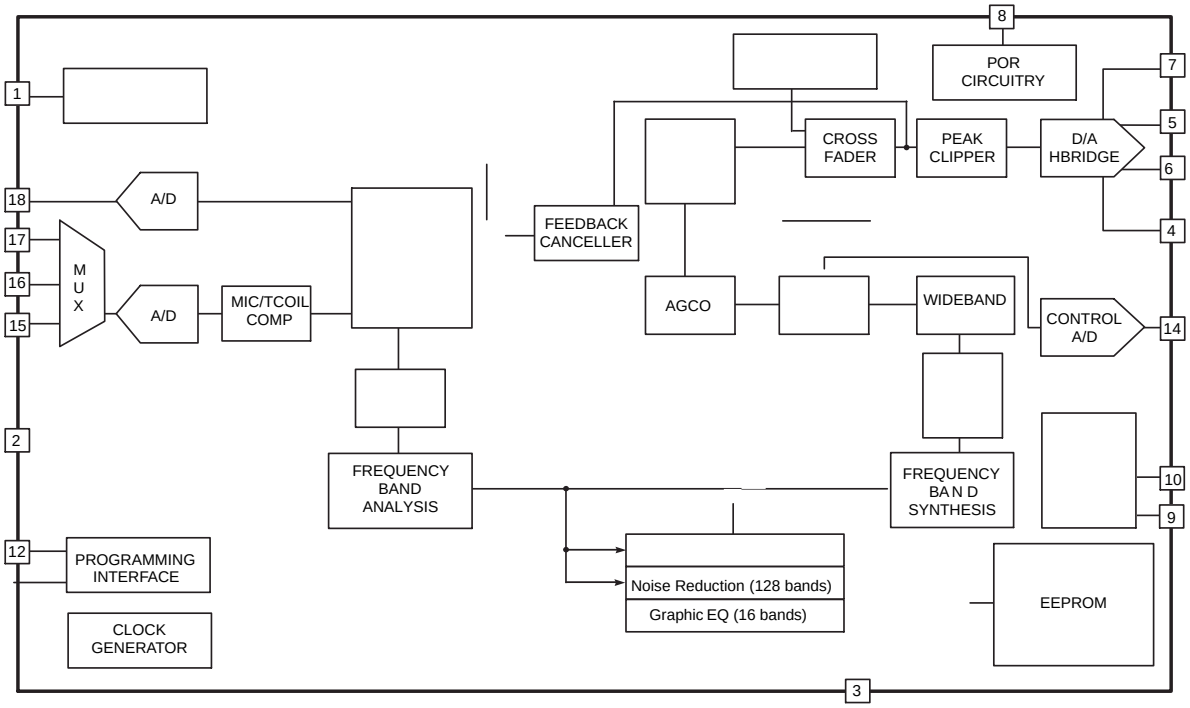
January, 2021

BLOCK DIAGRAM



* If Input Mode = 1 mic omni, mic + telecoil, mic + DAI
** If Input Mode = 2 mic omni, rear only, directional

Figure 1. Hybrid Block Diagram

SPECIFICATIONS

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Value	Units
Operating Temperature Range	0 to +40	°C
Storage Temperature Range	−20 to +70	°C
Absolute Maximum Power Dissipation	50	mW
Maximum Operating Supply Voltage	1.65	VDC
Absolute Maximum Supply Voltage	1.8	VDC

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

WARNING: Electrostatic Sensitive Device − Do not open packages or handle except at a static−free workstation.

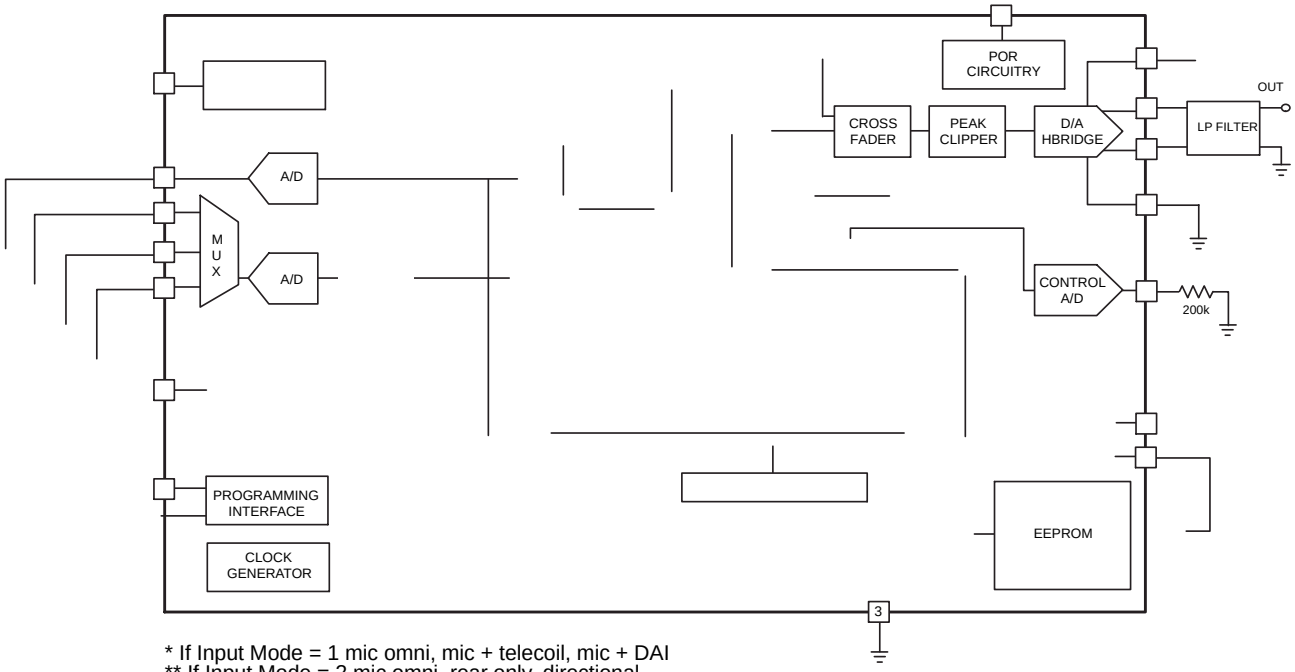
WARNING: Moisture Sensitive Device − RoHS Compliant; Level 3 MSL. Do not open packages except under controlled conditions.

Table 2. ELECTRICAL CHARACTERISTICS (Supply Voltage V_B = 1.25 V; Temperature = 25°C)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Minimum Operating Supply Voltage	V_{BOFF}	Ramp down, audio path	0.93	0.95	0.97	V
		Ramp down, control logic	0.77	0.80	0.83	
Supply Voltage Turn On Threshold	V_{BON}	Ramp up, zinc−air	1.06	1.10	1.16	V
		Ramp up, NiMH	1.16	1.20	1.24	
Hybrid Current		All functions, 32 kHz sampling rate	−	665	−	μA
		All functions, 16 kHz sampling rate	−	575	−	
EEPROM Burn Cycles	−	−	100 k	−	−	cycles
Low Frequency System Limit	−	−	−	125	−	Hz
High Frequency System Limit	−	−	−	16	−	kHz
Total Harmonic Distortion	THD	V_{IN} = −40 dBV	−	−	1	%
THD at Maximum Input	THD_M	V_{IN} = −15 dBV, Headroom Extension − ON	−	−	3	%
Clock Frequency	f_{CLK}	−	3.973	4.096	4.218	MHz
REGULATOR						
Regulator Voltage	V_{REG}	−	0.87	0.90	0.93	V
System PSRR	$PSRR_{SYS}$	1 kHz, Input referred, Headroom Extension enabled	−	70	−	dB
INPUT						
Input Referred Noise	IRN	Bandwidth 100 Hz − 8 kHz	−	−108	−106	dBV

Figure 2. I^2C Mode Timing

TYPICAL APPLICATIONS



* If Input Mode = 1 mic omni, mic + telecoil, mic + DAI
** If Input Mode = 2 mic omni, rear only, directional
Note: All resistors in ohms and all capacitors in farads, unless otherwise stated.

Figure 3. Test Circuit

RHYTHM R3910 OVERVIEW

R3910 is a programmable multi−processor DSP platform implemented on a thin−stacked package. This DSP platform is the hearing industry's first 90 nm Silicon−on−Chip platform enabling design of highly−efficient and flexible hearing aid solutions. The multi−processor DSP system maximizing MIPS/μW with a unique reconfigurable architecture, integrated high−resolution dual ADC and a single DAC available in miniaturized package sizes, offering unmatched DSP processing capability and flexibility in an ultra small footprint with best in the industry power consumption. R3910 incorporates industry leading hearing algorithms allowing for easy integration into a wide range of hearing products.

more biquad filters, post3 and post4, and the peak clipper. The last stage in the signal path is the D/A H−bridge.

White noise can be shaped, attenuated and then added into the signal path at two possible locations: before the volume control (between the wideband gain and the volume control) or after the volume control (between post 4 and the peak clipper) as shown in Figure 1.

Functional Block Description

iSceneDetect 1.0 Environment Classification

The iSceneDetect feature, when enabled, will sense the environment and automatically control the enhancement algorithms without any user involvement. It will detect speech in quiet, speech in noise, wind, music, quiet and noise

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 information is recorded using two methods in parallel:

- *Short−term method* − a circular buffer is serially filled with entries that record the state of the first five of the above variables at the configured time interval.
- *Long−term method* − increments a counter based on the memory state at the same time interval as that of the short−term method. Based on the value stored in the counter, length of time the hearing aid was powered on can be calculated.

There are 750 log entries plus 6 memory select counters which are all protected using a checksum verification. A new log entry is made whenever there is a change in memory state, volume control, or battery level state. A new log entry can also be optionally made when the environmental sound level changes more than the programmed threshold, thus it is possible to log only significantly large changes in the environmental level, or not log them at all.

The ARK software iLog graph displays the iLog data graphically in a way that can be interpreted to counsel the user and fine tune the fitting. This iLog graph can be easily incorporated into other applications or the underlying data can be accessed to be used in a custom display of the information.

Tinnitus Treatment

R3910 has an internal white noise generator that can be used for Tinnitus Treatment. The noise can be attenuated to a level that will either mask or draw attenuation away from the user's tinnitus. The noise can also be shaped using low−pass and/or high−pass filters with adjustable slopes and corner frequencies.

As shown in Figure 1, the Tinnitus Treatment noise can be injected into the signal path either before or after the volume control (VC) or it can be disabled. If the noise is injected before the VC then the level of the noise will change along with the rest of the audio through the device when the VC is adjusted. If the noise is injected after the VC then it is not affected by VC changes.

The Tinnitus Treatment noise can be used on its own without the main audio path in a very low power mode by selecting the Tinnitus Treatment noise only. This is beneficial either when amplification is not needed at all by a user or if the user would benefit from having the noise supplied to them during times when they do not need acoustic cues but their sub−conscious is still active, such as when they are asleep.

The ARK software has a Tinnitus Treatment tool that can be used to explore the noise shaping options of this feature. This tool can also be easily incorporated into another software application.

If the noise is injected before the VC and the audio path is also enabled, the device can be set up to either have both the audio path and noise adjust via the VC or to have the noise only adjust via the VC. If the noise is injected after the VC, it is not affected by VC changes (see Table 4).

Table 4. NOISE INJECTION EFFECT ON VC

Noise Insertion Modes	VC Controls	Noise Injected
Off	Audio	Off
Pre VC	Audio + Noise	Pre VC
Post VC	Audio	Post VC
Noise only Pre VC	Noise	Pre VC
Noise only Post VC	−	Post VC
Pre VC with Noise	Noise	Pre VC

Narrow−band Noise Stimulus

R3910 is capable of producing Narrow−band Noise Stimuli that can be used for in situ audiometry. Each narrow−band noise is centred on an audiometric frequency. The duration of the stimuli is adjustable and the level of the stimuli are individually adjustable.

A/D and D/A Converters

The system's two A/D converters are second order sigma−delta

Figure 6. Independent Channel I/O Curve Flexibility

After designing a filter, the quantized coefficients can be entered into the PreBiquads or PostBiquads tab in the Interactive Data Sheet. The coefficients b0, b1, b2, a1, and

RHYTHM R3910

Mode 3: Static Switch on MS1 and MS2

This mode uses two static switches to change memories. Table 8 describes which memory is selected depending on the state of the switches.

In this mode, it is possible to jump from any memory to any other memory simply by changing the state of both switches.

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.

RHYTHM R3910

PAD LOCATIONS

Table 10. PAD POSITION AND DIMENSIONS

	Pad Position	Pad Dimensions
Pad No.	X	

Table 10. PAD POSITION AND DIMENSIONS

Pad No.	X	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		

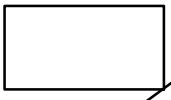
SIP25, 5.59x3.18
CASE 127DN
ISSUE A

DATE 21 JUL 2020

SCALE 2:1

ARITY A

GENERIC



XX = Specific Device Code
ZZ = Lot Traceability

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