Input Signal Conditioner (ISC) Circuit Design

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**1 Description**

The Input Signal Conditioner (ISC) is an amplifier and low-pass filter circuit responsible for conditioning the raw microphone signal from a dynamic microphone to be sampled by an Analog-to-Digital Converter (ADC). The circuit comprises of a DC biasing network, non-inverting amplifier, and a 2nd Order Butterworth active low-pass filter (LPF). Presented is the circuit design and specifications to signal the raw microphone signal to be sampled by the Cirrus Logic Inc. CS5343-CZZ Sigma-Delta ADC.

**2 Design Requirements**

**2.1 Sallen-Key Low Pass Filter Design**

There are two critical parameters to consider for selecting an Op-amp for the Sallen-Key LPF: 1) Gain Bandwidth Product (GBWP), 2) Slew Rate. The closed-loop bandwidth of the amplifier must be at least 100 times greater than the passband (or cutoff) frequency of the filter. Thus, the minimum GBWP is calculated as

The Slew Rate is related to the internal circuitry of the Op-amp and determines how fast the output voltage or current can change. Ideally, the slew rate, measured in volts per microseconds, should be relatively high. The minimum slew rate is calculated based on the cutoff frequency and peak-to-peak output voltage of the amplifier. The minimum slew rate is calculated as

Based on the Op-amp requirements, the Microchip MCP6271 rail-to-rail, single-supply Op-amp is chosen.

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| --- | --- | --- |
| **Specification** | **Designator** | **Value** |
| Filter Type | N/A | Butterworth |
| Configuration | N/A | Sallen-Key |
| Order | N | 2 |
| Passband Frequency | Fc | 15KHz |
| DC Gain | A | 1 V/V |
| Min. GBWP | GBWP\_MIN | 1.5MHz |
| Min. Slew Rate | SR\_MIN | 0.09 V / (us) |

The design of the lowpass Sallen-Key filter was generated by the Microchip FilterLab® software. The software provides the 1% tolerance resistance and capacitance values to obtain a realistic, implementable filter design.

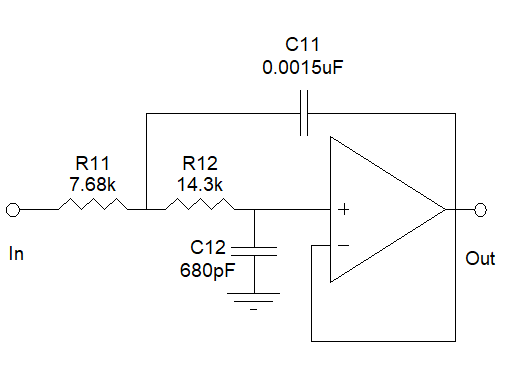


Figure - Sallen-Key, Butterworth, LPF generated by Microchip FilterLab design software (Fc=15KHz).

The designed filter was the simulated in LTSpice with the corresponding MCP6271 Op-amp spice parameters.

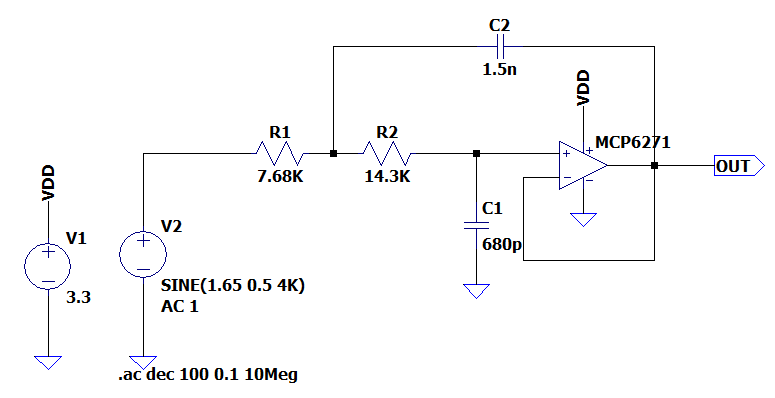


Figure - LTSpice simulation schematic of LPF.

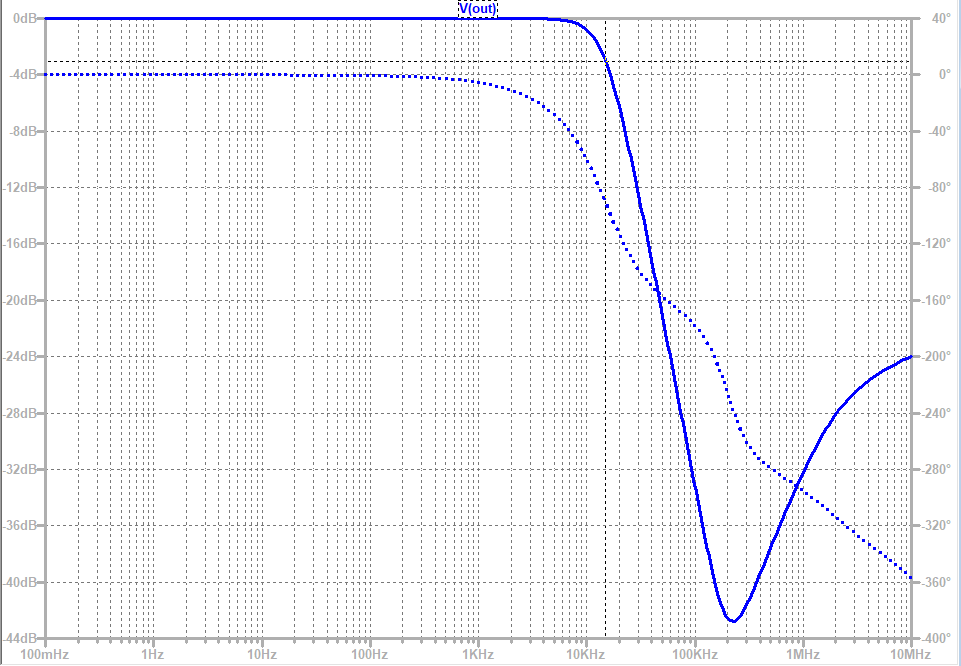


Figure - LTSpice simulated LPF frequency response.

Figure 3 shows the expected magnitude and phase response of the filter. Analyzing the magnitude response shows flat 0dB gain for the passband frequencies and -20dB per decade attenuation after the passband. The expected frequency range of the microphone signal will maintain most of the energy from approximately 50Hz to 2KHz. In this frequency range, it is observed there is a nearly constant group delay (linear phase) as desired.