Preconfigured DSP System for Hearings Aids

RHYTHM SB3229

Description

The RHYTHM™ SB3229 hybrid from ON Semiconductor is a trimmer−configurable DSP system based on a four−channel compression circuit featuring a feedback cancellation algorithm.

Based on a phase cancellation method, SB3229's adaptive feedback reduction algorithm provides added stable gain to enable extra gain and user comfort. It features rapid adjustment for dynamic feedback situations and resistance to tonal inputs.

In addition to these adaptive algorithms, SB3229 also supports the following features: up to four channel WDRC, low−distortion compression limiting, cross fading between audio paths for click−free memory changes, eight−band graphic equalizer, eight configurable

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SPECIFICATIONS

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Value

Table 2. ELECTRICAL CHARACTERISTICS °

Parameter	Symbol	Conditions	Min	Typ	Max	Units
OUTPUT						
	–	–	–		–	
		–	–			

TYPICAL APPLICATIONS

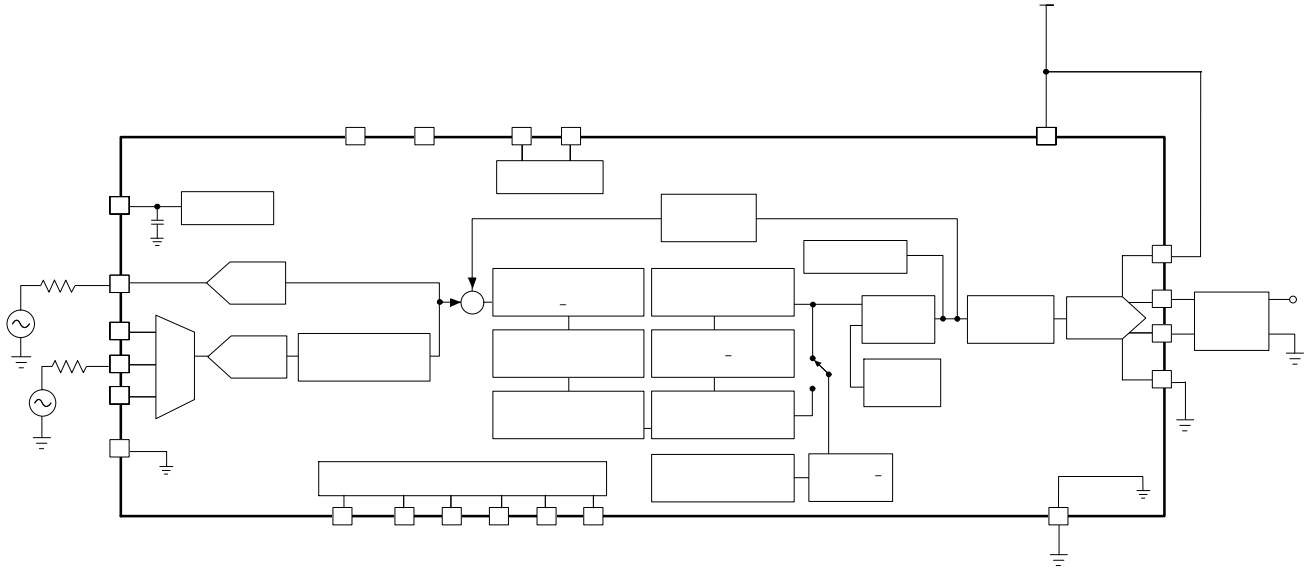


Figure 2. Test Circuit

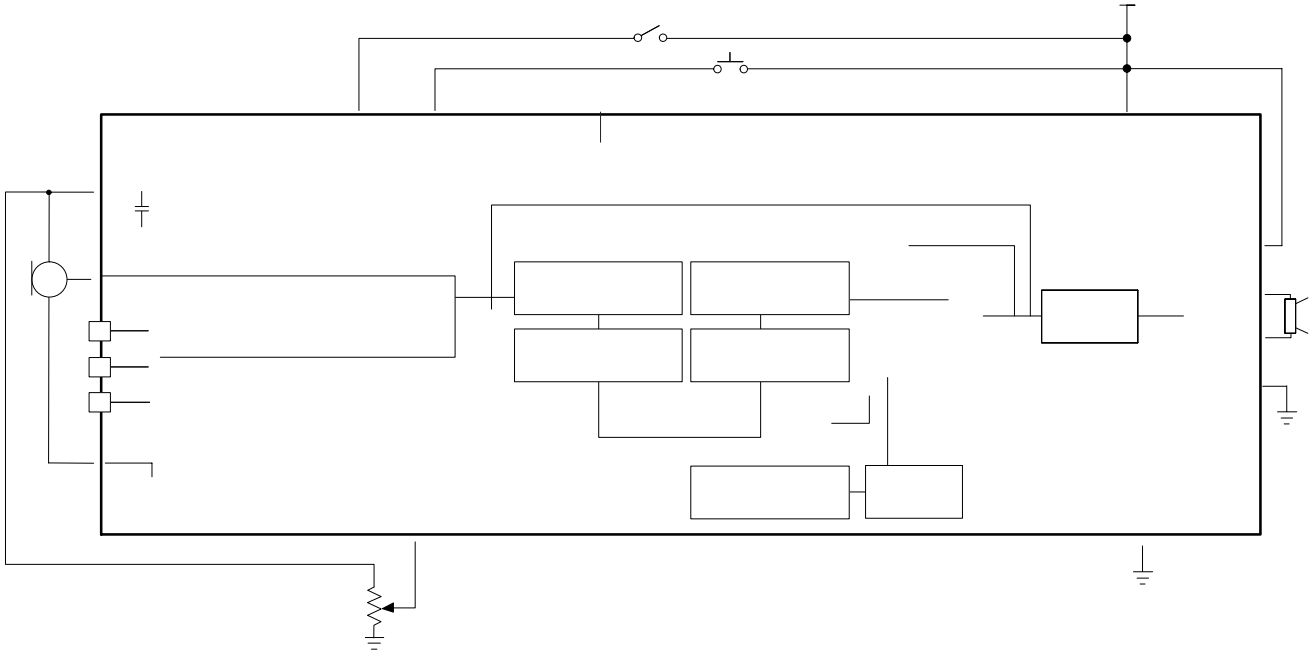
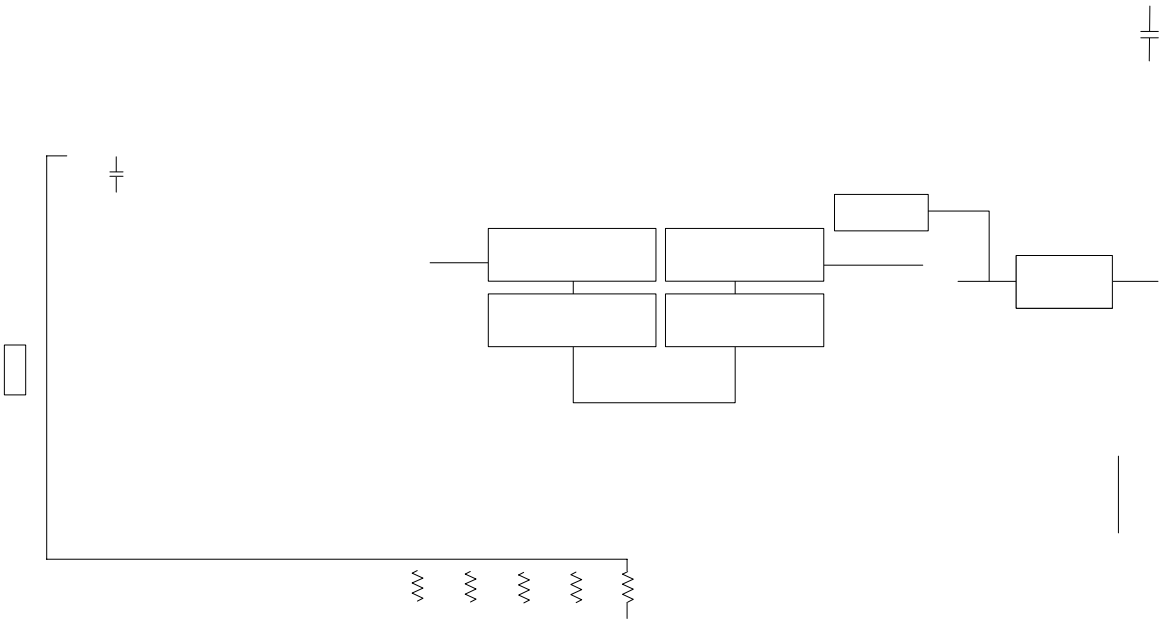


Figure 3. Typical Programmable Application Circuit

TYPICAL APPLICATIONS (continued)



Analog Inputs

SB3229 provides for up to four analog inputs, Microphone 1 (MIC1), Microphone 2 (MIC2), Telecoil (TCOIL) and Direct Audio Input (DAI) with the following configurable front end modes:

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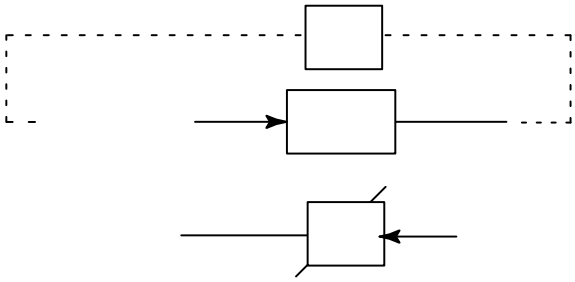

Figure 6. Adaptive Feedback Canceller (AFC) Block Diagram

Table 5. MS SWITCH LOGIC LEVELS VS. IDS PULLUPDOWN SETTINGS

"PullUpDown" Setting in IDS	MS Switch State	MS Input Logic Level	Switch Connection

In the following mode descriptions, it is assumed that the PullUpDown setting has been properly configured for the MS switch wiring so that a CLOSED switch state is at the correct input logic level.

Mode 1: Momentary Switch on MS1

This mode uses a single momentary switch on MS1 input to change memories. Using this mode causes the part to start in memory A, and whenever the button is pressed, the next valid memory is loaded. When the user is in the last valid memory, a button press causes memory A to be loaded. Thus, the possible selection sequences are:

If 4 valid memories: ABCDABCDA…
If 3 valid memories: ABCABCA…
If 2 valid memories: ABABA…
If 1 valid memory: AAA…

Mode 2: Momentary Switch on MS1, Static Switch on MS2 (D−only, Jump to Last Memory)

This mode uses a static switch on MS2 and a momentary switch on MS1 to change memories. It can be used to support the Automatic Telecoil feature, see section Automatic Telecoil.

If the static switch on MS2 is OPEN, the part starts in memory A and is controlled by the momentary switch on MS1 as described in section Momentary Switch on MS1, with the exception that memory D is not used. If the static switch on MS2 is set to CLOSED, the part automatically jumps to memory D (occurs on startup or during normal operation). In this setup, the state of the momentary switch on MS1 is ignored. When MS2 is set to OPEN, the part loads in the memory that was active prior to jumping to memory D.

The possible memory selection sequences are:
If MS2 = OPEN and there are four valid memories, MS1 selects: ABCABCA…
If MS2 = OPEN and there are three valid memories, MS1 selects: ABABA…
If MS2 = OPEN and there is one valid memory: A
If MS2 = CLOSED: D

Mode 3: Static Switch on MS1 and MS2

This mode uses two static switches to change memories. In this mode, it is possible to jump from any memory to any other memory by changing the state of both switches. If the two switches are changed one after the other, the part transitions to an intermediate memory before reaching the final memory. The part starts in whatever memory the switches are selecting. If a memory is invalid, the part defaults to memory A.

Table 6. STATIC SWITCH TRUTH TABLE: D−ONLY DISABLED

Binary State (MS1/MS2)	Selected Memory

Mode 4: Static Switch on MS1, Static Switch on MS2 (D−only, Jump to Last Memory)

This mode uses two static switches to change memories. Similar to the behaviour described in the Static Switch on MS1 and MS2 section, this mode will switch to memory D if the static switch on MS2 is CLOSED (the state of the switch on MS1 is ignored). The mode, however, supports a maximum of three memories (even if four valid memories are programmed). This mode can be used to support the Automatic Telecoil feature (see the Automatic Telecoil section).

In this mode, it is possible to jump from any memory to any other memory by changing the state of both switches. If the two switches are changed one after the other, the part transitions to an intermediate memory before reaching the final memory.

The part starts in whatever memory the switches are selecting. If a memory is invalid, the part defaults to memory A.

Table 7. STATIC SWITCH TRUTH TABLE: D−ONLY ENABLED; (EXAMPLE WITH THREE VALID MEMORIES)

Binary State (MS1/MS2)	Selected Memory

Rocker Switch Support

The device supports connection of a rocker switch to the digital volume control interface that can perform volume control (VC) adjustments and/or memory selection (MS).

There are three modes of operation:

- Digital Volume Control Mode
- Momentary Memory Select Mode
- Mixed Mode (VC and MS)

In Digital VC mode, the rocker switch provides the digital volume control functionality as described in this section.

In Momentary Memory Select mode, the rocker switch allows cycling through the memory profiles in both directions. An “up” switch closure indicates a program advance to the next *higher* numbered memory and “down” switch closures indicates a program retreat to the next *lower* numbered memory. In this mode, volume control is only available through software control.

In Mixed Mode, operation of the switch as a volume control or memory select is governed by the time duration of the switch closure: either short or long. The discrimination of short and long pulses is set by a programmable, time−threshold value, from 1 s to 5 s in 1 s increments. An additional programmable parameter determines whether the short pulses refer to volume−control operation or memory−select operation.

If long pulses control memory select operation, the memory change is initiated once the switch is held for the long pulse period without requiring the switch to be released. In Digital VC mode or Momentary Memory Select mode, the action takes place after the switch is released.

AGC−O

The AGC−O module is an output limiting circuit with a fixed compression ratio of ∞ : 1. The limiting level is programmable as a level measured in dB from full scale. The maximum output of the device is 0 dBFS.

The AGC−O module has its own level detector, with programmable attack and release time constants.

Graphic Equalizer

SB3229 has a 8−band graphic equalizer. Each band provides up to 24 dB of gain adjustment in 1 dB increments.

Biquadratic Filters

Additional frequency shaping can be achieved by configuring generic biquad filters. The transfer function for each of the biquad filters is as follows:

$$H(z) = \frac{b0 + b1 \times z^{-1} + b2 \times z^{-2}}{1 + a1 \times z^{-1} + a2 \times z^{-2}}$$

NOTE: The *a0* coefficient is hard−wired to always be ‘1’. The coefficients are each 16 bits in length and formatted as one sign bit, one integer bit and 14 fractional bits. This maps onto a decimal range of −2.0 to 2.0 before quantization (−32767 to 32767 after quantization).

Thus, before quantization, the floating−

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transition time. The duration of an Acoustic Indicator is configurable, with a maximum value of 6.35 seconds.

Power Management

SB3229 has three user−selectable power management schemes to ensure the hearing aid dies gracefully at the end of battery life. Shallow reset, Deep reset and Advanced Reset mode. It also contains a programmable power on reset delay function.

Power On Reset Delay

The programmable POR delay controls the amount of time between power being connected to the hybrid and the audio output being enabled. This gives the user time to properly insert the hearing aid before the audio starts, avoiding the temporary feedback that can occur while the device is being inserted. During the delay period, momentary button presses are ignored.

Power Management Functionality

As the voltage on the hearing aid battery decreases, an audible warning is given to the user indicating the battery life is low. In addition to this audible warning, the hearing aid takes other steps to ensure proper operation given the weak supply. The exact hearing aid behaviour in low supply conditions depends on the selected POR mode. The hearing aid has three POR modes:

- Shallow Reset Mode
- Deep Reset Mode
- Advanced Mode

Shallow Reset Mode

In Shallow Reset mode, the hearing aid will operate normally when the battery is above 0.95 V. Once the supply voltage drops below 0.95 V the audio will be muted and remain in that state until the supply voltage rises above

transients. Once the changes are complete, the main audio path is reactivated. Any changes made during programming are lost at power−off unless they are explicitly burned to EEPROM memory.

Improvements have been made to the ARK software, resulting in improved communication speed. Certain parameters in ARKonline® can be selected to reduce the number of pages that need to be read out. In SDA mode, SB3229 is programmed via the SDA pin using industry standard programming boxes. I^2C mode is a two−wire interface which uses the SDA pin for bidirectional data and CLK as the interface clock input. I^2C programming support is available on the HiPro (serial or USB versions) and ON Semiconductor's DSP Programmer 3.0.

Input Connection and Layout Considerations

It is recommended to connect unused audio input pins directly to MGND to minimize the possibility of noise pickup. Inputs are internally AC coupled, so there is no additional leakage current when inputs are connected directly to ground.

In order to further minimize noise at the inputs the following guidelines are recommended:

- MGND is used as reference ground plane for input signals. All input components should be grounded to MGND. This ground plane should be isolated from all other ground connections in the system.
- Keep the input traces as short as possible and avoid routing traces near high noise sources such as the OUT+ and OUT− pins
- Star ground input component grounds to the MGND connection.

Unused trimmer inputs should also be connected to GND.

ORDERING INFORMATION

Device	Package	Shipping

Table 8. PAD POSITION AND DIMENSIONS

Pad No.	X	Y	Xdim (mm)	Ydim (mm)
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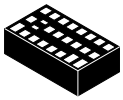


SCALE 2:1

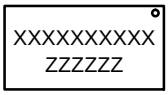
SIP25, 5.59x3.18
CASE 127DN
ISSUE A

DATE 21 JUL 2020

CROWNS OF THE PADS.

RECOMMENDED
MOUNTING FOOTPRINT

GENERIC
MARKING DIAGRAM*



XX = Specific Device Code
ZZ = Lot Traceability

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.