



# NJU25018

## TruSurround™ Digital Audio Processor with BBE



### Description

The NJU25018 is a 24-bit digital signal processor dedicated to decoding a stereo audio source and creating the sensation of being surrounded by multiple speakers. Based on patented technology from SRS Labs, TruSurround™ utilizes Head Related Transfer Functions (HRTFs) to envelop the listener with full 360° surround coming from only a pair of speakers. One of the distinguishing advantages of TruSurround is a broad "sweet spot," offering effective virtual surround within an area up to 75% between the speakers and some surround effect outside the area between the speakers. Additionally, because TruSurround is based on the proprietary SRS® (Sound Retrieval System®) 3D Sound technology, when a standard stereo source is fed into the NJU25018, the resulting output is an expanded sound image that minimizes the speakers as the point source of audio information, presenting good stereo separation independent of listener position.

In addition to 3D virtual surround sound, the NJU25018 offers BBE® processing to enhance audio with a transfer function that boosts high and low frequency content while applying a particular phase response that improves the perceived clarity and transient response. The NJU25018 is also a full featured Dolby™ Pro Logic™ decoder with 5 output channels (L, R, SL, SR, C) plus optional subwoofer (0.1) channel. Audio functions included in the NJU25018 are digital speaker crossover filters and digital tone control with separate bass and treble settings. Applications that can benefit from the NJU25018 include TVs, self-powered multimedia speakers, and A/V stereo systems used for home theater.

### Features

- ◆ SRS TruSurround 3D 360°Surround Processing  
Wide listening area
- ◆ BBE High-Definition Sound Enhancement
- ◆ Dolby Pro Logic Decoder With Optional Subwoofer Output  
5.0 or 5.1ch output (L,R,SL,SR,C,SW)  
On-chip digital surround delay, 30ms max.
- ◆ Dolby 3 Stereo With Optional Subwoofer Output  
3.0 or 3.1ch output (L,R,C,SW)
- ◆ System Level Audio Management  
Bass Management  
Programmable subwoofer filter  
Programmable front high pass filters  
Tone Control  
Independent bass and treble  
+15dB to -16dB in 1dB steps  
Master Volume Control  
Clipping Indicator
- ◆ Mono-to-Stereo Synthesis
- ◆ A Ready-To-Use DSP-Based 3D Audio Solution  
Includes on-chip memory

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TruSurround is a trademark of SRS Labs, Inc. SRS and the SRS symbol are registered trademarks of SRS Labs, Inc. in the United States and selected foreign countries. TruSurround is incorporated under license from SRS Labs, Inc.

"Dolby," "Pro Logic," and the double-D symbol are trademarks of Dolby Laboratories. The NJU25018 may only be supplied to licensees of or companies authorized by Dolby Laboratories. Please refer all licensing inquiries to Dolby Laboratories, phone 415.558.0200, fax 415.863.1373.

Figure 1 NJU25018 Block Diagram

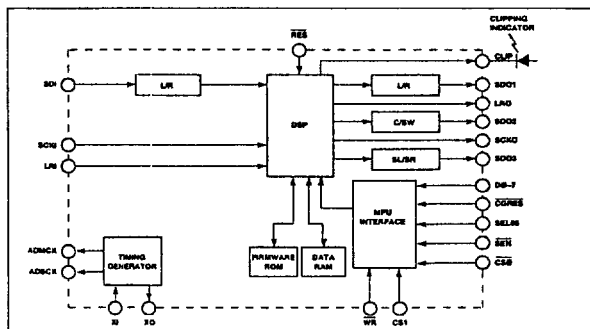
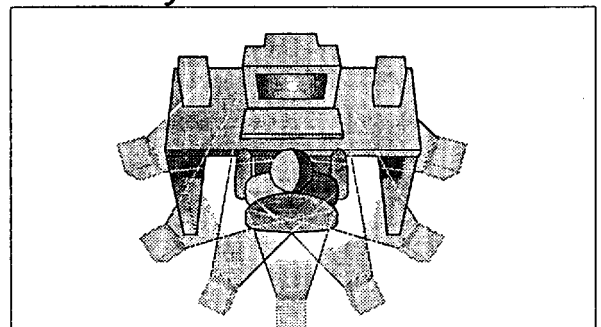


Figure 2 TruSurround™ Virtual Surround System



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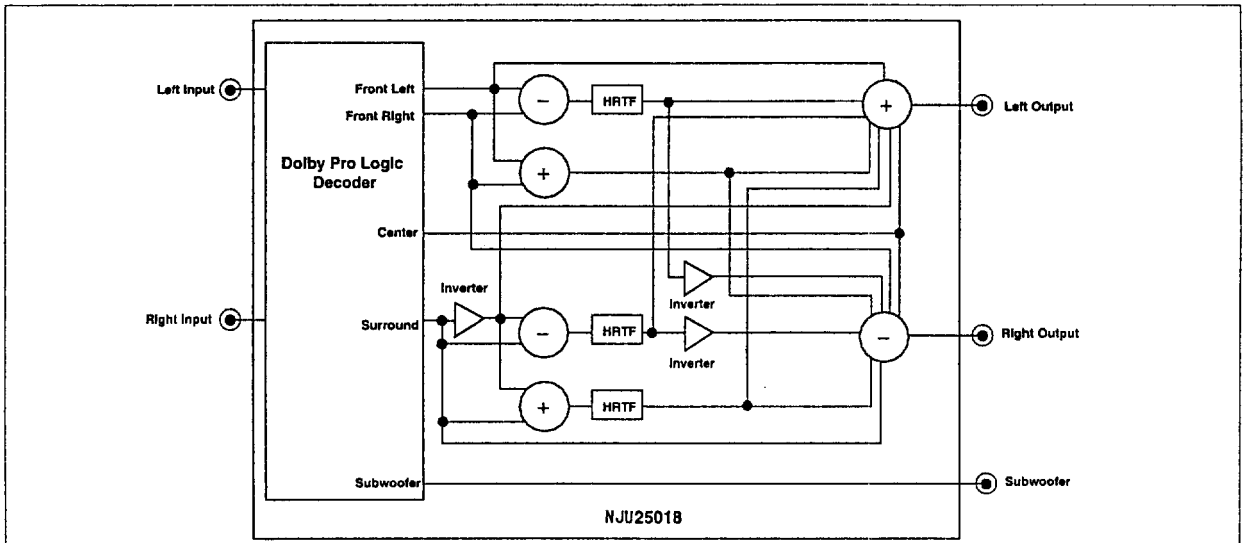
## SRS TruSurround Mode

Surround information from the audio source is extracted by the Dolby Pro Logic decoder processing in the NJU25018. Head Related Transfer Functions (HRTFs), based on the natural characteristics of the human hearing system, are used on both Front and Rear Surround channels to synthesize virtual surround speakers to the side and rear of the listener. The Front HRTFs have frequency tailoring of the difference signals (L-R) to extend the sound image past the physical boundaries of the actual speakers. A different set of frequency coefficients are applied to the Rear HRTFs that have a much greater peak and valley differ-

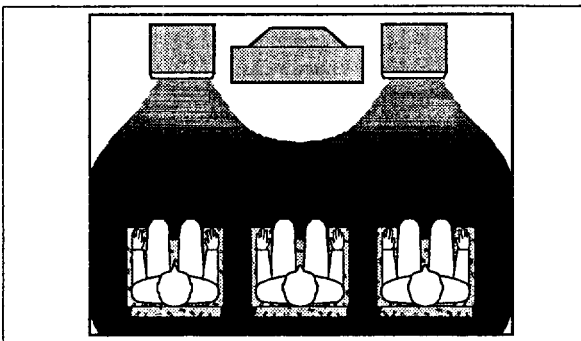
ences and center frequencies. These are chosen to cause the rear channels to virtualize behind the listener. The virtualized surround is then mixed back into the Left and Right output along with Phantom Center. There is also a Subwoofer Output with low pass crossover filter that is active in all modes.

The NJU25018 initializes in TruSurround mode with I<sup>2</sup>S audio data format for use with a codec (A/D+D/A), and does not need a microprocessor for 2ch 3D Surround.

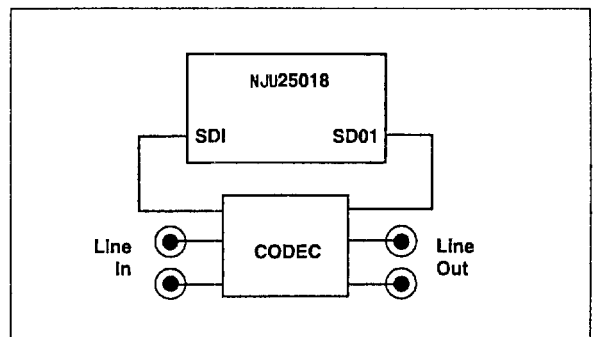
**Figure 3 SRS TruSurround Processing**



**Figure 4 TruSurround Listening Area**



**Figure 5 Minimum System Without Microcontroller**





### Dolby Pro Logic Mode

The NJU25018 can be switched from TruSurround mode (2ch + Subwoofer) to Dolby Pro Logic mode (5ch + Subwoofer) using a microprocessor command. The Dolby Pro Logic mode has all the necessary controls to implement a complete Dolby Surround system, including Surround Trims, Surround Delay using internal memory, Noise Sequencer, and Center Modes. Also included are Dolby 3 Stereo mode, Simulated Surround for mono input sources, and Normal Stereo Modes.

Dolby Surround processing with a DSP affords high performance with 24 bits of resolution and precise digital filtering for perfect matching between channels with exact consistency between units. With the freedom to choose a wide variety of codecs, A/Ds, and D/As to fit the target specification and cost, the NJU25018 can be optimized for any market, from the lowest cost multimedia systems to high end audiophile equipment.

Figure 6 Typical NJU25018 5.1-Channel Dolby Pro Logic System

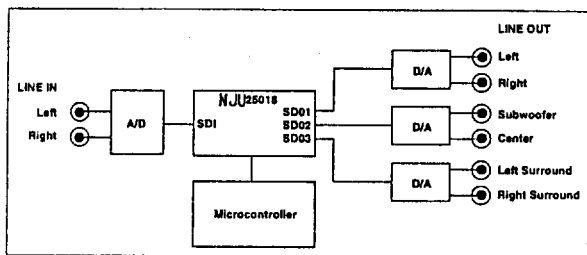
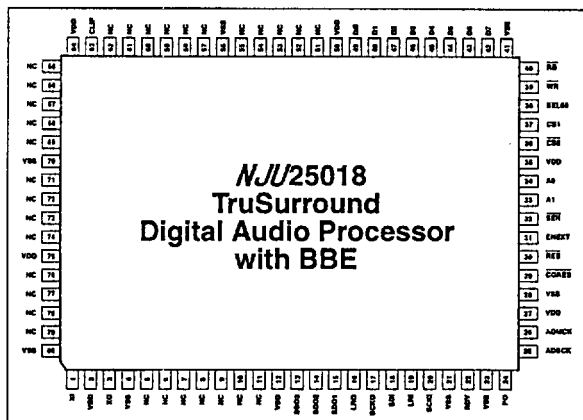


Figure 7 Pin Configuration



### BBE® High Definition Audio

The BBE process is a proven method of improving the quality of any audio by restoring the transients lost in the dynamics of speakers, which create a progressively greater impedance with increasing frequencies. BBE compensates for the natural tendency of loudspeakers to add progressively longer delay times to the high frequencies. An equal and opposite delay curve is programmed in the DSP digital filters for the low frequencies, delivering the high frequency transients first. At the same time, the digital process increases the amplitude of both high and low frequencies, resulting in boosted bass and treble. The result is a noticeable improvement in the presence and clarity of the audio, with the most accurate reproduction of live audio possible. BBE is purely an audio enhancement, and does nothing to alter the content or the effect of the Surround information or the 3D audio process.

Figure 8 BBE Gain vs. Frequency

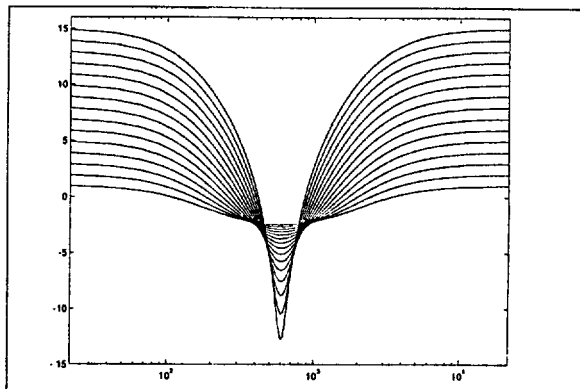
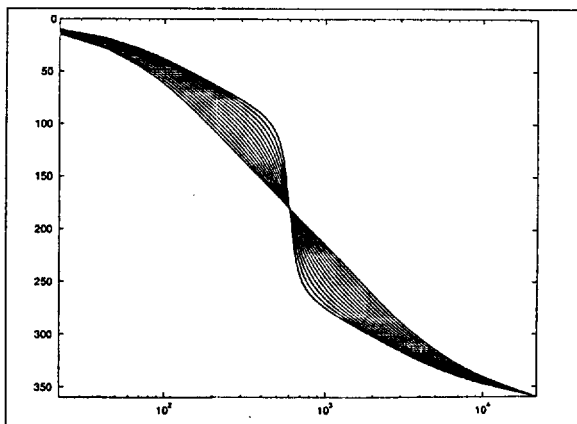


Figure 9 BBE Phase vs. Frequency





## Functional Description

### Digital Audio Data Interface

Three digital audio data formats are supported: left justified, right justified, and I<sup>2</sup>S. The data is always MSB first, two's complement. Either 16-bit or 18-bit data can be accommodated. The polarity of the L/R clocks (LRI, LRO) is programmable along with the active edge of the serial bit clocks (SCKI, SCKO). A master clock (ADMCK) and serial bit clock (ADSCK) output for the A/D and D/A converters are provided by an internal, programmable clock generator for synchronous operation with the DSP clock (768Fs). Asynchronous data rates are possible as long as the output is slaved to the input and it is close to the three supported sampling frequencies (32 kHz, 44.1 kHz, and 48 kHz).

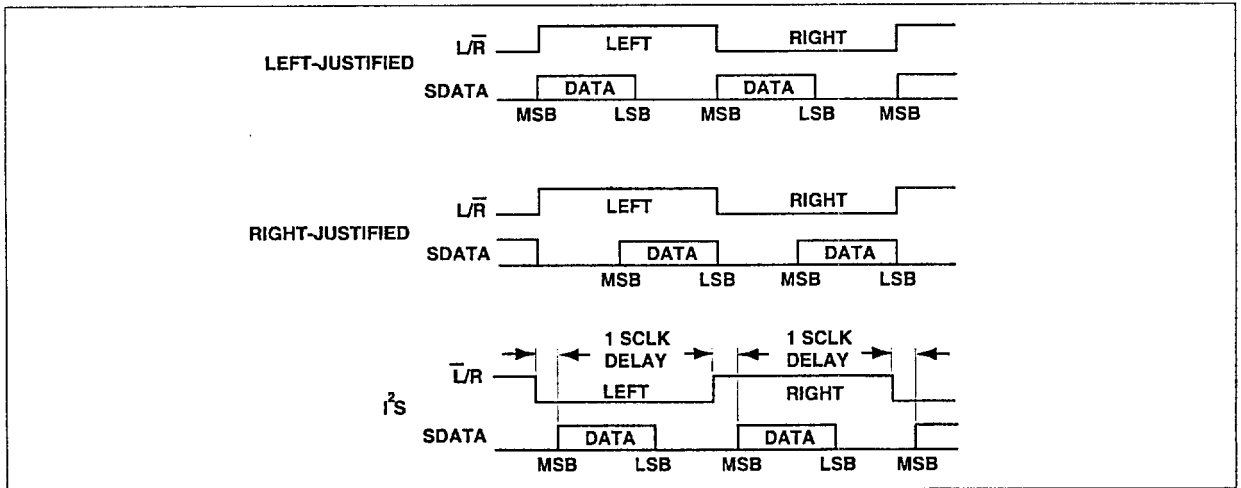
There is one stereo digital audio input and three stereo digital outputs for L and R Front channels, L and R Surrounds, Center and Subwoofer. All three serial data outputs must have identical

data formats. In each data format mode, SCLK and LRCLK polarities are independently programmable for input and output. Audio data width (16/18 bits), and SCK and MCK frequencies (32/64Fs, 256/384Fs, respectively) must be the same for both input and output.

### Serial Data Formats

There are three serial data formats supported for interfacing an A/D and three D/As to the digital audio interface: Left Justified, Right Justified, or I<sup>2</sup>S mode. In Left Justified Mode, the data is positioned at the left or "front" side of the L/R pulse. In Right Justified Mode, the data is at the right or "rear" of the L/R pulse. Sometimes this mode is called Japanese Mode or EIAJ Mode. The I<sup>2</sup>S Mode is similar to Left Justified Mode, except that the data is delayed one SCLK period and the sense of LRI and LRO is inverted.

Figure 10 Examples of 18-Bit Serial Data



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