AX5689 DIGITAL AUDIO CONVERTER AND AMPLIFIER CONTROLLER

1 Features

- General features:
  - 8-channel digital Class-D amplifier controller with digital inputs
  - 8 differential low-latency ADCs
  - 8 programmable digital control loop-filter slices
  - 8 CMOS level PWM outputs, configurable as 8 single-ended, 4 BTL channels or combinations
  - Feedback loop possible after the output filter, across the loudspeaker nodes
  - Configurable interconnections between slices and ADCs for versatility and MIMO control
  - 2-WIRE and SPI Control Interface with selectable address for multi-chip systems
- Audio Input / Output:
  - I2S / TDM Serial Audio Interface with 16 downstream and 8 upstream channels
  - Input sample rate: 32 - 768 kHz
  - 16 to 32-bit supported audio formats
  - Volume control and soft mute
  - Dynamic loop control with programmable ramping enabling pop-free mode transitions
- Performance with a typical output stage:
  - 115 dB dynamic range A-weighted (up to 124 dB with parallel ADCs)
  - 0.001% THD @ 10 W / 4 Ω / 20 – 20 kHz

2 Applications

- Streaming audio amplifier solutions
- TV Sound-bars, audio entertainment solutions
- Active loudspeakers
- High performance (buffered) DAC solutions
- High-resolution low-latency ADC solutions
- Active noise reduction systems

3 Description

The AX5689 is an 8-channel audio amplifier controller IC with digital inputs and CMOS level PWM outputs. It enables high order digital control loops, with feedback after Class-D output filters.

Embedded low-latency ADCs are used to close the loop behind the output filter in the digital domain. The digital control loop has a constant high loop gain for all audio frequencies. The AX5689 suppresses all errors caused by the power supply, power stage and output filter within the whole audio band (20 Hz - 20 kHz) with typically 80 dB. The AX5689 reaches superb performance levels while enabling cost down options.

The SNR on set level is typically 115 dB. The frequency response is load independent and distortion levels are typically 0.001% at 10 W / 4 Ω / 6 kHz for a 100 W solution, resulting in a premium sound at consumer cost levels.

The low-latency ADCs, PWM outputs and programmable interconnects allow custom configurations, like analog audio inputs / analog line outputs, power supply control, current sensing, temperature sensing, etc.

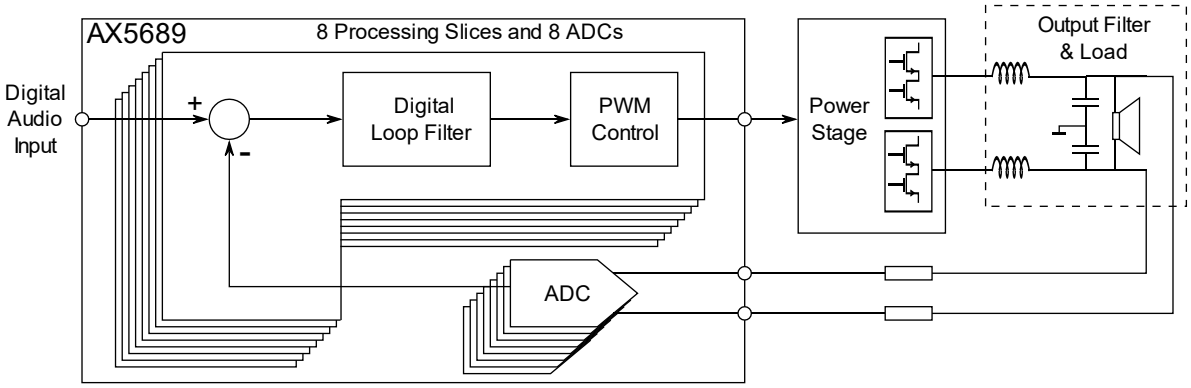
The AX5689 is compatible with power stages from various vendors and can read and respond to power stage diagnostic signals. The maximum output power is dependent on the user application and is scalable with the number of channels, selected power stages, loads and supply.

4 Package Information

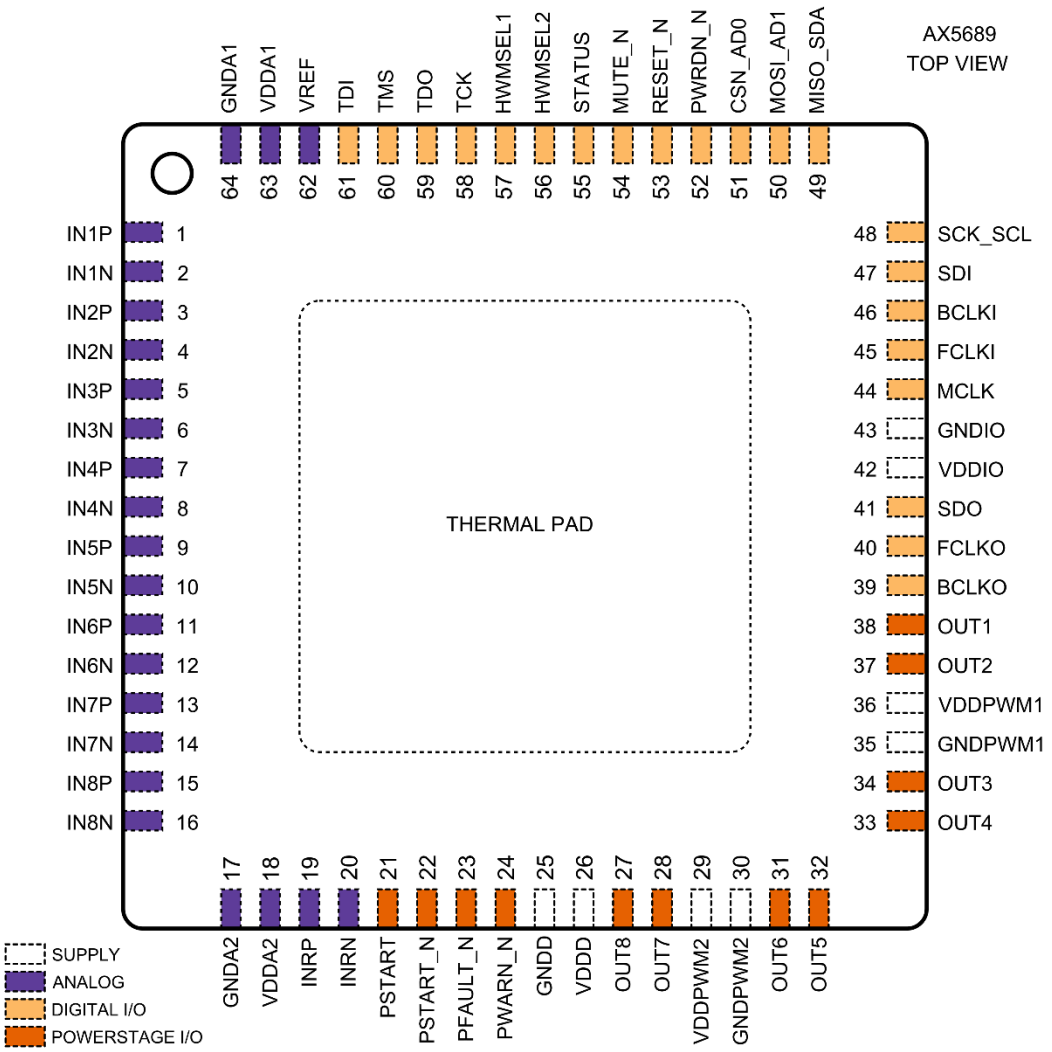
Part Number	Package	Pitch
AX5689/V	QFN64 9x9mm (Lead Free)	0.5 mm
AX5689/RV	QFN64 9x9mm (Lead Free/Tape/Reel(1))	0.5 mm

(1) Reel Quantity: 2200 pcs

Typical Application Diagram



5 Pin Configuration and Functions



6 Ordering Information

Device	Package	Moisture level Sensitivity	Peak soldering Temperature
AX5689/V	QFN64 9x9mm (lead free), pitch 0.5mm	MSL3	260 ˚C
AX5689/RV	QFN64 9x9mm (lead free, tape and reel), pitch 0.5mm	MSL3	260 ˚C

7 Detailed Description

The AX5689 is a controller IC for digital audio reproduction consisting of 8 signal processing blocks and 8 data converters along with programmable, flexible signal routing.

The AX5689 contains 8 low-latency ADCs which are optimized for fast and therefore stable control loop operation. The typical latency from analog signal change to bitstream output change is 1 clock cycle. ADCs may also be selected for auxiliary functions such as analog inputs or power supply sensing. The outputs of the ADCs may be decimated and made available through the serial digital output interface.

The device accepts up to 16 PCM input channels through a serial audio interface and analog inputs through its ADCs. The serial audio interface can also deliver up to 8 channels of data from internal nodes or ADC signals back to the host.

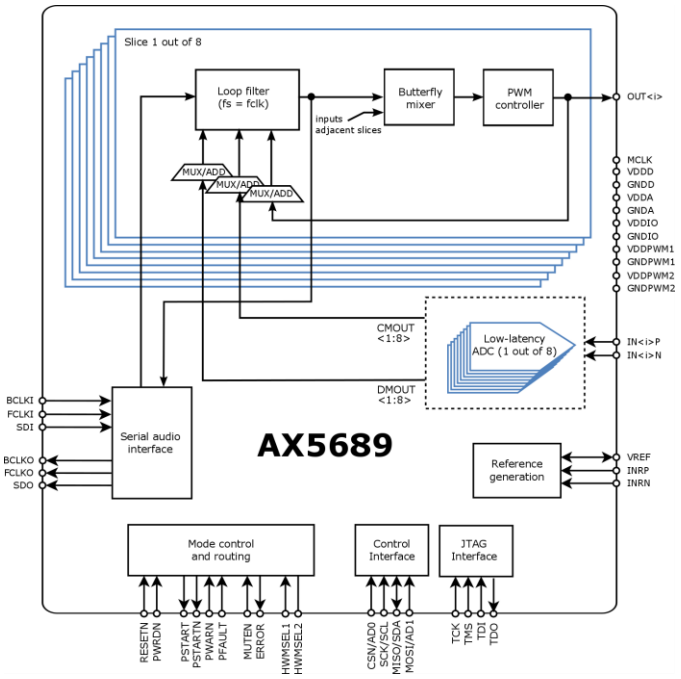


Figure 1 - AX5689 block diagram

The AX5689 furthermore contains 8 sophisticated digital control loop structures, consisting of volume control, second order sections and rounding controls. Each of the channels is separately configurable and programmable. Channels may be split or cascaded to create more complex structures.

An interleaving stage is provided for combining channel outputs in a BTL or multi-level PWM manner.

A versatile PWM controller converts the signal to 1-bit form with a wide selection of pulse frequencies and modulation methods. The CMOS level PWM outputs can be fed directly to a switching power stage that is followed by an output reconstruction filter. The filter compensation in the AX5689 can correct for a wide range of external filter configurations.

The device is programmed via an SPI or 2-WIRE interface. The interface provides access to all features and is used to define the data path. Three hardware modes are provided with preset BTL configurations.

The combination of these blocks in one IC makes the AX5689 suitable as a digital amplifier with ADC feedback loop encompassing external components such as a power stage and output filter.

An amplifier that uses the AX5689 can achieve high performance at low cost as all error sources within this loop are highly suppressed by the loop gain. This results in relaxed requirements for e.g. the power supply, the power stage and output filter components, thus making it easier to optimize the costs of the system.

8 Package Dimensions

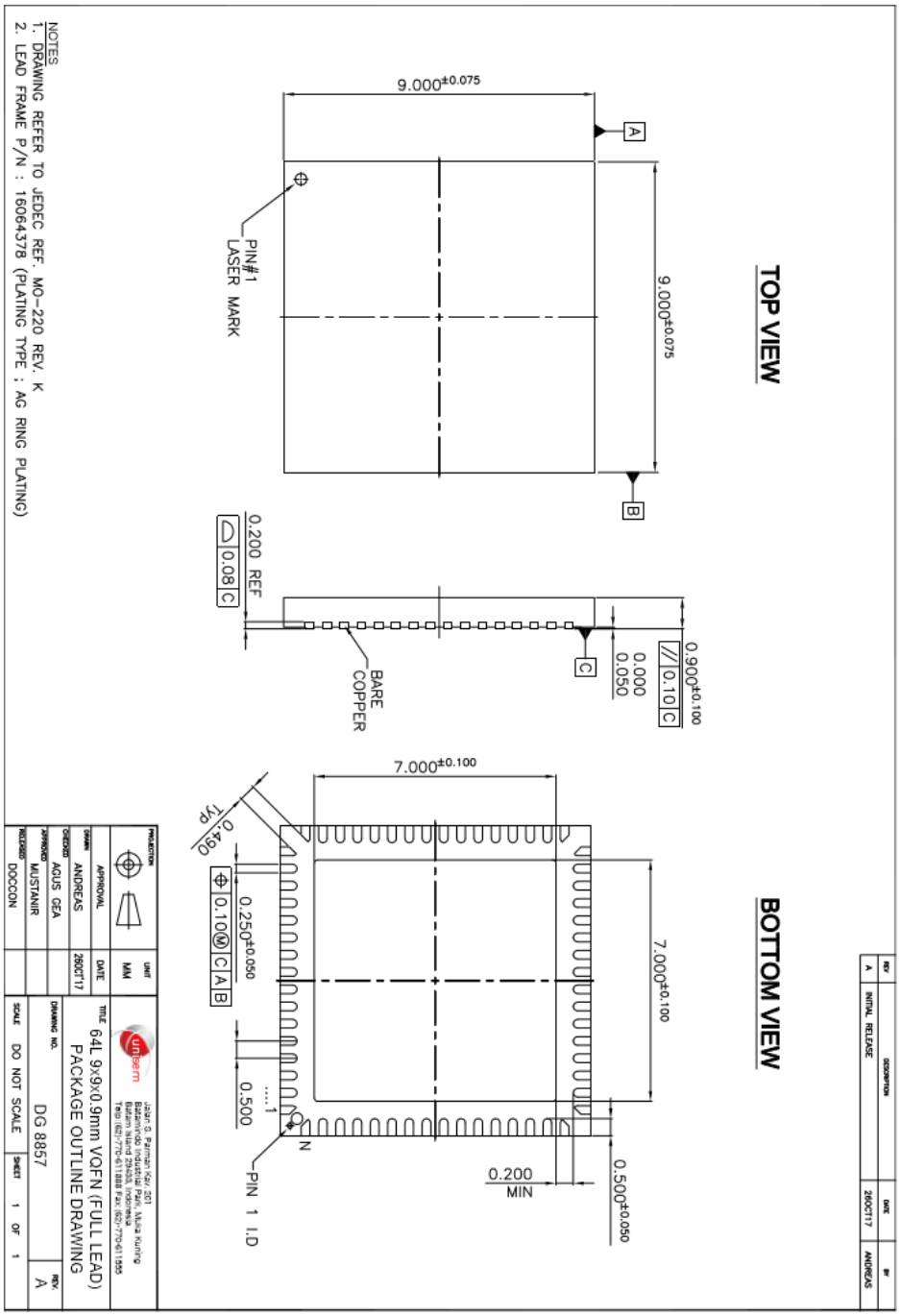


Figure 2: Package Diagram

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