ANALOG DEVICES

AN-134
APPLICATION NOTE

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An Automatic Microphone Mixer

This application note describes an audio-signal activated microphone mixer, as shown, designed to accommodate eight input channels. The SSM-2120 Dynamic Range Processor is the nucleus of this design. The device includes two VCAs and two rectifier and control amplifier circuits. The application is designed for unattended microphone mixing functions, as would be used in a conference room that required sound reinforcement or conversation recording. The circuit provides automatic and transparent channel ON/OFF operation. The audio output automatically turns ON in less than 10ms and back OFF after 2 to 4 seconds of no audio. Each channel incorporates independent and automatic operation, with ON threshold sensitivity and level adjustment (trim) controls.

THE MICROPHONE PREAMPLIFIER CIRCUIT

For optimum circuit performance, the nominal output level from the microphone preamplifier or other audio source(s) should be –10dBu. The –10dBu level allows the SSM-2120 to provide the widest dynamic range and lowest noise, while optimizing the headroom of the automatic switch and the microphone preamplifier.

THE AUDIO SWITCH

Each audio signal is switched ON and OFF by a VCA (voltage controlled amplifier) element. By controlling the turn-ON and turn-OFF ramp time, the VCA produces transient-free switching. No distortion or "pops" are introduced using this technique. The turn-ON is ramped from a maximum of 90dB to 0dB attenuation in approximately 30ms. With the complete removal of the audio, the turn-OFF ramp of ≈100ms will begin after approximately three (3) seconds.

The VCA's input is a current input, virtual ground node. The design shown in Figure 1 assumes that $\pm 15V_{DC}$ will power the system. With this supply voltage, the 37.4kΩ input resistor(s) will keep the VCA operating at the optimum distortion and dynamic range. The 150kΩ resistor connected from V_{CC} ($+15V_{DC}$) to the reference current pin 10 of the 2120, sets the VCA bias operating point. The VCA's current output is then connected to a voltage by a transimpedance amplifier using a low noise SSM-2134 op amp. The VCA input(s) and output(s) are capacitively coupled to remove DC components from previous stages.

THE CONTROL CIRCUIT

The input signal is rectified and averaged before it is filtered by the integrator capacitor (10µF electrolytic). The small signal averaging time constant with this capacitor is approximately 60ms. The attack time is 30ms to 3dB of the final level, and is nearly independent of the magnitude of level increase. The discharge time is controlled by the 3.3MΩ resistor returned to V_{EE} ($-15V_{DC}$), which also sets the rectifier reference current.

The control circuit amplifier has a voltage gain of 217. The inverting input is used to set the ON/OFF threshold point, too, and allows for the ON Threshold level adjustment. The ON Threshold range is adjustable from -40dBu to 0dBu as referenced to the input of the VCA element. The control port +Vc of the VCA is used so that a negative control voltage applied will produce an attenuation effect. R_4 (221Ω) and R_5 (4.64kΩ) attenuate the control voltage by a factor of 22, resulting in a maximum attenuation value of 90dB with no audio signal present.

To minimize the effect of ON/OFF control voltage appearing in the output signal of the VCA, the Feedthrough null control circuit is recommended. It provides an external method for balancing the internal VCA currents and component values.

THE OUTPUT SECTION

The design incorporates a virtual ground current summing bus, that is fed by the individual mixing channel level control(s) and 10.0kΩ resistor(s). The Level control(s) provides 21dB attenuation range (0dB to –21dB), and is designed to balance the different inputs, but not turn them off fully. The 100kΩ (linear taper) level control(s), for a linear rotation produces a logarithmic attenuation curve.

The virtual ground summing amplifier establishes half of the balanced output circuit, with another inverting amplifier completing the balanced output circuit. The circuit is able to drive 600Ω loads to +24dBm levels with low distortion and high reliability.

TABLE 1: Circuit Performance Specifications

Input Voltage, without Preamplifier, (for +4dBu Out)	–10dB
Input Impedance, Unbalanced	≈1kΩ
Headroom (Nominal for –10dBu In and Out)	32dB
Turn ON Time (to 3dB of Final Value)	30ms
Turn OFF Time (No Signal)	≈3sec
Turn OFF Ramp Time	100ms
Feedthrough (Trimmed)	>1mV
ON/OFF Threshold Range (Nominal)	0dBu to –40dBu
ON/OFF Gain Extent	0dB to –90dB
Frequency Response for ±0.1dB	20Hz to 20kHz
S/N Ratio @ 0dB Gain	110dB
THD + Noise (from 20Hz to 20kHz)	0.005%
IMD (SMPTE 60Hz and 4kHz, 4:1)	0.02%
Output Voltage Slew Rate	12V/µs
Rated Output Level (600Ω Load)	+24dBu
Output Impedance	68Ω
Output Type	Balanced
Power Supply Requirements	$\pm 15V_{DC}$ Regulated

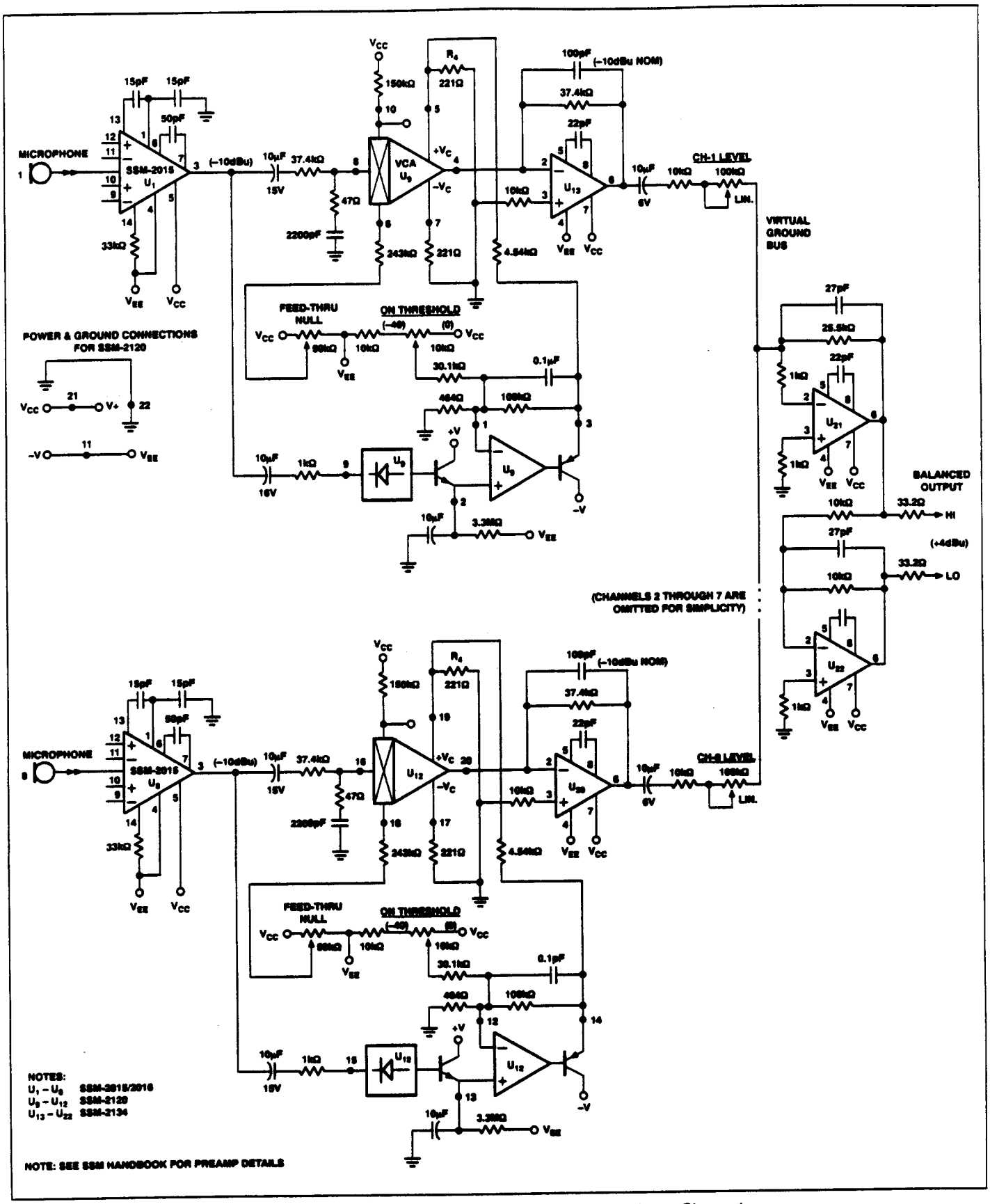

FIGURE 1: *Automatic Channel Activation Microphone Mixer Diagram Illustrates 8 Input Channels*