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25 PAD HYBRID CASE 127DN

## PAD CONNECTION

N/C N/C

<sup>2</sup>C Interface

provides full programmability at the factory and in the field. The Rhythm SB3231 hybrid contains a 256 kbit EEPROM intended

for programmable and trimmer based devices.

## Features

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Directional Processing					MARKING DIAGRAM
Adaptive Noise Reduction					
Adaptive Feedback Cancellation	VIN2	17	18 VIN1		VREGSB3231-E1
WDRC Compression with Choice of 1, 2 or 4 C	Channels	of			^^^^
Compression	TIN	16	19 TR4	SB32	MGND 231 = Specific Device Code
EVOKE Acoustic Indicators	DAI	15	20 TP3	E1 3	= RoHS Compliant Hybrid GND
Noise Generator for Tinnitus Treatment or In-s	itu Audi	ometry			
Frequency Response Shaping with Graphic EQ	VC	14	TR2	4	PGND
Trimmer Compatibility – Four Three-Terminal		40	22	-	
Trimmers with Configurable Assignments of Co	ontrol	13	TR1	5	661+
Parameters	SDA	12	23 N/C	6	OUT-
	CLK	11	25 24	7	VBP
	MS1	10	9	8	VB

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Table 2. ELECTRICAL CHARACTERISTICS	(Supply Voltage $V_B = 1.25$ V; Temperature = 25 C)
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Parameter	Symbol	Conditions	Min	Тур	Max	Units
OUTPUT						
D/A Dynamic Range	-	100 Hz – 8 kHz	-	88	-	dB
Output Impedance	Z <sub>OUT</sub>	-	-	10	13	Ω
CONTROL A/D						
Resolution (monotonic)	-	-	7	-	-	bits
Zero Scale Level	_					

## Table 3. I<sup>2</sup>C TIMING

		Standard Mode		Fast Mode		
Parameter	Symbol	Min	Max	Min	Max	Units
Clock Frequency	f <sub>PC_CLK</sub>	0	100	0	400	kHz
Hold time (repeated) START condition. After this period, the first clock pulse is generated.	<sup>t</sup> HD;STA	4.0	-	0.6	-	μsec
LOW Period of the PC_CLK Clock	t <sub>LOW</sub>	4.7	, ,			

# **TYPICAL APPLICATIONS (continued)**



Note: All resistors in ohms and all capacitors in farads, unless otherwise stated.

Figure 3. Typical Programmable Application Circuit

## **RHYTHM SB3231 OVERVIEW**

High level gain (HLGAIN) Upper threshold (UTH)

Compression ratio (CR)

During the Parameter Map creation, constraints are applied to the compression parameters to ensure that the I/O characteristics are continuous. Parameter adjustments support two popular styles of compression ratio adjustment:

The compression region of the I/O curve pivots about the upper threshold. As the compression ratio trimmer is adjusted, high–level gain remains constant while the low–level gain changes.

The compression region of the I/O curve pivots about the lower threshold. Low–level gain remains constant as the compression ratio trimmer is adjusted.

The squelch region within each channel implements a low level noise reduction scheme (1:3 expansion) for listener comfort. This scheme operates in quiet listening environments (programmable threshold) to reduce the gain at very low levels.

#### Automatic Telecoil

The automatic telecoil feature in Rhythm SB3231 is to be used with memory D programmed with the telecoil or MIC + TCOIL front end configuration. The feature enables the part to transition to memory D upon the closing of a switch connected to MS2. With the feature enabled and a reed switch connected to MS2, the static magnetic field of a telephone handset will close the switch whenever the handset is brought close to the device, causing the hybrid to change to memory D. The part will transition back to the initial memory once the switch is deemed opened after proper debouncing.

A debounce algorithm with a programmable debounce period is used to prevent needless switching in and out of memory D due to physical switch bounces when MS2 is configured for automatic telecoil. Upon detecting a close to open switch transition, the debounce algorithm monitors the switch status. The debounce algorithm switches the device out of memory D only once the switch signal has been continuously sampled open over the specified debounce period.

#### Adaptive Feedback Canceller

The Adaptive Feedback Canceller (AFC) reduces acoustic feedback by forming an estimate of the hearing aid feedback signal and then subtracting this estimate from the hearing aid input. The forward path of the hearing aid is not affected. Unlike adaptive notch filter approaches, Rhythm SB3231's AFC does not reduce the hearing aid's gain. The AFC is based on a time-domain model of the feedback path.

The third–generation AFC (see Figure 6) allows for an increase in the stable gain<sup>1</sup> of the hearing instrument while minimizing artefacts for music and tonal input signals. As with previous products, the feedback canceller provides completely automatic operation.

1. Added stable gain will vary based on hearing aid style and acoustic setup. Please refer to the Adaptive Feedback Cancellation Information note for more details.



Estimated feedback

Figure 6. Adaptive Feedback Canceller (AFC) Block Diagram

#### Feedback Path Measurement Tool

The Feedback Path Measurement Tool uses the onboard feedback cancellation algorithm and noise generator to measure the acoustic feedback path of the device. The noise generator is used to create an acoustic output signal from the hearing aid, some of which leaks back to the microphone via the feedback path. The feedback canceller algorithm automatically calculates the feedback path impulse response by analyzing the input and output signals. Following a suitable adaptation period, the feedback canceller coefficients can be read out of the device and used as an estimate of the feedback–path impulse response.

#### **Adaptive Noise Reduction**

The noise reduction algorithm is built upon a high resolution 64–band filter bank (32 bands at 16 kHz sampling) enabling precise removal of noise. The algorithm monitors the signal and noise activities in these bands, and imposes a carefully calculated attenuation gain independently in each of the 64 bands.

The noise reduction gain applied to a given band is determined by a combination of three factors:

Signal-to-Noise Ratio (SNR)

Masking threshold

Dynamics of the SNR per band

The SNR in each band determines the maximum amount of attenuation to be applied to the band – the poorer the SNR, the greater the amount of attenuation. Simultaneously, in each band, the masking threshold variations resulting from the energy in other adjacent bands is taken into account. Finally, the noise reduction gain is also adjusted to take advantage of the natural masking of 'noisy' bands by speech bands over time.

Based on this approach, only enough attenuation is applied to bring the energy in each 'noisy' band to just below the masking threshold. This prevents excessive amounts of attenuation from being applied and thereby reduces unwanted artifacts and audio distortion. The Noise Reduction algorithm efficiently removes a wide variety of types of noise, while retaining natural speech quality and level. The level of noise reduction (aggressiveness) is

## **Memory Select Switches**

One or two, two-pole Memory Select (MS) switches can be used with Rhythm SB3231. This enables user's tremendous flexibility in switching between configurations. Up to four memories can be configured and selected by the MS switches on Rhythm SB3231. Memory A must always be valid. The MS switches are either momentary or static and are fully configurable through IDS in the IDS setting tab. The behavior of the MS switches is controlled by two main parameters in IDS:

MSSmode: this mode determines whether a connected switch is momentary or static.

Donly: this parameter determines whether the MS2 switch is dedicated to the last memory position

There are four basic MS switch modes of operation as shown in Table 4 below.

## Table 4. MS SWITCH MODES

MS Switch Mode	MS1 Switch	MS2 Switch	Max # of Valid Memories	Donly	MSSMode	Use
Mode 1	Momentary	None	4	Off	Momentary	Simplest configuration
Mode 2	Momentary	Static	4	On	Momentary	Jump to last memory
Mode 3	Static	Static	4	Off	Static	Binary selection of memory
Mode 4	Static	Static	3	On	Static	Jump to last memory

The flexibility of the MS switches is further increased by allowing the MS switches to be wired to GND or VBAT, corresponding to an active low or active high logic level on the MS pins. This option is configured with the MSPullUpDown/MS2PullUpDown setting in the IDS settings tab as shown in Table 5 below.

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

"PullUpDown" Setting in IDS	MS Switch State	MS Input Logic Level	Switch Connection
Pulldown	CLOSED	HI	To VBAT
Pulldown	OPEN	LOW	To VBAT
Pullup	CLOSED	LOW	To GND
Pullup	OPEN	-	

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#### Deep Reset Mode

In Deep 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. The device remains in this state until the supply voltage drops below the hardware reset voltage of 0.6 V. When this occurs, the device will load memory A and operate normally after the supply voltage goes above 1.1 V.

#### Advanced Reset Mode

Advanced Reset Mode on Rhythm SB3231 is a more sophisticated power management scheme than shallow and deep reset modes. This mode attempts to maximize the device's usable battery life by reducing the gain to stabilize the supply based on the instantaneous and average supply voltage levels. Instantaneous supply fluctuations below 0.95 V can trigger up to two 3 dB, instantaneous gain reductions. Average supply drops below 0.95 V can trigger up to eighteen, 1 dB average gain reductions.

While the average supply voltage is above 0.95 V, an instantaneous supply voltage fluctuation below 0.95 V will trigger an immediate 3 dB gain reduction. After the 3 dB gain reduction has been applied, the advanced reset model holds off checking the instantaneous voltage level for a monitoring period of 30 second in order to allow the voltage level to stabilize. If after the stabilization time the instantaneous voltage drops a second time below 0.95 V during the next monitoring period, the gain will be reduced an additional 3 dB for a 6 dB total reduction and a 30 second stabilization time is activated. The advanced reset mode continues to monitor the instantaneous voltage levels over 30 second monitoring periods. If the instantaneous voltage remains above 1.1 V during that monitoring period, the gain will be restored to the original setting regardless of whether one or two gain reductions are applied. If two gain reductions are applied and the instantaneous voltage level remains above 1.0 V for a monitoring period, the gain will be restored to a 3 dB reduction.

Should the average supply voltage drop below 0.95 V, the device will then reduce the gain by 1 dB every 10 seconds until either the average supply voltage rises above 0.95 V or a total of 18 average gain reductions have been applied, at which point the audio path will be muted. If the average supply voltage returns to a level above 1.1 V, the audio path will first be un–muted, if required. The gain will then be increased by 1 dB every 10 seconds until either the average supply voltage drops below 1.1 V, or all average gain reductions have been removed. No action is taken while the average supply voltage resides between 0.95 V and 1.1 V.

NOTE: Instantaneous and average gain reductions are adjusted independently.

When the hardware reset vops betV the audmuted, u11 r0 TgoJT5.8Tj/2244 .8Tj/2244 aductiofor

#### **ORDERING INFORMATION**

Device	Package	Shipping <sup>†</sup>
SB3231–E1	25 Pad Hybrid Case 127DN	25 Units / Bubble Pack
SB3231–E1–T	25 Pad Hybrid Case 127DN	250 Units / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

### Hybrid Jig Ordering Information

To order a Hybrid Jig Evaluation Board for Rhythm SB3231 contact your Sales Account Manager or FAE and use part number SA3405GEVB.

## PAD LOCATIONS

## Table 9. PAD POSITION AND DIMENSIONS

	Pad Position	Pad DimensionsP a	d
Pad No.			

#### Table 9. PAD POSITION AND DIMENSIONS

Pad No.	Х	Y	Xdim (mm)	Ydim (mm)
1	0	0	0.508	0.838
2	-0.686	0	0.508	0.838
3	-1.372	-0.127	0.508	0.584
4	-2.057	-0.127	0.508	0.584
5	-2.743	-0.127	0.508	0.584
6	-3.429	-0.127	0.508	0.584
7	-4.115	-0.127	0.508	0.584
8	-4.801	0	0.508	0.838
9	-4.801	1.067	0.508	0.584
10	-4.801	2.159	0.508	0.584
11	-4.115	2.159	0.508	0.584
12	-3.429	2.159	0.508	0.584
13	-2.743	2.159	0.508	0.584
14	-2.057	2.159	0.508	0.584
15	-1.372	2.159	0.508	0.584
16	-0.686	2.159	0.508	0.584
17	0	2.159	0.508	0.584
18	0	1.067	0.508	0.584
19	-0.686	1.067	0.508	0.584
20	-1.372	1.067	0.508	0.584
21	-2.057	1.067	0.508	0.584
22	-2.743	1.067	0.508	0.584
23	-3.429	1.067	0.508	0.584
24	-4.115	0.673	0.457	0.305
25	-4.115	1.359	0.457	0.305



SIP25, 5.59x3.18 CASE 127DN ISSUE A

DATE 21 JUL 2020

CROWNS OF THE PADS.

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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.

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