ANALOG DEVICES

AN-121
APPLICATION NOTE

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High Performance Stereo Routing Switcher

The SSM-2402 Dual Audio Switch comprises the nucleus for this 16 channels-to-one high performance stereo audio routing switcher, which features negligible noise and low distortion over the frequency range of 20Hz to 20kHz. This performance is achieved even while driving 600Ω loads at signal levels up to +30dBu.

The SSM-2402 affords a much simplified electrical design and printed circuit board layout, along with reduced manufacturing cost, when compared with discrete JFET circuits of similar performance. The electrical performance of the design described is vastly superior to CMOS switch designs, which are more prone to failure resulting from electrical static discharge.

The switching control of the SSM-2402 may be activated by conventional mechanical switches or 5 volt TTL or CMOS logic circuits. The application shown utilizes a simple mechanical control switch for illustration purposes only. Many diverse X/Y control schemes, destination control, or computer controlled designs can be utilized.

The "T" configuration of the SSM-2402 switch provides excellent ON-OFF isolation. The SSM-2402 also features 7ms ramped turn on and 4ms ramped turn off for click-free switching. Additionally, the switch has a break-before-make switching sequence. Both features become significant in large audio switching systems where the audio path can pass through multiple switching elements. Such controlled switching is very important in large systems used in broadcast program switching or in production work.

The application circuit design also employs the SSM-2015 balanced input amplifier (Figure 1). The input impedance is high (≈100kΩ), balanced or unbalanced. The input circuit incorporates a single pole RFI filter with a cutoff frequency set at 145kHz. In addition, the input circuit attenuates the signal by 25dB and extends the common-mode input voltage range to ±98 volts peak, with common-mode rejection greater than 70dB from 20Hz to 20kHz. The SSM-2015 is set to produce a 15dB gain. The signal drive level into the SSM-2402 switch is then

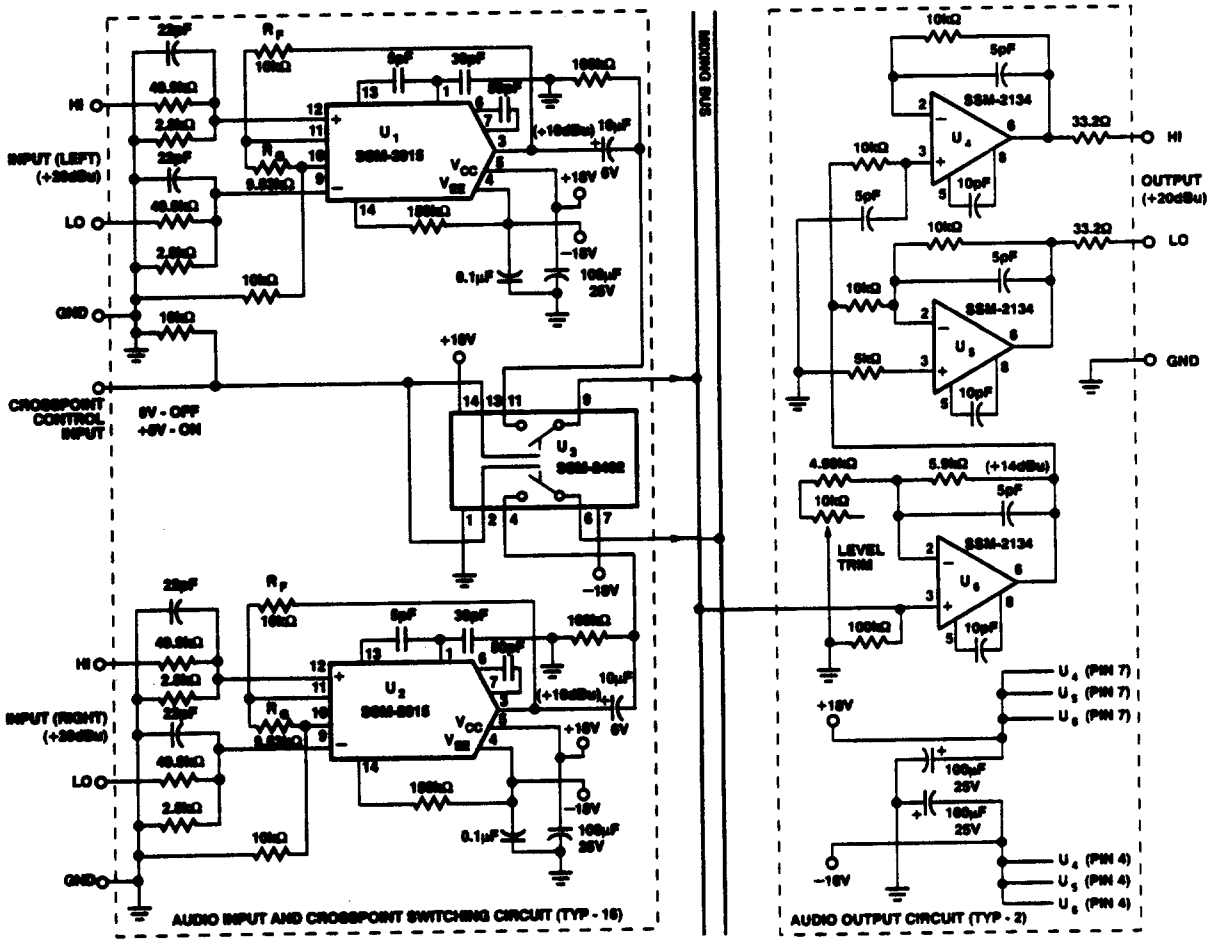

FIGURE 1: *Switcher Schematic*

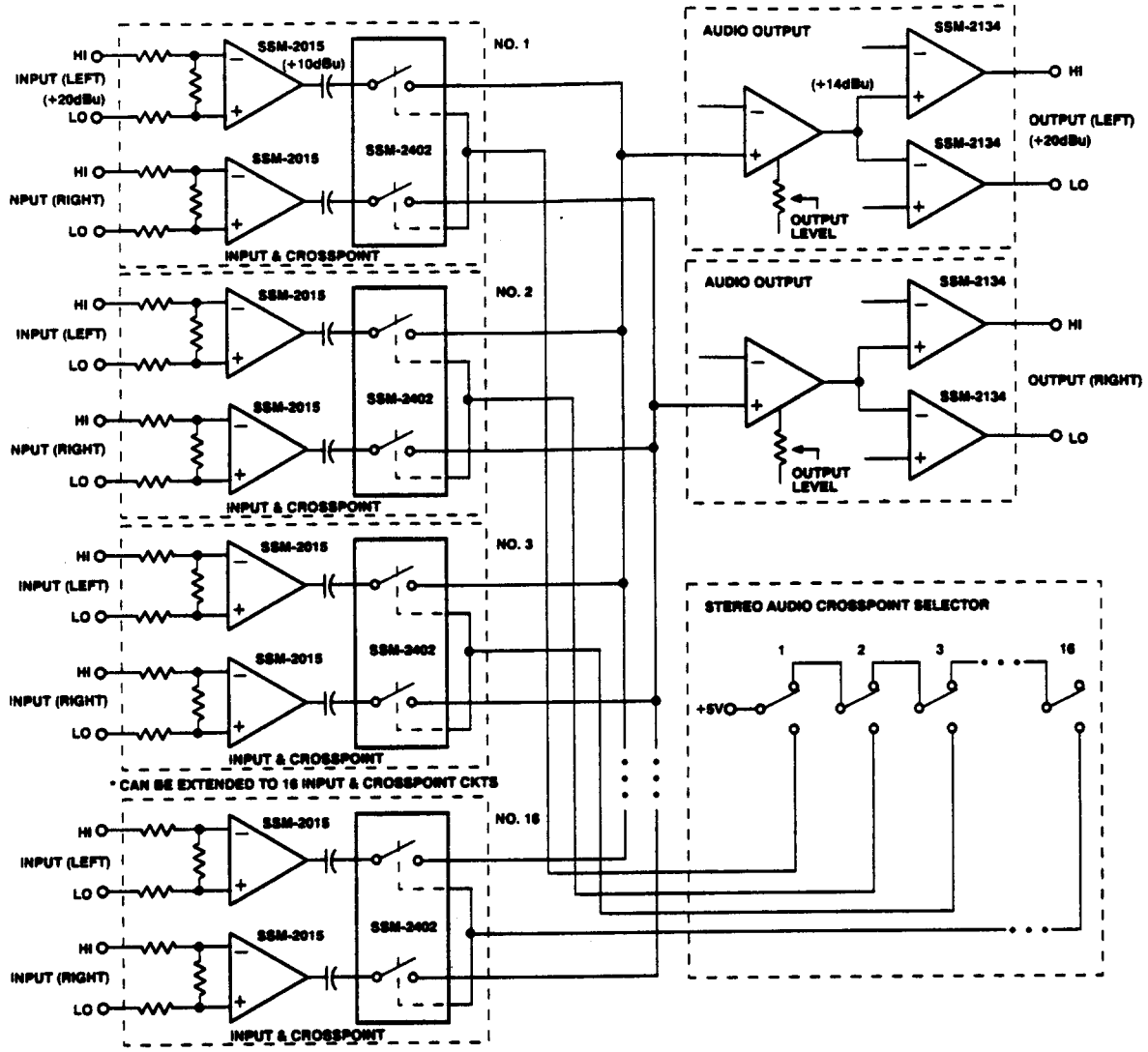

FIGURE 2: *Switcher Functional Block Diagram*

+10dBu with a +20dBu input level and +14dBu peak, well within ideal operating range. Good signal-to-noise is maintained, with generous head-room available by electing to use ±18VDC power supply voltages.

The routing switcher bus carries high level unbalanced audio, but is driven with low impedance sources. With the output impedance of the SSM-2015 at virtually 0Ω and the SSM-2402 switch ON, resistance is typically 60Ω. Bus-to-bus crosstalk is exceptionally low. For example, assuming 14pF coupling between buses and 20kHz signal, the crosstalk (isolation) exceeds 80dB. The 14pF would be representative for the 16 X 1 stereo design shown. Shielding of the buses with a printed circuit board ground plane and physically isolating the input and output circuits will reduce the crosstalk even further. The "T" configuration of the SSM-2402 switch virtually eliminates crosstalk between the various input signal sources.

The output amplifier incorporates a buffer amplifier that provides 4dB of gain (nominally), with adjustable output level trim control. The buffer also isolates the switching bus from the balanced output amplifier circuit. The balanced output is designed to drive 600Ω loads and utilizes two SSM-2134 IC amplifiers. The differential design increases drive capability, yet increases the heat dissipation surface area, and keeps IC package temperature well within safe operating limits, even when driving 600Ω loads. The SSM-2134 is recommended due to its low noise, wide frequency response, and output drive current capabilities.

Overall performance of the 16 X 1 stereo switcher is noteworthy. Input-to-output frequency response is flat to within 1dB over a 10Hz to 50kHz band. Total harmonic distortion plus noise is less than 0.03%, from 20Hz to 20kHz. SMPTE intermodulation distortion is less than 0.02%. The use of ±18VDC power supplies produces a +30dBm clip level, even when driving 600Ω loads.

TABLE 1: Circuit Performance Specifications

Max Input Level	+30dBu
Input Impedance, Unbalanced	100kΩ
Input Impedance, Balanced	200kΩ
Common-Mode Rejection (20Hz to 20kHz)	>70dB
Common-Mode Voltage Limit	±98V Peak
Max Output Level	+30dBu/dBm
Output Impedance	67Ω
Gain Control Range	±2dB
Output Voltage Slew Rate	6V/μs
Frequency Response (±0.05dB)	20Hz to 20kHz
Frequency Response (±0.5dB)	10Hz to 50kHz
THD + Noise (20Hz to 20kHz, +8dBu)	0.005%
THD + Noise (20Hz to 20kHz, +24dBu)	0.03%
IMD (SMPTE 60Hz & 4kHz, 4:1, +24dBu)	0.02%
Crosstalk (20Hz to 20kHz)	>80dB
S/N Ratio @ 0dB Gain	135dB