



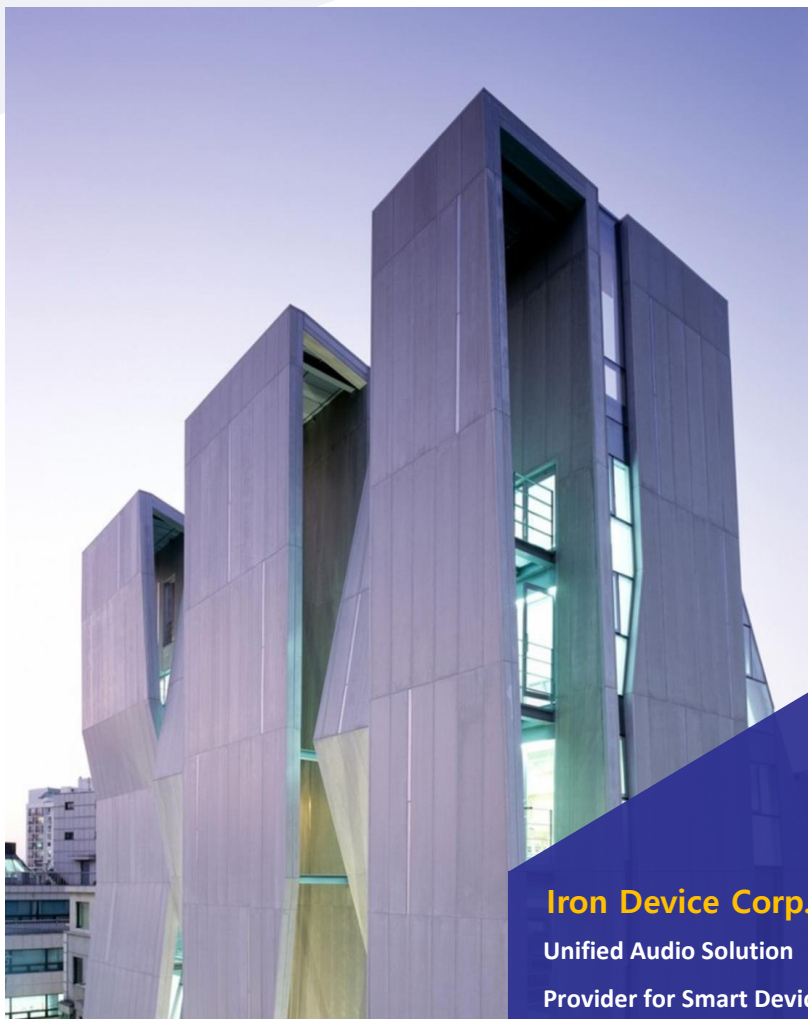
Unified Audio Solution Provider for Smart Devices



WHO we are

Specialized in a mixed-signal company, focused on providing leading-edge digital/analog/power-mixed **single silicon device solution**

IRON DEVICE COMPANY PROFILE



Iron Device Corp.

Unified Audio Solution

Provider for Smart Devices



Analog-Digital-Power in a *SingleSilicon™* with valued software solution

- Business field : System Semiconductor
- Main Product : Audio/Power Semiconductor

Iron Device Corporation is specialized in a **mixed-signal company**, focused on providing leading-edge digital/analog/power-mixed single silicon device solution.

Iron Device offers the state-of-art mixed signal semiconductors and optimizes sound quality in mobile phones, smart speakers, headphones, hearables, other smart devices and more.

Iron Device technology has enabled high-end audio technologies to be implemented into a single silicon device, comprising digital audio modulators, DSP, precision linear amplifiers and high current switching power drivers.

IRON DEVICE PROFILE & HISTORY



Deep experienced
**R&D and MP-Supporting
engineers**
(From Samsung LSI, Fairchild Semi., etc.)



For **15 years**, Iron Device Corp. has been in **system semiconductor business**



20 registered
&
2 pending
patents



More than **400 million** units of **Mass Production**
*cumulative quantity

Iron Device HISTORY



2008~2010

2008
Established Iron Device Corporation with B&O ICEpower a/s

2008
Contract with major foundry: TSMC, MagmaChip, UMC, DBHitek, etc.

2010
Joined Korea International Trade Association

2011~Present

2012
Established R&D center

2014
Selected as a star fabless company by Ministry of Trade, Industry and Energy

2016
Invested by **Silicon Mitus** and Government

2017
Established R&D center in Denmark

2018
Started mass production of SMA series

2019
Supply SMA series to global mobile & speaker companies: >100Mpcs

2021
Supply SMA series: >200Mpcs (acc.)
Invested by **MIRAE ASSET** Venture Investment, etc.

2022
Started supplying with independent supply chain management



WHAT we do

Provide **Unified Audio Solution** for Smart Devices

IRON DEVICE DOES

Iron Device with

No.1 Global smartphone company

1st Sound on Display with **Iron Device** Piezo Driver



- Perfect solution for Smart Device with **High Performance / Low Price / Smallest size**

IRON DEVICE TECHNOLOGY 1/2

Providing Rx Path & Tx Path IP and Solutions



Audio Amplifier

Audio Codec

Audio A/D, D/A Converter

Boost Converter

Motor Driver

Gate Driver

Iron Device Corporation is specialized in a mixed-signal semiconductor, focused on providing leading-edge digital/analog/power-mixed single silicon device solutions.

One Chip Solution AI(Smart) Speaker

- **ADC**
: 8-ch. wideband 24-bit ADCs for simultaneous audio sampling (120dB SNR)
- **Stereo Speaker Amplifiers**
: 50 W x 2-ch. maximum audio output powers full digital amplifier
: Closed-loop Class-D output stage(110dB SNR)
- **HiFi Speaker Amplifier DSP**
: Strong Asynchronous Sample Rate Converter (ASRC)
: 32bit – (15+5) band x 2ch. PEQ / BassBoost / Multiband DRC



AI Speaker



AI TV



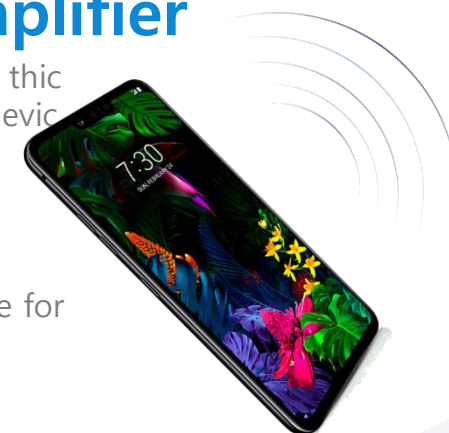
AI Speaker

Target Applications

- AI Speakers, Smart Speakers
- Wireless Speakers
- Sound Bars
- Digital Set Top Boxes
- Automotive AI Systems

Display sound Amplifier

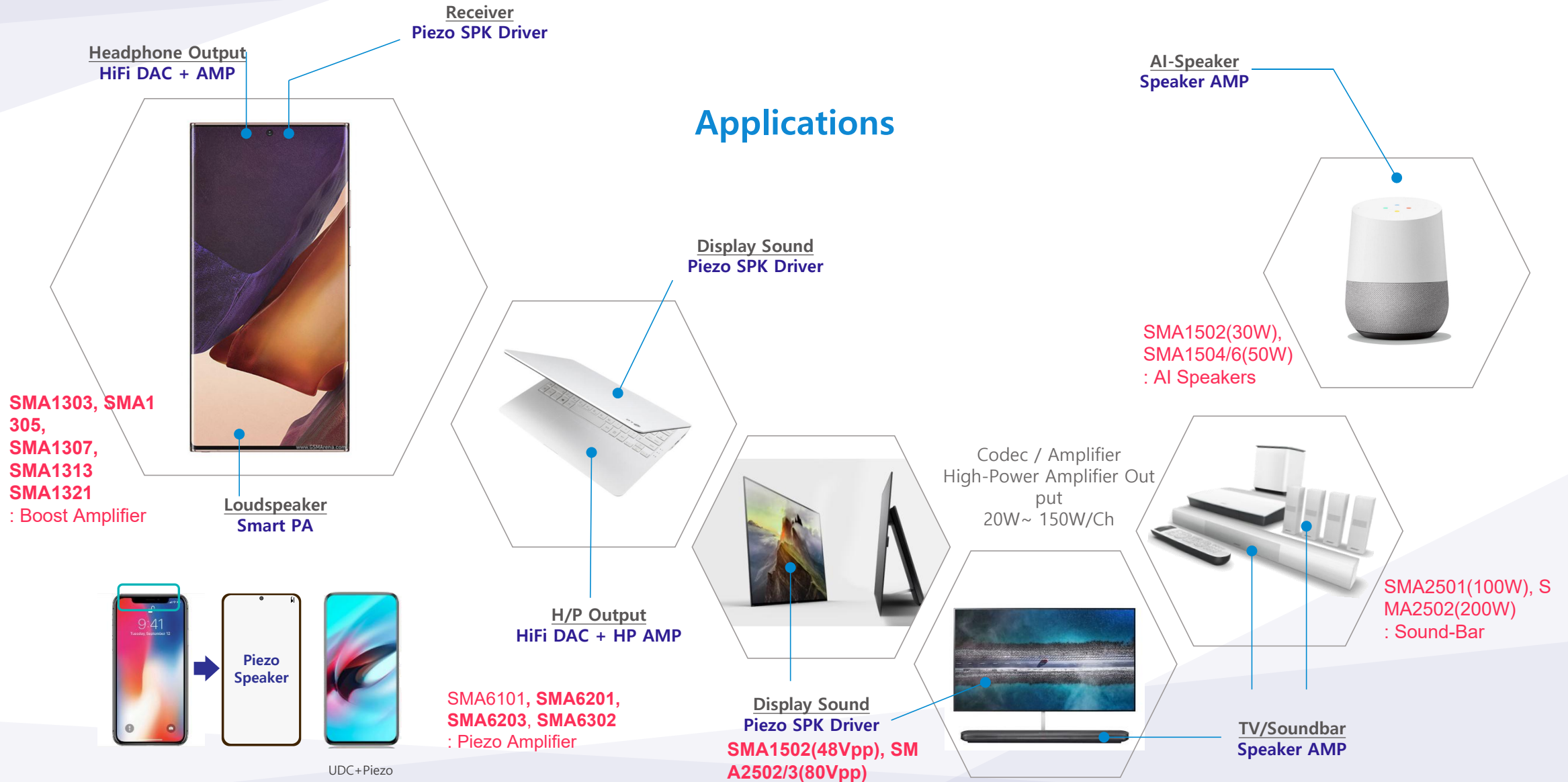
Designed to reduce screen bezel and thickness in smartphones and portable devices.



- **High Efficiency Boost Converter**
: High efficiency 25 V output voltage for 50 VPP piezo drive
: Envelope Tracking class-H control by digital feed-forward processing
- **High Performance Digital Piezo Speaker Amplifier**
: **Full digital class-D audio amplifier: Max. 50 VPP output**
: Large capacitive load drive: Max. 5 μ F load drive
: Low output noise: < 30 μ Vrms (A-weighted)
: High audio performance: SNR 112 dB
: Load current sense ADC for load impedance detection
- **Digital Signal Processing for Sound Tuning**
: **DSP for no-series-resistance piezo drive**
: Piezo tuning filter
: Dynamic gain control

Product Portfolio

Applications



IRON DEVICE'S PRODUCT in APPLICATION 1/2

Representative Application Products



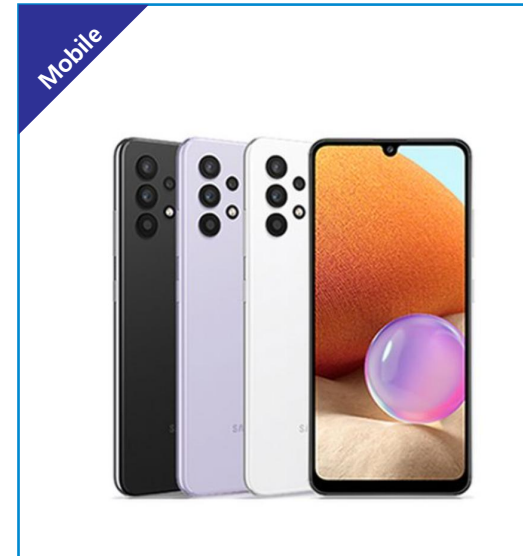
SMA1301 in Smartphone

Boosted Digital Speaker Amplifier



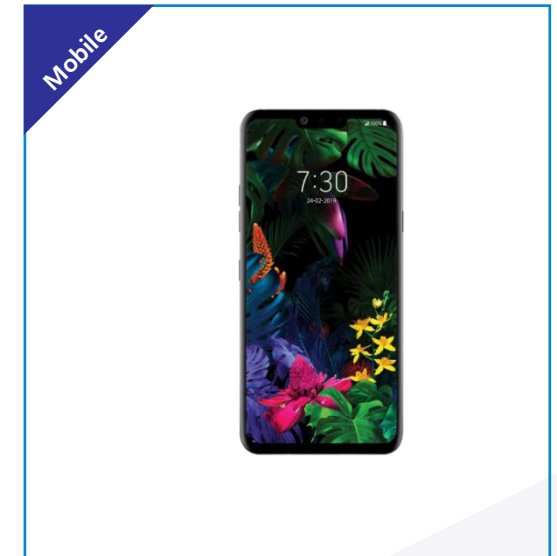
SMA1303 in Smartphone/Tablet

Boosted Digital Speaker Amplifier
- Enhanced and Tiny



SMA1305 in Smartphone/Tablet

High-Boosted Digital Speaker Amplifier
- Envelope Tracking, APS protection



SMA6101/6201 in Smartphone

Boosted Digital Speaker Amplifier
for Piezo Speaker

IRON DEVICE'S PRODUCT in APPLICATION 2/2

Representative Application Products



SMA1502 in Display Sound Monitor

SMA1502

2X30 W Digital Input Closed –Loop / Class
D Audio Amplifier with Audio DSP



SMA1502 in Table TV

SMA1502

2X30 W Digital Input Closed –Loop / Class
D Audio Amplifier with Audio DSP



SMA1506 in Smart Speaker

SMA1506

2X30 W Digital Input Closed –Loop / Class
D Audio Amplifier with Audio DSP



SMA1502 in Smart Speaker

SMA1502

2X30 W Digital Input Closed –Loop / Class
D Audio Amplifier with Audio DSP

WHY with us

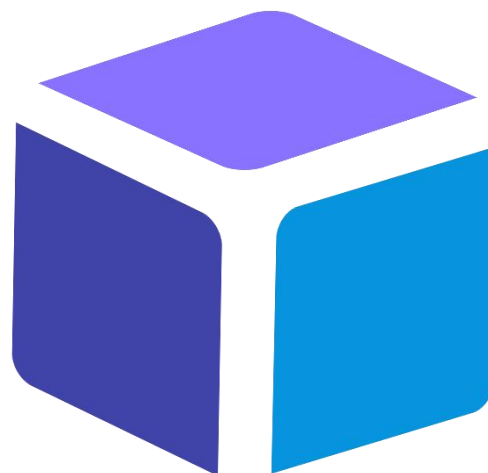
- Specialized digital/analog/power-mixed single silicon device solution
- Single-chip Implementation of Analog-Power-Digital Mixed Signals
- High Voltage/Passive Current Drive IC Design Technology and Protective Circuit Technology



IRON DEVICE CORE STRENGTH 1/2

Wide Range Technology

- Driving from low power earphones to powerful loud speakers
- High Fidelity Data Conversion and Signal Processing
- Using Bipolar-CMOS-DMOS Process/Circuit Technology



High Quality Proven Supply Chain



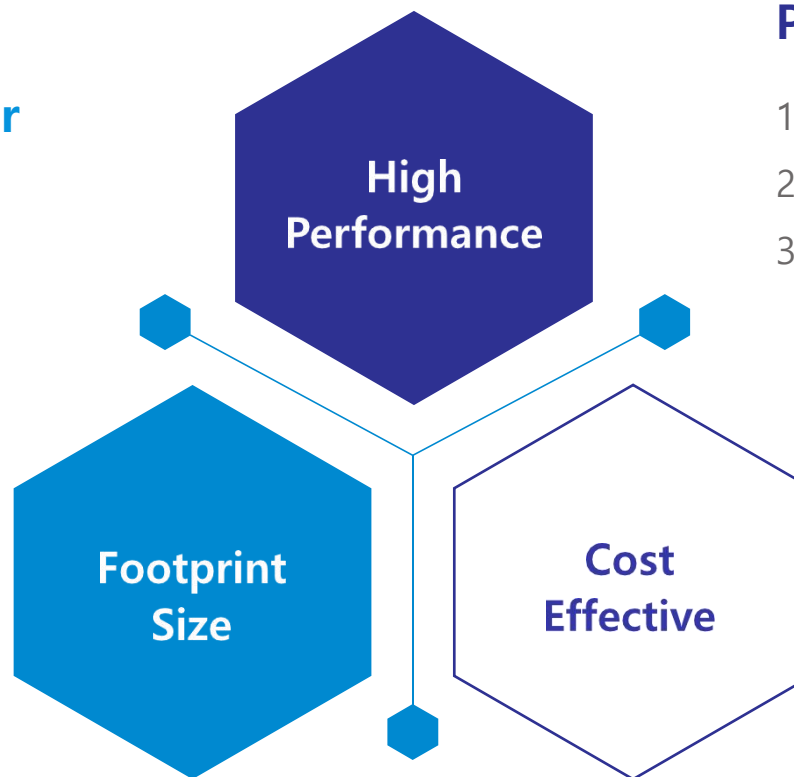
In-house Strong IP Portfolio

- Silicon-proven by long-term mass production

IRON DEVICE CORE STRENGTH 2/2

Key Value:

Performance + Size + Price
Audio Solution for Each Customer



Performance

1. Digital Amplifier with Feedback: Low Distortion
2. Digital Processing for Strong Sound Tuning
3. Analog and Digital Signal Integration

Size

1. Single Chip Solution in a Tiny Package
2. External Component Reduction

Price

1. BOM Cost Reduction
2. Single Chip Integration
3. Low Current Consumption

APPLICATION #1

Wireless Speakers / **Smart Speakers** / Sound Bars



Application Guide #1

Wireless Speakers / Smart Speakers / Sound Bars

Typical Application – Smart Speakers

- 12V Power Supply with Digital Input (I2S/TDM)

SMA1506
Digital Input
+ DSP
30W x 2

More Power
~36V

SMA2503
Digital Input
+ DSP
150W x 2

More Power
PBTL

SMA2503
Digital Input
+ DSP
200W x 1

- 12V~24V Power Supply with Analog or Digital Input (I2S/TDM)

* 1~2-Mic + 2-Speakers

SMA1502
Analog/Digital
Input + DSP
30W x 2

~36V

SMA2502
Analog/Digital
Input + DSP
150W x 2

More Power
PBTL

SMA2502
Analog/Digital
Input + DSP
200W x 1

- 12V~32V Power Supply with Digital Input (I2S/TDM)

* 1~8-Mic + 2-Speakers

SMA5311
8-Mic.
Digital Input + DSP
8-Mic. + 50W x 2

- Two-Cell Battery System

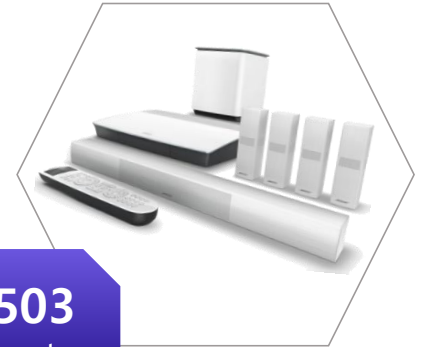


SMA6021
Class-H
Two cell to 12V
Boost Converter

Ex. SMA1502+SMA6021

*Support Analog or Digital Mic.

- Android/Linux Device Driver and PC-Tuning Tools are ready



SMA5311 PRODUCT BRIEF

8ch Mic input ADC and 2ch x 50 W Closed-Loop Class-D Amplifier with Audio DSP and TDM interface

■ Key Features

- Supports I2S, LJ, RJ, **TDM**, IOM-2 digital audio format inputs Analog
- **Multi-channel digital input/output** interface (fs = 8kHz ~ 192kHz)
- **8-Ch. Wideband Microphone ADC**
 - 8-ch. analog inputs with AFE for microphone interfaces
 - Support both of analog and digital(PDM) mems microphones
 - **8-ch. wideband 24-bit ADCs for simultaneous audio sampling (120dB SNR)**
 - Softvolume/AGC/Noisegate
- **Stereo Speaker Amplifiers**
 - **50 W x 2-ch.** maximum audio output powers full digital amplifier
 - Closed-loop Class-D output stage
 - Internal **power management** circuits – for Simple power design
 - **Digital data returning path (SDO output) for AI speakers**
- **HiFi Speaker Amplifier DSP**
 - **Strong Asynchronous Sample Rate Converter (ASRC)**
 - **32bit - 15 band x 2ch. PEQ / BassBoost / Multiband DRC /**
/ Soft mute / Soft volume / etc.
 - Input digital **mixer**
- **Clock Source Support**
 - X-tal oscillator / MCLK / **SCK** / BCK / etc.
 - **Internal Fractional-N PLL**
- **Smart Analog Protections and Diagnostics**

■ Thin Single Chip Package

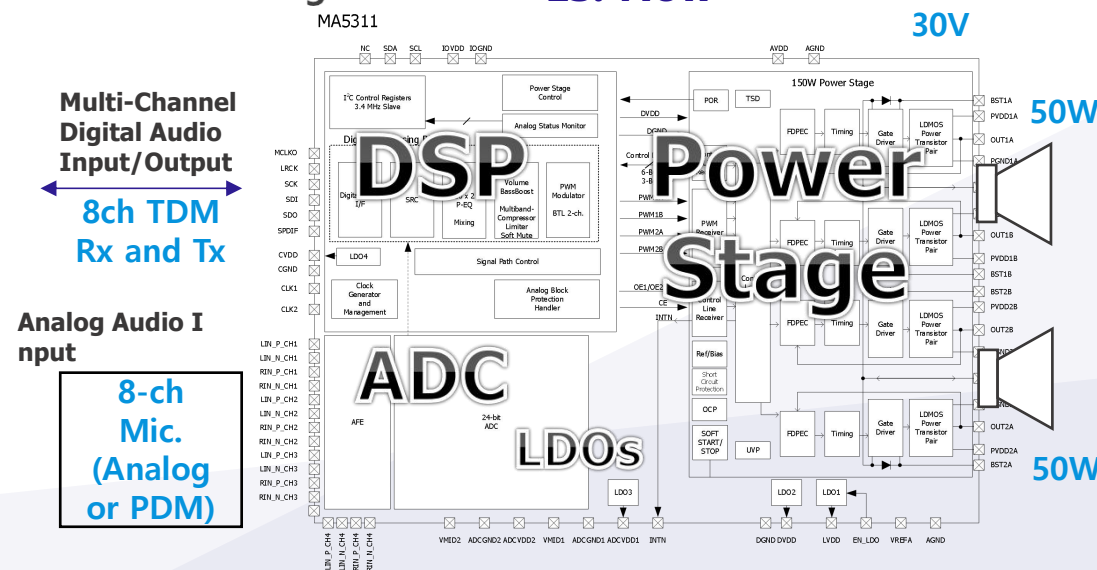
- 88pin-QFN-10x10

■ Target Applications

- **AI Speakers, Smart Speakers**
- **Wireless Speakers**
- **Sound Bars**
- **Digital Set Top Boxes**
- **Automotive AI Systems**

■ Block Diagram

ES: Now

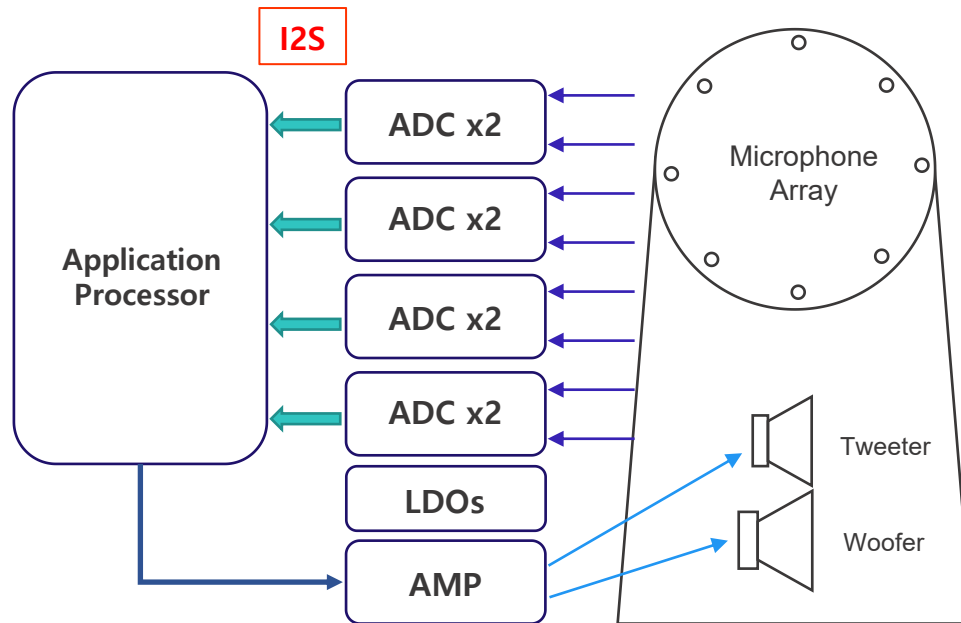


One Chip Solution AI Speaker Audio Amplifier

8ch Mic input ADC and 2ch x 50 W Closed-Loop Class-D Amplifier with Audio DSP and TDM interface

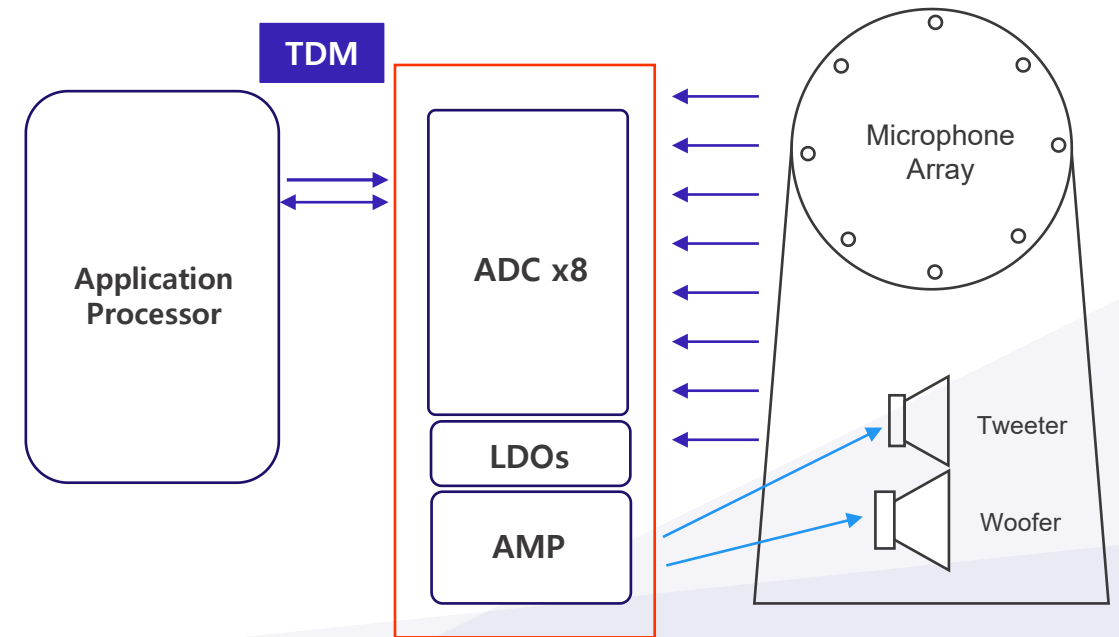
- Innovative Single Chip Solution for AI or Smart Speakers

*Vendor A and H - AI Speaker Solution



More than 5 chips are needed

* Iron Device's NEW Solution



Only 1-Chip!

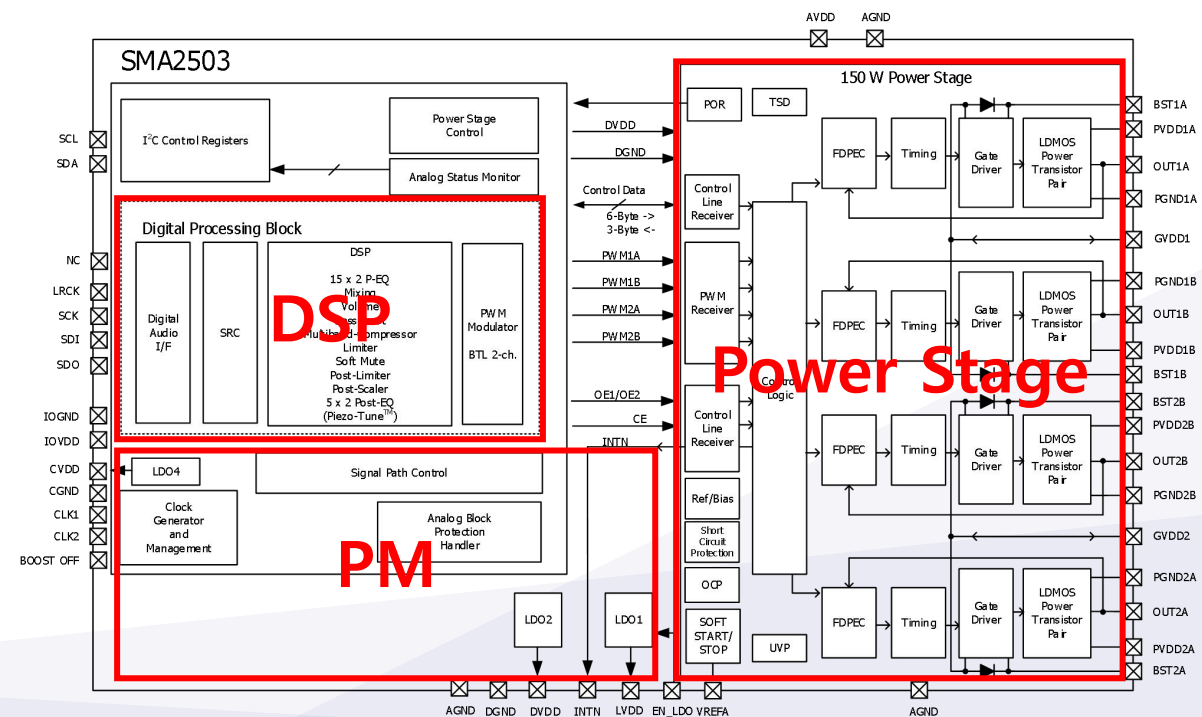
SMA2503 PRODUCT BRIEF

2.1- channel 150W x2 Digital Audio Amplifier

Features

- 2 x 150W full digital amplifier with **closed loop**
- **2x Full bridge or 4x half bridge output channels in a single device**
 - **Stereo Bridge Tied Load (BTL)**
 - **Mono Parallel Bridge Tied Load (PBTL) for Subwoofer(200W)**
- Digital input (8KHz ~ 192KHz)
- SRC(Sample Rate Converter)
- Programmable digital cross-over filter
- Dynamic base boost, **multiband compressor, & limiter**
- **15 band X 2 channel PEQ + 5 band X 2 channel post-PEQ**
- Diagnostics(I2C & Interrupt)
- Programmable Post Scaler (**0.125dB/step**) and Tone Generator
- Low idle power consumption
- Novel over current protection schemes / Short circuit protections
- Under voltage protection (UVP)
- High efficient N+N power DMOS output stages
- Robust metal structure – with Internal thick copper metal layer
- BCDMOS, 48-HSSOP package

ES: Now



APPLICATION #2

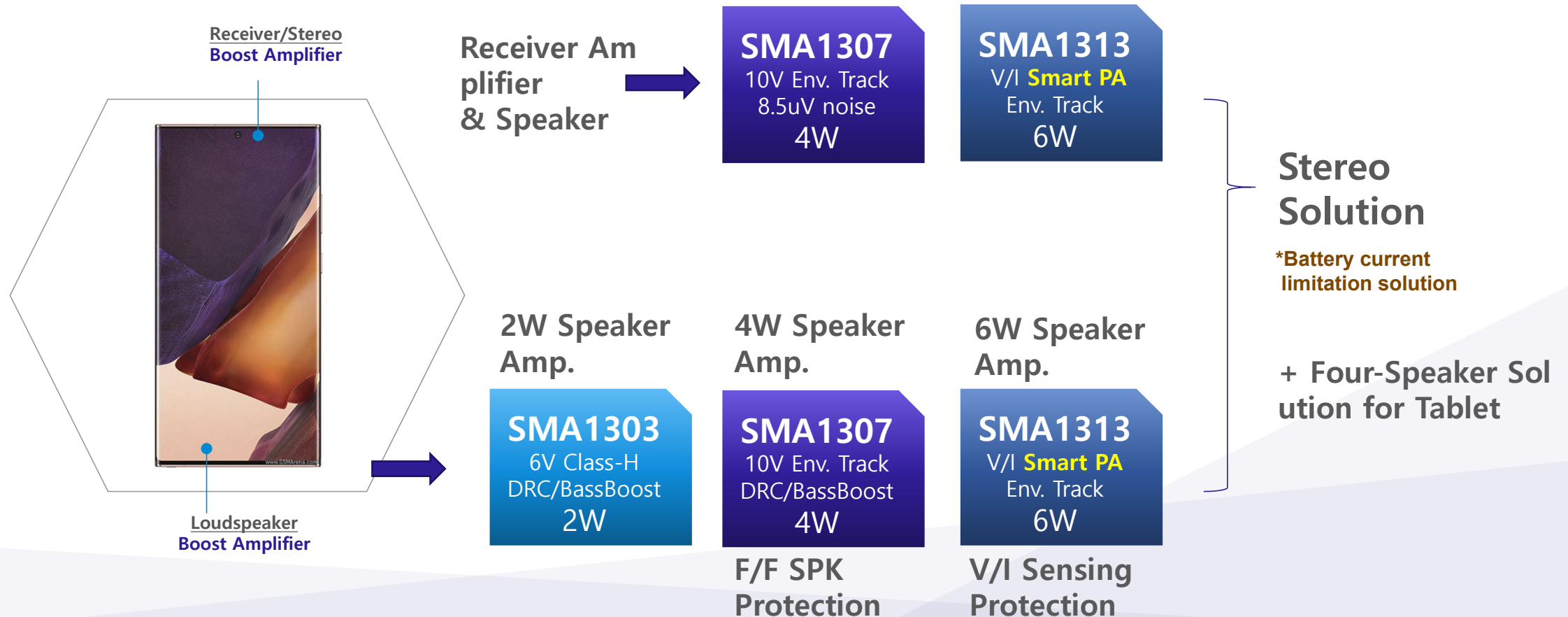
Dynamic Speaker Amplifiers /
Boost Speaker Amplifiers / Receiver Amplifiers



Application Guide #2

Dynamic Speaker Amplifiers / Boost Speaker Amplifiers / Receiver Amplifiers

Typical Application – Smart Phone / Tablet



Smart Phone Speaker Amplifiers

Software & Hardware
Mixed Design

Boost Amplifiers for Louder Sound (Higher Sound Pressure Level)

- **Speaker Protection:**
 1. Thermal Control
 2. Excursion Control

Gen. 1) **Boost Amplifiers**



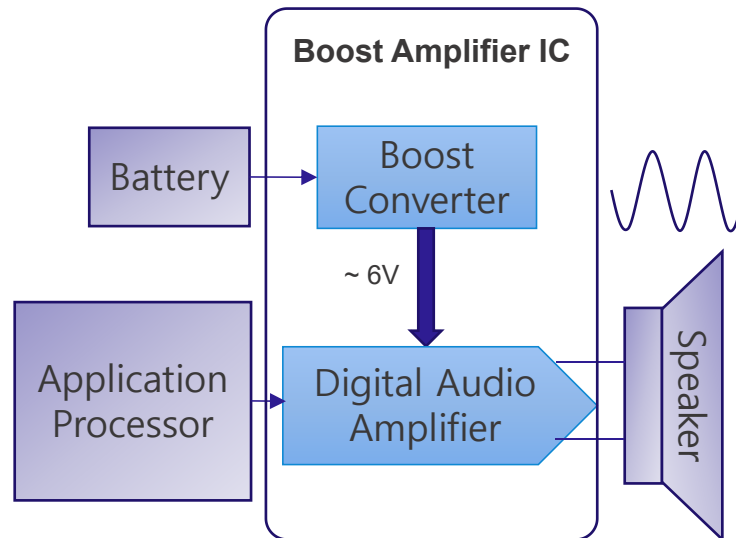
Gen. 2) **V/I Sensing Protection
Boost Amplifiers**



Gen. 3) **APS Boost Amplifiers
(Predictive Control)**

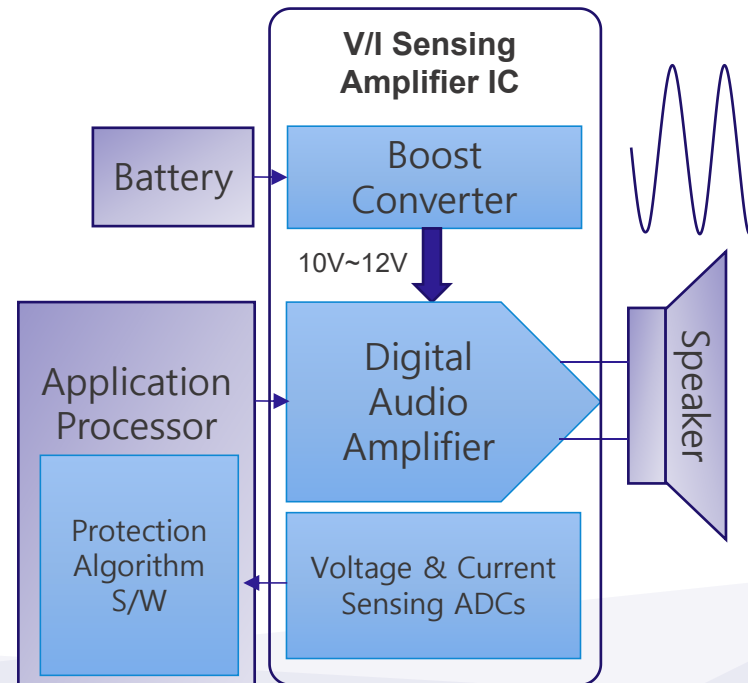
SMA1301 / **SMA1303**

- Limited Boost Power
for Speaker Damage



SMA1302 / SMA1311 / **SMA1313**

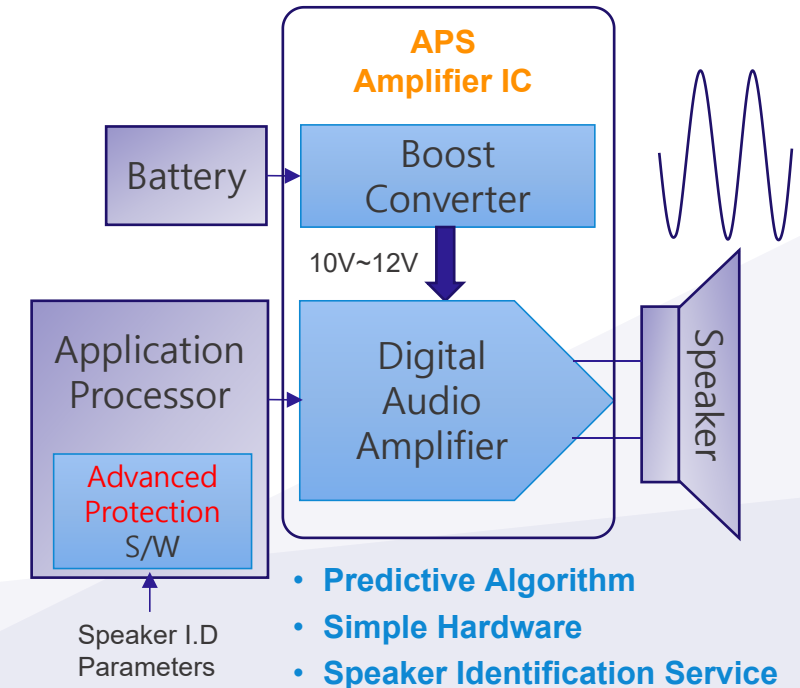
- Higher Boost Power
by protection algorithm



- Higher MIPS needed

SMA1305 / **SMA1307** / **SMA1321**

- Higher Boost Power
by protection algorithm



- **Predictive Algorithm**
- **Simple Hardware**
- **Speaker Identification Service**

Features

- ## Target Applications

- ## Block Diagram / Typical Application



SMA1307 PRODUCT BRIEF

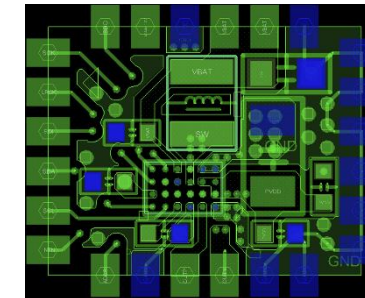
10V Boosted 4W Digital Amplifier – F/F Speaker Protection

Features

- Boost converter output voltage (programmable. **Max. 10V**)
 - Multi-step Class H boost control to maximize efficiency
 - Novel current-mode regulation circuit
- Full digital Class D Audio Amplifier
 - **4.3W @ 8Ω+33uH, 1% THD+N, 1kHz**
- 84% system efficiency @ 2W, 8Ω+33uH, 1KHz
- High audio performance: 105dB SNR, <0.01% THD+N
 - **8.5uVrms idle noise @ RCV Mode**
- Digital audio input interface (I2S/ TDM **8ch-32bit**)
- Support four(4) I2C addresses with a single pin
- Digital signal processing (Limiter/Compressor/HPF/etc.)
 - Soft volume and mute
- **Brownout protection/Battery monitoring**
- Thermal management / shutdown circuit
- Fault diagnostics by I2C Interface
- Internal low power PLL and clock monitoring circuits
- **Tiny package 24 ball (4x6) 0.4mm pitch CSP***
- **SmartPowerMeter™ –for thermal control***

Target Applications

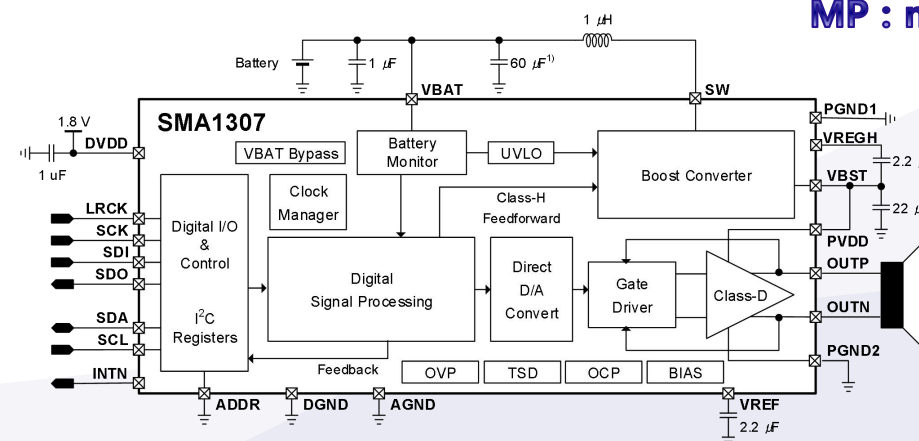
- Mobile phones
- Tablets
- Wireless mobile speakers



***Can be supplied as PCBA (9x10 mm²)**

Block Diagram and Typical Application

MP : now



SMA1313 PRODUCT BRIEF

6 W Mobile Boosted Audio Amplifier with V/I Sensing

■ Boosted 24-bit Hi-Fi Audio Amplifier with V/I Sensing

- Two ADCs for **V/I sensing**
- One DAC - direct conversion
- Supports **44.1kHz, 48kHz, and 96kHz(Hi-Res)** sample rates

■ High Efficiency Envelope Tracking Boost Converter

- Typical output voltage 11 V
- **Envelope tracking** boost control to maximize efficiency

■ High Performance Digital Speaker Amplifier

- Full digital Class-D audio amplifier
- **Max. 6 W** speaker output at 8 Ω , THD+N < 1%, 1 kHz
- SNR 105 dB, THD+N 0.01%
- Idle noise **7 μ Vrms** at the receiver mode
- Low idle power consumption with **noise gate**
- Analog gain control 1dB/step for receiver mode
- Support four I2C addresses with a single pin
- **1.2V ~ 1.8V** wide range I/O voltage

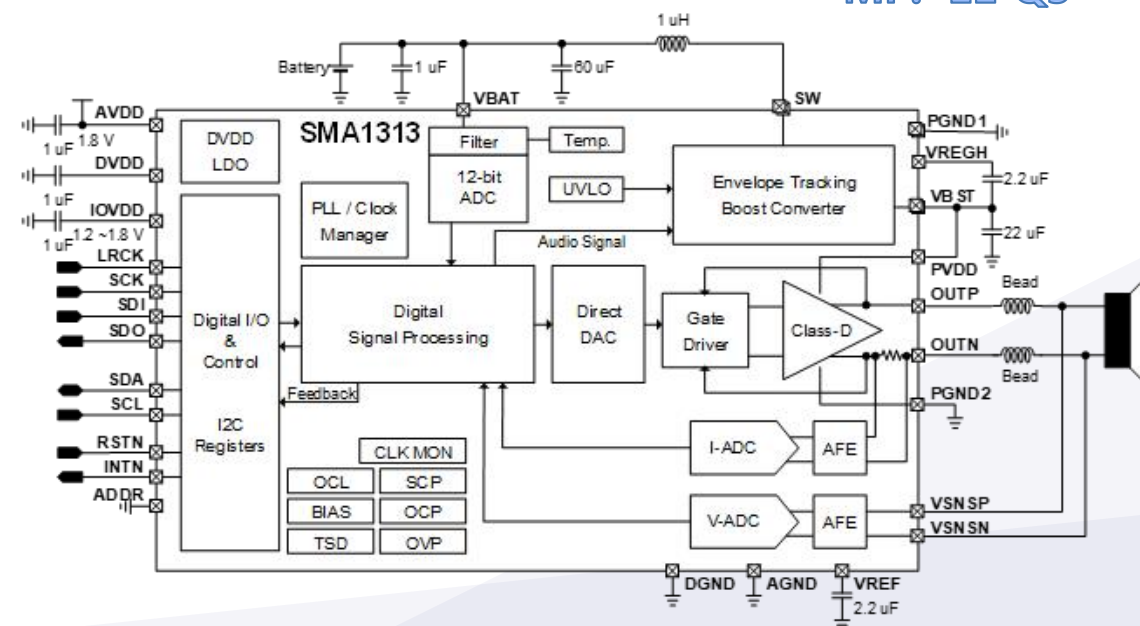
■ V/I Sensing & Speaker Protection Algorithm

- Provided with IronTune™ software solution
- **Input current control** for stereo solution

Next Gen. V/I Sensing Smart PA (Flagship ~ Mid range)
: Stereo Optimized, High Efficiency, QCOM AP 1.2V I/O Support, etc.

■ Typical Application Circuit

ES: Now
MP: '22 Q3



5x6-WLCSP (1.8mm x 2.1mm, 30 ball, 0.35pitch)

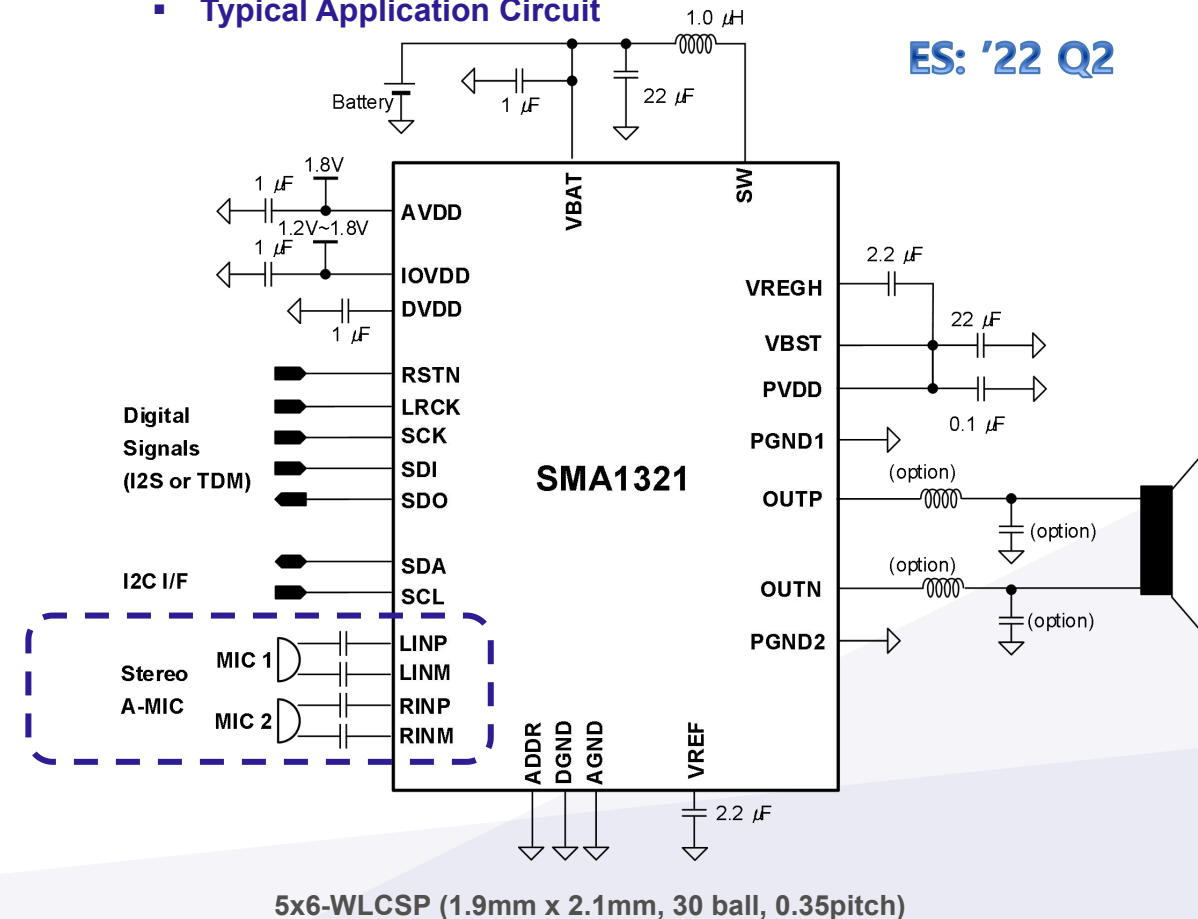
SMA1321 PRODUCT BRIEF

Mobile Codec with 6 W Boosted Amplifier & APS

For Codec-less Phone (now, using Digital-MEMS Mic.)
: Support Analog-MEMS Mic., which needs lower cost

- **Integrated 24-bit Hi-Fi Audio CODEC**
 - Two ADCs, 100dB SNR with adaptive gain controls
 - One DAC - direct conversion
 - Supports 44.1kHz, 48kHz, and 96kHz(Hi-Res) sample rates
- **Audio Inputs for Two Analog Microphones**
 - Two differential analog microphone inputs
 - Low noise mic-LDO output / AFE with PGA
 - High pass filters / High resolution volumes
- **High Efficiency Envelope Tracking Boost Converter**
 - Typical output voltage 10.5 V
 - **Env. tracking** boost control to maximize efficiency
- **High Performance Digital Speaker Amplifier**
 - Includes all SMA1305 features
 - Low idle power consumption with noise gate
 - Analog gain control 1dB/step for receiver mode
- **SmartPowerMeter™ for Advanced Protection (APS)**
 - Provided with IronTune™ software solution
 - Input current control for stereo solution

Typical Application Circuit

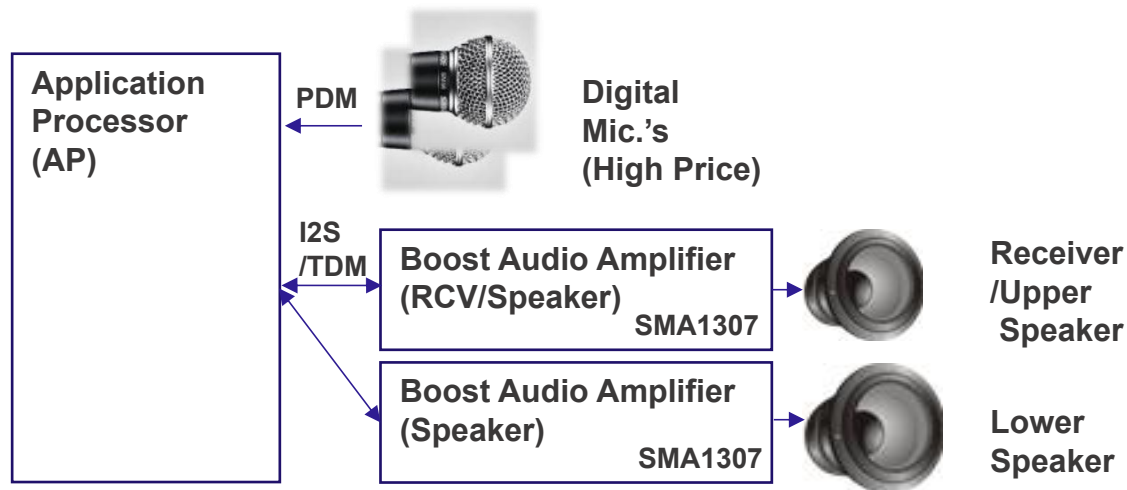


'Codec-less' Smart Phone Audio Solution

System Block Diagram

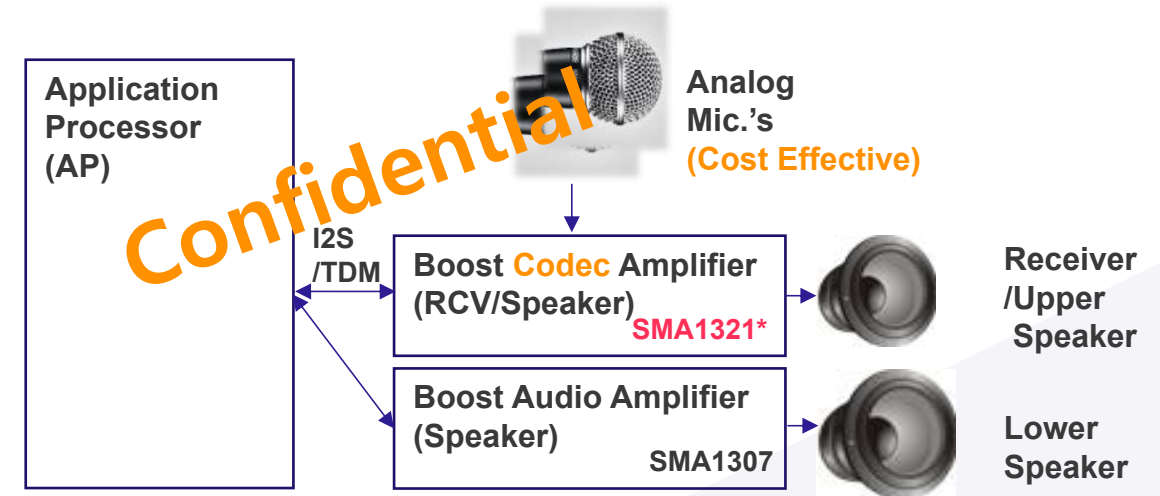
▪ Codec-less System (Conventional)

- Two Digital-MEMS Mic. – Connection to AP
 - Analog Gain control is not allowed, Higher Cost
 - Software audio signal chain is not synchronized.



▪ Codec-less System (New Solution)

- SMA1321 Boost-Codec



➔

**System Cost Saving
& Lowering AP Dependency**

SMA1307 PRODUCT HIGHLIGHTS

Features / Performance

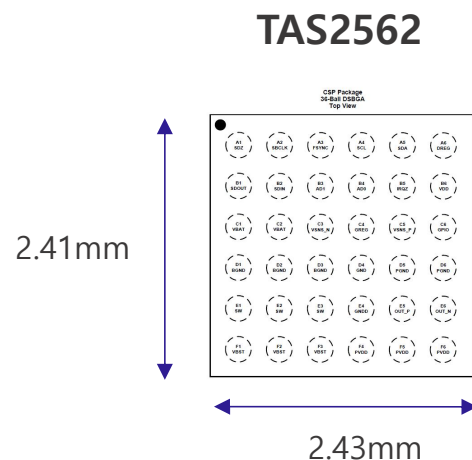
	SMA1303	TAS2562	SMA1307
Continuous Output Power (8Ω+33uH, 1% THD+N)	2W	5W	4W
Idle Noise (W/ A-weighted)	27 uV (SPK Mode)	15 uV	8 uV (RCV Mode) 24 uV (SPK Mode)
Typ. Boost Output Voltage	6.1 V	11 V	10 V
System Efficiency	82.4 % @2 W	83 % @1 W	85.6 % @1 W
Class-H	2 Step	Class H	Envelope Tracking (50mV Step)
Boost Con. SW. Freq.	2 MHz	4 MHz	2 MHz
THD+N	0.01 % @ POUT=1 W	0.01 % @ POUT=1 W	0.01 % @ P _{OUT} =1 W
DNR	100 dB	109 dB	100 dB
SNR	103 dB	112.5 dB	>105 dB
Output Offset Voltage	-	±1 mV	±0.4 mV (RCV Mode)
Boost Inductance	1 uH	1 uH	1 uH
*Special Features	-	V/I sensing	SmartPowerMeter™ BatteryLevelStreaming™
Package	20 pins (1.78mm x 2.09mm)	36 pins (2.41mm x 2.43mm)	24 pins (1.67mm x 2.47mm)

SMA1307 PRODUCT HIGHLIGHTS

Footprints

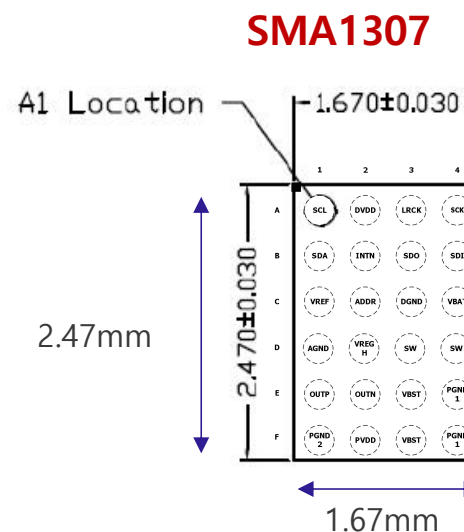
■ Footprints according to each Solution

- TAS2562 vs. SMA1307



TAS2562
: 5.9sq.
WLCSP
36-ball

5.9[sq.mm]
100%



SMA1307
: 4.2sq.
WLCSP
24-ball

4.2[sq.mm]
71%

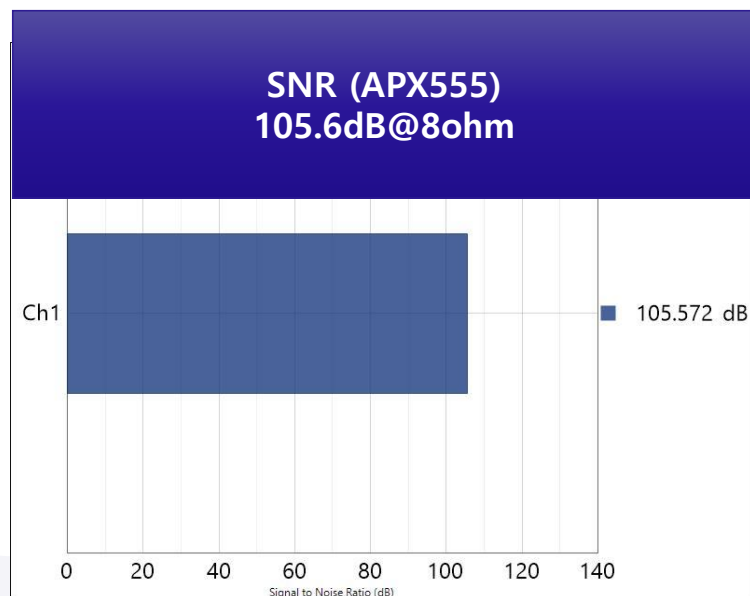
**Compact Size by S
ingleSilicon™ Tech
nology**

SMA1307 MEASUREMENT RESULT

SNR and NOISE

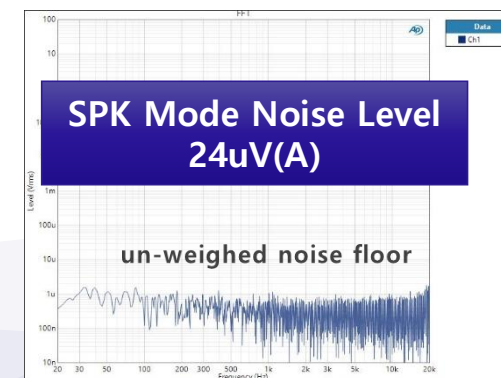
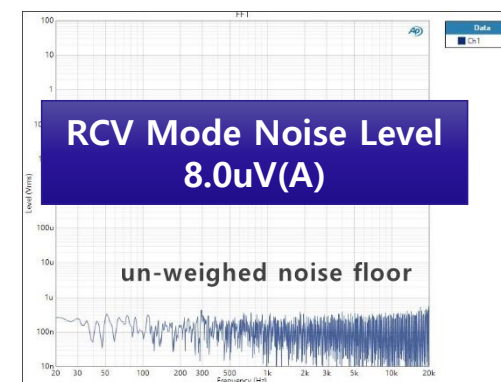
■ Signal to Noise Ratio

- VBAT 4.0V
- 8 Ohm Load
- A-weighted
- Input 1kHz, THD+N <1%



■ Noise Level

- VBAT 4.0V
- 8 Ohm Load
- A-weighted



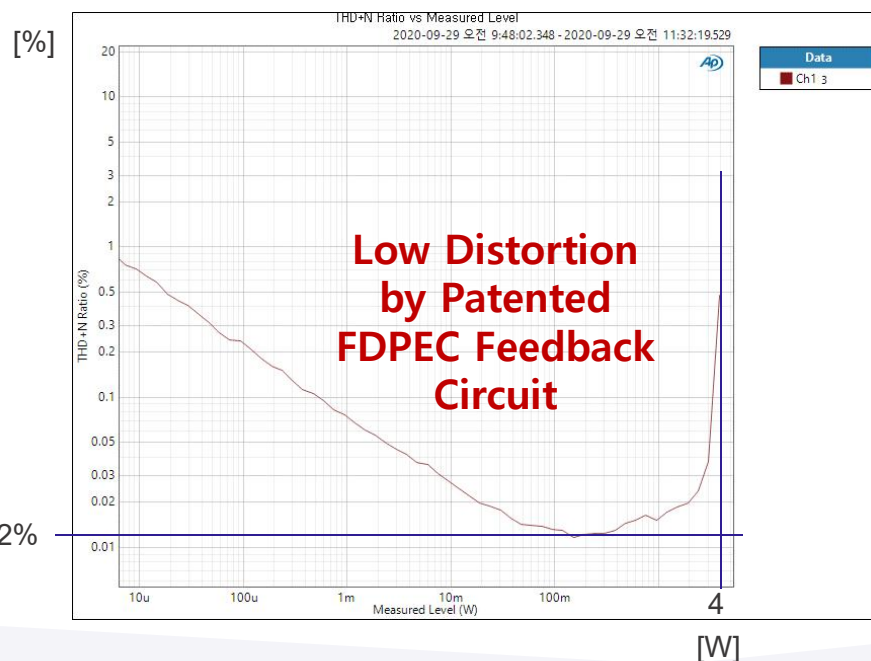
**World's
Lowest Noise Level**

SMA1307 MEASUREMENT RESULT

THD+N vs. Power, Efficiency

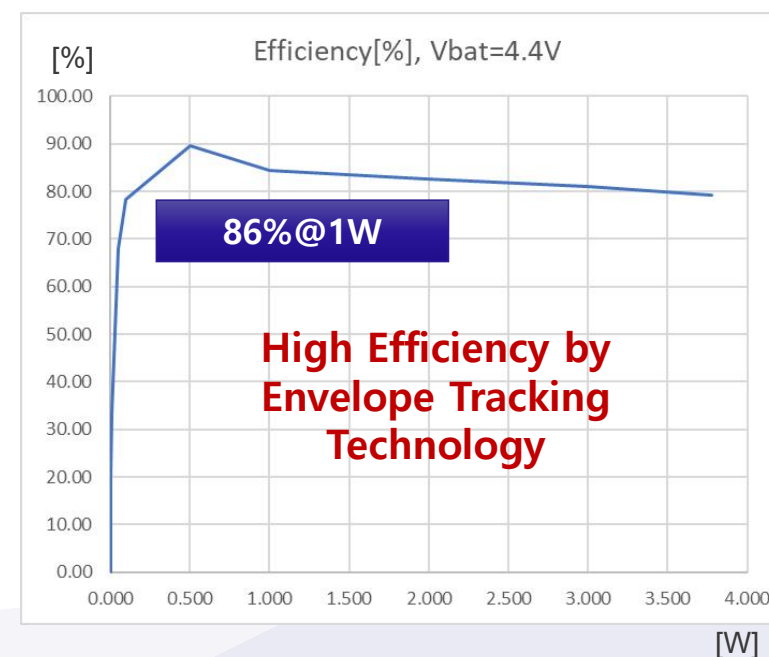
■ THD + N vs Power

- VBAT=4.0V, DVDD=1.8V
- A-weighted
- Input 1kHz



■ Efficiency

- VBAT 4.4V
- 8 Ohm Load
- Input 1kHz

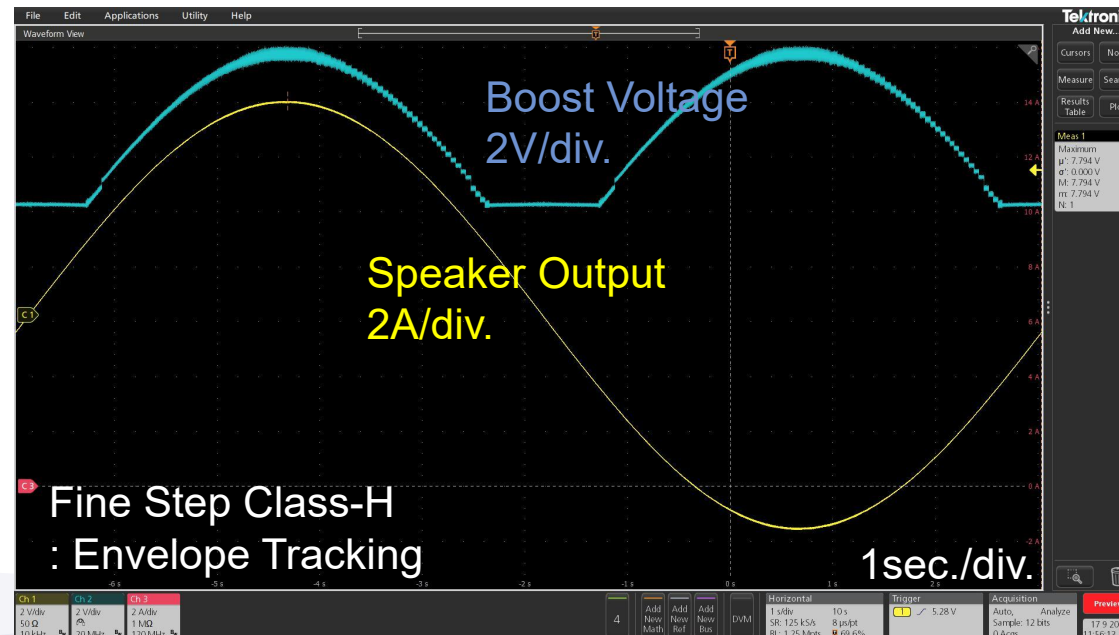


SMA1307 MEASUREMENT RESULT

Measurement Result – Class H Operation

Fine-step Class-H Operation – Envelope Tracking Boost Converter
for a higher efficiency and minimizing charging step peaks -> **256 Steps for SMA1307**

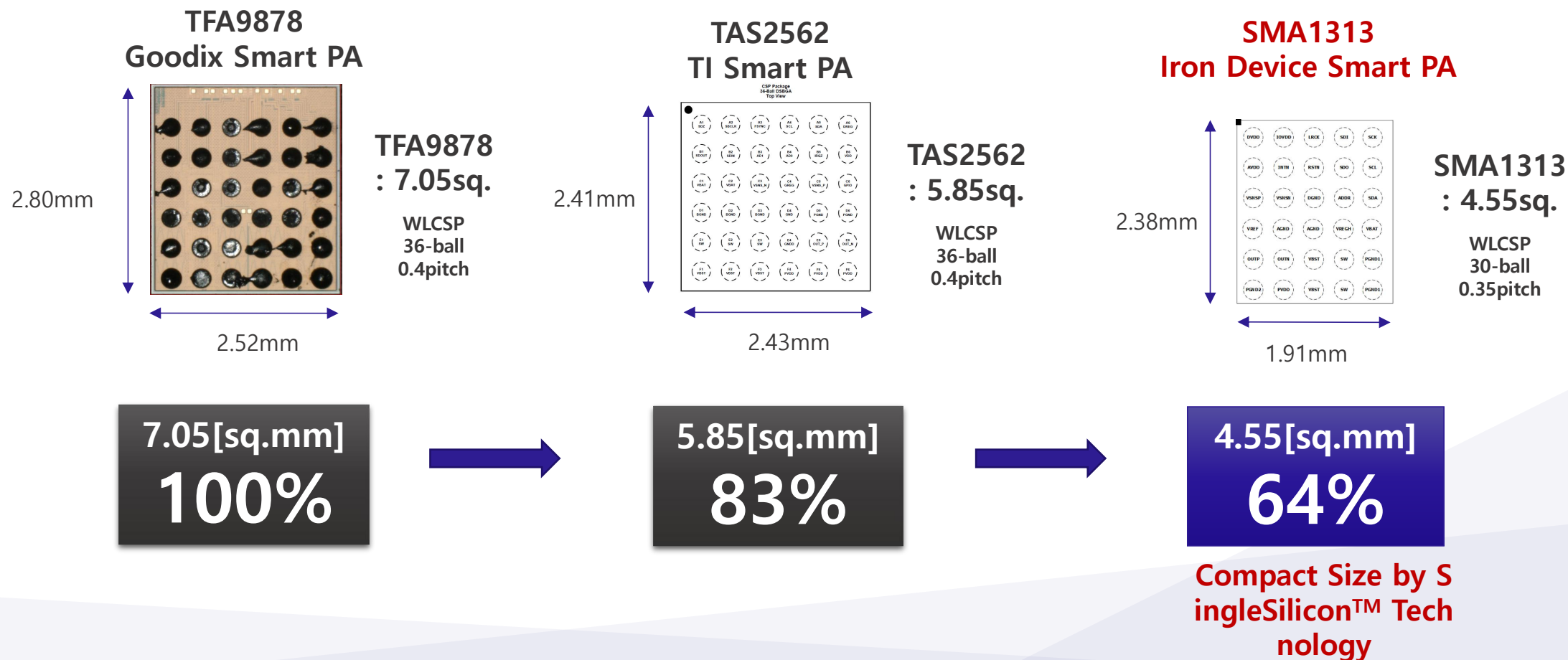
Ex. Speaker Output vs. Boost Voltage Waveform



New Product - SMA1313 V/I Sensing SmartPA

Minimum Footprint among V/I Sensing Smart PA : with next Gen. Performance

Footprints Comparison

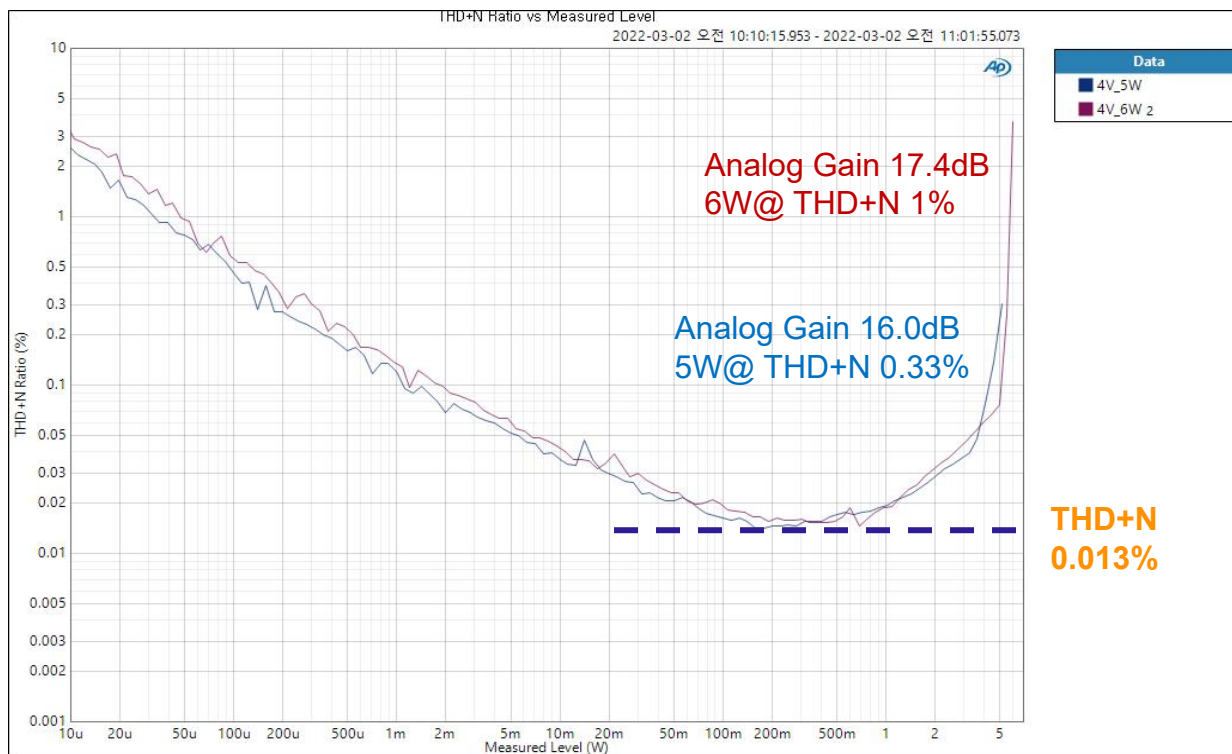


New Product - SMA1313 V/I Sensing SmartPA

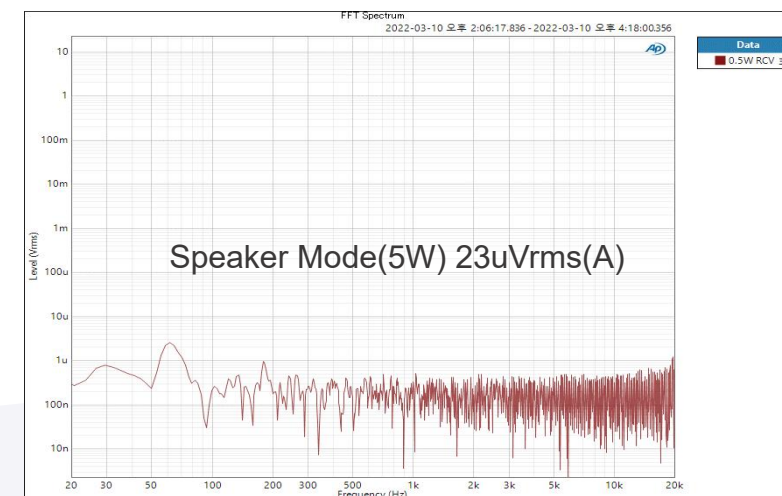
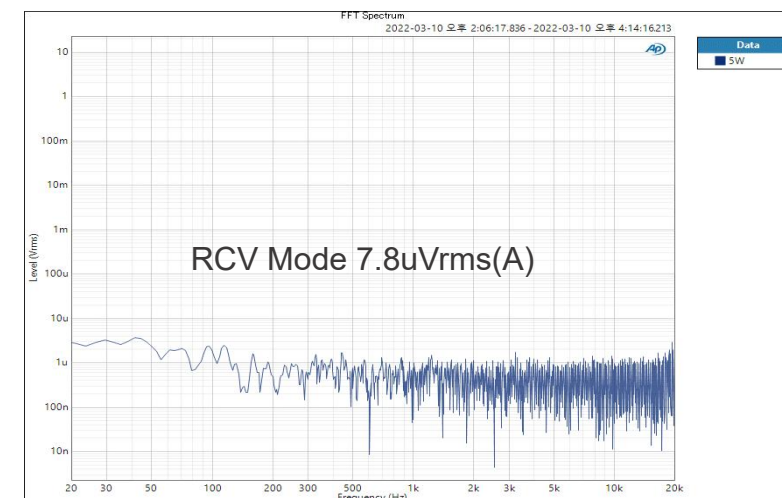
Audio Performance

Output Power vs THD+N

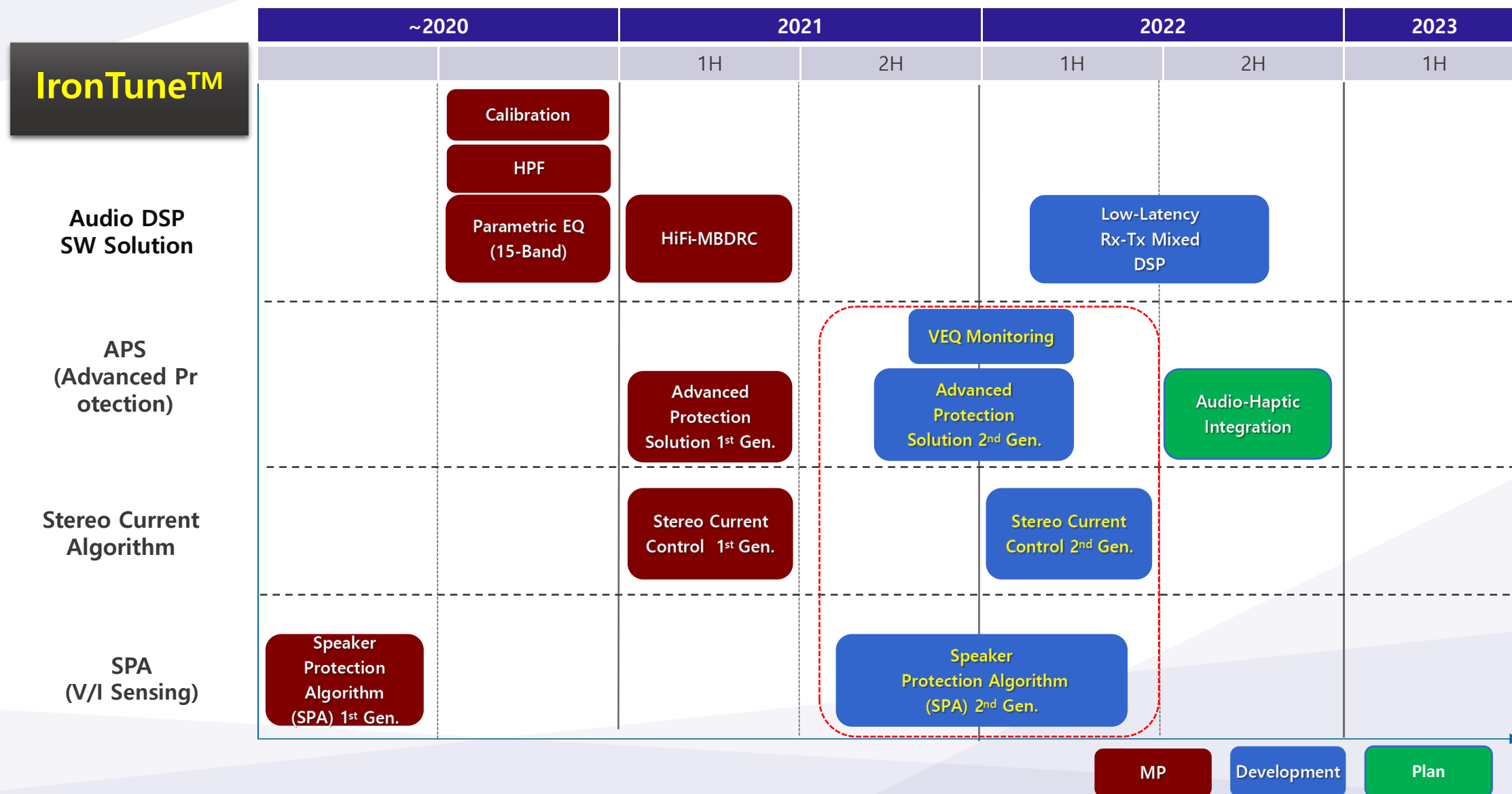
- Analog Gain 16.0dB / 17.3dB



Idle Noise



Audio SW & Algorithm Roadmap





APPLICATION #3

Display Sound Amplifiers / Piezo Speaker Amplifiers

SMA6302 PRODUCT BRIEF

Boosted Digital Stereo Speaker Amplifier for Piezo Speaker with HiFi DAC

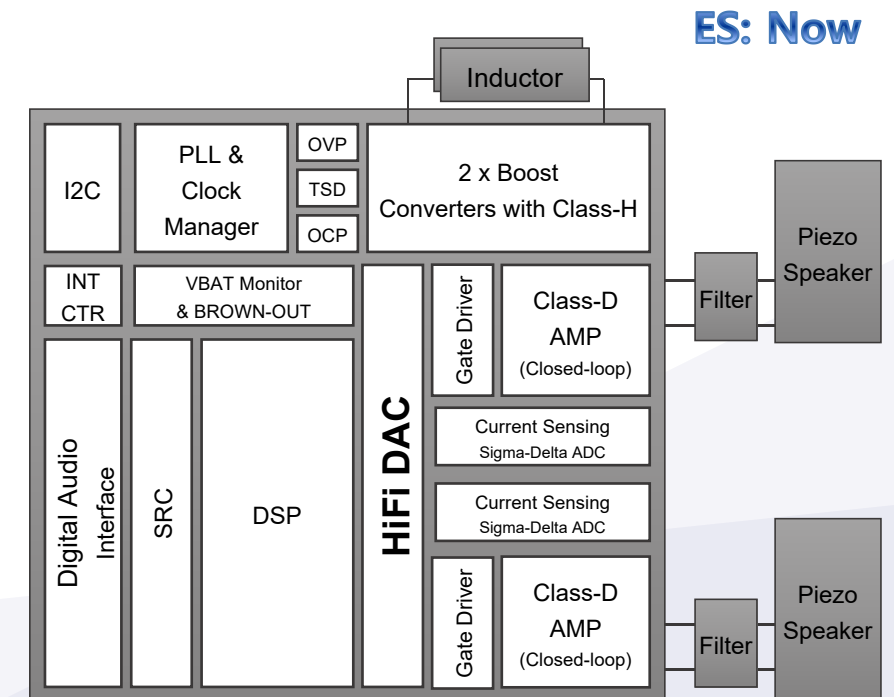
Features

- **Low output noise by HiFi DAC: < 20uVrms(A)**
- High audio performance: **SNR 117dB**
- 20V Output Voltage for 40Vpp Piezo Drive
- Eight-step Class-H control by digital feed-forward processing
- Seven-step smart brown-out function
- Tone Generator and Mixer
- Large capacitive load drive: Max 5uF load drive
- **I2S/TDM(8ch)** Digital audio input interface: 8k~192kHz
- Soft volume and soft mute
- **5+5 band** (pre and post DRC) 32-bit PEQ for sound tuning
- DRC(Dynamic range compressor)
- **Upgraded Piezo-Tune™ DSP Filter** for no-series-resistance
- Digital audio feedback signal for echo cancelation
- Overcurrent, Under / over voltage & overcurrent limit for boost converter
- Thermal management / shutdown circuit / **Thermal sensing read-out function**
- **Impedance Detection Circuit**
- 75pins CSP Package

Target Applications

- Mobile phones
- Tablets

Block Diagram and Typical Application



NEW PRODUCT - SMA6203

Boosted Digital Speaker Amplifier for Piezo Speaker

Features

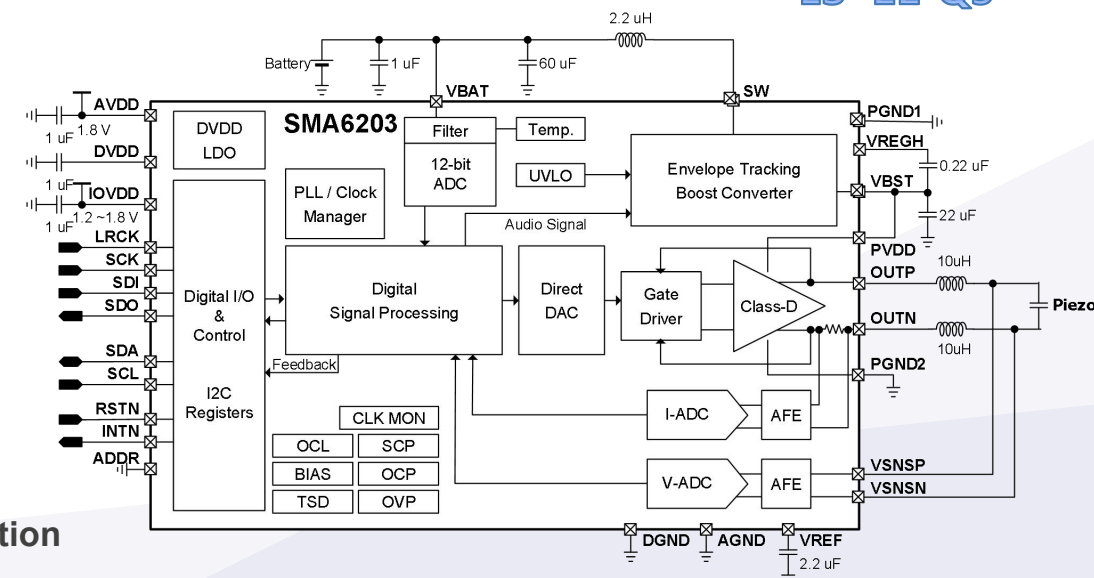
- **25V Output Voltage for 50Vpp Piezo Drive**
- **Envelope Tracking** Class-H control by digital feed-forward processing
- **Noise gate function**
- High audio performance: SNR 120dB
- Seven-step smart brown-out function
- Tone Generator and Mixer
- Large capacitive load drive: Max 5uF load drive
- **I2S/TDM(8ch)** Digital audio input interface: 44.1k, 48k, 96kHz
- DSP for no-series-resistance piezo drive
- Soft volume and soft mute
- **5+5-band 32-bit PEQ** for sound tuning
- **DRC**(Dynamic range compressor)
- **Ungraded Piezo-Tune™ DSP Filter**
- Digital audio feedback signal for echo cancelation
- Protection (OCP, UVLO, OVP, OCP & OCL for boost converter)
- Thermal management / shutdown circuit / thermal sensing read-out function
- 42 ball WLCSP Package, 0.35mm pitch

Target Applications

- Mobile phones
- Tablets

Block Diagram and Typical Application

ES '22 Q3



Other Applications

SiC/GaN Gate Drive ICs

▪ For Next-Generation Power Device Driving

- | | | | |
|---|---------|---|-------|
| - | MA6522 | High Temp. High Speed 35V 5A Gate Driver for 1200V SiC | - E/S |
| - | MA6523 | High Temp. High Speed 35V 10A Gate Driver for 1200V/1700V SiC | - MP |
| - | MA6524A | Isolation Type Single Channel Gate Driver for 650V GaN/ 1200V SiC | - E/S |
| - | MA6525A | Isolation Type Dual Channel Gate Driver for 650V GaN/ 1200V SiC | - E/S |
| - | MA6531 | Single Low-Side Gate Driver for GaN | - E/S |
| - | MA6532 | 100V Half-Bridge Gate Driver for GaN | - E/S |

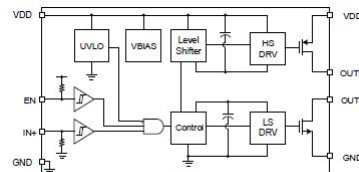


Figure 1. MA6523 Block Diagram

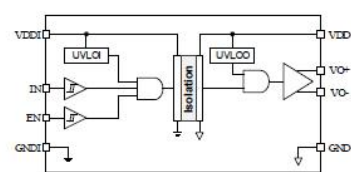


Figure 1. MA6524 Block Diagram

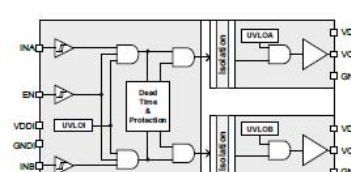


Figure 1. MA6525 Block Diagram

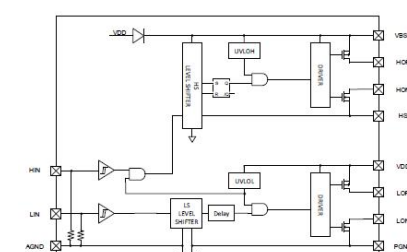


Figure 1. MA6532 Block Diagram

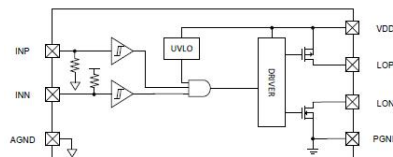


Figure 1. MA6531 Block Diagram

