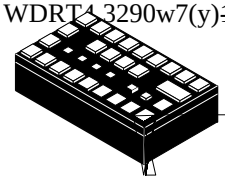
AYRE SA3291

P W DSP
S m H a A

Description

Ayre™ SA3291 is a preconfigured wireless DSP system utilizing Near−Field Magnetic Induction (NFMI) technology.

Ayre SA3291 enables hearing aids to wirelessly synchronize program modes and volume control and stream telecoil signals from one hearing aid to the other. Wireless synchronization [channel WDRT13290w7(y)13444r)134441.1906s In-Tw8ring



− The Ayre SA3291 adaptive noise reduction algorithm monitors noise levels independently in 128 individual bands and employs advanced psychoacoustic models to provide user comfort.

− The Ayre SA3291 is equipped with a noise source that can be used to mask tinnitus. The noise

BLOCK DIAGRAM

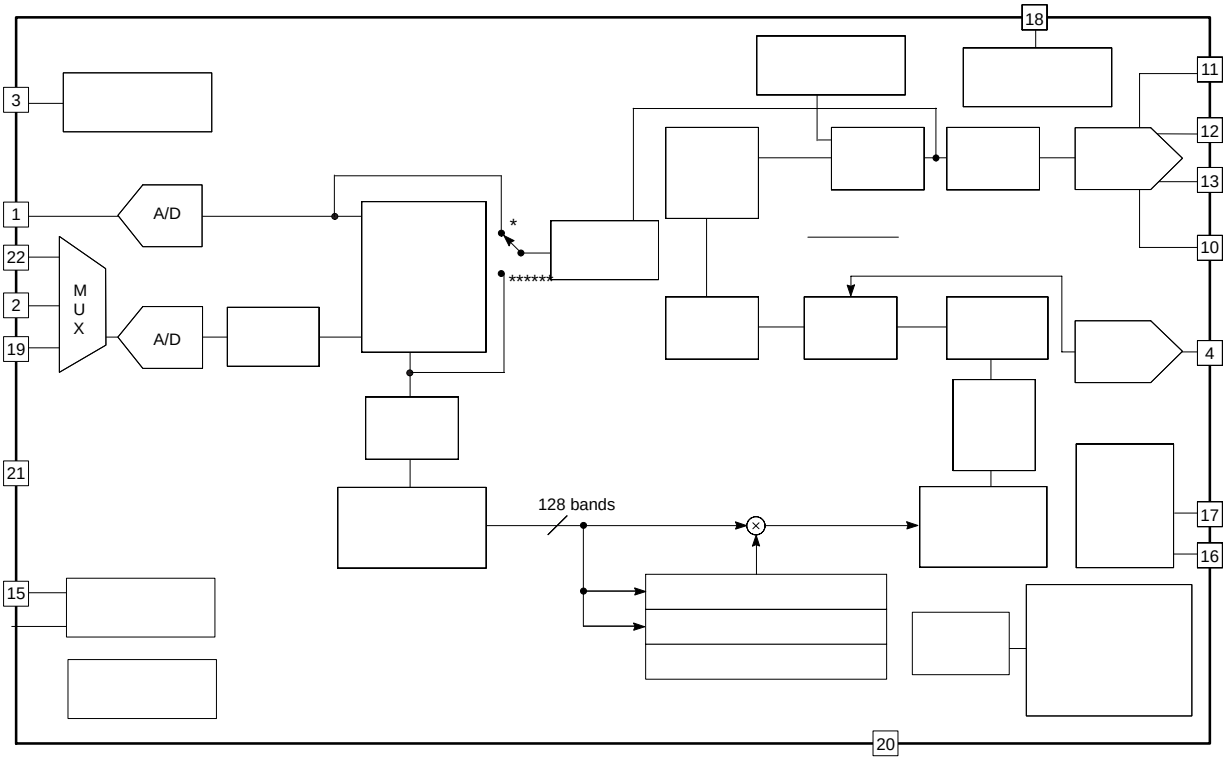


Figure 1. Hybrid Block Diagram

SPECIFICATIONS

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Value	Units
Operating Temperature Range	0 to +40	°C

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

Parameter	Symbol	Conditions	Min	Typ	Max	Units
INPUT						
Maximum Input Level	–	–	–	–15	–	dBV
Analog Input Voltage Range	V_{AN_IN}	V_{IN1}, V_{IN2}, AI	0	–	800	mV
	V_{AN_TIN}	T_{IN}	–100	–	800	
Input Dynamic Range	–	Headroom Extension – ON Bandwidth 100 Hz – 8 kHz	–	95	96	dB
Audio Sampling Rate	–	–	8	–	48	kHz
OUTPUT						
D/A Dynamic Range	–	100 Hz – 8 kHz	–	88	–	dB
Output Impedance	Z_{OUT}	–	–	10	13	Ω
VOLUME CONTROL						
Volume Control Resistance	R_{VC}	Three–terminal connection	200	–	1000	kΩ
Volume Control Range	–	–	–	–	42	dB
PC_SDA INPUT						
Logic 0 Voltage	–	–	0	–	0.3	V
Logic 1 Voltage	–	–	1	–	1.25	V
PC_SDA OUTPUT						
Stand–by Pull Up Current	–	Creftrim = 6	3	5	6.5	μA
Sync Pull Up Current	–	Creftrim = 6	748	880	1020	μA
Max Sync Pull Up Current	–	Creftrim = 15	–	1380	–	μA
Min Sync Pull Up Current	–	Creftrim = 0	–	550	–	μA
Logic 0 Current (Pull Down)	–	Creftrim = 6	374	440	506	μA
Logic 1 Current (Pull Up)	–	Creftrim = 6	374			

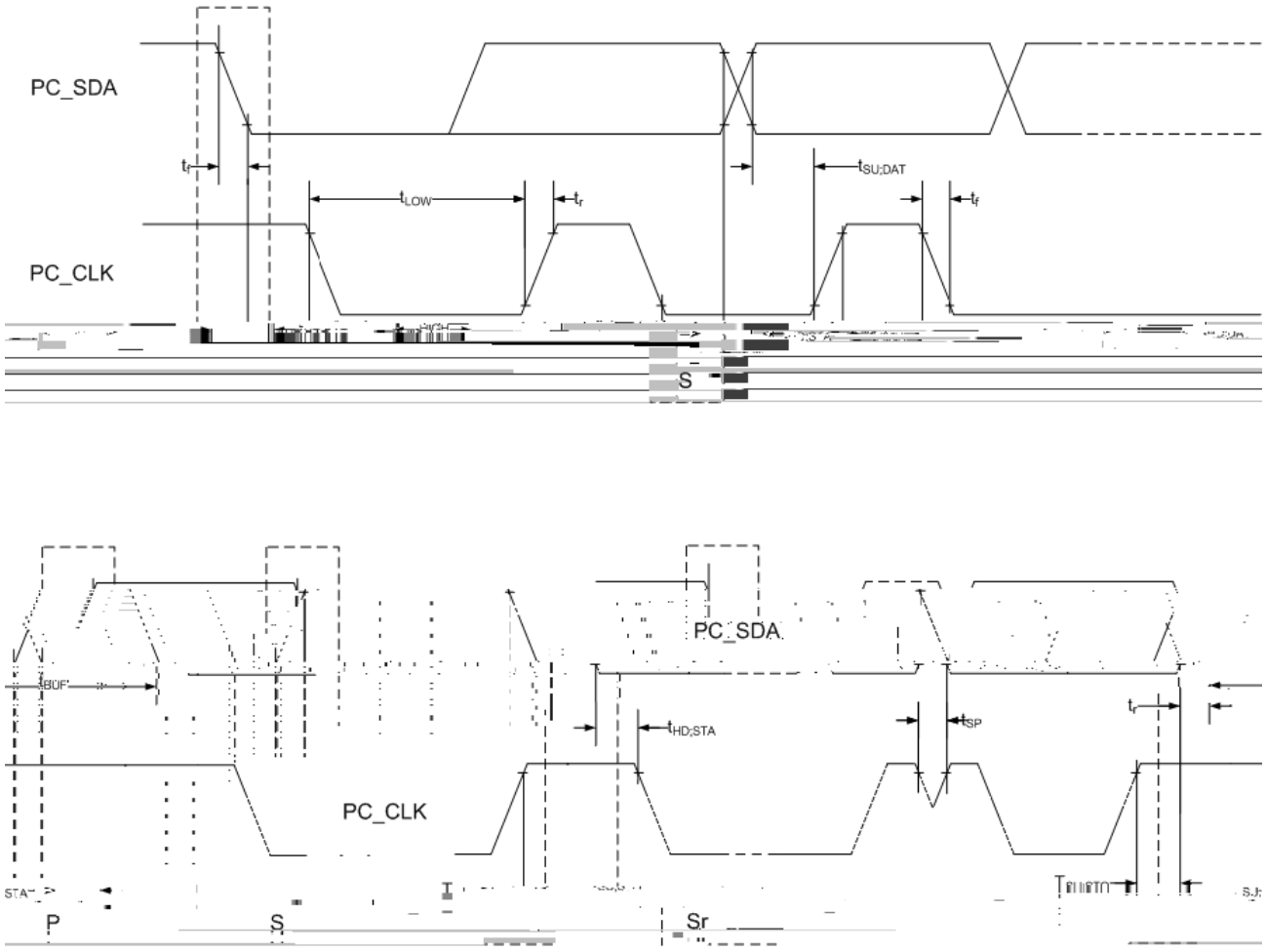


Figure 2. I²C Mode Timing

SIGNAL PATH

The integrated NFMI transceiver is designed to provide many highly desirable features in a wireless hearing aid product. With minimal processing overhead, the transceiver and its built−in MAC and link control function provides networked mode support for 3 or more devices, unidirectional low latency stereo audio streaming and high−speed data transfer from one transmitter device to two hearing instruments. The use of NFMI technology avoids all the propagation problems that exist in an RF−based wireless system. While having a small wireless range typically limited to less than 60 cm, depending on the transmitter device, the NFMI system has good immunity to the human

environments and make the necessary adjustments to the parameters in the audio path, such as ADM, ANR, WDRC, FBC, in order to optimize the hearing aid settings for the specific environment.

iSceneDetect will gradually make the adjustments so the change in settings based on the environment is smooth and virtually unnoticeable. This feature will enable the hearing aid wearer to have an instrument which will work in any environment with a single “memory”.

EVOKE Advanced Acoustic Indicators

Advanced acoustic indicators provide alerting sounds that

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

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, VC, 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

The Ayre SA3291 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 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.

Narrow−band Noise Stimulus

The Ayre SA3291 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 modulators operating at a 2.048 MHz sample rate. The system's two audio inputs are pre−conditioned with antialias filtering and programmable gain pre−amplifiers. These analog outputs are over−sampled and modulated to produce two, 1−bit Pulse Density Modulated (PDM) data streams. The digital PDM data is then decimated down to Pulse−Code Modulated (PCM) digital words at the system sampling rate of 32 kHz.

The D/A is comprised of a digital, third order sigma−delta modulator and an H−bridge. The modulator accepts PCM audio

There are 3 modes of operation:

- Digital VC
- Momentary Memory Select
- Mixed Mode

In Mixed Mode, the switches behaviour is configurable to be set to that a short or long press of the switch will invoke either a memory or VC change (i.e., a short press is a memory select, a long press is a VC change).

There is a programmable threshold that can be used to set the timing behaviour.

Volume Control

The VC can be either external (digital VC) or programmable. When using a Digital Volume Control (DVC) with the Ayre SA3291, the switch should be connected to the VC and D_VC pins with momentary switches connected to each. Closure of the switch to the VC pin indicates a gain increase while closure to the D_VC pin indicates a gain decrease. Figure 7 shows how to wire the DVC to SA3291.

A toggle switch can be used as a DVC, momentarily connecting the VC to either Vreg or GND. By connecting the VC to Vreg, the volume will be increased one step, and by connecting the VC to GND, the volume will be decreased one step.

The following parameters can be programmed into the hybrid to specify the DVC functionality:

- DVC enable or disable
- Volume up/down step size of 1 dB, 2 dB, 3 dB or 4 dB
- Volume up/down beep frequency and volume
- DVC range between 0 dB and 48 dB in 1 dB steps
- Default DVC value when the hybrid is powered up
- Volume up/down beep enable
- Max/Min beep enable
- Max/Min beep frequency & volume

If the Max/Min beep is enabled then when the volume has been incremented to the maximum value of the specified DVC range the device will play two beeps to indicate that it cannot increase the volume any more. The same is true for decrementing the volume and reaching the minimum value of the DVC range.

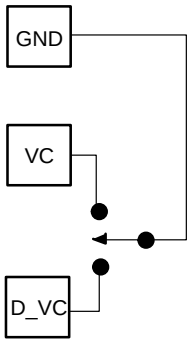


Figure 7. Wiring for Digital Volume Control

Memory Select Switches

One or two, two−pole Memory Select (MS) switches can be used with the Ayre SA3291. This enables users tremendous flexibility in switching between configurations. These switches may be either momentary or static and are configurable to be either pull−up or pull−down through the settings tab in IDS.

Up to six program modes can be configured on the Ayre SA3291. Memory A must always be valid. All memory select options are selectable via the settings tab in IDS.

Momentary Switch on MS

This mode uses a single momentary switch on MS (Pin 17) to change program modes. 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.

This mode is set by programming the ‘MSSMode’ parameter to ‘Momentary’ and ‘Donly’ to ‘disabled’.

If 6 valid program modes: ABCDEFABCDEF…
If 5 valid program modes: ABCDEABCDE…
If 4 valid program modes: ABCDABCDA…
If 3 valid program modes: ABCABCA…
If 2 valid program modes: ABABA…
If 1 valid program mode: AAA…

Momentary Switch on MS, Static Switch on MS2 (Jump to Last Memory)

This mode uses a static switch on MS2 (Pin 16) and a momentary switch on MS (Pin 17) to change program modes. If the static switch is OPEN, the part starts in memory A and behaves like momentary, with the exception that memory D is not used. If the static switch on MS2 is set to HIGH, the part automatically jumps to memory D (occurs on start−up or during normal operation). In this setup, the momentary switch’s state is ignored, preventing memory select beeps from occurring. When MS2 is set to OPEN, the part loads in the last select memory.

This mode is set by programming the ‘MSSMode’ parameter to ‘Momentary’ and ‘Donly’ to ‘enabled’.

If MS2 = OPEN and there are 6 valid program modes: ABCEFABCEF…
If MS2 = OPEN and there are 5 valid program modes: ABCEABCE…
If MS2 = OPEN and there are 4 valid program modes: ABCABCA…
If MS2 = OPEN and there are 3 valid program modes: ABABA…
If MS2 = HIGH: D…

Table 4. DYNAMIC EXAMPLE WITH FOUR VALID PROGRAM MODES (T = momentary switch is toggled; 0 = OPEN; 1 = HIGH)

MS2	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0
MS	0	T	T	0	T	T	0	T		0	0					

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.

NOTE: The values set in IDS are relative values from 0 to 11 seconds; not absolute. The POR delay is relative to the configuration loaded on the WOLVERINE platform.

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 1.1 V. Once the supply voltage drops below the control logic ramp down voltage, the device will undergo a hardware reset. At this point, the device will remain off until the supply voltage returns to 1.1 V. When the supply voltage is below the control logic voltage, but above 0.6 V and rises above the 1.1 V turn on threshold, the device will activate its output and operate from the memory that was active prior to reset. If the supply voltage drops below 0.6 V, and rises above the 1.1 V turn on threshold, the device will reinitialize, activate its output and operate from memory A.

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 Ayre SA3291 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 operating with no instantaneous gain reductions, an instantaneous supply voltage fluctuation below 0.95 V will trigger an immediate 3 dB gain reduction. A waiting period of 30 seconds is in place after the first instantaneous gain reduction. Only after the waiting period has elapsed will an instantaneous supply voltage fluctuation trigger the second 3 dB gain reduction. While an instantaneous gain reduction is being applied, the instantaneous supply voltage level will be checked every 30 seconds and a 3 dB gain reduction removed should the level be above a certain threshold.

Should the average supply voltage drop below 0.95 V, the device will begin to reduce the gain by 1 dB every 10 seconds until either the average supply voltage rises above 0.95 V or all 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 instantaneous voltage falls below the hardware shutdown voltage, the device will undergo a hardware reset. When it turns back on because the voltage has risen above the turn−on threshold, it will behave the same as it would in shallow reset mode.

Low Battery Notification

Notification of the low battery condition via an acoustic indicator is optionally performed when the battery voltage drops below a configurable low battery notification threshold. The low battery indicator is repeated every five minutes until the device shuts down.

Software and Security

The Ayre SA3291 incorporates the following security features to protect the device from cloning and against software piracy:

- DLL protection by password − prevents a third party from using IDS to reconfigure parts.
- Hybrid authentication by 128−bit fingerprint to identify parts in application software − prevents a third party

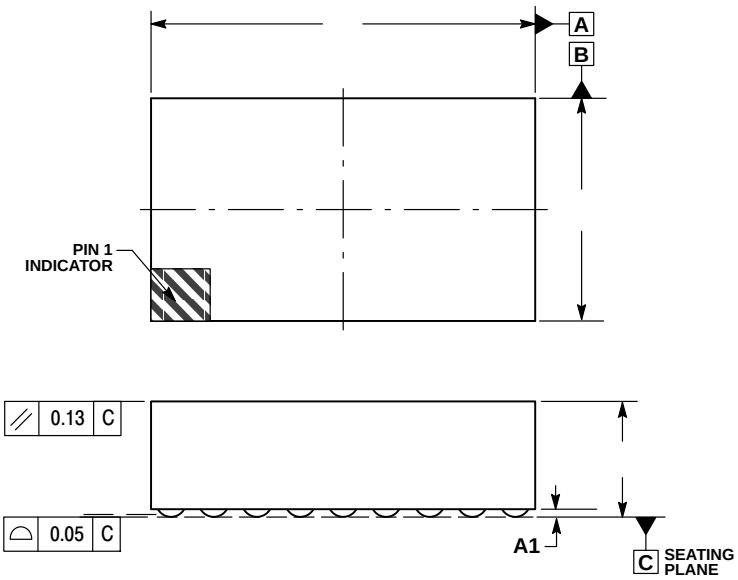
PAD LOCATIONS

Table 7. PAD POSITION AND DIMENSIONS

Pad No.	Pad Position		Pad Dimensions	
	X	Y	Xdim (mil)	Ydim (mil)
1	0	0	20	24
2	−27.5	0	20	24
3	−55	0	20	24
4	−82.5	0	20	24
5	−110	0	20	24
6	−137.5	0	20	24
[redacted]				
[redacted]			20	24

SIP32 6.35x3.68
CASE 127DW
ISSUE O

DATE 12 APR 2016



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. COPLANARITY APPLIES TO SPHERICAL CROWNS OF SOLDER BUMPS.
4. DIMENSIONS b, b1, L AND L2 ARE MEASURED AT THE MAXIMUM BUMP DIMENSION PARALLEL TO DATUM C. THE POSITIONAL TOLERANCE APPLIES TO ALL OF THE SOLDER BUMPS.

	MILLIMETERS	
DIM	MIN	MAX
A	---	1.960
A1	0.076	0.180
b		
e	0.914 BSC	
e1	0.696 BSC	

*For additional information on our Pb−Free strategy and soldering details, please download the