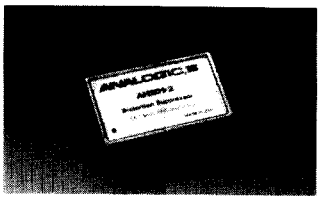


ANALOGIC

AH201

Distortion Suppressor

Description

The AH201 is a low-cost distortion suppressor, used to reduce the total distortion generated by unmatched bit switching in the decoder digital-to-analog (D/A) converter section of a digital audio or communications system. The AH201 features exceptionally low noise (−115 dB), and a time-constant limited response that eliminates slew-rate limiting problems, yet is short enough (3.4 μs) to ensure no significant attenuation of signals up to 20 kHz. These features, combined with a typical feedthrough rejection of 100 dB, provide a significant improvement in the performance of any digital audio decoder. Optimum performance is obtained by using the AH201 in combination with a true 16-bit D/A converter such as the ANALOGIC MP1926A.

All D/A converters generate some dynamic distortion each time they perform a conversion. This distortion results from code-dependent switching glitches or from slew-rate limiting of the D/A's output amplifier. Conventional sample-and-hold (S/H) amplifiers used at the D/A output do not suppress this distortion adequately for high performance, professional audio applications due to slew-rate limiting when changing modes. The AH201, however, can reduce the distortion from these nonlinearities by up to 40 dB or more, depending upon the decoder with which it is used. (Refer to Figure 2 for example).

The AH201 is a direct result of ANALOGIC's considerable experience in digital audio including professional audio recording, studio links, and telecommunications. Designed for ease of interconnection and maximum flexibility, the distortion suppressor requires a single control line per channel to provide all necessary control. The AH201 accepts a ± 10V input and can drive up to ± 16 mA into a 600-ohm load. The distortion suppressor is offered as a single or dual device, packaged in a 24-pin, double-width DIP, fully shielded metal can. Its small size, low noise, low cost and exceptional performance qualify the AH201 for use in any digital-audio system.

Features

- **Low Harmonic Distortion** 0.003% (−90 dB), maximum
- **Ultra-low Noise** — −115 dB
- **Single-Channel (AH201-1) or Dual-Channel (AH201-2) Versions**
- **Time-Constant Limited Response** Eliminates distortion due to slew-rate limiting
- **Small Size** — 24-pin DIP
- **Single Control Line/Channel**
- **Optimized for D/A Deglitching**

Applications

- **Professional Digital Recording Systems**
- **Satellite Downlinks**
- **Video Disc Audio**
- **Signal-Processing Systems**
- **Compact-Disc Systems**

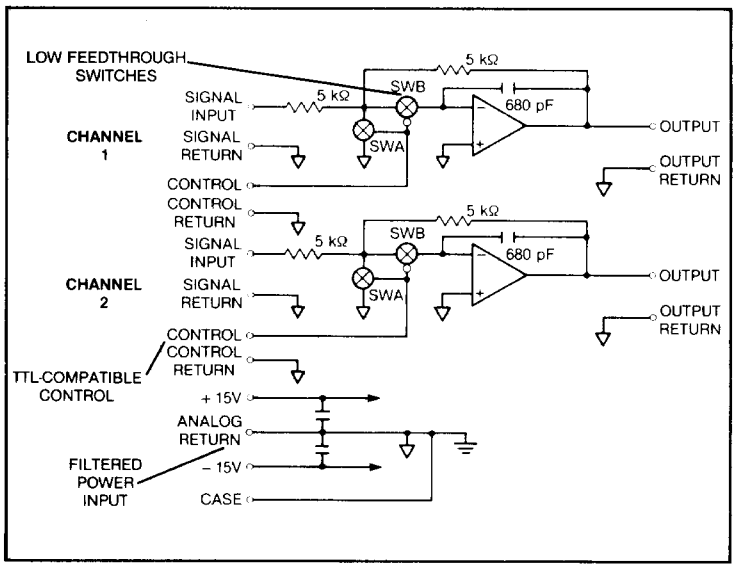


Figure 1. AH201 -2 Functional Block Diagram

SPECIFICATIONS

(All Specifications are guaranteed at 25°C unless otherwise noted)

INPUT

Input Voltage Range:
± 10V

Input Voltage Without Damage:
± 15V

Input Impedance:
5 kohms, ± 2%

OUTPUT

Output Voltage:
± 10V

Load:
600 ohms, minimum

Protection:
Short circuit to ground

Output Impedance @ dc:
0.1 ohm, maximum

TRANSFER CHARACTERISTICS

Frequency Response dc to 20 kHz:
0 dB, ± 0.3 dB maximum

Time Constant[1]:
3.4 μs, nominal

Settling Time:
Determined by time constant

Bandwidth (SAMPLE Mode):
46 kHz (Time-constant limited)

Gain[2]:
− 1, ± 0.02, maximum

ACCURACY (AT 25°C)

Integral Nonlinearity:
± 0.002% FSR, maximum

Noise (20 kHz Bandwidth)[3]:
10 μV rms, maximum

Total Distortion:
Down by at least 90 dB for frequencies up to 20 kHz (including harmonic distortion)

Peak Line Harmonic Distortion:
Down by at least 96 dB for frequencies up to 20 kHz

Output Offset Voltage (SAMPLE Mode)[2]:
± 12 mV, maximum

Feedthrough (HOLD Mode)[5]:
Down by 96 dB minimum, 100 dB typical for ± 10V sinewave up to 20 kHz

Power Supply Sensitivity Gain:
20 ppm FSR/V, maximum

Offset:
20 μV/V, maximum

Channel-to-Channel Crosstalk[4]:
Down by at least 100 dB

DIGITAL CONTROL INPUT

Logic Levels:
TTL compatible

SAMPLE Mode (Output Connected to Input):
Logic 0; 0V to 0.4V, maximum

HOLD Mode (Output Disconnected from Input):
Logic 1; + 2.4V, minimum to + 5V

POWER REQUIREMENTS (Exclusive of load)

+ 15V, ± 3%:
10 mA, maximum
(single channel, − 1)
20 mA, maximum
(dual channel, − 2)

− 15V, ± 3%:
10 mA, maximum
(single channel, − 1)
20 mA, maximum
(dual channel, − 2)

ENVIRONMENTAL AND MECHANICAL

Operating Temperature Range:
0°C to 70°C

Storage Temperature Range:
− 25°C to + 85°C

Relative Humidity:
0 to 85%, noncondensing to 40°C

Dimensions (Single or Dual Channel)
1.305" x 0.775" x 0.3", maximum
(20.07 x 33.14 x 7.62 mm)
24-pin double-width DIP

Pin Spacing:
0.6" x 0.1"

Packaging:
Metal can

Shielding:
Electromagnetic—6 sides
Electrostatic—6 sides

Note 1: Other time constants also available. Consult factory.

Note 2: From 0°C to + 70°C.

Note 3: Measured at 50% duty cycle. 10 μV rms equals − 115 dB referenced to rms full scale.

Note 4: Measured on one channel with its input grounded, with a ± 10V sinewave of frequency up to 20 kHz applied to the input of the other channel; applies to dual-channel AH201-2 version only.

Note 5: Feedthrough specification given is for standard 3.4 μs time constant. Feedthrough performance will be different for time constants other than 3.4 μs. Please consult factory.

Theory of Operation

The operation of a single-channel AH201-1 is described. Each channel of the AH202-2 operates in a similar manner.

The AH201-1 consists of an inverting amplifier, a hold capacitor, and a pair of specially selected analog switches controlled by an external mode command. As shown in Figure 3, the mode is switched to minimize the effects of DAC nonlinearities on the output of the recovery system.

When the D/A output has settled to the value corresponding to the digital code at its input, the AH201 is commanded to the SAMPLE mode; shunt switch "A" opens and series switch "B" closes, connecting the settled D/A output to the output of the AH201. In this mode, the AH201's output response is exponential with the 3.4-μs time constant.

The AH201 remains in the SAMPLE mode until just prior to the time when the D/A is updated to a new value, when it is commanded into the HOLD mode. The switch positions reverse, shunting the changing D/A output signal to ground. The previous output level, now stored on the capacitor, is maintained as the output of the AH201. The 96-dB, minimum, feedthrough rejection of the AH201 effectively isolates the output from the transients and other nonlinear settling characteristics of the D/A converter.

When the distortion suppressor is switched between its two modes, it passes signals up to 20 kHz without introducing significant distortion. For example, with the AH201 switching at 50 kHz, the peak line distortion for a full amplitude sinewave at 20 kHz is 96 dB down with respect to the full-scale level.

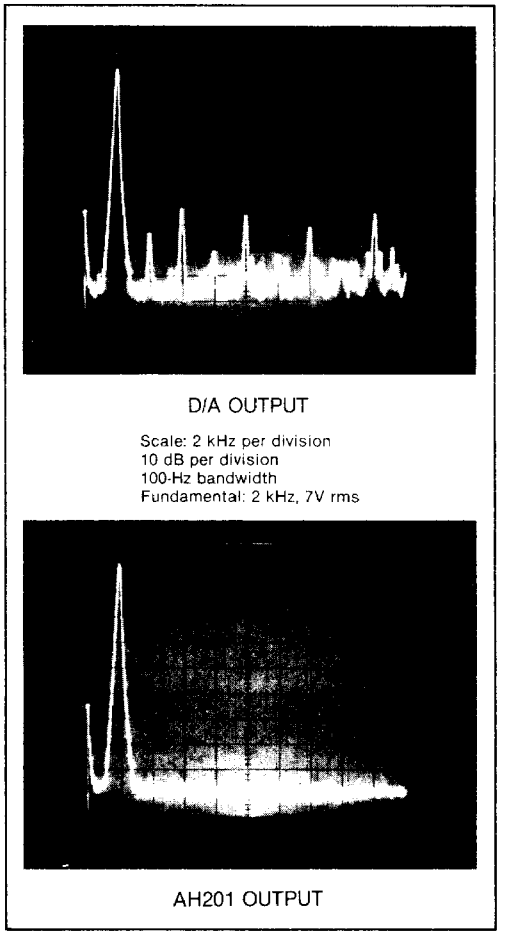


Figure 2. System Improvement with AH201

USING THE AH201

Grounding

The power return, analog input and output returns, and control return are all tied together internally and to the case. For convenience in pc-board layout, return pins for each function are located adjacent to the corresponding signal pins. To avoid ground loops, no connection should be made to the case ground pins 1, 12, and 15.

When using the AH201-1 single-channel version, it is necessary to connect pins 2 to 3 and 5 to 4. In addition, no connection should be made to pin 20. In both the single-channel AH201-1 and dual-channel AH201-2 versions, no connection should be made to pins 6, 7, 13, 14, 18, 19, or the case ground pins 1, 12, and 15.

Control

One control line is provided for each channel of the AH201. A logic 0 selects the SAMPLE mode, connecting the output to the input; a logic 1 selects the HOLD mode, isolates the output from the input. Please refer to Figure 3 for typical timing information.

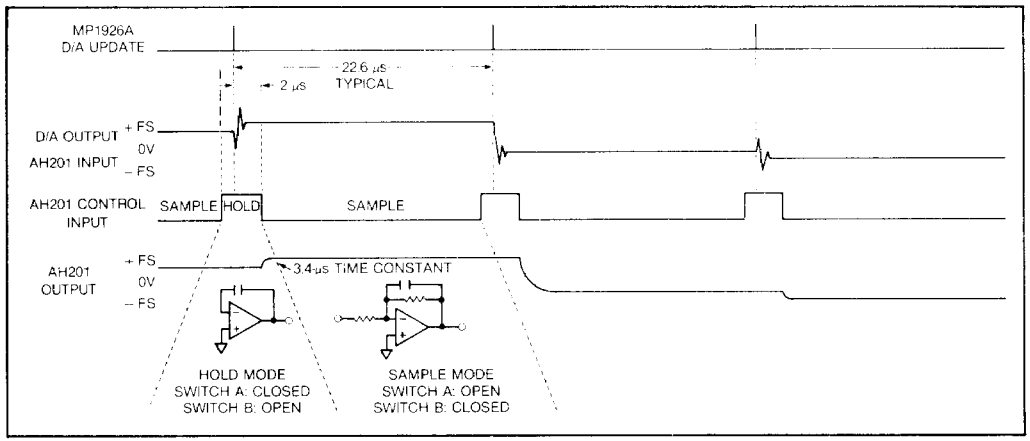


Figure 3. Typical Timing for a Single Channel System (44.1 kHz Sample Rate)

A time-constant limited response affects all input-voltage changes in the same proportion as long as the settling time allowed is constant. For this example, the on (SAMPLE) time of 17 μs (5 time constants) results in a gain error of 0.1 dB. If required, this gain reduction can be corrected by the system gain adjustment.

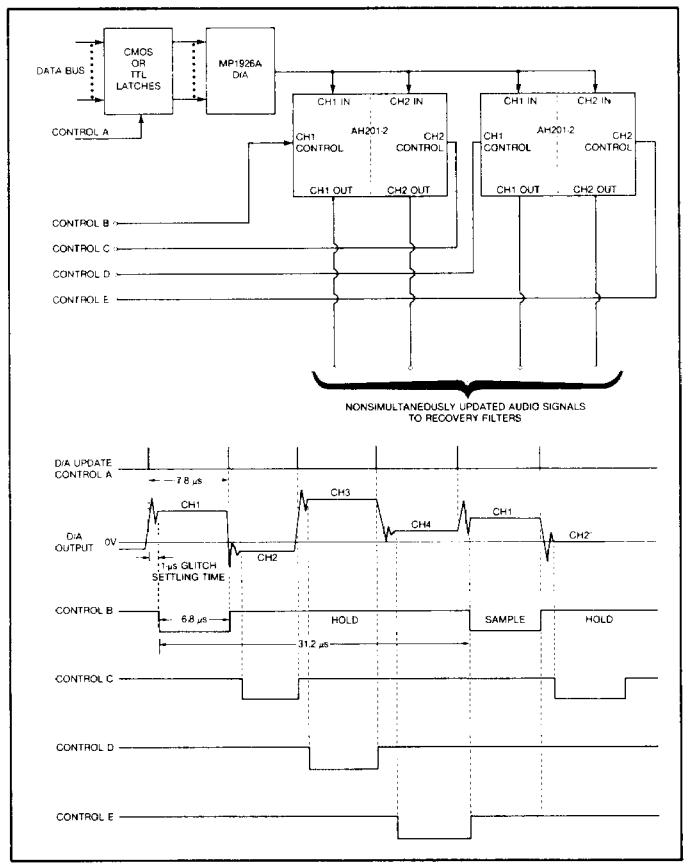
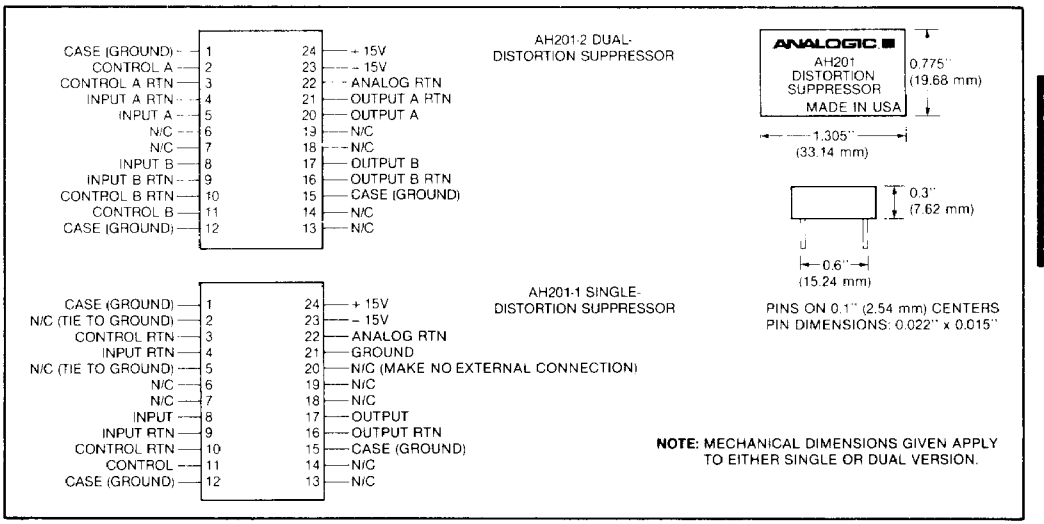


Figure 4. Non-Simultaneous Updating of Multiple Audio Channels (15 kHz bandwidth per channel, 16-bit resolution, 32 kHz sampling rate).

TYPICAL APPLICATIONS

Satellite Downlink Program Distribution

Multiple channels may be sequentially updated using one high-speed, high-accuracy D/A converter (such as the ANALOGIC MP1926A 16-bit Sign/Magnitude D/A) and multiple AH201s (– 1 or – 2). For example, a satellite ground station used in a program-channel distribution system would be required to update multiple audio outputs, but not necessarily simultaneously. Figure 4 illustrates one possible implementation using a single D/A converter to sequentially update four, 15-kHz bandwidth, audio channels. A nominal 32-kHz sample rate per channel is assumed. This means that the D/A converter must update four channels every 31.2 μs or one channel every 7.8 μs, which is well within the settling capability of the MP1926A. The AH201 circuit in each channel is simply turned on (SAMPLE mode) for the last 6.8 μs of the corresponding MP1926A update period.



Mechanical & Pinout

ORDERING GUIDE

Single-Channel Distortion Suppressor...Specify **AH201-1**

Dual-Channel Distortion Suppressor...Specify **AH201-2**

Stereo Program Distribution

Figure 5 illustrates the highest performance yet lowest cost method available for simultaneously updating stereo analog outputs, at rates up to 55 kHz from 16-bit resolution data (98 dB dynamic range). Conventional implementation requires two D/A converters plus digital double buffering to achieve simultaneous updating. The ANALOGIC MP1926A, with a voltage settling time of only 5 μs to 1 LSB for a 5V step, allows both channels to be updated from a single D/A converter within the 18 μs available. The only buffering required for simultaneous updating can be provided by an additonal AH201-2 configured as shown in Figure 5.

The timing diagram shows that the AH201 (Z1 in the Figure) samples the D/A output during a time slot assigned to Channel 1. It then holds this new Channel 1 level while the D/A output settles to a new Channel 2 value. As a result of the AH201's 96 dB feedthrough rejection in the HOLD mode, the Channel 2 information signal has a negligible effect on Channel 1. When the inputs to the AH201-2 (Z2 in the Figure) have settled to the new levels, both channels are switched into the SAMPLE mode simultaneously, causing both channel outputs to be updated. It should be noted that the two channels will be 180 degrees out of phase due to the double inversion in Channel 1. To bring both channels in-phase, an AH201-2 can be substituted for the AH201-1 (Z1), and the control for its second channel can be hardwired in the SAMPLE mode, as shown in the inset of Figure 4; alternatively, the sign of the data for one of the channels can be inverted prior to being presented to the DAC inputs.

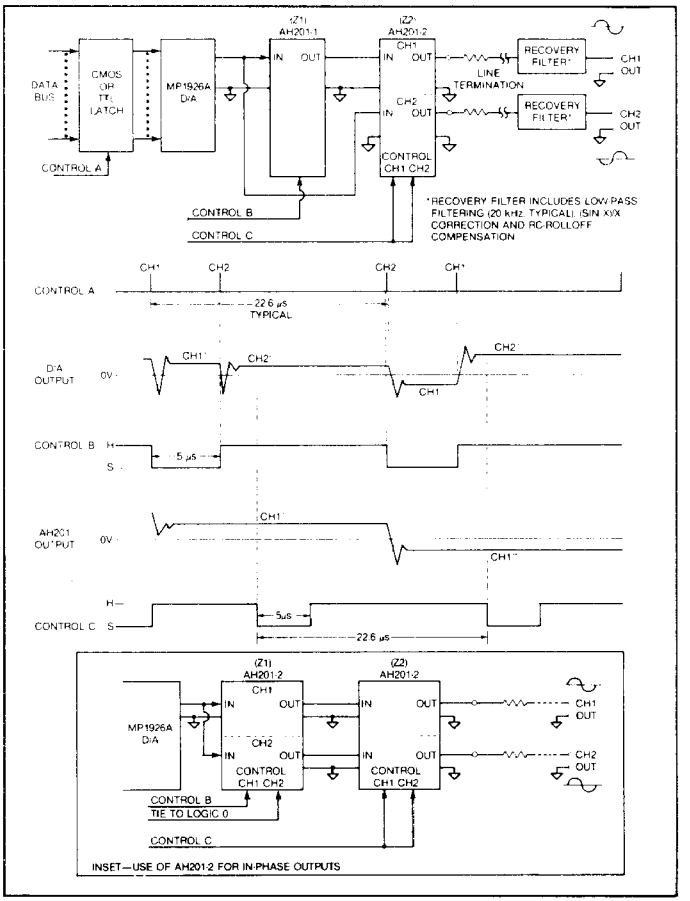


Figure 5. Simultaneous Updating of Stereo Audio Channels.