

Safe & Sound

**TI Class-D Audio Solutions for
safety critical automotive
applications**



**ENGINEERING
THE WORLD**

SLYW061

1

TI Automotive Audio = Safe and Sound

Safer roads
ahead with
TI's audio
technology



**ECALL: TIME
SAVED = LIVES
SAVED**



Increased pedestrian
safety with acoustic
vehicle alerting
systems (AVAS)



High Quality
Audio and
Speaker
detection.

Automotive audio solutions

- Designed **with safety** applications **in mind**
- diagnostic coverage enables **integrated safety**
- Meet automotive **temperature**, **voltage** and **EMC** requirements
- **Reliable and robust** (AEC-Q100)

eCall Legislation Update



- ❑ European Commission mandates eCall across EU for all passenger vehicles
- ❑ Can save upto 2500 lives/year & reduce traffic congestion due to accidents
- ❑ OEM push since 2004, many already offer Telematics services with eCall option
- ❑ Technology certification to complete by Oct1, 2017

Legislation	TAS5421-Q1 Value Proposition
Minimum 15min talk time	<ul style="list-style-type: none">• Highly efficient mono Class D amplifier, low power dissipation
Safety critical application	<ul style="list-style-type: none">• Integrated load diagnostics with I2C reporting• N40c to 125c operation for harsh automotive environments• CISPR25 L5 performance to prevent EMI interference
Flexible operation off car battery or backup battery	<ul style="list-style-type: none">• Wide supply voltage range, supports start/stop & protects against load dump. >90% efficiency optimizes backup battery size
Loud & clear audio quality	<ul style="list-style-type: none">• 10W output power at 4ohm, <1% THD+N

Value Proposition: Need

- What is eCall?

eCall is an initiative with the purpose to bring rapid assistance to motorists involved in a collision anywhere in the European Union.



Value Proposition: Need

- Need:



- In case of a **crash**, an **eCall-equipped car automatically calls the nearest emergency center.**
- **eCall cuts emergency services response time.** [...] The quicker response will save hundreds of lives [...].
- The **EC proposals for legislative acts** foresaw [...] the **deadlines for implementation** will most likely be the **end of 2017 or early 2018.**

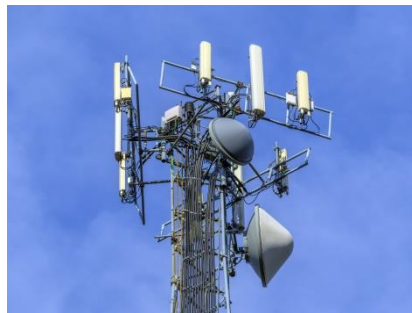
eCall in Action

**Accident Condition
Detected:**
eCall system contacts
emergency call center
and sends GPS
location information



Thanks to eCall,
Emergency Services
arrive quicker to the
accident site.

**TIME SAVED TRANSLATES INTO
LIVES SAVED**



**Accident Confirmed
by Operator**



**Accident Condition
Detected:**
Call center receives
GPS location
information



**Emergency
Services notified**

eCall: Motivation and Status

Source: Strategy Analytics

Motivation

- Estimated to speed emergency response time by 40% in urban areas and 50% in rural areas

(Source: Transport Research Library, UK. Nov 2011)

- eCall can save up to 2500 lives/year & reduce traffic congestion due to accidents

- EU study ranks cost benefit ratio right after ESC, before Lane Departure Warning, if obligatory

(Source: European Commission : Impact Assessment of EU wide eCall implementation, Brussels, 9.2011)

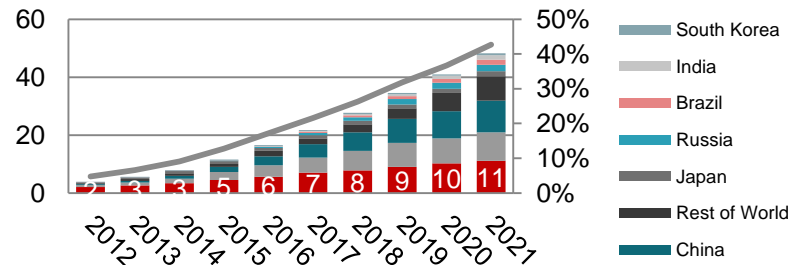
	Electronic Stability Control		Advanced Emergency Braking		eCall	Lane Departure Warning
	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles	(all vehicles)
Benefit / Cost Ratio (BCR)	3.97	1.16	0.43	2.15	3.16	1.1

Table 4: Comparison of BCR for in-vehicle intelligent safety technologies

Status

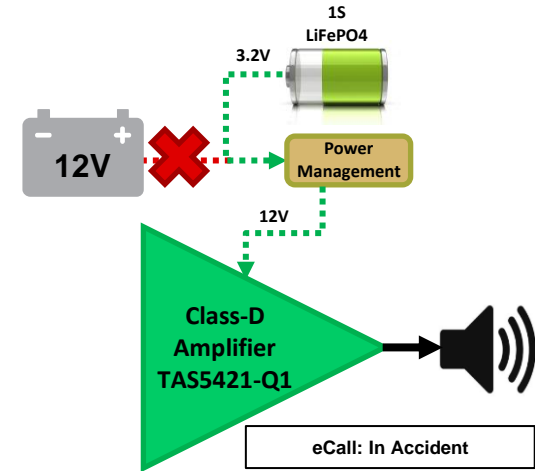
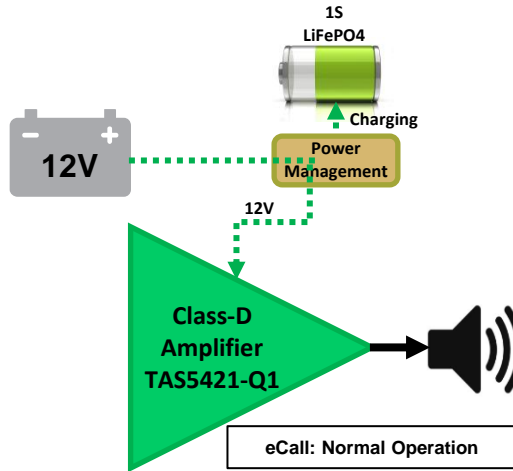
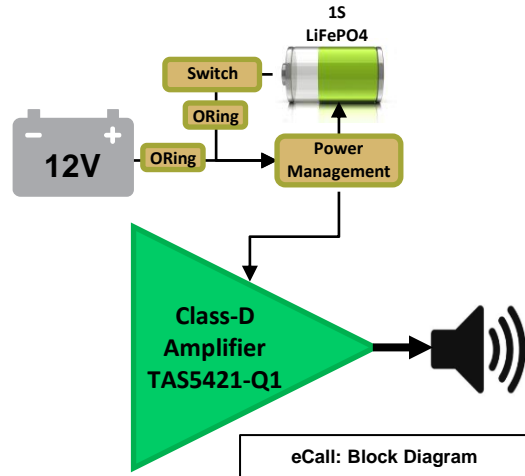
- EU regulation reached trilogue negotiation (Commission, Parliament and Council)
- ERA GLONASS based eCall deployment confirmed in Russia starting 2015
- Expected installation rate: 2014: 9%, 2021: 43%
- Dominated by eCall Plus (proprietary systems) which requires subscription fees

Regional vehicle production and eCall installation rate



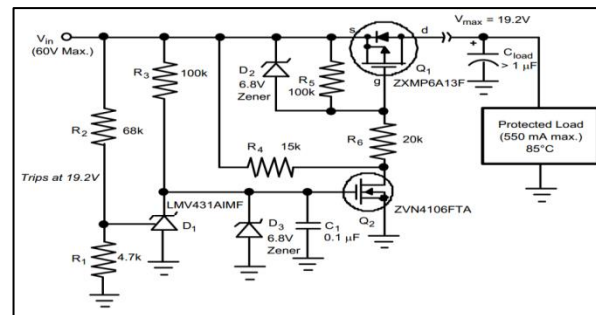
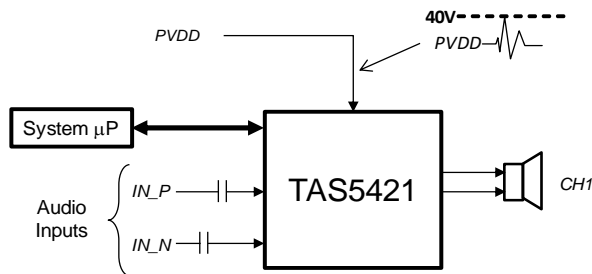
Value Proposition: Approach and Benefits

Feature	Benefit	Why is this important?	Alternative
90% Efficiency and Low Quiescent Current	Runs on backup power for extended periods.	eCall systems need to run for long times autonomously using only backup battery power when the connection to the car acid-lead battery is severed during an accident. Legislation requires eCall to run for extended periods of time.	If a lower efficiency solution is used (like a class AB amplifier), the system would need ADDITIONAL BATTERY CELLS that not only ADD COST AND SPACE BUT ALSO WEIGHT .



Value Proposition: Approach and Benefits

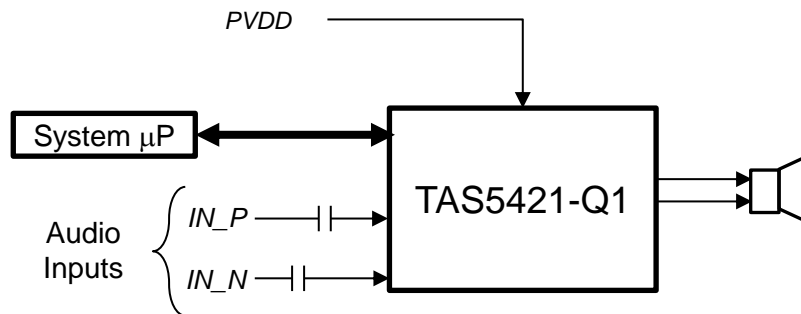
Feature	Benefit	Why is this important?	Alternative
40V Load Dump & Over Temp Protection	Protects against harsh automotive transients.	As eCall and instrument cluster is an automotive application, high voltage load dump transients are present in the power supply. This high voltage transients can damage the class-D amplifier.	Although DISCRETE LOAD DUMP solutions can be implemented, these solutions ADD COMPLEXITY, COST AND DEVELOPMENT TIME .



Typical over voltage protection circuitry. Cost >\$0.50

Value Proposition: Approach and Benefits

Feature	Benefit	Why is this important?	Alternative
I2C Load Diagnostics (Shorts, Open, DC output)	Integrated operational monitoring to reduce cost	Integrated continuous monitoring and a full diagnostics suite reduce component count and ensure reliability and usability.	Although <u>DISCRETE DIAGNOSTICS SOLUTIONS AND REDUNDANCY</u> can be implemented to ensure reliability, these solutions ADD COMPLEXITY, COST AND DEVELOPMENT TIME.



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Safer roads
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eCall: time
saved = lives
saved



**INCREASED
PEDESTRIAN
SAFETY WITH
ACOUSTIC
VEHICLE ALERTING
SYSTEMS (AVAS)**



High Quality
Audio and
Speaker
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Automotive audio solutions

- Designed **with safety** applications **in mind**
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Legislation Update: EV Sound Gen



- ❑ Electric and hybrid cars will have to generate noise to make them safer for pedestrians, especially the visually impaired.
- ❑ European Council rules “new models of electric and hybrid vehicles will have to make a noise by 2019 and all new electric and hybrid cars must be audible by 2021”
- ❑ AVAS (Acoustic Vehicle Alerting System) is mandatory in France, Spain, China (EV only), NHTSA & Japan for light vehicles. Under consideration for 2-3 wheelers.

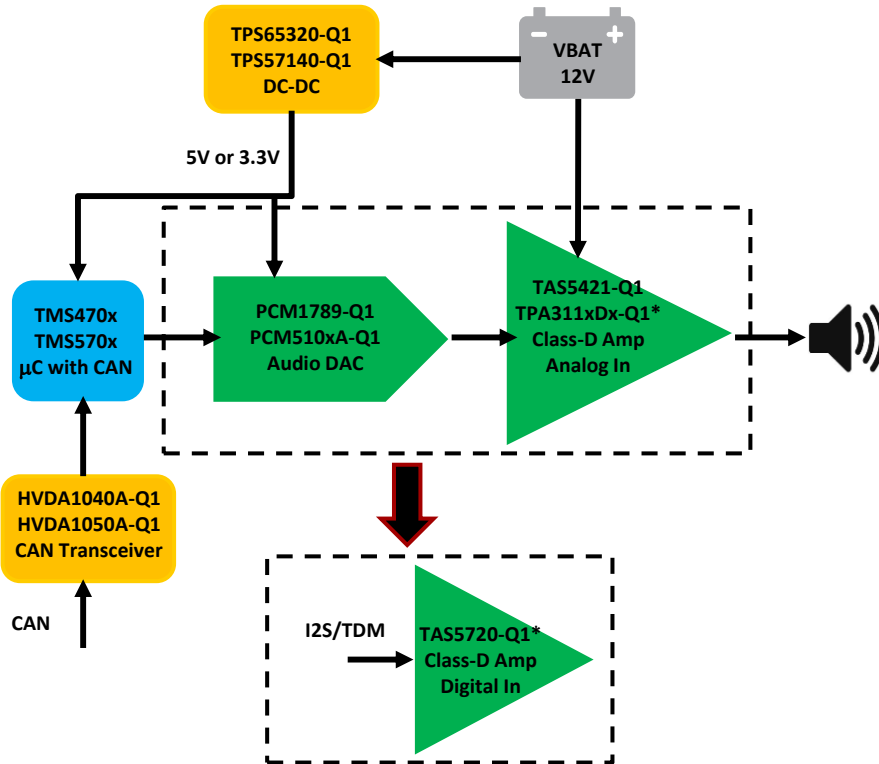
Legislation	TI Value Proposition
Mono or dual speakers (front/back)	<ul style="list-style-type: none">• Highly efficient Class D audio amplifiers – mono, stereo & digital input options• High performance audio DAC with optional integrated PLL, analog mute & control interfaces
Safety critical application	<ul style="list-style-type: none">• Integrated load diagnostics with I2C reporting (TAS5421)• CISPR25 L5 performance to prevent EMI interference (TAS5421)• Supply voltage range 4.5v to 18v supports start/stop (TAS5421)
Loud & clear audio	<ul style="list-style-type: none">• 15W-30W per channel output power options• Differential inputs for increased noise immunity
Robust operation	<ul style="list-style-type: none">• n40c to 125c operation for harsh automotive environments

AVAS (Acoustic Vehicle Alerting Systems)

AIP Leadership

TI Analog

TI Embedded
Processing



TI Value Proposition

- ❑ >90% efficient Class-D Amp
- ❑ Single or dual channel options
- ❑ Automotive EMI protection (TAS5421)
- ❑ Digital input amp eliminates DAC (TAS5720)
- ❑ Direct connection to VBAT
- ❑ Integrated load dump protection (TAS5421)
- ❑ Integrated diagnostics for safety critical EV sound gen system (TAS5421)
- ❑ High performance DACs support 5V or 3.3V
- ❑ n40c to 125c operation for harsh automotive environments (external speakers)

TI Automotive Audio = Safe and Sound

Safer roads ahead with TI's audio technology



Ecall: time saved = lives saved



Increased pedestrian safety with acoustic vehicle alerting systems (AVAS)



HIGH QUALITY AUDIO AND SPEAKER DETECTION.

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- Meet automotive **temperature**, **voltage** and **EMC** requirements
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TEXAS INSTRUMENTS

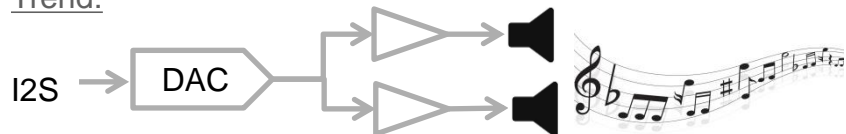
Instrument Cluster - Trends

Today:

PWM



Trend:



❑ Improved audio performance

Audio DAC vs. PWM signal

❑ Higher output power

❑ Integration of audio function for e.g. park distance control and other ADAS function

❑ Safety and diagnostic requirements

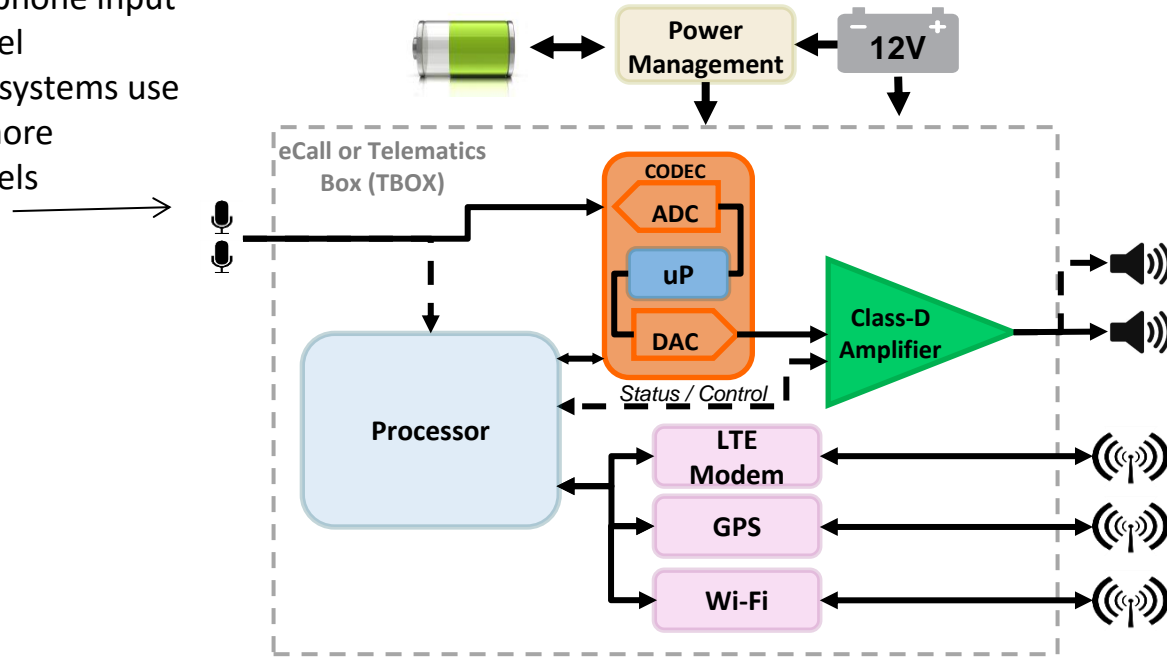
Trend	TI value proposition
Improved audio performance	<ul style="list-style-type: none">• Wide portfolio of Audio DACs and amplifier with AEC-Q100 grade
Higher output power	<ul style="list-style-type: none">• Class D improves efficient and relaxes thermal design
Start/Stop support	<ul style="list-style-type: none">• TAS5421-Q1: wide supply voltage range down to 4.5V
Loud & clear audio quality	<ul style="list-style-type: none">• TAS5421-Q1: 18W in 8Ohm• TPA3111D1-Q1: 10W in 8Ohm• TLV320DAC3100-Q1: 4.5W in 4 Ohm
Safety and diagnostic requirements	<ul style="list-style-type: none">• Integrated load diagnostic with TLV320DAC3100 & TAS5421

Audio Subsystem Reference Design for Automotive Emergency Call (eCall)

Typical Telematics Block Diagram

Audio inputs:

- Typically one microphone input channel
- A few systems use 2 or more channels



Audio Subsystem Reference Design for Automotive Emergency Call (eCall)



Features

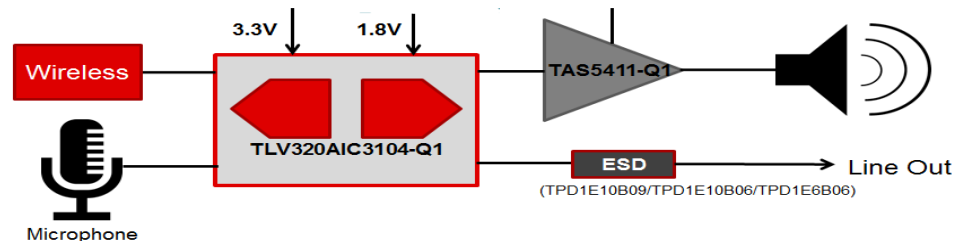
- Integrated load dump protection to withstand 40V voltage spikes
- Wide input voltage range: 4.5V - 18V
- Integrated diagnostics for output pin to pin shorts, short to ground, short to battery, and open load
- Up to 8W of output power through a 4 ohm speaker
- Dual channel TLV320AIC3104-Q1 allows for input from a microphone and audio data from a wireless module to facilitate a 2-way call
- Tested for radiated emissions according to CISPR-25
- Codec has configurable options for gain, digital audio format, PLL, and filtering

Applications

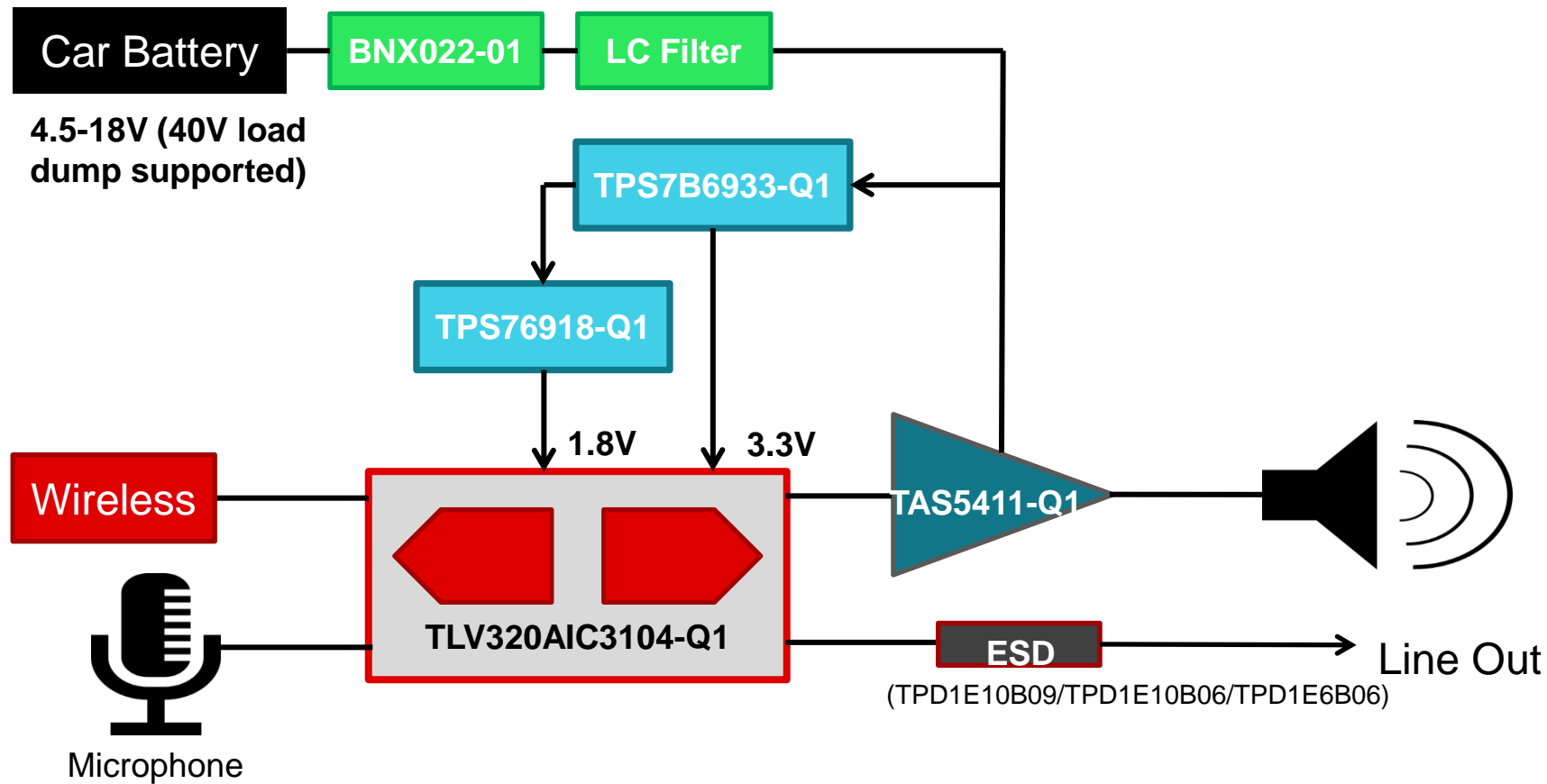
- Automotive Emergency Call (eCall)
- Telematics + eCall
- Gateway + eCall

Benefits

- The integrated load-dump protection reduces external voltage clamp cost and size
- Onboard load diagnostics report the status of the speaker through I2C, which reduces external components needed for diagnostic coverage
- TLV320AIC3104-Q1 + TAS5411-Q1 combo allows for:
 - reduced power consumption
 - reduced heat
 - reduced peak currents in the electrical system
- Loud, clear audio in an unpredictable emergency environment
- Ability to use an additional output from the codec for the head unit or other car audio needs



TI Design Proposed System



1-pagers

TAS5421-Q1:

Mono channel, Differential Input Class-D Audio Amplifier with Load Dump & I2C Diagnostics

Features

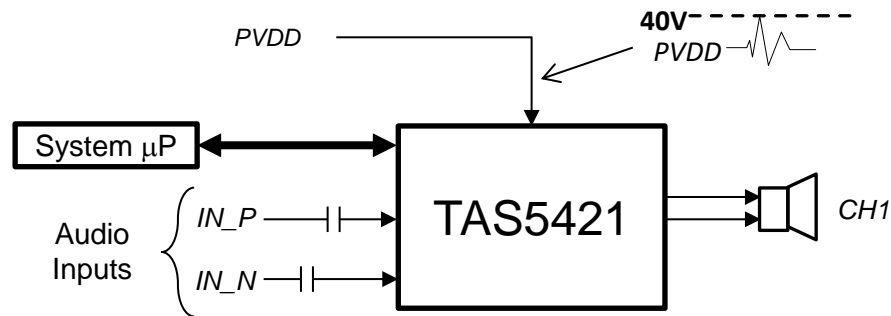
- 90% Efficiency and Low Quiescent Current
- Output Power: 22W at 4Ω, 10% THD+N, 14.4V
- I2C Load Diagnostics (Shorts, Open, DC output)
- 40V Load Dump & Over Temp Protection
- 4.5 - 18 V operation
- Differential audio input
- Automotive EMI Performance (CISPR25 L5)
- Fully AEC-Q100 qualified

Applications

- Automotive Emergency Call – eCall
- Telematics Systems
- Instrument Cluster Systems
- Automotive EV sound generation
- Infotainment Audio

Benefits

- Runs on backup power for extended periods.
- Excellent fidelity at high power.
- Integrated operational monitoring to reduce cost
- Protects against harsh automotive transients.
- Supports automotive cold/crank & start stop
- Increased immunity to system noise
- Shortens system development time/cost
- High reliability for automotive applications



TAS5411-Q1:

Mono channel, Differential Input Class-D Audio Amplifier with Load Dump & I2C Diagnostics

Features

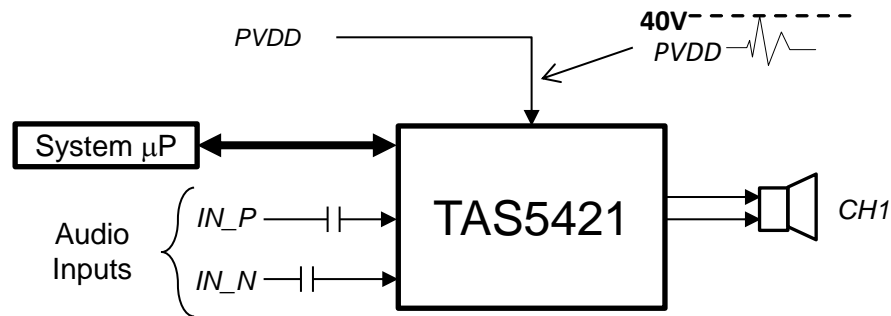
- 90% Efficiency and Low Quiescent Current
- Output Power: 8W at 4Ω, 10% THD+N, 14.4V
- I2C Load Diagnostics (Shorts, Open, DC output)
- 40V Load Dump & Over Temp Protection
- 4.5 - 18 V operation
- Differential audio input
- Automotive EMI Performance (CISPR25 L5)
- Fully AEC-Q100 qualified

Applications

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TAS5720L:

Digital Input, Mono Channel Class-D Amp

Features

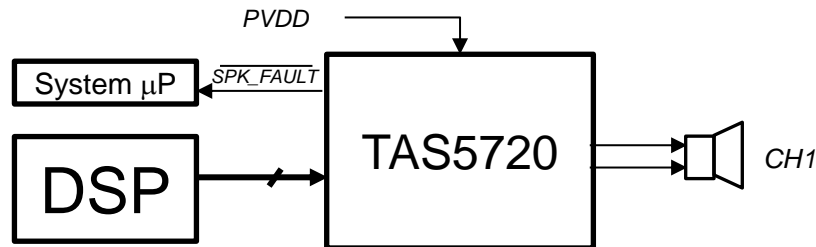
- Digital I2S audio input
- Output Power: >8W at 4Ω, 10% THD+N, 14.4V
- 4.5 to 16.5 V operation
- User programmable switching frequency
- SpeakerGuard™ protection: Adjustable Power Limiter and DC protection
- Over-Current, Over-Voltage, Under-Voltage, Over-Temperature, Clock Errors and DC detect status via SPK_FAULT

Applications

- Automotive Instrument Cluster
- Automotive telematics

Benefits

- Improves noise immunity and reduces system complexity
- Adequate sound pressure level for voice apps
- Supports automotive cold/crank & start stop
- Optimizes system EMI profile.
- Protects speakers from overdrive and damaging DC currents
- Excellent reliability and robust operation



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