TI 无线高保真耳机方案在线直播

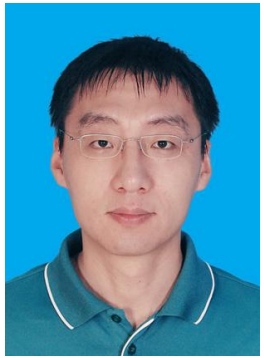
2018.07.24

主讲课程及内容

时间	课题	讲师
10:00 – 10:15	无线耳机整体方案及设计趋势	Kerry Song
10:15 – 10:40	TI 无线耳机电池管理系统设计	Alen Chen
10:40 – 11:05	TI 无线耳机 LED 驱动设计	Michelle Shi
11:05 – 11:30	TI 无线耳机功放系统设计	Raphael Xu
11:30 – 11:45	TI MCU 及触控方案设计	Ling Zhu
11:45 – 12:00	TI 其他常用耳机方案介绍	Kerry Song

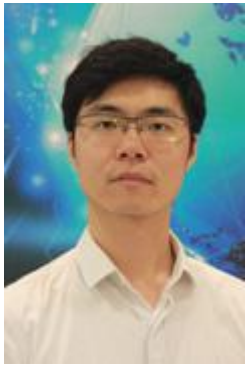
专家阵容

施晨美 (Michelle Shi)
TI LED产品市场工程师
拥有超过十年半导体行业销售与市场经验，目前主要负责TI LED驱动芯片在全球个人电子应用产品市场推广、业务开发与策略管理。



徐洋 (Raphael Xu)
TI 低功率功放产品线应用工程师
目前负责低功率功放的应用，擅长智能功放产品及技术。

陈思远 (Alen Chen)
TI 电池管理应用工程师
重点关注电池管理、快速充电、可穿戴智能硬件等应用领域。



宋征程 (Kerry Song)

TI 模拟应用工程师
目前主要负责模拟 IC 在消费类市场的应用和推广，擅长电源管理技术。

朱灵 (Ling Zhu)
TI 微控制器应用工程师
目前主要负责超低功耗微控制器的研发和应用，重点关注低功耗传感和测量，擅长电容触摸技术。

TWS市场及技术趋势

TWS市场火爆：

近年来，随着科技的进步和蓝牙无线方案的成熟， 市场上开始涌现了许多真无线蓝牙耳机，并有取代传统线缆式无线耳机的趋势。这极大地提高了无线耳机的观赏性和便携性。

厂商类型：

手机厂商

老牌音频厂商

新兴品牌

互联网品牌

技术趋势：

小体积：芯片封装小，外围电路简单，高集成度
续航使用时间：高效率，低Iq，小电池的充分利用
新功能：金属触控，生物信号检测，灯光效果
其它重要技术趋势：连接稳定，降噪，语音助手，无线充电

TI 耳机整体方案及关键技术

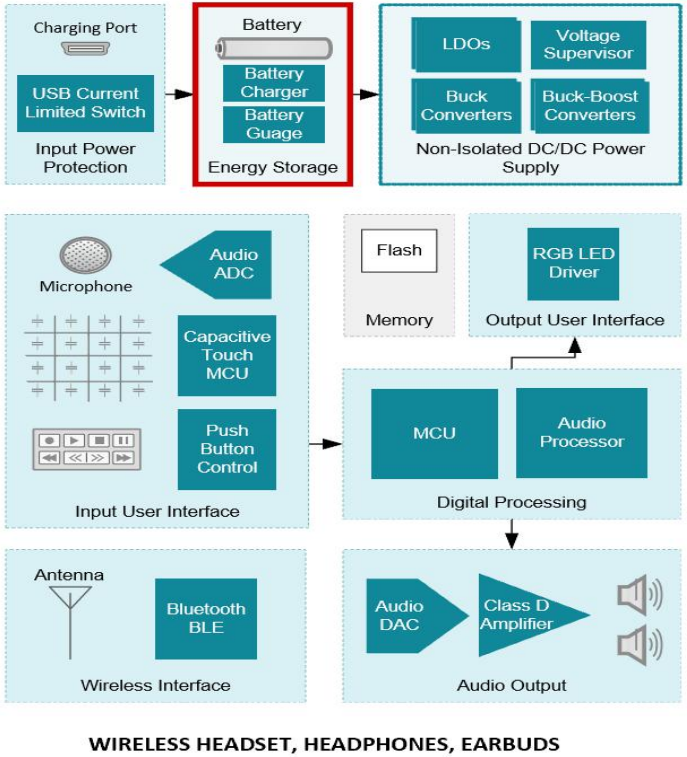
耳机类型：TWS，游戏耳机，HIFI耳机，…

电池管理：
超小体积
高效率，超低Iq
电源路径管理
电池保护与计量

Example TI solution:
BQ25100, BQ24078, BQ27426

电源：
低Iq(关断模式)
短路保护功能
高效率，小体积

Example TI solution:
TPS61099, TLV733P, TLV62568



WIRELESS HEADSET, HEADPHONES, EARBUDS

音频：
(耳放, DAC)
Class G省电
DirectPath免隔直电容
高保真大功率

Example TI solution:
TPA6141A2, TPA6130A2, PCM5102A

用户交互：
(LED驱动, ADC, 触控)
寄存器配置灯光效果
高信噪比，低功耗
电容式触控

Example TI solution:
LP5569, TLV320ADC3101, MSP430FR2512

适用于TWS 耳机参考设计

TI Designs Number: TIDA050007

TIDesigns

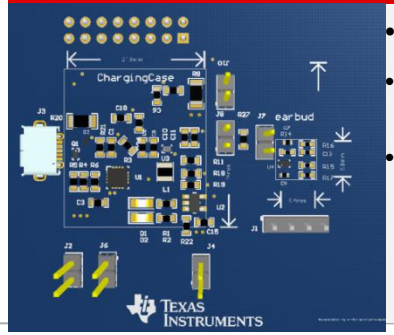
Solution Features

- 18uA Ultra-low standby current
- Support Up to 1.5A fast charging current
- Pass-through mode when VIN>VOUT
- Higher than 15% charging cycles than traditional 5V constant output boost charging case
- Features protection functions: Ouput Short Circuit Protection, Input Over Voltage Protection
- Down to 1mA charging current accuracy

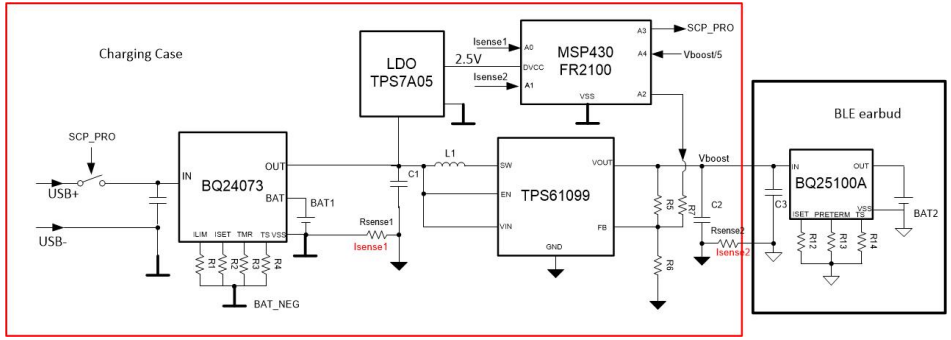
Solution Benefits

- High charging efficiency to achieve 15% more charger cycles
- Ultra low standby current to extend battery lifetime
- Small solution size, easy PCB design
- High charging accuracy

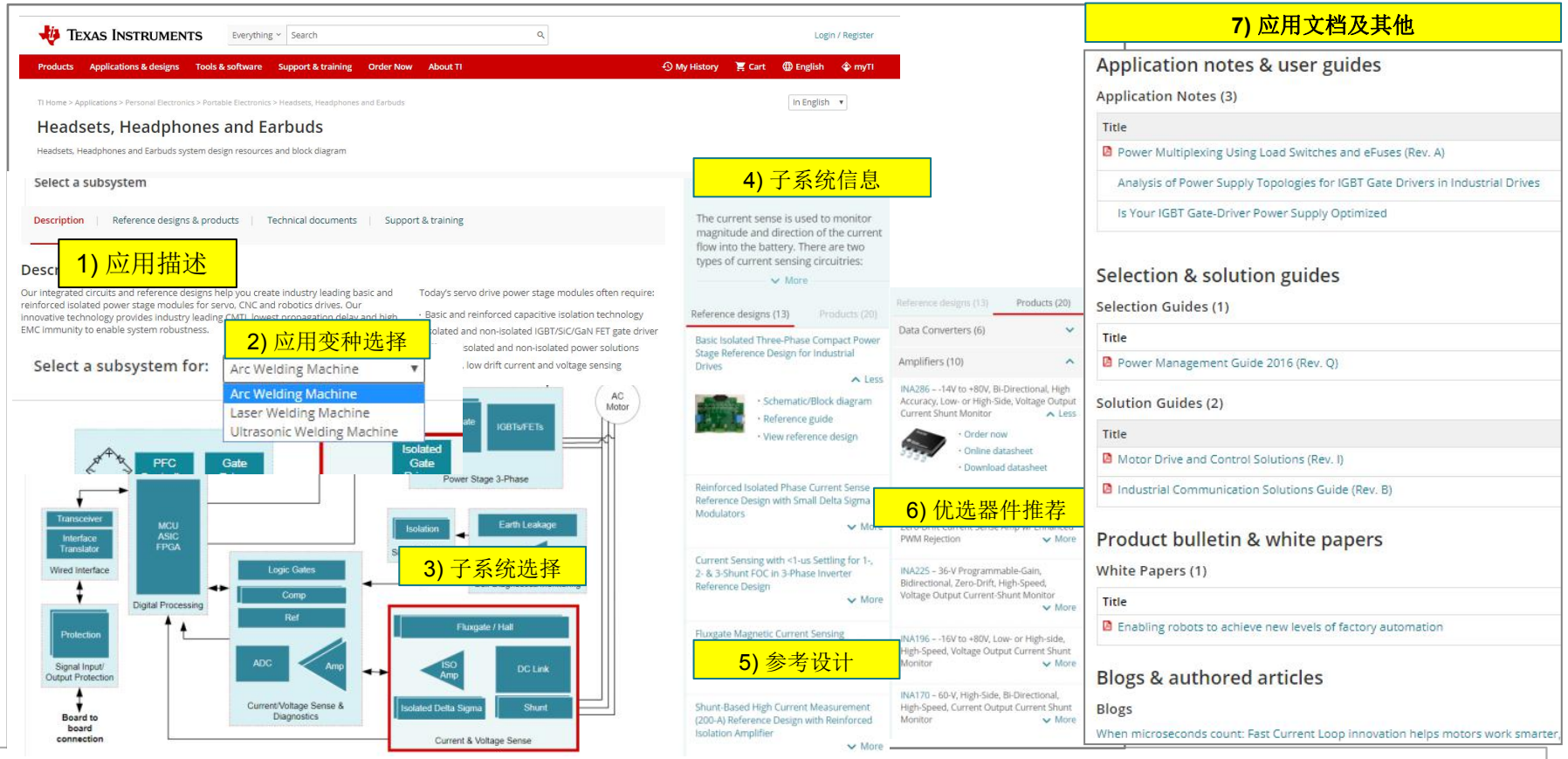
Tools & Resources



- **TIDA050007**
- **Design Files:** Schematics, BOM, Gerbers, and more
- **Device Datasheets**:
  - TPS61099
  - BQ25100A
  - BQ24073
  - MSP430FR2100
  - TPS7A05



系统级方案助力解决设计疑难



TI.com.cn：为您提供一站式体验

选型

- 10万种产品覆盖电源、处理器、无线连接、音频、放大器、时钟、DLP、传感、电机驱动等
- 提供工业、汽车、通信设备、个人消费电子等应用**系统级解决方案**
- 提供**交叉参照**搜索多个供应商的产品

设计

- 3,000款TI Designs参考设计，覆盖工业、汽车、医疗、个人消费电子等应用领域
- 提供定制电源、照明、滤波、时钟和传感设计的WEBENCH® 设计中心

TIDesigns　WEBENCH Design Center

支持

- 7/24**在线支持社区**，技术疑难解答、海量技术博文分享
- 全年无歇**在线培训**，理论基础、动手实验，为您充电加油
  - E2E（中文）
  - E2E (英文)

TI E2E™ Community

购买

- 全球响应，数万样片开发板任君选择，尽在TI Store
- 可支持手机端浏览购买，可用支付宝支付
- 不定期折扣及促销活动

TI store

myTI账户：个性化服务及定制

myTI 账户: 专属您的私人订制

https://my.ti.com

加入myTI 会员的好处:

- TIstore 一站式购物平台， 数万样片
  开发工具，一网打尽
- 参与 TI 在线技术支持社区
- 利用 WEBENCH® 设计工具轻松进行设计
  和模拟
- 订阅产品更新，获得最新设计工具，
  系统方框图与指南等信息
- 标记您最喜爱的产品
- 管理 / 订阅新闻简报
- 注册 / 参加在线培训与活动
- 获得个性化的建议

接下来...

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无线耳机电池管理方案

TWS Ear buds, Hearing Aids, Wireless Headphones

July 24，2018

陈思远（Alen Chen）
德州仪器BMS中国 应用工程师

概要

- 无线耳机电池管理需求回顾
- 耳机的充电管理
- 充电盒子的充电管理
- 电池电量计量和保护
- TWS 耳机电池管理参考设计
- 无线耳机适用方案总结

Battery Management: What problem are we solving?

www.ti.com/bms

Battery Charging Products BCP 电池充电产品

- Faster & Cooler charging
- High efficiency and Flexibility
- Highly integrated
- Low power and high power
- Extend battery life & run time

Battery Gauge Products BGP 电池电量计量产品

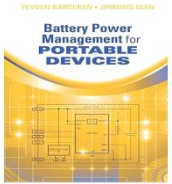
- Longer run time (15%-20%)
- Maximum Life
- 99% Accuracy (Impedance Track™)
- Reports state of charge & state of health
- High cell count precision AFE & cell balancing
- Primary, secondary & total protection
- Enhanced safety
- Counterfeit batteries & accessories

Battery Automotive Products BAP 汽车电池管理产品

- High cell count precision AFE & cell balancing for automotive applications
- Primary, secondary & total protection
- Enhanced safety

Industry Leader

- Wireless Power Standard, ISO26262, Smart Battery Data interface and more
- Impedance Track™ and CEDV fuel gauging
- Energy Harvesting
- 100's of patents



Committed to Customers

- Investing more R&D in emerging technologies & applications
- 300 battery engineers world wide
- 500 customers trained yearly
- Online Battery Management University

Better user experience

无线耳机电池管理方案

Focus for Today

运动无线耳机

- **bq2510x**

Smallest termination current and solution size w/o power path

- **Gauge BQ27426/BQ27421**

Low power, high accuracy

- **Protector BQ2970**
- Simple, easy to use

TWS 真无线耳机 以及充电盒子

- **bq2423x**

Power Path for instant power on for charging case

- **bq2510x**

Smallest termination current and solution size w/o power path

- **bq25120A**

Smallest Solution for Full Featured Applications

头戴式无线耳机（降噪）& Hearing aids

- **bq25120A**

  Smallest Solution with integrated power management

- **bq24040**

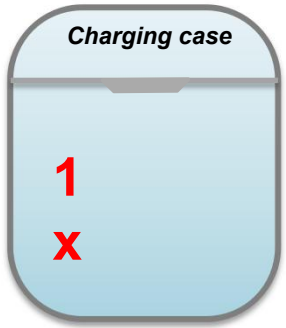
  1A no Power Path

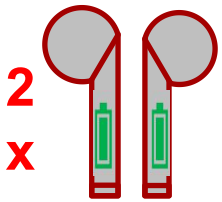
- **bq2407x**

  1.5A w/ Power Path

TWS 真无线耳机

- **典型的真无线耳机有着3颗电池**
  - ✓ 耳塞内的电池容量/内阻和充电盒子的电池有着很大的不同
  - ✓ 为了达到最佳的用户体验，核心的充电功能需求有着很大的不同
- **线型 vs 开关充电 Charger**
  - ✓ 线型充电
    - 简单易用 低成本
    - 路径管理
    - 低静态自耗电
  - ✓ 开关充电
    - 充电速度快并且温升低
    - 高集成度，且具备反向boost升压功能
    - 完善的保护功能





BQ25100B
BQ24232H

BQ24073

BQ24040

BQ21040

什么是理想的无线耳机充电芯片？

High Accuracy in Current & Voltage

防止过充，最大化电池使用寿命

Low Termination Current

在不过充的情况下，将电池充的尽可能充的更满，延长使用时间

Low Battery leakage

减少电池耗电，延长待机时间

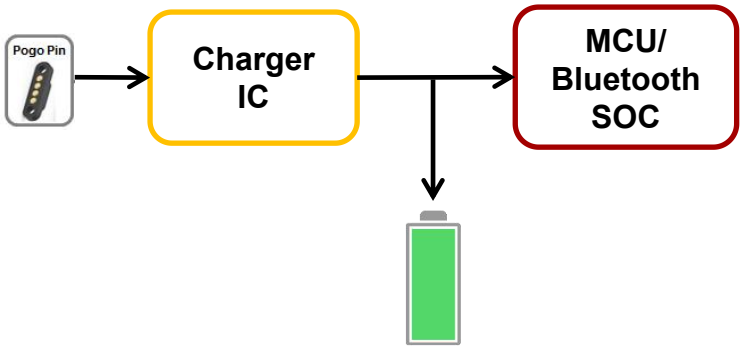
Small Size

节约宝贵的空间

耳机的充电管理

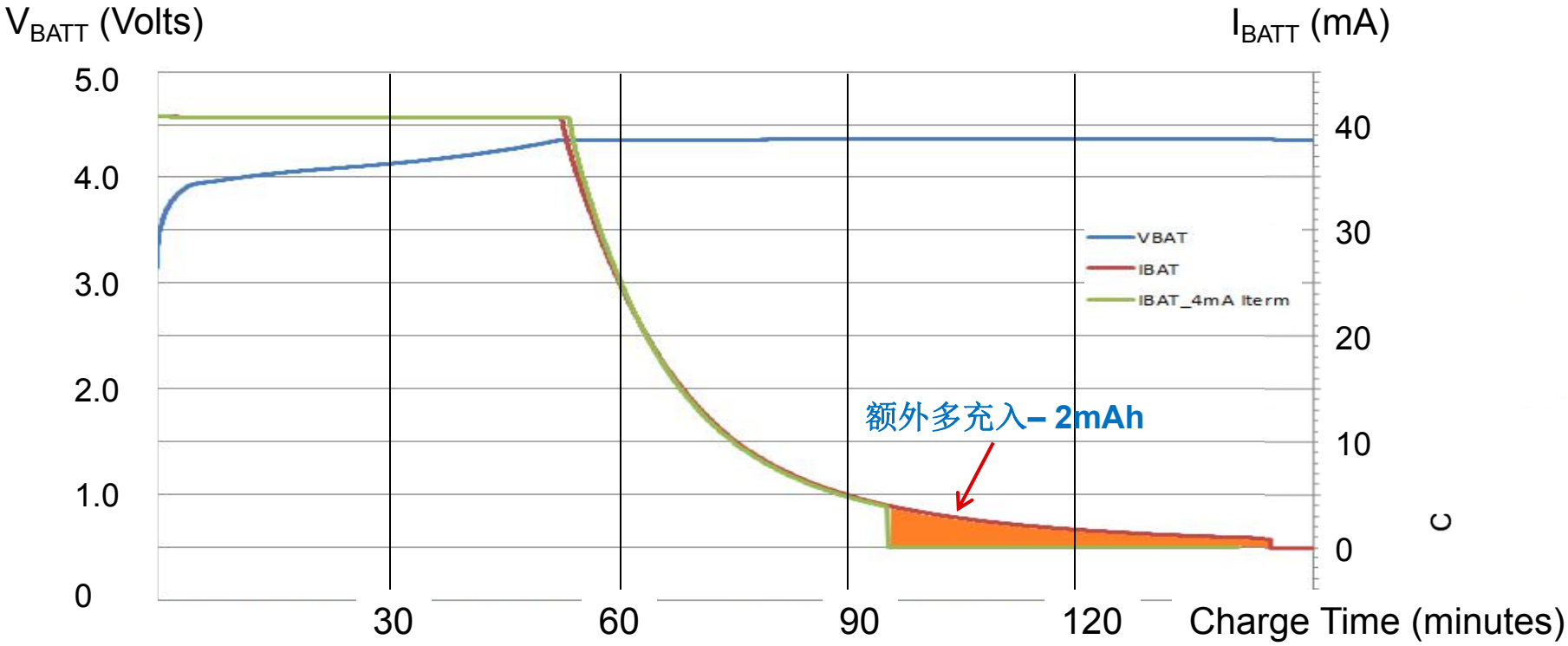
How We Won

- Battery 25mAH to 80mAH, charge current <200mA
- **Linear Charger Features**
  - **0.5mA accurate termination** current ensures battery more fully charged (5 ~ 10% effective capacity difference)
  - **Smallest solution size 6.5mm²**
  - **Ultra Low Iq**: 2nA (Shipmode), 700nA (HiZ)
  - **5mA min fast charge current**
  - **Fully programmable temperature thresholds and charging profile**
  - **System hardware reset (Power cycle)** through I2C or button press
  - **Multi-point System Monitoring** with integrated ADC



BQ25100 total solution size

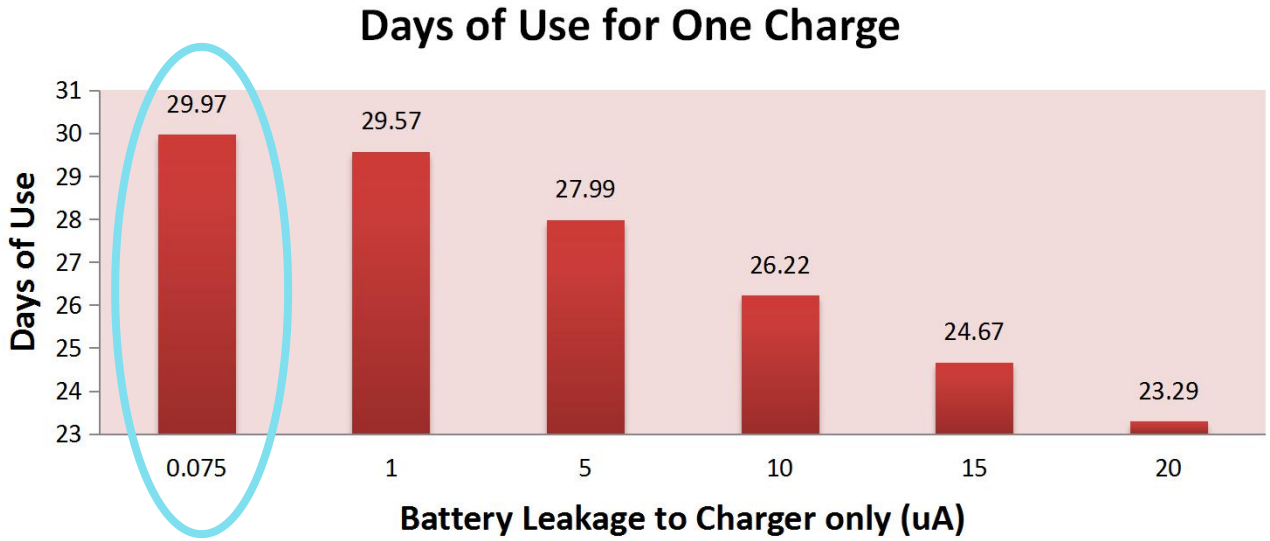
Accurate Small Battery Termination



- 用41mA 的充电电流去充一个41mAh的电池（1）
- 截止电流 4 mA (10%) 或者 1 mA
- 阴影区代表着5～10%的电池容量

Low Battery Leakage
– Significantly Improves Battery Life

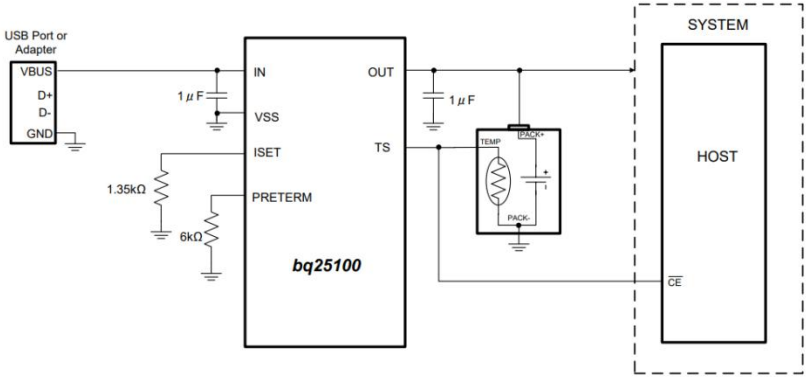
For a sport band that uses 50mAH battery and supports 30 days of normal use, how critical is the battery leakage?



bq25100
75nA Leakage/Quiesent Current

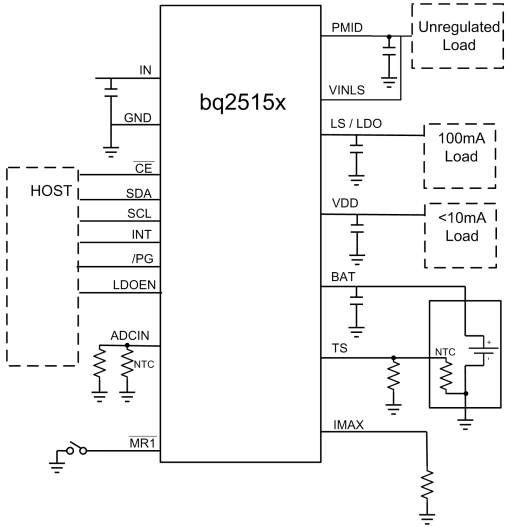
耳机充电芯片选择

BQ25100 – Simple Standalone Charger



- 用于提高充电性能，替代SOC/PMIC充电
- 最小的方案面积 6.25mm²
- 75nA IQ, 1mA 截止电流
- 简单使用方便
- 自由度较低，不能用软件动态调整.

BQ25120A/150 – Charger + ADC + Buck/LDO + I2C



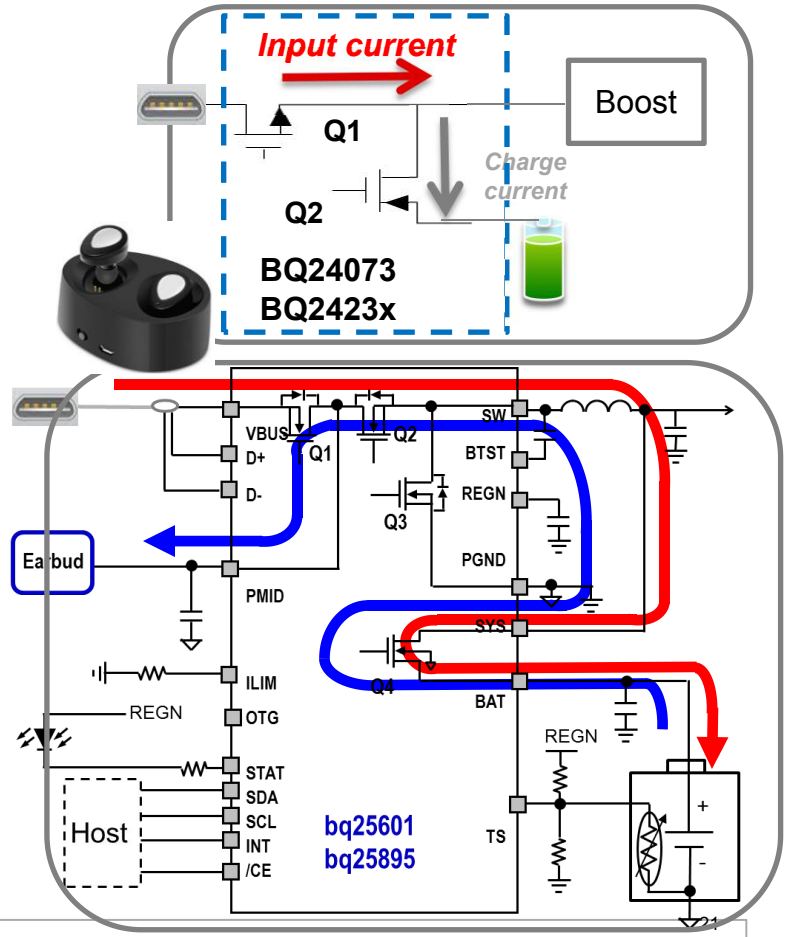
- 用于需要高灵活性且需要MCU 控制的场合.
- 系统电压，充电电流，温度可通过ADC监控
- 充电曲线可以客制化调整通过I2C
- 路径管理和Buck/LDO

* BQ25150 sampling now

用于充电盒子的充电IC

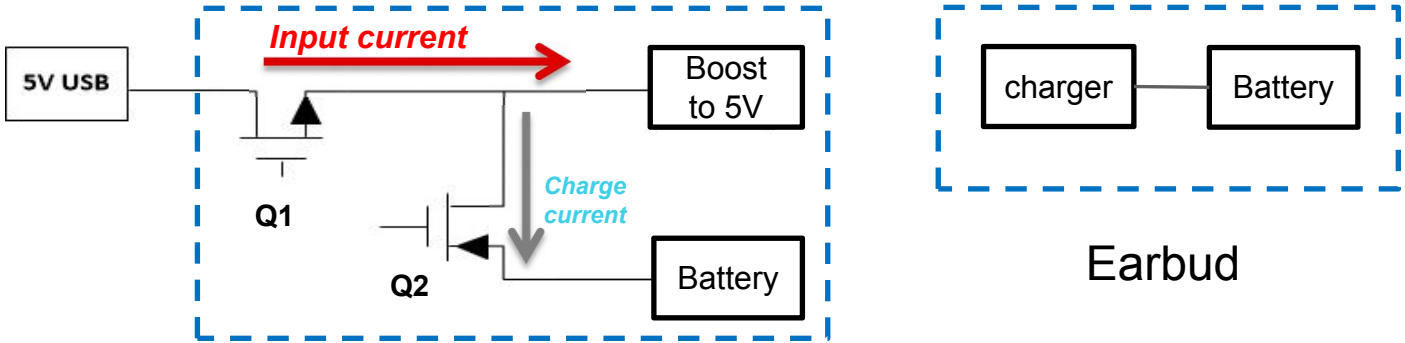
How We Won

- Battery 0.2Ah to 1.5Ah, charger current up to 1+A
- **Linear Charger Features 线性充电**
  - **路径管理** 对耳机和充电盒本身同时充电
  - 充电电流最高可以到 **1.5A**
  - **低 Iq** = 2nA (Ship-mode), <1uA (Standby)
  - 简单易于使用
- **Switching Charger Features 开关充电**
  - **高效率，**快速且低温升的进行充电
  - **路径管理**
  - **D+/D- BC1.2**适配器类型识别
  - **单芯片**进行充电和**升压**输出
  - 完善的的保护功能



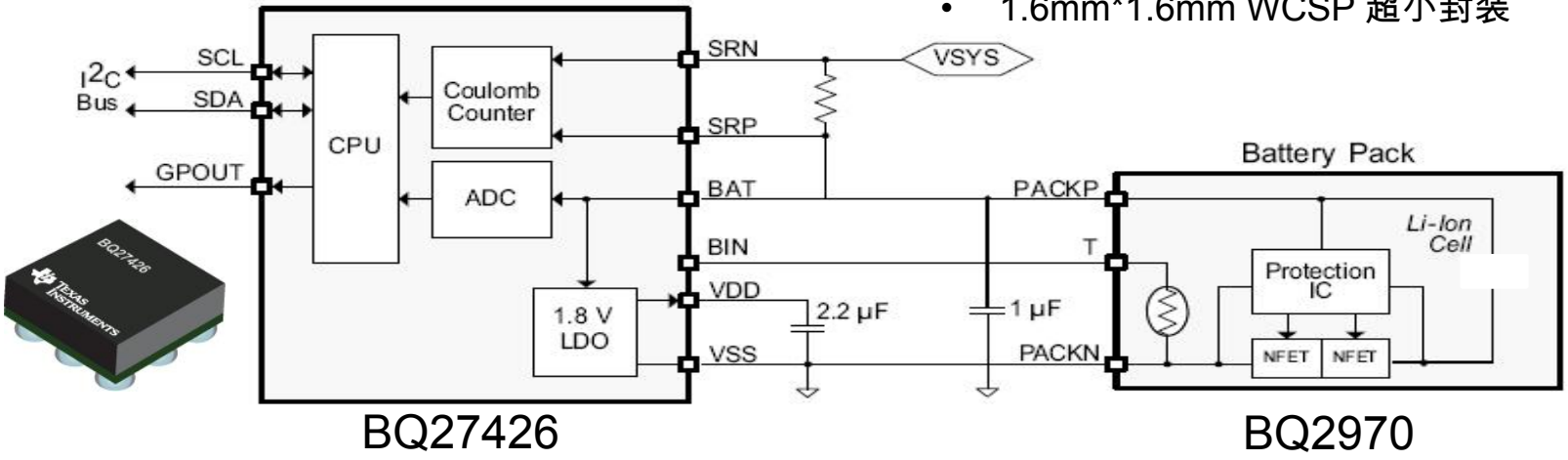
Power Path 路径管理在充电盒子中(Linear charger)

- 对外供电由适配器通过 Q1传送; 充电电流由Q2控制
- 在输入功率足够的情况下，耳机充电和充电盒子自身充电可以同时进行。
- 在输入功率不够的情况下，耳机有更高的充电优先级，即使充电盒子自身的电池已经没电了
- 将自身充电路径和对外输出路径分开; 实现准确的充电截止
- 在需要对充电盒子和耳机同时充电的情况下，路径管理是必要的



电量计和电池保护

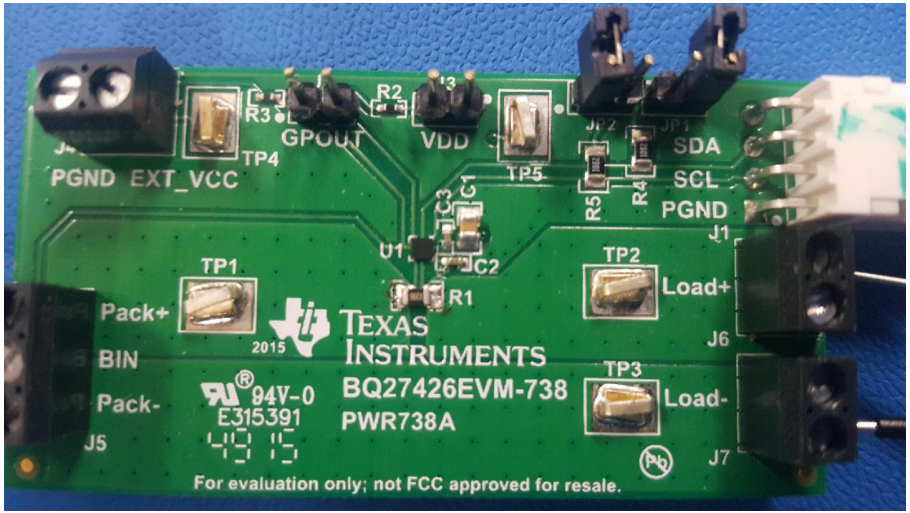
BQ27426
- 超低功耗9uA休眠模式，0.6uA关断模式
- 1.6mm*1.6mm WCSP 超小封装



- 耳机电池小内阻较大，单单使用电压难以预估电池电量
- 准确的预估当前电池电量，通过将电池放的更干来延长电池的使用时间
- 高精度电流，电压，温度检测（电流分辨率可以通过比例的方式增强到100uA或者更高），可用于状态的准确判断

提高电量计的电流分辨率: bq27426 Example

- 500 mAh 电池期望的分辨率是 100 µA
- 校准比例为10　1mA/100uA
- 选择一颗100 mΩ 1%的电流取样电阻
- 校准的时候实际使用200mA，但是告知电量计该电流是2000mA



Ultra-low Standby Power Reference Design for Wireless Earbuds Battery Charger

TI Designs Number: TIDA050007

TIDesigns

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- Support Up to 1.5A Fast Charging Current
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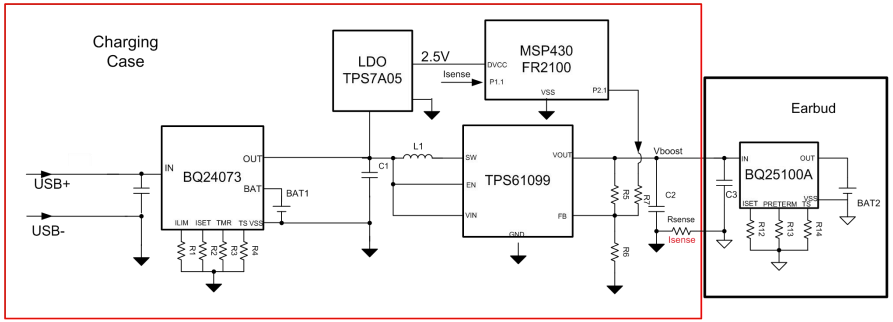

Tools & Resources

TIDA050007

Design Files: Schematics, BOM, Gerbers, and more

Device Datasheets:

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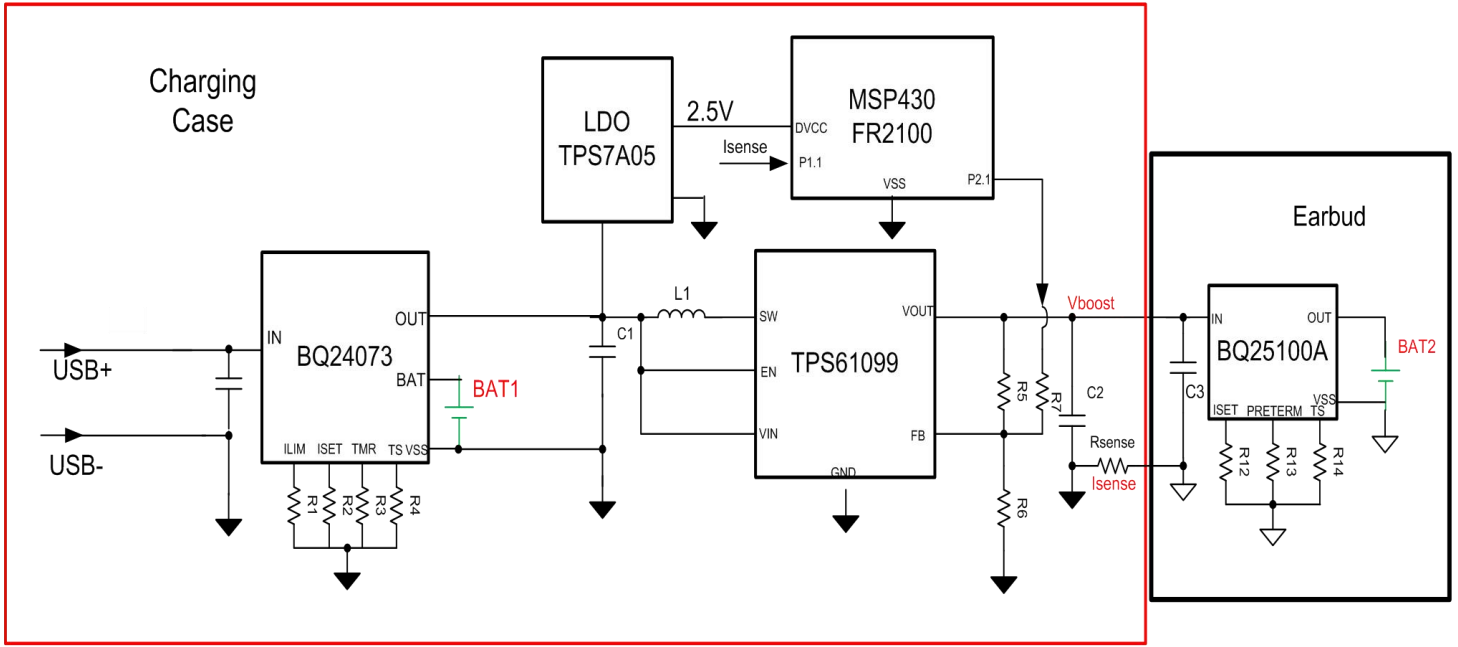
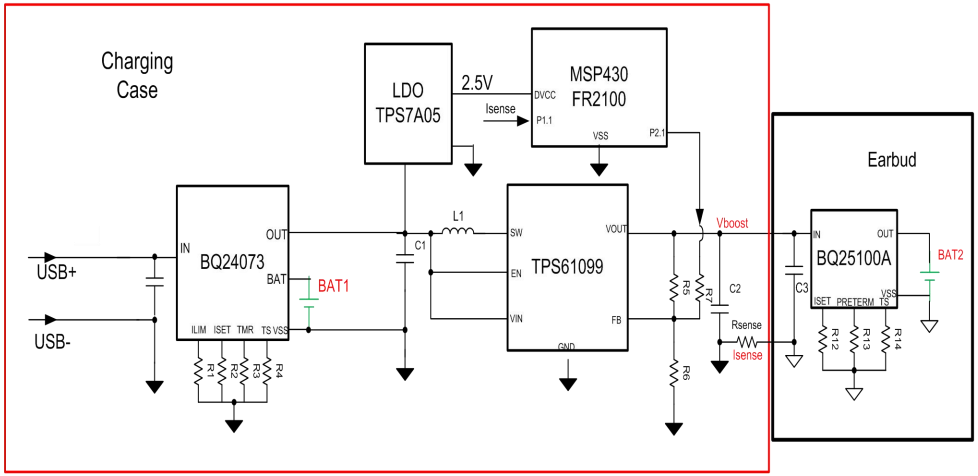
- BQ25100A
- BQ24073
- MSP430FR2100
- TPS7A05

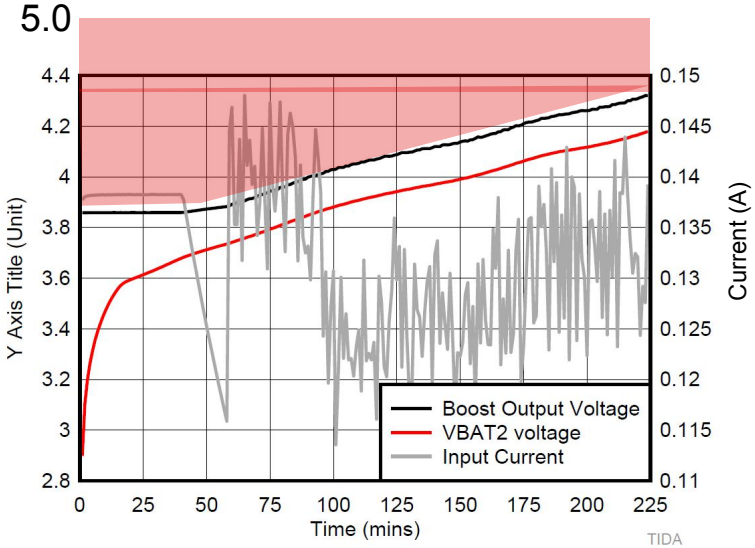
TIDA050007 系统构成



- 18uA系统待机功耗
- 如果必要的话，TPS61099的EN Pin可以接到MCU，关闭boost 输出，最小化充电盒子自身耗电。

TIDA050007 利用boost输出的电压跟随法提高效率



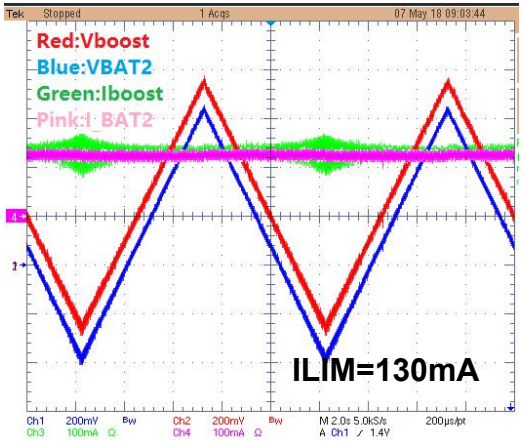


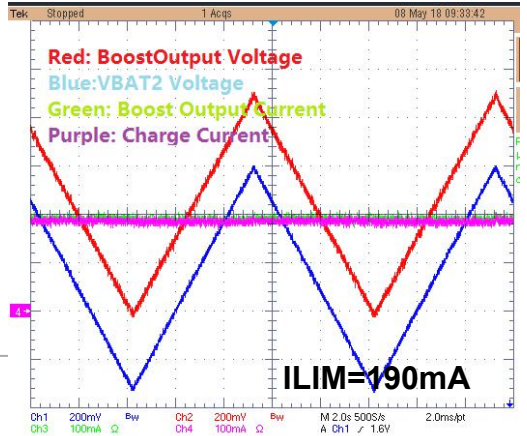
- BAT2耳机电池电压明显低于BAT1充电盒子电压时，TPS61099进进入直通模式
- BAT2电压接近或者高于BAT1时，TPS61099进入电压跟随模式
- 5V个boost输出电压的差值乘以电流，就是所节约出来的功率/能量

Test Results

	Boost Output Adjustable		Boost Output 5-V fixed	
	ILIM=130mA	ILIM=190mA	ILIM=130mA	ILIM=190mA
VBAT1=3.3V	2.77 W·H	2.83 W·H	3.40 W·H	3.34 W·H
VBAT1=3.6V	2.75 W·H	2.81 W·H	3.34 W·H	3.37 W·H
VBAT1=4.0V	2.70 W·H	2.77 W·H	3.36 W·H	3.37 W·H
VBAT1=4.2V	2.66 W·H	2.73 W·H	3.35 W·H	3.35 W·H
Average	2.72 W·H	2.78 W·H	3.36 W·H	3.36 W·H
Charging Efficiency	88.2%	86.2%	71.4%	71.4%

A 600mA·H BAT2 is used in this test.
The energy consumed by this battery is 2.4WH (600mA·H* 4V)

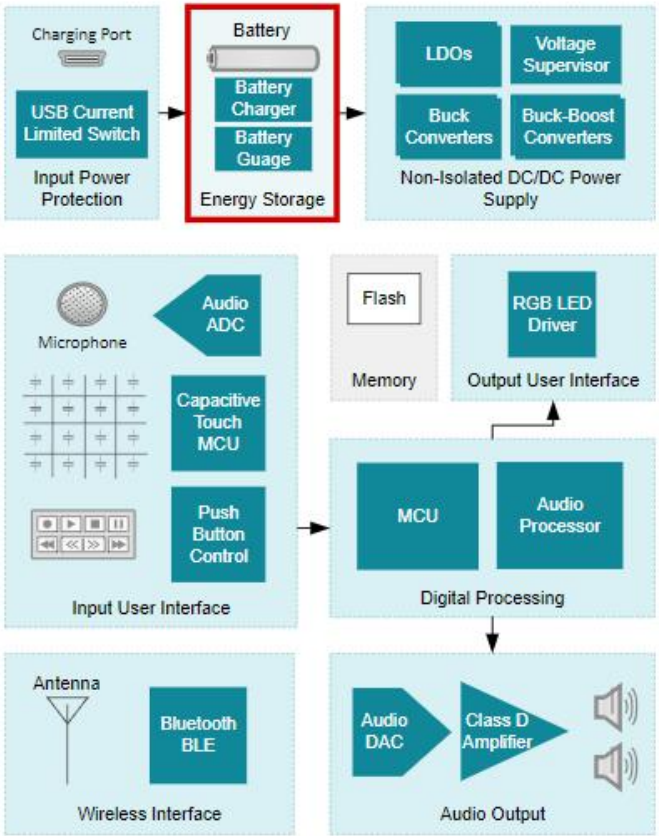




方案总结

BMS solution	产品型号	充电电流	描述
耳机充电	BQ25120A	300mA	高集成度 +ADC+Buck+LDO I2C控制
	BQ25150*	500mA	高集成度 +ADC+LDO I2C控制
	BQ25100	250mA	超小体积，超低截止电流
充电盒子	BQ24073	1.5A	大电流线型充电，带路径管理
	BQ2423x	500mA	线型充电，带路径管理,低成本
	BQ25601/6	3.0A	快速开关充电，路径管理，带反向4.5V～5.5V升压
	BQ25895	5.0A	快速开关充电，路径管理，适配器类型识别， 带反向4.5V～5.5V升压
	TPS61099	1A Boost	超低功耗，同步升压芯片
电量计	BQ27426	NA	低功耗，低成本电量计， 外置电流取样电阻
	BQ27421	NA	低功耗，低成本电量计， 集成电流取样电阻
电池保护	BQ2970	NA	低成本，通用电池保护

TI – Wireless Headsets Solutions



ti.com.cn/wirelessheadset

Our solutions help you create Bluetooth headphones, headsets and earbuds that are **smaller, smarter, reliable and more efficient**. From in-ear monitors, to over-ear or on-ear headphones with Bluetooth 5, consumers continue to want next-generation devices that deliver the best possible audio experience, while reducing outside noise.

接下来...

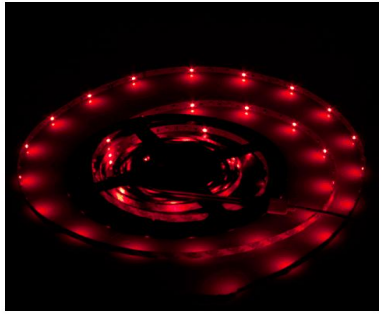
时间	课题	讲师
10:00 – 10:15	无线耳机整体方案及设计趋势	Kerry Song
10:15 – 10:40	TI 无线耳机电池管理系统设计	Alen Chen
10:40 – 11:05	TI 无线耳机 LED 驱动设计	Michelle Shi
11:05 – 11:30	TI 无线耳机功放系统设计	Raphael Xu
11:30 – 11:45	TI MCU 及触控方案设计	Ling Zhu
11:45 – 12:00	TI 其他常用耳机方案介绍	Kerry Song

TI 无线耳机 LED 驱动设计

德州仪器LED驱动产品线
施晨美(Michelle Shi)

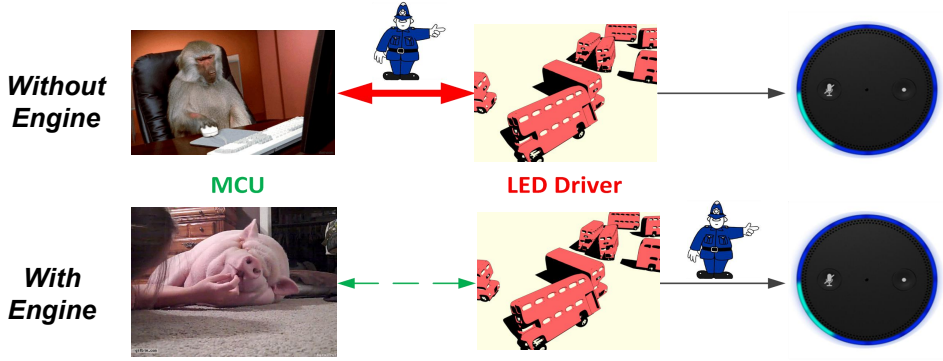
RGBW Driving AAA LEDs

Driving Animated LEDs

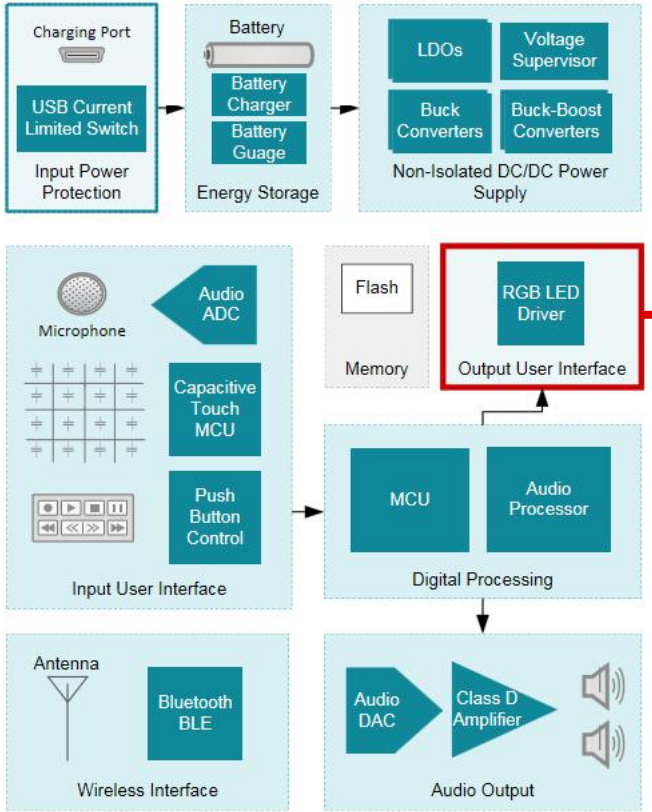


Driving Amount of LEDs

Driving Autonomous LEDs



TI – Wireless Headsets Solutions



The Output User Interface subsystem consists of drivers for indicator LEDs.

REFERENCE DESIGNS (3) PRODUCTS (4)

Power Management (4)

LP5569 – Nine-Channel I2C RGB LED Driver With Engine Control and Charge Pump

Order now
Online datasheet
Download datasheet

LP55231 – 9 Channel RGB / White LED Driver with Internal Program Memory and Integrated Charge Pump - WQFN

LP5521 – 3 channel RGB/White LED driver with internal program memory and integrated charge pump

TLC59116 – 16-Bit Fast-Mode Plus (FM+) I2C-Bus Constant-Current LED Sink Driver

WIRELESS HEADSET, HEADPHONES, EARBUDS

RGBW LED Driver

Low Iq
Engine Control

CC: Common Cathode
CA: Common Anode

DC: Dot Correction
BC: Brightness Control

New Generation

LP50xx

- 9/12/18/24/30/36 CH, 25.5mA, CA
- 12 bit PWM (20Khz)
- Const. Current
- QFN

LP5569

- 9 CH, 25.5mA, CA
- 12 bit PWM (20Khz) & 8 bit DC
- Const. Current
- QFN

New Generation

TLC59208/108/116

- 8/16/16 CH, 50/120/120 mA, CA
- 8 bit PWM & 6 bit BC
- Const. Current / Open Drain (F)
- 17V Out, QFN & TSSOP

LP3943/4

- 16/8 CH, 25 mA, CA
- 8 bit PWM
- Open Drain
- QFN

LP5523/231

- 9 CH, 25.5 mA, CC
- 12 bit PWM & 8 bit DC
- Const. Current
- BGA & QFN

LP55281

- 12 CH, 40 mA, CA
- 6 bit PWM, Boost with Audio Sync
- Const. Current
- BGA

LP5524/2

- 4/1 CH, 25.5 mA, CC
- Const. Current
- BGA

LP5562/0

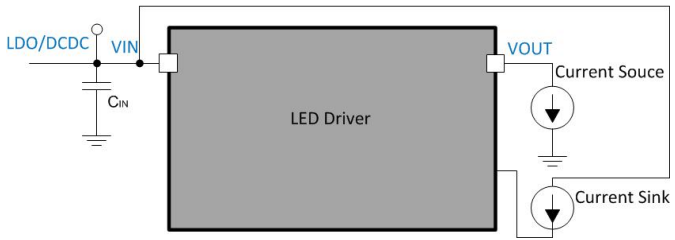
- 4/1 CH, 25.5 mA, CA/CC
- 8 bit PWM & 8 bit DC
- Const. Current
- BGA

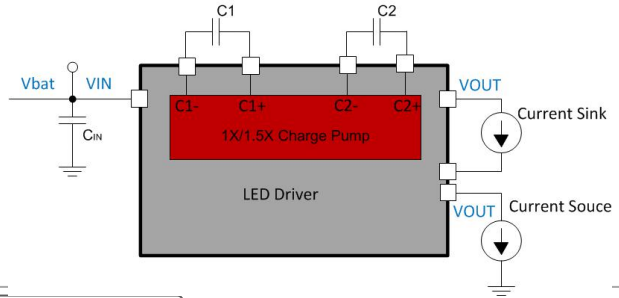
LM2755/1

- 3/1 CH, 20/150 mA, CA
- 5 bit PWM
- Const. Current
- BGA

LP5521

- 3 CH, 25.5 mA, CC
- 8 bit PWM & 8 bit DC
- Const. Current
- BGA & QFN





Production
Sampling
Development
Concept

Texas Instruments

LP5569

9-Channel I2C RGB LED Driver With Engine Control and Charge Pump

Features

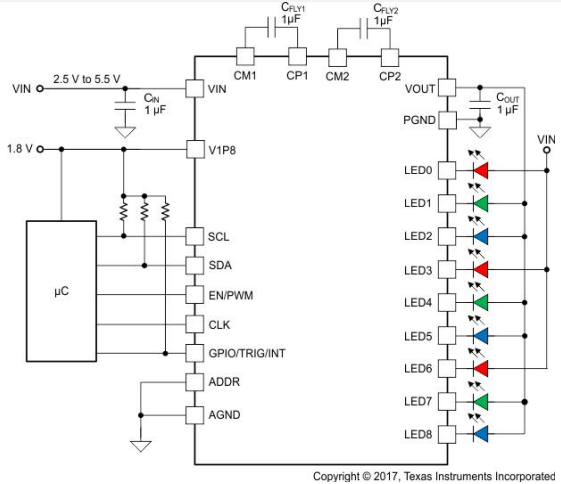
- Supply Voltage Range: **2.5**-5.5V
- 9 High-Accuracy Current Sinks
  - 25.5 mA Maximum per Channel
  - 8-Bit Individual Current Control
  - **12-Bit 20-kHz** Internal Individual PWM Control Without Audio Noise
- **Three Programmable LED Engines**
  - Independent Illumination Control Without Active Microcontroller Control
  - Synchronization Among Multiple Devices
  - Up to 256 Instructions in SRAM for Storing Sequences of Lighting Patterns
  - LP5523- and LP55231-Device-Compatible Command Set
- Flexible Dimming Control
  - I2C Dimming Control
  - Engine Dimming Control
  - **PWM Direct** Input Dimming (100-Hz to 20-kHz)
- **Adaptive Charge-Pump** to Drive High-VF LEDs With Low Battery Voltage
- Master Fader Control Allows Dimming of Multiple LEDs by Writing to Only One Register to Reduce the I2C Bus Traffic
- 2-µA Low Standby Current and 10-µA in Automatic Power-Save Mode When LEDs Are Inactive
- POR, UVLO, and TSD Protection

Applications

- Smart Speaker, Smart Home Appliance
- Doorbell, Electric Lock
- Smoke Detector, Thermostat
- Set-Top Box, Smart Router
- Bluetooth® Headset, Handheld Device

Benefits

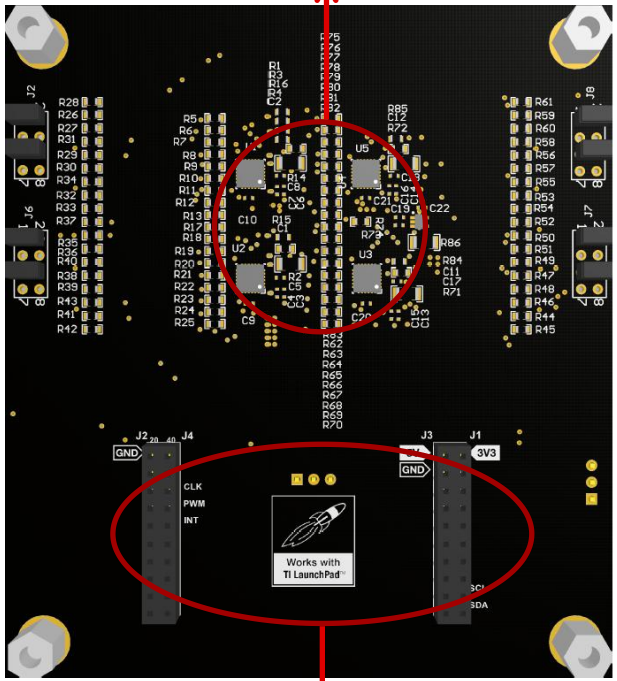
- Ultra smooth color changing and fading with high PWM resolution and dot correction
- Autonomous operation reduces system power consumption when the processor in sleep mode
- Easy coding for Flexible LED lighting Patterns
- Full functionality over battery voltage range
- Easy manufacturability with integrated diagnostic



PART NUMBER	GROUP	I2C SLAVE ADDRESS
LP5569RTWR	0	32h-35h and 40h (40h is broadcast address)
LP5569ARTWR	1	42h-45h and 40h (40h is broadcast address)

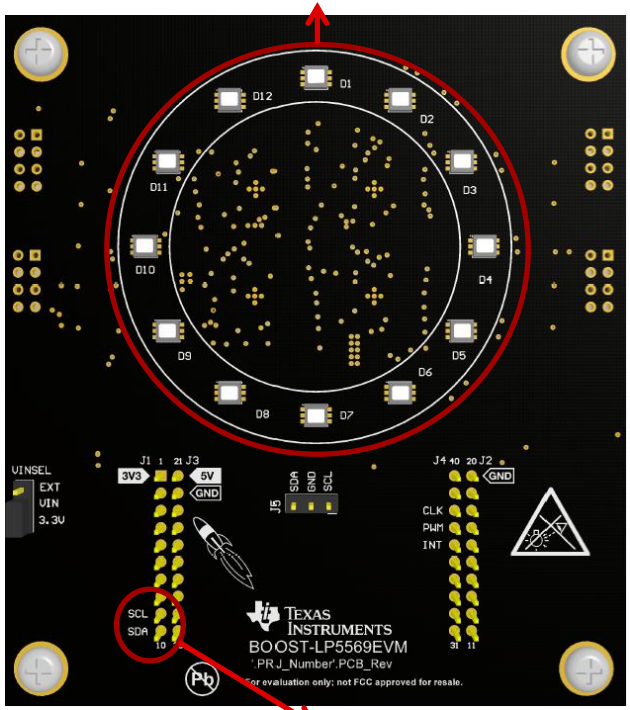
LED Ring Demo – LP5569

4 pcs LP5569



MSP432 Launchpad

12 RBG LED Module



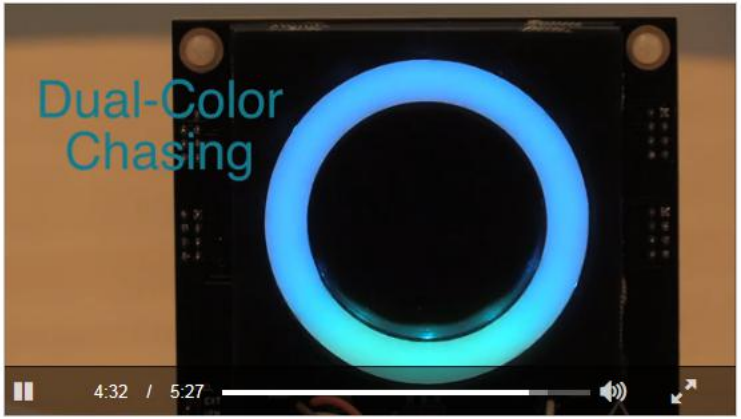
I2C Interface

LED Ring Effects:

- Breathing (mono-color & mixing-color)
- Chasing (mono-color & mixing-color)
- Two colors chasing in another color base

Demo Videos in Ti.com

Videos



LP5569 Demo Video

LP5569 I2C RGB LED driver demo

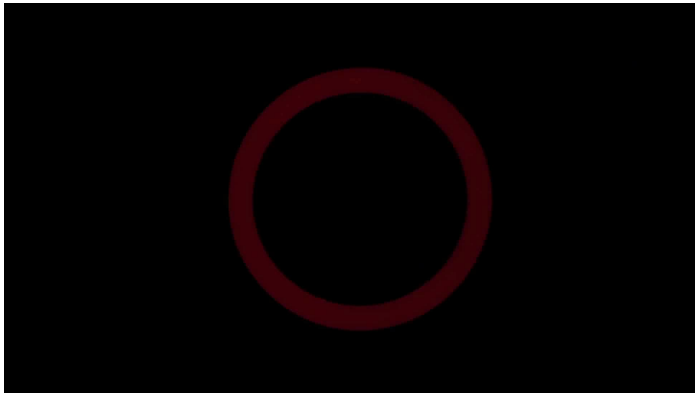
TI's LP5569 I2C RGB LED driver helps you achieve ultra-smooth color and brightness control with less power and zero added noise. Learn more in this video.

Posted: 25-Jan-2017

Duration: 05:26

View the LP5569 I2C RGB LED driver datasheet.

LP5024 Demo Video



LP50xx (Riverstone)
36/30/24/18/12/9-Ch I2C RGB LED Driver

Features

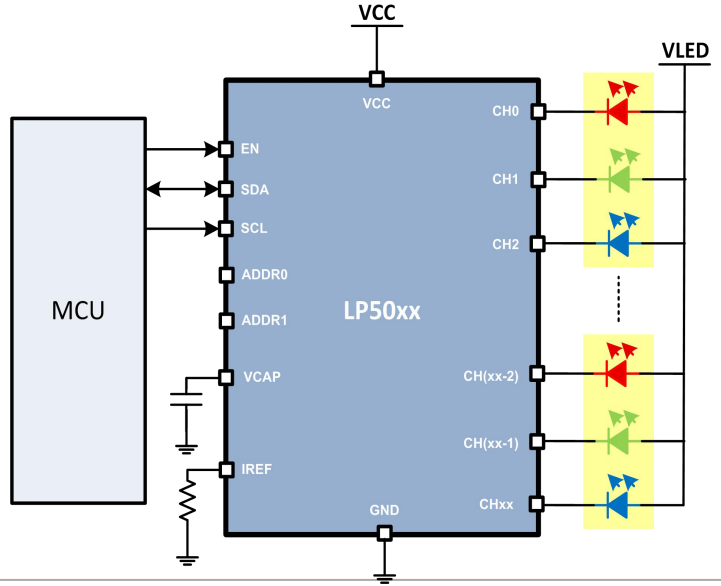
- Operating Voltage Range:
  - Vcc Range: 2.7V to 5.5V
  - EN, SDA and SCL pins compatible with 1.8V, 3.3V and 5V Power rails
  - Output Maximum Voltage: 6V
- Constant Current Sinks with High Precision
  - 25.5 mA Maximum per Channel when VCC in full range
  - 35 mA Maximum per Channel when VCC ≥ 3.3V
  - Device-to-Device Error: ±5%; Channel-to-Channel Error: ±5%
- **Ultralow Quiescent Current**
  - Shutdown Mode: 1uA (Max.) when EN = LOW
  - Power Saving Mode: 10uA (Typ.) when EN = HIGH & All LEDs Off > 30ms
- **Integrated 12 Bit, 29 kHz PWM Generator for each channel**
  - Independent Color Mixing Register per channel
  - Independent Brightness Control Register per RGB LED Module
  - Optional Logarithmic- or Linear-Scale Brightness Control
  - Integrated 3-Phase-Shifting PWM Scheme
- **3 Programmable Banks (R/G/B) for Easy Software Control of each Color**
- Two External Hardware Address Pins for Connection up to 4 Devices
- Broadcast Slave Address for Configuring Multiple Devices Simultaneously

Applications

- Smart Speaker, Smart Home Appliance
- Doorbell, Electric Lock
- Smoke Detector, Thermostat
- Set-Top Box, Smart Router
- Bluetooth® Headset, Handheld Device

Benefits

- Easy and Optimized Design for Color Mixing and Brightness Smooth Control with high resolution PWM generators in each channel
- 26KHz internal PWM Generators offer enough margin to eliminate the audible noise
- Easy Software Control of Each Color and Good Channels Synchronization with 3 programmable banks
- Balance System Level Power Consumption without Side Effect for LED Animation by ultralow quiescent current in Power Save Mode
- Minimize the Input Power Budget with 3 phases PWM shifting



LP50xx Value Propositions

Features	Benefits
Each Channel 12 bits / 29KHz PWM Generator	Easy and Optimized Design for Color Mixing and Brightness Smooth Control No Audible Noise
3 Programmable LED Banks	Easy Software Control of Each Color and Better Channels Synchronization
10uA Ultra low quiescent current in Power Saving Mode	Balance System Level Power Consumption without Side Effect for LED Animation
3 phases PWM shifting	Minimize the Input Power Budget

LP5523/LP55231

9 Channel LED Driver | Internal PWM | I2C

Features

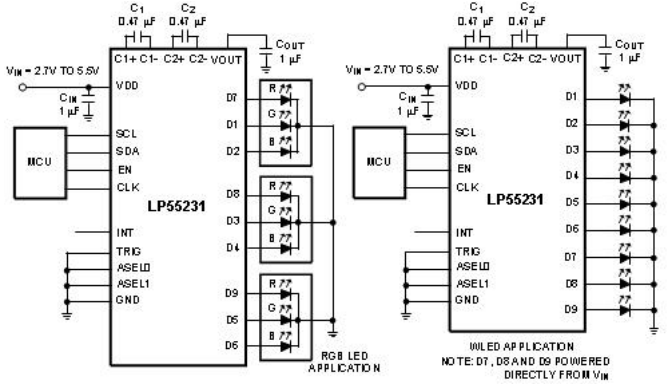
- Grouping option of LEDs, 3 execution engines
- 25.5mA full scale, 8 bit current resolution, 12 bit PWM control
- Adaptive high efficiency charge pump
- Internal program memory
- Trigger input interface
- 20nA typical standby current
- **LP5523 - 24 pin 2.3 x 2.3 uSMD package**
- **LP55231 - 24 pin 4.0 x 4.0 QFN package**

Benefits

- Flexible control of LED lighting patterns
- Lots of current control for LED lighting and/or color balancing
- Full functionality over battery voltage range
- No need for extra memory chip or microcontroller
- Allows for GPIO triggering, rather than I2C write
- Low system power impact when disabled
- Flexibility in size vs. manufacturability

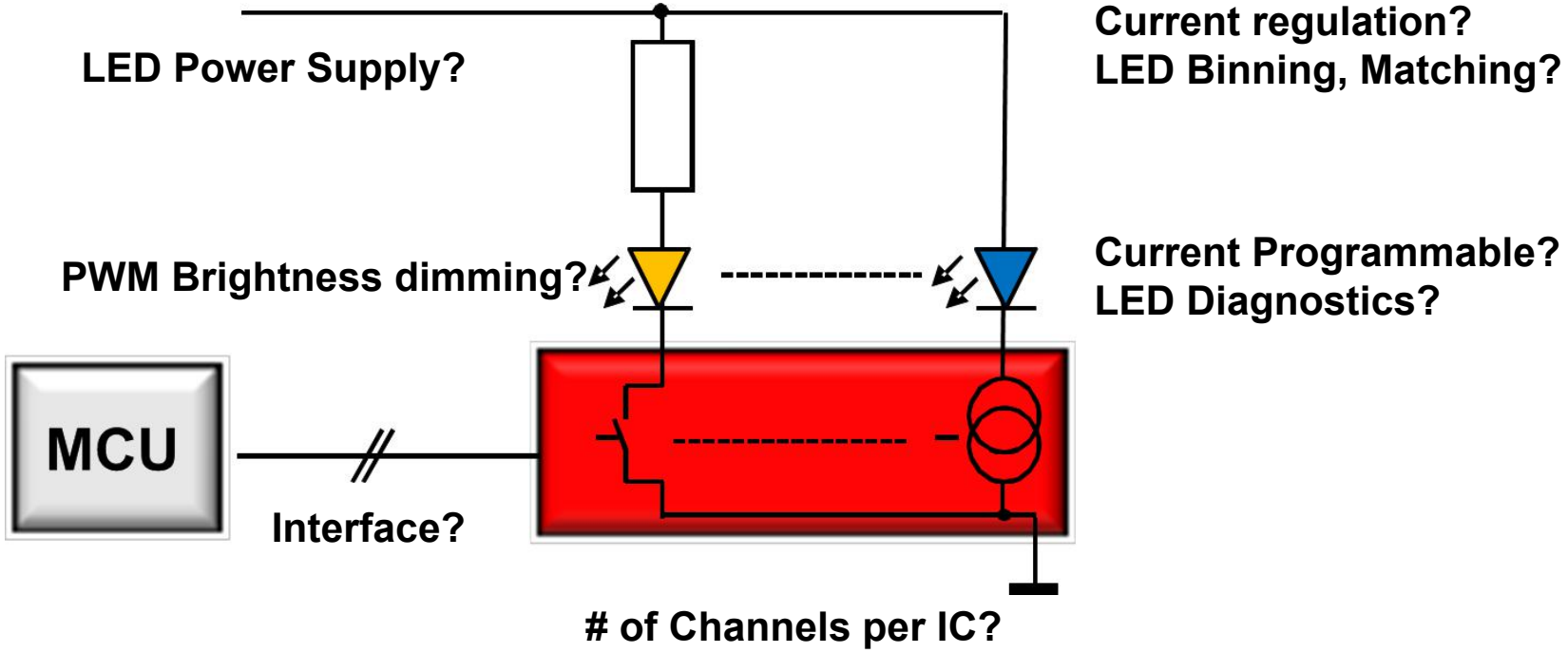
Applications

- Electronic Thermostats
- Fire Notification
- Robotics
- Intruder Notification
- Light Switches/Dimmers
- Gaming/Smart Headphones



Design Considerations

Multi-channel LED Driver Design Considerations

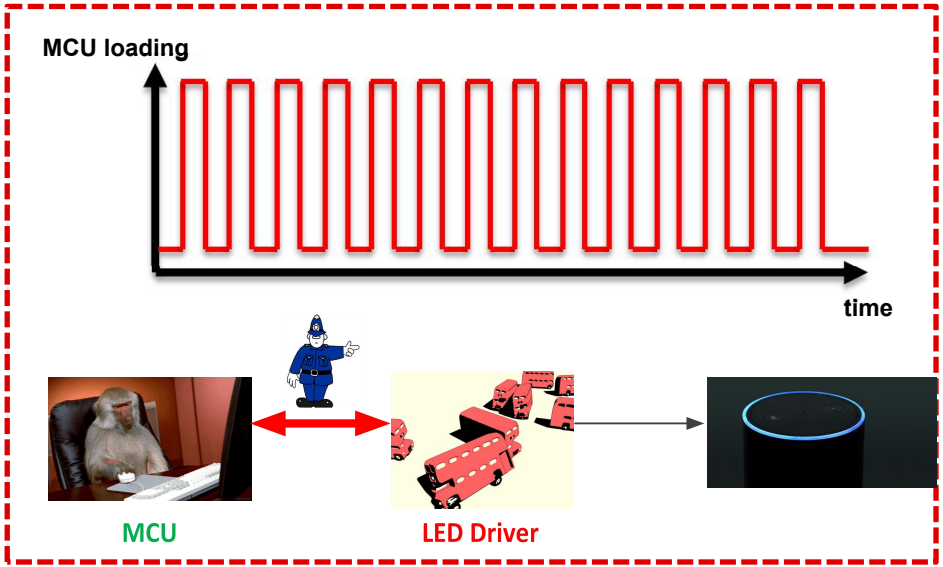


Multi-channel LED Indictors Design Considerations

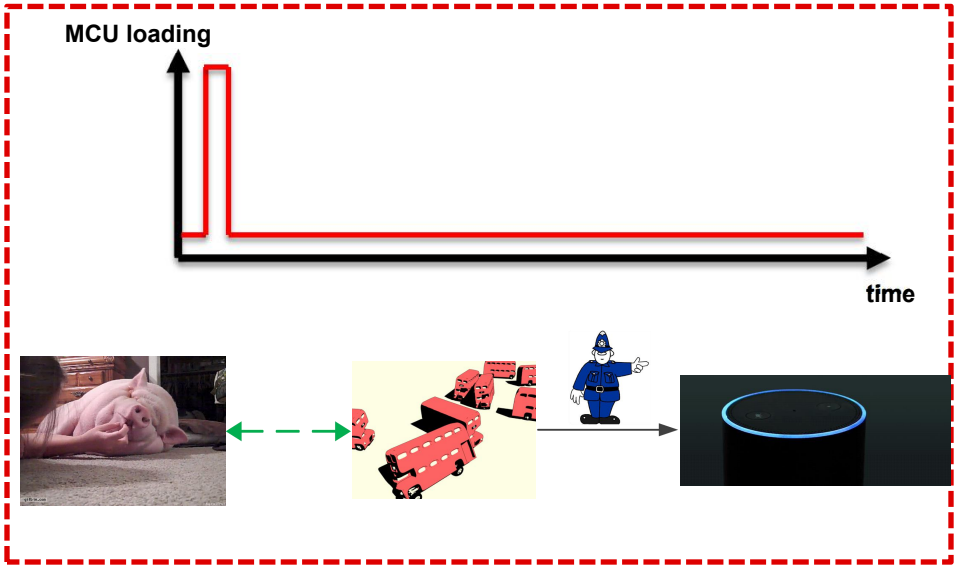
DESIGN CONSIDERATIONS	SOLUTION	BENEFITS
LED Power Supply	Battery	No regulated power supply needed
	Regulated power rail, i.e. DCDC	Regulated power supply, better thermal dissipation
LED Current Regulation	Resistor + low side switch	Low cost
	Constant current driver	Better matching accuracy; mixed LED binning
Programmable Constant Current	Global current setting through resistor	Easy to design
	Individual channel current setting	Calibration for mixed color LED
PWM Brightness Dimming	Direct I/O PWM control	no software, fail-safe
	Integrated PWM generator	Save I/O resource
Diagnostic	Open load, short to ground, short LED, off-state open load detection	Safety related tell-tale
MCU Interface	I/O ports	Easy to design, low cost
	Serial or Bus, i.e. SPI/I2C	Cascade for more ICs, save I/O resource

Lighting Engine

- Without Lighting Engine



- With Lighting Engine

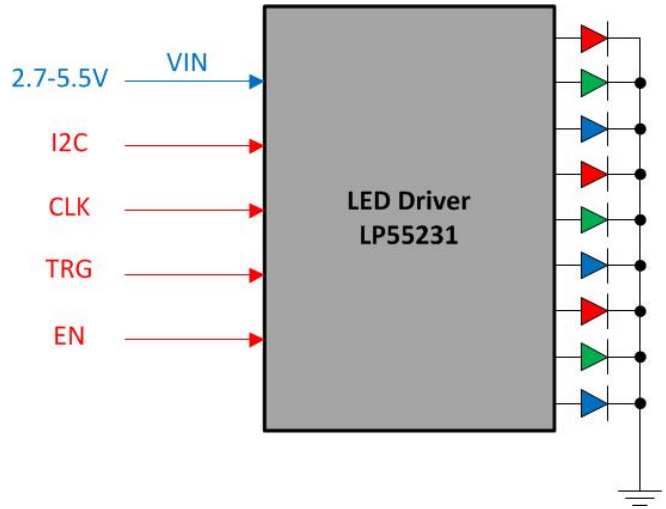


✓ Off-loads from MCU, instead of full-duty occupancy.

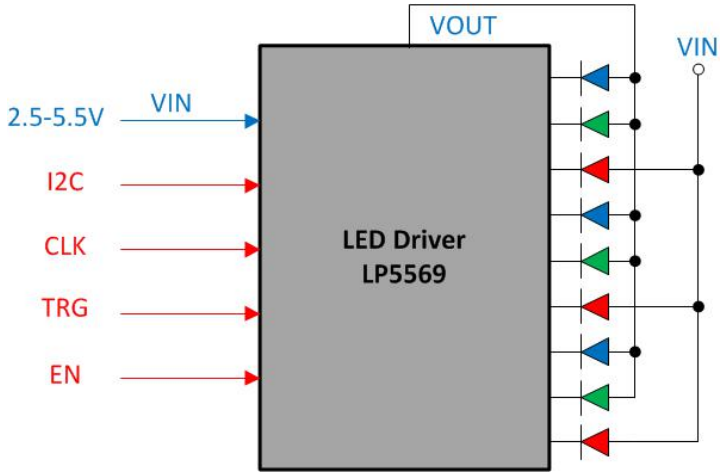
✓ Save the system standby power, MCU could be in sleep mode with ultralow Iq.

RGBW Indicator LED Driver Topologies

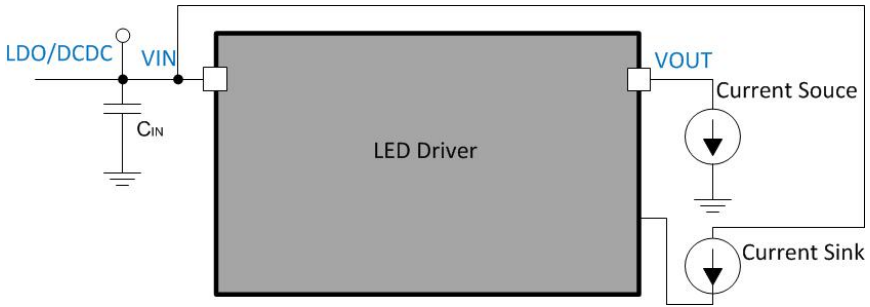
Current Source / Common Cathode



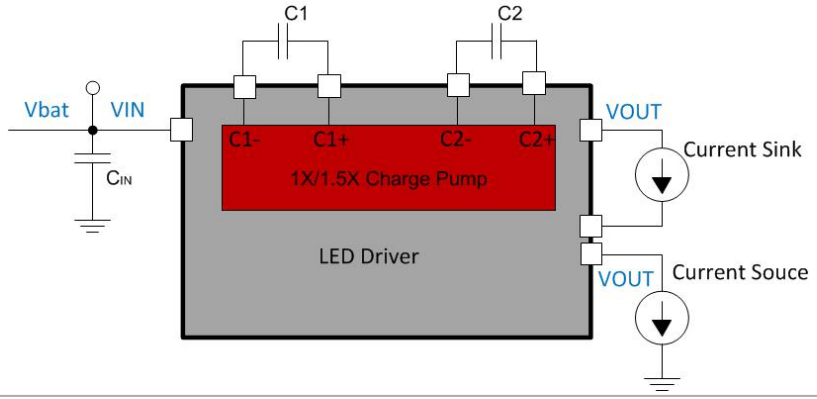
Current Sink / Common Anode



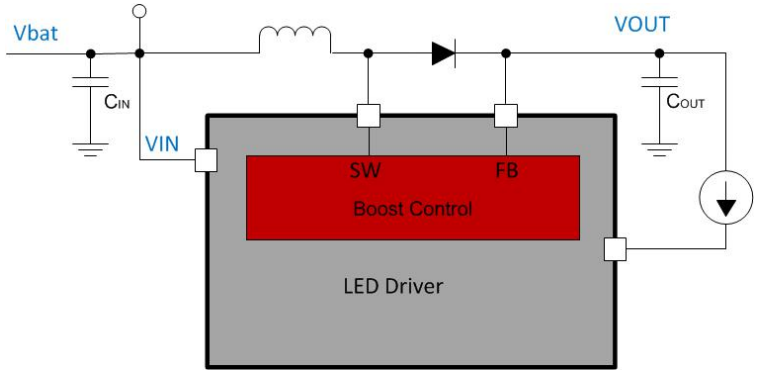
First Power Stage for the Current Sink and Current Source



TLC59116
LP5562



LP5569
LP5523
LP55231
LP5521



LP55281

接下来...

时间	课题	讲师
10:00 – 10:15	无线耳机整体方案及设计趋势	Kerry Song
10:15 – 10:40	TI 无线耳机电池管理系统设计	Alen Chen
10:40 – 11:05	TI 无线耳机 LED 驱动设计	Michelle Shi
11:05 – 11:30	TI 无线耳机功放系统设计	Raphael Xu
11:30 – 11:45	TI MCU 及触控方案设计	Ling Zhu
11:45 – 12:00	TI 其他常用耳机方案介绍	Kerry Song

Headphone Amplifier Overview

Raphael Xu

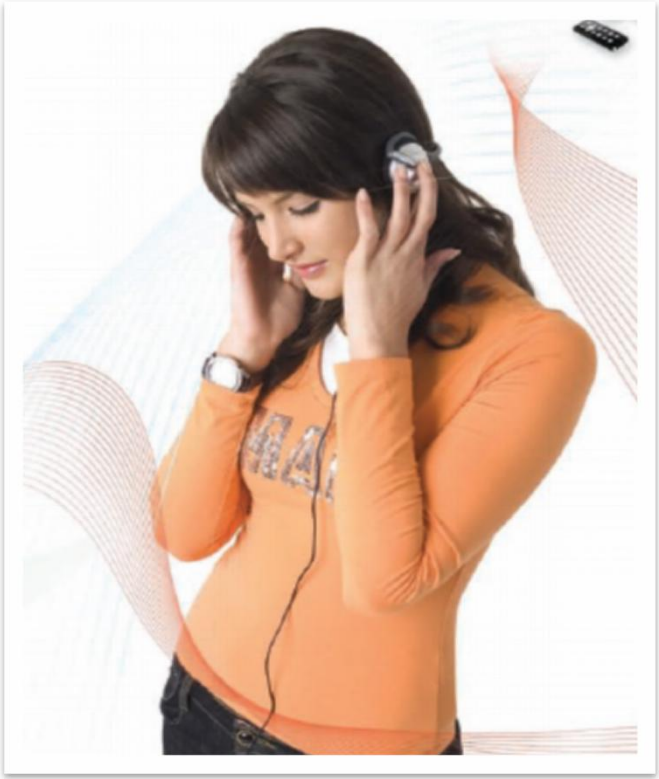
July, 2018

Key Headphone Amplifier Key Use Cases

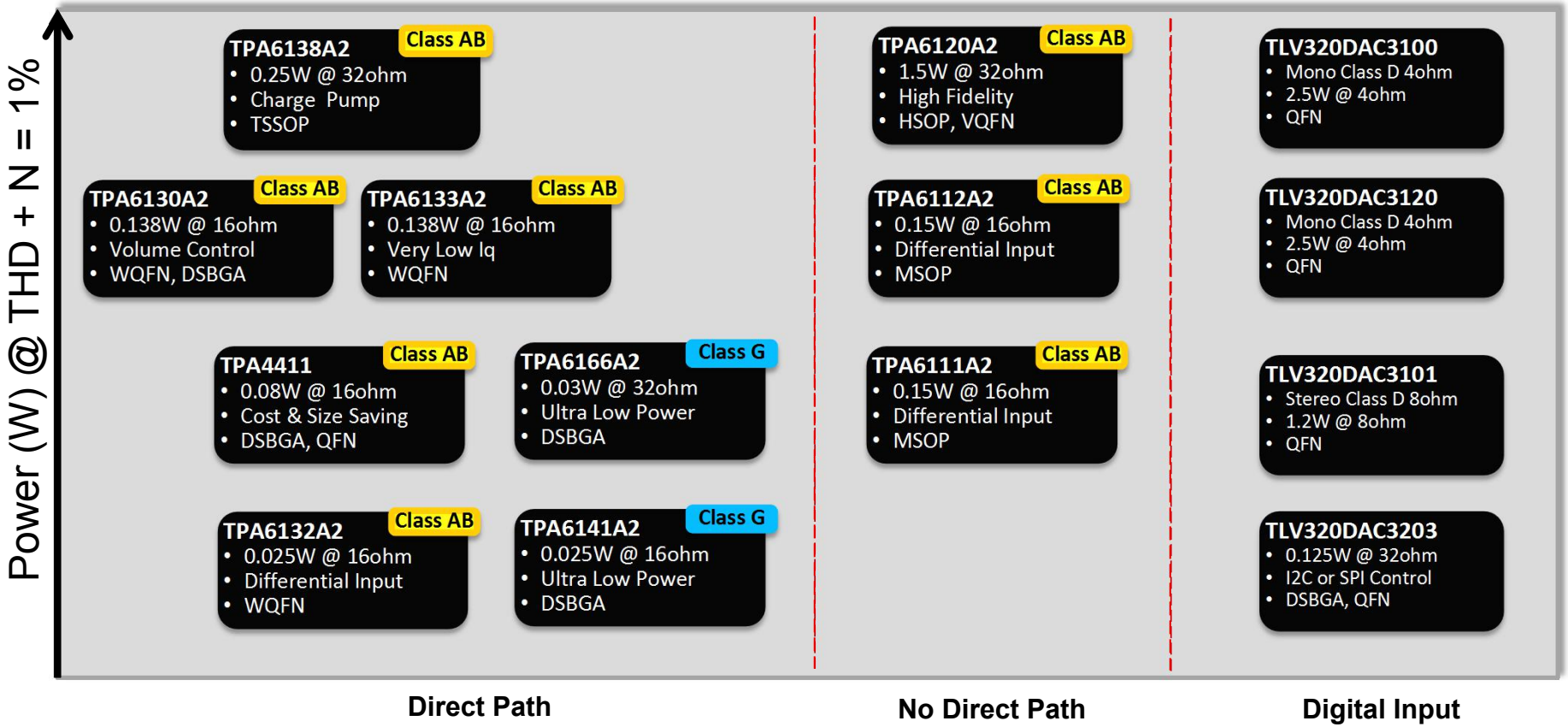
- **Primary uses**
  - Portable, battery power, consumer grade devices
  - AC power, consumer grade
  - ACpower, professional grade
- **View on the market: New Trends**
  - Digital only audio interface
  - Wireless ear buds, need mono amps
  - Bluetooth headphones and speakers
  - But all is not lost for 3.5mm jacks

Low Power Headphone Amplifier Portfolio Features

- DirectPath (ground-centered outputs)
- Output power from 25 – 150mW
- Flexible inputs/outputs
  - Differential and SE options
- Ultra-low shutdown power modes
- Class AB and G amplifier solutions
- Numerous Integrated features
  - Filter-free outputs, I2C Programmability, Selectable Gain, Volume control, Digital microphone input, Charge pump, secondary ADC, automotive specs
- Multiple packaging options
  - As small as 1.6mm^2
  - WCSP, QFP, TSSOP, MSOP, SOIC



Stereo Headphone Amplifiers



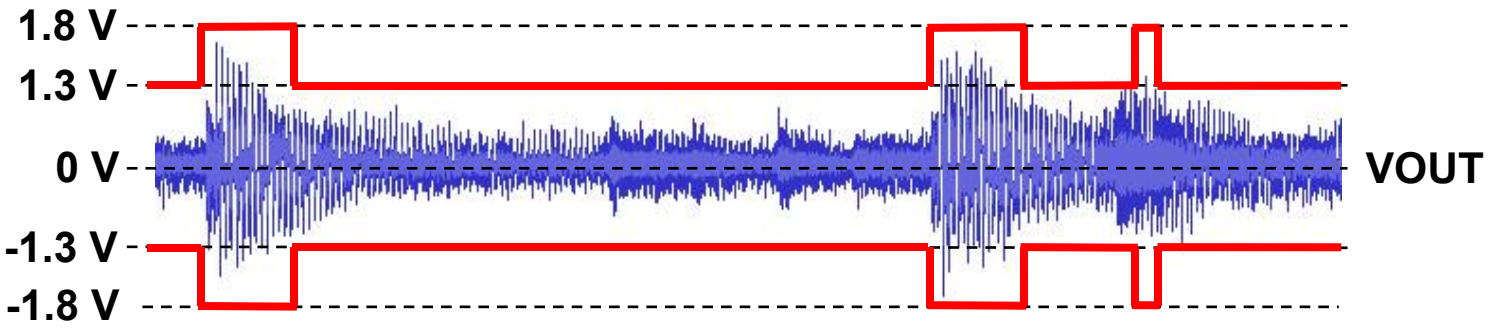
Stereo Headphone Amplifier Comparison

		High Output			Easy to Use			Power Savings	
Products		TPA6112A2	TPA6120A2	TPA6130A2	TPA6132A2	TPA6133A2	TPA6138A2	TPA6141A2	TPA6166A2
Architecture		Class-AB	Class-AB	Class-AB DirectPath	Class-AB DirectPath	Class-AB DirectPath	Class-AB DirectPath	Class-G DirectPath	Class-G DirectPath
Input Signals		Differential	Differential & Single	Differential	Differntial	Single	Differential & Single	Differntial	Differential
Output Signals		Single	Single	Single	Single	Single	Single	Single	Differential
Supply Voltage (V)	Min	2.5	±5	2.5	2.3	2.5	2.5	2.5	1.7
	Max	6	±15	5.5	5.5	5.5	5.5	5.5	1.9
Output Power at max supply		150	150	142	22	142	40	25	30
Signal-to-Noise Ratio (dB)		100	128	98	100	93	96	105	105
DC Offset Voltage (mV)		2	0.15	0.5	0.135	0.5	0.5	0.05	0.05
Quiescent Current (mA)		1.5	-	4.2	1.05	4.2	-	0.6	1
Shut down Current (µA)		10	-	1.4	0.6	1	14	1	1.05
A-Weighted Noise Floor (μV_{RMS})		11	0.9	9	5.5	12	13	5.3	2
I2C Volume Control		No	No	Yes	No	No	No	No	Yes
Packaging Options (Pins/Balls)	MSOP/HSOP	3 x 5 MSOP (10)	7.5 x 12.82 HSOP (20)	-	-	-	-	-	-
	TSSOP	-	-	-	-	-	6.9 x 5.6 TSSOP (14)	-	-
	QFN	-	3.5 x 3.5 QFN (14)	4 x 4 QFN (20)	3 x 3 QFN (16)	4 x 4 QFN (20)	-	-	-
	WCSP/BGA	-	-	2 x 2 DSBGA (16)	-	-	-	1.6 x 1.6 WCSP (16)	2.5 x 2.5 WCSP (25)
Special Features		Automotive Qualified	Low THD 112 dB; high SNR at 128 dB; 1300V/µs Slew Rate	I2C volume control Automotive Qualified version in 2018	Space saving package	Shutdown and Mute pins	Easy to use package	Class-G power savings	Class-G power savings; Jack Detect; Mic Pre-amp

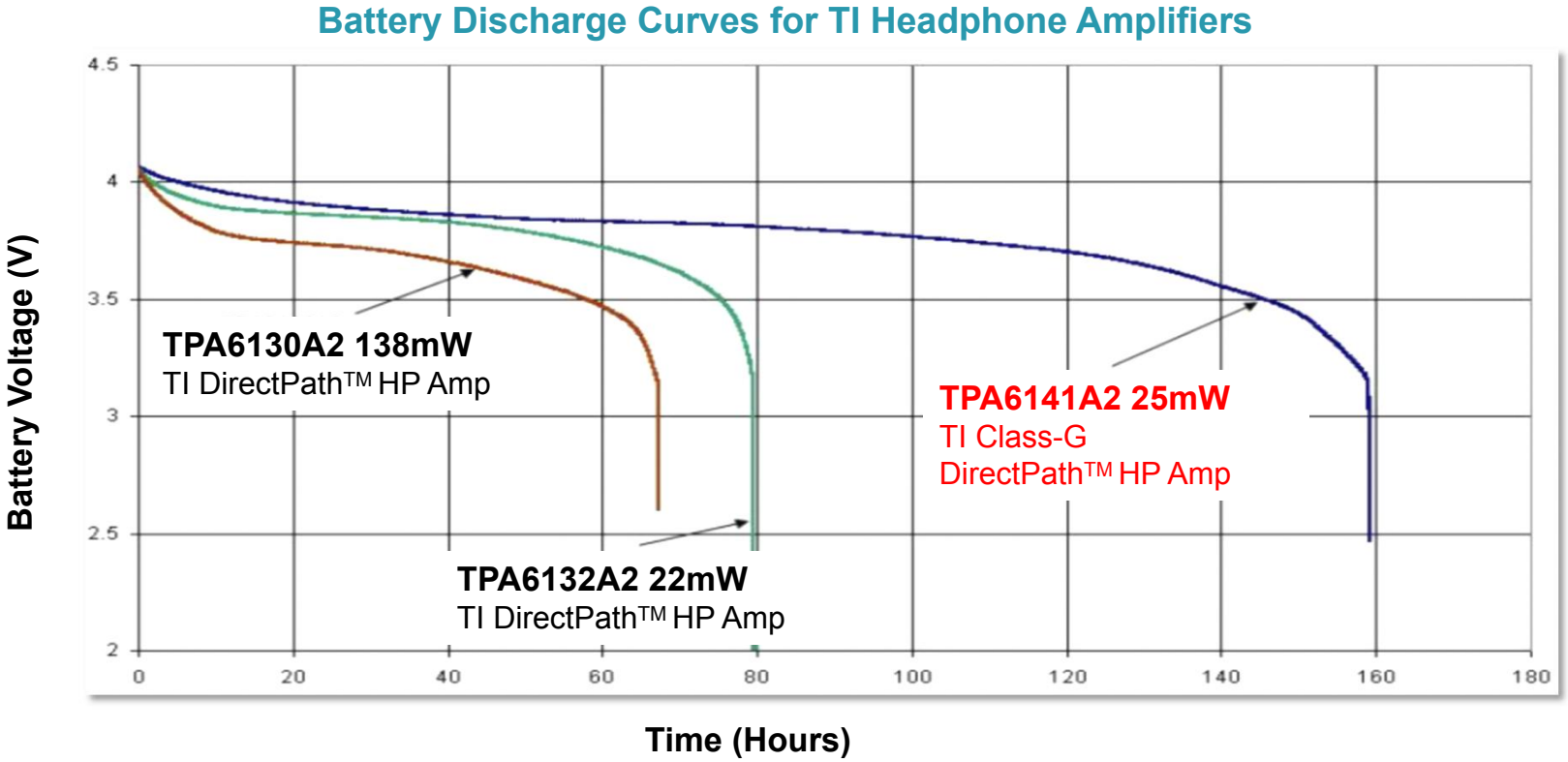
		High Output	Power Savings
Features		**TPA6120A2**	**TPA6141A2**
Mono or Stereo		Stereo	Stereo
Input Signals		Differential	Analog
Input, Digital or Analog		Analog	Differntial
Output Signals		Single	Single
Recommended Supply Voltage (V)	Min	±5	2.5
	Max	±15	5.5
Output Power (W)	Load (Ω)	32	16 | 32 | 32
	Supply (V)	-	2.7
	THD (%)	-	1 |10 | 1
	Power (W)	1.50	0.025 | 0.032 | 0.026
Signal- to- Noise Ratio (dB)		128	105
DC Offset Voltage (mV)		2	0
Quiescent Current (mA)		-	0.6
Shut down Current (µA)		11.5	1
Noise Floor Gain (μV_{RMS})	A-Wt	0.9	5.3
PSRR (dB)		75	105
Auto-Short Circuit Recovery		No	No
Packaging Options	Size (mm) Package	7.5 x 12.82 HSOP (20) 3.5 x 3.5 VQFN (14)	1.6 x 1.6 WCSP
	Pins	20, 14	-
	Ball	-	16
	Pitch (mm)	-	0.4
Stat-up Time (ms)		-	5
Dc-Dc Boost		No	No
Special Features		Hi-Fi	DirectPath Class G technology to significantly prolong battery life. Gain select

Class-G advantages over Class-AB

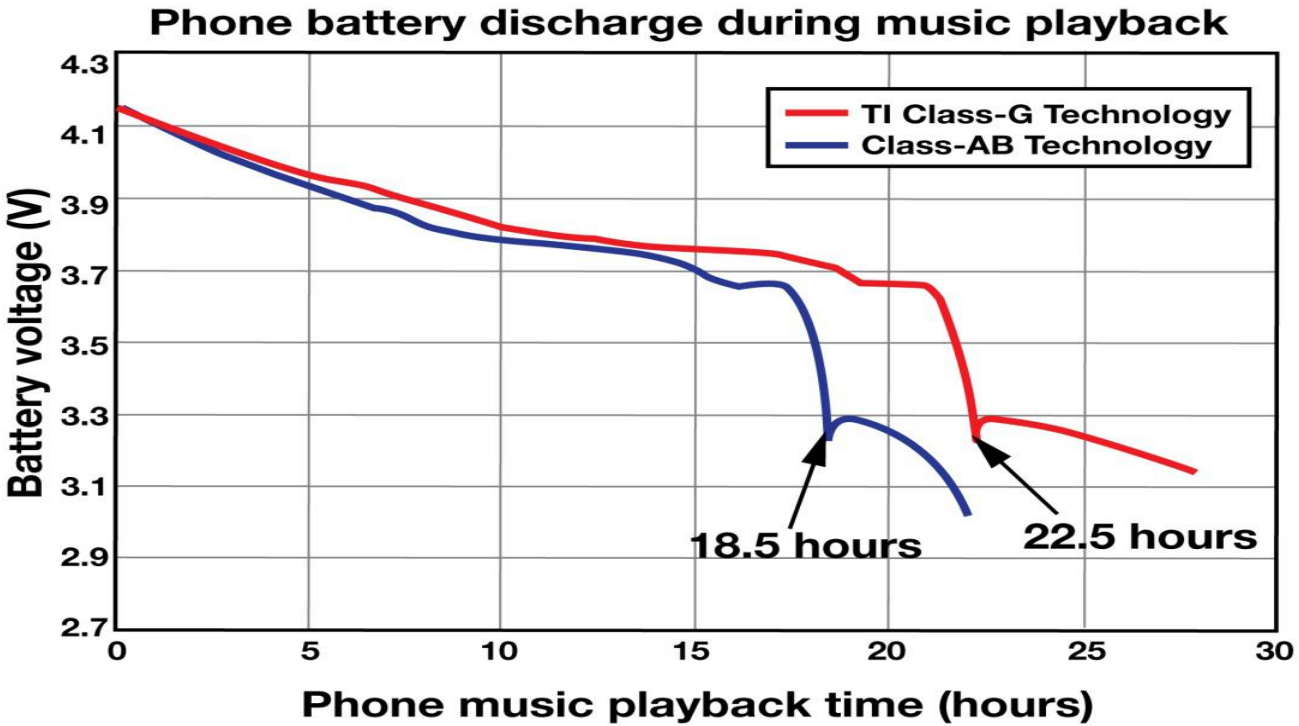
- Lots of wasted power with fixed supply rail Class-AB around 4 mA_{RMS} per channel into 32 Ω with 1 mW sine wave
- Class-G adds a lower voltage rail and control that adjusts supply voltage with the audio signal
- Voltage Increases to prevent distorting and clipping large peak voltages
- Voltage decreases during small peaks which improves battery life



TPA6141 Class-G Battery Life Comparison



TPA6141 Class-G Music Playback comparison



		High Output	Power Savings
Features		**TPA6120A2**	**TPA6141A2**
Mono or Stereo		Stereo	Stereo
Input Signals		Differential	Analog
Input, Digital or Analog		Analog	Differntial
Output Signals		Single	Single
Recommended Supply Voltage (V)	Min	±5	2.5
	Max	±15	5.5
Output Power (W)	Load (Ω)	32	16 | 32 | 32
	Supply (V)	-	2.7
	THD (%)	-	1 |10 | 1
	Power (W)	1.50	0.025 | 0.032 | 0.026
Signal- to- Noise Ratio (dB)		128	105
DC Offset Voltage (mV)		2	0
Quiescent Current (mA)		-	0.6
Shut down Current (µA)		11.5	1
Noise Floor Gain (μV_{RMS})	A-Wt	0.9	5.3
PSRR (dB)		75	105
Auto-Short Circuit Recovery		No	No
Packaging Options	Size (mm) Package	7.5 x 12.82 HSOP (20) 3.5 x 3.5 VQFN (14)	1.6 x 1.6 WCSP
	Pins	20, 14	-
	Ball	-	16
	Pitch (mm)	-	0.4
Stat-up Time (ms)		-	5
Dc-Dc Boost		No	No
Special Features		Hi-Fi	DirectPath Class G technology to significantly prolong battery life. Gain select

TPA6141A2

DirectPath™ Class-G Amplifier with Gain Select

Features

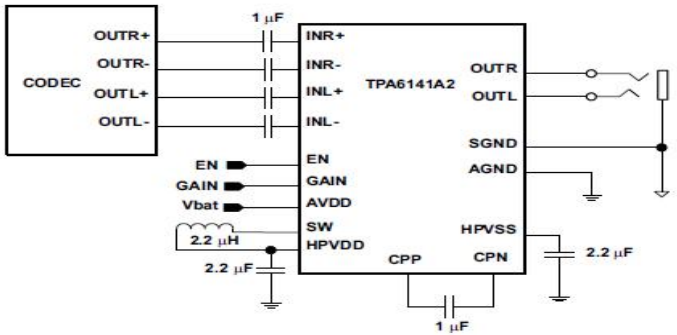
- Class-G Amp w/ 32mW/Ch into 32Ω
- DirectPath Ground-Referenced Outputs
- Differential Inputs with integrated low-pass filter
- 2.5-5.5V supply voltage
- Gain Control
- Ground Sense Pin
- YFF: 16-ball, 1.6 x 1.6mm, 0.4mm pitch wCSP

Benefits

- Maximizes battery life
- Eliminates DC blocking caps
- Reduced system noise
- Covers the power supply rails typically available in portable systems
- Chose either 0 or 6dB
- Reduces ground-loop noise

Applications

Handsets
Tables
Notebook PCs
Docking Stations
Remote Control



Headphone Amplifier Overview

July, 2018

TPA6138A2

25mW Class-AB Amplifier with DirectPath™

Features

- 25mW output power into 32Ω at 3.3V
- DirectPath Ground-Referenced Outputs
- Differential Inputs
- Active mute control
- External Under-voltage Mute
- Integrated charge pump
- PW: 14-pin, 4.5 x 5mm, 0.65mm pitch TSSOP

Benefits

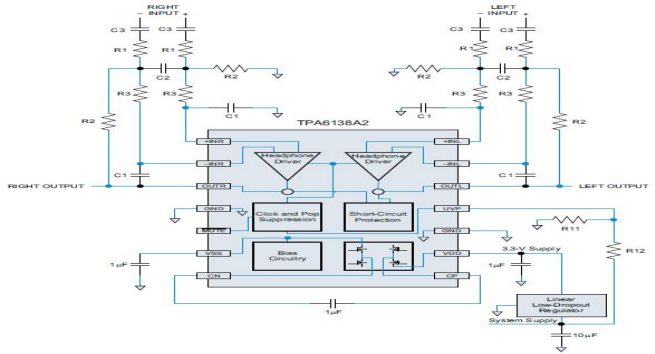
- Louder audio than the leading competition
- Eliminates DC blocking caps
- Better noise rejection = better audio quality
- Pop-free audio On/Off control
- Output mute upon power supply removal
- Remove split-rail power requirement

Applications

Television

Speaker Bar

STB



TPA6133A2 / TPA6130A2

138mW Class-AB Amplifiers with DirectPath™

Features

- 138mW output power into 16Ω at 5V
- DirectPath Ground-Referenced Outputs
- I2C Configurable (TPA6130)
- 2.5-5.5V Supply voltage
- Low supply current : 4mA at 5V
- 109dB PSRR
- RTJ: 20-pin, 4 x 4mm, 0.5mm pitch QFN
- YZH: 16-ball, 2 x 2mm, 0.5mm pitch wCSP (TPA6130A2 only)

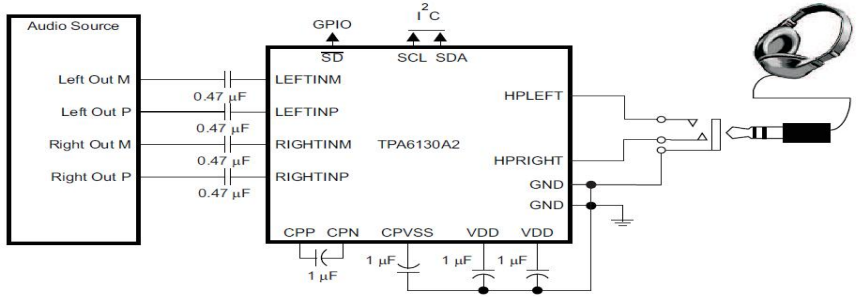
Benefits

- Louder audio than the leading competition
- Eliminates DC blocking caps
- Available with or without I2C control
- Covers the power supply rails typically available in portable systems
- Low power consumption for battery-powered applications
- Enables direct-to-battery connections

Applications

Notebook PCs

Docking Stations



TPA6141A2

DirectPath™ Class-G Amplifier with Gain Select

Features

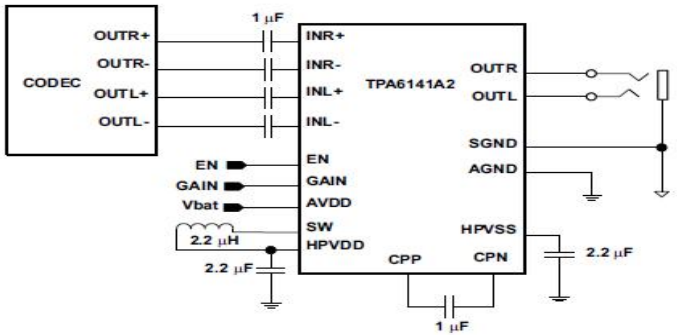
- Class-G Amp w/ 32mW/Ch into 32Ω
- DirectPath Ground-Referenced Outputs
- Differential Inputs with integrated low-pass filter
- 2.5-5.5V supply voltage
- Gain Control
- Ground Sense Pin
- YFF: 16-ball, 1.6 x 1.6mm, 0.4mm pitch wCSP

Benefits

- Maximizes battery life
- Eliminates DC blocking caps
- Reduced system noise
- Covers the power supply rails typically available in portable systems
- Chose either 0 or 6dB
- Reduces ground-loop noise

Applications

Handsets
Tables
Notebook PCs
Docking Stations
Remote Control



TPA6166A2

DirectPath™ Class-G Amplifier with Jack Detection

Features

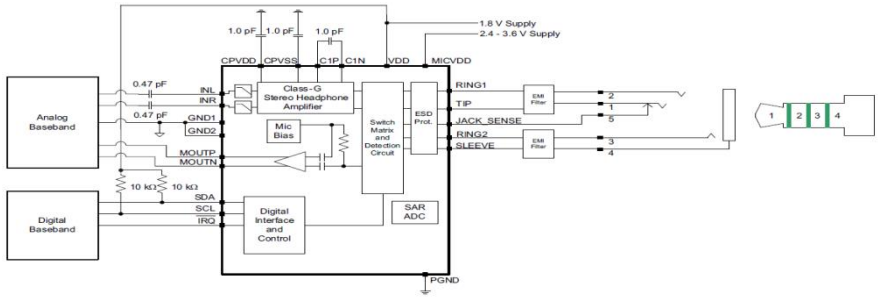
- Class-G Amp w/ 30mW/Ch into 32Ω
- DirectPath Ground-Referenced Outputs
- -42 to +6dB volume control
- Differential Microphone Pre-Amp
  - Two programmable Gains
- Advanced Accessory detection
- Secondary ADC for passive multi-button support
- I2C Control
- YFF: 25-ball, 2.5 x 2.5mm, 0.4mm pitch wCSP

Benefits

- Maximizes battery life
- Eliminates DC blocking caps
- 1dB steps and control for each channel
- Removes requirement of external AC coupling capacitor
- Easily determine attached devices and customize settings
- Ability to use low-power passive buttons for wakeup purposes
- Standard inter-chip communication

Applications

Handsets
Tables
Notebook PCs
Docking Stations



TPA6132A2

25mW Class-AB Amplifier with DirectPath™

Features

- 25mW output power into 16Ω at 2.3V
- DirectPath Ground-Referenced Outputs
- Selectable Gain (-6,0,3,6dB)
- 2.3-5.5V Supply voltage
- Low supply current : 2.1mA at 2.3V
- 100dB PSRR
- RTE: 16-pin, 3 x 3mm, 0.5mm pitch QFN

Benefits

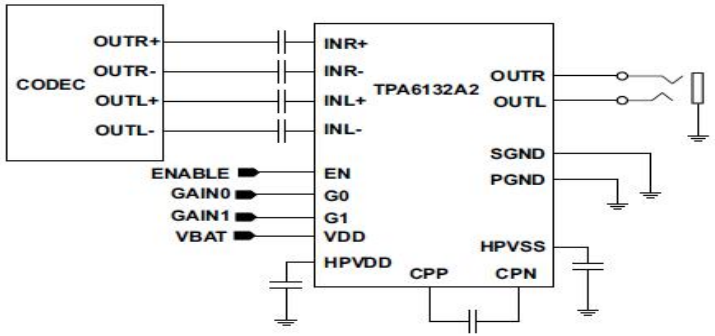
- Loud and Low power option
- Eliminates DC blocking caps
- Customize to your applications
- Covers the power supply rails typically available in portable systems
- Low power consumption for battery-powered applications
- Enables direct-to-battery connections

Applications

Handsets

Notebook PCs

Docking Stations



TPA6138A2

25mW Class-AB Amplifier with DirectPath™

Features

- 25mW output power into 32Ω at 3.3V
- DirectPath Ground-Referenced Outputs
- Differential Inputs
- Active mute control
- External Under-voltage Mute
- Integrated charge pump
- PW: 14-pin, 4.5 x 5mm, 0.65mm pitch TSSOP

Benefits

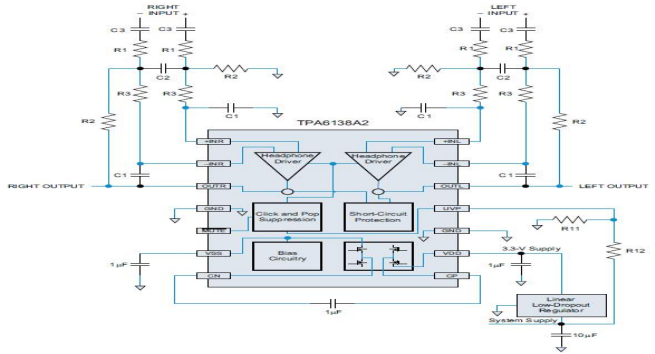
- Louder audio than the leading competition
- Eliminates DC blocking caps
- Better noise rejection = better audio quality
- Pop-free audio On/Off control
- Output mute upon power supply removal
- Remove split-rail power requirement

Applications

Television

Speaker Bar

STB



TPA6112A2

150mW Class-AB Amplifier

Features

- 150mW output power into 16Ω at 2.3V
- Differential Inputs
- 2.5-5.5V Supply voltage
- Low supply current : 1.5mA at 2.5V
  - 10uA current in Shutdown mode
- DGQ: 10-pin, 3x5mm, 0.5mm pitch MSOP

Benefits

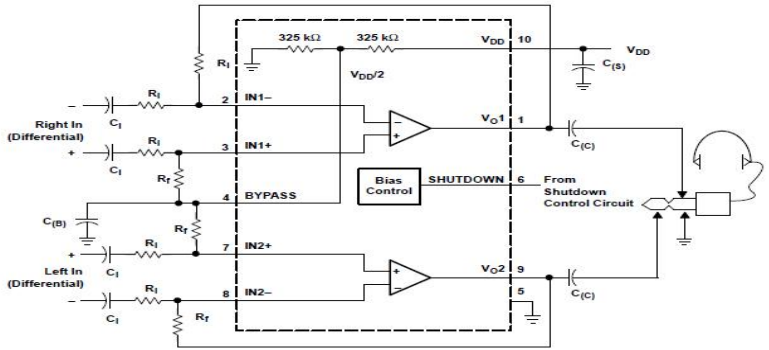
- Louder audio than the leading competition
- Increased immunity to noise
- Covers the power supply rails typically available in portable systems
- Low power consumption for battery-powered applications

Applications

Handsets

Notebook PCs

Docking Stations



TPA6120A2

High Fidelity Headphone Amplifier

Features

- Current-feedback amplifier
- 128dB Signal-to-noise / 112dB THD+N
- Output Noise: 0.9uVrms
- Differential Inputs

- Independent power supplies
- RGY: 14-pin, 3.5x3.5mm, 0.5mm pitch QFP
- DWB: 20-pin, 7.5x13mm, 1.2mm pitch

Benefits

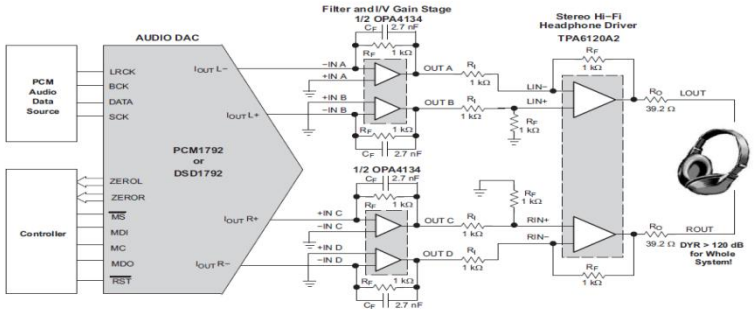
- Low voltage noise and distortion
- Highest performance amplifier
- Very low output noise
- Achieves maximum dynamic range and noise immunity
- One amplifier can be turned off to save power / Low crosstalk

Applications

HiFi Smartphone

Professional / Consumer Audio Equipment

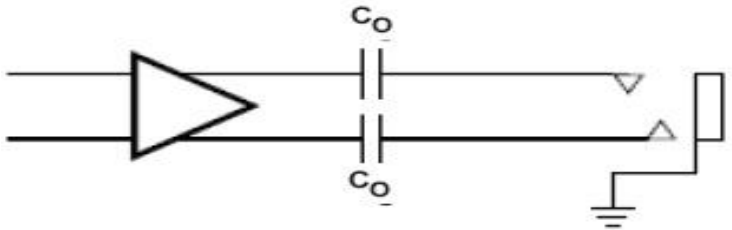
Headphone driver

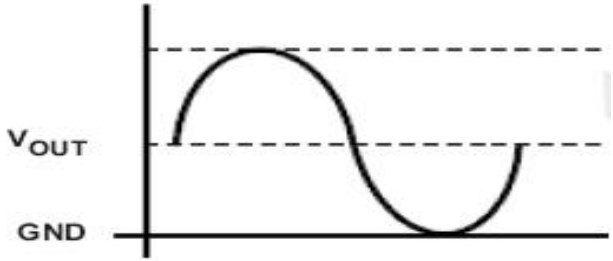


Headphone Architectures

- Standard
  - Large output capacitors (100uF+)
- Pseudo-ground
  - Also called Output Capacitor-Less (OCL)
  - Uses a VCOM bias voltage
- DirectPath™
  - Charge-pump generates negative rail
  - Eliminates output caps

Standard Headphone Amp

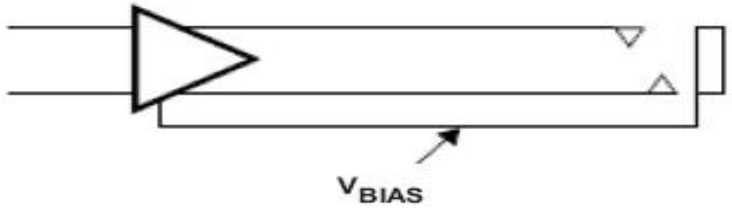


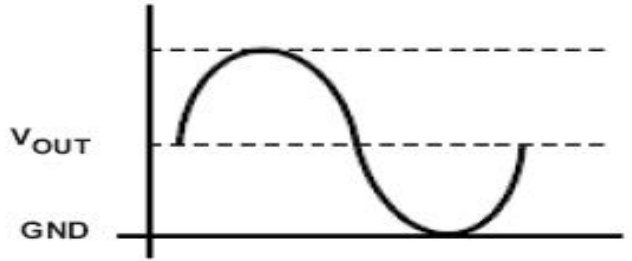


- Pros
- Well understood
- Good channel separation
- Interfaces with non-headphone accessories

- Cons
- Needs large output caps
  - Increases size (and height)
  - Increases THD
  - Increases cost!

Output Capacitor-Less Amp

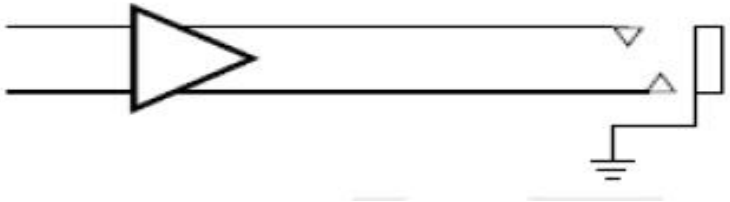


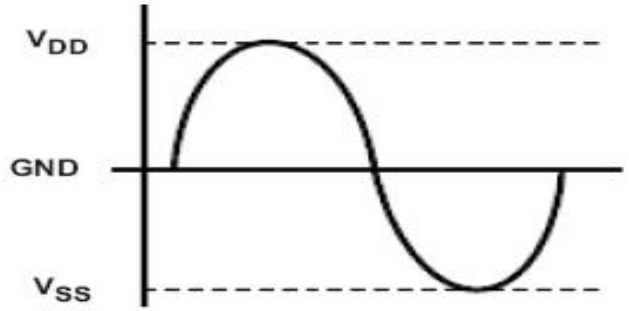


- Pros
- No large output caps

- Cons
- Lower channel separation
- Does not interface with non-headphone accessories

Ground Centered DirectPath Amp





- Pros
- No large output caps
- Excellent low frequency response
- Excellent channel separation
- Interfaces with non-headphone accessories

- Cons
- Due to charge pump, amp has to be designed to reduce quiescent current
- TI amps have low quiescent current

接下来...

时间	课题	讲师
10:00 – 10:15	无线耳机整体方案及设计趋势	Kerry Song
10:15 – 10:40	TI 无线耳机电池管理系统设计	Alen Chen
10:40 – 11:05	TI 无线耳机 LED 驱动设计	Michelle Shi
11:05 – 11:30	TI 无线耳机功放系统设计	Raphael Xu
11:30 – 11:45	TI MCU 及触控方案设计	Ling Zhu
11:45 – 12:00	TI 其他常用耳机方案介绍	Kerry Song

CapTIvate™ for Headsets

The world’s lowest power cap-touch MCU in a tiny 2.3mm x 2.3mm package

Ling Zhu

CapTIvate overview

www.ti.com.cn/captivate

Robust and reliable

Tolerant to electromagnetic disturbances
Resistant to oil, water and grease
Consistent performance in temperature variations
IEC and IPX certified solutions for reliability

Single-chip versatility

Up to 64 buttons
Proximity, sliders, wheels
<2uA wake-on touch/proximity, grip detection
Touch through metal, plastic, glass and wood

Tools and support

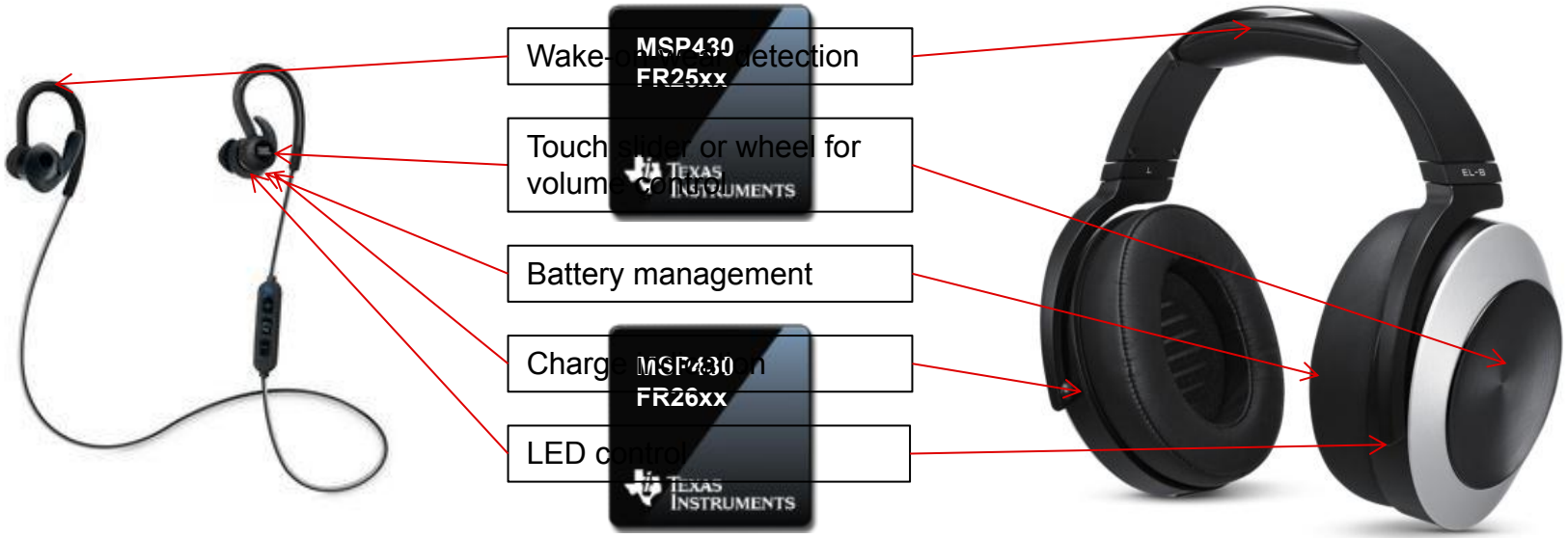
Easy to use tools and software
CapTIvate Design Center: Get started in <5 minutes
TI E2E™ support community
Extensive online training and documentation

DEVICES

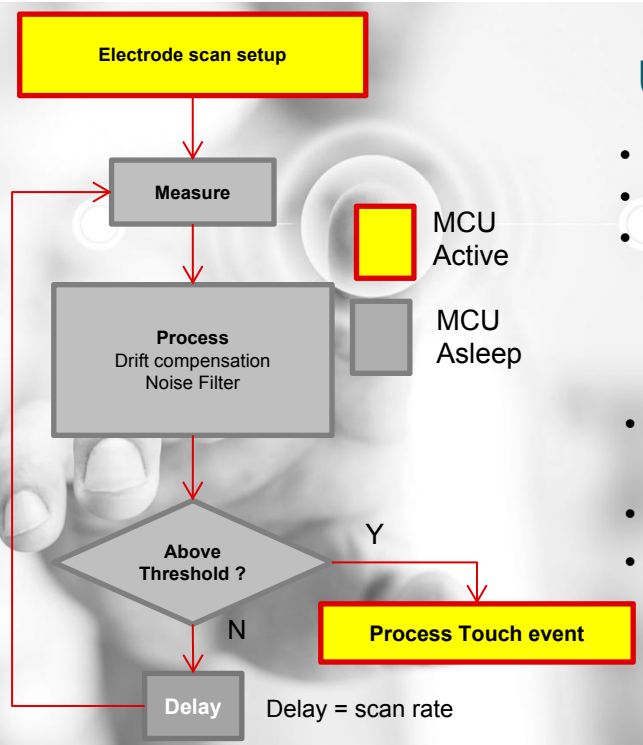
MSP430 FR25xx

MSP430 FR26xx

Possible use cases



CapTIvate for Headsets – Ultra low power



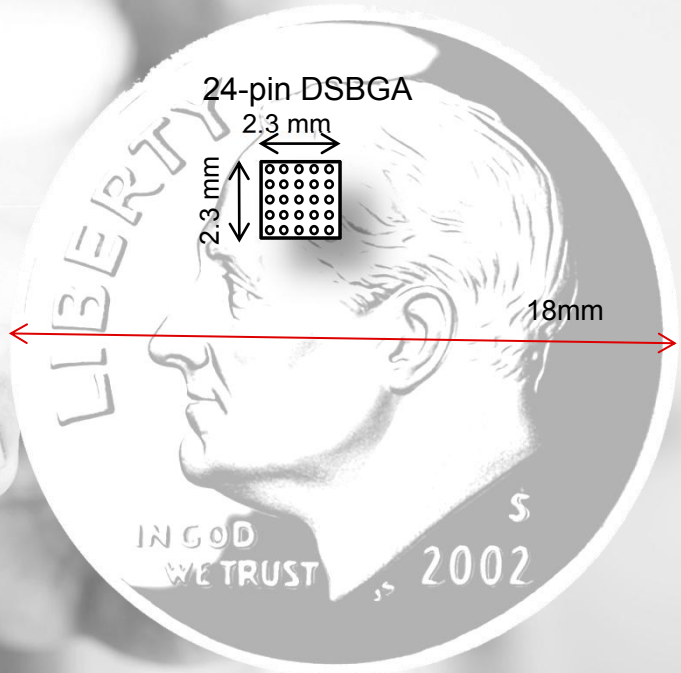
Up to 90 percent lower power than other solutions

- Scan up to four buttons at 0.9 µA per button with the CPU completely turned off
- Autonomous peripherals enable you to do more with less power
- Experience up to 5 years of battery life on a single coin cell battery

World's only FRAM MCU with CapTIvate™ technology

- FRAM and CapTIvate technology on the same device allows for HMI applications with ultra-low-power data logging and state retention capabilities
- 10^{15} write endurance
- 100x faster and 250x lower energy writes than other non-volatile technology

CapTIvate for Headsets – DSBGA



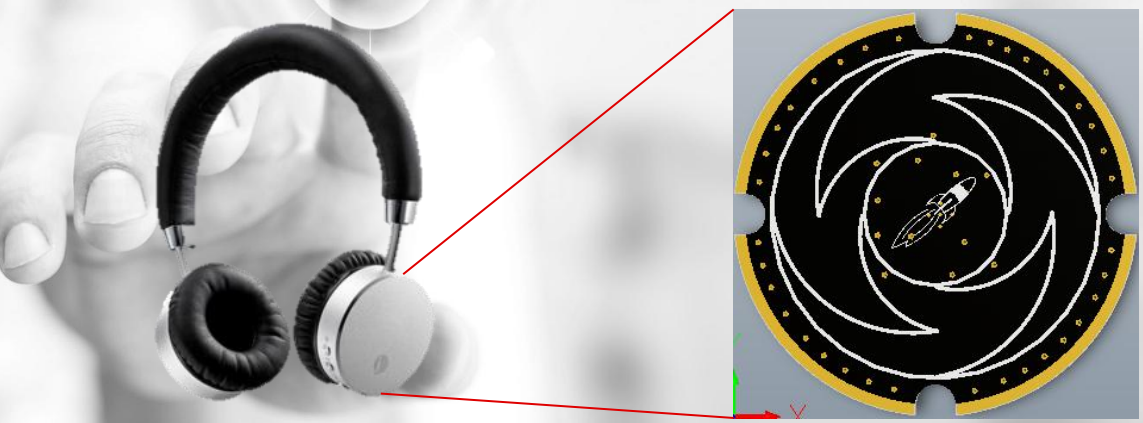
MCU compared to a dime

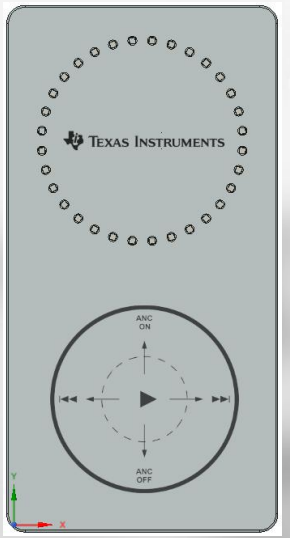
MCU compared to a pen

Sensors kit with high resolution slider, 3 mutual capacitance buttons, and 2 self capacitance buttons

CapTIvate for Headsets – Touch on Metal

- Touch on metal
  - Enable gesture control via a series of swipes and taps on the metal casing.
  - Work with gloves.

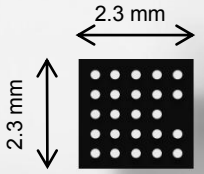




http://www.ti.com/lit/an/slaa811a/slaa811a.pdf

CapTIvate for Headsets – Summary

Ultra low power



Tiny package

Touch on metal

Get started today

Development tools & resources

- Use the CapTIvate Design Center to develop your solution without writing a single line of code
- MSP-CAPT-FR2633 Development Kit
- Comprehensive technology guide to assist your design
- Start tuning your sensors in less than 5 minutes
- CapTIvate Touch MCUs Portfolio

接下来...

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11:45 – 12:00	TI 其他常用耳机方案介绍	Kerry Song

TI 其他常用耳机方案介绍

TI针对无线耳机应用的方案及产品推荐

分类	产品/方案	描述	数据表及下载
系统方案 Hot!	耳机整体方案	交互式系统框图，提供子系统器件及参考设计选型	查看详情
参考设计	TIDA-050007	TWS超低功耗待机电源参考设计	查看详情
电源及电池管理系统	BQ25100	250mA单路输入、单节锂离子电池充电器	查看详情
	BQ24045	适用于单节应用的锂离子电池充电器	查看详情
	BQ24078	具有电源路径管理功能的 1.5A 线性充电器	查看详情
	BQ27426	具有集成感应电阻的系统端 Impedance Track™ 电量监测计	查看详情
	TPS61099	具有超低静态电流的同步升压转换器	查看详情
	TLV733P	用于便携式器件带有折返电流限制的无电容器，300mA，低压降稳压器	查看详情
	TLV62568	采用 SOT-23 封装的 1A 高效降压转换器	查看详情
音频系统	TPA6141A2	25mW G 类 DirectPath™ 立体声耳机放大器 (TPA6141)	查看详情
	TPA6132A2	具有杂音抑制功能的 25mW DirectPath™ 立体声耳机放大器 (TPA6132)	查看详情
	PCM5102A	具有 32 位 1.8V IO 的 2VRMS DirectPath™ 111/106/100dB 音频立体声 DAC	查看详情
LED驱动系统	LP5569	带引擎控制和电荷泵的九通道 I2C RGB LED 驱动器	查看详情
	LP5018	LP5018 18 通道 I2C 恒定电流 RGB LED 驱动器	查看详情
用户交互系统	TLV320AIC3254	采用可编程 miniDSP 的超低功耗立体声音频编解码器	查看详情
	TLV320ADC3101	支持数字麦克风和 miniDSP 的 92dB SNR 低功耗立体声 ADC	查看详情
	MSP430FR2512	采用 CapTIvate 技术（功耗最低且最抗噪的电容式触控技术）的 MSP430 MCU	查看详情
主控	MSP430FR2100	具有 1KB FRAM、0.5KB SRAM、10 位 ADC 的 16MHz 超低功耗微控制器	查看详情
信号检测	AFE4410	光学心率监测和生物传感且具有 FIFO 的超小型集成式 AFE	查看详情
	DRV5032	超低功耗 1.65V 至 5.5V 霍尔效应开关传感器	查看详情
其他常用器件	SN74LVC1G3157	1 通道 2:1 模拟开关	查看详情

适用于TWS 耳机参考设计

TI Designs Number: TIDA050007

TIDesigns

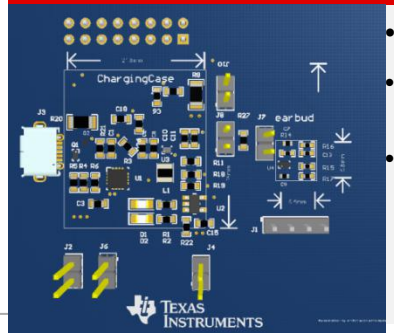
Solution Features

- 18uA Ultra-low standby current
- Support Up to 1.5A fast charging current
- Pass-through mode when VIN>VOUT
- Higher than 15% charging cycles than traditional 5V constant output boost charging case
- Features protection functions: Ouput Short Circuit Protection, Input Over Voltage Protection
- Down to 1mA charging current accuracy

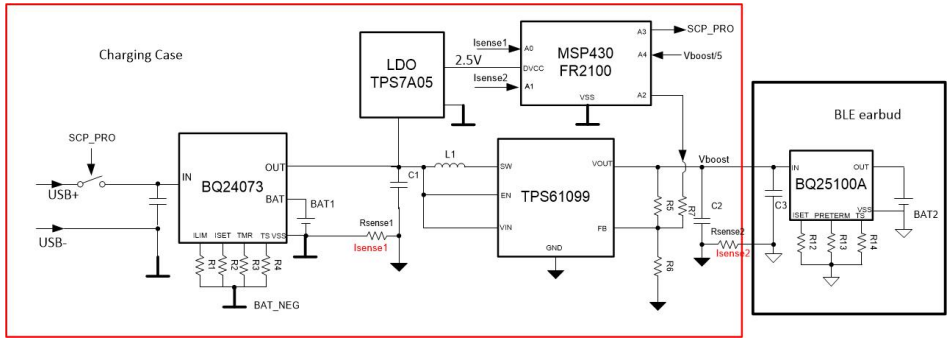
Solution Benefits

- High charging efficiency to achieve 15% more charger cycles
- Ultra low standby current to extend battery lifetime
- Small solution size, easy PCB design
- High charging accuracy

Tools & Resources



- **TIDA050007**
- **Design Files:** Schematics, BOM, Gerbers, and more
- **Device Datasheets**:
  - TPS61099
  - BQ25100A
  - BQ24073
  - MSP430FR2100
  - TPS7A05



Texas Instruments

Boost TPS61099

Up to 5.5V output synchronous boost with ultra-low quiescent current

FEATURES

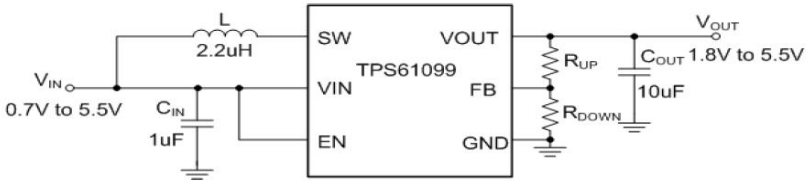
- **0.8uA ultra-low I_Q under Light Load**
- Operating Input Voltage from 0.7 V to 5.5 V
- Adjustable Output Voltages from 1.8 V to 5.5 V
  - Fixed version available
- 0.8 A Min. Switch Current Limit
- **True Disconnection During Shutdown**
- >70% Efficiency at 10µA Load
- >90% Efficiency at 10mA ~ 200mA Load
- 6 Pin 1.23 mm x 0.88 mm WCSP Package
- **Pass-through mode**

APPLICATIONS

- Heart rate monitor
- RF module power supply
- Sensor power supply
- Wearable devices

BENEFITS

- Small package to allow compact system design
- Ultra low Iq and true disconnection to extend battery run time
- High output capability to support pulse load
- Short Circuit Protection



Vout options / Vout	
TPS61099	Adjustable
TPS610997	5.0V

LDO TPS7A05

200mA, Ultra Low IQ LDO in small package

Features

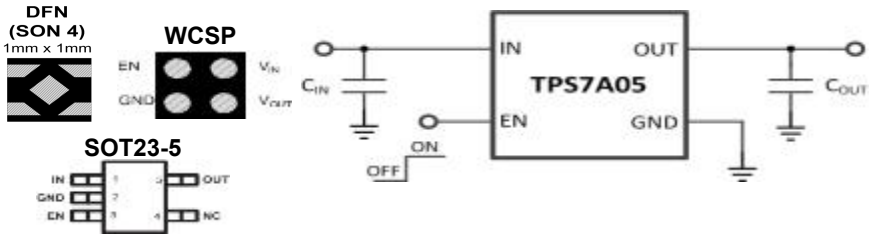
- Ultra Low I_Q: 1uA (typ); 2uA,max (-40C to +85C)
- 1% Typical Accuracy, 1.5% (-40C to +85C)
- Fast Transient Response
  - 1mA to 100mA load: 50us recovery
- Very Low Dropout
  - 204mV(max) @ I_{OUT}=200mA,V_{OUT}=3.3V
- Available in fixed output voltages 0.8V to 3.3V
- WCSP (0.65mm X 0.65mm), SON-4 (1x1)
- Available with Active Pulldown
- T_J = -40 to +125C operation

Applications

- Wearable fitness devices
- Tablets, e-readers, Remote Controls
- Portable Consumer products
- Always-on power supplies

Benefits

- Low current for long battery life
- Stable output for low power applications
- Suited for applications with low duty cycles and long sleep durations
- Allows for maximum efficiency by optimizing upstream power for minimum power loss.
- Powers processor with sub 1.2V power rails
- Small packaging for space critical applications
- Allows for compliance loads requiring deterministic power down behavior.



Device	V_{IN}	I_{OUT}	V_{DO}	I_Q	Package
TPS7A05	1.4V – 5.5V	200mA	204mV (max) @V_{OUT}=3.3V	1uA	WCSP (0.35mm pitch) QFN-4 (1x1); SOT23-5

TI Designs TIDA-00011: *Optical Heart Rate Monitor Reference Design with Connectivity*

New and ideal device for headset: AFE4410

Solution Features

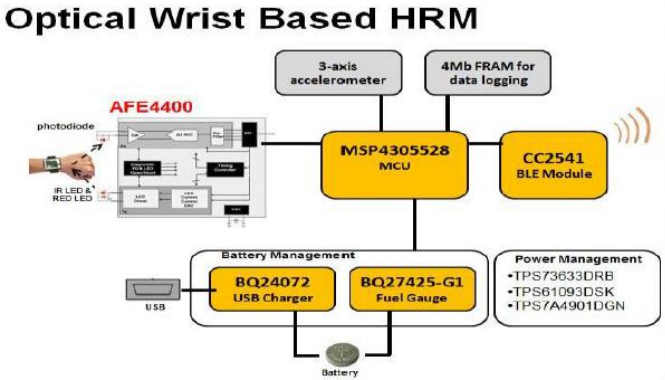
- Measure pulse from veins in wrist using the **AFE4400**
- **MSP430F5528** microcontroller for holding algorithm and motion cancellation calibration data
- BLE module connection featuring TI's **CC2541**
- **BQ24072** USB charger and **BQ27425-G1** fuel gauge devices for battery management

Solution Benefits

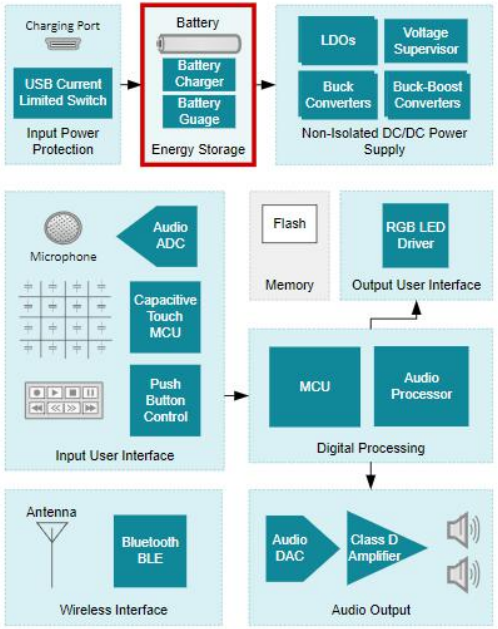
- Accelerate and simplify your wrist based HRM design while ensuring measurement performance needed for Fitness designs
- Easy connectivity to BLE enabled smartphones, tablets, etc.
- Ultra-low power consumption

Tools & Resources

- http://www.ti.com/tool/TIDA-00011
- Includes
  - Schematics
  - Layout
  - Gerber files
  - BOM



找方案，上TI.com



ti.com.cn/wirelessheadset

有问题，来E2E

e2echina.ti.com

感谢参与!