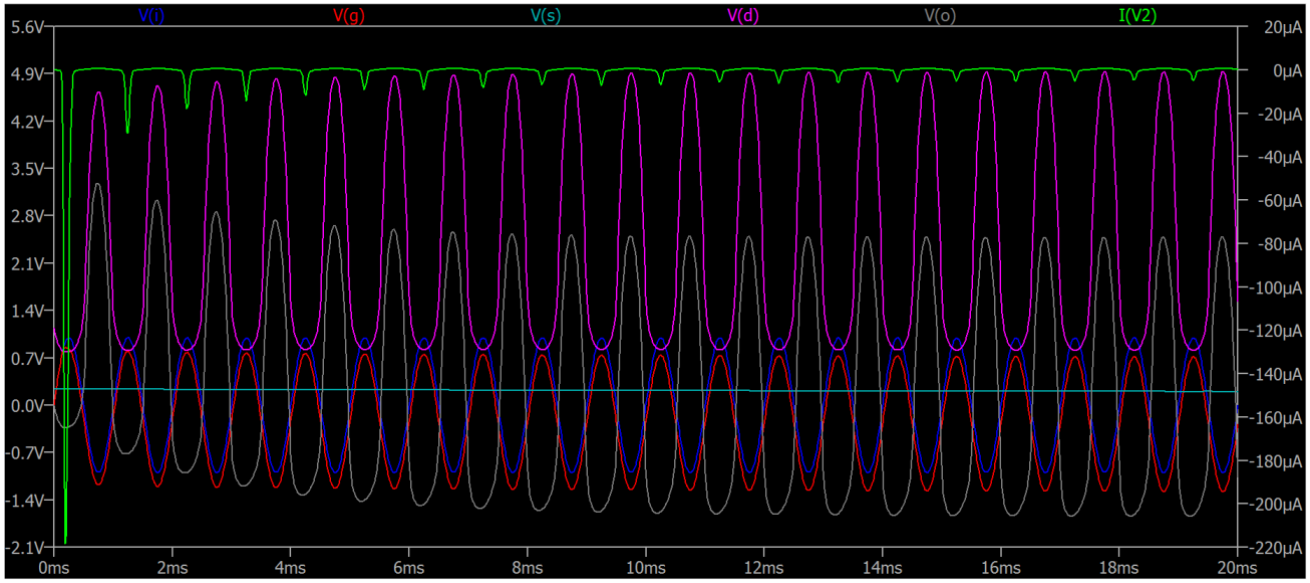


Figure 6.

The circuit in **Figure 7.** is a switch, the switch can be a manual switch or a pedal that would pass through the signal when the switch is connected.

Switch

JFET is essentially a voltage controlled resistor. The “ON” state resistance is low while the “OFF” state resistance is extremely very high. Thus JFETs are used as switches.
The gate junction is reverse biased and there is no current flow through the device and hence is the extremely high input impedance characteristic of JFET devices.

JFET devices are controlled in the depletion mode by removing or depleting charge carriers from the n-channel. The amount of depletion depends on the Gate voltage. When the Gate is made more negative, the current flow for a given value of Source-to-Drain voltage is reduced. Modulating the Gate voltage modulates the current flow through the device. That is essentially is a switch behavior and the output signal of the JFET is a copy of the input signal.

When the Gate-Source voltage, VGS is zero, n-channel FET will operate in saturation region and behave almost as a short circuit and the output voltage will be zero. When the voltage between gate and source is negative then the FET is in its cut-off or pinch-off region which means there is practically no channel and the FET acts like an open circuit with the drain current, ID is equal to zero.

The signal at the gate has to be AC coupled in order to remove the DC component or bias and allow the NJFET to operate as a switch. The RC time of the capacitor and the resistor at the switch determine the delays of the switch from one state to the other.

In order to turn off the switch and not let signal through, the switch or pedal is flipped and that causes the gate to be more negative than the drain and source and getting it close to 0V, the diode is reversed biased, not conducting, and guarantees that the gate is off. In order to turn the switch on and let the signal through the gate voltage is around 0 V or ground, the diode in this case is forward biased and conducting.

Switching time is dependent on gate capacitance. When the control voltage goes low, the gate capacitance is rapidly discharged through the diode, which is very low impedance when conducting. When the control voltage goes high, cutting off the diode, the gate has to recharge through the resistor, which is a much longer time constant.

The switch voltage is the battery voltage of 6V. The current of the input signal is represented also. The input signal is sinewave of 1V amplitude.

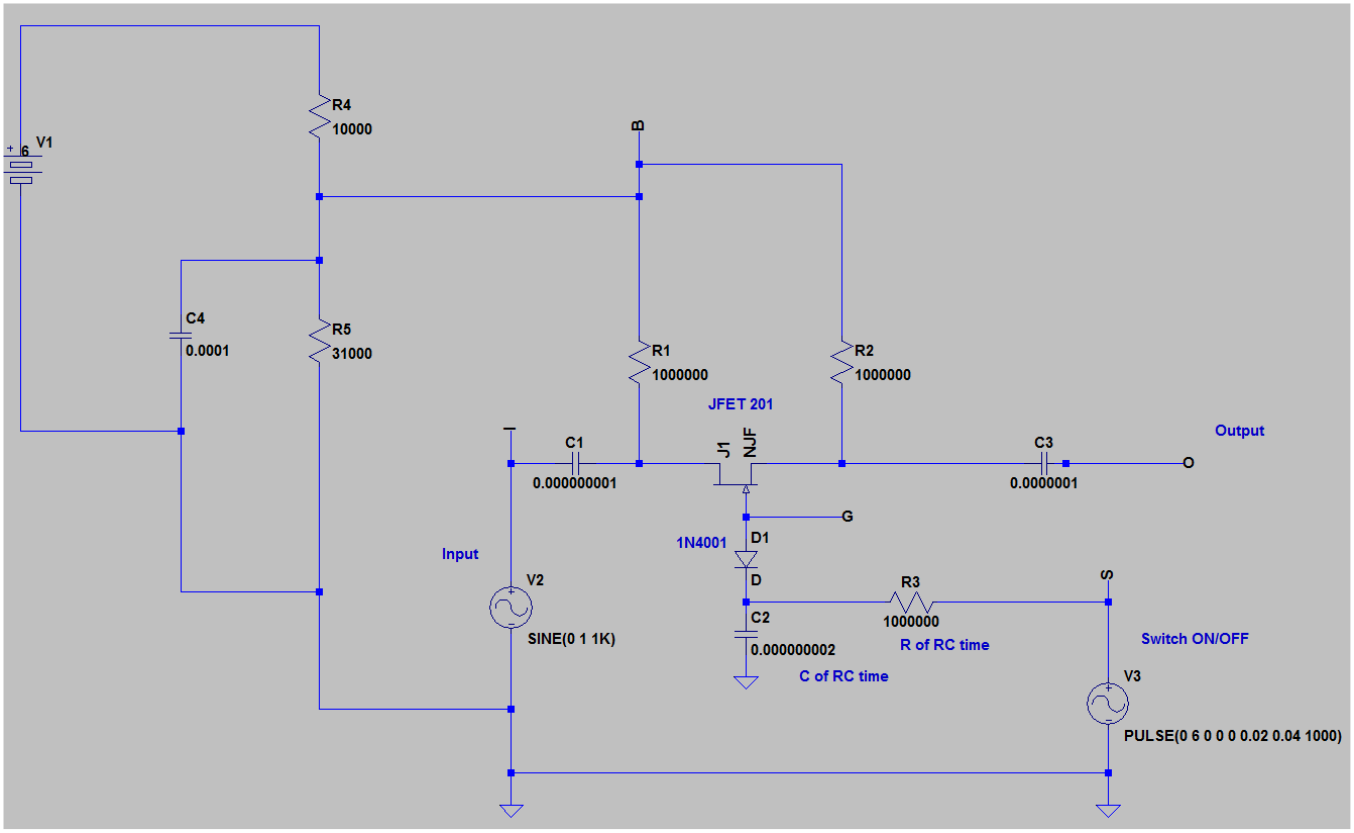
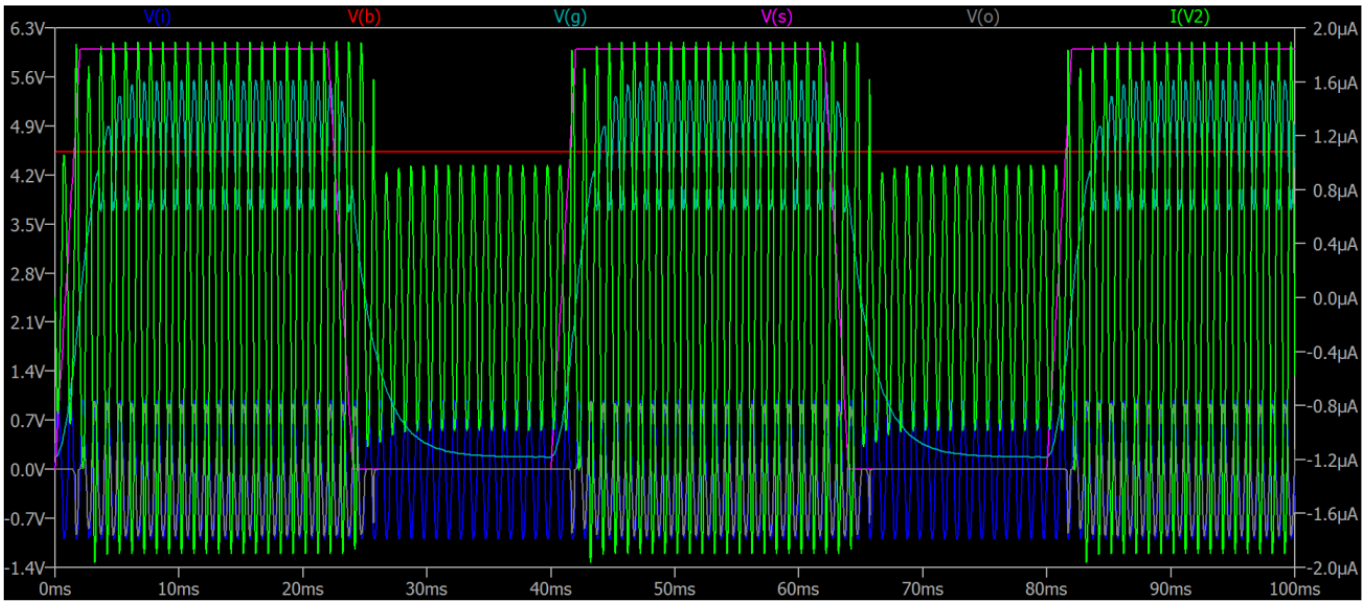


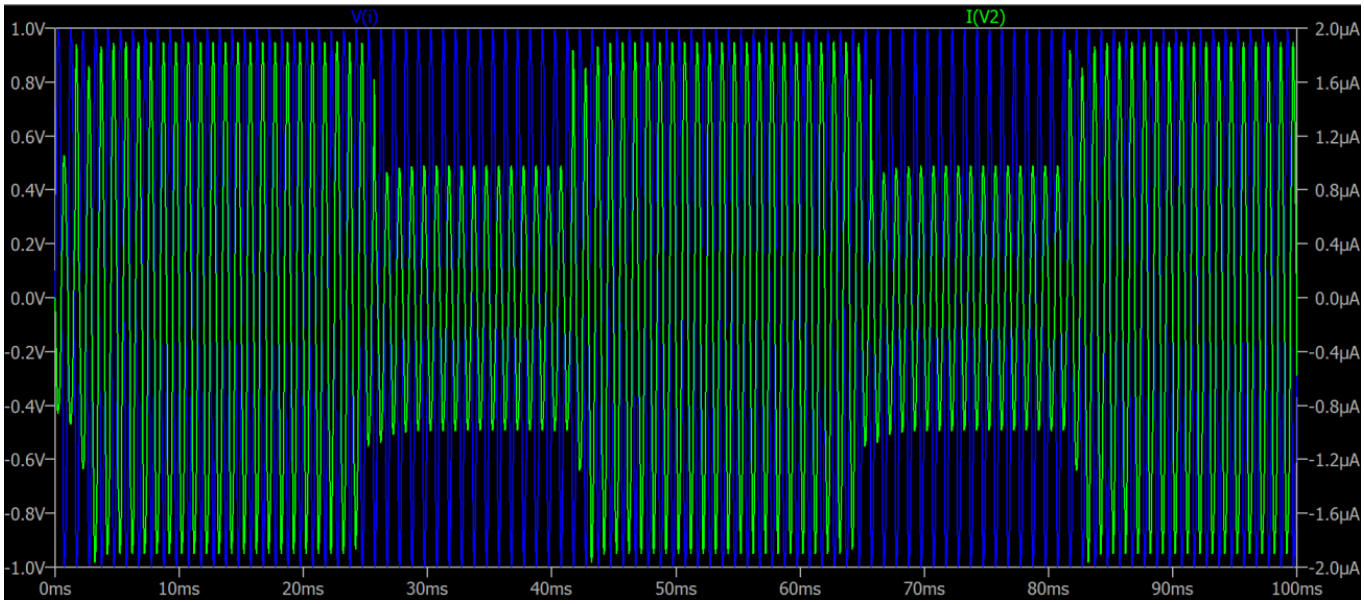
Figure 7.

The waveforms are represented in several plots for clarities. Signal waveforms do not have the same color in the various plots.

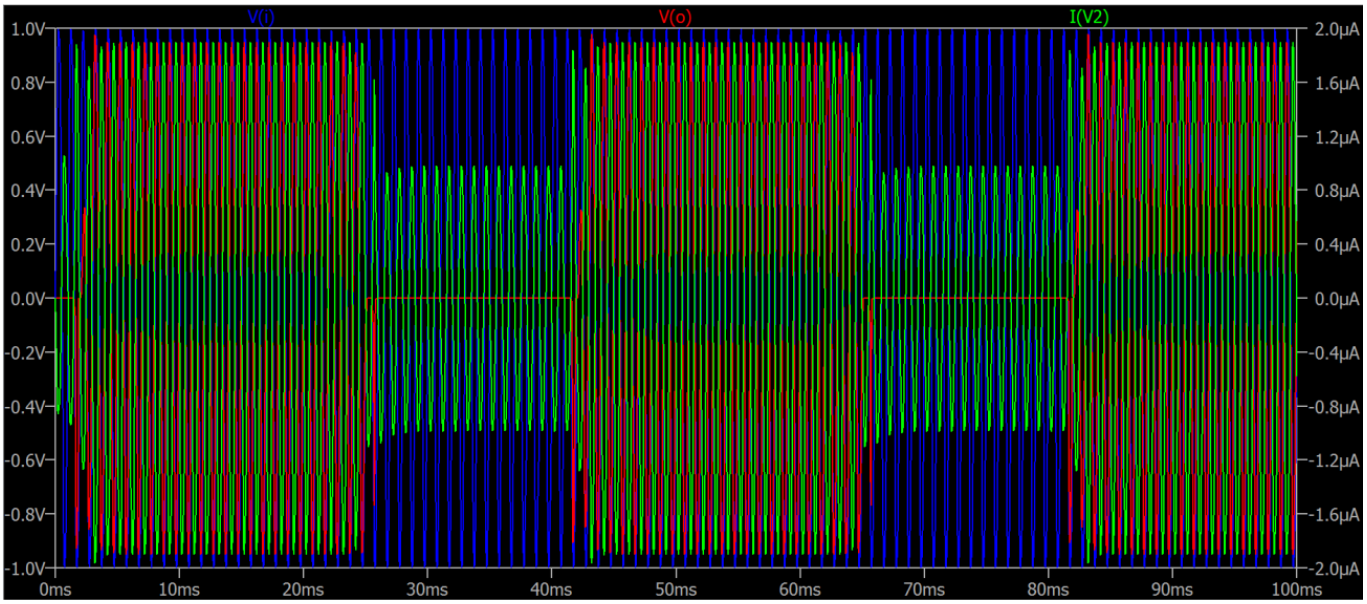
The switch is waveform S, when it is connected or high, the input signal is passed through with delay. When the switch is off, open, then the input waveform is not passing through to the output.



The next waveform plot is the current and voltage of the input signal. It is a sine wave in blue color.



The next plot is showing the output signal in red. The output signal is a copy of the input signal when the switch is connected.



The next plot shows the switch waveform in Turquoise color. The output signal in red is not a copy of the input signals, it is constant, when the switch, green waveform is low or disconnected.