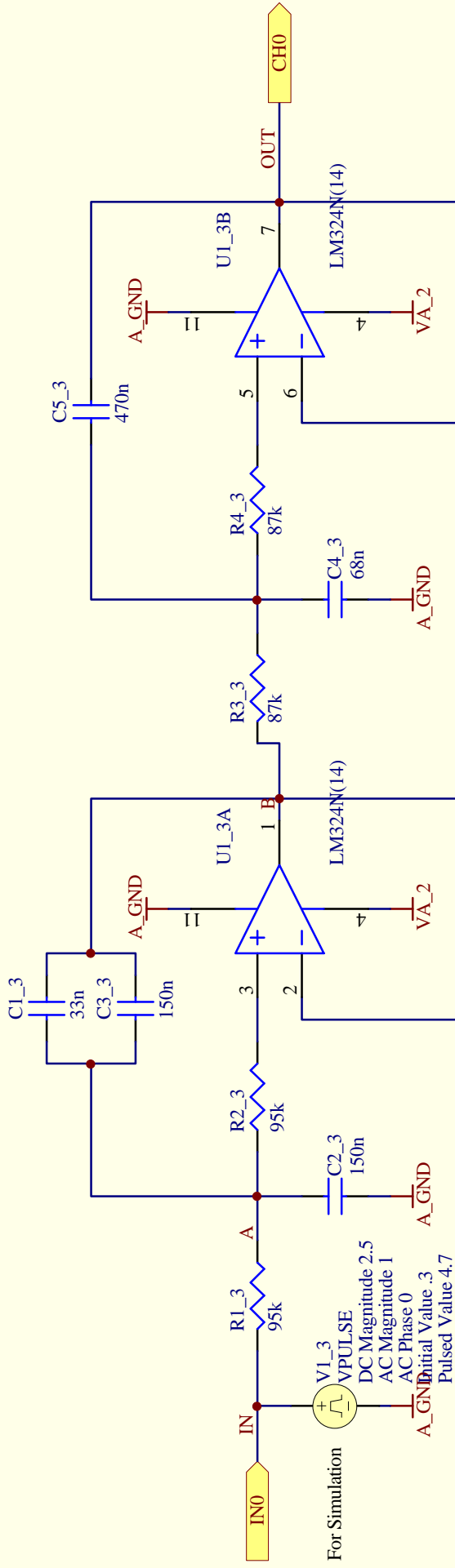
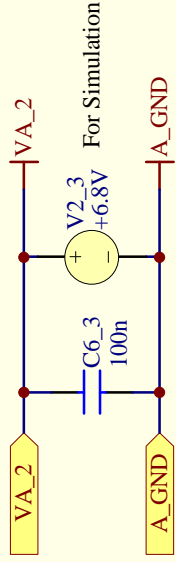


Fourth Order Non-inverting Sallen-Key (SK)  
Butterworth Lowpass Filter Stage  
fc = 10 Hz



For Simulation  
 V1\_3 VPULSE  
 DC Magnitude 2.5  
 AC Magnitude 1  
 AC Phase 0  
 Initial Value .3  
 Pulsed Value 4.7  
 Time Delay 0  
 Rise Time 1u  
 Fall Time 1u  
 Pulse Width .5  
 Period 1  
 Phase Delay \*  
 \*  
 \*  
 \*  
 \*  
 \*



The op-amp LMC660 is specified as single supply, rail-to-rail quad op-amp up to 15 Volt VCC. But there shows up a very bad non-linear characteristic: If the input voltage is in the range .85 VCC - 1.0 VCC, the output quickly jumps to 1.0 VCC. This behavior destroys the whole filter characteristic in the upper voltage range. Therefore, to cope with this problem, either the supply voltage has to be increased or it has to be assured that the input signals never reach the critical level. In this case, the supply voltage level has been lifted.

After having carried out only slight alterations on the filter characteristics and its components (changed from Chebyshev to Butterworth filter characteristics), the initially used LMC660 quad op-amp started oscillating. So I had to replace the LMC660 with a LM324 quad op-amp. Conclusion: 'Analog circuitry that has not been tested explicitly does not work.'

### Title 4th Order Butterworth Filter Stage

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