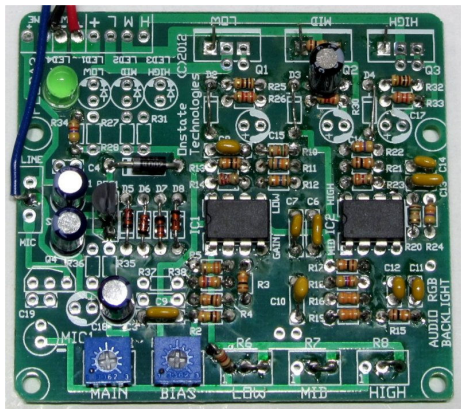## Audio Spectrum Frequency Band Filter

Description:

The Audio Spectrum Frequency Band Filter is a multi-functional module for audio projects. Three op-amp based Sallen-Key filters separate the audio signal into low, mid, and high bands in real-time. The main design of the module was for displaying audio signal level brightness (AKA colour organ/light organ) to responds to music beat and intensity on LED strips. However, the outputs can be connected to audio amps, A/D converters, or DC rectified for specific audio or signal conditioning applications. The low and high band levels can be decrease when you mostly want to hear people talking while watching online videos when the background audio is loud compared to the voice audio. The audio source can be from a line level source or earphone output or with its built-in microphone circuit.

Circuit Operation:

The audio input signal is buffered, amplified and level limited before going to each Sallen-Key filter. Variable resistor R1 (MAIN) is used to adjust the signal level into the amplifier. The amplified audio is then passed through the low-pass (LOW), band-pass (MID) and high-pass (HIGH) filters to separate the input audio. The output of each band is at line-level audio.

Optional: Optional microphone circuit for sound input.
R6, R7 and R8 adjusts individual band levels.
Audio output signal AC, DC and/or W/offset.

Technical Specifications:

Dimension:	66mm x 60mm (2.6"x2.36")
Operating voltage:	12V nominal (9V - 14V)
Output current:	30mA per channel (op-amp).
Standby current:	< 15mA.
Audio input level (min):	100mV. Fixed gain adjustable.
Audio input level (max):	2V RMS.
Microphone input.	Electret, speech audio level.
LED strip (N-CH MOSFET):	0.5A (per band). Common +.
Low pass:	40-290Hz (-3dB)
Band pass:	1.0kHz (320Hz – 2900Hz)
High pass:	3100Hz (-3dB)

NOTE: BOM sets filters around the audio voice band range.
Bass=16-256 Hz. Voice=300-3000kHz. Treble=2.0-16kHz.

PCB:
1. 1/16" glass fiber. FR4 type, ROHS and lead-free.
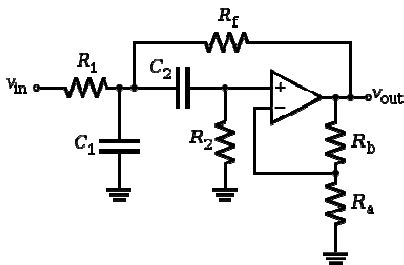2. Through-hole plated, HASL coated holes. Double-sided copper traces.
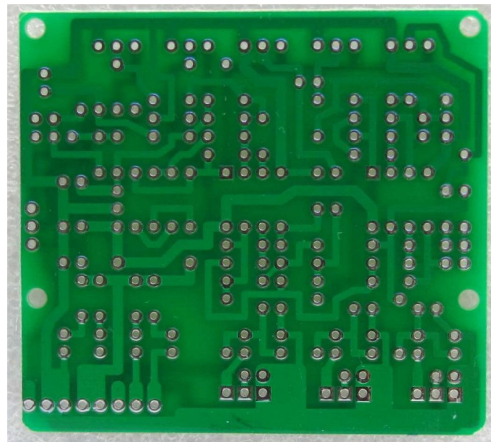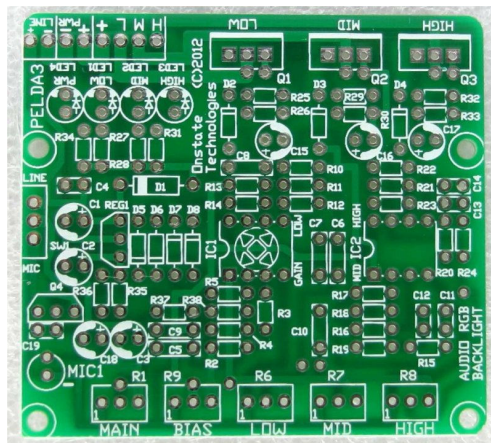
Filter Band Calculation:

The pass filters are based on Sallen-Key RC filter circuit topology.
Internet seach Sallen-Key filters for more technical information and design.
See schematic for design information.

Low and high pass filters:
Center frequency (-3dB)
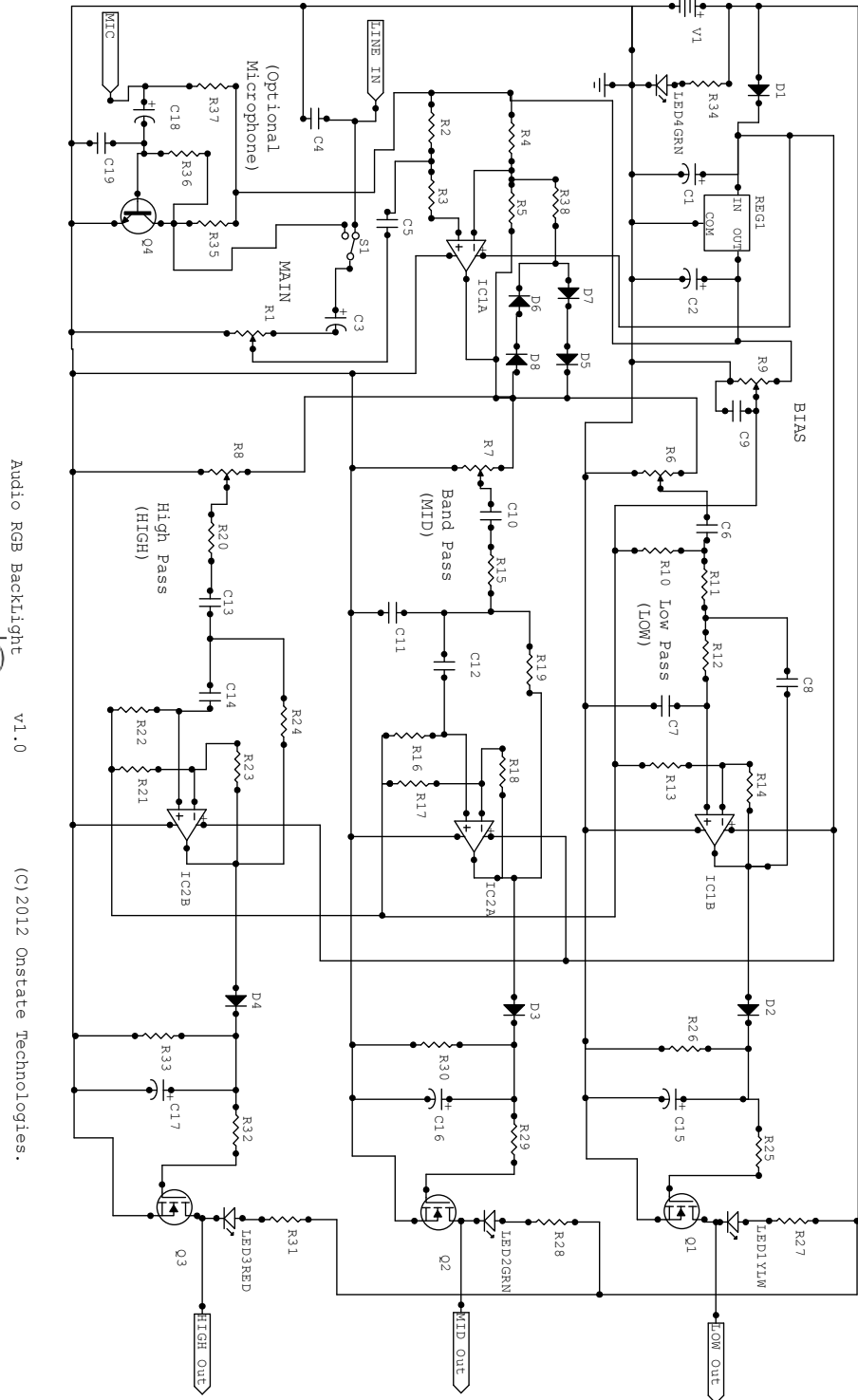$f_0 = 1/(2\pi \, \text{sqrt}(R_1 R_2 C_1 C_2))$

Bandpass filter:

$$f_0 = \frac{1}{2\pi} \sqrt{\frac{R_f - R_1}{C_1 C_2 R_1 R_2 R_f}}$$

$$Q = \frac{\sqrt{(R_1 + R_f)R_1 R_f R_2 C_1 C_2}}{R_1 R_f(C_1 + C_2) + R_2 C_2\left(R_f - \frac{R_b}{R_a}R_1\right)}$$

Gain=$1 + R_b/R_a$ Keep G<3.
Q=Quality factor($f_0/\Delta F$)
f_0= center frequency