Common mode and differential filter

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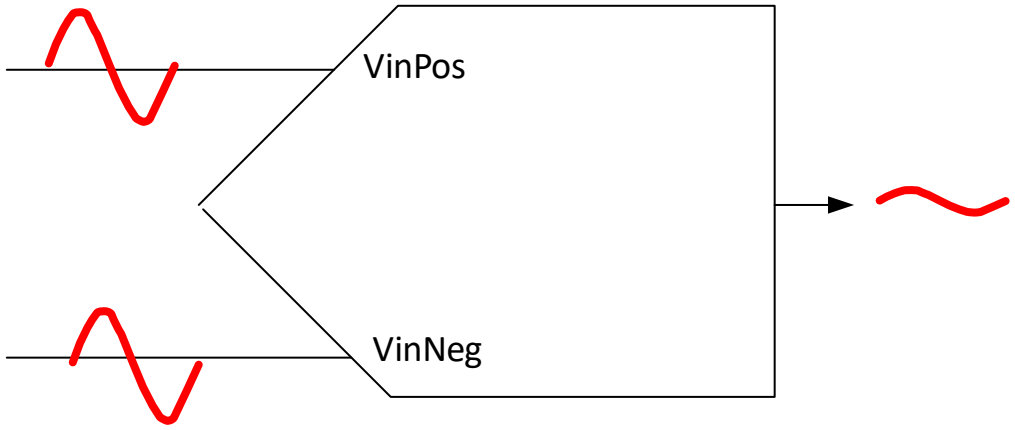
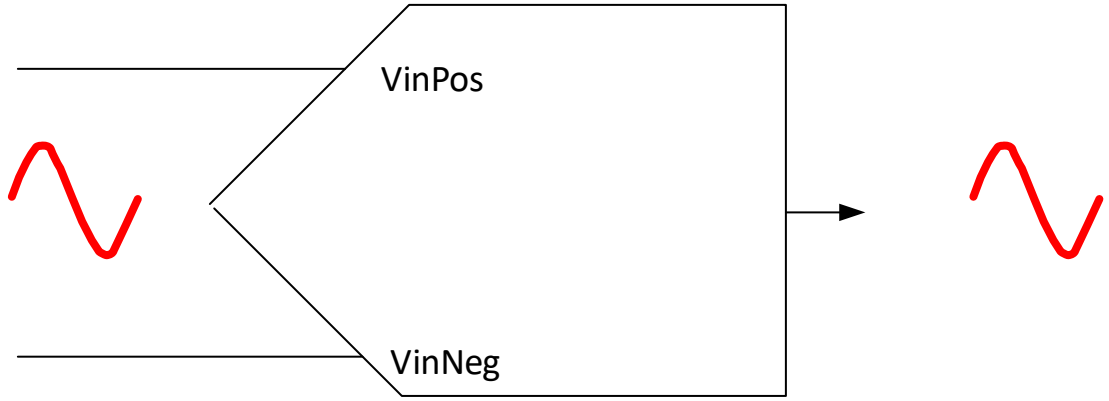
Common mode rejection

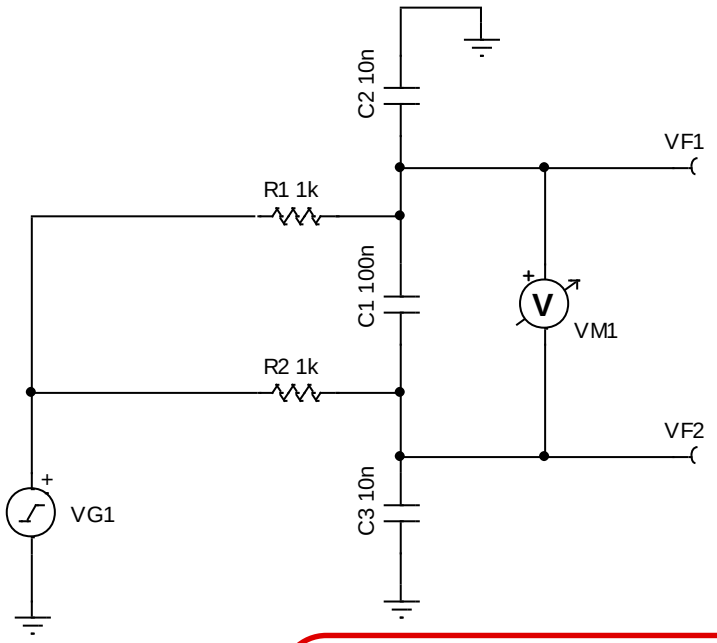


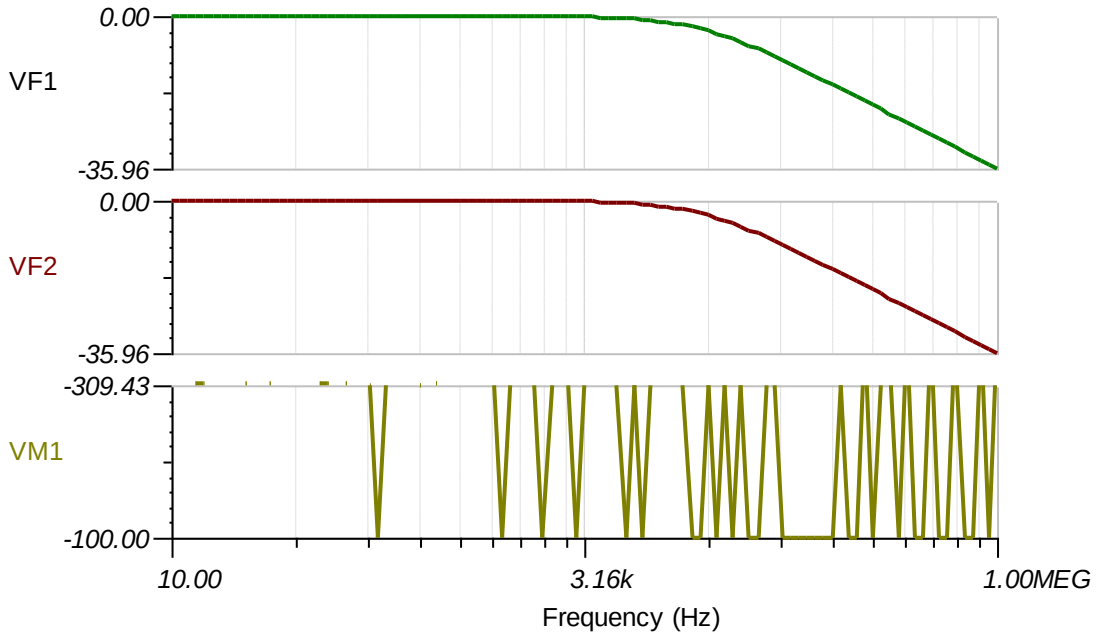


Common mode signals are inherently rejected by amplifiers and ADC. The signal is called common mode because the same amplitude signal is on both inputs (VinPos = VinNeg)

Differential mode signals are passed through the ADC or amplifier. The signal is the difference of the two inputs (Vdif = VinPos – VinNeg)

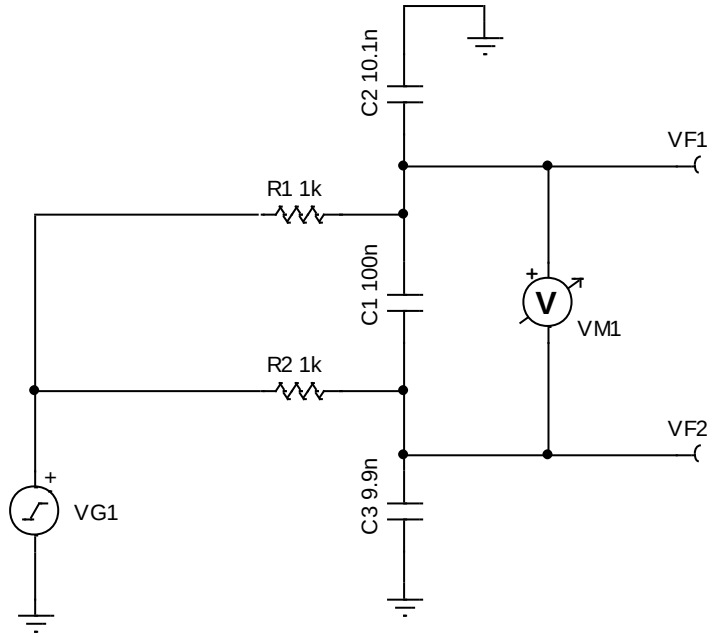
Common mode attenuation with filter components matched

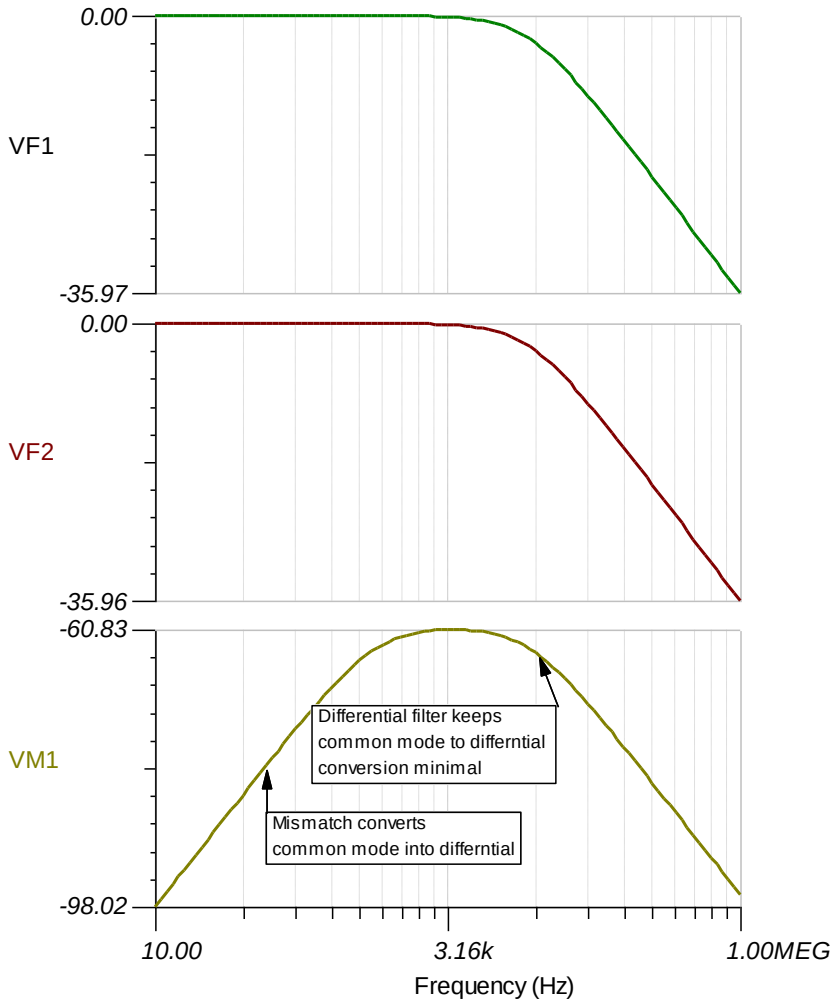




If the noise pickup is common to both inputs, the common mode filter will attenuate each signal equally. In this example there is no differential signal so VM1 reads essentially zero. Most importantly, note that the components are exactly matched on both inputs.

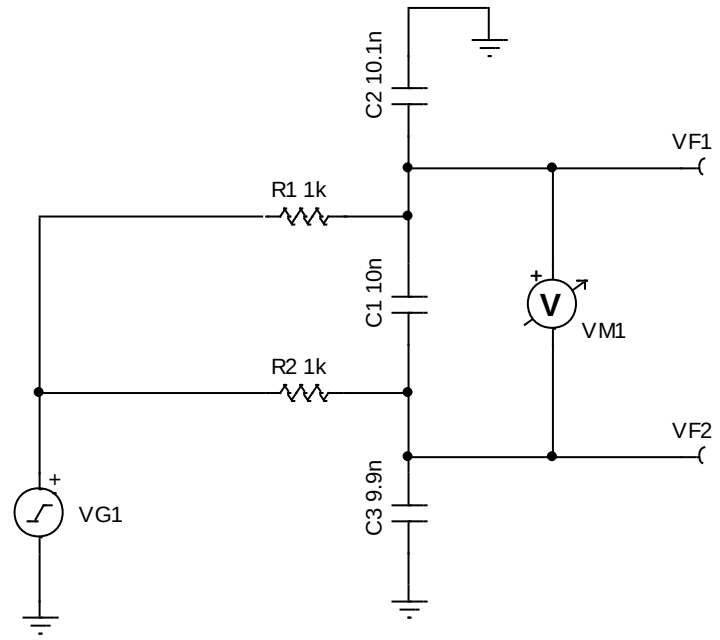
Common mode attenuation with filter components not matched

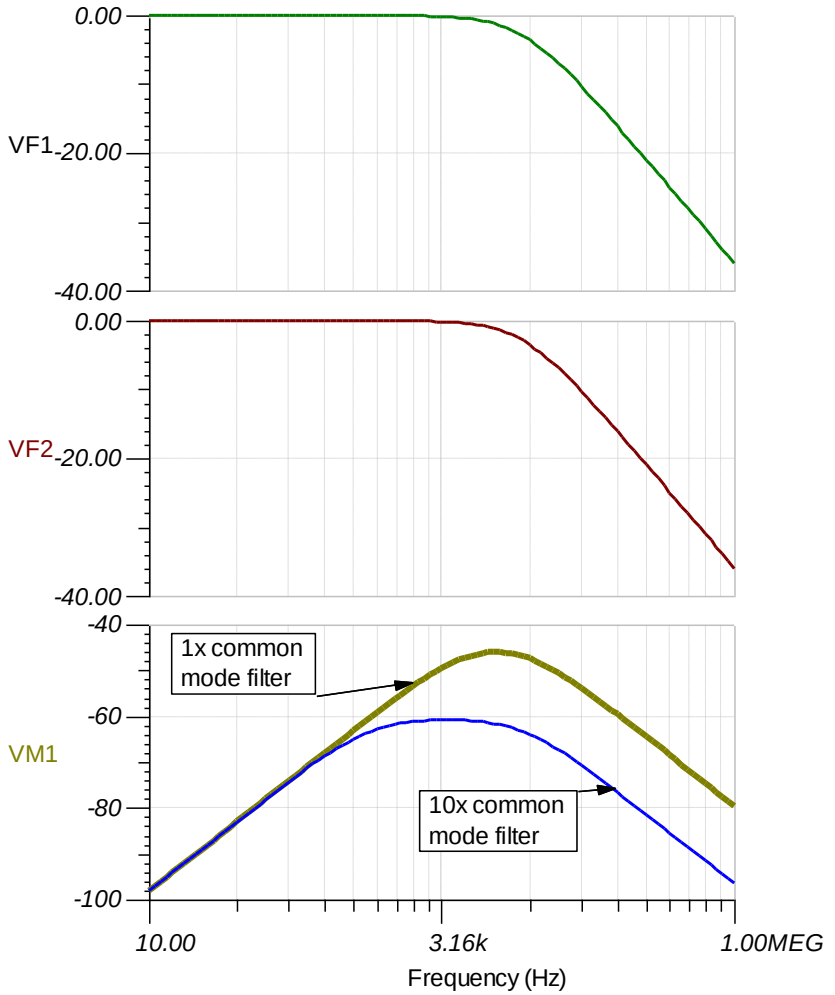




In this example there is some mismatch in the common mode capacitors from tolerance. This mismatch translates the common mode signal to differential signal. This is a problem because the device will inherently reject some common mode signal but will not reject differential signal. The differential mode capacitor will attenuate the converted noise. Making the differential filter capacitor larger than the common mode capacitor will help to minimize the conversion issue.

Small common mode cap with filter components not matched





Here is the same simulation with a 1x common mode filter. In this case the common mode to differential mode conversion increases the noise from -60dB to -46dB (5x larger). This is why the common mode filter is normally set at least 10x the differential filter. This minimizes the common mode to differential mode conversion.