Nuvoton Introduces Smart Amp Evaluation Platform with Klippel Controlled Sound Technology

Jin Kim (Nuvoton) and Jonathan Gerbet (Klippel GmbH)

Loudspeakers are highly nonlinear and time-variant systems. Signal distortion, heating, climate and other external influences limit the maximum level and the quality of the reproduced sound. Recently, Nuvoton introduced a couple of new mono smart amplifier devices, NAU83G10 and NAU83G20, with integrated Klippel Controlled Sound (KCS) technology to cope with these undesired effects.

Conventional smart amplifier devices use linear speaker models, which assume speaker parameters being independent from voice coil excursion, velocity and other states. Newer smart amplifiers also have integrated current sensing to adapt for some time-variant parameters such as DC resistance to be able to protect the transducer thermally or identify a changing resonant frequency.

Compared to these devices using linear adaptive models, the KCS algorithm employs an adaptive and nonlinear speaker model that can greatly improve the speaker performance and sound quality. The nonlinear speaker model describes speaker states such as voice coil excursion and velocity not only at low levels (small signal domain), but also in the large signal domain where the voice coil excursion is high.

This allows the mechanical protection system to work very precisely over the full operating range, which is not possible with linear models. In addition, a nonlinear model can identify and actively shift the voice coil to its optimum position using a small DC voltage. This is achieved by exploiting nonlinear distortion found in the current signal, which is caused by nonlinear transducer parameters.

These features allow the transducer to operate over a wider working range without damaging the speaker and improve the sound quality and acoustic echo cancellation (AEC) barge-in performance by reducing linear and nonlinear speaker distortion. Furthermore, the possibility of describing the speaker's behavior in the nonlinear range of operation allows the use of transducers with more nonlinear motor topologies to focus on maximizing efficiency (*Green Speaker Design*).

	Conventional Smart Amplifier	Nuvoton Amplifier with KCS
Thermal Protection	X	X
Monitoring of Speaker States/ Parameters	X*	X
Constant Performance over Lifetime	X*	X
Mechanical Protection	X*	X
Automatic System Alignment		X
More Efficiency using *Green Speaker*		X
Reduction of Nonlinear Distortion		X
Stabilization of Voice Coil Position		X
Maximum SPL		X
Maximum Bass		x
***Considering only small signal parameters, which are valid at lower amplitudes where the speaker can be described as a linear system; inferior accuracy in the large signal domain**		

Table 1: Comparison of Conventional and Nuvoton Smart Amplifiers

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The adaptive identification of the speaker's resonant frequency, damping and other time-variant parameters allows KCS to compensate time-variant behavior and hence ensures that the performance stays constant over the product's lifetime. By doing an automatic system alignment, KCS eases system tuning as the user only has to specify a target response (such as 6th order high-pass filter at a certain cut-off frequency) and KCS automatically calculates a filter to achieve this target.

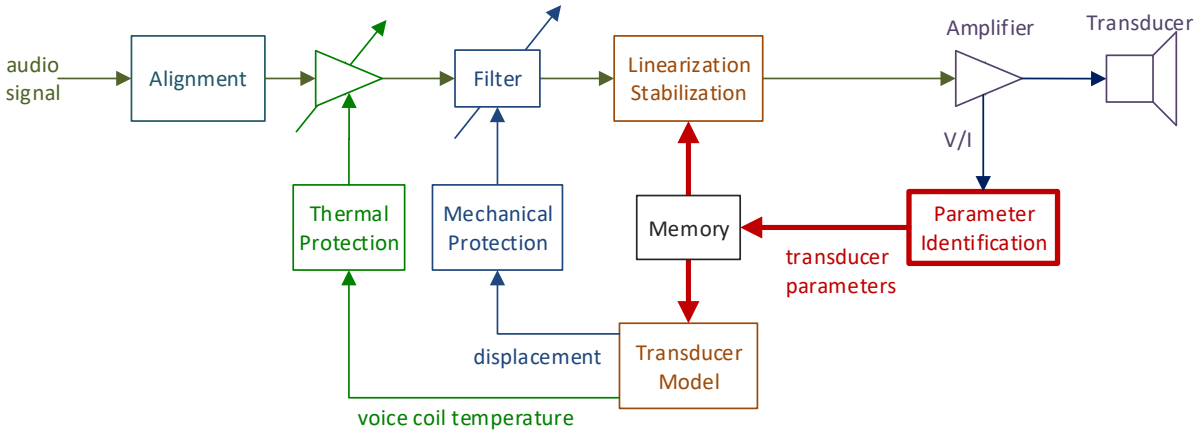

Figure 2: KCS Flow Chart

Both the NAU83G10 and the NAU83G20 devices are mono Class D amplifiers with IV sense ADCs. A powerful Cadence Tensilica HiFi Audio DSP core is integrated inside to run the KCS algorithm efficiently, and both devices can support I2C control and I2S/PCM/TDM audio interface. The NAU83G10 device can deliver up to 8 W output power into 4 Ohm load and 6.5 W for an 8 Ohm load using a highly efficiency Class G boost converter. The NAU83G20 device can deliver up to 20 W for a 4 Ohm load and 11 W for an 8 Ohm load using an external battery supply around 12.6 V.

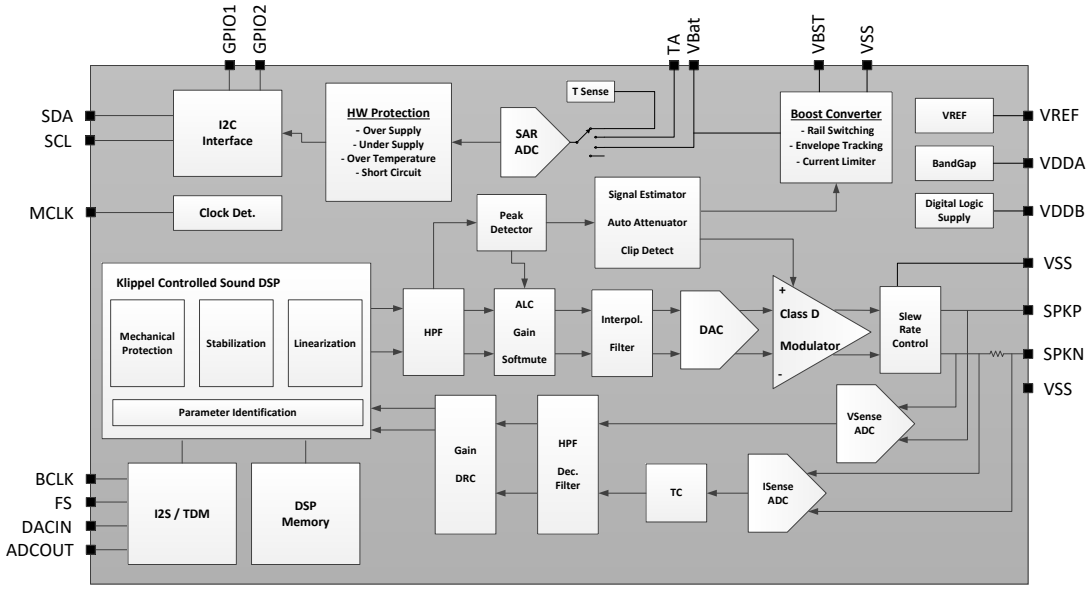

Figure 2: Schematic of NAU83G10

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NAU83G10 Key Features

Powerful Mono Boosted Class-D Amplifier

- 8 W Output Power @4Ω, 10% THD+N, 5V VBat
- 6.5 W Output Power @8 Ω, 10% THD+N, 5V VBat
- 0.021% THD+N @ 8 Ω Load, 1W Output Power
- 12 µVRMS Output Noise in Receiver mode
- 55 µVRMS Output Noise in Speaker mode
- 92 dB PSRR for 200 mVpp ripple at 217 Hz
- Click-and-Pop Suppression (30 µVRMS)

Highly Efficient Class-H Boost Converter

- Programmable Boost Voltage of up to 12V
- Class H Envelope Tracking in 0.177 V step

Programmable Serial Interfaces:

- I2C Interface
- I2S/PCM/TDM Interface

ALC

- Battery Tracking Limiter
- Brownout Prevention
- Battery Supply Current Limiter

NAU83G20 Key Features

Powerful Mono Class-D Amplifier

- 20W Output Power @4Ω, 10% THD+N, 12.6V VBat
- 10.8 Watts into an 8 Ohm load at 10% THD+N, 12.6V VBat
- 0.021% THD+N @ 8 Ω Load, 1W Output Power
- 65 µVRMS Output Noise in Speaker mode
- 92 dB PSRR for 200 mVpp ripple at 217 Hz
- Click-and-Pop Suppression (30 µVRMS)

Programmable Serial Interfaces:

- I2C Interface
- I2S/PCM/TDM Interface

ALC

- Battery Tracking Limiter
- Brownout Prevention

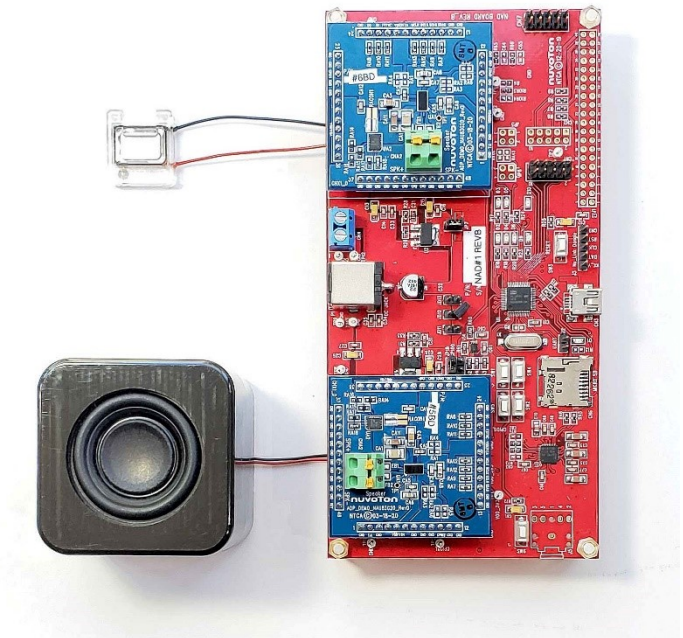

Figure 3: Nuvoton Audio Development Platform with Reference Speakers

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The new evaluation system for the NAU83G10 and the NAU83G20 smart amp devices is now ready and available for customer use. It provides necessary hardware and software to demonstrate the performance of these novel amplifiers together with KCS. For starting quickly, the evaluation platform ships with reference speakers, initial KCS data sets and equalizer settings so that the customer can immediately evaluate the system's performance. Users of the evaluation system can get a free temporary license for the Klippel QC measurement system for performing objective tests on request.

The customer is also able to connect and tune his or her own speaker with this evaluation system for their target application. The initial identification of KCS speaker parameters is done almost automatically using the Klippel Analyzer 3 measurement system. Klippel has developed novel, easy-to-use nonlinear speaker identification algorithms to optimally meet the needs of smart amplifier users. The identification of a new speaker only takes a few minutes and does not require an audio expert. The maximum working range of the device under test is identified automatically. Comprehensive information about the suitability and potential quality of the speaker system is given.

Nuvoton and Klippel started a joint product development together in 2017 with a common goal of revolutionizing the loudspeaker experience by optimizing both hardware and firmware for the nonlinear speaker control algorithm.

> *"We are very excited to be working with Klippel on creating this new class of smart amp devices, which can deliver maximum output at greater sound quality from smaller speakers, offer precise speaker protection, provide real-time speaker diagnostic data, simplify the speaker tuning process, and increase the barge-in AEC performance compared to the conventional linear model-based smart amplifier,"* said Aditya Raina, General Manager of the Smart Home Audio product business group at Nuvoton Technology Corporation America.

NAU83G10 and NAU83G20 engineering samples and evaluation systems are available now through all Nuvoton sales channels.

Further information are available on the Klippel Controlled Sound website and on www.nuvoton.com.

Nuvoton, a subsidiary of Winbond Electronics Corp, shipped more than one-billion voice and audio chips in the last twenty-plus years. The Nuvoton audio integrated circuit devices were developed to help designers worldwide successfully develop high-fidelity audio applications at price points that will fuel growth in high-quality audio in an ever-broadening range of portable devices.

KLIPPEL is an innovative leader in providing unique test equipment for electro-acoustical transducers and audio systems. Founded in 1997 by Dr. Wolfgang Klippel, the novel techniques developed for control and measurement systems of loudspeakers are the result of over 30 years of fundamental research.

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