Input Diodes for ac Coupled Circuits

12/31/2015

Why does the average input voltage rise?

- Many op amps have back-to-back diodes across the input
- During slew rate condition the amplifiers differential voltage may be volts
- Volts across back-to-back diodes turns them on. This charges the input capacitor
- A “saw tooth” type waveform will only slew on the fast edge. So it only slews in one direction. This will charge the input capacitor on each sharp edge.
- Using op amps without back-to-back diodes will solve the issue

OPA1642: Input

- In your initial E2E post you mentioned that you see the problem with the OPA1642
- This did not make sense to us as the OPA1642 does not have back-to-back diodes, so this device should not have showed the issue.
- Please confirm that you were using the OPA1642 and not the OPA1652 or another device.
- The use of back-to-back diodes is common and so the OPA1642 is one of the best candidates for this circuit.
- The response to your posting was delayed as I needed to order the OPA1642 to confirm that it did not show the issue you mentioned. I built the circuit and it behaved normally.

What are back to back input diodes

8.3.1 Input Protection Circuitry

The OPAx192 uses a unique input architecture to eliminate the need for input protection diodes but still provides robust input protection under transient conditions. Conventional input diode protection schemes shown in Figure 54 can be activated by fast transient step responses and can introduce signal distortion and settling time delays because of alternate current paths, as shown in Figure 55. For low-gain circuits, these fast-ramping input signals forward-bias back-to-back diodes, causing an increase in input current, and resulting in extended settling time, as shown in Figure 56.

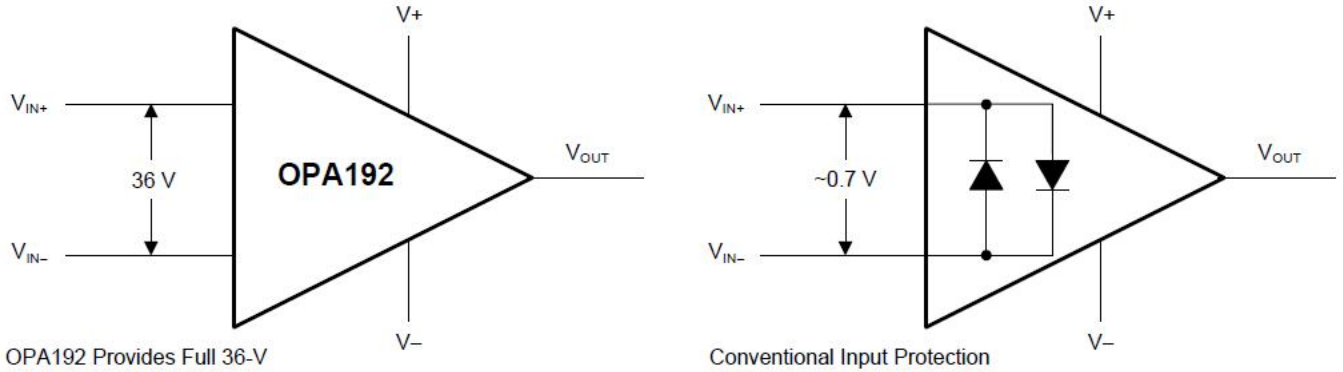
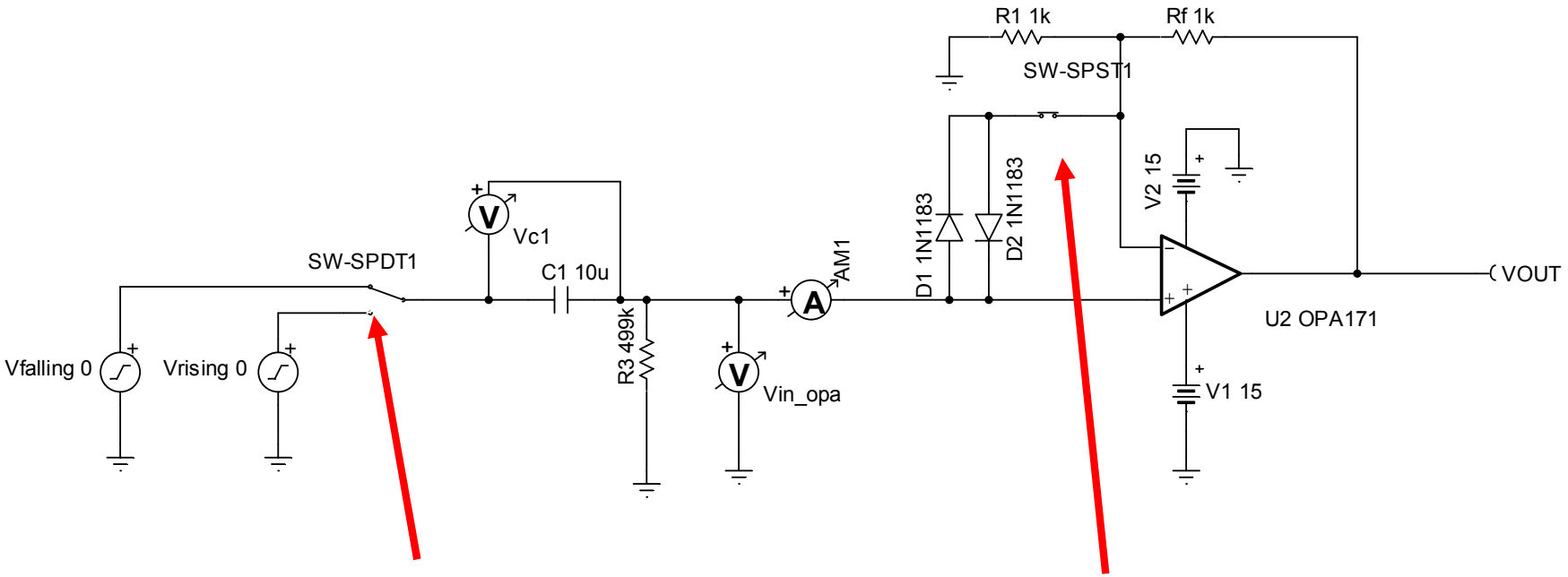


Figure 54. OPA192 Input Protection Does Not Limit Differential Input Capability

Simulate With and Without Input Diodes



Try with sharp rising edge or sharp falling edge

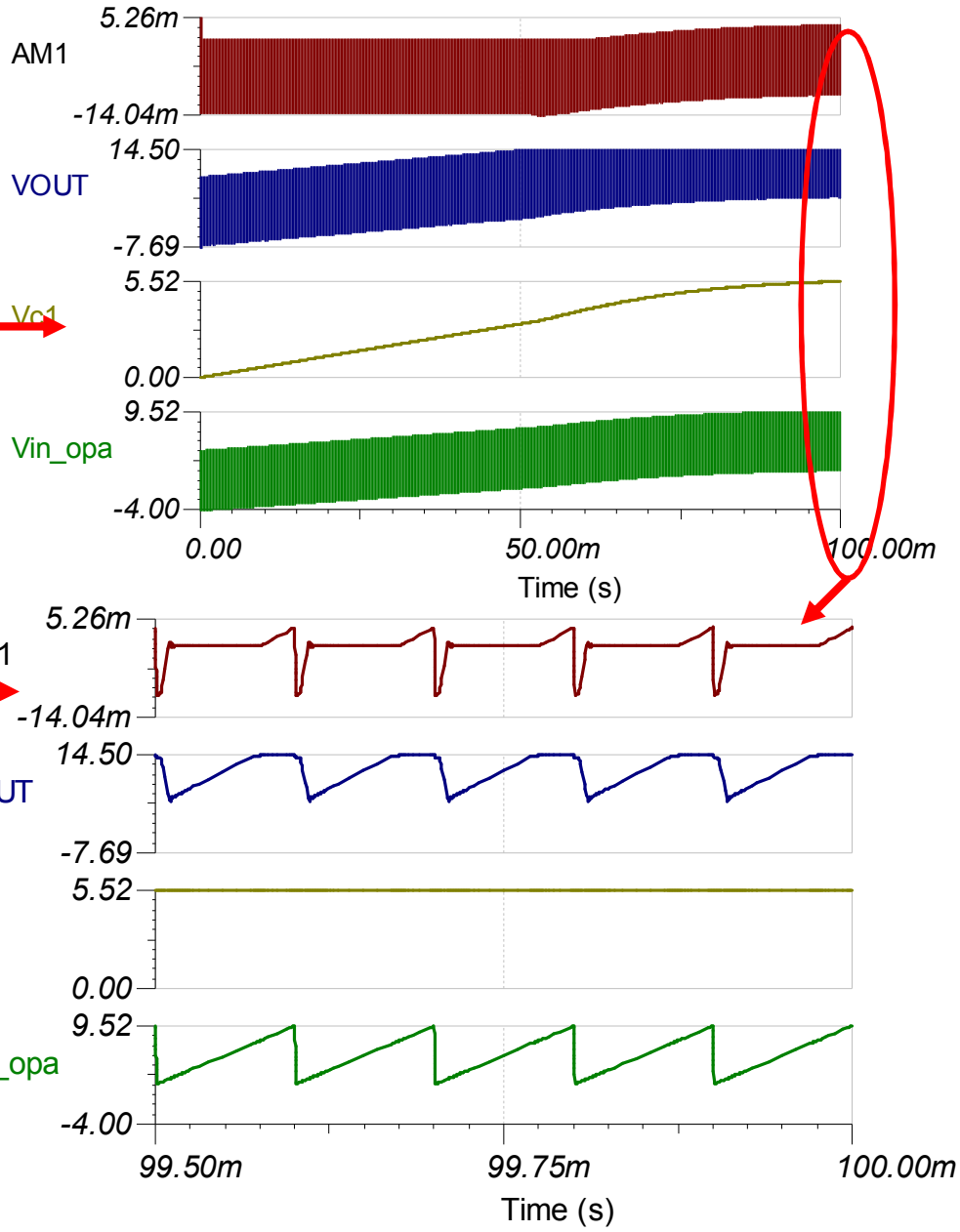
Connect and disconnect input diodes

With diodes, sharp falling edge

Notice that the voltage on the capacitor increases after start-up.

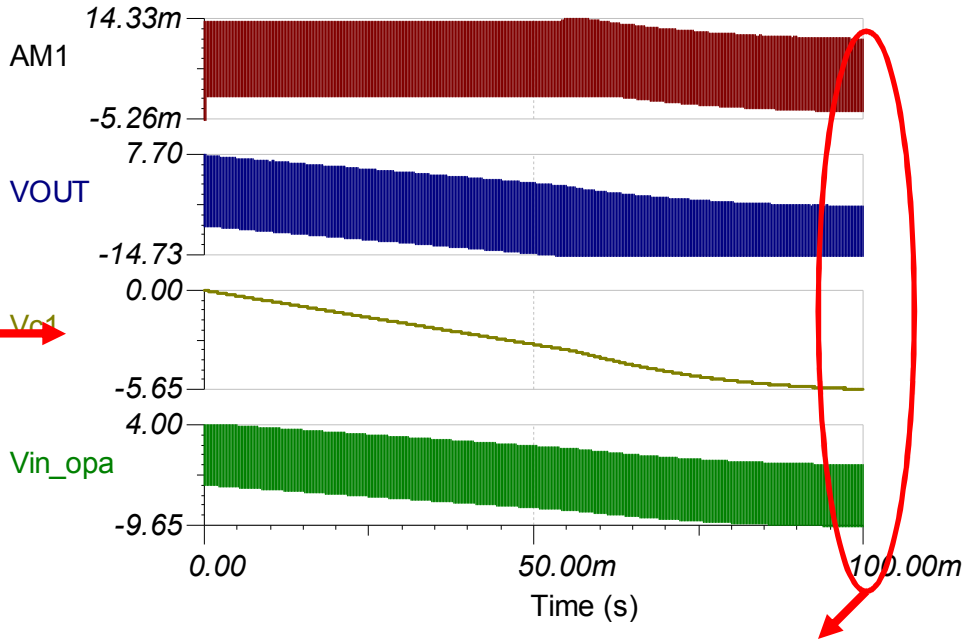
The current coming out of the non-inverting input is miliamps! This current is from op amp slewing.

ac coupled diodes.TSC

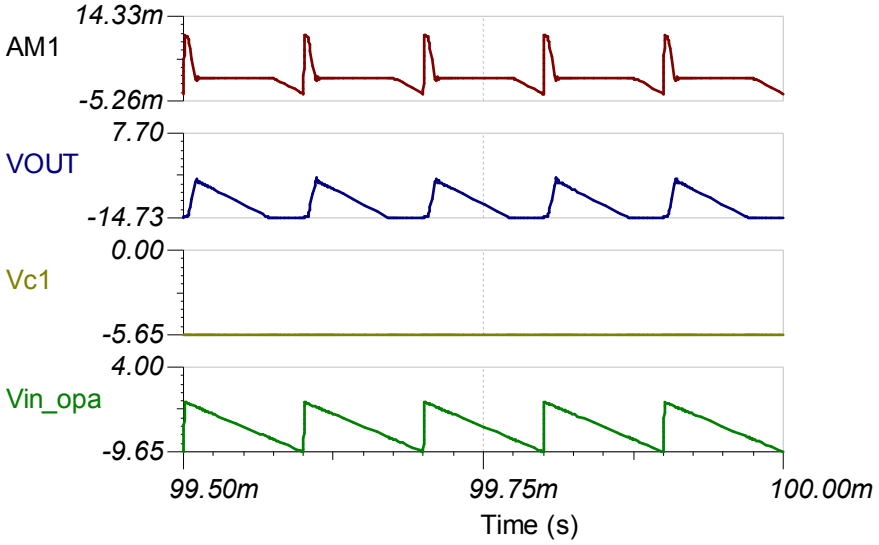


With diodes, sharp rising edge

With rising edge the voltage on the capacitor now decreases after startup. It increased with falling edge.

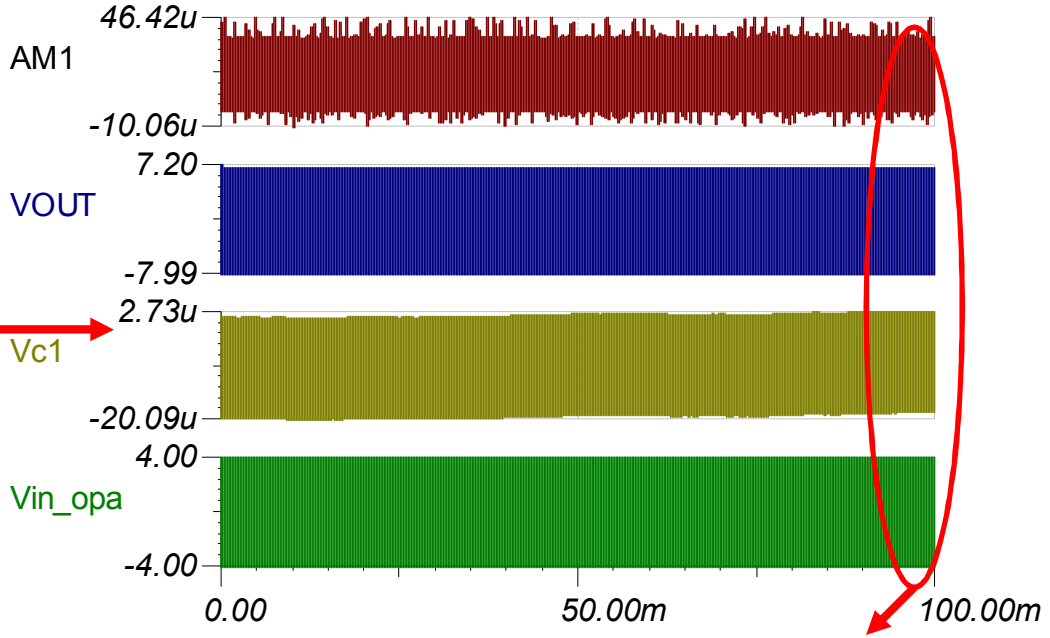


The polarity of the current pulses changed from falling edge

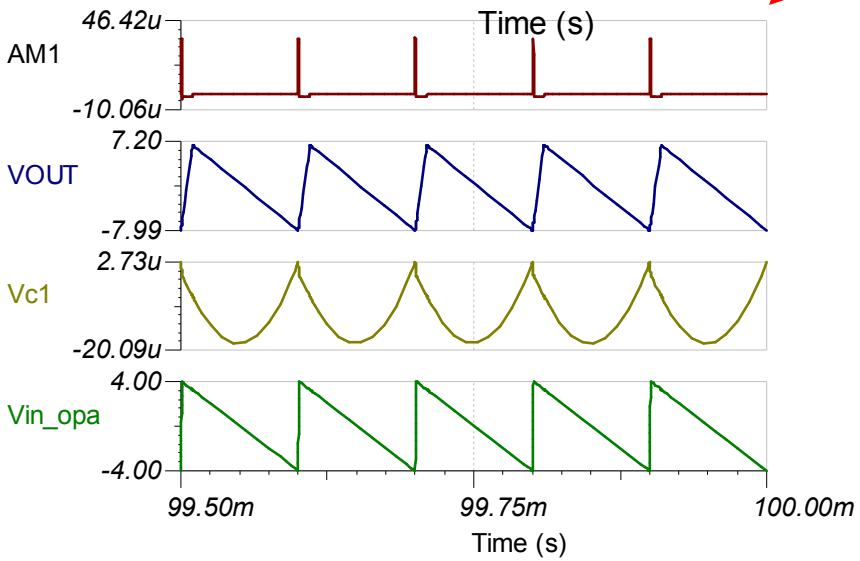


Diodes Disconnected, sharp rising edge

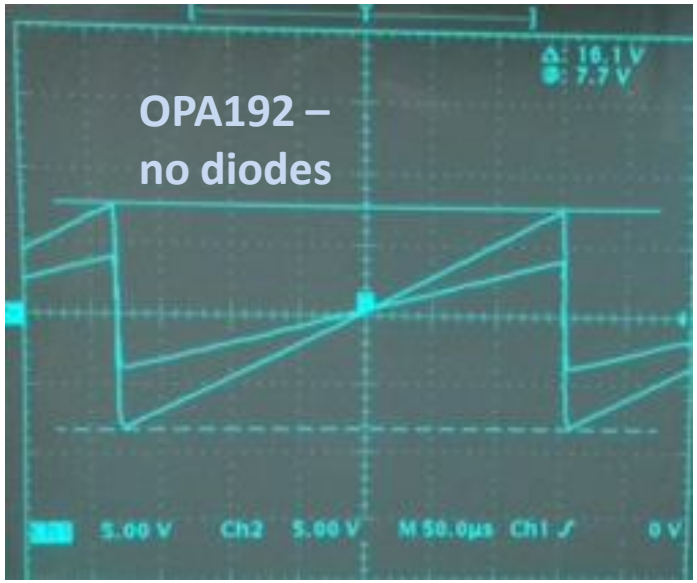
The voltage across the capacitor is practically constant at zero volts.



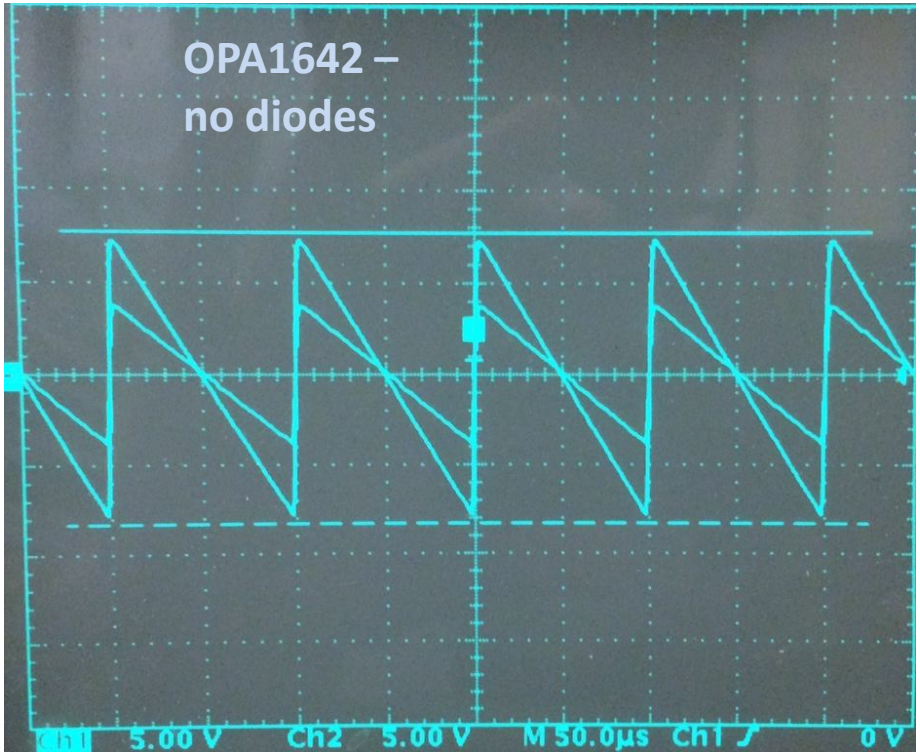
Current in to the non-inverting input is very small. Capacitive coupling through input capacitor.

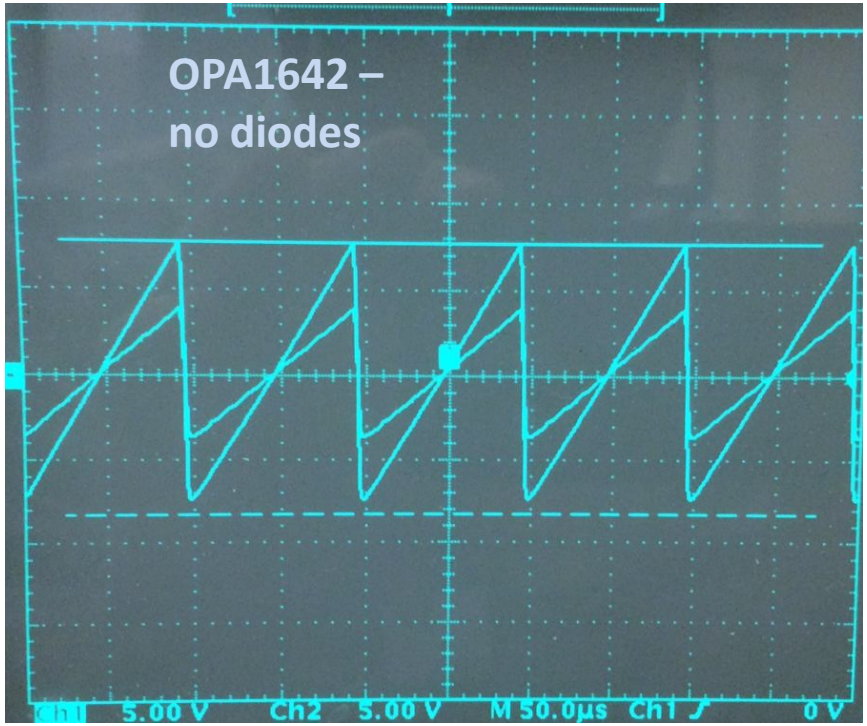


Measured results



Measured results





Conclusion

- In the cases with back-to-back diodes the input coupling capacitor charges during the fast edge of the sawtooth waveform.
- In the case of amplifiers without back-to-back diodes the input capacitor is not charged.
- For this type of application you need to use amplifiers without back-to-back input diodes.
- Note 1: Simulation and Measured results match.
- Note 2: For devices with the diodes, the effect is minimized for amplifiers with high slew rate as the current charging the input capacitor is trunked on for a shorted time period.
- Note 3: For devices with the diodes, the effect is minimized for symmetrical waveforms; i.e. if the amplifier slews equally on both directions, the charging and discharging will cancel.
- Note 4: For devices with the diodes, you will only see this effect if the amplifier slews. In normal operation, you will not turn on the input diodes and will not see this charging.