

无线充电及穿戴式 产品解决方案



Oct. 2015



❖ 无线充电产品概述及方案



TI无线充电接收端解决方案选型指南

Part Number	bq51003	bq51013B bq51010B	bq51020/1 bq51221	bq51025	bq51050/51B/52B
Architecture					
Standard Supported	WPC	WPC	WPC & WPC/PMA	WPC (10W Prop)	WPC
Power	<2.5W	2.5 – 3.5W	5W	5-10W	3-4W
CSP (mm ³) QFN (mm ²)	3 x 2 x 0.5	3 x 2 x 0.5 3.5 x 4.5	3.6 x 2.9 x 0.5	3.6 x 2.9 x 0.5	3 x 2 x 0.5 3.5 x 4.5
IC/Sys Eff	93%/70%	93%/75%	96%/78%	96%/84%	90%/77%
I2C	No	No	Yes	Yes	No
Pad Det/ Alignment Aid	No	No	Yes	Yes	No
Solution Size	50 mm ²	75 mm ²	77 mm ²	120 mm ²	75 mm ²
Typical Coil	20 x 20 mm ²	35 x 35 mm ²	42 x 38 mm ²	48 x 32 mm ²	35 x 35 mm ²

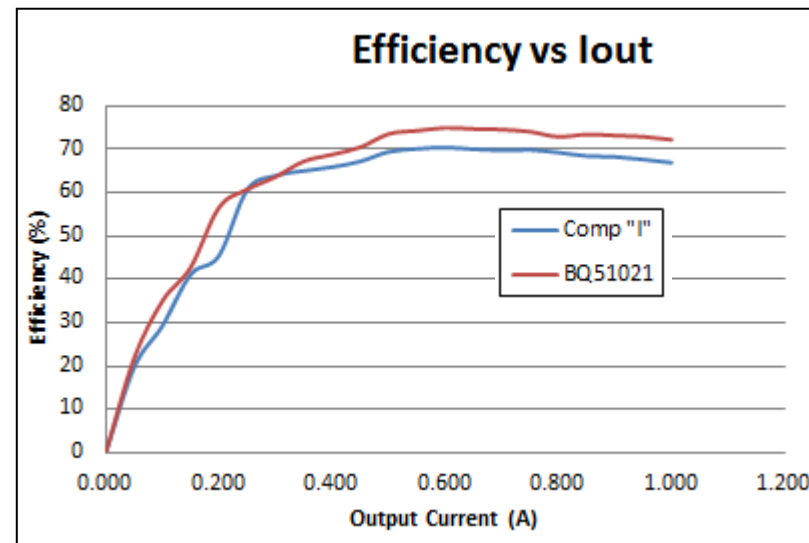
bq51221/021/020

Dual Mode (WPC/PMA) & WPC 5W Wireless Power Receivers

Features

- **bq51221 - WPC1.1 and PMA Compliant Receiver** automatically switches to correct
- **bq5102X – WPC 1.1** compliant Receiver
- **Guaranteed 5W Operation**, ensures Faster Charging with minimal temperature rise
- **Adjustable Output Voltage (4.5 to 8V)** allows o/p voltage to be optimized to the system to reduce Power Dissipation
- **I2C Interface** adds Design Flexibility and provides Unique Features such as Programmable Current Limit
- **Smallest Solution Size for 5W system**, allows all electronics to fit into $<75\text{mm}^2$
 - 3.6 x 2.9mm x 0.5mm CSP

System Efficiency



Applications

- Smart Watches
- Smart Phones
- Health Monitors
- Scanners/POS
- Cordless Instruments
- Powerbanks

bq51025

Proprietary 10W WPC 1.1 Compliant Receiver

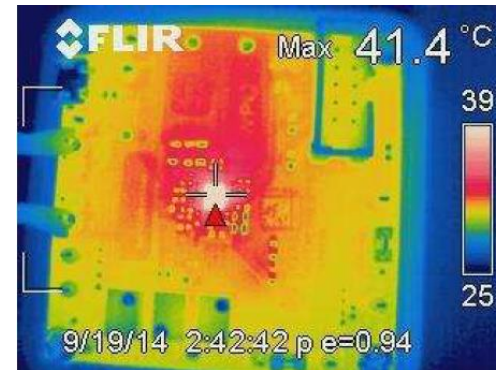
Features

- **Enables 10W Output power** when paired with bq500215 Transmitter
 - Smallest, most efficient 10W design
- **WPC 1.1 Compliant with all Industry Qi Transmitters**
 - Ability to differentiate system with faster charging while ensuring Qi compatibility
- **Adjustable Output to 10V ensures Highest Efficiency and lowest Power Dissipation**
 - Efficiency up to 84% at 10W
- **10V Output support 1S and 2S Charging**
- **I2C Interface** allows customers to control features including Vout, Iout, FOD and System Status

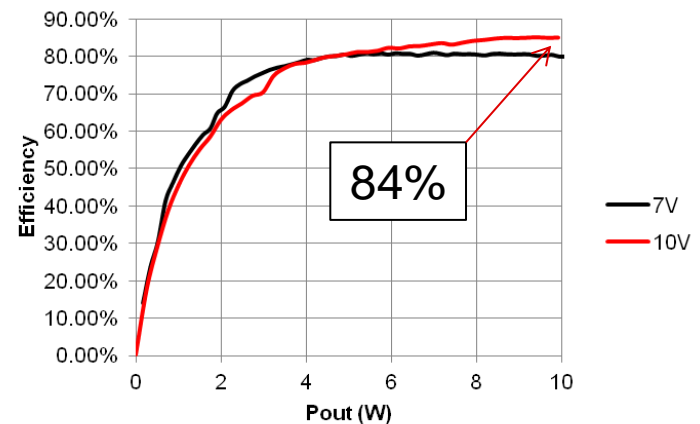
Applications

- Smart Phones
- Scanners/POS
- Cordless Instruments
- Health

Thermal Performance at 7V/10W



Efficiency



bq51010B/13B/5XB, bq51003

Cost Efficient, Up to 3.5W WPC1.1 Wireless Power Receiver

Features

- **2nd Generation** Wireless Power Receiver Family
 - Lowest Cost Solution
- **Smallest solution Size**
 - Small 3.0 x 2.0x 0.5mm CSP or QFN Package
 - Fully integrates critical RX Functions
- **Fully WPC1.1 Compliant** w/ FOD Protection
- **Critical Features include:**
 - Powerpath auto selects AC/USB or Wireless I/P
 - Adjustable Current Limit and Coil Overvoltage protection to optimize system efficiency
- **bq5105xB removes need for extra Battery Charger,**
 - Saving Board Area and reducing cost
 - Improving Efficiency
 - **New bq51052B has 4.4V** for new battery types

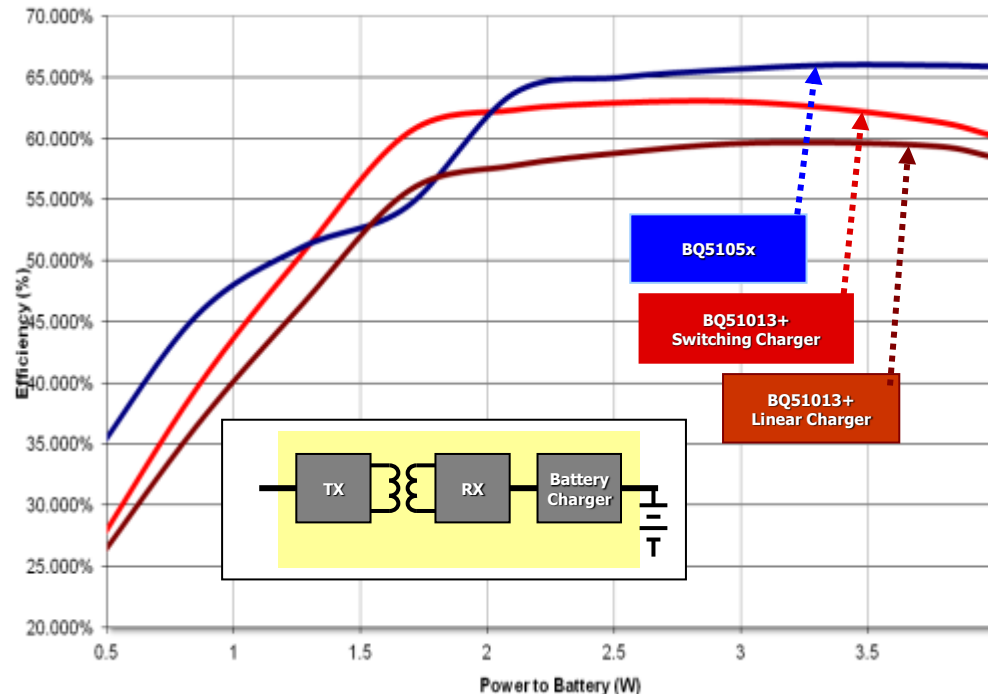
Part Number	Arch	O/P	Power
bq51003	Power Supply	5V	2.5W
bq51013B		5V	<4W
bq51010B		7V	5W
bq51050/1/2B	Direct Charge	4.2/4.35 /4.4 V	<4W

Applications

- **Smart Watches**
- **Higher Current Wearables**
- **Health Monitors**
- **Powerbanks**

The Value of Direct Charge (bq51050/51/52B)

- **Direct Charge is when the Wireless Power Receiver Integrates the Battery Charger**
 - The output goes straight into the battery
- **Key Benefits**
 - Reduced Solution size and cost as it removes the need for an extra component
 - Increased Efficiency because it removes the need for a Power Stage
- **When Can it be used?**
 - When Wireless Power is the only power source in a system. I.e, no extra DC/DC in



TI无线充电发射端解决方案选型指南

	bq500210	bq500212A	bq500412	bq500414Q	bq500215
Voltage In	19V	5V	12V	12V	12V
Standard	WPC 1.0	WPC1.1	WPC1.1	WPC1.1	WPC1.1
Transmitter Type	A1/A10 (1 Coil)	A5/A11 (1 Coil)	A6/A19 (1, 2 or 3 Coil)	A6	A29
Output Power	5W	5W	5W	5W	5-10W
Full/Half Bridge Drive	HB	FB	HB	HB	FB
Dynamic Power Level	No	Yes	Yes	No	No
Charging Area	18mm Diameter	18mm Diameter	70x20mm Diameter	~70x20mm Diameter	16mm Diameter*
WPC1.1	No (Contact Factory)	Yes	Yes	Yes	Yes (up to 5W)
Released to Market	Yes	Yes	Yes	Yes	Yes
Samples/ EVM	Yes	Yes	Yes	Now	Yes

bq500212A

Simplified BOM, 5V Transmitter for A5/A11

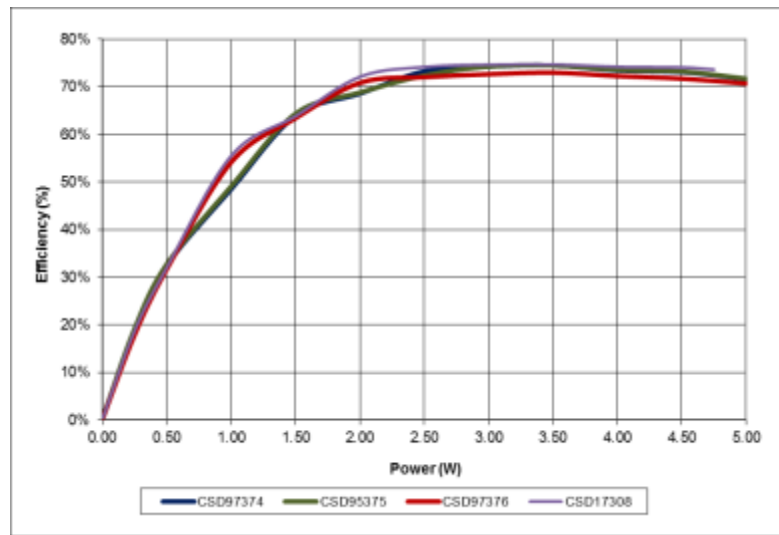
Features

- **Simplified BOM reduces** system cost in 5V A5/A11 WPC1.1 Transmitters. Only 5 IC's needed
- **Enhanced “Foreign Object Detection”** scheme simplifies Compliance to WPC1.1
- Patented **“Dynamic Power Limit™”** approach for robust operation from USB port/Low Power adapter
- **Simplified Standby Circuit** ensures compliance w/ CEC-100 Specification
- Supports **Hybrid Cap scheme** w/ X7R/COG Res Caps to reduce System Cost

Applications

- **USB TX for Smart Phones**
- **Smart Watches and Wearables**
- **Health Monitors**

System Efficiency



Standby Power	bq500212A
No Rx on Pad	<100mW
Rx on Pad (Charge Comp)	<50mW

bq500215

Proprietary 10W WPC 1.1 Compliant Transmitter

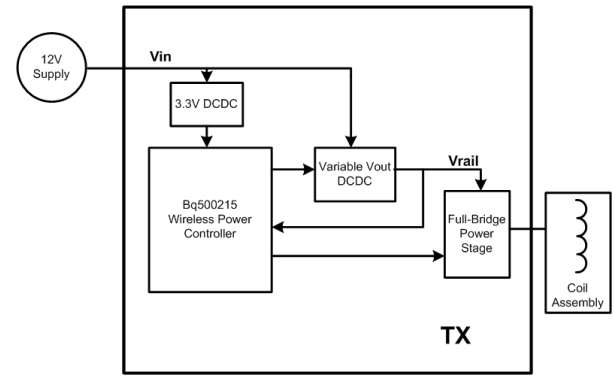
Features

- Enables 10W Output power when paired with bq51025 Receiver
 - Smallest, most efficient 10W design
- WPC 1.1 Compliant with all Industry Qi Receivers
 - Ability to differentiate system with faster charging while ensuring Qi compatibility
- 12V, Full Bridge Design
- Integrated Buck Controller removes need for separate DC/DC, to control Input voltage to Coil
- New FOD Ping Approach senses for Metal Object before power delivery
 - Meets WPC1.1 Specifications

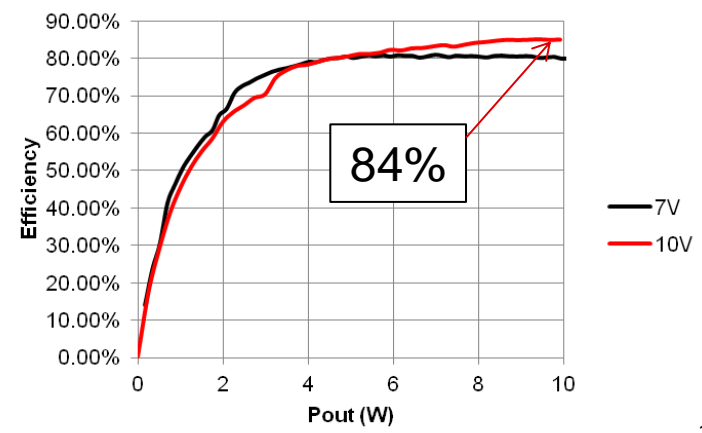
Applications

- TX Smart Phones
- Scanners/POS
- Cordless Instruments
- Health

Fixed Frequency Control

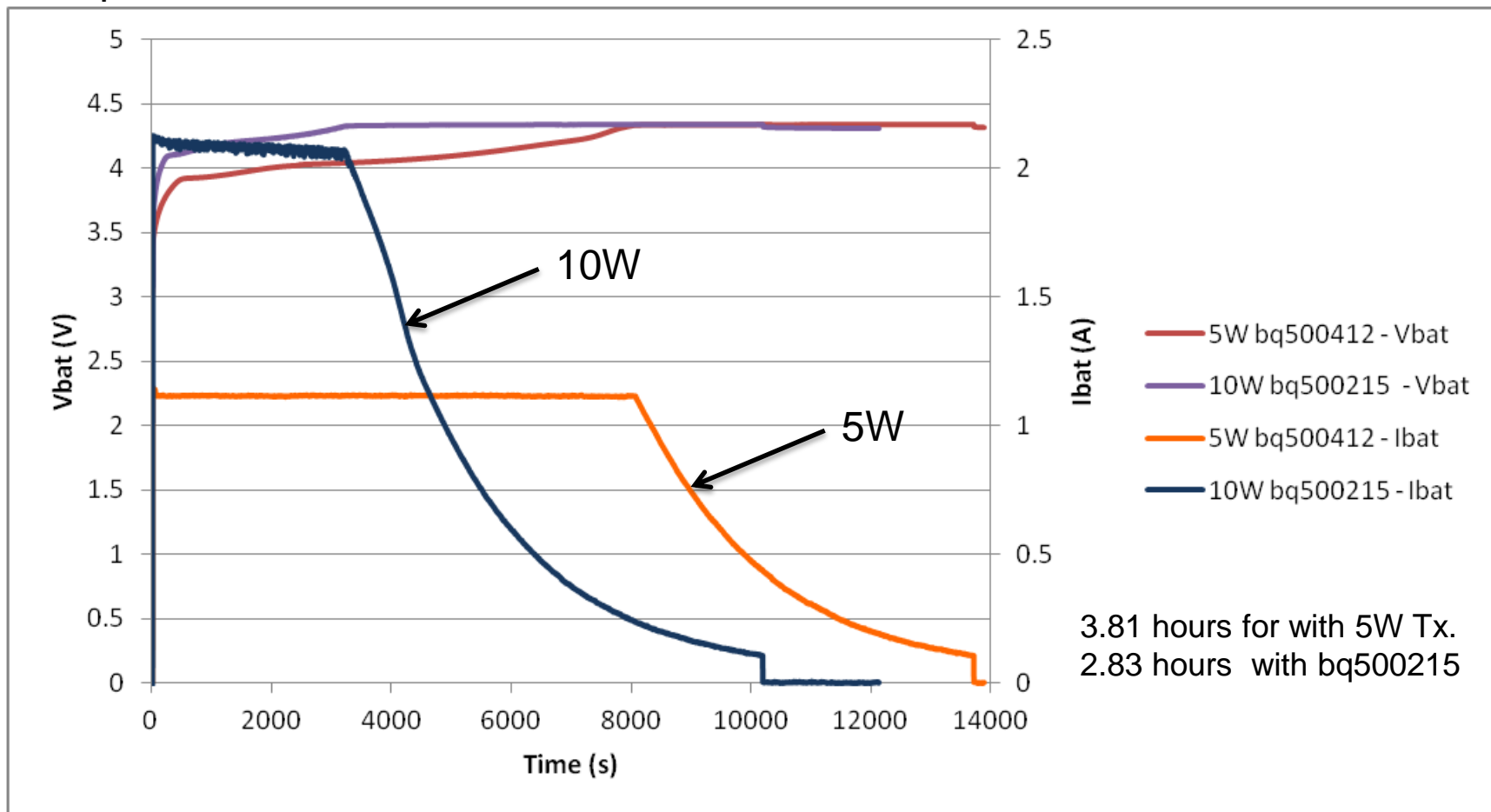


Efficiency



TI 10W无线充电+bq24261=缩短充电时间

Charge Cycles for 3100mAh battery using bq55021 with 5W Tx and bq500215 10W Tx



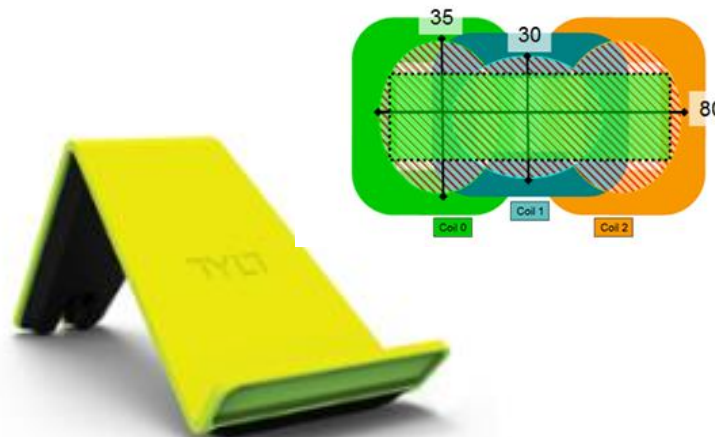
bq500412

Reduced BOM Solution for 1-3 Coil, 12V Transmitters

Features

- **Freepositioning Wireless Power Transmitter Solution**
- **Supports A6 and A19 Transmitter Types**
 - 12V Input Voltage, 1, 2 or 3 Coils
 - Drives one coil at a time for highest efficiency
- **No Holes in Charging Area**
 - Even in transition between coils
- **Simplified BOM**
 - 1 Drive Stage instead of 3, 30% less IC's
- **Enhanced “Foreign Object Detection”** scheme simplifies Compliance to WPC1.1
- Implements **“Dynamic Power Limit™”** approach for robust operation from USB port/Low Power adapter

Coil & Charging Area



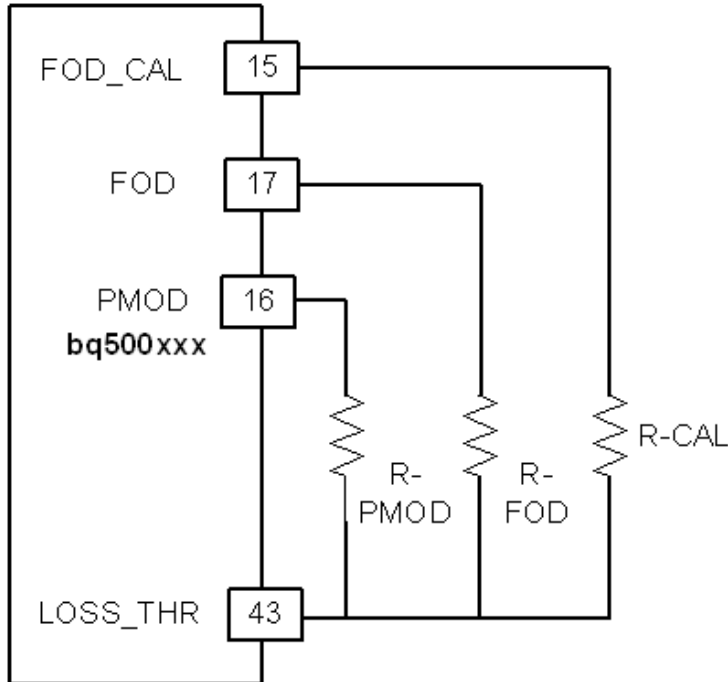
Applications

- **Transmitter w/ Improved user experience**
- **Aftermarket TX for Auto**
- **Infrastructure Applications**

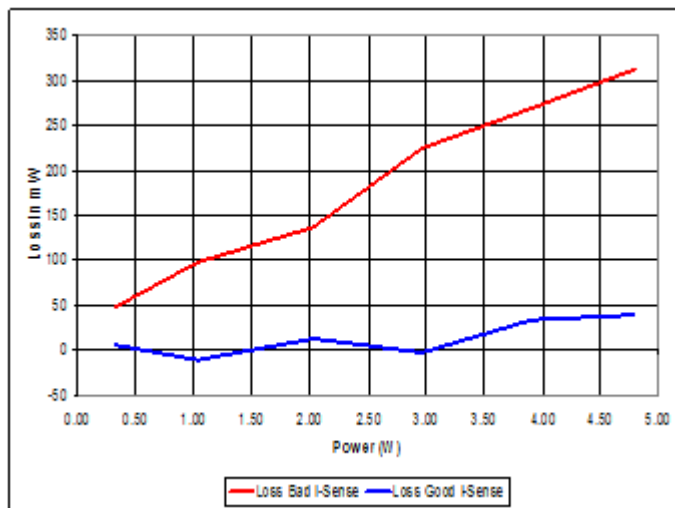
❖ 无线充电方案 设计要点



发送端 FOD Threshold setting



- ENABLE both FOD & PMOD feature w. **Independent threshold**
- THREE resistors are used to set three values:
 - R_FOD between pin17 and pin34 sets FOD
 - R_PMOD between Pin16 and pin34 sets FOD
 - R_CAL between pin15 and pin34 sets FOD_CAL.
- Omitting R_PMOD will disable the PMOD function.
- Omitting R_FOD will disable the FOD function.
- Omitting R_CAL will result in the default FOD_CAL setting which MAY not result in compliance FOD algorithm for a give system.
- Key advantages w. this configuration includes:
 - WPC 1.1 Compliance
 - Additional protection for WPC 1.0 RX
- When we enable PMOD, there is a potential concern for interoperability issues w. some certified WPC 1.0 RXs



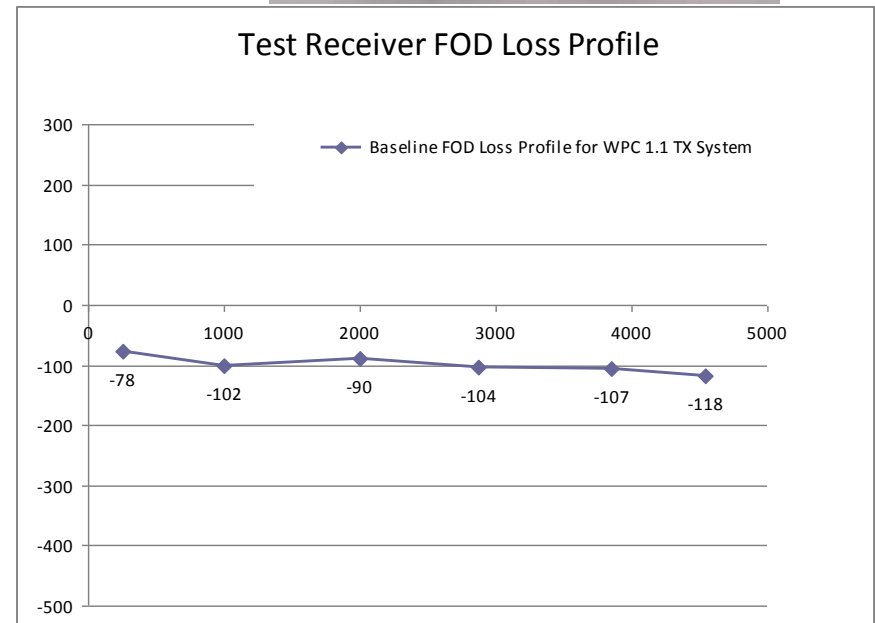
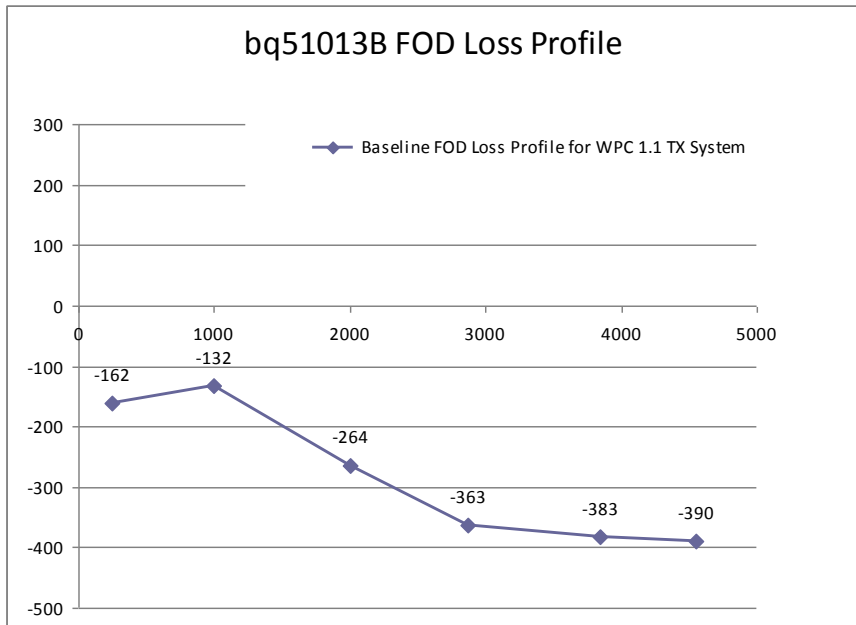
接收端FOD调试

Loss with RX vs Loss with FOD RX

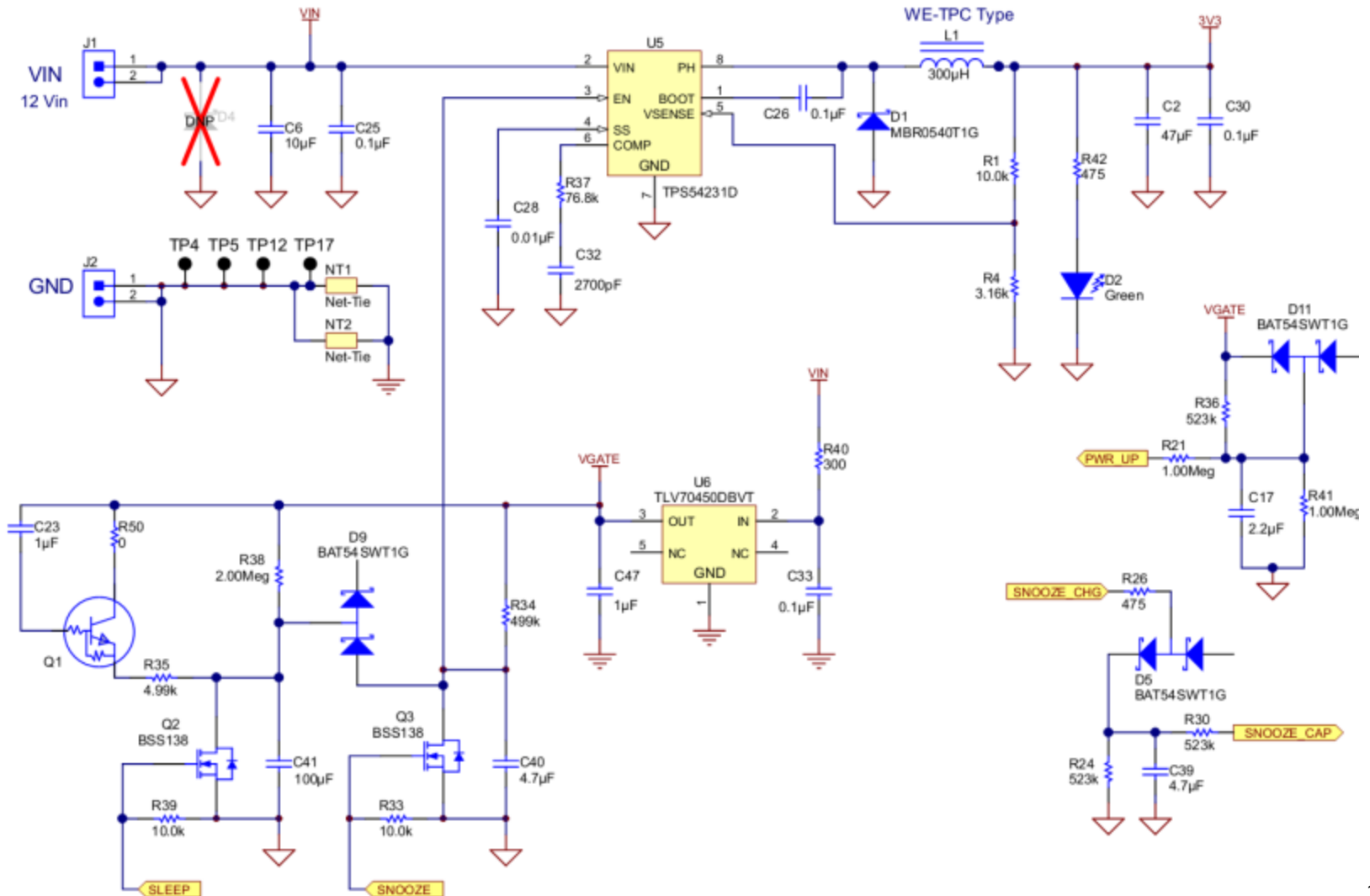
- Standard RX cannot be used for this measurement
- WPC 1.1 RX will have an offset programmed into loss



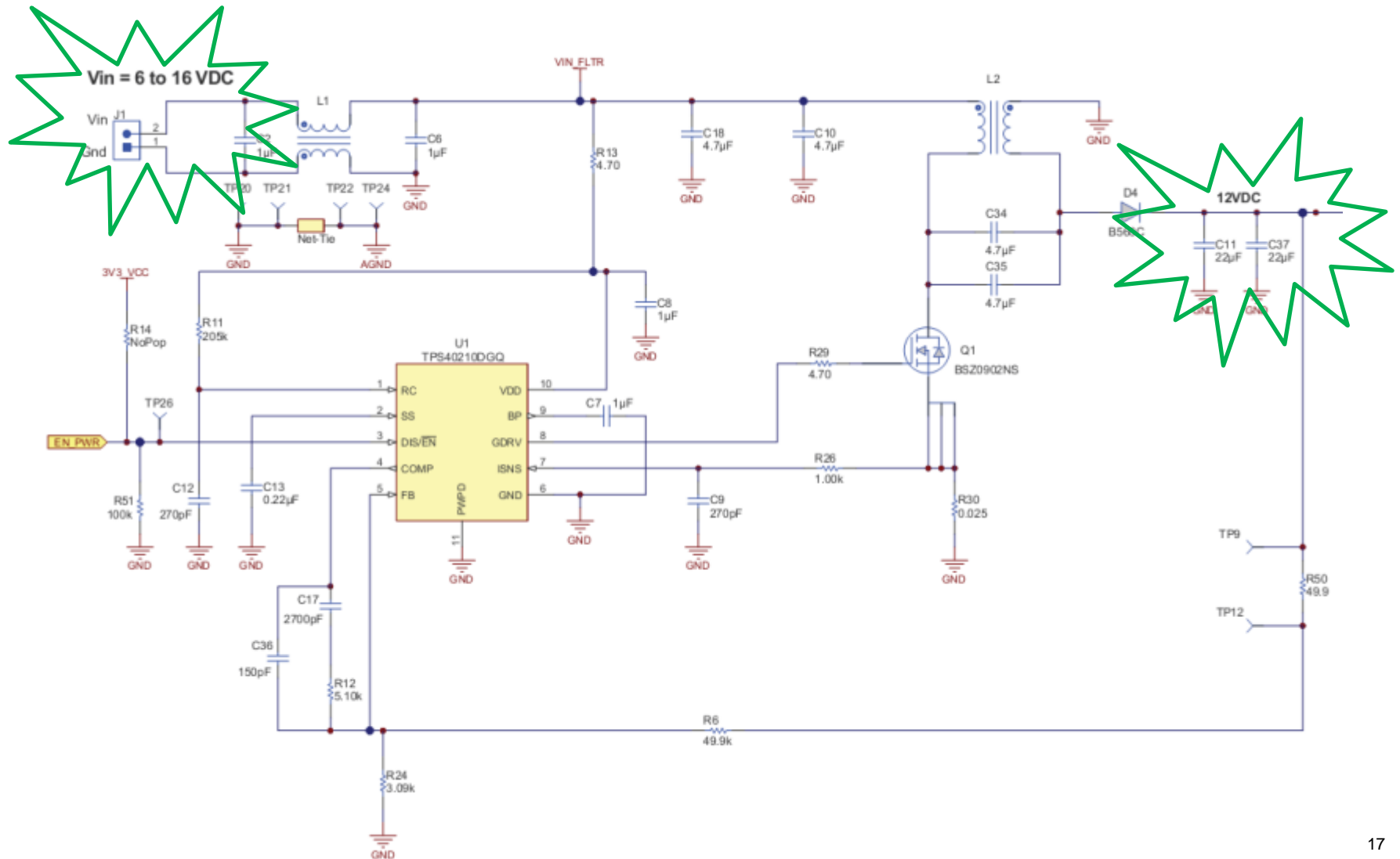
RX FOD Tuning Tool



Bq500215 Snooze&Sleep电路, 降低待机功耗



SEPIC 电路作为前级，适合宽范围电压输入应用



❖ 可穿戴产品简介:

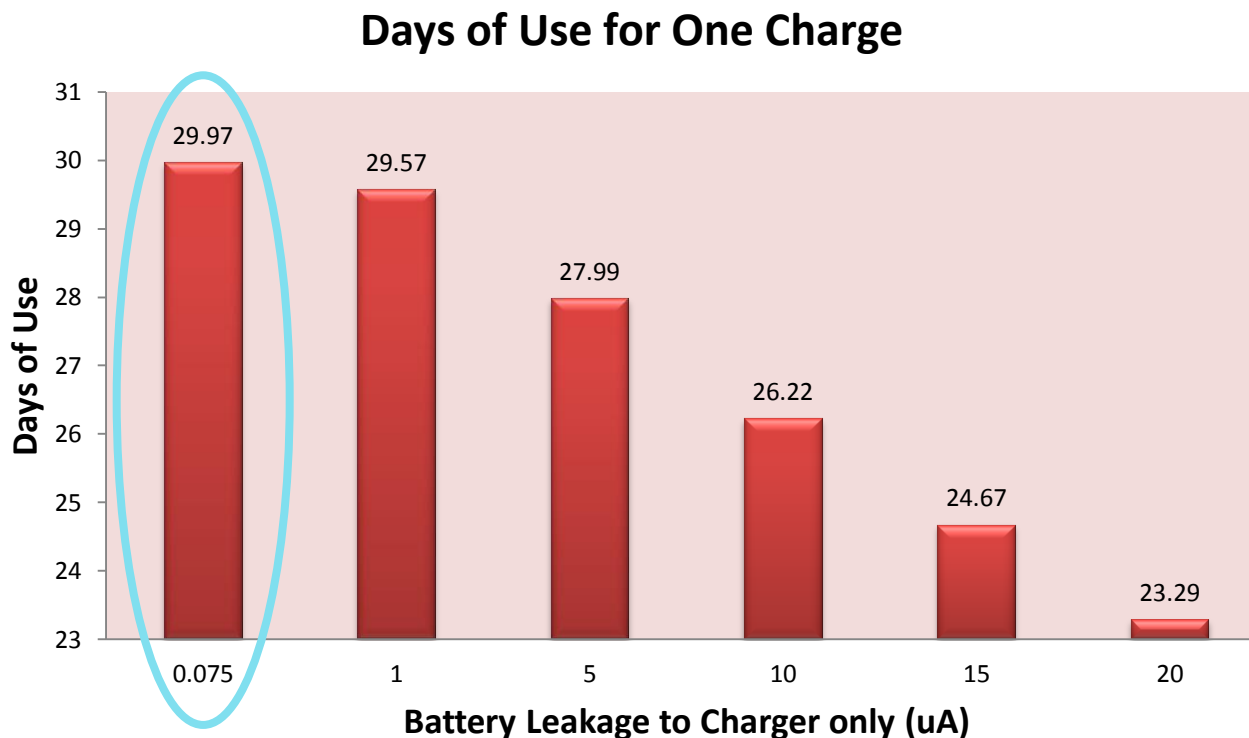
bq25100
bq25120



低电池漏电流

– 有效改善电池待机时间

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

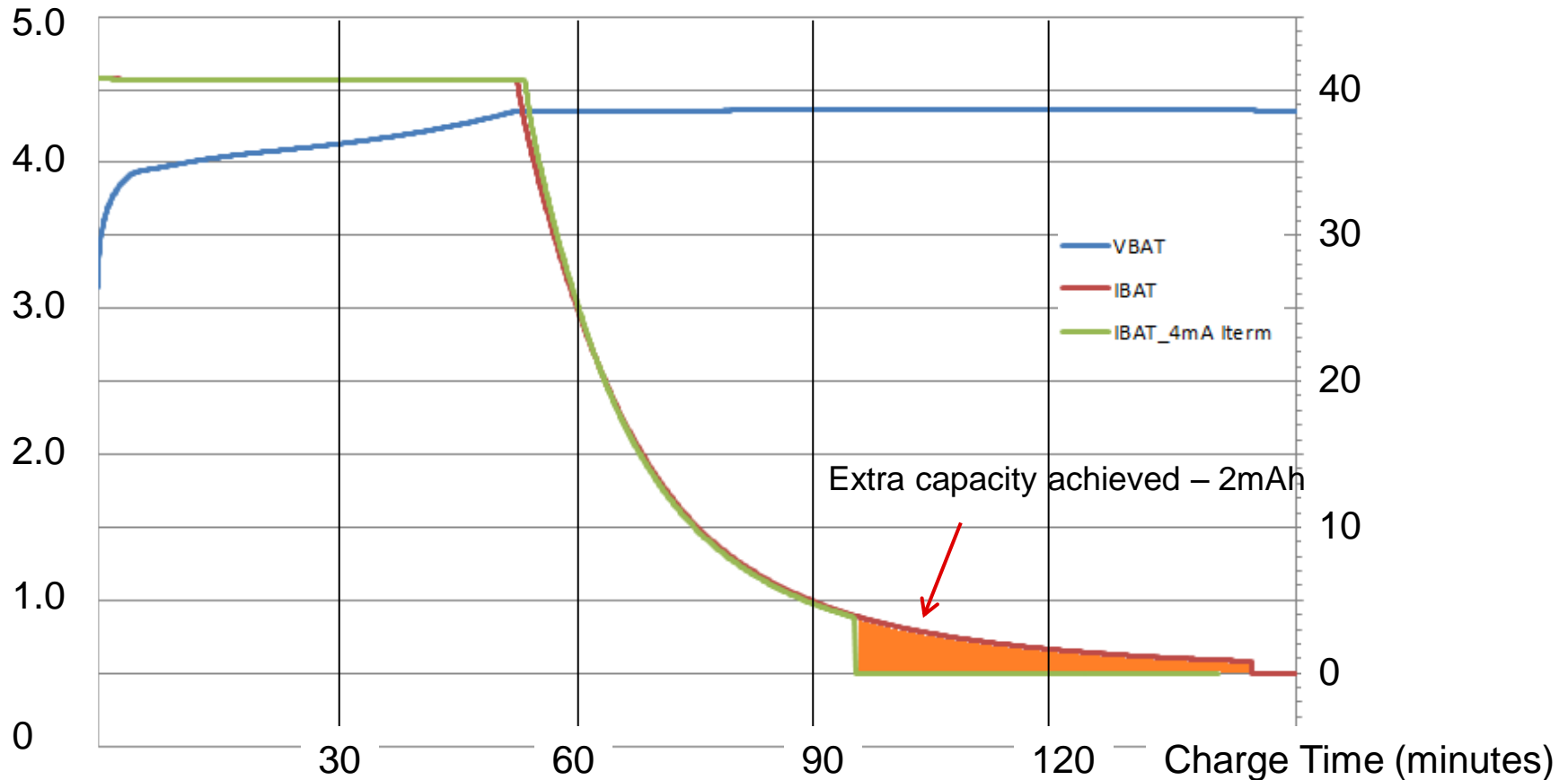


bq25100
75nA Leakage/Quiescent Current

Accurate Small Cell Charge Termination

V_{BATT} (Volts)

I_{BATT} (mA)



- Charged 41 mAh battery at 40 mA fast charge current (1C)
- Termination at 4 mA (10%) or 1 mA
- Shaded area represents additional 5 – 10% capacity restored on each charge

20

bq2510X

Ultra small 250mA Linear Charger in 0.9mm x 1.6mm WCSP, 75nA leakage, 1mA termination

Features

- Ultra small 0.9mm x 1.6mm WCSP
- Accurate charge current control down to 10mA
- Sub 1mA termination current control
- 75nA battery quiescent current
- 30V input voltage rating
- $\pm 0.5\%$ voltage regulation
- Programmable pre-charge/termination current (bq25100, bq25100A, bq25100H)

Applications

- Fitness Accessories
- Smart Watches
- Bluetooth Headsets
- Hearing Aids



Benefits

- Ideal for space limited applications
- Small battery leakage and accurate termination control maximizes battery run time
- Maximize effective battery capacity
- Allows for extending battery life
- Robust against unstable input signals
- Flexible with different pre-charger/termination needs

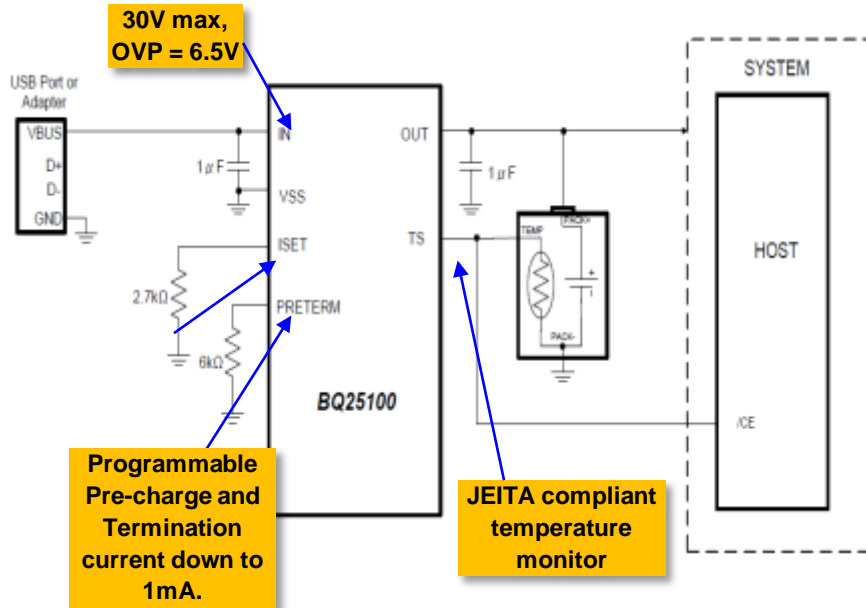
Smallest size & Maximized battery life!!!

bq2510x Family

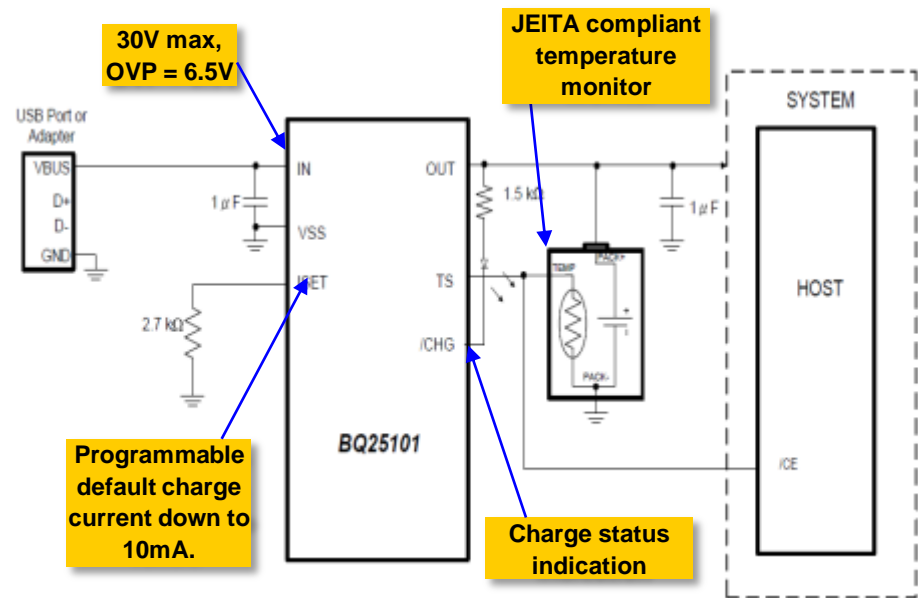
Part Number	Preterm or /CHG	Battery Voltage
bq25100	Preterm	4.2V
bq25100A	Preterm	4.3V
bq25100H	Preterm	4.35V
bq25100L*	Preterm	4.06V
bq25101	/CHG	4.2V
bq25101H*	/CHG	4.35V

bq2510X 应用框图

bq25100/100H/100L



bq25101/101H



高集成度和低静态电流 (Iq) 电池管理解决方案

- 满足可穿戴设备和物联网 (IoT) 应用的对电池共同的要求
 - 更小的解决方案尺寸
 - 超低功耗
 - 高效率
- bq25120 简介
 - 业内尺寸最小、功耗最低的电池管理解决方案
 - 工作电压为 1.8V 时，静态电流仅为 700nA
 - 通过支持常开功能，从而延长了电池的使用寿命
- bq25120 应用
 - 可穿戴设备
 - 工业 IoT 应用



bq25120 的特性和优点

- **700nA 的最低静态电流 (I_q)**
 - 通过使用电源路径技术以及一个低I_q降压转换器， bq25120可以在1.8V的工作电压下保持常开状态。
 - 50nA 的待机模式静态电流
- **高集成度和灵活性**
 - bq25120 包含一个集成电池电压监视器，从而实现了充电指示器、降压转换和按钮控制功能
 - 能够设置电池充电器电压、电流、终止阈值、输入电流限值、负载开关控制、灵活定时器和复位选项等参数
- **最小的电池管理解决方案**
 - 2.5mm x 2.5mm晶圆芯片封装 (WCSP)
 - 可以在大约 24mm² 的面积上进行小而紧凑型设计
- **稳健耐用充电**
 - 低至 500μA 的精确充电终止电流
 - 最大限度地增加了充电周期完成前传送到电池中的电能

将电路板面积减少一半



bq24232
Linear charger
with PowerPath
technology
3 mm × 3 mm



TPS62740
Low Iq
DC/DC switcher
2 mm × 3 mm



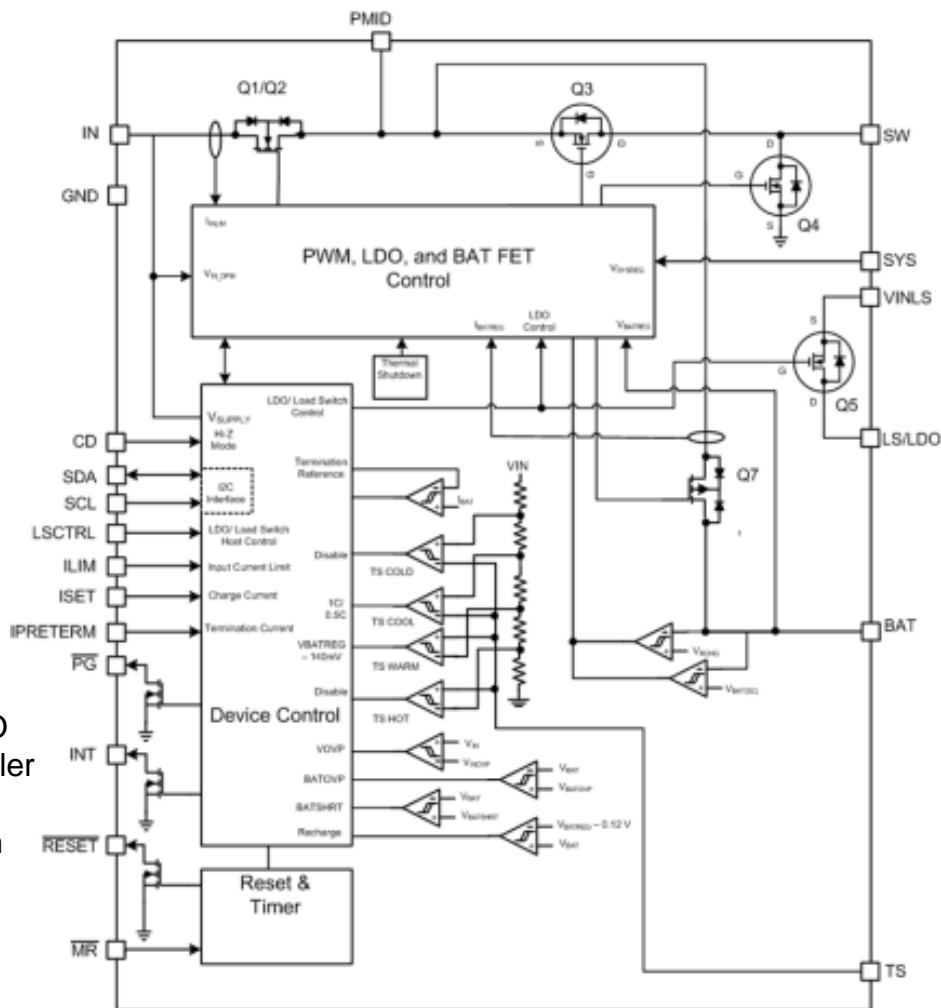
TPS3422
Push button
controller
1.45mm × 1.00mm



Battery
monitor



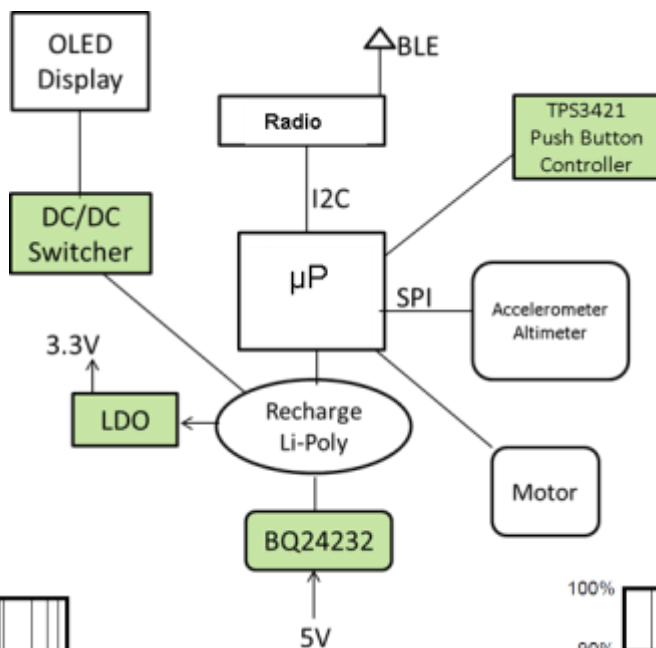
bq25120
Linear charger
DC/DC switcher
Load switch / LDO
Push-button controller
Battery monitor
2.5 mm × 2.5 mm



bq25120 – 解决方案尺寸和 Iq 比较

典型应用方框图

绿色项目包含在 bq25120 内



Iq 减少 2/3
尺寸减少 1/2

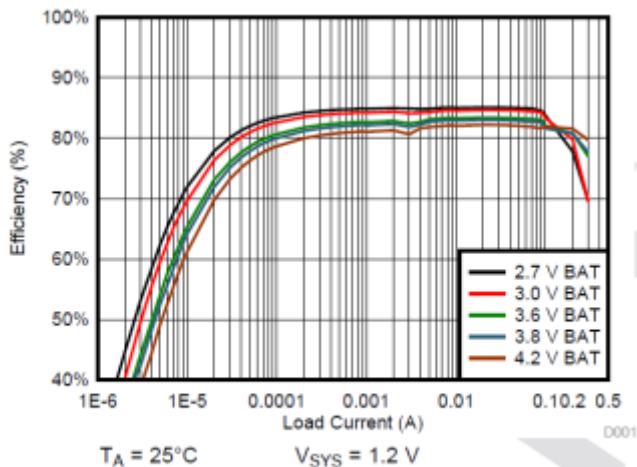


Figure 44. 1.2V_{SYS} System Efficiency

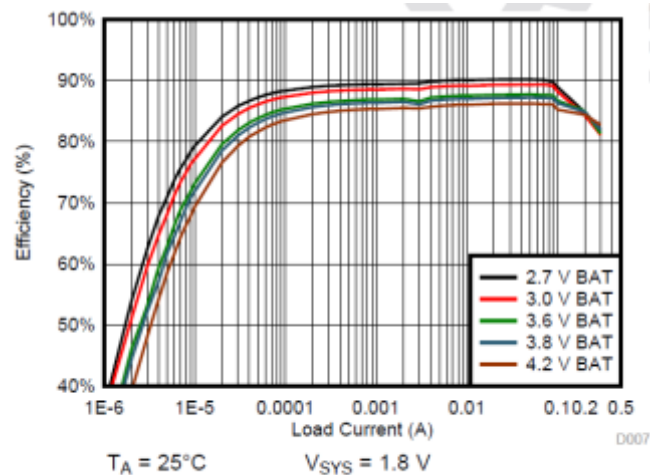


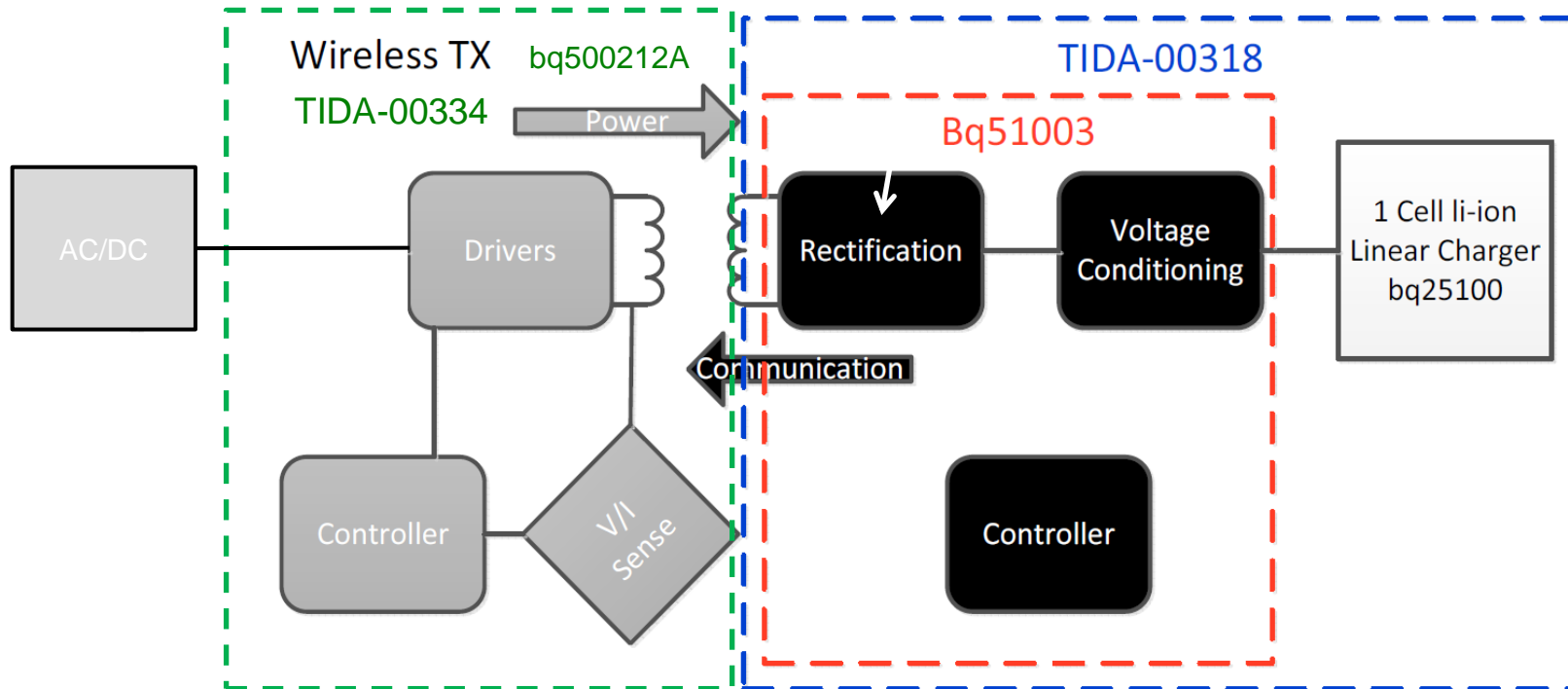
Figure 46. 1.8V_{SYS} System Efficiency

❖ 穿戴式应用解决方案及参考设计



Wireless Charging for Wearables

- Three “TI Designs” to demonstrate performance and simplify product development
- TI Receiver design: <http://www.ti.com/tool/TIDA-00318> (Qi cert w/ Charger)
- TI Receiver design: <http://www.ti.com/tool/TIDA-00329> (Smallest size, no Qi)
- TI Transmitter design: <http://www.ti.com/tool/TIDA-00334> (Small size, no Qi, 2.5W)
- TI Transmitter design: <http://www.ti.com/tool/TIDA-00415> (Smallest, 1W no Qi)



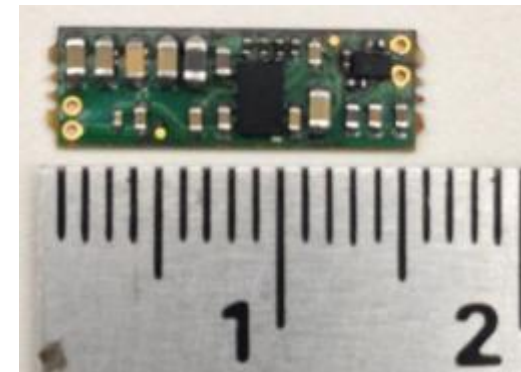
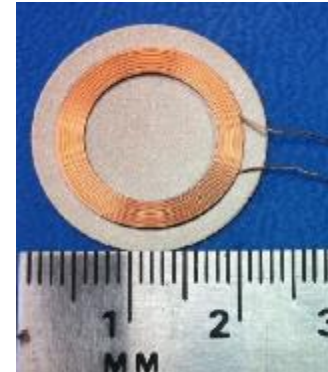
TIDA-00318

TI Design: Wireless Power Receiver w/ Charger for Wearable Applications

Features

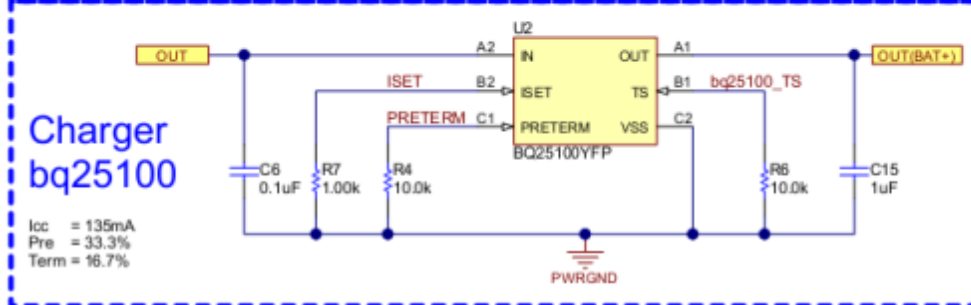
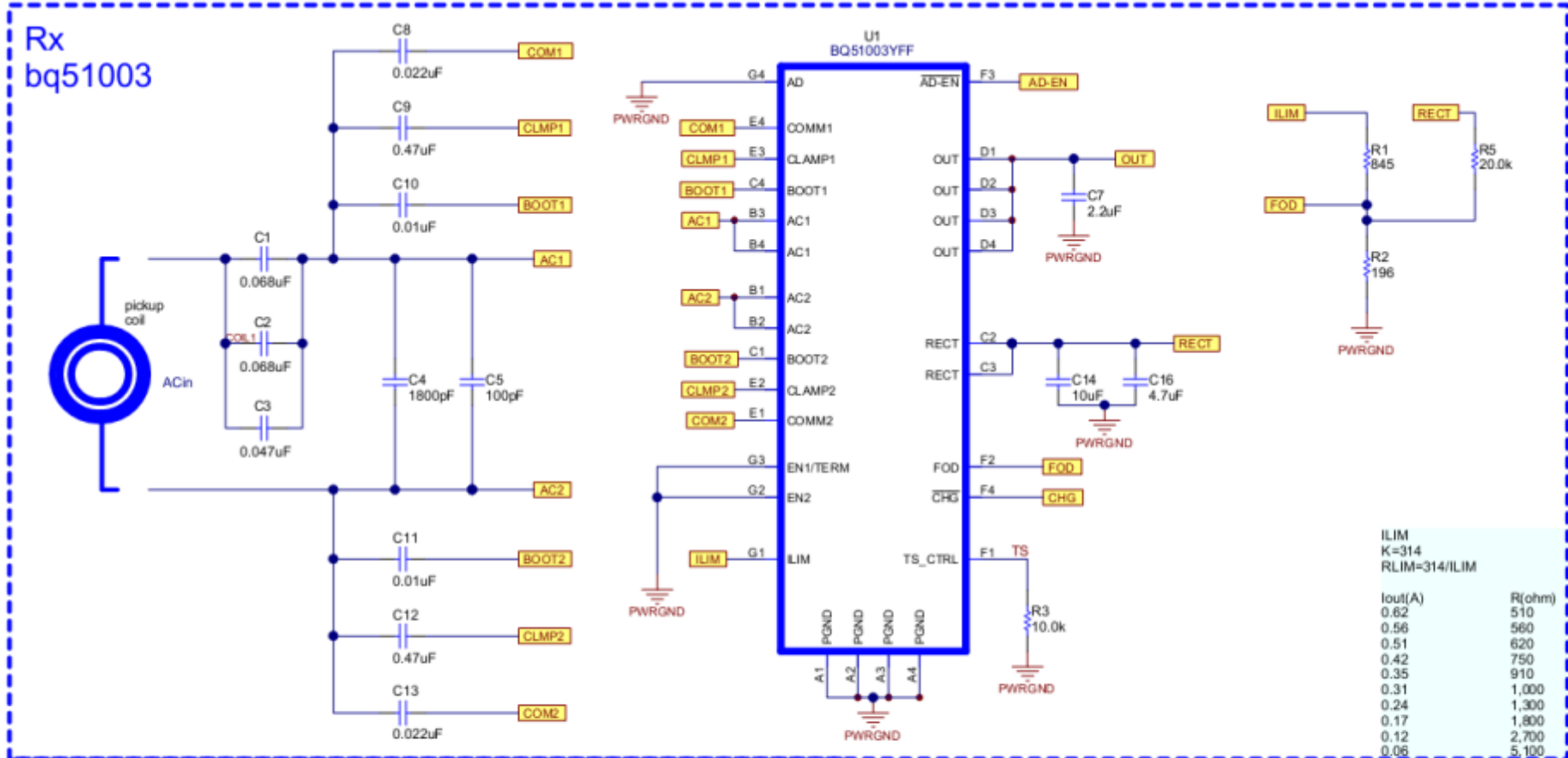
- Wireless Power receiver solution using bq51003 RX and bq25100 Charger
- Qi Compliant ensures operation on any WPC Transmitter
- Small Size: 5x15(mm²) Receiver
- bq25100 Chargers enables:
 - Adjustable charging current: 10~250(mA)
 - Supports 1mA Charge Termination Currents
 - <75nA battery leakage current
- Ideal to be used with bq500212A Transmitter
 - TIDA – 00334 (2.5W Design)
 - TIDA - 00415 (1W Design)

EVM and Coil Size



<http://www.ti.com/tool/TIDA-00318>

TIDA-00318 SCH



Pre-charge		Fast-charge		Termina
K=300		K=135		K=600
50(%)x300=15kohm		R=135/Current		50(%)x6
% of CC(%)	R(kohm)	Icc(A)	R(ohm)	% of CC
100	30	0.24	560	50
90	27	0.22	620	45
80	24	0.20	680	40
67	20	0.18	750	33
60	18	0.15	910	30
50	15	0.12	1100	25
40	12	0.10	1300	20
30	9.1	0.08	1800	15
21	6.2	0.05	2700	10
10	3	0.01	13000	5

TIDA-00329

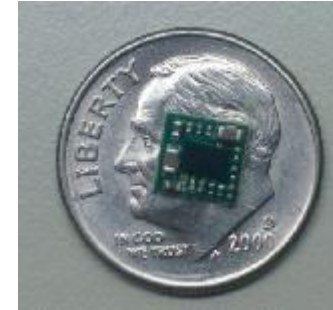
TI Design: Ultra Small Wireless Power Receiver for Wearable Applications

Features

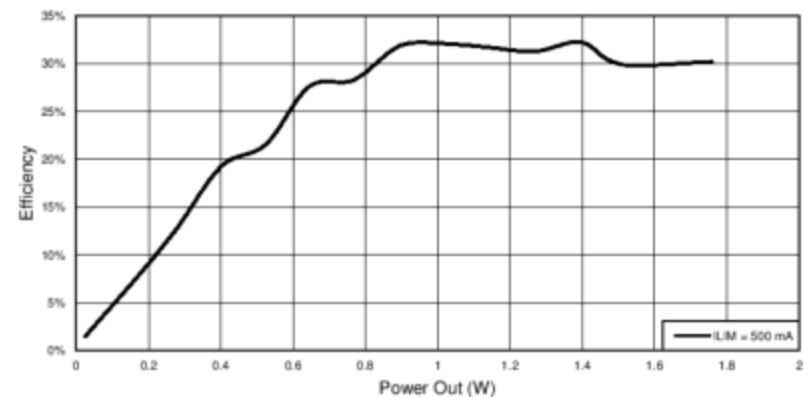
- **Wireless Power Receiver solution w/ smallest area for:**
 - **<29mm² Total Area**
- **Adjustable Output Current to 500mA allows efficiency to be optimized based upon application need**
- **Not Qi Compliant, enables smallest solution by removing Capacitors**
- **Same reference design can be used for two designs;**
 - bq51003 fixed 5Vout
 - bq51050/51B Direct Charger
- **Ideal to be used with bq500212A Transmitter**
 - TIDA – 00318 (2.5W Design)
 - TIDA - 00415 (1W Design)

<http://www.ti.com/tool/TIDA-00329>

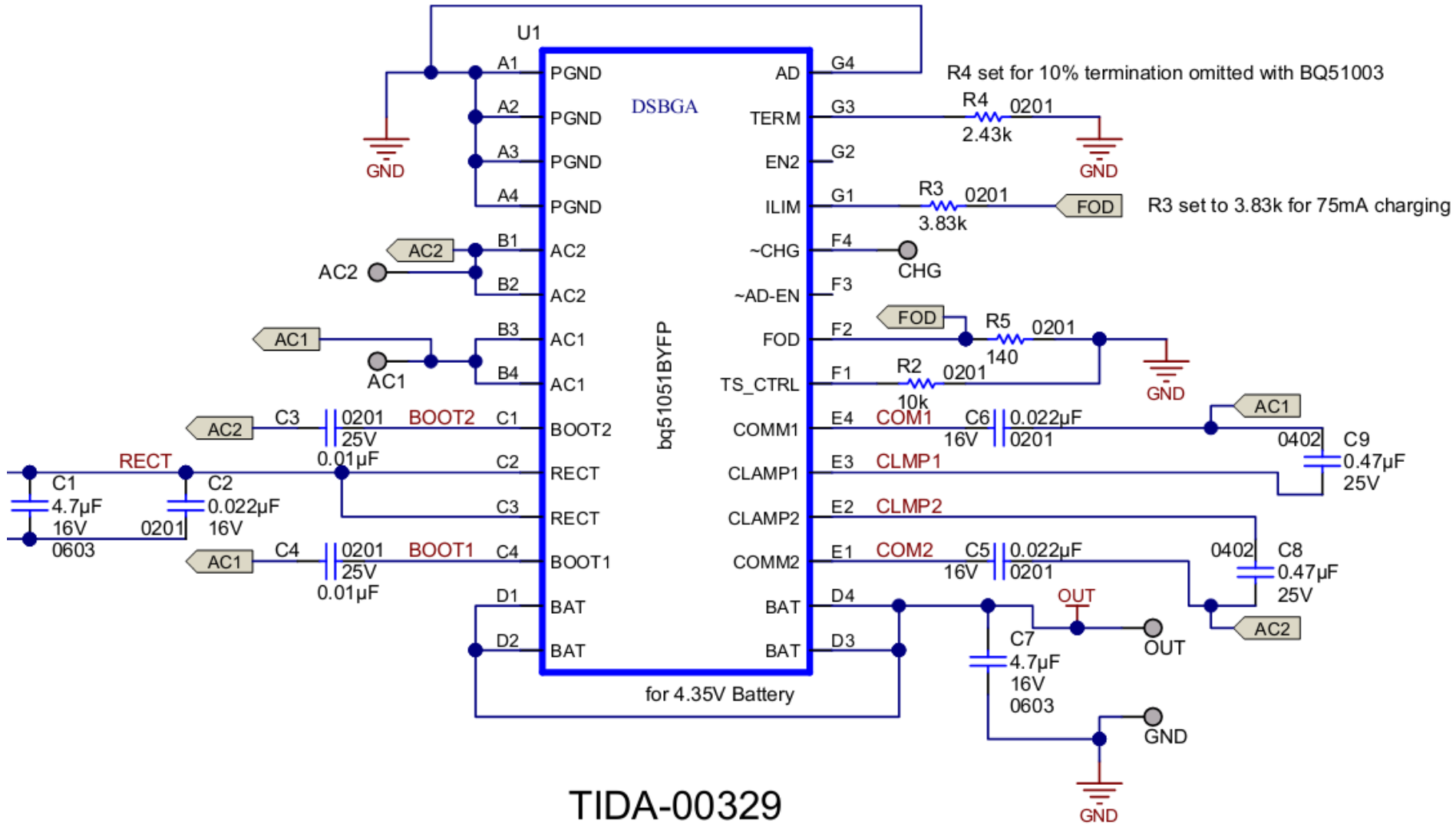
EVM Size



Efficiency w/



TIDA-00329 SCH



TIDA-00329

TIDA-00415

TI Design: Ultra Small Wireless Power Receiver for <1W Wearable Applications

Features

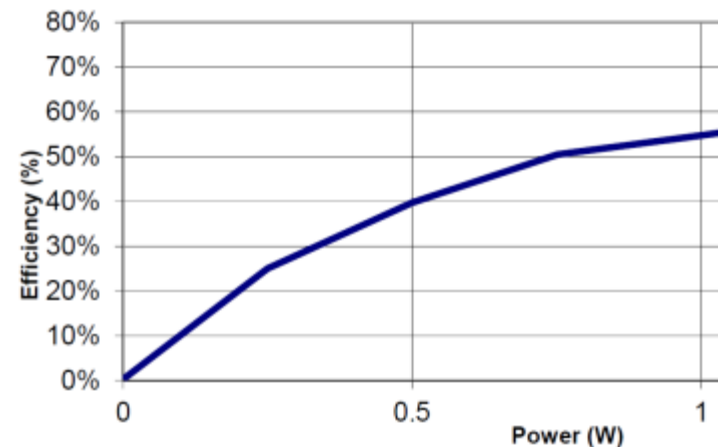
- **Small Transmitter solution for Wearable Systems**
 - <20mm Coil
 - Electronics fits inside Coil Area
- **Optimized for low power systems and 5V USB input**
 - <1W Received Power
- **Optimized System Design using bq500212A for reduced cost and board area**
 - Half Bridge Power Stage
 - No Current Sense Amplifier
- **Not Qi Compliant but can be designed to work with Qi Compliant receivers**
- **Ideal to be used with bq51003 Receiver**
 - TIDA – 00318 (Qi Receiver + Charger)
 - TIDA - 00329 (Non Qi Receiver)

<http://www.ti.com/tool/TIDA-00415>

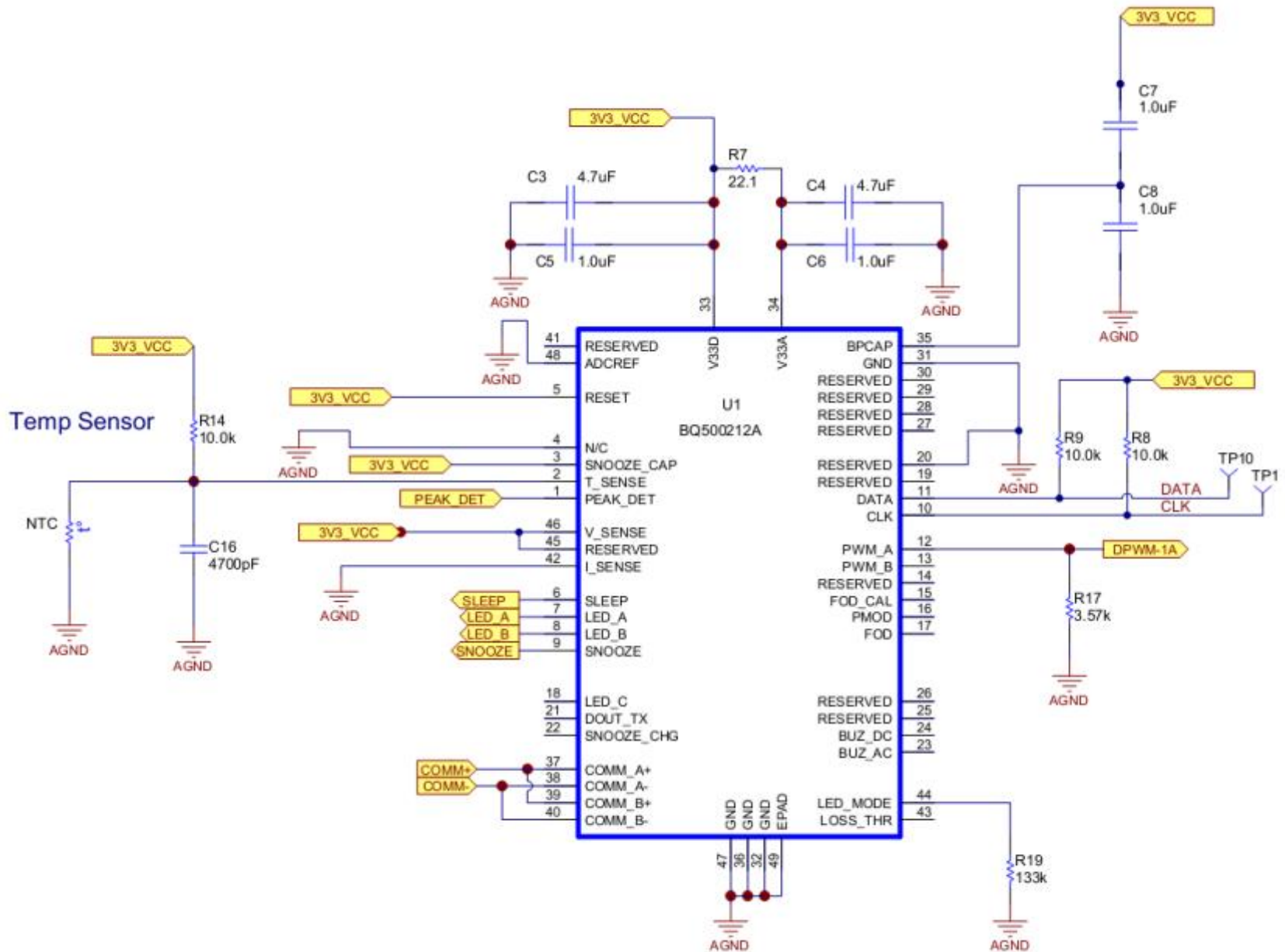
EVM Size



Efficiency w/ TIDA-00318



TIDA-00415 SCH



TIDA-00334

TI Design: Ultra Small Wireless Power Receiver for <2.5W Wearable Applications

Features

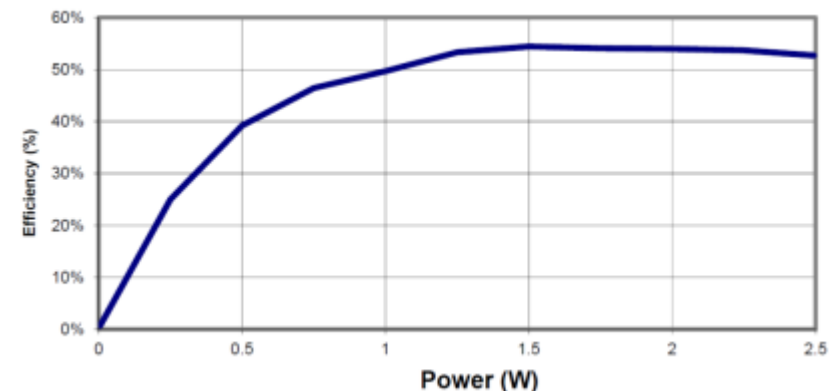
- **Small Transmitter solution for Wearable Systems**
 - <30mm Coil
 - Electronics fits inside Coil Area
- **Optimized for low power systems and 5V USB Input**
 - <2.5W Received Power
- **Optimized System Design using bq500212A for reduced cost and board area**
 - Full Bridge Power Stage
 - Current Sense Amplifier for FOD
- **Not Qi Compliant but can be designed to work with Qi Compliant receivers**
- **Ideal to be used with bq51003 Receiver**
 - TIDA – 00318 (Qi Receiver + Charger)
 - TIDA - 00329 (Non Qi Receiver)

<http://www.ti.com/tool/TIDA-00334>

EVM Size



Efficiency w/ TIDA-00318



TIDA-00243

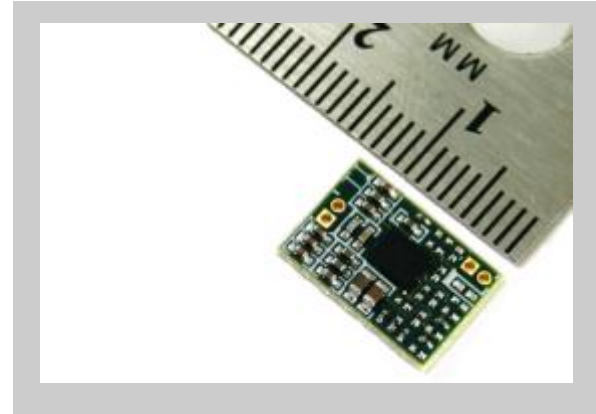
TI Design: Miniature Dual Mode (WPC/PMA) Receiver

Features

- **Wireless Power Receiver Compatible with WPC and PMA Standards**
- **Designed for 5V/1A Output**
- **Key Device Features:**
 - Adjustable Output to enable the Industries Highest Efficiency Receiver
 - Low R_{dson} FETs for minimal power dissipation
 - I2C Interface for System Design Flexibility (ie Adj V_{out}, FOD & Current limit)
 - Small Package Size: 3.6 x 2.9mm x 0.5mm CSP
- **Ideal to be used with bq500212A Transmitter**
 - **EVM: BQ500212AEVM-550**

<http://www.ti.com/tool/TIDA-00243>

EVM Size





Thank You!