



Dolby Pro-Logic Surround Matrix Decoder

SSM-2125/SSM-2126

FEATURES

Noise Generator and Autobalance Circuits are Contained On-Chip
Autobalance On/Off Control
4-Channel Pro-Logic and Dolby 3 (Surround Channel Defeat) Modes Available
Selectable Center Channel Modes—Normal, Wideband, Phantom, Off
Direct Path Bypass (Normal 2-Channel Stereo Mode)
Wide Channel Separation
Center to Left, Right Channels—35 dB min (SSM-2125)
Any Channel to Another—25 dB min (SSM-2126)
Wide Dynamic Range—103 dB typ
Low Total Harmonic Distortion—0.02% typ
Available in a 48-Pin Plastic DIP
CMOS and TTL Compatible Control Logic

APPLICATIONS

Direct View and Projection TV
Integrated A/V Amplifiers
Laserdisc and CD-V Players
Video Cassette Recorders
Stand-Alone Surround Decoders
Home Satellite Receiver/Descramblers

GENERAL DESCRIPTION

The SSM-2125 and SSM-2126 are Dolby® Pro-Logic Surround Decoders developed to provide multichannel outputs from Dolby Surround encoded stereo sources.

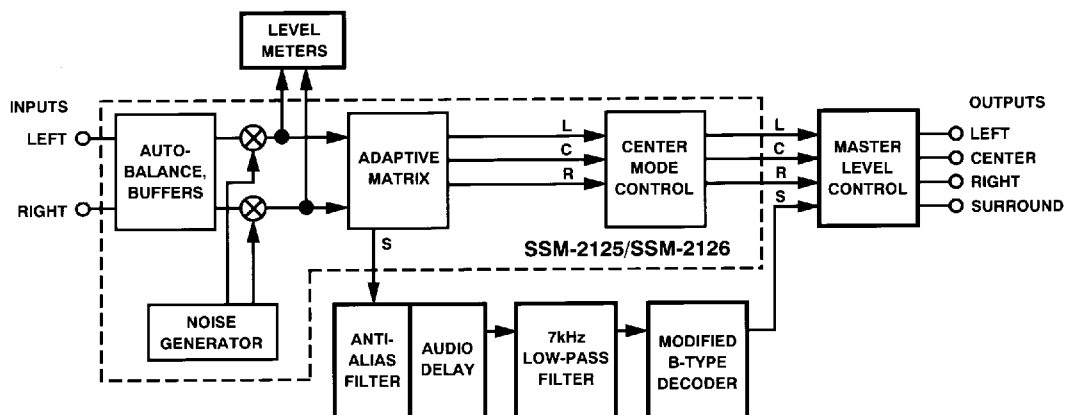
Over 2000 major films and an increasing number of broadcasts are available in Dolby Surround. Surround encoding is preserved in the stereo audio tracks of normal video discs, video cassettes, and television broadcasts, permitting the decoding to multichannel audio in the home.

Major design considerations of the SSM-2125/SSM-2126 are excellent audio performance and a high level of integration. In addition to the Adaptive Matrix and Center Mode Control, also included on-chip are the Automatic Balance Control and Noise Generator functions. A complete Pro-Logic system can be realized using the SSM-2125/SSM-2126 and few external components. Using SSM's extensive experience in the design of professional audio integrated circuits, the SSM-2125/SSM-2126 offers typical 103 dB dynamic range and 0.025% THD. A direct path bypass mode allows normal stereo operation with high fidelity without the need for external switching or parallel signal paths.

The SSM-2125 is a premium grade that is selected to a minimum channel separation specification of 35 dB for the center to left and right channels, and 25 dB for the remaining channels. The standard grade, the SSM-2126, provides minimum channel separation of 25 dB from any channel to another.

The SSM-2125/SSM-2126 is available only to licensees of Dolby Licensing Corporation, San Francisco, California, from whom licensing and application information must be obtained.

FUNCTIONAL BLOCK DIAGRAM



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REV. 0

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SSM-2125/SSM-2126 — SPECIFICATIONS ($V_S = \pm 6\text{ V}$, $T_A = +25^\circ\text{C}$, $V_{IN} = 0\text{ dBd}$ at 1 kHz,¹ Center Mode Control: Wide, unless otherwise noted.)

| Parameter | Symbol | Conditions | SSM-2125 | | | SSM-2126 | | | Units |
|------------------------------------|-----------|---|----------|----------------|-----------|----------|----------------|-----------|------------|
| | | | Min | Typ | Max | Min | Typ | Max | |
| CHANNEL SEPARATION | | | | | | | | | |
| Center | | C Input; R, L Outputs | 35 | 48 | | 25 | 35 | | dB |
| | | C Input; S Output | 25 | 35 | | 25 | 35 | | dB |
| Right | | R Input; L, C, S Outputs | 25 | 35 | | 25 | 35 | | dB |
| Left | | L Input; C, R, S Outputs | 25 | 35 | | 25 | 35 | | dB |
| Surround | | S Input; L, R, C Outputs | 25 | 35 | | 25 | 35 | | dB |
| CHANNEL OUTPUT LEVEL | | $V_{IN} = 0\text{ dB}$; L, R, C, S Output | | | ± 0.5 | | | ± 0.5 | dBd |
| TOTAL HARMONIC DISTORTION | THD | All Channels | | 0.02 | 0.1 | | 0.02 | 0.1 | % |
| SIGNAL-TO-NOISE RATIO | SNR | $V_{IN} = 0\text{ V}$, CCIR2K/ARM All Channels | -83 | -87 | | -80 | -87 | | dBd |
| HEADROOM | HR | Clipping = 3% THD All Channels | 15 | 16 | | 15 | 16 | | dBd |
| BYPASS MODE DYNAMIC RANGE | | Clipping to Noise Floor | | 104 | | | 104 | | dB |
| NOISE SOURCE OUTPUT LEVEL | | All Channels | | -13.5 | | | -13.5 | | dBd |
| NOISE SOURCE OUTPUT LEVEL MATCHING | | Any Channel to Another | | 1 | | | 1 | | dB |
| AUTOBALANCE CAPTURE RANGE | | | ± 3 | ± 3.8 | ± 6 | | ± 3.8 | | dB |
| LOGIC THRESHOLD HI LO | | Relative to L_{REF} | +2.4 | | +0.8 | +2.4 | | +0.8 | V V |
| OPERATING SUPPLY VOLTAGE | V_S | Single Supply Dual Supply | | +12 ± 6 | | | +12 ± 6 | | V V |
| SUPPLY CURRENT | I_{SY} | No Input Signal | | 40 | 50 | | 40 | 50 | mA |
| INPUT IMPEDANCE | Z_{IN} | L, R Inputs | | 5 | | | 5 | | k Ω |
| OUTPUT IMPEDANCE | Z_{OUT} | L, R, C, S Outputs | | 600 | | | 600 | | Ω |

NOTE

¹0 dBd = 500 mV rms Dolby level output at any channel; Left and Right inputs: 500 mV rms (0 dBd); Center input: L = R = 354 mV rms (-3 dBd); Surround input: L = -R = 354 mV rms (-3 dBd).

ABSOLUTE MAXIMUM RATINGS

Supply Voltage +16 V or $\pm 8\text{ V}$
Logic Inputs V+ to V-
Storage Temperature Range -55°C to $+125^\circ\text{C}$
Operating Temperature Range -20°C to $+70^\circ\text{C}$
Junction Temperature $+150^\circ\text{C}$
Lead Temperature Range (Soldering, 60 sec) $+300^\circ\text{C}$
Thermal Resistance¹

θ_{JA} 38°C/W
 θ_{JC} 14°C/W

NOTE

¹ θ_{JA} is specified for worst case mounting conditions, i.e., device in socket.

ORDERING GUIDE

| Model | Temperature Range | Package Option |
|--------------|--|----------------|
| SSM2125XXXP* | -20°C to $+70^\circ\text{C}$ | 48-Pin P-DIP |
| SSM2126XXXP* | -20°C to $+70^\circ\text{C}$ | 48-Pin P-DIP |

NOTE

*The SSM-2125/SSM-2126 is available only to licensees of Dolby Laboratories. Each customer will be assigned a special part number for ordering purposes. Contact local ADI sales office for further details.

Table I. External Component List

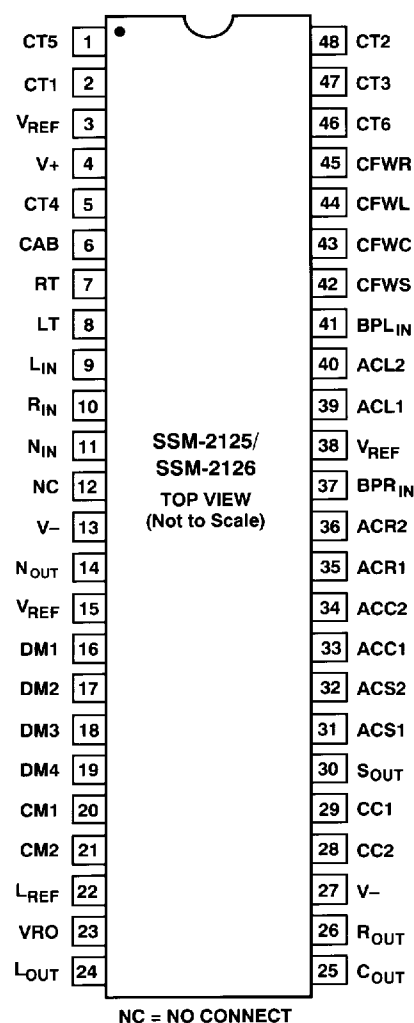
| Component | Value | Tolerance* | Comment (Noncritical Unless Otherwise Noted) |
|-----------|----------------|------------------|--|
| C1 | 0.1 μ F | 20% | Standard Electrolytic |
| C2 | 0.1 μ F | | |
| C3 | 680 pF | | |
| C4 | 0.1 μ F | | |
| C5 | 0.1 μ F | | |
| C6 | 680 pF | | |
| C7 | 4.7 μ F | | |
| C8 | 0.22 μ F | | |
| C9 | 0.22 μ F | | |
| C10 | 0.33 μ F | | |
| C11 | 0.33 μ F | | |
| C12 | 0.33 μ F | | |
| C13 | 0.33 μ F | | |
| C14 | 22 nF | | |
| C15 | 22 nF | | |
| C16 | 22 nF | | |
| C17 | 22 nF | | |
| C18 | 0.1 μ F | 20% | Standard Electrolytic |
| C19 | 4.7 μ F | | |
| C20 | 0.22 μ F | | |
| C21 | 0.22 μ F | 20% | Standard Electrolytic |
| C22 | 10 μ F | | |
| C23 | — | — | Not Needed |
| C24 | 10 nF | $\geq 100 \mu$ F | Standard Electrolytic |
| C25 | 10 nF | | |
| C26 | 10 nF | | |
| C27 | 100 μ F | | |
| C28 | 0.1 μ F | | |
| C29** | 100 μ F | | |
| C30** | 0.1 μ F | | |
| C31 | 100 μ F | | |
| C32 | 0.1 μ F | | |
| R1 | 15 k Ω | 5% | Not Needed |
| R2 | 47 k Ω | 5% | |
| R3 | 15 k Ω | 5% | |
| R4 | 47 k Ω | 5% | |
| R5 | 7.5 k Ω | 5% | |
| R6 | 7.5 k Ω | 5% | |
| R7 | — | — | |
| R8 | — | — | |
| R9 | 22 k Ω | 5% | |
| R10 | 22 k Ω | 5% | |
| R11 | 10 M Ω | 5% | |
| R12 | 22 k Ω | 5% | |

NOTES

*10% unless otherwise indicated.

**Used only in Dual Supply Application Circuit.

PIN CONNECTIONS



SSM-2125/SSM-2126

PIN DESCRIPTION

| Pin # | Name | Function |
|-------|-------------------|--|
| 1 | CT5 | Long Time Constant, C/S |
| 2 | CT1 | Short Time Constant, L/R Comparators |
| 3 | V _{REF} | Reference Voltage: Ground or Pseudoground |
| 4 | V+ | Positive Supply |
| 5 | CT4 | Short Time Constant, C/S Comparators |
| 6 | CAB | Autobalance Time Constant |
| 7 | RT | Buffered, Autobalanced Right Channel Signal |
| 8 | LT | Buffered, Autobalanced Left Channel Signal |
| 9 | L _{IN} | Left Channel Input |
| 10 | R _{IN} | Right Channel Input |
| 11 | N _{IN} | Filtered Noise Input |
| 12 | NC | Do Not Connect |
| 13 | V- | Negative Supply (Ground in Single Supply) |
| 14 | N _{OUT} | Noise Output |
| 15 | V _{REF} | Reference Voltage: Ground or Pseudoground |
| 16 | DM1 | Digital Operating-Mode Control Input |
| 17 | DM2 | Digital Operating-Mode Control Input |
| 18 | DM3 | Digital Operating-Mode Control Input |
| 19 | DM4 | Digital Operating-Mode Control Input |
| 20 | CM1 | Digital Center-Mode Control Input |
| 21 | CM2 | Digital Center-Mode Control Input |
| 22 | L _{REF} | Logic Reference Voltage (Threshold = L _{REF} + 1.4 V) |
| 23 | VRO | V _{REF} Out—Pseudoground Output |
| 24 | L _{OUT} | Left Channel Output |
| 25 | C _{OUT} | Center Channel Output |
| 26 | R _{OUT} | Right Channel Output |
| 27 | V- | Negative Supply (Ground in Single Supply) |
| 28 | CC2 | Center Normal-Mode Filter Input (Z = 15 kΩ) |
| 29 | CC1 | Center Normal-Mode Filter Output |
| 30 | S _{OUT} | Surround Channel Output |
| 31 | ACS1 | Surround Channel Steering Signal AC Coupling and High-Pass Filter |
| 32 | ACS2 | Surround Channel Steering Signal AC Coupling and High-Pass Filter |
| 33 | ACC1 | Center Channel Steering Signal AC Coupling and High-Pass Filter |
| 34 | ACC2 | Center Channel Steering Signal AC Coupling and High-Pass Filter |
| 35 | ACR1 | Right Channel Steering Signal AC Coupling and High-Pass Filter |
| 36 | ACR2 | Right Channel Steering Signal AC Coupling and High-Pass Filter |
| 37 | BPR _{IN} | Filtered Right Channel Input to Steering Signal Generator |
| 38 | V _{REF} | Reference Voltage: Ground or Pseudoground |

| Pin # | Name | Function |
|-------|-------------------|--|
| 39 | ACL1 | Left Channel Steering Signal AC Coupling and High-Pass Filter |
| 40 | ACL2 | Left Channel Steering Signal AC Coupling and High-Pass Filter |
| 41 | BPL _{IN} | Filtered Left Channel Input to Steering Signal Generator |
| 42 | CFWS | Surround Channel Full-Wave Rectifier Low-Pass Filter |
| 43 | CFWC | Center Channel Full-Wave Rectifier Low-Pass Filter |
| 44 | CFWL | Left Channel Full-Wave Rectifier Low-Pass Filter |
| 45 | CFWR | Right Channel Full-Wave Rectifier Low-Pass Filter |
| 46 | CT6 | Short Time Constant, C/S |
| 47 | CT3 | Short Time Constant, L/R |
| 48 | CT2 | Long Time Constant, L/R |

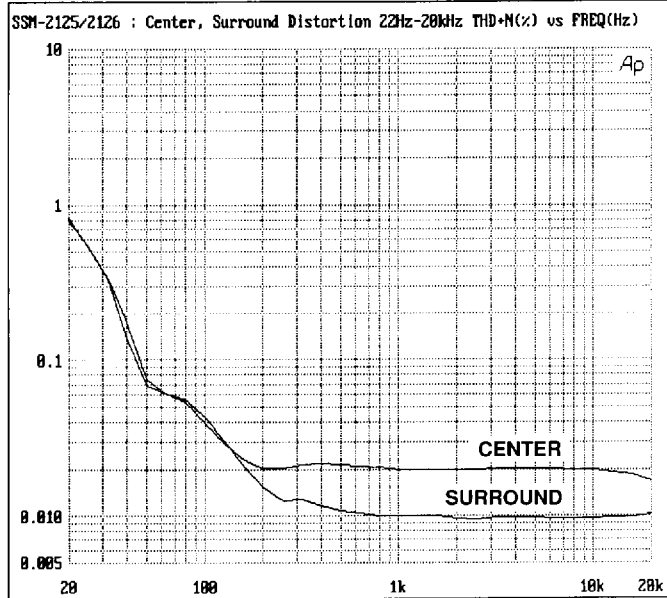


Figure 1. THD+N vs. Frequency,* Center and Surround Channels ($V_{IN} = 0 \text{ dBd}$, $R_L = 100 \text{ k}\Omega$)

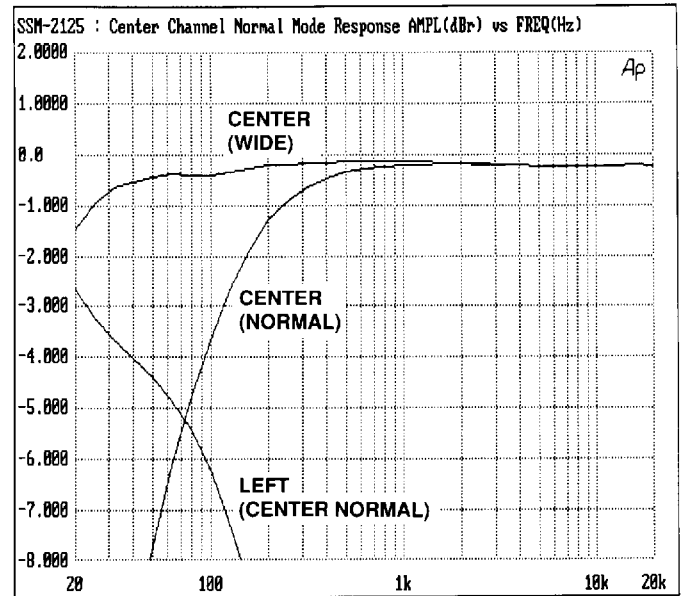


Figure 3. Bass-Splitting Filter Response (Center Channel Normal and Wide Modes)

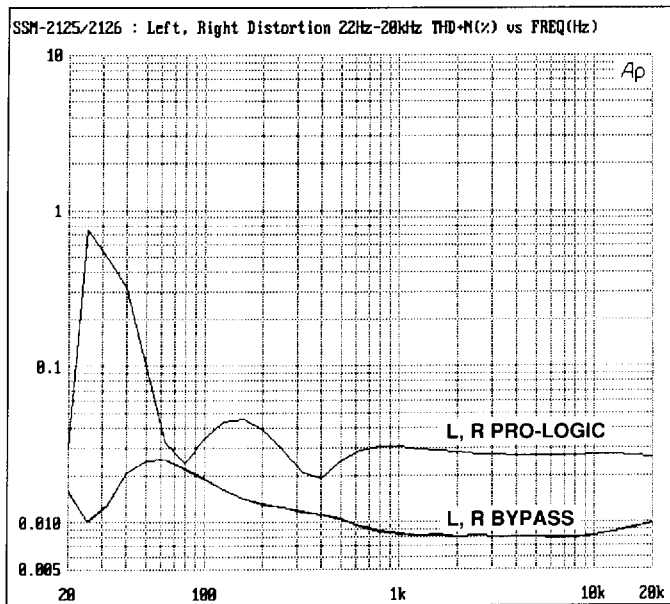


Figure 2. THD+N vs. Frequency,* Left and Right Channels ($V_{IN} = 0 \text{ dBd}$, $R_L = 100 \text{ k}\Omega$)

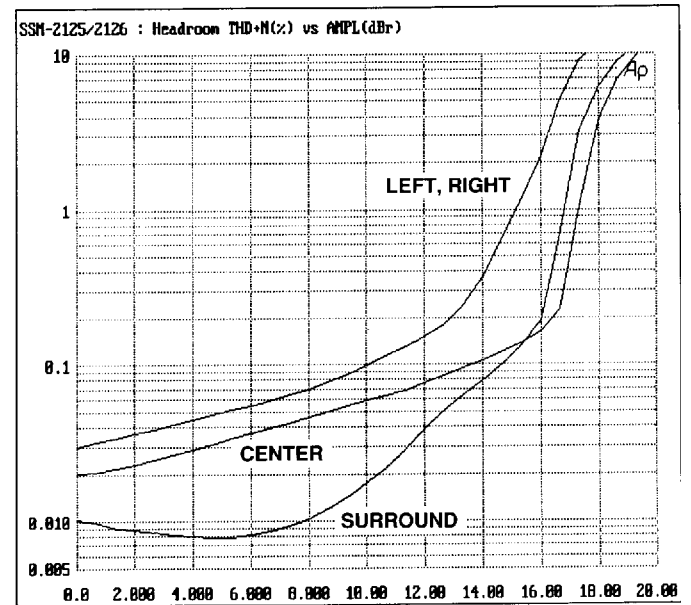


Figure 4. Headroom THD+N vs. Amplitude (0 dB = 0 dBd = 500 mV rms)

*80 kHz low-pass filter used for Figures 1 and 2.

SSM-2125/SSM-2126

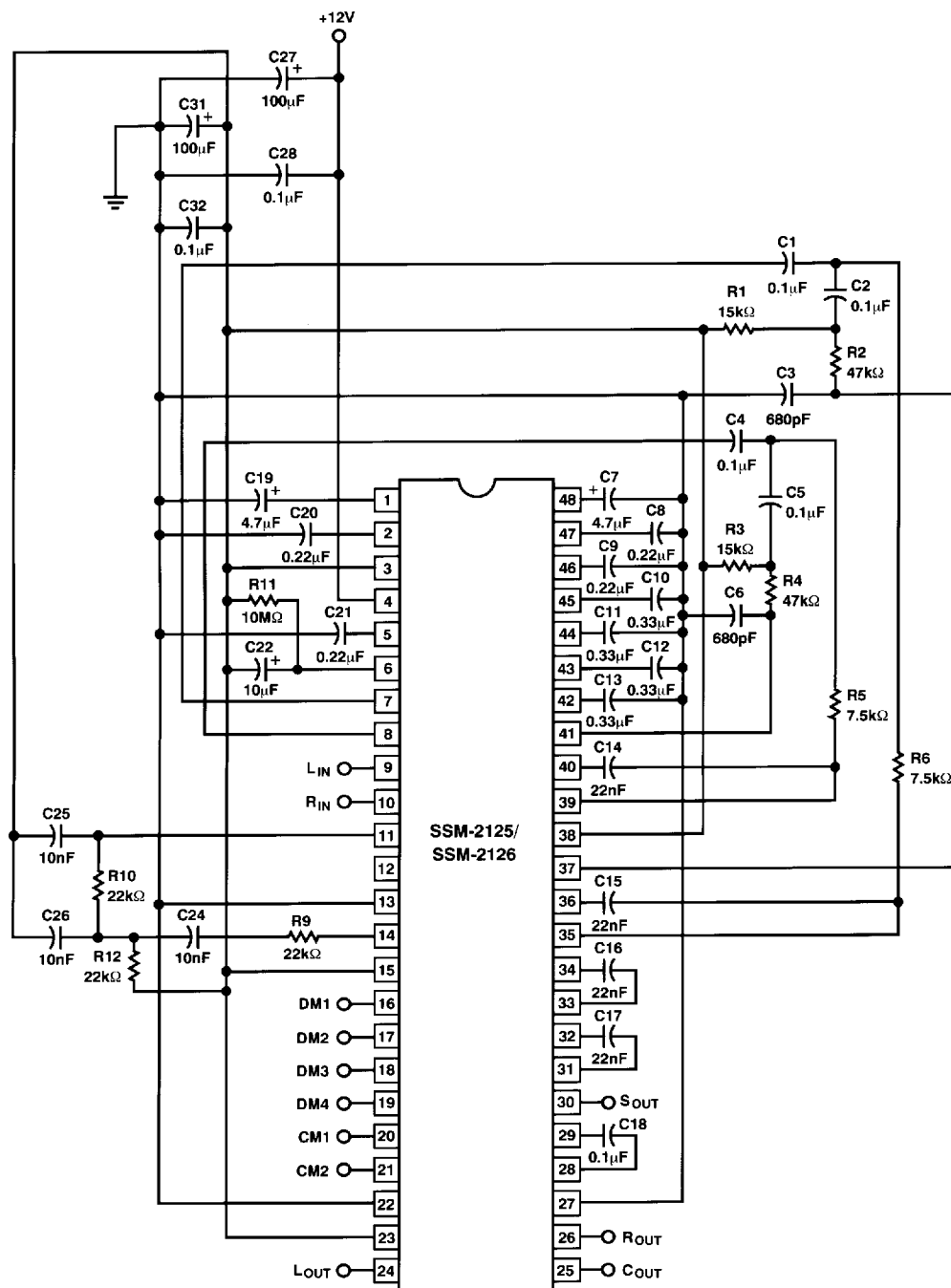


Figure 5. Single Supply Application Circuit

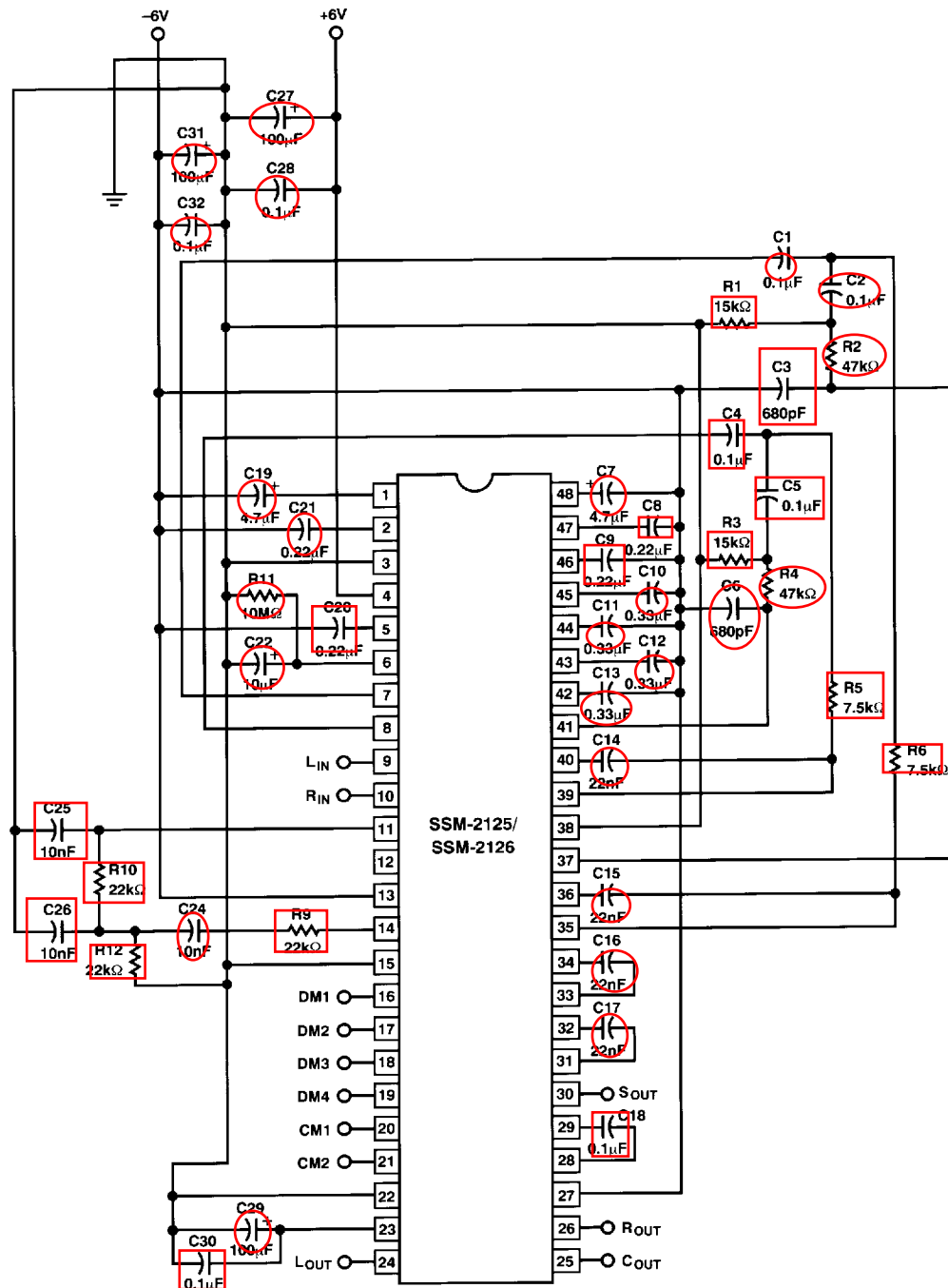


Figure 6. Dual Supply Application Circuit

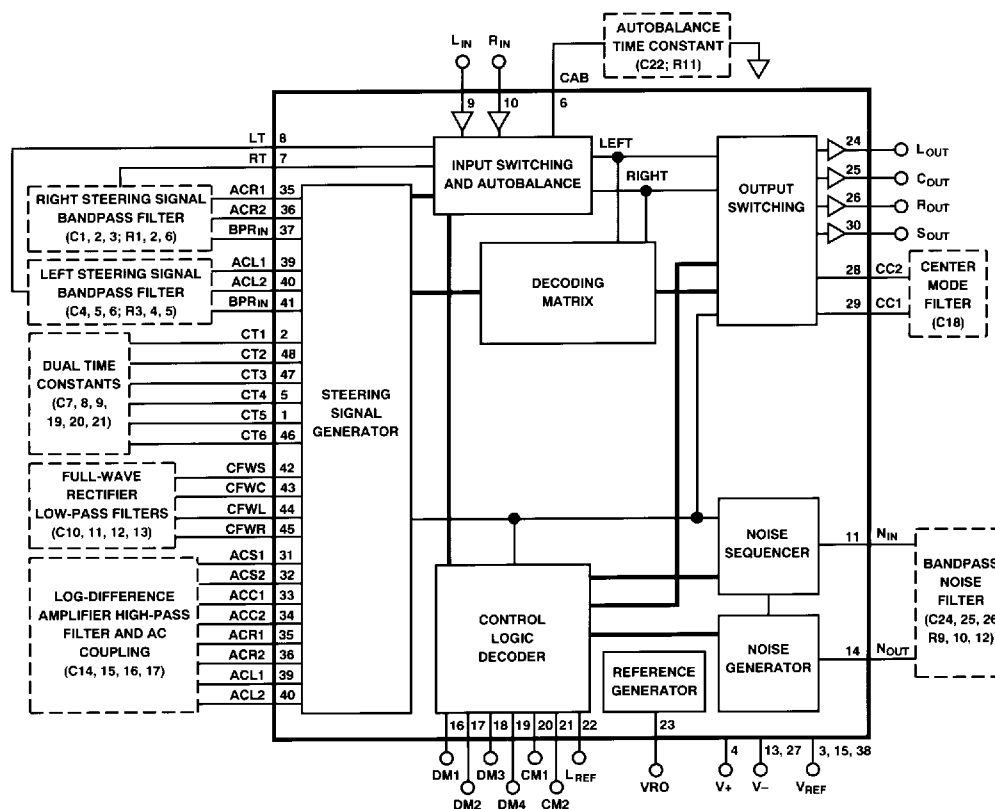


Figure 7. SSM-2125/SSM-2126 Block Diagram Showing External Component Functions

APPLICATIONS INFORMATION

POWER SUPPLIES

The SSM-2125/SSM-2126 is designed to use either a dual ± 6 V or single $+12$ V supply, with a tolerance of $\pm 10\%$. Internal reference points on the IC and a 6 V reference, generated on-chip, are brought to external pins. When operated in dual supply mode, the reference inputs (labeled V_{REF}) are connected to the external ground. In single supply mode, the internal 6 V reference (labeled VRO) is wired to the V_{REF} pins, providing a pseudoground reference. In either mode, the internal reference VRO should be decoupled with a 100 μ F electrolytic capacitor in parallel with a 0.1 μ F ceramic capacitor.

Dual supply mode offers the highest fidelity operation and eliminates the necessity for input and output decoupling capacitors. All signals are ground referenced in dual supply mode, allowing dc coupling of the inputs and outputs. Additionally, the power on settling time is reduced when operating with dual supplies.

In single supply mode, decoupling capacitors are required, as the signals are referenced to the $+6$ V pseudoground reference. Any noise introduced onto the V_{REF} line will appear at the output, so careful decoupling of the reference is required to maintain excellent noise and distortion performance. The 100 μ F V_{REF} decoupling capacitors should be placed close to the VRO pin (Pin 23), and 0.1 μ F capacitors close to each V_{REF} pin.

DOLBY LEVEL

The discrete implementation of Dolby Pro-Logic Surround used a Dolby level of 500 mV. To maintain high audio quality and excellent signal-to-noise ratio, the SSM-2125/SSM-2126 was designed to operate with a 500 mV Dolby level. With this level, the SSM-2125/SSM-2126 provides 87 dBd SNR (CCIR2K/ARM) and 16 dB of headroom. In addition, the SSM-2125/SSM-2126 is capable of operation to the Pro-Logic specification at a Dolby level of 300 mV, with the result of reduced SNR and increased headroom. At the 300 mV level, SNR is typically 83 dBd with 20 dB of headroom. Either way, total dynamic range of the device is 103 dB (0 dBd = 500 mV).

AUTOBALANCE

Left and right signals with an imbalance less than ± 3.8 dB will activate the autobalance circuitry when DM3 = 1. Once activated, the circuit will correct up to 4 dB of balance error. Autobalance is available in both the Pro-Logic and stereo bypass modes. When autobalance is OFF, the autobalance VCAs are bypassed.

NOISE GENERATOR AND SEQUENCING

The SSM-2125/SSM-2126 noise source is best described as white noise passed through a 0.2 Hz comb filter and a 10 kHz low-pass filter. Thus, the noise is comprised of separate equal-amplitude peaks spaced at 0.2 Hz apart, as shown in Figure 8. Figure 9 shows overall frequency response of the filtered noise source.

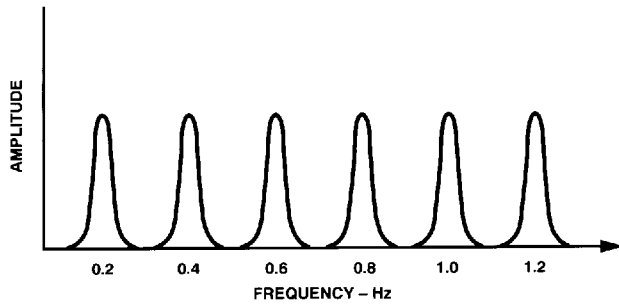


Figure 8. Comb-Filtered Noise Source Characteristics

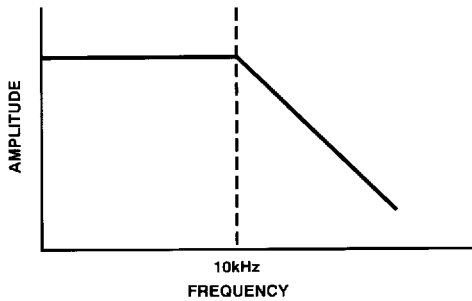


Figure 9. Overall Frequency Response of Filtered Noise Source

For systems that are not microprocessor controlled, Figure 10 suggests one option to implement automatic noise sequencing using standard logic. The CD4060 (or equivalent), although only partially used, was selected since it contains a clock and 2-bit binary counter on-chip. The timing interval is set by:

$$f = \frac{1}{2.2 R_1 C_3}$$

where $2R_1 < R_2 < 10R_1$.

The values shown in Figure 10 will provide a frequency of 2.9 Hz. One half of a CD4556 can be used to drive LED panel indicators if desired, as shown.

FUNCTIONAL MODES

The SSM-2125/SSM-2126 uses a positive logic system, whereby a voltage greater than 2.4 V above L_{REF} is considered a "1," and voltage levels between L_{REF} and 0.8 V are considered a "0." Tables II and III provide truth tables for logic inputs DM1 through DM4, and CM1 and CM2. "Dolby 3" mode, which disables surround steering, is available as shown. Normal operating mode for the decoder is with a "1" on all logic inputs. This provides 4-channel logic, autobalance ON, and center normal mode. Internal pullups will automatically set the chip into this state if the inputs are left unconnected.

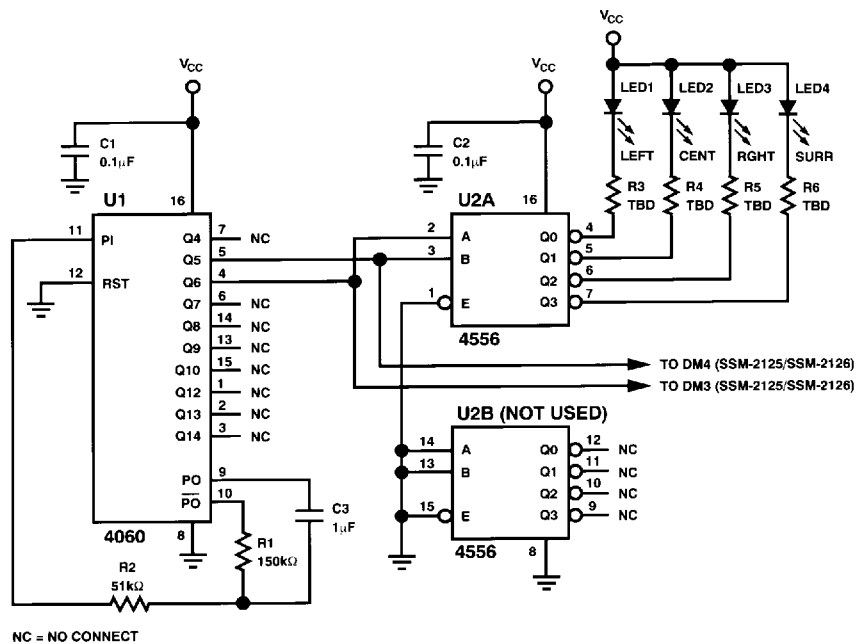


Figure 10. Automatic Noise Sequencing Circuit

SSM-2125/SSM-2126

Table II. Control States for DM1-DM4

| DM1 | DM2 | DM3 | DM4 | Operating State |
|-----|-----|-----|-----|---|
| 1 | 1 | 1 | 1 | Dolby 4-Channel ("Pro-Logic"), Autobalance On |
| 1 | 1 | 0 | 1 | Dolby 4-Channel ("Pro-Logic"), Autobalance Off |
| 1 | 0 | 1 | 1 | Dolby 3-Channel ("Dolby 3"), Autobalance On |
| 1 | 0 | 0 | 1 | Dolby 3-Channel ("Dolby 3"), Autobalance Off |
| 0 | 1 | 1 | 1 | Surround Channel Noise |
| 0 | 1 | 1 | 0 | Right Channel Noise |
| 0 | 1 | 0 | 1 | Center Channel Noise |
| 0 | 1 | 0 | 0 | Left Channel Noise |
| 0 | 0 | X | 1 | Mute |
| 0 | 0 | 1 | 0 | Stereo Bypass, Autobalance On |
| 0 | 0 | 0 | 0 | Stereo Bypass, Autobalance Off |

Table III. Center Channel Functional Modes

| CM1 | CM2 | Mode |
|-----|-----|-------------------------|
| 0 | 0 | Center Channel Off |
| 0 | 1 | Center Channel Wideband |
| 1 | 0 | Phantom Center Channel |
| 1 | 1 | Normal Center Mode |

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

48-Pin Plastic DIP

